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RESEARCH ARTICLE

Estimation of Spinal Dysfunction in Construction Site Labourers

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Abstract

Purpose: The study aimed to assess the extent of spinal dysfunction experienced by construction site workers, considering factors such as experience, posture, discomfort, range of motion, and muscle strength. **Method:** This cross-sectional study selected 107 construction workers from various sites using a simple random sample approach, which was secured in writing. The study utilized various assessment tools, including the Double Leg Lowering Test, Nordic Musculoskeletal Pain Rating Scale, and Posture assessment, to evaluate the patient's pain levels using the SPSS version 23.0. **Findings:** The study found a significant correlation (P=0.0376) between worker type and postural abnormalities. Masons had 68.4% severe lumbar lordosis, 78.9% hyperextended knees, and 86.3% prominent thoracic kyphosis. There was significant correlation (P 0.0001) between the workers' experience and results of the double leg lowering test. Furthermore, there was a significant difference (P= 0.0017) between the Visual Analogue Pain Rating Scale and work experience. As laborers become more experienced, their abdominal muscles may weaken, causing significant tension on their spines. **Conclusion:** The study concluded that construction site workers with 10+ years of experience, undergo significant spinal dysfunction due to decreased abdominal muscle strength, resulting in increased strain on their spines.

Keywords
Spinal Posture, Lumbar Core Strength, Lumbar Derangement, Lumbar Radiculopathy

INTRODUCTION

Construction is an important industry that employs an enormous number of people. Due to recent advancements and the onset of industrialization, this business is essential to the construction of roads, bridges, buildings, and other infrastructure (Tiwary & Gangopadhyay et al., 2011). India's construction industry is flourishing, which has resulted in a significant increase in the labour force. With a 10% yearly growth rate in India, it is one of the fastest expanding industries. It involves a broad range of jobs with an extensive workforce, the majority of whom are unstructured or unorganized labourers. In India, around 340 million (72%) workers are employed in the unorganized sector, with roughly half of them employed in the construction companies (Bowles & MacPhail, 2008; Mishra et al., 2012; Rajasekhar et al., 2009; Mutatkar et al., 2013). Construction work in India is divided into two categories: organized and unorganized. Majority of construction workers work in unorganized areas. Working practices in unorganized industries are considerably more rudimentary and traditional than in organized sectors. Labourers in unorganized areas are often hired on a daily wage basis by labour contractors. Before being hired, the labourers receive no training and are unaware of the ergonomic risks associated with their job (Haslam et al., 2005; Ponnuswamy et al., 2003). Among the most numerous and susceptible groups of unorganized labour in India are labourers who work in building construction. These workers are constantly under a lot of pressure to complete the eight hours of work a day on average. They may be forced to work overtime even

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after eight hours of intense labour due to unforeseen circumstances (Sahu & Subhashis et al., 2010).

Majority of contractors refuse to take responsibility for worker injuries and other occupational health risks, and they do not pay for worker health complaints. Manual material handling is the most affordable and straightforward solution because labour costs are low in India. Lifting, loading, carrying, pushing, tugging, unloading, and delivering are all necessary for these manual material handling jobs. The physical demands of construction work are matched with ergonomic hazards due to the manual material handling and various equipment operating tasks. Indeed, heavy lifting, repetitive joint motions, forceful exertions, and awkward postures are just a few of the ergonomic risk factors that construction workers frequently encounter. As a result, many ergonomic health issues and injuries affect construction workers. The most prevalent forms of ergonomic health issues at work among construction workers are sprains and strains in various body parts, which can occasionally prevent them from working (Sahu and Subhashis et al., 2010). Risks associated with construction are eight times higher than those associated with the manufacturing sector (Telaprolu et al., 2013).

Approximately 33% of newly identified workplace injuries in the general population and 77% in the construction industry are related to musculoskeletal disorders (MSDs), which are the single largest cause of work-related illness worldwide. In addition to reducing productivity at work, musculoskeletal disorders are the main cause of disability, missed work days due to illness, and sick leave. Through both direct and indirect mechanisms, musculoskeletal disorders affect every aspect of health. The effects on the physical dimension of health, such as bodily injuries, missed workdays, and delayed healing because the injuries are repetitive, influence other dimensions of health as well, such as mental health and consequently the social and emotional dimensions. The socioeconomic status is indirectly impacted by lost wages, absenteeism from work due to illness, medical expenses, and in some cases, hospitalization of employees. Poor working conditions, inadequate training, bad posture, long workdays with little time for breaks, psychosocial factors like support from coworkers and supervisors, and other elements like job pace and monotony are some of the etiological factors contributing to the occurrence of this condition (Punnett et al. 2004). Many musculoskeletal pains and disorders can be brought on by the physical demands of construction workers' manual material handling and awkward, prolonged working postures (Telaprolu et al., 2013). On the other hand, prolonged pain perception may indicate work related musculoskeletal disorders (WRMSDs) (Silverstein et al., 2002). Injury and disease of the soft tissues, including muscles, tendons, ligaments, joints, and cartilage, that affect almost all tissues, including the nerves and tendons in the neck, shoulders, backs, arms, and legs, is known as a WRMSDs (Kusmasariand Sutalaksana et al., 2018) .Apart from the high number of deaths attributable to the nature of the work, WRMSDs are prevalent health issues among construction workers (Jinadu et al., 1987). Chronic disorders that can worsen over time comprise the majority of WRMSDs. These may also be the consequence of injuries received in an accident at work, and they may be of either episodic or chronic duration. They can also develop into more serious disorders over time, moving from mild ones. While many adult people worldwide suffer from these disorders, which are rarely fatal, they nevertheless significantly lower their quality of life (Roy et al., 2022).

WRMSDs that arise from the nature of construction work have a greater negative impact on workers' quality of life, lead to missed work or absenteeism, increase work restrictions, or result in disability than any other group of diseases, and have a significant financial cost to both individuals and society.Majority of the unskilled labour performed by women in the construction sector includes carrying and lifting large objects, scaling ladders, and other similar tasks. Women mazdoors who perform these jobs are highly susceptible to both acute and cumulative WRMSDs (Telaprolu et al., 2013). One of the biggest work-related health issues and a major contributing factor to construction workers' reduced productivity is WMSD (Sahu & Subhashiset al., 2010) .The three main risk factors linked to WRMSDs are high force levels, awkward postures, and repetitive movements (Silverstein et al., 2002). Workers in the construction industry are more likely to experience WMSDs in their upper and lower extremities as well as their back (van der Molen et al., 2004). The occupation with the highest risk of back pain at work is construction (Latza et al., 2002). In developed countries, lower back pain (LBP) is among the most common and widespread

musculoskeletal disorders that lead to disability and absenteeism from work. LBP is regarded as one of the main causes of disability, financial burden, loss of quality of life, incapacity to work, and absenteeism from work (Bc et al., 2019; Harrianto et al., 2009; Jain et al., 2024; Vujcic et al., 2018). Around 60% to 90% of people will experience low back pain at some point in their lives. Numerous factors that contribute to lower back pain (LBP) are linked to employment. Approximately 37% of LBP worldwide is related to employment (Punnett et al., 2005). There are now three distinct categories of possible risk factors: (a) personal characteristics like height, age, weight, and smoking (b) physical elements like intense lifting, quick work rates, repetitive motion patterns, inadequate rest periods, contorted body positions, uncomfortable and whole-body vibration, contact stress, and extremely high or low temperatures (c) Psychosocial elements, including organizational stress, dissatisfaction with job, and psychological requirements and mental workloads (Holmström et al., 1992; Latza et al., 2000).

Construction work requires workers to adopt a variety of awkward, extreme, and repeated postures including bending, twisting, and sometimes even back extension. Performing these posture by strenuous work for an extended period of time can result in low back MSDs (Buchholz et al., 1996). Risk raises if such work involves the twisting of the trunk (Hakkanen et al., 1997). Many researchers have noted the close relationship between working postures and incidences of musculoskeletal symptoms, despite the fact that assessing spinal dysfunction in construction workers has received little attention (Armstronget et al., 1986; Armstronget et al., 1993; Corlettand Bishop et al., 1976; Sahu et al., 2010). As a result, the purpose of this study was to fill a critical knowledge gap concerning the importance of assessing the level of spinal dysfunction among construction labourers. The hypothesis of the study was to estimate spinal dysfunction in construction labourers.

MATERIALS AND METHODS

This cross-sectional study was conducted at Karad with consent from the institutional ethical committee. A total of 107 male and female construction workers, ages 25 to 45, from various construction sites in Maharashtra. They were chosen a simple random sampling approach. Computer generated SPSS software was used. Participants with a normal body mass index (BMI), or 18.5-24.9, as well as men and women who had worked as laborers on construction sites for more than ten years and 5 hours daily were included in the study. Pregnant women, those with underlying co-morbidities, and those with pre-existing spinal abnormalities were not allowed to participate. Our primary goal was to assess the degree of spinal dysfunction experienced by construction site workers and to put a number on it by taking in account several characteristics such as years of experience, posture, discomfort, range of motion, and muscle strength.

Procedure

Ethical approval (KIMSDU/IEC/01/2021) was obtained from the Institutional Ethical Committee of KIMSDU. People were contacted, and those who met the requirements for inclusion were chosen. Those who wished to participate were given written and verbal informed consent after the protocol was described. Data regarding the subjects' demographics was obtained. They were explained the study's objectives and given information on how it would be conducted. A spinal dysfunction examination was performed on each of them using the Nordic Musculoskeletal Pain Rating Scale, the Posture examination, the Double Leg Lowering Test, and the Nordic Musculoskeletal Discomfort Scale. Data was collected.

Outcome measures

Double leg lowering test.

One way to think of core stability is as the result of the lumbopelvic hip complex's muscular capability and motor control. There are numerous tests available to assess and measure trunk muscular strength. The intra-tester reliability of the double-leg-lowering (DLL) test is excellent, with values ranging from 0.93 to 0.98 (Martin et al., 1996; Rathod et al., 2021).

Range of motion of cervical, thoracic, and lumbar spine

Physical therapists employ goniometric measurements to determine appropriate treatment approaches, assess baseline restrictions of motion, and record the efficacy of these interventions. Goniometry, arguably our most popular assessment method, is an essential component of the "basic science" of physical therapy (Sahu and Subhashis et al., 2010).

Posture assessment

The two-dimensional evaluation of posture, using a plumb line, is very common, due to its low cost and simplicity. Abrams et al. (2006), postulated guidelines to evaluate posture in accordance with the alignment of ideal plumb line for the measurement of the sagittal and frontal plane.
Following positions carry a significant lifetime risk of developing spinal problems.

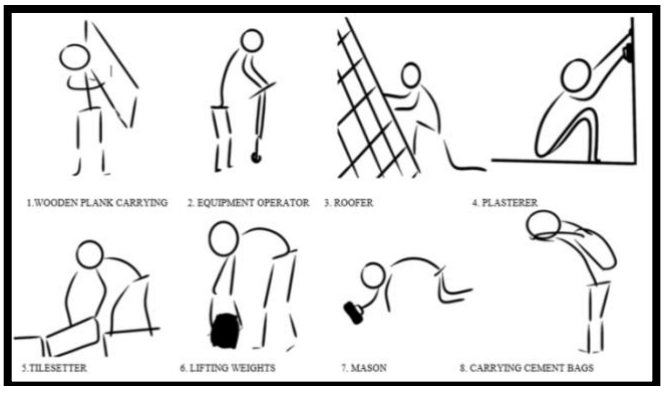

Figure 1. Postures assumed by labourers

Diagram 1 in figure 1 shows the position of a laborer holding a wooden plank. The shoulder that is being used is under a lot of loads. Additionally, there is a tendency for the spine to curve laterally, which increases the risk of scoliosis. An equipment operator is seen in Diagram 2; while he operates equipment, he slumps forward, which causes spinal dysfunction. Roofers are represented in Diagram 3. The task of a roofer entails a lot of bending, shoulder extension, and lunging. The plasterer's stance is depicted in the fourth diagram. Prolonged periods of squatting required for this job could cause low back pain. Diagram 5 shows the postural alignment of a tile setter, whose job also requires a lot of bending, which puts stress on the spine. Diagram 6 illustrates the unusual stance.

Manual muscle testing of upper limb, lower limb, and spine.

The most popular technique for recording muscle power impairments is MMT. It is the approach most frequently employed to record muscle strength impairments. When applying force against the subject's resistance, the examiner rates the subject's researched muscle groups as "strong" or "weak" on a five-point rating scale (Cuthbert et al., 2007; Shinde & Ghadage, 2022).

Visual analogue scale for pain assessment.

One of the main methods used to identify spinal dysfunction in workers is the assessment of pain intensity. Number of scales are frequently used to measure the degree of pain. In clinical practice, the NRS, VAS, and VRS are frequently employed among them. The validity and reliability of these pain-rating measures for determining pain severity have been demonstrated (Alghadir and Ahmad et al., 2018; Kulkarni & Shinde, 2020).

Nordic musculoskeletal discomfort scale.

In nine body locations, the Nordic Musculoskeletal Questionnaire (NMQ) measures musculoskeletal discomfort and activity avoidance. The NMQ consists of only three questions on the prevalence of symptoms over a year and a week, as well as an annual prevention from normal work (whether done at home or away from home) (Dawson & Anna et al., 2009).

Statistical analysis:

The outcome measures were assessed at the start of the study. The study was manually and statistically analyzed (SPSS version 23.0). When statistically analyzing the data collected, descriptive statistics such as mean, percentage, and standard deviation were utilized. ROM was used to evaluate spine mobility. MMT analyzed and calculated upper limb, lower limb, and spine strength. The double leg lowering test was used to evaluate core stability. Pain at rest and during activity was analyzed and calculated by mean and standard deviation, whereas demographic data were determined by percentage.

RESULTS

A survey consisting of 107 laborers who had worked on construction sites for over a decade was conducted. Its primary goal was to use a variety of outcome measures to quantify the spinal dysfunction among them. Our statistical investigation revealed a significant link (P=0.0376) between the type of workers and their postural anomalies, including lifters, equipment operators, Masons, roofers, and plasterers.

Table 1. The distribution of demographic characteristics in the sample

Parameter	Frequency	Percentage
Age group		
25-30	28	26.1%
31-35	20	18.6%
36-40	15	14.01%
41-45	44	41.1%
Gender		
Male	71	66.3%
Female	36	33.6%
Type of Worker		
Mason	22	20.5%
Roofer	11	10.2%
Plasterer	16	14.9%
Welder	14	13.08%
Tile Setter	5	4.6%
Equipment Operator	19	17.7%
Lifter	20	18.6%
Years of Workıng		
10-12	49	45.79%
13-15	8	7.47%
16-18	12	11.21%
19-21	27	25.23%
22-24	11	10.28%

Interpretation

Table 1 shows that 26.1% of the population was between the ages of 25 and 30, 18.6% between 31 and 35, 14.01% between 36 and 40, and 41.1% between 41 and 45. Most workers are younger than the 41–45 age range. It was also noted that men made up around 70% of the workforce, with women making up the remaining 30%. Masons made up the largest group of workers (20.5%), while tile setters made up the smallest (4.6%). 45.7% of workers had worked for ten to twelve years, 7.4% for 13 to 15 years, and 11.2% for 16 to 18 years of age. The remaining 10.28% had experience ranging from 22 to 24 years, while about 25.23% had experience spanning 19 to 21 years.

Table 2. Posture assessment

Type of worker	Cervical Spine (Exaggerated)	Shoulder (Forward)	Thoracic Spine (Exaggerated)	Lumbar Spine (Exaggerated)	Knees (Hyperextended)
Mason	15.7%	57.8%	86.3%	68.4%	78.9%
Roofer	72.7%	81%	72.7%	36.3%	72.7%
Plasterer	0%	50%	62.5%	37.5%	50%
Welder	0%	64.2%	64.2%	35.7%	7.14%
Tile setter	40%	60%	100%	80%	20%
Equipment op	15.7%	42.1%	68.4	52.6%	5.2%
Lifter	15%	75%	65%	25%	50%

Interpretation

According to table 2, 68.4% had extreme lumbar lordosis, 78.9% had hyperextended knees, and 86.3% of the masons displayed exaggerated thoracic kyphosis. In roofers, 72.7% of the cervical spine was exaggerated, 81.8% of the shoulders were hunched forward, 72.7% had an excessive thoracic kyphosis, and 72.7% had an exaggerated lumbar lordosis. 37.5% of plasterers had a lumbar lordosis that was excessive, and 62.5% of them had a thoracic kyphosis that was excessive. Only 7.14 percent of welders had excessive lumbar lordosis, while 64.2% had forward shoulders. 80% of tile setters have a pronounced lumbar lordosis. Only 5.2% of equipment operators had hyperextended knees, compared to 68.4% who had extreme

thoracic kyphosis and 52.6% who had exaggerated lumbar lordosis. Lifters' knees were hyperextended in 50% of cases, and their thoracic spines were accentuated in 65% of cases.

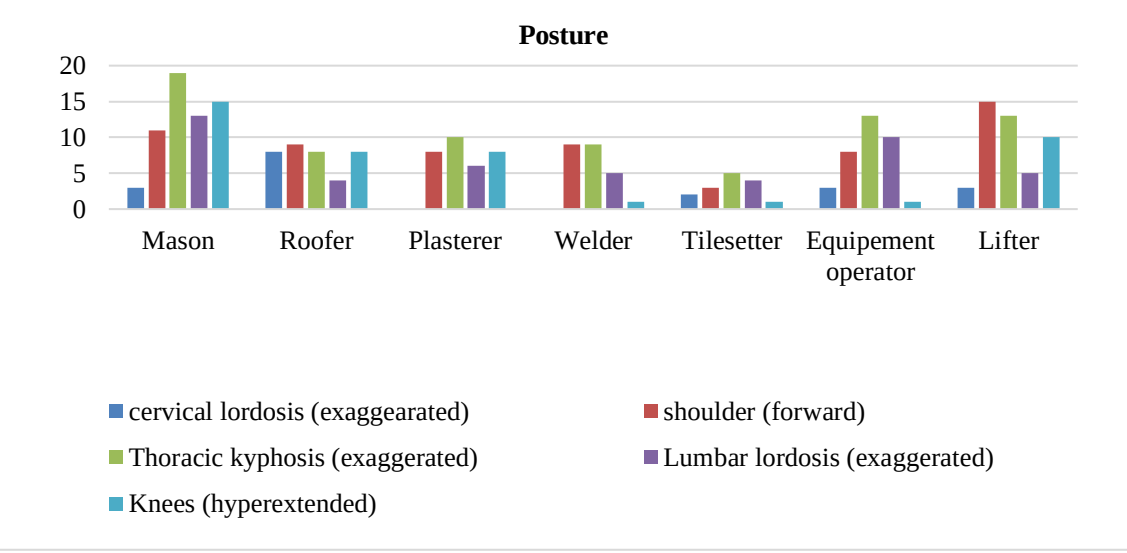

Figure 2. Postural abnormalities observed in workers.

Table 3. Double leg lowering test

Years of working	Normal	Good	Fair	Poor	Trace	P-Value
10-12	4%	38.9%	46.9%	10.2%	0%	0.0001
13-15	0%	0%	25%	75%	0%	
16-18	0%	0%	0%	83%	16.6%	
19-21	0%	0%	0%	92.5%	7.4%	
22-24	0%	0%	0%	72.7%	27.2%	

Interpretation

The double leg lowering test and the laborers' employment history were substantially correlated (P=0.0001) as shown in Table 3. The percentage of individuals with work experience of 10 to 12 years [49 (100%)] who performed the Double Leg Lowering Test as determined by the Manual Muscle Test Score (MMT) were found to have normal (4%), good (38.9%), fair (46.9%), bad (10.2%), and trace (0%) results. Among those with 13 to 15 years of work experience, 8 (100%) displayed fair (25%) and bad (75%) performance. Individuals with 16–18 years of job experience [12 (100%)] had poor (83.3%) and trace (16.6%). People with 19 to 21 years of work experience (n = 27; 100%) exhibited poor (92.5%) and trace (7.4%) behaviors. Individuals with 22 to 24 years of work experience [11(100%)] only demonstrated bad (72.7) and trace (27.2%) performance.

Table 4. Manal muscle testing (MMT) of spine

Type Of Worker	Cervical	Thoracic	Lumbar	P- Value
Mason	4.6±0.5	4±0.7	3.4±0.7	0.0120
Roofer	4.1±0.5	4.5±0.6	4±0.7	
Plasterer	4.1±0.5	4.6±0.6	3.7±0.7	
Welder	4.7±0.5	4±0.6	4±0.7	
Tile setter	4.8±0.5	3.2±0.7	4.2±0.7	
Equipment operator	4.7±0.5	3.8±0.7	3.9±0.7	
Lifter	4.20.5	4.6±0.6	3.8±0.7	

Interpretation

Table 4 displays the average results of manual muscle testing of the cervical, thoracic, and lumbar spine in relation to the different worker types. The difference between these two criteria is thought to be significant (P=0.0120). The median MMT values of thoracic spine of tile setters, equipment operators, and plumbers were lower than the rest, at 3.2, 3.8, and 3.6. Plasterers, equipment operators, and lifters showed somewhat lower lumbar MMT values, which are 3.7, 3.9, and 3.8, respectively. This indicates that there was more strain on their lower backs.

Table 5. Manual Muscle Testing of Limbs

Joint	Right	Left	P- Value
Shoulder Flexors	4.8±0.4	4.8±0.3	0.37
Shoulder Extensors	4.7±0.4	4.7±0.4	
Shoulder Abductors	4.8±0.3	4.8±0.3	
Shoulder Adductors	4.9±0.2	4.9±0.2	
Elbow Flexors	4.8±0.3	4.8±0.3	
Elbow Extensors	4.8±0.3	4.8±0.3	
Wrist Flexors	4.7±0.4	4.6±0.5	
Wrist Extensors	4.8±0.3	4.9±0.2	
Hip Flexors	4.9±0.2	4.9±0.2	
Hip Extensors	4.8±0.3	4.9±0.2	
Hip Abductors	4.9±0.2	4.9±0.2	
Hip Adductors	4.8±0.3	4.9±0.1	
Knee Flexors	4.7±0.4	4.8±0.3	
Knee Extensors	4.8±0.3	4.8±0.3	
Ankle Dorsiflexors	4.8±0.3	4.9±0.2	
Ankle Plantarflexors	4.9±0.2	4.9±0.2	

Interpretation

Table 5 provides the average results for Manual Muscle Testing of the upper and lower limbs. They are not regarded as being significant (P=0.37). Every muscle group showed MMT in the 4-5 range. This demonstrates that because they are active and not sedentary, their limb strength was not as negatively impacted.

Table 6. Visual analog pain rating scale

Years of working	At rest	On activity	P- Value
10-12	2.5±1.35	5.1±1.9	0.0017
13-15	3.5±1.2	7.6±1.6	
16-18	4.3±1.3	7.9±2.0	
19-21	4.7±1.3	8.2±2.0	
22-24	4.9±1.2	8.6±1.8	

Interpretation

Table 6 lists the values of the Visual Analog Pain Rating Scale and the years of experience of workers on construction sites. P=0.0017 deems them to be highly significant. Based on the observed pattern, an increase in working experience is accompanied by an increase in discomfort experienced. In workers who have been employed for 22–24 years, it almost approaches a count of nine. It is shown to be lowest among employees who have worked for 10 to 12 years.

Table 7. Range of motion of spine

Cervical Flexion	86.2±3.62º
Cervical Extension	64.8±7.02º
Lateral Flexion	36.5±6.1º
Cervical Rotation	85.7±6.1º
Thoracolumbar Flexion	10.9±1.2 cm
Thoracolumbar Extension	2.4±0.18 cm

Interpretation

The average values for the cervical and thoracolumbar spine's range of motion are shown in Table 7.A goniometer was used to assess cervical flexion, extension, lateral flexion, and cervical rotation in accordance with the spine's range of motion. Cervical flexion and extension were somewhat greater than normal in these. The Schober's approach was utilized to measure the flexion and extension of the thoracolumbar region. They also showed higher-than-normal readings. This demonstrated that over time, employees are more likely to have hypermobile joints.

Table 8. Nordic musculoskeletal discomfort scale

	Have you at any time during last 12 months had trouble in:	Have you had any trouble in the last 7 days? If yes, where?	Have you ever hurt your body part in an accident? If yes, where?
Neck	75.7%	29.9%	0%
Shoulder	45.7%	10.2%	14.01%
Wrist/hand	23.3%	13%	26.1%
Upper back	89.7%	80.3%	2.8%
Lower back	72.8%	81.3%	0.9%
Hip/thighs	4.6%	8.4%	0.9%
Knees	43.9%	56.07%	10.2%
Ankle	5.6%	12.1%	14.9%
None	0.9%	0.9%	41.1%

Interpretation

The Nordic Musculoskeletal Discomfort Scale is shown in Table 8. It was discovered that throughout the preceding year, 75.7% of employees had neck discomfort, 45.7% had shoulder discomfort, 23.3% had wrist or hand discomfort, 89.7% had upper back pain, and 72.8% had lower back pain. Just 4.6% reported hip or thigh pain, 43.9% reported knee pain, and 5.6% reported ankle pain. In the week prior, 10.2% of workers reported shoulder discomfort, 13% reported wrist discomfort, and 29.9% of workers reported neck pain. About 80% of workers reported having different problems with their upper and lower backs, 56.07% with their knees, and 12% with their ankles. Worker injuries included 14.01% to the shoulder, 26.1% to the wrist, and only 2.8% to the upper back. Each of the lower back and hips makes up 0.9%. Roughly 10% reported knee pain and 14.9% reported ankle pain.

DISCUSSION

The purpose of the study, "Estimation of Spinal Dysfunction," was to measure the degree of spinal dysfunction experienced by workers on construction sites by considering various factors such as years of experience, posture, range of motion, muscle strength, pain, and discomfort. A total of 107 construction site laborers, both male and female, between the ages of 25 and 45, who had worked for more than ten years and five or more hours a day, and who had a normal body mass index (BMI), were included in the study. According to research by Lette, Abate, et al., 43.9% of workers in the building industry experienced a musculoskeletal disorder within the preceding year. Upper back, wrist/hand, and lower back diseases were the three most prevalent musculoskeletal conditions in this study. Because of their repetitive uncomfortable

postures, high levels of stress at work, and heavy lifting, construction site workers have a higher-than-average risk of acquiring low back pain, according to the prevalence statistics (Lette & Abate, et al. 2019).

In this study, 107 construction labourers were approached from various construction sites in Maharashtra. After the selection of participants as per the criteria of the study, they were informed about the study and written consent was taken. Our investigation examined spinal dysfunction using the double leg lowering test, Nordic Musculoskeletal discomfort scale, Visual analogue pain rating scale, range of motion, muscle strength and posture assessment. These outcome measures have proven reliability and validity. The results of our study revealed that female workers who participated in the study (table 1), the mean age ranged from 25 to 45 years, most participants had 10-12 years of working experience and worked for 7-9 hours every day.

Musculoskeletal symptoms were found to be more common in workers who had long workdays, awkward postures, insufficient breaks, and repetitive movements. When workers performed the same motion too frequently, too quickly, or for too long, or when they involved the same joints and muscle groups, these symptoms were especially dangerous (Reddyet al., 2016). The lumbar region is the body part most affected by musculoskeletal symptoms (MS) in construction workers, with a prevalence of 51% over the course of a year, along with knee, shoulder, and wrist musculoskeletal symptoms, according to a 2018 systematic review of literature on the prevalence of musculoskeletal symptoms in the industry. The study aimed to synthesize musculoskeletal symptoms prevalence in different construction trades, gender, and age groups (Umer et al., 2018). The capacity of the spinal group of muscles to carry out tasks is known as spinal muscular performance. Poor muscle performance may play a role in the development of both mechanical and non-mechanical lower back pain. According to SB Shinde, their study discovered that IT professionals have lower spinal muscle performance. In comparison to static abdominal muscle performance, it was determined that there was a considerable decrease in static extensor performance (Sandeep & Radha et al., 2021).

The ergonomic evaluation of work-related musculoskeletal disorders among construction laborers working in unorganized sectors in West Bengal, India" is the title of a 2010 study (Sahu & Subhashis et al., 2010) which comprised 90 women and 140 men working on construction sites, sought to learn more about musculoskeletal symptoms including pain by using the Nordic questionnaire. One of the biggest ergonomic stressors for the prevalence of low back pain is the fact that, according to Sahu, Subhashis, et al., (2010), industry workers routinely lift and carry loads significantly above the National Institute for Occupation Safety & Health Recommended Weight limit (NIOSHRWL). Furthermore, many uncomfortable positions have been linked to musculoskeletal conditions, where bending or twisting the trunk is a common cause of low back pain. Additionally, the low back had the highest level of postural stress compared to all other body joints because forward bending of the back was the most repeated uncomfortable position. A musculoskeletal problem of the low back may be the cause of the low back discomfort that 49.2% of male laborers and 51.1% of female laborers reported having for seven days (Sahu & Subhashis et al. 2010).

According to a study by Telaprolu Neeraja, data suggested that women had greater exposure to repetitive hand movements and working in a general body static position (more standing than seated). Men's jobs were defined by a little bit more weight lifting and a dynamic body posture that suggested more walking during the workday (Neeraja et al., 2014). Our findings showed a strong correlationbetween the type of workers, including lifters and equipment operators as well as Masons, roofers, and plasterers, and their postural anomalies (p=0.0376).The spinal range of motion was considerably decreased in patients with lymphedema in breast cancer survivors, according a study titled Analysis of Spinal Dysfunction in Breast Cancer Survivors with Lymphedema.The lateral muscles of the spine, the abdominals, and the extensors all had much decreased strength and endurance.Our study found a significant correlation (P=0.0001) between the workers' employment history and their performance on the double leg lowering test.As workers' experience in work increased, their abdominal strength decreased (Babasaheb & Shinde Sandeep, et al. 2021). Adeyemi et al conducted a study in which it was concluded that manual handling tasks still carry a sizable amount of physical stress. Information

about protecting workers from sickness and injuries at construction sites is seriously lacking. The outcomes of the tasks analysis showed that ergonomics have a relatively small role in the building sites that were under study.Most workers who conduct manual lifting tasks will face an elevated risk of workplace accidents.Mortar lifting tasks had the highest Lifting index scores of all the vocations evaluated (Adeyemi & Oluwole, et al., 2013).

According to our research, 66.6% of laborers performed poorly on the double leg lowering exam. It is a sign of weak abdominal muscles, which in turn places a great deal of strain on the spine when carrying loads. Workers in occupations with 35% or higher rates of low back pain incidence, such as welders, reinforcing bar placers, plasterers, interior finishers, roofers, bricklayers, and tilers, frequently have to adopt anti-physiological postures for extended periods of time due to the unique aspects of their jobs, according to Kaneda et al.'s study. He thought that the development of LBP was significantly influenced by these uncomfortable and restricting positions. A multi-regression analysis of the risk factors for low back pain (LBP) showed that the postures associated with twisting, deep forward bending, half bending, and unstable body balance on scaffolding had the strongest correlations with the development of LBP among working conditions (Kaneda et al., 2001). A review done by M. Gervais, there is an obvious need to raise awareness about the benefits of preventing back diseases in the construction industry. In fact, the success of any prevention program depends on such an awareness effort.There is general agreement in the literature that building projects need to be better planned and managed, and that decisions about occupational health and safety need to be made with the long-term effects in mind (Gervais & Michèle et al. 2003).

It should be made clear that enforcing preventative measures and an intertwined accoutrements operation program (delivery, storehouse, business inflow, robotization) will only be effective in achieving these pretensions if dangerous runningoperations are linked and suitable preventative measures are planned before the factual construction work begins.Due to the near- irreversibility of these spinal changes, preventives must be taken to help them entirely or incompletely, as well as to insure that workers are defended from spinal dysfunction indeed after long shifts. Feedback on work procedures, information sharing about proper running ways, and training are all exemplifications of operation ways that support safety and the avoidance of reverse problems. Also, it's possible to arrange construction work to lessen stress and weariness by giving peer- support mechanisms is one illustration of this strategy (Gervais and Michèle et al., 2003) rotating the workers in chargeof delicate jobs, including 15-alternate microbreaks to stretch and rest the reverse as well as paid warm- up and back exercise intervals, abstain from working overtime, which is linked to an increased threat of back injuries. For those who work in concrete buttressing, produce ministry that will allow you to move and store sword rods at midriff height.Use a Swedish tying machine to tie rods from a standing position.Rather than using sword rods, use welded fabric network.Install supports that let you store rods at the same height as the bending or cutting outfit [to avoid lifting].give enough mechanical backing, similar as bottom pedals, conveyors, wagons, handles, regulators, and electric or mechanical hoists (Gervais and Michèle et al., 2003).

For operators of heavy equipment create a more ergonomic driving system by revising the placement of levers, improving the quality of chairs, and creating adjustable seats with lumbar supports. Create a crane that is independent of the position of the cabin. Enhance sight fields by increasing the surface area of windows by 50% and extending them to the cabin's floor and minimize vibration for carpenters, give workers tables or sawhorses that can be adjusted in height. Use hammers with curved handles for greater ergonomics and lighter steel-shafted hammers. Utilize shovels with curved, longer handles. Drywall sheets can be moved using dollies by adding handles to them. When moving or installing insulation, use mechanical aids and lifts. Use machinery that is simpler to disassemble. To hold tools overhead, use supports. Belts can be used to stop tool kickback. On the ground, assemble the rooftops. Install safety rails (Gervais and Michèle et al., 2003). For roofers make their materials more compact. Transport tar paper with a cart. Use two-wheeled wheelbarrows rather than one-wheeled ones. Utilize machinery to take off the shingles. Modify the geometry of the structural components and lessen their size and weight. Utilize a method that enables workers to continue to stand. A mini-spreader should always be used. Use ladders that are sufficiently long. Install guardrails on beams for

high-steel workers. Provide reusable floors and guardrails for workstations. Install catwalks and improve access to workstations. Provide harness hitch points. To perform tasks at relatively low heights, use mobile platforms. Regular building work necessitates repeatedly lifting things to shoulder height. Reduced blood supply, recurrent straining of tendons, rupture of the muscle fibers, and contractile forces acting on the cervical spine have all been related to the prolonged activity of neck muscles during these tasks. While repetitive straining on the cervical vertebrae has been linked to degenerative conditions including disc herniation and cervical spondylosis, repetitive straining on the muscles and tendons has been linked to muscle-specific neck ailments like tension neck syndrome (Nimbarte & Ashish et al., 2010).

Given that lifting tasks are inherently linked to the construction industry, alternate materials (such as lightweight concrete blocks), pre-blended grout and mortar, techniques, and equipment (such as vacuum lifters) could be employed to reduce the risk of neck injuries among construction workers (Kaneda et al., 2001). Because of the ergonomic risks they encounter on the job, musculoskeletal disorders are a common aftereffect for construction workers and can have a serious negative effect on health. Factors that are linked to the health impact include low-income status, immigration status, unfavorable work attributes, substandard housing, and unfavorable environmental factors (Meo et al., 2013). If used sooner and more effectively than later, all the aforementioned strategies will help lower the prevalence of spinal dysfunction among workers on construction sites. If workers who complain about pain and discomfort in certain body parts receive proper rehabilitation, it may be possible to reduce their impairment, enhance their health, and reduce the amount of time they miss from work due to accidents at work (Sahu and Subhashis et al. 2010). Smaller sample size, a smaller geographic area, and accessibility to remote locations were limitations of this study. It is advised that future studies take these variables into account to generalize the findings. This study will be helpful when treating construction site labourers with spinal dysfunction.

Conclusion

Studies indicate a link between low back pain and challenging work-related postures like trunk flexion, trunk rotation, and lifting over the past few decades. According to our research primary prevention of lower back pain may be accomplished more successfully if preventive measures consider attitudes regarding pain as well as the ergonomic work environment. Based on our findings, it was found that construction site workers with 10+ years of experience, undergo significant spinal dysfunction due to decreased abdominal muscle strength, resulting in increased strain on their spines. Construction workers, including lifters, equipment operators, masonry, roofers, and plasterers, exhibit significant postural anomalies and hypermobile spines due to ongoing stress and strain. This results in significant spinal dysfunction after years of continuous operation on construction sites.

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Conflict of İnterest

There are no conflicting relationships or activities.

Ethics Statement

This research followed ethical standards and received approval from the Institutional Ethical Committee of Krishna Vishwa Vidyapeeth, KIMSDU dated 19/05/2023 and numbered 612/2022-2023.

Author Contributions

Design of the Study, SS and TH; Data Gathering, PJ; Statistical Evaluation, SS; Data interpreting PJ and TH; Writing of the Manuscript, PJ and SS; and Search of the Literature, TH and SS. Each author has reviewed the final draft of the manuscript and given their approval.

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RESEARCH ARTICLE

Effects of Neuromuscular Exercise on Dynamic Balance, Vertical Jump and Trunk Endurance in Ice Hockey Players: A Randomized Controlled Trial

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Abstract

This study aims to investigate the impact of a 12-week neuromuscular exercise program on balance, vertical jump, and core endurance parameters in female ice hockey players. Y balance test, vertical jump test and McGill test were used for evaluation of dynamic balance, vertical jump and trunk endurance, respectively. A 12-week training program was conducted on 50 female ice hockey players. The exercise group showed significant differences in anterior and posteromedial balance scores for both right and left ($p<0.05$), but there was no significant difference in posterolateral scores ($p>0.05$). The control group didn't show significant improvements in the vertical jump ($p>0.05$), while the neuromuscular exercise group demonstrated a statistically significant improvement ($p<0.05$). Trunk extension endurance improved significantly in the control group ($p<0.05$), but there were no significant differences in trunk flexion and lateral endurance ($p>0.05$). In contrast, the neuromuscular exercise group significantly improved all trunk endurance values ($p<0.05$). Neuromuscular exercise training applied to ice hockey players can improve the balance, vertical jump, and trunk endurance parameters. Therefore, the inclusion of neuromuscular exercise programs in the training programs of female ice hockey players can enhance their physical performance and may reduce the risk of injury.

Keywords
Endurance, Exercise, Physiotherapy, Rehabilitation

INTRODUCTION

The initial success of female ice hockey players is an important sign of the tendency toward more equal gender representation. While still the case, one must admit that female players encounter very different problems during the training and competition sessions because of the specifics of their anatomy and biomechanics compared to men (Ransdell & Murray, 2011; Tuominen et al., 2016). Physiological and biomechanical elements, including muscle strength, size, and distribution, as well as hormonal variations, have a considerable influence on the particular requirements of female ice hockey players (Schick & Meeuwisse, 2003). Understanding and addressing these unique challenges are crucial in providing tailored training programs that effectively enhance the performance of female athletes in the sport.

With its quickness, gear, and body combining, ice hockey is high on the list of hazardous sports. One can suffer a great variety of injuries in ice hockey that include concussions, head/ neck traumas, leg and foot injuries, shoulder problems, and muscle strains (Mosenthal, Kim, Holzshu, Hanypsiak, & Athiviraham, 2017; Wörner, Kauppinen, & Eek, 2024). These injuries can result in significant short- and long-term health effects for players, including cognitive, psychological, and physiological consequences. As a result, it is crucial to design training programs that address the specific needs of female athletes to

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optimize their performance and reduce the risk of injuries. The focus of an exercise program for ice hockey players depends on the season stage. In-season training aims to maintain the strength and movement patterns developed during the off-season while preparing players for the demands of training camps and regular-season play (Allard, Martinez, Deguire, & Tremblay, 2022). Research has shown that off-ice physical performance correlates with on-ice performance in elite ice hockey players. Various off-ice variables such as strength, agility, and fitness have been found to correlate with on-ice-skating sprint performance and overall game performance. These findings suggest that off-ice exercise and physical performance are important factors in determining the on-ice performance of ice hockey players (Farlinger, Kruisselbrink, & Fowles, 2007; Schwesig, Laudner, Delank, Brill, & Schulze, 2021; Wagner et al., 2021; Williams, 2020).

Female ice hockey athletes must focus on polishing their balancing skills, jumping abilities, and endurance if they want to become elite players. They are the skills that can give a substantial performance on the ice. Developing these skills requires a multifaceted approach that includes targeted exercises and training regimens Numerous exercise strategies target improving performance and minimizing injury risk for ice hockey athletes (Dæhlin et al., 2017; Hedrick, 2002; Wolfinger & Davenport, 2016). Athletic performance, injury prevention, and physical fitness are among the many beneficial areas identified in neuromuscular training studies which is of great interest for the field of sports physiology and exercise physiology. What we term neuromuscular training is a particular type of training that focuses on optimizing the coordination of actions of the nervous system and the muscles. While it uses a mixture of strength, balance, coordination, and proprioceptive exercises, it enables individuals to have more control over their body and efficient movement. Neuromuscular training aims to optimize muscle activation, joint stability, and overall neuromuscular control, leading to improved athletic performance and reduced risk of injuries (Akbar et al., 2022; Zouhal et al., 2019; Sarıca & Gencer, 2024).

Neuromuscular exercise training emphasizes the motor neuron functioning to coordinate the muscles well, ultimately leading to the refinement of coordination, balance, and general movement. This training regimen, with great success in many sports for maximizing performance and injury prevention, is widely used. However, its application to female ice hockey players has not been extensively studied. With the specific goals of improving balance, jumping, and endurance in this population, we must first understand the potential effects of a neuromuscular exercise training program to develop evidence-based interventions. Specific neuromuscular training programs can consider the distinct physical challenges of female ice hockey players. These programs often incorporate exercises that target the lower body, core stability, and proprioception to improve muscle strength, control, and coordination. By enhancing these aspects, players can better withstand the forces exerted on their bodies during the dynamic and physically demanding nature of ice hockey.

The current study sought to investigate the consequences of implementing neuromuscular exercise programs in conjunction with standard training routines on the dynamic balance, vertical jump, and trunk endurance parameters of female hockey players.

MATERIALS AND METHODS

Participants and Recruitment

Female ice hockey players aged between 15 and 30, who are licensed by the Turkish Ice Hockey Federation and actively participating in the league, voluntarily took part in this study. The research was conducted during the season. To be considered for the study, participants were required to be in good health, free from any diseases, and absent any musculoskeletal injuries that would impede their training or affect the measurement outcomes. Additionally, they had to be active club ice hockey players.

In our study, we implemented a randomized controlled trial. Ice hockey players were split into two groups: the neuromuscular training group (experimental) and the control group. The division was done randomly using a computer program. The experimental group underwent 12 weeks of hockey and neuromuscular training while the control group stuck to their regular hockey routine. Assessments were regularly conducted during training sessions throughout the season with tests administered an hour before warm-up.

Study participants were thoroughly informed about the risks, obligations, and advantages associated with the research before they provided written consent. The research project was carried out following the guidelines established by the Declaration of Helsinki, and it was previously approved by the ethics committee at Uskudar University (approval number (61351342/February 2023-16)). Additionally, the study was registered on the ClinicalTrials.gov platform (registration number is NCT05998057).

Procedures

All participants in the study, in addition to providing personal information, were required to complete a demographic form that included details such as their positions, national team history, the number of years they have been involved in sports, their current injury status, any previous surgeries they have undergone, and their regular medication use. The study utilized three tests to evaluate the athletes' balance, vertical jump, and trunk endurance. The Y-Balance Test was used to assess balance, the Vertical Jump Test was used to measure vertical jump, and the McGill Trunk Endurance Test (MGDT) was used to evaluate trunk endurance. These evaluations were conducted twice, at the beginning of the study and again after the 12-week program.

Dynamic Balance Assessment

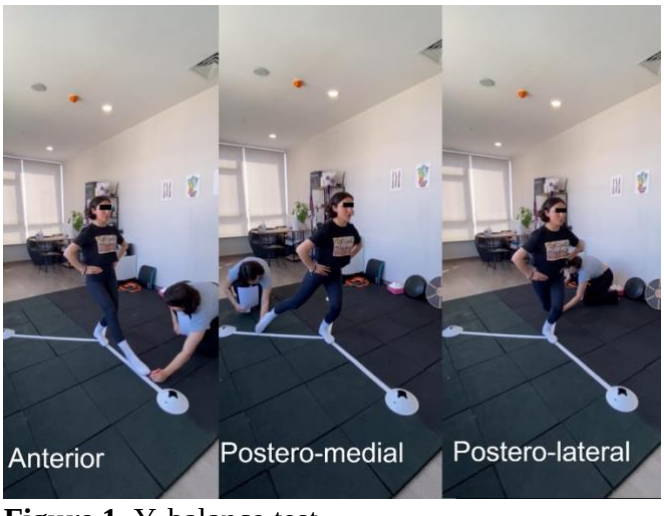

Figure 1. Y-balance test

Y balance test was used to determine the dynamic balance of all athletes. The Y Balance Test (YBT) is a dynamic test used to measure balance, strength, flexibility, core control, and proprioception required for single-leg stance. It is commonly used to assess physical performance, functional symmetry, and the risk of lower extremity injury. The test involves reaching in three different directions: anterior, posterolateral, and posteromedial while standing on one leg (Fig. 1). To score the test, the average reach distance in each direction is calculated, and the distance in each direction is expressed as a percentage of the patient's leg length. The YBT is a reliable tool for assessing balance and identifying athletes at increased risk for injury, making it a valuable test in sports injury prevention and rehabilitation (Plisky et al., 2009; Plisky, Rauh, Kaminski, & Underwood, 2006; Shaffer et al., 2013).

Vertical jump assessment

Vertical Jump Test was used to evaluate the jumping performance of the participants. The vertical jump test, also known as the Sargent Jump, is a test designed to measure lower body strength and power (Sargent, 1921). The test involves measuring the height an individual can jump using a vertical jump test gauge or a marked wall (Fig. 2). The procedure for the vertical jump test is as follows: The person stands sideways against a wall and extends the hand closest to the wall. With the feet flat on the ground, the point of the toes is marked or recorded. This is called standing reaching. The person puts chalk on their fingertips to mark the wall with the height of their jump. The person then moves away from the wall and jumps vertically as high as possible, using both their arms and legs to help propel their body upwards. Try to touch the wall at the highest point of the jump. The distance difference between the standing height and the jumping height is points. The best of three attempts is recorded, and the results can be compared to normative data for various age groups and genders (Maulder & Cronin, 2005).

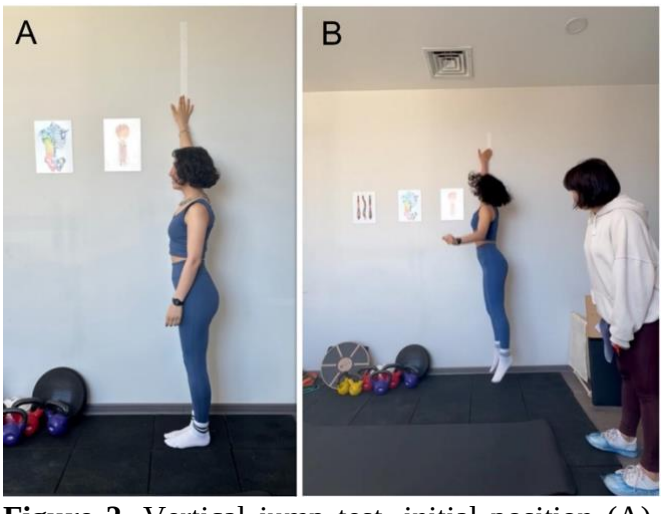

Figure 2. Vertical jump test, initial position (A), vertical jump (B)

Trunk Endurance Assessment

The McGill Trunk Endurance test is a test that is based on how long a person can maintain a static position as a maximum time (Fig. 3). The different ways to check people's trunk endurance are through the trunk flexor endurance test, trunk lateral endurance test, and trunk extensor endurance test. These tests measure the stability of the deep core muscles, the anterior muscles group, and the lateral core muscles. In this test, the trunk endurance time measured is in seconds, and the test is terminated as soon as the individual notices any changes in trunk position, or exhibits fatigue and can no longer hold the given position. Clinicians mostly rely on the trunk endurance test to monitor the muscle's performance improvement in the context of a rehabilitation program (Evans et al., 2007; McGill et al., 1999).

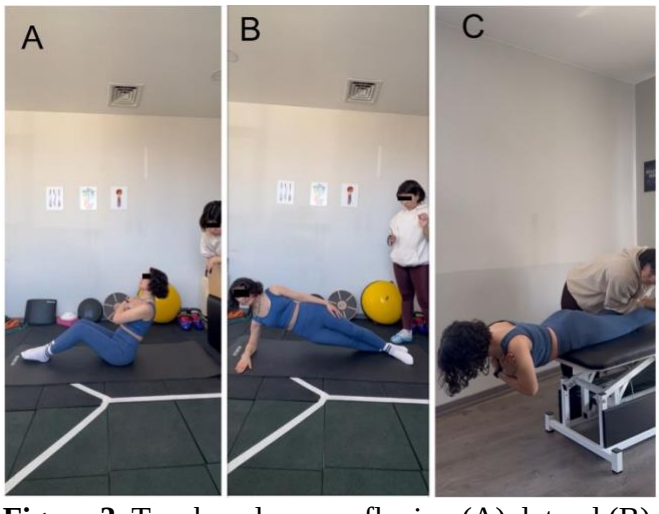

Figure 3. Trunk endurance, flexion (A), lateral (B), extension (C)

Intervention

Routine Training Program

Participants in the control group maintained their conventional training regimen, which consisted of 5 days a week of classical training for 12 weeks. This program comprised a 10-minute warm-up, and 40 minutes of technical and tactical off-ice training, and concluded with a 10-minute cool-down session.

Neuromuscular Training Program

The neuromuscular training program was designed for ice hockey players and includes core stabilization, balance, and plyometric exercises (Table 1). In addition to the routine training programs, athletes in the experimental group underwent supervised neuromuscular training for 40 minutes daily five days a week for 12 weeks. Since our neuromuscular training program includes warm-up exercises, no additional warm-up time is allocated.

Statistical Analysis

The study's sample size was determined by conduc ting a power analysis using G*Power (Version 3.1.9.6 (Faul et al., 2009). The data from the study was analyzed using the licensed SPSS 25 software program. The normal distribution of the variables was examined using the Kolmogorov-Smirnov normality test, and the differences between groups were analyzed using a Dependent Sample T-test due to the normal distribution of the variables. A significance level of $p<0.05$ was accepted when interpreting the results.

RESULTS

Demographics

A total of 50 female ice hockey players participated in a 12-week training program, which included both an exercise group and a control group. The average age of the players in the exercise group was 20.04± 4.06 years, while the average age of the players in the control group was 20.12± 3.90 years. There was no statistically significant difference between the two groups terms of their baseline values ($p>0.05$). Of the 50 participants, 16 were left-dominant and 34 were right-dominant. No significant differences were observed between the groups in terms of the dominant side. The demographic data for the participants are provided in Table 2.

Dynamic Balance

Following the findings of the Y balance test, a substantial rise in values was observed for both the right and left sides in all groups ($p<0.05$). The scores differed significantly between the two groups in the anterior and posteromedial directions for both the right and left sides ($p<0.05$). There was no significant difference in the posterolateral scores between the groups on either the right or left sides ($p>0.05$). A comprehensive presentation of all Y balance scores and their corresponding significance levels can be found in Table 3.

Vertical Jump

Upon analyzing the vertical jump assessment data, it was found that the group that received routine training showed no significant change in their post-intervention values ($p>0.05$). In the neuromuscular exercise group, a statistically significant difference was observed in the post-

treatment values ($p<0.05$). There was also a significant difference when looking at the scores between the groups ($p<0.05$). A complete overview of all vertical jump scores and the corresponding levels of significance can be found in Table 3.

Trunk Endurance

In the routine exercise group, the outcome of the post-treatment examination revealed a statistically significant improvement in the trunk extension endurance value ($p<0.05$). There was no significant difference in trunk flexion, and right and left lateral endurance scores ($p>0.05$). In the neuromuscular exercise group, there was a statistically significant improvement in all trunk endurance values ($p<0.05$). An extensive summary of all trunk endurance scores and their corresponding levels of statistical significance can be found in Table 3.

Table 1. Neuromuscular training program

Exercise	Repetition/Duration
Lunge to Hamstrings Stretch	3 sets 30seconds
Standing Hip Out	3 sets 30seconds
90-90 Hip Stretch	3 sets 30seconds
World's Greatest Stretch	3 sets 30seconds
Star Excursion	3 set 5 reps
Side Jumps+ Balance	3 sets 10 reps
Forward Hops + Balance	3 sets 10 reps
Squat	3 sets 10 reps
Squat Jump	3 sets 10 reps
Jumping Spider Push-up	3 sets 10 reps
Double Leg Vertical Jump	3 sets 10 reps
Broad Jumps	3 sets 10 reps
Lateral Box Shuffles	3 sets 10 reps
Plank	3 sets 30 seconds
Side Plank	3 sets 30 seconds
Bird Dog	3 sets 10 reps
Glute Bridge	3 sets 10 reps
Single Leg Glute Bridge	3 sets 10 reps
Single Toe Raises	3 sets 30 seconds
Nordic Hamstrings	3 sets 10 reps
Monster Walk	3 sets 10 reps

Table 2. Demographic data of participants

Data	Group	Values				p
		Minimum	Maximum	Mean	±Sd	
Age (years)	NMT	16,00	28,00	20,04	4,06	0,944
	RT	16,00	28,00	20,12	3,90	
Height(m)	NMT	1,55	1,77	1,65	0,06	0,978
	RT	1,55	1,73	1,65	0,04	
Weight(kg)	NMT	50,00	62,00	55,80	3,98	0,209
	RT	48,00	65,00	57,28	4,24	
BMI (kg/m2)	NMT	17,76	22,23	20,47	1,31	0,169
	RT	18,04	23,88	21,01	1,39	

*NMT: neuromuscular training; kg: kilogram; m: meter; RT: routine training sd: standard deviation; p: statistical significance

Table 3. Balance, vertical jump and endurance scores

Data	Group	Values			
		Pre mean±sd	Post mean±Sd	p0	p1
Y-balance anterior right(cm)	NMT	95±2,48	99,54±2,76	<0.001	
	RT	95,20±2,69	97,65±2,39	<0.001	0,005
Y-balance anterior left(cm)	NMT	94±2,45	99±2,68	<0.001	
	RT	94,68±3,22	97,1±2,6	<0.001	0,001
Y-balance posteromedial right(cm)	NMT	81,43±2,47	83,98±2,1	<0.001	
	RT	79,9±2,41	81,45±1,99	<0.001	0,024
Y-balance posteromedial left(cm)	NMT	80,74±1,87	82,89±1,72	<0.001	
	RT	79,76±1,9	80,61±1,74	0.008	0,009
Y-balance posterolateral right(cm)	NMT	77,96±2,53	80,83±1,94	<0.001	
	RT	75,97±2,32	78,06±2,36	<0.001	0,09
Y-balance posterolateral left(cm)	NMT	77,37±2,12	79,94±1,51	<0.001	
	RT	75,42±2,35	77,86±2,1	<0.001	0,806
Vertical jump(cm)	NMT	16,52± 1,26	16,32±1,07	<0.001	
	RT	17,56±1,04	16,48± 1,08	0,212	0,001
Trunk flexion endurance(sec)	NMT	72,56±2,79	76,00±1,66	<0.001	
	RT	71,28±2,26	71,28±2,26	-	<0.001
Trunk right lateral flexion endurance(sec)	NMT	47,16±2,08	49,00±1,83	0.006	
	RT	46,96 ±1,95	47,04 ±1,97	0.161	0,006
Trunk left lateral flexion endurance(sec)	NMT	46,64±2,98	48,52±1,85	0.003	
	RT	46,92±3,12	47,36±2,83	0.102	0,025
Trunk extension endurance(sec)	NMT	68,68±2,04	76,32±1,68	<0.001	
	RT	69,24±2,55	70,56±2,52	<0.00	<0.001

*p0: within-group statistical significance p1: between-group statistical significance

DISCUSSION

While previous studies have demonstrated the positive impact of neuromuscular training programs on various aspects of athletic performance in different sports, the current study delved deeper into understanding the unique requirements of female ice hockey players. This approach aimed to provide valuable insights tailored specifically to address the complex and distinctive needs of this athletic population. Our study's findings indicate that the neuromuscular exercise program is effective in enhancing balance, vertical jump, and trunk stabilization in female ice hockey athletes. Furthermore, our research is the first to investigate the impact of such a program on these specific aspects.

The influence of neuromuscular training on athletic performance has been extensively examined in numerous studies, which have consistently revealed its beneficial effects on various aspects of physical fitness. Neuromuscular training has been shown to improve dynamic balance, and sports performance, including sprint, agility, and power abilities in female basketball players (Hewett et al., 2005). It also reduced the incidence of serious lower limb injuries and improved lower limb strength and postural control (Filipa et al., 2010). Plyometric and dynamic stabilization and balance training have been effective in increasing measures of neuromuscular power and control, suggesting that a combination of these training types may maximize preseason training effectiveness for female athletes (Pasanen et al., 2009). Systematic reviews have indicated that neuromuscular training can decrease injury incidence and that a combination of plyometric power, biomechanics and technique, strength, balance, and core stability training can induce neuromuscular changes and potential injury prevention effects in female athletes (Myer et al., 2005). Neuromuscular training programs focusing on core stability and lower extremity strength have improved performance on the star excursion balance test in young female athletes (Myer et al., 2006). Comprehensive neuromuscular training programs have been associated with improved performance measures and lower-extremity movement biomechanics related to ACL injury risk (Benis et al., 2016). Body-weight neuromuscular training has been shown to improve postural control and lower limb stability in female basketball

players, as assessed with the Y-Balance Test (Kim et al., 2017).

Neuromuscular training programs have been shown to improve vertical jump performance in female collegiate athletes, with significant increases in initial and maximum knee flexion angles during drop jumps, and improved performance in vertical jump and hopping tests (Pasanen et al., 2009). Neuromuscular training has also been effective in reducing lower limb injury incidence and improving physical fitness measures such as countermovement jump performance and balance in young female track-and-field athletes (Kooroshfard & Rahimi, 2022). Plyometric training was found to have positive effects on vertical jump in young basketball athletes, with significant improvements observed in countermovement jump and squat jump (Correia et al., 2020). A study revealed that a neuromuscular warm-up program led to enhanced jumping performance and static balance in floorball players (Bonato et al., 2018). A six-week neuromuscular training program resulted in improved athletic performance measures and altered movement patterns during jumping tasks in female collegiate athletes (Chappell & Limpisvasti, 2008). A systemic review and meta-analysis state that combined strength training, which includes plyometric and traditional strength exercises, has a moderate effect in improving vertical jump performance in basketball players (Uysal et al., 2023). After an 8-week neuromuscular warm-up program, elite junior skiers demonstrated improved dynamic balance ability; however, no statistically significant changes were observed in vertical jump performance (Vitale et al., 2018).

Trunk endurance is a key aspect for athletes as it contributes to overall core stability and function. Trunk endurance refers to the ability of the trunk muscles to sustain contractions over some time. Studies have found that trunk muscle endurance significantly increased following exercise training (Song et al., 2023; Taneja et al., 2023). Although trunk endurance is an essential aspect for athletes, research on the development of this parameter, particularly in ice hockey players, is limited.

Our study demonstrates that dynamic balance, vertical jump, and trunk endurance can be enhanced through the implementation of neuromuscular exercise training in conjunction with routine programs. Moreover, the study may pave the way for further research exploring the long-term effects of neuromuscular exercise training on injury prevention and overall performance in female ice hockey. Longitudinal studies tracking the participants beyond the 12-week intervention period can provide insights into the sustainability of the observed improvements and the potential reduction in injury incidence. Additionally, investigating the underlying physiological mechanisms, such as neuromuscular adaptations and motor control changes, through advanced techniques like electromyography and motion analysis, can deepen our understanding of how neuromuscular exercise training influences the physical attributes of female ice hockey players.

In conclusion

The findings of this randomized controlled trial underscore the potential of a 12-week neuromuscular exercise training program to improve balance, jumping ability, and endurance in female ice hockey players. Drawing upon recent literature, this study highlights the multifaceted benefits of neuromuscular interventions for enhancing athletic performance, reducing injury risk, and optimizing player development in ice hockey and beyond. Future research endeavors should focus on elucidating the long-term effects, optimal implementation strategies, and scalability of such interventions to maximize their impact on female athletes' health and performance outcomes.

Conflict of interest

The authors declare no conflict of interest. Also, no financial support was received.

Ethics Committee

The approval was taken from the Üsküdar University Non-Interventional Research Ethics Committee (reference number 61351342/February 2023-16).

Author Contributions

The authors accomplished this study by making significant contributions including designing the study according to the formulation of its objectives.

MK and ÖŞ performed on conception and design of the study. MK collected the data. ÖŞ and ES performed data analysis and interpretation. All authors were contributors and responsible for the manuscript's content and approved the version submitted for publication.

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RESEARCH ARTICLE

Comparative Analysis of Plyometric Training Protocols in Volleyball: A Meta-Analysis

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Abstract

Purpose: This meta-analysis synthesizes findings from 40 research studies to comprehensively examine the impact of plyometric training protocols on overall performance outcomes in volleyball athletes. **Method:** A systematic search identified relevant studies on plyometrics and volleyball performance. Data on training programs, performance measures, and outcomes were extracted. Statistical analysis assessed the overall effect size and addressed potential variation between studies. **Findings:** The constant-effects version revealed a giant wonderful common impact (Fisher r-to-z converted correlation coefficient = 0.7531, 95% CI: 0.6952 to 0.8110), affirming the fine relationship between plyometrics and volleyball overall performance. However, the random-effects model indicated giant heterogeneity among authentic effects (I^2 = 78.53%), prompting a radical exploration of ability sources of variability. Despite diagnosed limitations, inclusive of heterogeneity and ability publication bias, this meta-analysis underscores the want for standardized protocols and in addition studies to refine training strategies. **Conclusion:** The importance of this analysis lies in its contribution to proof-primarily based practices, providing valuable insights to coaches and practitioners in search of to optimize plyometric training for volleyball athletes. As a complete reference, it courses destiny research endeavors and advances know-how within the nuanced courting between plyometrics and volleyball.

Keywords
Plyometric Training, Volleyball Overall Performance, Athletic Training, Sports Science

INTRODUCTION

Volleyball has modified beyond recognition within the beyond three a long time from an unorganized recreation into a relatively competitive sport, requiring a excessive level of bodily fitness, mental alertness and mastery over strategies. Volleyball has developed into a exceedingly competitive sport which requires a excessive stage of physical, physiological and psychological health. The sport at a excessive degree of competition calls for faster unexpected moves and speedy reaction (Vassil & Bazanovk, 2012). Volleyball fits have no time restrict and suits can last for numerous hours, if the teams are calmly matched. Successful play in volleyball isn't always the final results of strength by myself however it's far the made from the mixed show of energy and tactical competencies. Modern game of volleyball is characterized by using accuracy, concentration and cleverness (Peitz et al., 2018).

Volleyball athletes frequently engage in plyometric training to beautify their electricity and agility on the court. Plyometric physical games, characterized by using speedy stretching and contracting of muscular tissues, aim to enhance muscle energy, explosiveness, and common overall performance in sports activities (Sarkar et al., 2020). In the context of volleyball, the needs of the sport require athletes to execute powerful jumps,

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fast directional changes, and precise actions, making plyometric education a important thing in their conditioning routine (Muanjai & Namsawang, 2015). While the benefits of plyometric Training in volleyball are extensively stated, there exists a want for a complete analysis of various plyometric Training protocols. Previous studies has provided treasured insights into the efficacy of plyometrics in improving vertical bounce top and agility in volleyball players (Stojanović et al., 2017). However, a comparative analysis of various plyometric education methods is lacking, leaving coaches and practitioners with constrained steering on the most suitable protocols for maximizing athletic overall performance in volleyball.

Plyometrics, derived from the Greek word 'plethyoin' (meaning 'same period'), involves exercises that enhance muscle power through rapid lengthening followed by a strong contraction. The term 'plyo' signifies 'greater,' and 'metric' indicates a 'measured amount,' emphasizing the technique's foundation and a quick muscle stretch preceding a contraction yields a significantly stronger response (Rocha Henrique et al., 2023). Plyometric exercises, including depth jumping, hopping, and bouncing drills, utilize gravitational force and the contractile and elastic properties of muscle tissues to enhance muscle strength and performance. This dynamic training method, which increases strain on targeted muscles, can be seen as an advanced form of the 'shock' method for boosting athletic performance (Ramírez-Campillo et al., 2016). The surprise technique recommended by Verkhoshansky involves rebounded jumps from a peak to enhance the athlete's reactive neuromuscular system. Plyometric exercises, derived from the Greek words for "increase" and "measure," involve muscles working both concentrically and eccentrically. The principle behind plyometrics is that a rapid muscle lengthening immediately before contraction leads to a significantly stronger contraction (Ali et al., 2023; ALi et al., 2023; Almeida et al., 2021). Other phrases used alongside plyometric are depth jumping, box leaping and bounce Training. The delivered contraction electricity is thought to be due to a energy of muscle spindles involving the reflex and resulting in an growth frequency of motor unit discharge.

Depth leaps, a type of plyometric exercise, involve an athlete standing on a platform and stepping off to immediately execute a maximal vertical or horizontal jump upon landing (Vadivelan & Sudhakar, 2015). Plyometric education is one of the high-quality methods of developing explosive power in sports activities. Basically, plyometrics offer a way of Training for the highest quality relationship between electricity and pace with the intention to ultimately show up itself as explosive power. Today plyometric actions are carried out in almost all sports. Basic strength level ought to be attained earlier than beginning plyometric Training programmer. The preference of exercising need to correspond to age, sex and biological improvement of sports activities person (A. Ali et al., 2023; ALi et al., 2023; S. L. Ali et al., 2023; Dinh et al., 2023; Saleem Naz Babari et al., 2024). These should progressively increase the stress at some point of an entire training cycle. Body weight have to be the figuring out aspect in assigning the cost of jumps in workout (Bedoya et al., 2015). Generally, the number of sessions to be dedicated to the plyometric Training is 2 or 3 instances according to week Plyometric exercising is a fairly new concept of education that applies the precise precept concerning the existing energy situations of the muscle prior to explosive contraction. The effect of plyometric physical games in increasing vertical jumping potential has beens studied experimentally, but no try has been made if they're extra effective than the kinetic exercise (Beato et al., 2018).

Plyometric education, a shape of exercising characterized with the aid of speedy muscle lengthening and contraction, has turn out to be a distinguished thing within the conditioning regimens of volleyball athletes. The fundamental precept underlying plyometrics is the usage of the stretch-shortening cycle, wherein muscle mass are unexpectedly stretched and straight away shrunk to generate maximal force (Kobal et al., 2017). In the context of volleyball, plyometric physical activities intention to decorate precise components of athletic performance important to the game. Volleyball is characterized through explosive actions together with leaping, spiking, and speedy lateral transitions, all of which demand an excessive degree of energy and agility. Plyometric education is specifically relevant to volleyball gamers because it targets the neuromuscular device, enhancing the efficiency of muscle contractions and improving the pressure manufacturing required for dynamic movements at the court (di Cagno et al., 2020; Shafiq et al., 2024). Common plyometric sports in volleyball education

encompass intensity jumps, bounding, and box jumps, all designed to mimic the demands of the sport and improve talents like vertical bounce top and short directional modifications. Incorporating plyometric training into volleyball conditioning has proven effective outcomes on overall performance outcomes. Studies have tested upgrades in vertical bounce peak, spiking strength, and average agility among volleyball athletes who go through systematic plyometric training interventions (Giovanelli et al., 2017). The transferability of plyometric variations to the unique demands of volleyball makes it a treasured Training modality for coaches and athletes striving to optimize on-court carry out.

The present literature on plyometric Training in volleyball lacks a comprehensive synthesis of studies that immediately compares distinctive Training protocols. Although several studies have for my part investigated the impact of plyometric Training on various overall performance results in volleyball athletes, there stays a superb gap inside the literature regarding the comparative analysis of these protocols (Nwanna et al., 2024; Sporri et al., 2018). This gap in knowledge poses a task for coaches and practitioners seeking proof-based guidance on the simplest plyometric education strategies for volleyball athletes.

Identify the Gap or Controversy within the Existing Literature and Current studies in plyometric education for volleyball predominantly includes person research analyzing particular factors of overall performance, along with vertical soar top or agility. However, a comprehensive understanding of the relative effectiveness of different plyometric education protocols is missing. Some studies may emphasize one type of plyometric exercising over any other, creating a capacity controversy in the literature concerning the most advantageous technique for volleyball. This gap in know-how necessitates a meta-analysis which can systematically assessment and synthesize the present evidence, supplying a more nuanced attitude at the comparative efficacy of numerous plyometric training interventions.

Highlight the Need for a Comparative Analysis of Plyometric Training Protocols in Volleyball The want for a comparative analysis arises from the numerous natures of plyometric sporting events hired in volleyball Training and the absence of consensus at the most useful protocols. Coaches and athletes currently lack a complete aid that directly compares the effects of various plyometric education strategies, hindering the improvement of proof-primarily based Training packages (Chu, 1998; Gjinovci et al., 2017) By conducting a meta-analysis, we purpose to deal with this hole with the aid of offering a synthesized view of existing research, taking into consideration a better-informed expertise of which plyometric education protocols yield the most sizeable improvements in volleyball performance.

The number one goals of this meta-analysis are to systematically review and synthesize present studies on plyometric training protocols in volleyball. The desires and specific targets of the meta-analysis are as follows:

Evaluate the Comparative Efficacy of Plyometric Training Protocols, Address Methodological Variability Across Studies, Quantify the Magnitude of Plyometric Training Effects, Explore Subgroup Analyses to Identify Moderators, Assess Publication Bias and Study Quality Provide Evidence-Based Recommendations for Coaches and Practitioners.

MATERIALS AND METHODS

This meta-analysis was conducted in accordance with the guidelines specified in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement (Figure 1).

Inclusion Criteria

The meta-analysis will encompass various take a look at designs, with a primary emphasis on randomized controlled trials (RCTs) to make certain a higher degree of methodological rigor. Additionally, observational studies, and systematic reviews/meta-analyses may be taken into consideration to offer a comprehensive evaluate of the available proof. Inclusion criteria will contain studies presenting members identified as volleyball athletes. This consists of people actively engaged in volleyball Training or competitive play, irrespective of age, gender, or skill degree. The numerous inclusion of contributors aims to capture a vast representation of the volleyball populace. The intervention of hobby may be plyometric training protocols. This encompasses quite a few physical games designed to decorate muscular strength, agility, and other performance-associated attributes specific to volleyball. Plyometric sporting activities may additionally consist of but are not confined to depth jumps, container jumps, and bounding

sporting activities. Selected research should record quantitative statistics on overall performance indicators directly relevant to volleyball. Key outcome measures encompass, however are not limited to, vertical soar height, agility (e.G., travel run instances), spiking energy, and different generally assessed metrics reflective of volleyball performance.

Exclusion Criteria

Exclusion criteria applied to research that lack enough records for effect size calculations or exhibit methodological flaws that compromise the inner validity of the consequences. This ensures that covered research make contributions sturdy and dependable facts to the meta-analysis. Studies that do not explicitly check out the results of plyometric Training on volleyball overall performance may be excluded. This criterion guarantees that the meta-analysis remains centered on the particular studies query concerning the effect of plyometrics in the context of volleyball.

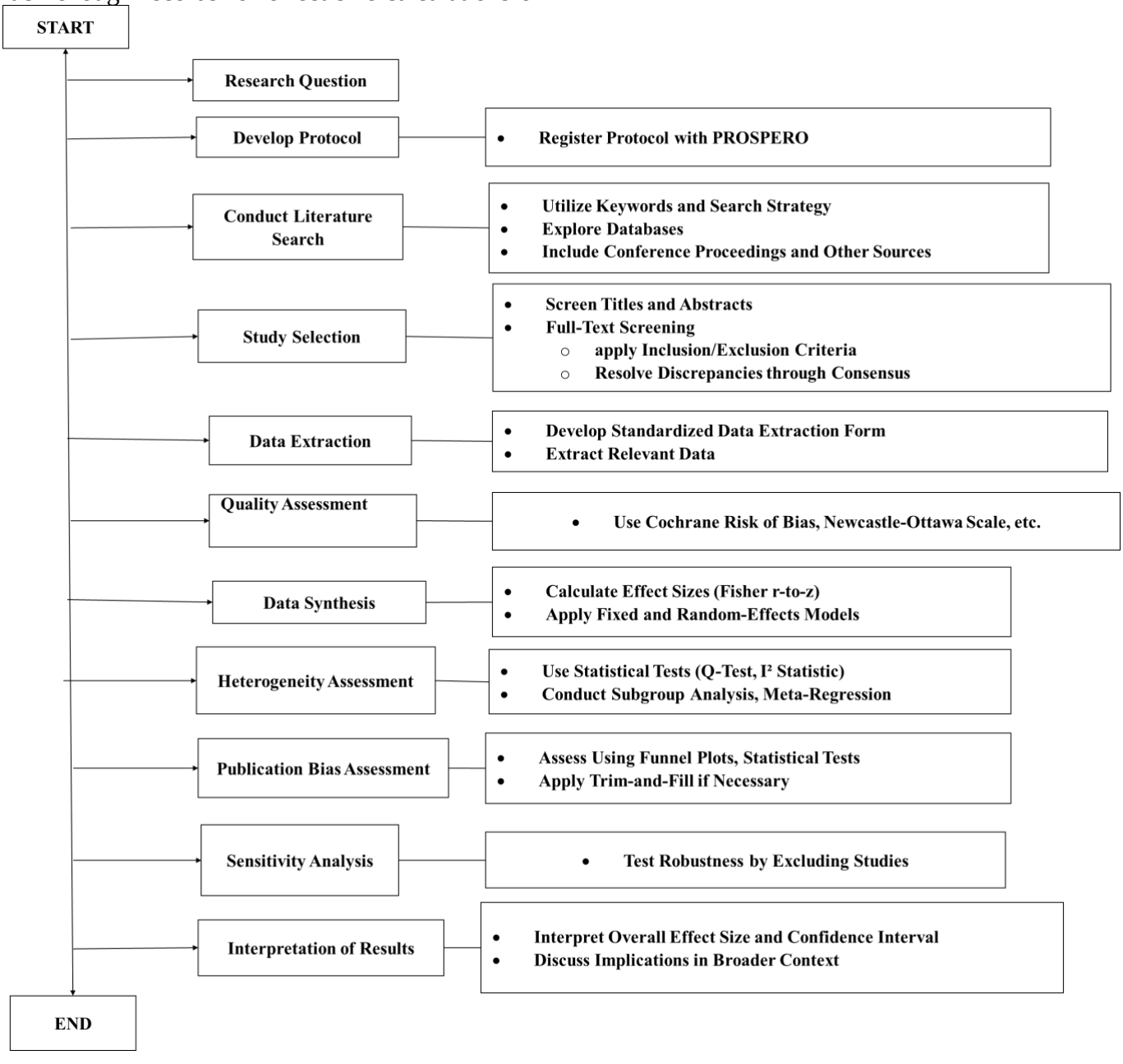

Figure 1. PRISMA Flow diagram of meta-analysis

Search Strategy

Electronic databases, including PubMed, Scopus, SPORT Discus, and PsycINFO, can be systematically searched the use of a combination of controlled vocabulary terms and relevant key phrases. Inclusion criteria could be implemented to

filter out outcomes, making sure alignment with the observe kinds, individuals, interventions, and final results measures outlined above. Exclusion standards could be used to dispose of research that fall outdoor the scope of the research question, preserving the specificity of the meta-analysis. The literature search will encompass research posted within 2015-2022 years. This time-frame moves a stability between capturing current advancements and practices in plyometric education at the same time as maintaining a sufficiently robust body of literature for analysis.

Data Extraction and Quality Assessment

Clearly distinguish among various observe designs, presenting insights into the strengths and barriers related to every layout. For instance, RCTs provide excessive inner validity, while observational studies may additionally offer treasured actual-international context (Table 1).

Table 1. Previous study results

Study	Participants	r	N
(Alp & Mansuroglu, 2021)	Male	0.4	20
(Harmandeep et al., 2015)	Male & Female	0.1	10
(Mroczek et al., 2017)	Female	0.4	60
(SHAIK MANNAN, 2015)	Male & Female	0.3	62
(Rao & Rao, 2016)	Male	0.8	14
(Ahmad & Jain, 2020)	Female	0.8	21
(Novita et al., 2022)	Female	0.3	25
(Gjinovci et al., 2017)	Male	0.6	60
(Kumar & Jadia, 2021; Shoukat et al., 2024)	Male & Female	0.8	50
(shaık mannan, 2015)	Male	0.4	26
(Vadivelan & Sudhakar, 2015)	Male	0.2	34
(Mroczek et al., 2017; Riaz et al., 2024)	Male	0.7	14
(Çimenli et al., 2016)	Male & Female	0.9	15
(Mroczek et al., 2017)	Male	0.7	12
(shaık mannan, 2015)	Female	0.9	23
(Krzysztofik et al., 2021)	Female	0.6	17
(Mroczek et al., 2017)	Male	0.2	19
(Çimenli et al., 2016)	Female	0.5	30
(Vassil & Bazanovk, 2012)	Male & Female	0.7	63
(Maciejczyk et al., 2021)	Male	0.9	41
(Zghal et al., 2019)	Male	0.7	43
(Machado et al., 2019)	Male	0.2	23
(Fischetti et al., 2018)	Female	0.4	34
(Weeks et al., 2023)	Male & Female	0.5	36
(Bianchi et al., 2018)	Male	0.8	29
(Becerra-Patiño et al., 2023)	Female	0.9	31
(Alp & Mansuroglu, 2021)	Female	0.3	37
(Sporri et al., 2018)	Male	0.6	26
(Giovanelli et al., 2017)	Female	0.5	29
(di Cagno et al., 2020)	Male	0.8	31
(Kobal et al., 2017)	Male	0.9	22
(Beato et al., 2018)	Male	0.3	51
(Bedoya et al., 2015)	Male & Female	0.9	34
(Vadivelan & Sudhakar, 2015)	Female	0.7	40
(Almeida et al., 2021)	Female	0.5	56
(Ramírez-Campillo et al., 2016)	Female	0.8	18
(Rocha Henrique et al., 2023)	Male	0.5	22
(Stojanović et al., 2017)	Female	0.7	26
(Muanjai & Namsawang, 2015)	Male & Female	0.9	20
(Sarkar et al., 2020)	Male	0.7	42

Delve into player characteristics to recognize the variety of the look at populace. Document any versions in age, gender, skill stage, or different applicable elements that might impact the generalizability of the findings. Extract detailed records about the plyometric Training protocols,

which include the specific physical activities worried, training frequency, period, and any variations throughout interventions. Systematically categorize the effects measured in each take a look at. This can also involve performance indicators unique to volleyball, as well as any secondary results that contribute to a holistic know-how of the intervention's effect.

Assess the adequacy of randomization approaches and participant allocation, emphasizing research with robust strategies to reduce choice bias. Evaluate whether or not blinding turned into carried out effectively, considering both participant blinding and final results assessment blinding. Blinding complements the reliability of examine consequences by decreasing the potential for bias. Examine how research address player dropouts and withdrawals. Transparent reporting and appropriate dealing with of missing statistics contribute to the overall methodological first-class. Employ the Cochrane Risk of Bias tool for RCTs, considering domains together with random collection generation, allocation concealment, blinding, incomplete final results statistics, and selective reporting. Utilize the Newcastle-Ottawa Scale for observational research, comparing selection, comparability, and outcome assessment to gauge observe nice. Which includes systematic reviews/meta-analyses, apply AMSTAR 2 (A Measurement Tool to Assess Systematic Reviews) to evaluate the methodological first-rate of those higher-degree evidence syntheses. For drawing the forest plot, the "metafor" library in R was employed. The statistical analyses were conducted using R (version 2023.09.1+494), and the specific functions within the "metafor" package were utilized for effect size estimation and forest plot generation (Supplemrtry file 1).

RESULTS

Correlation Coefficients (r, N)

The fixed-effects model, implemented to the records with k=40 research, revealed an anticipated average Fisher r-to-z transformed correlation coefficient of 0.7531 (ninety-five% CI: 0.6952 to 0.8110) (Table 2). The intercept had a good sized advantageous estimate of zero.753, indicating that, on common, plyometric education protocols have been associated with a advantageous effect at the outcome measure. The Z-check for the intercept changed into notably significant (Z = 25.5, p < 0.001), indicating that the found impact differed drastically from zero. The random-effect model, additionally carried out to the same dataset, yielded an anticipated average Fisher r-to-z converted correlation coefficient of zero.781 (ninety five% CI: zero.655 to zero.908). The intercept, with a advantageous estimate of 0.781, remained substantial (Z = 12.1, p < 0.001). The Tau² estimator the usage of the Hunter-Schmidt technique became said as 0.000, indicating no observed heterogeneity table 3.

The model fit statistics and information criteria offer valuable insight into the appropriateness of statistical model under meta-analysis (table 4). The maximum-likelihood model demonstrates a advanced match, as indicated by using its lower log-chance, deviance, AIC, BIC, and AICc values compared to the restricted maximum-likelihood model. While the reduction in deviance and lower AIC and BIC values in the maximum-probability version suggest a higher balance between goodness of fit and model complexity, warning is warranted in deciding on the version entirely based totally on these metrics. It is crucial to do not forget the theoretical context and capability overfitting, as overly complicated models might not generalize well to new statistics. Therefore, a comprehensive interpretation entails weighing statistical standards in opposition to the great implications of the fashions in the particular context of the meta-evaluation.

Table 2. Fixed and random effect model

Fixed-Effects Model (k = 40)							
		Estimate	se	Z	p	CI Lower Bound	CI Upper Bound
Fixed Effect Model	Intercept	0.753	0.0295	25.5	< .001	0.695	0.811
Random Effect Model	Intercept	0.781	0.0645	12.1	< .001	0.655	0.908

Table 3. Heterogeneity statistics.

Heterogeneity Statistics					
Tau	Tau²	I²	H²	R²	df
0.000	0 (SE= NA)	78.53%	4.657	.	39.000

Table 4. Model Fit Statistics and information.

Model Fit Statistics and Information Criteria					
	Log-Likelihood	Deviance	AIC	BIC	AICc
Maximum-Likelihood	-63.160	181.636	128.321	130.009	128.426
Restricted Maximum-Likelihood	-63.919	127.838	129.838	131.501	129.946

Visualization through Forest Plot and Funnel Plot Analysis

Various studies have been performed to assess online publication bias the Fail-Safe N, a measure of the wide variety of extra studies with null findings required to make the discovered effect non-large, was 9405 (table 5). The Begg and Mazumdar Rank Correlation test and Egger's Regression test indicated no massive book bias, despite the fact that Egger's Regression recommended some asymmetry (p = 0.017), The statistical analyses for publication bias were conducted using R scripts with the "metafor" library. The forest plot generated using R is presented in Figure 5, illustrating effect sizes and confidence intervals for each study. The Trim and Fill manner advised the capability addition of 2 studies to regulate for asymmetry.

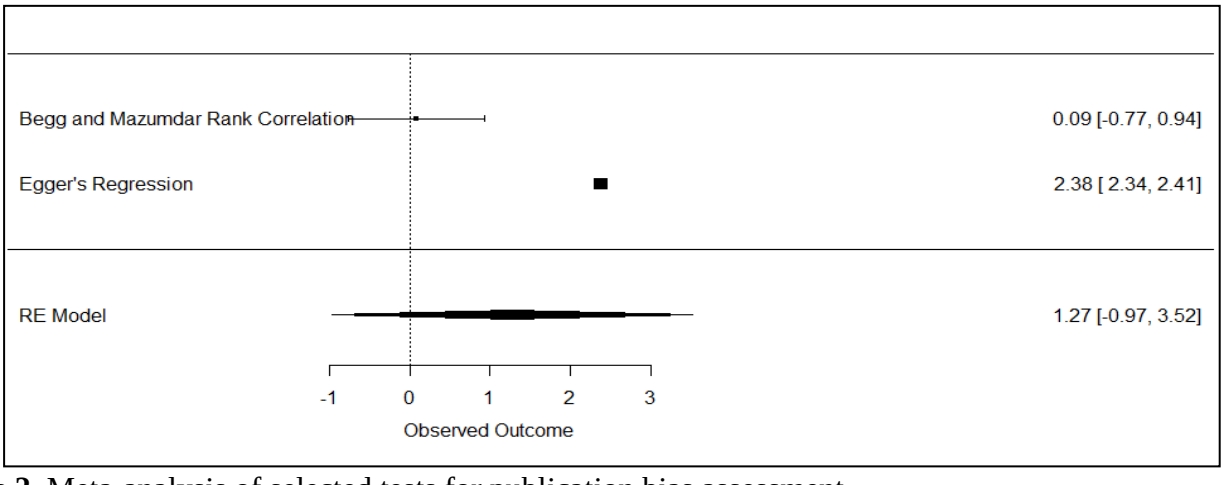

Figure 2. Meta-analysis of selected tests for publication bias assessment

Table 5. Key statistical metrics for publication bias assessment

r		
Test Name	Value	p
Fail-Safe N	9405.000	< .001
Begg and Mazumdar Rank Correlation	0.087	0.435
Egger's Regression	2.377	0.017
Trim and Fill Number of Studies	2.000	.

The analysis utilized the Fisher r-to-z transformed correlation coefficient to measure outcomes in the meta-analysis of polymetric training protocols. Applying a fixed-effects model, the results included the Q-test for heterogeneity (Cochran 1954) and the I² statistic (Table 4). To

identify potential outliers or influential studies, studentized residuals and Cook's distances were evaluated, with studies surpassing the Bonferroni-corrected threshold for studentized residuals (100 x (1 - 0.05/(2k)) Outliers in the data, defined as values exceeding the median plus six times the interquartile range in Cook's distances (a measure of influence in regression analysis), were identified. Funnel plot asymmetry was assessed using rank correlation and regression tests, with observed outcome standard errors as predictors, to detect potential biases (Figure 3).

The analysis comprised 40 studies, with Fisher r-to-z transformed correlation coefficients observed ranging from 0.1003 to 1.4722, predominantly positive across all estimates (100%). The fixed-effects model yielded an estimated average Fisher r-to-z transformed correlation coefficient of \(\hat{\theta} = 0.7531\) (95% CI: 0.6952 to 0.8110), indicating a significant deviation from zero (z = 25.4948, p<0.0001). The Q-test suggested heterogeneity among the true outcomes (Q(39) = 181.6355, p < 0.0001, I^2 = 78.5284%).

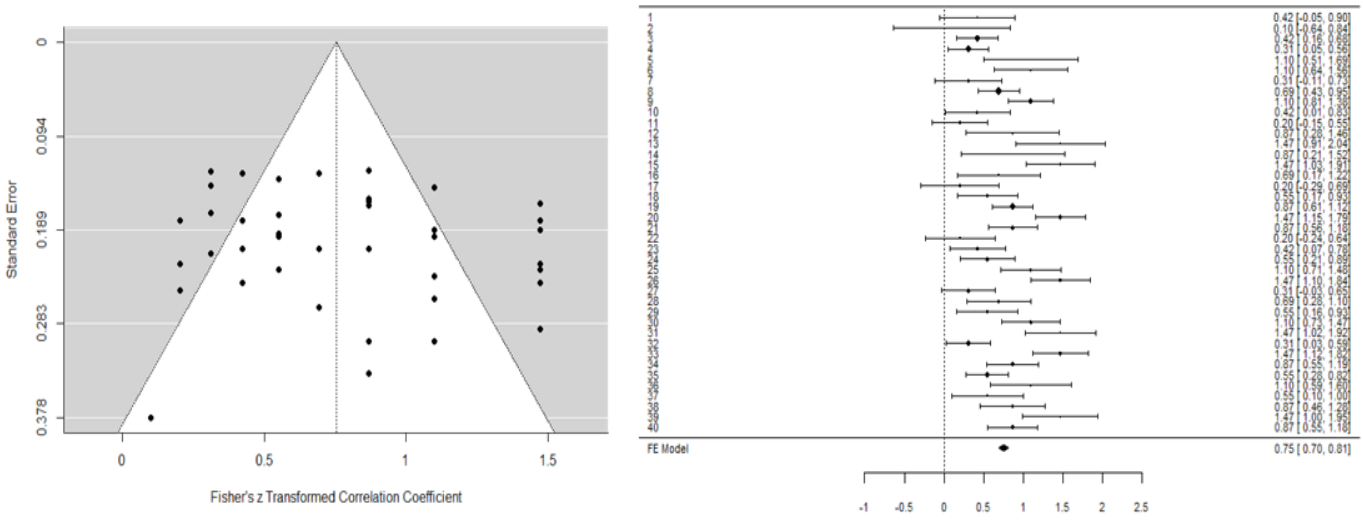

Figure 3. Result of a meta-analysis

The Q-test suggested heterogeneity among the true outcomes (Q(39) = 181.6355, p < 0.0001, I^2 = 78.5284%). Analysis of the studentized residuals identified potential outliers in studies 4, 15, 20, 26, and 33, with values exceeding ±3.2272. However, Cook's distance analysis revealed no studies with excessive influence. The regression test showed funnel plot asymmetry (p = 0.0175), whereas the rank correlation test did not indicate such asymmetry (p = 0.4346).

DISCUSSION

This meta-analysis underscores the significant positive impact of plyometric training on volleyball athletes' performance, as reflected in the strong overall effect size (Fisher r-to-z converted correlation coefficient = 0.7531, 95% CI: 0.6952 to 0.8110). Our results align with previous studies that demonstrate the effectiveness of plyometric training in enhancing explosive power, agility, and vertical jump height—critical attributes for success in volleyball (de Villarreal et al., 2021). The notable heterogeneity observed (I^2 = 78.53%) suggests that variations in training protocols, participant characteristics, and outcome measures may have contributed to the observed disparities between studies, consistent with findings from similar meta-analyses in sports science (Moran et al., 2021; Ramirez-Campillo et al., 2023).

The fixed-effects model highlighted a robust positive relationship between plyometric training and volleyball performance outcomes. However, the random-effects model, with its larger variance, suggests that the effect size may not be uniform across all contexts, reflecting the need for tailored training protocols that consider individual athlete needs and volleyball positions. For instance, setters, spikers, and blockers may benefit from specialized plyometric regimens targeting specific motor abilities (Vychodilová, 2023).

Despite the strong positive correlation, the considerable heterogeneity observed signals the necessity for further standardization in plyometric training regimens (Si et al., 2024). The variability among studies may be attributable to differences in training volume, intensity, and duration, as well as in participant demographics such as age, experience level, and physical conditioning. Similar heterogeneity was reported in studies of other sports disciplines, indicating that a one-size-fits-all approach may not be ideal for plyometric training (Liu et al., 2024).

Furthermore, the potential presence of publication bias, although relatively minor, suggests that some studies with null or negative results might not have been included in the analysis. This highlights the importance of continued, comprehensive reporting of all findings, regardless of statistical significance, to ensure a more balanced understanding of the true effects of plyometric training (Kons et al., 2023; Sanchez-Sanchez et al., 2024).

This meta-analysis provides compelling evidence supporting the effectiveness of plyometric training in volleyball, future research should focus on refining and standardizing protocols to mitigate the variability across studies. Coaches and practitioners are encouraged to adopt evidence-based practices that consider the unique physiological demands of volleyball, contributing to optimized performance and injury prevention. Continued exploration of individualized and position-specific training methods will be crucial in advancing the science of athletic conditioning.

Conclusion

In end, our meta-analysis sheds mild on the connection between plyometric Training protocols and overall performance results in volleyball. The found fine common effect underscores the capability benefits of incorporating plyometrics into Training regimens. However, the large heterogeneity recognized among real effects necessitates a cautious interpretation. Despite diligent efforts to cope with capacity sources of bias and variability, our findings are concern to the inherent challenges of synthesizing diverse research. The mentioned obstacles, such as heterogeneity, e-book bias worries, and variability in have a look at fine, underscore the complexity of the field and the need for refined methodologies in destiny research. Nonetheless, this meta-analysis provides a foundational information of the impact of plyometric education on volleyball performance and offers valuable insights for coaches and practitioners searching for proof-primarily based methods. As the sphere progresses, ongoing studies endeavors can build upon these findings, fostering a nuanced knowledge of most effective plyometric training strategies tailor-made to the dynamic desires of volleyball athletes.

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Declaration of Interest Statement

The authors declare that they have no competing interests regarding the publication of this manuscript

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Ethical Approval

The study titled “Comparative Analysis of Plyometric Training Protocols in Volleyball: A Meta-Analysis” was approved from the Abdul wali khan university Mardan. [Ref: AWKUM-23123451.

Author Contibution

Study Design, S.A., I.B.B. and A.C.G.; Data Collection, S.A.; Statistical Analysis, S.A., I.B.B.; Data Interpretation, S.A., and I.B.B.; Manuscript Preparation, S.A., I.B.B.; Literature Search, S.A., I.B.B and A.C.G. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The dataset used in this study, involving genetic identification and parasite determination in wild rats, is outlined within the manuscript.

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RESEARCH ARTICLE

The Effect of Extracurricular Education on the Motor Activity of School Children

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Abstract
Developing the population's physical activity (especially children and adolescents) is an integral part of the international strategy "Health for all in the XXI century". The purpose of our research is aimed at the development of children's motor activity, which is an integral part of the nation's health. Methods. 28 students aged 8-12 took part in the study (14 children who were engaged in go-karting - boys - 10 people and 4 girls and 14 children who were engaged in beadwork - of them 2 boys and 12 girls). The level of physical condition was assessed with the help of G. L. Apanasenko's express-diagnosis system, and the cognitive sphere of children (memory, attention, thinking) was studied according to L. Vygotskyi. Statistical methods were used for data processing and verification in the Statistica 6.0 program. During the research, it was established that in practice (karting and bead weaving) both mechanisms (educational/developmental and physical activity) are involved. In other words, moderate or high physical activity involving complex movements or rules will positively affect cognitive development. Conclusion. We found that children are influenced not only by sports but also by clubs that are part of the activities of extracurricular education institutions.

Keywords
Physical Activity, School, Sports, Beadwork, Karting

INTRODUCTION

The formation of humanity at all stages of its evolutionary development took place in an inseparable connection with active motor activity. The human body develops in constant motion. Nature itself has decided that human beings need to develop their physical abilities. The child is not yet born, and his future physical and mental development is already interrelated with physical activity (Bohnert at al, 2010). The need for movement, and physical activity is a characteristic feature of the growing organism. Unfortunately, an adult needs much less movement than a child. But movement is necessary, like food and sleep. The body takes a lack of food and sleep, causing a few aggravating sensations.

The development of the population's physical activity (especially children and adolescents) is integral to the international strategy "Health for All in the XXI century". Moreover, in the context of the COVID-19 pandemic (Apanasenko & Volhina, 2000) due to the significant congestion of medical infrastructure in each country, the government's policy of preventing premature death based on lifestyle modifications is the driving force of health.

Motor insufficiency goes completely unnoticed and is often accompanied by a sense of

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comfort. A lack of physical activity reduces the body's resistance to colds and the action of pathogenic microorganisms. People who lead a sedentary lifestyle, and are not engaged in physical culture, are more likely to suffer from respiratory and circulatory diseases. The impact of exercise on the human body is extremely large.

At the same time, excessive use of modern information technologies, reduction of motor activity of schoolchildren, destruction of the value of consciousness, and age-related functional changes in the activity of various body systems, especially children, have led to the deterioration of children's health (Metsäpelto & Pulkkinen, 2012). That is why the problem of forming a healthy lifestyle for school children is relevant.

Numerous scientific studies have shown (Blomfield & Barber, 2009) that physical activity significantly contributes to a healthy lifestyle, and in some cases reduces the negative impact on the human body of bad habits, increases stress resistance and distracts from antisocial behavior. Physical activity is a generating and stimulating factor in the system of a healthy lifestyle and is important for improving the physical development and fitness of the person, and prevention of various diseases, including infectious ones. The National Strategy for Physical Activity in Ukraine until 2025 "Physical Activity - Healthy Lifestyle - Healthy Nation" after analyzing the results of world experience (10 March 2020 - Covid-19) and the current state of development of the domestic system of physical fitness that determines the purpose and main objectives aimed at creating conditions for increasing the level of involvement of the population (especially children and adolescents) in health-improving physical activity.

It is important to choose the right physical activity for each child. Not every child is a born athlete or even particularly interested in sports (Lutsenko at al., 2020). Children should be able to learn the exercises that interest them. That is why the system of extracurricular education has many advantages, because not all extracurricular activities are physical, but are also aimed at developing the creative potential of the child.

All over the world, the out-of-school education system in Ukraine is an integral part of the lives of children and young people. Extracurricular education is an integral part of the education system defined by the Constitution of Ukraine, the laws of Ukraine "On Education", "On Extracurricular Education" (Kurok, Lucenko, at al., 2020), and aims to develop the abilities of children and youth in education, science, culture, physical education culture and sports, technical and other creativity, their acquisition of primary professional knowledge, skills, and abilities necessary for their socialization, further self-realization and/or professional activities.

Today there are several types of out-of-school education institutions in Ukraine, including out-of-school education institutions that can operate in the form of centers, complexes, palaces, houses, clubs, stations, rooms, studios, art schools, small academies of arts (folk crafts), small academies of sciences, art schools, sports schools, children's and youth sports schools of the Olympic reserve, physical culture and sports clubs at the place of residence, physical culture and health clubs for children with disabilities, specialized children's and youth sports schools of the Olympic reserve, children's stadiums, children's libraries, galleries, bureaus, health facilities that provide extracurricular education (Burgess, 2013).

A wide variety of extracurricular activities allows children to find their passions and talents. This can help children feel better. One of the most well-known benefits of extracurricular activities is improving self-esteem. Demonstrating a breadth of interest or commitment to a particular discipline, extracurricular programs can also help older children succeed when it comes to college or the job market.

Extracurricular activities should also be preferred for improving mental health. Both self-esteem and a sense of belonging contribute to the more general benefits associated with mental and psychosocial health. One study (Metsäpelto, & Pulkkinen, 2012) found that adolescents who participated in extracurricular activities showed higher levels of life satisfaction and optimism, as well as lower levels of anxiety and depressive symptoms. However, it has not been studied enough whether there is an improvement in children’s cognitive abilities in extracurricular activities or how it is related to motivating children to physical activity.

Therefore, our article aimed to establish the patterns of motivation of children to physical activity using out-of-school education centers. If school education provides the necessary scientific knowledge, then extracurricular education contributes to the diverse development and

formation of personality (Metsäpelto & Pulkkinen, 2012). By attending institutions that specialize in extracurricular education, your child will have the opportunity to discover new talents or develop existing skills. Teachers who work in such institutions try to maximize the creative potential of everyone who is enrolled in a club or studio.

Today, extracurricular education offers a wide choice and allows you to choose sections, studios, and classes that will not only promote the development of the child but also bring him joy. It can be both sports and creative. By attending a studio of applied arts or a drawing class, the child will develop artistic taste, learn to understand art, and be able to please their parents and loved ones with interesting works. Sports sections are also very popular - the physical development of the child is extremely important. Oriental martial arts or football, gymnastics, or swimming - the choice of the section only depends on the child's inclinations and level of physical fitness.

Visiting out-of-school education institutions takes place during leisure time in the educational institution. Extracurricular sections can operate directly on a school basis or work in local clubs, creative centers, palaces of children and youth, and other institutions of this type. Today, the out-of-school system in Ukraine is represented by state, municipal, and private educational institutions. This allows you to choose both free cultural, educational, and sports facilities, as well as those where parents must pay a certain amount for their children's education (Lucenko at al., 2023). Extracurricular education helps to organize interesting leisure for kids and unleash their creative potential! It is known that the optimal level of physical activity for children is the optimal level of health. Under quarantine, fitness is essential for the prevention of physical and mental health problems.

A sedentary lifestyle leads to health problems (Bohnert, Fredricks & Randall, 2010). Our research has shown that the probability of developing diseases increases by 20% at low levels of motor activity. The probability of multiple pathologies (more than 3 diseases) increases in children and adolescents almost 4 times with low levels of physical activity, and the probability of neurosis - is 2.5 times. Children who have screen time of more than 2 hours a day are also at risk for deteriorating health. According to our data, there are 65.8% of such children. This increases the likelihood of a 45% reduction in performance.

Girls are 2.5 times more likely to lead a sedentary lifestyle than boys.

Therefore, it is necessary to help children remain physically active both in everyday life and in such special periods as quarantine.

Extracurricular activities are additional classes that are not included in the curriculum of the educational institution, they are additional and should be fixed by the relevant regulations recommended by the Ministry of Education and Science of Ukraine. When it comes to education, extracurricular activities can improve daily subject areas or individual interests. These activities may include sports, dance, theater, craftsmanship, speech/debate, or cooking. Under the usual situation before COVID-19, all extracurricular activities for children took place in the school environment without many restrictions, especially protocols related to health safety.

Challenges posed by COVID-19. The presence of COVID-19 has created enormous challenges for all forms of learning (10 March 2020 - Covid-19) (school, extracurricular), as well as many obstacles to the ability to form comprehensive children. Of course, the teachers had a huge task to teach through the screen (Lucenko at al., 2023).

The days before the electronic device were long for both the teacher and the children, with no switching or extracurricular activities to relieve the stress and anxiety created by this new classroom environment. Virtual training during isolation in most regions has forced schools to cancel all sports that took place at school. All sports grounds were closed, all premises, such as theaters or libraries, were closed, and any activity involving children more than 1.5 meters apart was prohibited.

Advantages of extracurricular activities. Extracurricular activities offer all children the opportunity to succeed in a field that is not directly related to learning activities. These activities can increase a child’s confidence and reduce any anxious feelings caused by possible academic demands. Out-of-school activities also allow children to have much-needed unstructured socialization. Many children make friends with peers.

Children from different schools in the district gather to participate in extracurricular activities, and these opportunities provide an exchange of views in a particular field of activity. Many

extracurricular activities give children the opportunity to develop a sense of leadership as activities can involve growth with equalization of challenges to advance in it. Developing and increasing children's confidence is another advantage of extracurricular education. Socio-emotional connections through interaction with peers and/or coaches or instructors shape and improve the children's personality, problem-solving ability, opinion, advocacy, and decision-making skills.

Extracurricular activities for school-age children bring great benefits to the development of a full-fledged child; the absence of these measures, even temporarily, can cause side effects on children's development. Now as most children are familiar with virtual meeting platforms, opportunities for children to pursue a speech/debate program or multi-level learning programs such as art, karate, or dance lessons can be streamed across the screen. Many meeting applications have group facilities that allow teachers to meet with small groups or individual children and provide one-on-one instruction (Giuffrida at al., 2023).

Schools can also hold extracurricular family activities for the school community through virtual meetings, such as a game night, a large-scale skill, or a children's talent night that brings the school community together with fun and socializing. These extracurricular activities are probably the safest ones when you need to limit or eliminate contact with others. Extracurricular activities are necessary, expected, and valuable for children of all ages. Children need the opportunity to succeed outside the classroom or try to engage in activities that pique their interests, and then ignite a passion for the future that can inspire a career.

Purpose - developing children's motor activity is an integral part of the nation's health.

MATERIALS AND METHODS

Participants

The study was conducted in compliance with the basic bioethical provisions of the Council of Europe Convention on Human Rights and Biomedicine (from April 4, 1997), the Helsinki Declaration of the World Medical Association on Ethical Principles of Scientific Medical Research with Human Participation (1994-2008), as well as the order of the Ministry of Health of Ukraine No. 690 dated September 23, 2009.

The study was approved and supervised by the Ethics Committee Oleksandr Dovzhenko Hlukhiv National Pedagogical University (Ref: 20/24), dated 25 May 2024)

For 3 months (August, September-October 2023) the objects of pedagogical observations were children aged 8-12. 28 children were examined (14 children who attended karting classes - boys - 10 people and 4 girls and 14 children who attended beadwork - including 2 boys and 12 girls) (Table 1).

In the study group of children, we studied the level of physical health and features of the cognitive sphere. Karting classes were held 3 days a week - Tuesday, Friday, and Saturday (for practical application of knowledge and measurement of children's physical indicators, a trip to the autodrome is mandatory). Beading classes were also held during the week, but on other days - Monday, Wednesday, and Friday. Those children who were engaged in two groups at the same time - go-karting and bead weaving, combined their activities. The duration of such studies was three months (12 weeks) (Table 2). The duration of one lesson is 3 hours per day. We started our research with the first lesson according to the schedule - Tuesday, August 12, 2023.

Table 1. Demographic data of participants

Data	Group	Values				p
		Minimum	Maximum	Mean	±Sd	
Age (years)	Beadwork	8	12	9,71	1,39	0,5
	Karting	8	12	9,71	1,33	
Height (sm)	Beadwork	126	157	139,29	8,34	0,22
	Karting	126	158	140,43	8,35	
Weight (kg)	Beadwork	28	51	42,39	6,89	0,39
	Karting	28	53	41,89	7,34	

Table 2. A 12-week program of student research with a description of the methodology and duration

Week	Beading	Karting
1 week	1 class, duration 2 hours (Determining the level of physical condition of the body according to the method of G.L. Apanasenko - data collection by anthropometry, measurement of blood pressure, heart rate, hand muscle strength, vital capacity of the lungs and determination of the level of memory, attention and thinking according to the method of L. Vygotsky - test form)	1 class, duration 2 hours (Determining the level of physical condition of the body according to the method of G.L. Apanasenko - data collection by anthropometry, measurement of blood pressure, heart rate, hand muscle strength, vital capacity of the lungs and determination of the level of memory, attention and thinking according to the method of L. Vygotsky - test form)
	2 class, duration 2 hours (Determining the level of physical condition of the body according to the method of G.L. Apanasenko - data collection by anthropometry, measurement of blood pressure, heart rate, hand muscle strength, vital capacity of the lungs and determination of the level of memory, attention and thinking according to the method of L. Vygotsky - test form)	2 class, duration 2 hours (Determining the level of physical condition of the body according to the method of G.L. Apanasenko - data collection by anthropometry, measurement of blood pressure, heart rate, hand muscle strength, vital capacity of the lungs and determination of the level of memory, attention and thinking according to the method of L. Vygotsky - test form)
	3 class, duration 2 hours (Determining the level of physical condition of the body according to the method of G.L. Apanasenko - data collection by anthropometry, measurement of blood pressure, heart rate, hand muscle strength, vital capacity of the lungs and determination of the level of memory, attention and thinking according to the method of L. Vygotsky - test form)	3 class, duration 2 hours (Determining the level of physical condition of the body according to the method of G.L. Apanasenko - data collection by anthropometry, measurement of blood pressure, heart rate, hand muscle strength, vital capacity of the lungs and determination of the level of memory, attention and thinking according to the method of L. Vygotsky - test form)
2-12 week *	1 class	1 class
	2 class	2 class
	3 class	3 class

*Note – the corresponding data presented in the table were repeated every session during the 12 weeks of the study.

These groups of children studied in completely different physical and orientation extracurricular activities. Namely, karting is a kind of motorsport in which cards are used - small racing cars with open wheels. Maps can develop speeds from 24 km/h (amateur models) to 260 km/h (sports supercars). Karting is often seen as an initial step in preparing for more expensive and prestigious motorsports and beadwork - involves children mastering the basic knowledge of beadwork, the development of creative abilities of children, and the formation of their lasting interest in classes in arts and crafts clubs. Children learn to string beads in different ways, to make toys, jewelry, and paintings.

Data Collection Techniques

The level of physical condition corresponds to a certain level of physical health, which can be assessed using the diagnostic express system (Apanasenko & Volhina, 2000), which includes a set of anthropometric and functional indicators.

Express assessment (the main anthropometric indicators (body length and weight) are registered, as well as some functional ones - heart rate, systolic blood pressure, lung vital capacity, and hand muscle strength. Based on the obtained data, indices are calculated: body mass index, vital index, strength index, Robinson index. The results obtained during the initial examination are compared with tabular data with the assignment of a certain number of conditional points for each of the indicators registered for this recipient) of the level of physical health of recipients according to H.L. Apanasenko was developed in two versions: for school-age children and representatives of the adult contingent of the population.

The obtained measurement data was carried out in a specially designated room, we entered it into the author's research protocol, with which theparents were familiarized and consent was given by all the requirements of the law on bioethics. The research protocol contained the following information: age, gender, and anthropometric data - height, and

weight. Dynamometry (Dynamometry is a method of measuring the force of contraction of various muscle groups. There are different types of dynamometers for dynamometry. The most common spring dynamometer. The subject squeezes it with the brush of an outstretched hand. The compression force is indicated by an arrow on a special scale.) and Robinson's index were studied according to the formulas presented below. We calculated all this information in the Statistics 6.0 program. (statistics section). According to Apanasenko's method, the results of the study were translated into the corresponding points, presented graphically in the section.

When determining the level of physical health according to H.L. Apanasenko in adults, the main anthropometric indicators (body length and weight) are recorded, as well as some functional ones - heart rate, systolic blood pressure, the vital capacity of the lungs (VCL, ml), and the strength of the muscles of the hand (Apanasenko & Volhina, 2000)
Based on the obtained data, the indices are calculated:

$$\text{Body mass index} = \frac{\text{body weight, kg}}{(\text{height, m})^2}$$

$$\text{Vital index} = \frac{\text{VCL, ml}}{\text{body weight, kg}}$$

$$\text{Strength index} = \frac{\text{hand strength, kg}}{\text{body weight, kg}} \times 100\ \%$$

$$\text{Robinson's index} = \frac{(\text{heart rate, bpm}) \times (\text{SBP})}{\text{body weight, kg}}$$

Then a standard Martin-Kushelevsky functional test is performed and the recovery time after 20 squats in 30 seconds is recorded. The results obtained during the initial examination are compared with tabular data (separately for women and men), based on which a certain number of points are calculated for the real value of each specified parameter. The assessment of the integral indicator - the level of physical health (LPH, points) is carried out considering the total number of points obtained and the gradation of LPH into the following functional classes: "low", "below average", "average", "above average", "high" (Apanasenko & Volhina, 2000)

When registering the level of physical health of school-age children according to G.L. Apanasenko's method, the same functional indicators are registered, only the ratio of body mass and length is calculated according to special tables, and instead of the heart rate recovery time after 20 squats in 30 seconds, the index of their physical performance is calculated according to the Rufier formula Dixon. The results obtained during the initial examination are compared with tabular data with the assignment of a certain number of conditional points for each of the indicators registered for this recipient. The assessment of the integral indicator - the level of physical health LPH is carried out considering the total number of points obtained and the gradation of LPH into the following functional classes: "low", "below average", "average", "above average", "high". The study of cognitive areas in children, namely, studied the features of memory, attention, and thinking using the following techniques. Research of thinking with the help of Raven's progressive matrix tests, attention with the help of Proofreading (B. Bourdon), and memory according to the method of L. Vygotsky. It should be noted that at the time of the study, all children were completely healthy, and had a good mood while attending their group classes. Parents, in turn, were informed (by letter of agreement) about the appropriate data collection from their children and their further processing (a reference to the convention).

The study was conducted in compliance with the basic bioethical provisions of the Council of Europe Convention on Human Rights and Biomedicine (of April 4. 1997), Helsinki declaration of the World medical association on ethical principles of conducting scientific medical investigations with participation of humans (1994-2008), and the Order of the Ministry of Health Protection of Ukraine № 690 of September 23. 2009.

Statistical Processing

The data were processed by generally accepted statistical methods using the personal computer and the program Statistica 6.0. As the evaluation of each surveyed was based on the points scale we used later not the arithmetic average of the points scored, but the median. For comparison non-parametric methods of analysis were used, in particular the Wilcoxon test.

RESULTS

It may seem that school is a great environment for the development and support of children's

physical activity because that's where the lion's share of a child's life takes place. However, many schools refuse this opportunity. And this is not surprising: schools are required to improve constantly the academic achievements of children. As a result, many educators - and parents, by the way - believe that reading, writing, or math should always be given higher priority than physical education. Therefore, most parents with priority no less than children give priority to a variety of classes in out-of-school education.

Based on this, we decided to explore - how completely diverse classes (karting and beadwork) affect the physical development of school children.

Comparing the level of physical health of children involved in go-karting and beadwork at the beginning of the study, the level of physical health of boys in both groups was low and according to a rapid assessment of the level of physical health by G.L. Apanasenko (2004) scored 1,6 points in the beadwork group and 1,8 points in the karting group. At the end of the study, the level of physical health in karting groups increased and reached a level below average (4,4 points). In the beadwork group, the level of physical health increased (2,4 points) but remained low (Fig. 1a).

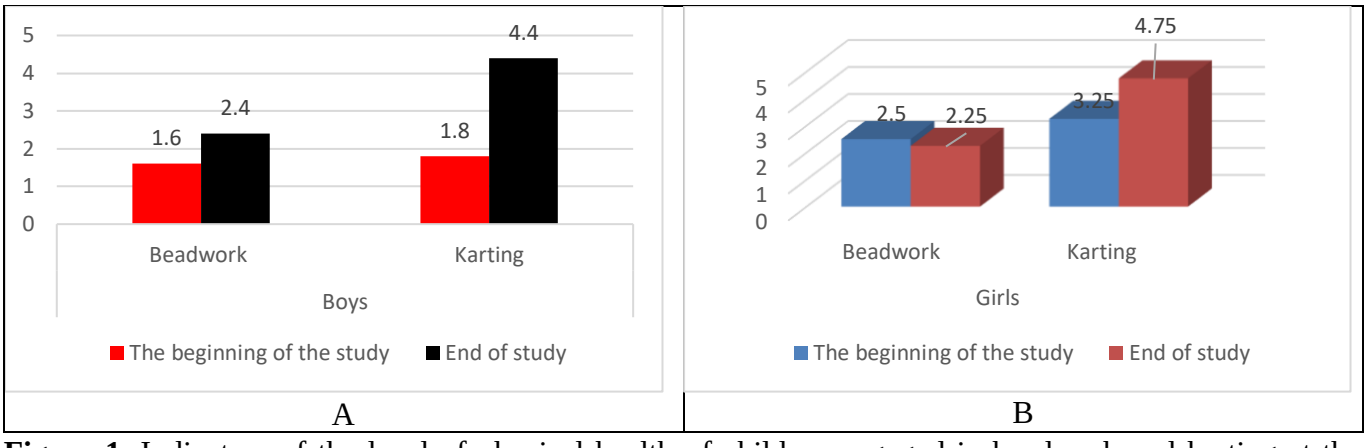

Figure 1. Indicators of the level of physical health of children engaged in beadwork and karting at the beginning and end of the study

The change in the level of physical health of girls in the karting group and the beadwork group is shown in Fig. 1b. At the beginning of the study, girls in both groups had a low level of physical health and averaged 2,50 points in the beadwork group. karting – 2,25 points. At the end of the study, the physical health of girls in both groups increased but remained below average.

The difference in physical health at the end of the karting girls' study was higher at 1,5 points. Thus, the rapid assessment of the level of physical health of boys and girls by G.L. Apanasenko proved that karting has a more effective effect on the level of physical health, which indicates a better adaptation of body systems to physical activity. However, it should be noted that children engaged in beadwork also had positive changes in their physical performance in contrast to the initial level of their values. Beadwork considers manual labor, which triggers muscle work, circulatory mechanisms, etc. Therefore, it cannot be said that activities that are not physically active hurt the physical health of children.

We were also interested in whether there is a direct relationship between the impact of physical activity on children's cognition during various classes. There is convincing evidence of the positive effects of exercise on the cognitive development of the child (Din, 2006). More physically active children generally do better in school: this is reflected in their math, writing, and reading results. Increasing physical activity is associated with improving academic achievement and strengthening connections between areas of the brain, as well as increasing the effective activation of areas of the brain involved in cognitive activity.

Interestingly, the strongest link between the physical and cognitive spheres is in the development of executive functions. Executive functions are a term that combines a set of high-level cognitive processes that allow you to control your behavior and plan actions according to the goal, change reactions depending on the conditions

and context of a situation, pay attention to certain incentives, store information, focus on a specific task, and slow down automatic responses. Executive functions are a very important moment for learning. So, logic tells us that - because the level of physical activity directly affects the executive functions, and executive functions are a necessary condition for academic success - the level of development of these functions in more physically active children will be higher. Consequently, the academic achievements of more active children will be higher. Therefore, using the techniques described above, we decided to explore the features of attention, memory, and thinking (Fig. 2).

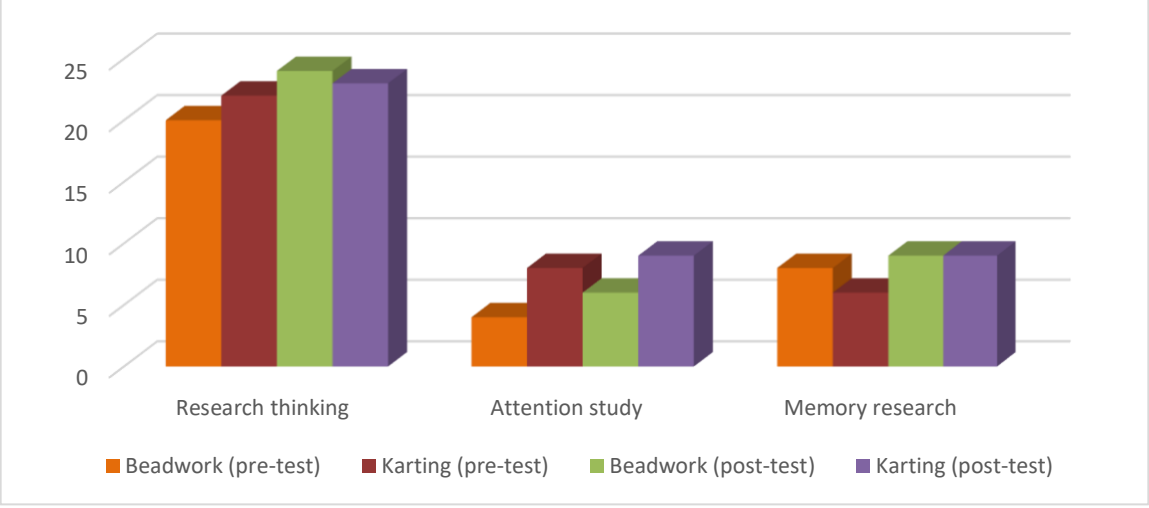

Figure 2. Features of attention, thinking, and memory under the influence of physical activity in children engaged in karting and beadwork.

So how does physical activity relate to cognitive activity?

We understand several mechanisms to explain this connection. The first of them is physiological. According to him, moderate and high physical activity (karting) - causes general physiological changes in the body and specific phenomena in the brain. Physical activity increases blood flow to the brain, leading to structural and functional changes in the long run. For example, increasing the volume of the brain or strengthening the connections between areas of the brain that are often activated together (Fig. 3).

Figure 3. Representatives of the karting club at winter pieces of training

The educational (developmental) approach (beadwork) emphasizes the fact that physical activity itself requires cognitive effort - for example, performing a range of movements with complex rules (Fig. 4). It is believed that such physical activity activates the same areas of the brain that we need to perform cognitive tasks.

Figure 4. In the photo the girl who at the same time goes to the centers of extracurricular education institution on beadwork - we weave necklaces on the special machine (beads) (A) and karting (B)

Thus, these areas have become more "trained", have worked more efficiently, and as a result they allow you to demonstrate greater cognitive abilities. According to the educational approach, qualitative aspects of physical activity (for example, types of activity) determine how strong and durable the impact on a person's cognitive performance will be (Fig. 5).

The results of the research show that in practice both mechanisms are involved. In other words, moderate or high physical activity, which includes complex movements or rules, will have the most positive effect on cognitive development.

Figure 5. A boy sews an angel for Mother's Day

DISCUSSION

As we noted at the beginning of our article, extracurricular education is an integral part of children's lives. It should be noted that the understanding of group work (in particular, the cart-making and bead-weaving that we studied) is characteristic only of extra-curricular education institutions. In Ukrainian schools, there is no such sports or dance club where children would have the opportunity to develop physically. Understanding of extracurricular work is characteristic of subject teachers who have the desire and inspiration to work with gifted children in mathematics, biology, chemistry, etc. All other types of activities that would interest children from a physical and socio-psychological point of view. are in out-of-school education institutions. Therefore, it became interesting for us to investigate the conditions of physical development of children engaged in various types of group work and the specifics of the impact on their physical condition in the conditions of distance education.

To date, both foreign (Bronfenbrenner & Morris, 2006; Shakib, Veliz, Dunbar & Sabo, 2011; Lobman, 2006) and domestic studies (Kurok, Lucenko, et al., 2020; Ramey & Rose-Krasnor, 2012) suggest that children's involvement in

physical activity may be associated with changes in certain brain structures (Burgess, 2013), leading to improved memory function (Forman, Olin, Hoagwood, Crowe & Saka, 2009), (including working memory), memory, as well as cognitive control.

The basic development of motor (mon. gov.ua), cognitive and social skills, which are crucial for further development, occurs in early and middle childhood. Therefore, research on the study of cognitive functions of children at the age of 7-12 years is of particular importance. In childhood, engaging in physical activity, and motor activity is especially important. Lack of physical activity in childhood can lead to limited perception and developmental disorders (10 Match 2020). In addition, the period of late childhood is the time when motility develops most dynamically (Council of Accreditation, 2011), as well as cognitive functions (Kaprio, 2006). Executive functions allow you to get involved in the situation by planning a certain action as well as to slow down or delay the reaction.

Exercise and physical activity increase blood circulation, which leads to a better supply of oxygen to the brain (Farb, & Matjasko, 2012; Kurok, Lucenko, et al., 2020) as well as provide the brain with nutrients (Metsäpelto, & Pulkkinen, 2012). Exercise positively affects all systems: motor, cardiovascular, respiratory, hormonal, immune, and nervous. Thus, it stimulates the maturation of motor areas of the brain, which in turn affects motor development and increases the speed of nerve impulses.

Physical activity also stimulates an increase in neurohormonal secretion (Veltz & Shakib, 2013) (substances produced by hypothalamic neurons and transported by blood or cerebrospinal fluid), significantly affecting the excitability of neurons that form synapses. School-age children who spend at least an hour a day exercising show much better cognitive function, and researchers emphasize that despite these undoubted benefits (Lobman, 2005), only about a third of children exercise regularly.

Conclusions

Based on the literature data and combining them with our study, we came to the following conclusion. It is especially necessary to encourage children to be physically active at the age of 7-12, as the child's cognitive functions increase. We also emphasize that physical activity positively affects all systems: motor, cardiovascular, respiratory, hormonal, immune, and nervous.

We also emphasize the fact that not only active sports improve general health, but also clubs that are part of the activities of out-of-school educational institutions as well. This is confirmed by our research on karting and beadwork.

It is an indisputable fact that the system of out-of-school education both in Ukraine and abroad, and we emphasize/insist on it, is part of the educational process when a child develops new knowledge, skills, and abilities through sports achievements, creativity, creativity, etc. That is, not only does the school affect the creative potential of children, and the development of certain abilities and skills, but also the extracurricular system makes its adjustments in this process.

Therefore, it is necessary to motivate children to physical activity and extracurricular education helps in this.

Ethical considerations

The study was approved and supervised by the Ethics Committee Oleksandr Dovzhenko Hlukhiv National Pedagogical University (Ref: 20/24), dated 25 May 2024)

Conflict of Interest

The authors declare no conflicts of interest.

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Author Contributions

Study conception and design: GL, OL; Data Collection: OD, VS; Analysis and Interpretation of results: GL, OL; Draft manuscript preparation: OL, OD, VS; All authors reviewed the results and approved the final version of the manuscript.

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RESEARCH ARTICLE

Ergonomic Pad Design of IoT-Based Portable Electric Wheel-chair

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Abstract

Background and Aims: Wheelchairs are a basic necessity for people with disabilities, especially people with physical disabilities. Although conventional wheelchairs have aided the mobility of people with disabili-ties, they are limited in scope due to physical exhaustion and health problems from sitting in wheelchairs for a long time. This research is important to develop seatback and cushion features for Health Electric Wheelchair Portable IoT-Based wheelchairs, for easy and comfortable mobil-ity for people with disabilities. The development of wheelchairs aims to reduce the negative im-pact of prolonged immobilization on people with physical disabilities. **Methods:** Research & Development method. The development stage: 1). The development of pads for Health Electric Wheelchair Portable IoT-Based seatback and cushion needed by wheelchair users; 2). Development of expert-validated Health Electric Wheelchair Portable IoT-Based ergonomics and seatback in accordance with the needs of wheelchair users to improve physical independence; 3). Modify components and equipment for Health Electric Wheelchair Portable IoT-Based cushion and seatback. **Results:** The result of this development of this wheelchair pays attention to ergonomic design by developing seatback and chair features for Health Electric Wheelchair Portable IoT-Based wheelchairs to provide safety and comfort when using wheel-chairs, especially physical disability. **Conclusion:** The development of cushion and seatback on wheelchairs can reduce the negative impact of immobilization on people with physical disabilities and is able to provide broad access for users to mobilize on wheelchairs and can adjust to the ergonomics of each user's body.

Keywords
Ergonomic, Wheelchair, Cushion, Seatback, Physical Disability

INTRODUCTION

In 2018, it was known that the proportion of people with disabilities in Indonesia for ages 5-17 years was 3.3% and 18-59 years old was 22% (Pusdatın Kemkes, 2019). The proportion of people with disabilities is increasing so many tools must be developed to meet their needs (Moll & Cott, 2013). Of the approximately 49 wheelchair users, it was found that about 96% of people with disabilities wanted to have a wheelchair that was safe, comfortable, and inexpensive (Sunardi et al., 2021, 2023) to provide ease of mobilization for users in terms of usability, accessibility, safety, cost, stigma and participation from time to time (Labbé et al., 2020).

Difficulty in movement or mobility (Jatmiko, 2019; Jauhari &Wasesa et al., 2022) being one of the most commonly reported functional difficulties, a problem that is usually overcome by using special devices or equipment (Dudgeon et al., 2008) such as wheelchairs or crutches. Wheelchairs are crucial in the independence of people who have physical barriers (Dudgeon et al., 2008; Hsu et al., 2012). The World Health Organization (WHO) estimates that around 65 million people in the world use wheelchairs (electric or manual) (WHO, 2018), representing about one percent of the world's

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population (Armstrong et al., 2008). Using the right and suitable wheelchair will help wheelchair users to improve their quality of life (Iksal & Darmo, 2012; Setyaningsih & Gutama, 2016) and also their social conditions (Jatmiko, 2019). As stated in a discussion paper by the South African Revenue Services (SARS) in relation to persons with disabilities, infrastructure modifications need to be made to make certain structures accessible to persons with mobility disabilities so that they can function or carry out daily activities (Naidoo et al., 2014). If the wheelchair is not suitable or comfortable, the body will be injured (Yuan & Guan, 2014) So that mobility is limited, environmental exploration is also limited (Bray & Tudor Edwards, 2020; Davis, 2011).

About <75% of pad designs greatly affect a person's sitting posture (Dénes et al., 2020). Because, sitting posture and is an important factor that affects the function of the limbs (Sprigle et al., 2003) underlying bone function due to pressure or shift (Shechtman et al., 2001) underlying bone function due to pressure or shift (Hsu et al., 2018), decreased ability to relieve pressure by frequently changing their body position causing them to experience pressure sores or low back pain (Ma et al., 2017). In fact, the main purpose of using a wheelchair is to maximize the functional potential in people with physical disabilities (Shechtman et al., 2001) using a comfortable pad and seatback (Bhatia et al., 2022). Therefore, optimizing the design of the wheelchair pad that can be adapted according to the needs of the user (Defloor & Grypdonck, 1999) and ergonomics should be one of the main goals in designing a wheelchair (Li et al., 2020).

More than 200 models of wheelchair pillows/pads commercially available (Sprigle et al., 2003). As stated by (Garber & Krouskop, 1984) pads used in wheelchairs should be able to reduce the pressure of wheelchair users, which is currently used clinically (Rosenthal et al., 1996) and made with a wide variety of materials such as water, gel, foam, corrugated (egg crate), viscoelastic (Koo et al., 1996; O'Sullivan et al., 2012) and contoured pillows, which are shaped to fit the individual's body (Gil-Agudo et al., 2009).

From the facts above, it is very important to develop a portable pad that has been made in PUPT 2021 to support the independence of mobility for people with physical disabilities. The development of wheelchair pad standards will include means to measure and describe pad characteristics and performance. This study concentrated on the first, pad characteristics defined as physical features or attributes. Meanwhile, for pad performance, it relates to the way the pad functions in its role as a surface.

MATERIALS AND METHODS

Wheelchair Pad Design

Pad/pillow selection is not a trivial matter for many wheelchair users (Sprigle et al., 2001). Loss of motor or sensory function is a significant risk factor for low back pain that workers are exposed to during periods of time when they are sitting or not sitting, such as manual material handling or lifting activities, or psychosocial factors (De Carvalho et al., 2010). As stated by (Kamegaya, 2016) the ideal sitting posture for wheelchair users is with the pelvis pressed posteriorly on the ischium (sitting bone) sliding forward by 5 cm with a significantly greater posterior pelvic tilt during sitting. Factors such as manufacturing materials, shape or even mechanical and thermal responses from sitting can be potential contributors to the appearance of back and ischium pain (Williams et al., 2017).

Pad has become a complex topic for low back pain researchers because of the sitting position problems as shown in Figure 1 (Hobson, 1992) is one of the most expensive disorders found (Defloor & Grypdonck, 1999; Kelsey, 1975; Magora, 1975). Many investigations have focused their attention on the factors that cause injuries, especially on activities and events associated with the onset of symptoms in wheelchair users (Riihimäki, 1991).

Various positions and sitting characteristics of wheelchair users as shown in Figure 1 require pad support so that wheelchair users do not experience pain or shifts in bone construction (Kirby, 2016), thus providing comfort and security to users (García-Molina et al., 2021). The benefits of pads provide assistance in the form of pressure or redistribution to minimize these risks (Chai & Bader, 2013) with different pad characteristics (Lee et al., 2016).

To increase understanding of the factors that provide pad comfort in wheelchairs with foam hardness with bone posture and terrain commonly traversed by wheelchair users (Ebe & Griffin, 2001). Thus, the pad can provide the best cushioning and pressure according to the needs of each individual (Pellow, 1999).

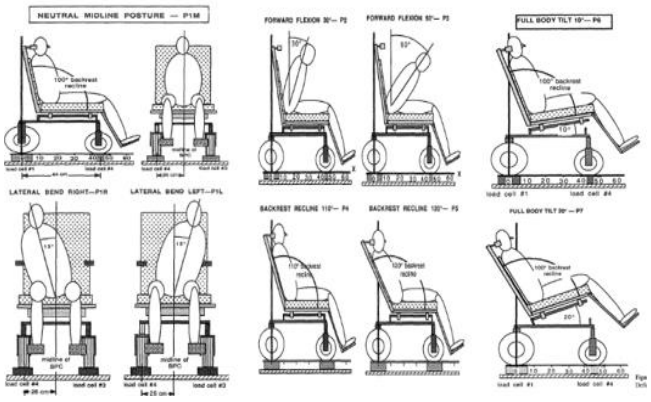

Figure 1. Wheelchair user's sitting posture (Hobson, 1992)

Wheelchair Pad Design

Surveys and studies show that more than 50% of respondents express the importance of ergonomic seating because proper ergonomic seating furniture with proper use can help reduce injuries and so-called cumulative trauma disorders (Parent-Thirion et al., 2007). From the point of view of ergonomics, high comfort is related to well-being, a feeling of security and a healthy sensation of the user (Dénes et al., 2020). The literature research process has identified 15 articles that contain that the material of the base and structure of the wheelchair is a factor in the discomfort of wheelchair users when using it (Syakura et al., 2021; Hostens et al, 2001) argued that an even distribution of pressure can be overcome after the ergonomic design of the seating system according to the needs with various anthropometric variations on foam cushions that have contour. Complies with many basic ergonomic requirements, health and level of dependency of the user (Diebschlag et al., 1988; Harms, 1990). Thus, creating better pressure than pads with flat foam.

In supporting ergonomics, anthropometry is needed, anthropometry plays an important role in the fields of industrial design, clothing design, ergonomics, and architecture (Sokhibi, 2017). In these areas, statistical data on the dimensional distribution of the body of a population are necessary to produce an optimal product (Kristanto & Saputra, 2019). Anthropometry will basically concern the physical size or function of the human body, including here linear size, weight, volume, space of movement, and others that will be very useful in planning work equipment or work facilities (Mardiana et al., 2020; Yudiantyo, 2020).

Method

The research method used is the Research and Development method (Gall et al., 2003). This method was used to develop research products that have been carried out previously, namely Health Electric Wheelchair Portable IoT-Based. The pad in the previous study will be re-designed, to be more suitable with the needs of wheelchair users and for embedding features related to ergonomics that follow bone construction. The initial stage of development is to conduct research on 1). the development of pads for Health Electric Wheelchair Portable IoT-Based seatback and cushion needed by wheelchair users; 2). development of expert-validated Health Electric Wheelchair Portable IoT-Based ergonomics and seatback in accordance with the needs of wheelchair users to improve physical independence; 3). modify components and equipment for Health Electric Wheelchair Portable IoT-Based cushion and seatback. The development procedure is described in Figure 2.

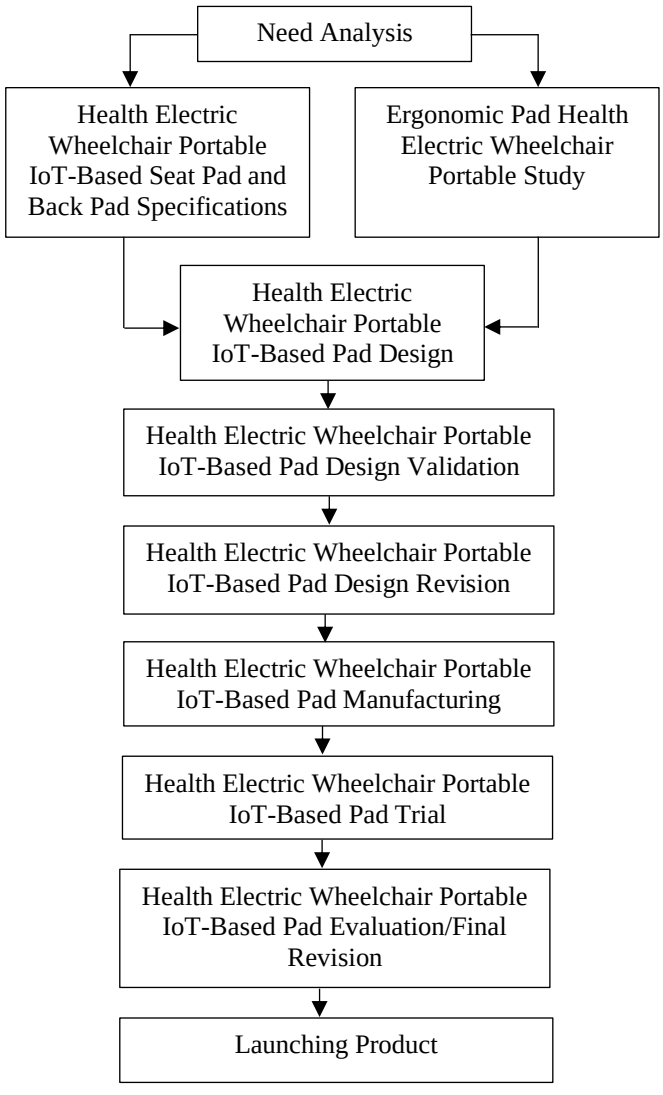

Figure 2. Development procedure

The method to be used to obtain research data is planned to use a survey method with a tool in the form of a questionnaire. In addition, it also uses the

interview method. For Health Electric Wheelchair Portable IoT-Based production equipment using existing equipment in the Laboratory of the Department of Mechanical Engineering, Automotive Engineering and the Physiology Anatomy Laboratory of Faculty of Sports and Health Sciences UNY.

RESULTS

The first step in developing wheelchair cushion and seatback needs features was to distribute a needs analysis questionnaire to people with disabilities and the questionnaire received responses from 49 wheelchair users. From the questionnaire, data was obtained that 1 respondent needed a sitting pad from a specific gel, so that if occupied for hours, he would not be sick to have the number of voters. The wide seating was chosen by 2 respondents. The soft seats was chosen by 15 respondents. The portable cushion feature in wheelchair seating was chosen by 16 respondents. Seats made of animal skins was chosen by 1 respondent. Seats that is permanently integrated with the wheelchair was chosen by 3 respondents. The feature of using a safety strap was chosen by 6 respondents. Features can be folded easily (portable) was chosen by 11 respondents. Temperature control feature (hot/cold) was chosen by 6 respondents. Head support feature in the seatback was chosen by 7 respondents with a voter percentage of 6%. Seat belt feature was chosen by 24 respondents with a voter percentage of 22%. A solid seatback feature with foam coating (padding) was chosen by 19 out of 24 respondents with a voter percentage of 17%. The height setting feature (portable) was chosen by 27 respondents with a voter percentage of 24%. The rear (right-left) thrust grip feature was chosen by 20 respondents with a voter percentage of 18%. The temperature control feature was chosen by 14 respondents with a voter percentage of 13%. The electronic form control feature was not chosen by 49 respondents. Portable features have the largest percentage with 37% with 38 voters from 49 respondents.

Based on data obtained from respondents, soft seatback and cushion were developed, ergonomic, adjustable and can be easily disassembled and installed on various types of wheelchairs (portable). The development and innovation of ergonomic design in this study focused on 3 main components, namely the cushion, back rest, and head rest. Based on data from the needs analysis questionnaire and reference studies related to ergonomics, the initial design and innovation of the 3 components were obtained:

Holder (Seat)

Innovation in wheelchair seats is adaptive (adjustable) using velcro, where the position of the hip support is adjusted, so that it can support and protect the Gluteus Maximus and Gluteus Medius muscles, which can then provide comfort for users.

Figure 3. Cushion

Seatback (Back Rest)

The innovation in the Back Rest is adaptive (adjustable) using a lever shift mechanism, which can be adjusted in height and stretch (width). This setting provides comfort and health in the shape of the user's body because it can support the waist, spine and back (lumbar support).

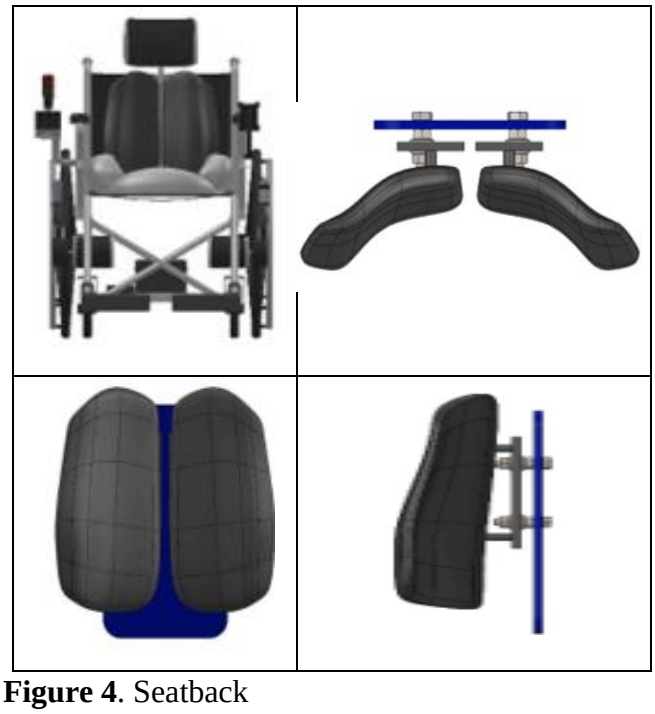

Figure 4. Seatback

Headrest

The innovation in the Head Rest is a shape that is adjusted to the anatomy of the head and the angle is adjusted for the comfort of the neck when

the head rests. Thus, wheelchair users with Head Rest will feel comfortable.

Figure 5. Headrest

DISCUSSION

Identifying the backrest and stand design required by the individual should be done as early as possible in the planning stages to ensure that the posture needs of the wheelchair user can be accommodated and used effectively (Horn, 2018). The use of pads on seatback and stands that are suitable for sitting posture can reduce maximum stress on muscles as well as bones (Ragan et al., 2002). Knowing the pressure on the pressure at the time of sitting is a logical method of assessing this factor (Akins et al., 2011). So that the pad on the cushion and seatback can improve balance significantly when the wheelchair user sits on a wheelchair (Aissaoui et al., 2001).

The symmetrical position and equal weight distribution of the subject on each pad measured by the interface pressure under the sacrum are further aspects that should be considered a priority (Reis, 2008). The wheelchair with a seatback tilt angle that can be adjusted according to needs and comfort can prevent decubitus ulcers . A greater tilt angle can facilitate circulation because the emphasis when sitting in a wheelchair is reduced. This additional component provides convenience to wheelchair users because it can reduce the effects of immobilization due to maintaining the fowler position for too long and prevent the occurrence of incorrect sitting posture on the wheelchair. Everyone has different anthropometry. Anthropometric differences in a person can cause differences in comfort in using the same seatback size. The adjustable seatback size will increase comfort for wheelchair users.

The development of wheelchairs can reduce the negative impact of immobilization on people with physical disabilities. The development of wheelchairs by adding pad seatback and cushion features for wheelchairs Health Electric Wheelchair Portable IoT-Based is useful to provide ease and comfort of mobility for people with disabilities and to reduce the negative impact of prolonged immobilization on wheelchairs. This wheelchair has the advantage of providing wide access for users to mobilize on a wheelchair and can adjust to the ergonomics of their respective bodies. It is very useful for people with physical disabilities because it can train muscle strength and nerve performance so that wheelchair users can minimize atrophy and severity of paralysis.

Conclusion

Wheelchairs are a basic need for people with disabilities, especially for physical disabilities. Although conventional wheelchairs have helped the mobility of people with disabilities, they are still limited in scope because they cause negative impacts in the form of physical fatigue and other health problems due to sitting in a wheelchair for too long. This research develops and innovates wheelchairs with attention to ergonomic design by providing Health Electric Wheelchair Portable IoT-Based wheelchair seatback and cushion features. The first step in developing wheelchair cushion and seatback features is to distribute a needs analysis questionnaire to people with disabilities and from the questionnaire response, soft, ergonomic, adjustable cushion and seatback are developed, and can be easily disassembled and installed on various types of wheelchairs (portable). The development and innovation of ergonomic design in this study then focused on 3 main components, namely the seatback, back rest, and head rest. The development of cushion and seatback on wheelchairs can in fact reduce the negative impact of immobilization on people with physical disabilities and is able to provide broad access for users to mobilize on wheelchairs and can adjust to the ergonomics of each user's body.

Conflict of Interest

During the development and publication of this work, the authors did not reveal any conflicts of interest.

Author Contributions

This research involved the participation of several contributors. Conceptualization, S,A.D,

Y.E, K.S and M.N.J; methodology, S, N.H and L.M.C.; design and development S, Y.E, T.T.P, anf S, validation, A.D, and K.S.; formal analysis, S, A.D and S.; investigation, S, N.H and L.M.C; writing original draft preparation, S, A.D, Y.E, S and E.P; writing review and editing, A.D, N.F and L.M.C visualization, Y.E, K.S, S, and T.T.P; supervision, S and Y.E

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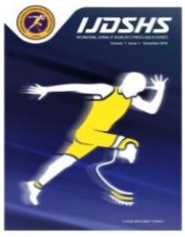

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RESEARCH ARTICLE

Social and Psychological Effects of Tennis on Disabled Individuals

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Abstract
In a social perspective disability can be identified as a 'disadvantage or limitation of activity' caused by a contemporary social organization that takes little or no account of persons with physical disabilities and excludes them from participation in social activities. This study focuses on the effects of sports, specifically tennis, on disabled individuals. In this respect, the research purposes to examine the social and psychological impacts of tennis on disabled individuals. The phenomenology technique, one of the qualitative research methods, was used in the study. 17 wheelchair tennis players, 10 men and 7 women, who played in the International Wheelchair tennis tournaments held in Antalya between 16 November and 5 December 2023, participated in the research. The data obtained from the interviews were analyzed using the thematic analysis. The data obtained from the study were themed under the umbrella of life routine, social and psychological impact, with the coding made as a result of the interviews. Under the theme of life routine, it was seen that issues such as personal development, sense of accomplishment, getting life in order, holding on to life, accepting disability, and health literacy were emphasized. Socialization, social support, commitment, new friendships, and communication skills stand out as values coded under the social impact theme. Self-confidence, happiness, coping with pressure and stress, controlling emotions, focusing, and feeling valuable are the subheadings of the psychological impact theme. It can be said that sports, namely tennis in this study, positively affect individuals' life routines and social and psychological lives.

Keywords
Disability, Tennis, Social Effect, Psychological Effect

INTRODUCTION

Current definitions and theories of disability can be divided into two broad categories: medical and social. The medical model that dominated thinking about disability for much of the twentieth century, especially in Western societies, adopted definitions and perceptions that suggested that disability was an impairment or other "defect" that an individual had that resulted in loss. In this view, disability has traditionally been mainly conceptualized individually or medically (Barnes, 1997). The tendency to define disability primarily through medical means has helped to stigmatize disabled people as having 'undesirable differences' from non-disabled people and to create labels that portray disabled people as 'deviant' and 'abnormal' (Goffman, 1963). Therefore, the assumption about the medical definition and explanation of disability and the policies and professional services it informs is that disabled people must be 'physically whole' or 'normal' to be able to adapt to a predominantly non-disabled environment. One of the most critical problems seen in these definitions is that they focus only on personal limitations, ignoring other personal and social needs of disabled people (Thomas & Smith, 2008). From a medical perspective, disability can be defined as the limitation or loss of physical abilities due to a physical or physiological disorder that occurs in the body from birth or later due to various injuries or diseases (Demir and Aysoy, 2002; Hanson and Hanline, 1990). In light of growing dissatisfaction with the medicalized explanation of disability that

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prevailed in the twentieth century, it began to be widely challenged by various political campaigns led by the disability movement in Europe and North America from the late 1960s onwards. These campaigns have shifted towards greater emphasis on the rights of disabled people to 'live independently .'As a result of these studies, a "social model" movement emerged that focuses on environmental and social barriers that exclude people perceived to be disabled from mainstream society. The social model rejects the view that disability 'results from the presence of a disability'; instead, he sees it as a 'disadvantage or limitation of activity' caused by a contemporary social organization that takes little or no account of persons with physical disabilities and excludes them from participation in social activities (Barnes, 1998). In order to better understand the subject, medical and social definitions of disability need to be examined. More generally, disability can be defined as conditions that can be experienced in a period of life as a part of human life, and that limit the physical, mental, emotional, and social abilities and roles of the individual temporarily or permanently (Emamvirdi et al., 2020). From a social and psychological perspective, it is seen that disabled individuals may be exposed to social discrimination, psychological barriers, and negative attitudes that prevent them from participating in many activities that non-disabled people take for granted and easily participate in (Damanik & Machdum, 2019). In order to get rid of these negative attitudes, there are many activities for disabled individuals to make their lives easier by realizing their potential and increasing their quality of life by enabling them to benefit society (Kumcağız & Avcı Çayır, 2018).

Thanks to sports, one of the most essential activities, disabled individuals become physiologically more robust and can easily integrate into society with sports' social and psychological effects. When it comes to disabled individuals, more emphasis should be placed on quality of life rather than just improving physiological variables. It has been widely proven that a physically active lifestyle is essential for everyone, especially people with disabilities, as it plays a vital role in an individual's health, perception of quality of life, and physical/mental well-being (Kamelska & Mazurek, 2015). It has been observed that adapted sports practices are successful in eliminating the barriers of disability, prejudice, age, gender, and socioeconomic status because they integrate different types of disabilities and provide an enjoyable environment for social integration (Blauwet & Willick, 2012; Wilhite & Shank, 2009). Sports for disabled people are also included in rehabilitation programs to ensure societal adaptation and reveal a sense of self-sufficiency (Koparan, 2003; Valliant et al., 1985). Numerous health, social, and psychological benefits can be obtained from participation in sports (Ciampolini et al., 2017). Psychological benefits include psychosocial well-being, increased self-confidence, increased happiness, reduced feelings of isolation, and improved mental abilities. At the same time, integration into society, challenging negative perceptions of disability at the individual and social level, development of transferable skills, and perceived personal development can be considered social benefits (Leutar et al., 2017; Richardson et al., 2017; Vaillant et al., 1985). The literature on the psychological recovery of individuals with disabilities typically emphasizes improving the quality of life or satisfaction through social integration (Kreuter et al., 1998). Social integration through sports or physical activities is essential to increase the self-confidence of individuals with disabilities.

Additionally, participation in sports activities can help people overcome pain or sadness and positively affect their acceptance of their disability (Ahn et al., 2014). Acceptance of disability is largely subjective and is associated with positive psychological outcomes such as life satisfaction, self-esteem, and self-perception (Lindowski & Dunn, 1974). Disabled individuals can achieve social integration through different sports branches, and tennis is one of the sports that positively affects disabled individuals physically, socially, and psychologically.

Tennis is considered one of the best sports for overall health and recently published research supports this claim (Sinai, 2024). Wheelchair tennis was invented by Brad Parks in 1976, 102 years after the invention of court tennis in 1874, and took its place in the sports industry as a Paralympic event at the 1988 Seoul Games (Davis, 2011). Individuals with physical disabilities often experience stigma and discrimination, which can lead to impaired social interaction and a lack of self-confidence. However, participation in sports, especially wheelchair tennis, can increase social support and integration for individuals with physical disabilities

(Roux, 2012). Playing tennis can provide various physical benefits for people with disabilities, including balance, mobility, agility, strength, and endurance (Leutar et al., 2017). Additionally, participation in wheelchair tennis improves disabled individuals' self-perception of their physical competence (Hedrick, 1984). In addition to the physical benefits, wheelchair tennis has also been found to have positive social and psychological effects on physically disabled individuals. Wheelchair tennis positively affects the thoughts and feelings of disabled individuals about themselves and society about disabled individuals (Stanescu, 2014).

The idea that sports impact individuals' physical, social, and psychological development is one of the most critical factors in motivating researchers to work in this direction. This study focuses on the effects of sports, specifically tennis, on disabled individuals. In this context, the research aims to examine the social and psychological effects of tennis on disabled individuals. The research has two main hypotheses. These are;

a) Tennis positively affects the social life of the disabled individual,

b) Tennis positively affects the psychological life of the disabled individual.

In order to find answers to these hypotheses, participants were asked the following questions to obtain detailed information about their experiences:

a) How has tennis affected your life in general?

b) If you were to list the effects of tennis on your life, what main topics would you mention?

c) What impact has tennis had on these fundamental topics you mentioned?

MATERIALS AND METHODS

Model of the Research

The phenomenology technique, one of the qualitative research methods, was used in the study. Phenomenology explores how people make sense of experience and transform experience into consciousness, individually and as shared meaning. Phenomenological research focuses on what people experience and how they interpret the world (Patton, 2014).

Participants

17 wheelchair tennis players, 10 men and 7 women, who played in the international wheelchair tennis tournaments held in Antalya between 16 November and 5 December 2023, participated in the research. Participants were selected using the purposive sampling technique. By purposeful sampling, participants were required to be 18 or older, to have participated in at least 3 national/international tournaments in the last year, and to have been playing wheelchair tennis for at least 2 years. The demographic information of the participants is shown in Table 1.

Table 1. Demographic Information of participants

Participant Number	Nickname	Gender	Age	Nationality	Tennis Background (Years)
P1	Sandra	Female	22	Portugal	12
P2	Jose	Male	30	Spain	20
P3	Yusuf	Male	42	Turkiye	17
P4	Jurgen	Male	38	Germany	3
P5	Elif	Female	28	Turkiye	2
P6	Beyza	Female	18	Turkiye	3
P7	Houssam	Male	42	Iran	17
P8	Nick	Male	36	Great Britain	16
P9	Marta	Female	25	Chile	13
P10	Sina	Male	53	Iraq	18
P11	Frank	Male	19	South Africa	2
P12	Min Jae	Male	27	China	12
P13	Tomasz	Male	42	Poland	6
P14	Hai	Female	25	China	12
P15	Sarra	Female	24	Marocco	6
P16	John	Male	27	Australia	12
P17	Hadir	Female	28	Iraq	13

Ethical Implications

This study followed ethical standards and received approval from the Burdur Mehmet Akif Ersoy University Non-invasive Clinical Research Ethics Committee, dated 05/07/2023 and numbered 2023/405. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

At the beginning of the interview, it was clearly stated to the participants that the interviews would be recorded. Each participant was guaranteed that personal data would be protected during the research process. It was clearly stated to the participants that they had the right not to answer any questions or to end the interview whenever they wanted. At the end of the interviews, all participants were asked if they had anything to add. After obtaining the consent of the participants, all interviews were recorded with a voice recorder.

Data Collection Tools

Data were obtained through semi-structured interviews. The interviews were held in a particular room set up for research at the tournament venue, and 25-30-minute sessions were held with the athletes. Pseudonyms were given to the players to protect personal information, but actual data on the players' nationalities were used to demonstrate the international diversity of the study. The interviews were conducted personally by the researcher. Before the research, the researcher explained the purpose of the research to the participants, requested voluntary consent to participate in the research, and informed the participants about the anonymity and confidentiality of the information shared.

Statistical Analysis

The data obtained from the interviews were analyzed using the thematic analysis method defined by Smith (2016). Thematic analysis is a method used to identify, analyze, and report patterns (themes) in data. It allows for the organization of the data set at the smallest size and the description of it in depth. However, thematic analysis not only remains at this dimension but often goes one step further and makes sense of many dimensions of the research subject (Boyatzis, 1998). According to this method, the first step in processing the data is the organization of the empirical material by marking sentences and sentence parts that are important related to the above research questions, which is done to identify the so-called first-order codes. Then, the related terms are combined into categories, and each first-order code is associated with the second-order related term. The last step is to assign relevant terms to categories and then analyze them (Smith, 2016).

RESULTS

In this section of the study, the findings obtained from the interviews were analyzed using the thematic analysis method, and the themes were coded according to the participants' thoughts.

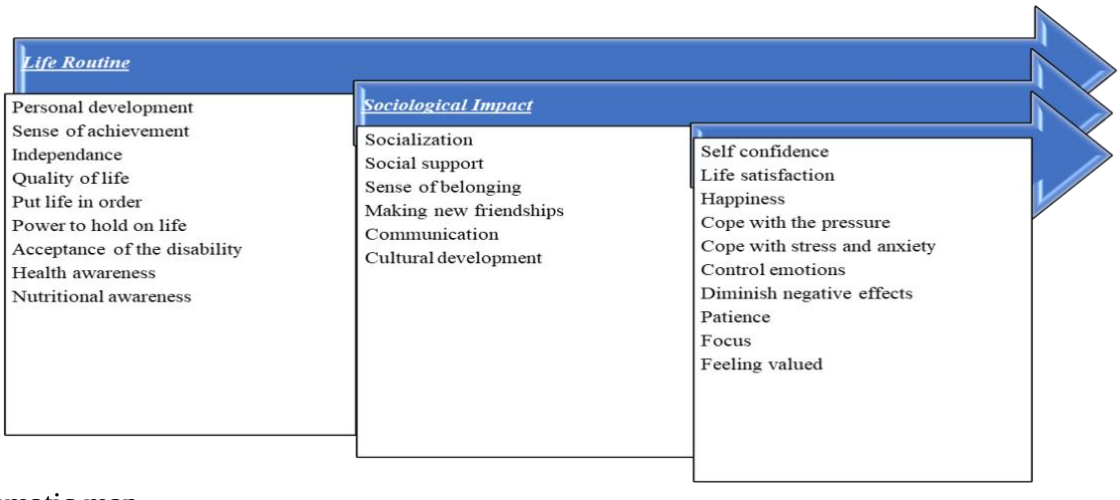

Figure 1. Thematic map

Life Routine

Table 2. Distribution of life routine theme according to codes

		N	PD	SA	GLO	HL	AD	HL	I	QL	HA	NA
Gender	Female	7	5	6	7	7	5	5	6	7	6	6
	Male	10	7	7	10	10	6	5	9	10	8	9
	Total	17	12	13	17	17	11	10	15	17	14	15
Age	18-27 years	8	5	5	8	8	5	6	7	8	6	7
	28-37 years	4	3	4	4	4	3	1	4	4	4	3
	38 years and above	5	4	4	5	5	3	3	4	5	4	5
	Total	17	12	13	17	17	11	10	15	17	14	15
Tennis Background	1-6 years	6	4	6	6	6	4	3	6	6	5	5
	7-12 years	3	2	1	3	3	1	2	3	3	2	3
	13 years and above	8	6	6	8	8	6	5	6	8	7	7
	Total	17	12	13	17	17	11	10	15	17	14	15

PD: Personal development, SA: Sense of accoplishment, GLO: Getting life in order, HL: Holding on life, AD: Accepting disability, HL: Healt Literacy, I: Independance, QL: Quality of life, Health awareness, Nutritional awaraness

When the interviews were analyzed, under the theme of life routine, it was seen that issues such as getting life in order, holding on life and quality of life were emphasized. All the participants mentioned about these three codes at the interviews. One of the most attention-grabbing results here is that although 50% of male participants mentioned the issue of health literacy, this rate was 71% among female participants. Another important result is that individuals who have been playing tennis for a shorter period of time mention many of the codes mentioned under this theme.

Even though I was introduced to tennis very late, I believe that it brought a specific discipline and order to my life. I get much pleasure from playing tennis. I think tennis has a very important place in my life for personal development (Yusuf).

When you are a disabled person, it mostly means you depend on someone to live, but with tennis, I feel independent. Because of the physical strength I gained from tennis, I can do many tasks on my own; I can socialize with people much more easily, and I feel psychologically comfortable (Jose). When I started tennis 12 years ago, I was timid. I did not speak much with the other people. I did not feel well because I was in a wheelchair; I was the only girl in my town with a wheelchair. Tennis helped me to accept my disability and to grow my personality and my confidence (Sandra).I can say that my quality of life has improved Tennis put my life in order. Times for breakfast, dinner, times for sleep, times for practice (Min Jae).

First, I started playing tennis to be more of a social person. My main goal in starting tennis was to socialize with the people around me. Tennis has become a part of my life as I have developed socially and achieved various successes (Nick). After I started playing tennis. Tennis has significantly increased my quality of life by making me physically stronger, giving me a more socially active personality, and improving my self-confidence (John).

Sociological Impact

Socialization, social support, sense of belonging, making new friendships, communication skills and cultural development stand out as values coded under the sociological impact theme. The most remarkable code under this theme is making new friendships, which all participants mentioned. The issue of communication, mentioned by 16 of the 17 participants, stands out as another striking topic.

I was not integrated into the school when I was in a wheelchair. Tennis helped me to socialize easily with other people because, in tennis, everyone is in a wheelchair, so in the beginning, I did not feel strange when I was talking to the other wheelchair players (Marta).

While traveling around, you get to know people, you feel friends, and you become a part of a team or a group. I think tennis is an excellent tool for socializing (Beyza).

It is very important to feel part of society. When I first became disabled due to an accident, I isolated myself from society, but with tennis, I

became able to establish relationships more easily with the people around me. Of course, it would not have been possible for me to achieve this without the support of the people around me, but thanks to tennis, I think this support has become meaningful (Tomasz). Thanks to tennis, I enjoy being with people from different cultures and getting to know different people (Frank).

Table 3. Distribution of sociological impact theme according to codes

		N	S	SS	SB	MNF	C	CD
Gender	Female	7	7	5	6	7	7	4
	Male	10	8	7	8	10	9	6
	Total	17	15	12	14	17	16	10
Age	18-27 years	8	7	6	6	8	7	4
	28-37 years	4	4	2	4	4	4	3
	38 years and above	5	4	4	4	5	5	3
	Total	17	15	12	14	17	16	10
Tennis Background	1-6 years	6	5	5	3	6	6	5
	7-12 years	3	2	2	3	3	3	1
	13 years and above	8	8	5	8	8	7	4
	Total	17	15	12	14	17	16	10

S: Socialization, SS: Social support, SB: Sense of belonging, MNF: Making new friendship, C: Communication, CD: Cultural development

Psychological Impact

Table 3. Distribution of psychological impact theme according to codes

		N	SC	LS	H	CP	CSA	CE	DNE	P	F	FV
Gender	Female	7	7	6	7	6	6	7	6	7	7	7
	Male	10	10	9	10	8	8	10	8	8	10	10
	Total	17	17	15	17	14	14	17	14	15	17	17
Age	18-27 years	8	8	7	8	6	7	8	6	7	8	8
	28-37 years	4	4	4	4	4	3	4	4	4	4	4
	38 years and above	5	5	4	5	4	4	5	4	4	5	5
	Total	17	17	15	17	14	14	17	14	15	17	17
Tennis Background	1-6 years	6	6	5	6	5	5	6	4	6	6	6
	7-12 years	3	3	2	3	3	2	3	3	2	3	3
	13 years and above	8	8	8	8	6	7	8	7	7	8	8
	Total	17	17	15	17	14	14	17	14	15	17	17

SC: Self confidence, LS: Life satisfaction, H: Happiness, CP: Cope with pressure, CSA: Cope with stress and anxiety, CE: Control emotions, DNE: Diminish negative effects, P: Patience, F: Focus, FV: Feeling valued

When the theme of psychological impact is analyzed, it is seen that the titles self-confidence, happiness, control emotions, focus and feeling valued come to the fore. All athletes participating in the research mentioned the mentioned codes.

When I started tennis 12 years ago, I was very shy. I did not speak much with the other people. I did not feel well because I was in a wheelchair; I was the only girl in my town with a wheelchair. Tennis helped me to accept my disability and to grow my personality and my confidence. Before tennis, it was impossible to make an interview like now. When I had presentations in class, I could not do it, but now I can speak with confidence. I feel like an average person, just like anyone else. I am not

thinking much about it now that I am in a wheelchair. (Sandra).

Playing tennis diminishes the adverse effects of stress; I have learned how to cope with stress. One of the most essential things about playing tennis is that I enjoy life a lot (Sina). One of the most important things I learned in tennis is patience. It is a versatile branch that increases focus and gives physical and mental strength. It is perfect for both my soul and my body. I feel happier when I play tennis (Sarra). Tennis is, for me, the way where I am getting to know myself better. I can discover my strengths and weaknesses more efficiently, thanks to tennis. Tennis is the mirror of my life. Thanks to tennis, I can easily see what kind of person I am. How people see me, how they evaluate me, or, more clearly, whether they look at me with pity does not interest me anymore. Tennis made it clear to me, such as seeing my potential or making me feel valued, what people around me could not do before tennis (Houssam).

DISCUSSION

The data obtained from the study were themed under the umbrella of life routine, social and psychological impact, with the coding made as a result of the interviews.

The fact that those who have been playing tennis for a shorter period of time touched on most of the issues under the theme of life routine can be interpreted as tennis being effective in putting the lives of disabled individuals in order in the beginning years. Under the theme of life routine, 11 participants stated that their quality of life increased thanks to tennis and that tennis has a significant place in their lives. In parallel with this result of the research, (Ciampolini et al., 2017; Çokluk et al., 2011; Diaz et al., 2019) also stated that sports positively affects the quality of life of disabled individuals. Another important sub-theme under the theme of life routine is the acceptance of disability, mentioned by 10 participants. The finding that being able to accept disability and live with it has a positive relationship with a person's quality of life (Ahn et al., 2021) supports the research results. The feeling of being able to live without being dependent on others is one of the most emphasized sub-themes within the theme of life routine. In the literature, some studies show that disabled athletes improve their ability to live independently thanks to sports (Murphy & Carbona, 2008; O'Connel, 2000).

It is seen that concepts such as socialization, social support, a sense of belonging, and making new friendships, which are coded under the sociological impact theme, are frequently used in defining social capital (Lee et al., 2013; Lawson, 2005; Putnam, 1995; Coleman, 1994). The main goal of the concept is to know the individual in the light of social connections (Aydemir, 2011). When it comes to sociological impact, one of the first concepts that comes to mind is the concept of socialization. All 17 participants in the study stated that they met many different people thanks to tennis and socialized with people much more quickly than before. In studies examining the effects of sports on the socialization of individuals (disabled/non-disabled), it has been seen that sports have a very important place in minimizing the obstacles between individuals and helping them integrate (Salkım et al., 2023; Güven et al., 2019; Arsic et al., 2012; Ruddell & Shinew, 2006). One of the most essential codes under the social impact theme is the participants' discourses about their communication skills. The fact that 95% of the participants (16 out of 17) mentioned the positive effect of tennis on communication skills can be interpreted as this sport has a very important place in the integration of disabled individuals with society. The athletes participating in the study stated that thanks to sports (tennis), there was a visible improvement in their communication skills; they had difficulty communicating with the outside world, especially after becoming a disabled individual, but with tennis, they felt much more comfortable in terms of communicating first with disabled individuals like themselves and then with non-disabled individuals. When the literature was examined, it was seen that studies were showing that sports had a positive effect on the communication skills of disabled individuals (Mohamed Tohamy, 2018; Duman & Sukan, 2014; Çavdar, 2011; Şenel, 2009).

The results obtained from the analysis showed that tennis affects disabled individuals most in the psychological field. All participants mentioned 5 of the 10 items coded under the theme of psychological domain, which shows that tennis affects disabled individuals much more than other domains mentioned in the study. It was observed that self-confidence, coping with pressure, and coping with problems by controlling emotions came to the fore. The results of the study are parallel to the results of Kumcağız and Avcı Çayır (2018) that disabled individuals cope with their problems and

live life in a more meaningful way thanks to sports. Life satisfaction was observed as another subtheme of the psychological impact theme. The study findings of Kamelska and Mazurek (2015), who associate the meaningfulness of life and life satisfaction with moderate physical activity, are parallel to the study.

Conclusion

As a result, it can be said that sports, namely tennis in this study, positively affect individuals' life routines and social and psychological lives. According to the results of the study, it can be easily said tennis affects disabled individuals more psychologically domain than the other domains. Therefore, it should be taken into consideration that sports play an important role in reintegrating disabled individuals into life, integrating them into society and helping them live a happier life.

Conflict of Interest

No potential conflict of interest has been declared regarding this article.

Ethical Considerations

The study adhered to the guidelines outlined in the Helsinki Convention and conducted after receiving ethical approval from Burdur Mehmet Akif Ersoy University Non-invasive Clinical Research Ethics Committee, dated 05/07/2023 and numbered 2023/405.

Author Contributions

Study design, SS; Data Collection, SS; Statistical Analysis, SS; Manuscript preparation, SS; Literature review, SS. The author have read and agreed to the published version of the Manuscript.

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RESEARCH ARTICLE

Physical fitness and BMI in Men's Vocational Sailing School

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Abstract

The maritime industry is known for its high physical demands. Students in maritime vocational programs, who will eventually work on ships, must have a good level of physical fitness to perform demanding tasks. Without adequate physical fitness, the risk of injury and fatigue increases, which can ultimately affect workplace safety and operational efficiency. This study aims to determine the Body Mass Index (BMI) and physical fitness levels of male students at SMK Baruna Pemalang. The research design uses a descriptive quantitative method to determine BMI and physical fitness levels. The test instruments are based on the Guidelines for the Nusantara Student Fitness Test from the Ministry of Youth and Sports of the Republic of Indonesia, with a validity of 0.471 and a reliability of 0.232. A sample of 61 male students was selected from a total population of 90 students. Data analysis in this study uses SPSS 26 to describe the BMI and physical fitness levels of the male students. The results indicate that the Body Mass Index of the students falls within the normal (healthy) range for a total of 35 students, while the average physical fitness level of the students is categorized as poor, with 46 students falling into this category. The findings of this study are expected to serve as baseline data for further research to improve the physical fitness levels of maritime vocational students.

Keywords
Body Mass Index, Physical Fitness, Sailing Vocational School Students

INTRODUCTION

Physical fitness stimulates body growth, prevents obesity or overweight, reduces stress, and increases happiness during adolescence. Therefore, it is necessary to deepen the understanding of the importance of physical fitness for the body. A healthy body is achieved through a balanced diet or nutrition that matches the body's activity needs (Indah et al., 2021; Sofianita et al., 2020; Syah et al., 2020).

The fitness level of the Indonesian population categorized as unfit reaches 76%. Those categorized as very unfit reach 53.63%. Only 5.86% of the population is in very fit or prime condition (Saputra, 2022). The Assistant Deputy for Educational Sports Management of the Ministry of Youth and Sports (Kemenpora) Ary Moelyadi mentioned that the physical fitness of students in Indonesia is still low (Shanti, 2021), supported by a statement from the Deputy III for Sports Culture of Kemenpora, Raden Isnanta, during a webinar with the theme "Socialization of the National Sports Grand Design (DBON)", Out of about 45 million students in Indonesia, only around 2.1 percent are known to be active in physical exercise (Suaramerdeka, 2021).

The rapid development of technology leads to changes in behavior, such as a decrease in physical activity (Ksajikyan et al., 2024; Y. Zhang, Xu, et al., 2021). If food intake increases while physical activity decreases, it results in accumulation in the body. The accumulation of energy materials in the body is usually in the form of fat or glycerides. Excess fat accumulation increases body weight, reducing physical agility. It can also cause pressure

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on several internal organs, such as the heart and lungs, and even muscles, which disrupts blood flow and metabolic processes, thus reducing fitness (Murphy et al., 2021).

Factors that influence physical fitness include physical activity, health promotion, yoga, gender, age, genetic and household registration characteristics (Huang et al., 2023; Kwon & Kwon, 2024; Lv et al., 2023; Soon Kim & Sung Lee, 2024; Tong et al., 2023; Yoo & Lee, 2022; Özdemir, 2023). Physical activity is one of the factors that can affect physical fitness (Di Maglie et al., 2022; López et al., 2021; Thomas et al., 2020). Other factors that can influence a person's level of physical fitness include nutritional adequacy (Lu et al., 2022; Oukheda et al., 2023; Rajabi et al., 2021), nutritional status (Boquete-Pumar et al., 2023; Liu et al., 2022; Machado et al., 2021; Zhang, Lai, et al., 2021), and physiological function (Zhang et al., 2022).

The importance of physical fitness and Body Mass Index (BMI) for maritime vocational students cannot be underestimated (Zalal et al., 2023). Maritime vocational education has specific characteristics that demand optimal physical and mental abilities from its students. Maritime vocational students are expected to face challenging working conditions at sea, such as extreme weather changes, heavy physical work, and the need to stay alert and responsive in emergency situations. Therefore, physical fitness and an ideal BMI status become crucial factors that must be considered. Especially for those who will work in the maritime industry.

The maritime world is known for its high physical demands. Maritime vocational students, who will later work on ships, must have good physical fitness to be able to carry out heavy tasks such as cargo handling, ship maintenance, and various other operational activities (Arleiny & Prastyanti, 2019). Good physical fitness ensures they have sufficient stamina, physical strength, as well as optimal coordination and balance abilities (Guo et al., 2022). Without adequate physical fitness, the risk of injury and fatigue increases, which can ultimately impact work safety and operational efficiency (INABA et al., 2021).

Body Mass Index (BMI) is an important indicator to assess whether a person has a healthy weight (Ben Brahim et al., 2023a; Li et al., 2023; Wang et al., 2023; Xie et al., 2023). An ideal BMI reflects a balance between weight and height, which can reduce the risk of chronic diseases such as obesity, diabetes, and cardiovascular diseases (CDC, 2021). For maritime vocational students, having a healthy BMI means they are more likely to have good fitness levels and optimal body endurance. Conversely, an unhealthy BMI can indicate health problems that could potentially hinder their physical performance in the field (WHO, 2017; Arleiny & Prastyanti, 2019).

Fitness and elements such as games, when used in accordance with the principles of self-determination theory, can enhance physical activity and student motivation (Ha et al., 2020; Martin et al., 2023; Mokmin & Jamiat, 2021). Fitness programs and health education should be integrated into the curriculum to ensure that students gain the knowledge and skills necessary to maintain their physical fitness. Additionally, regular health check-ups and BMI monitoring can help in the early detection of health issues and provide appropriate interventions.

Good physical fitness and BMI are not only important during education but also have long-term impacts on the careers and quality of life of maritime vocational students (Kubiyeva et al., 2019). Maintaining physical fitness will enable them to work more effectively and safely, as well as potentially have a longer and more successful career in the maritime field (Ilyas et al., 2021). Furthermore, healthy lifestyle habits formed during education will bring long-term benefits in terms of overall health and well-being.

Physical fitness and Body Mass Index (BMI) are crucial aspects for maritime vocational students. The profession of a sailor requires excellent physical condition to perform heavy tasks on board. Several reasons highlight the importance of good physical fitness and BMI for maritime vocational students: work on a ship involves quite heavy physical activities, such as lifting heavy loads, climbing ropes, and working in extreme weather conditions. Physical condition and BMI indicate that better physical fitness is positively correlated with lower BMI (Andrade-Lara et al., 2024).

The working environment on board can be hazardous, with risks of falling, slipping, or being hit by heavy objects. A physical health system that controls cleanliness, noise, and thermal comfort is essential for students' health (Appau et al., 2024).

Sailors often face stress, fatigue, and long working hours. Good physical fitness can improve

mental health, reduce fatigue, and enhance concentration and performance (Patel et al., 2019).

The physical fitness of students, especially in maritime vocational schools, is a crucial aspect that must be developed as part of their preparation for working on ships. However, in reality, some students are unaware of their fitness levels and whether their height and weight proportions are ideal. Therefore, the researcher intends to provide an overview and education to help students achieve an ideal level of fitness and Body Mass Index (BMI).

MATERIALS AND METHODS

Research Design

This study uses a quantitative approach with a descriptive research design. The aim of this study is to measure the physical fitness and Body Mass Index (BMI) of maritime school students using the Nusantara Student Fitness Test (TKPN) instrument (Rusdiana et al., 2022).

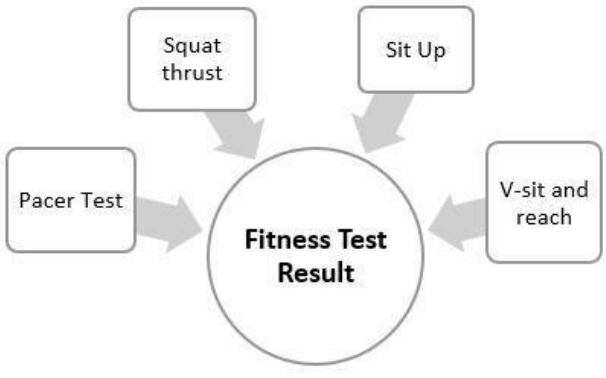

Figure 1. TKPN fitness test design

Population and Sample

This research was conducted in accordance with the Helsinki Declaration. Ethical approval for this study was obtained from the Ethics Committee of Universitas Negeri Semarang on November 1, 2023, with approval number 411/KEP/EC/2023. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

The population in this study consists of all male and female students at SMK Baruna Pemalang, a maritime vocational high school in Pemalang Regency, totaling 90 students. The sample for this study comprises 61 male students selected based on their willingness to participate in the test and their health status.

Research Instrument

The Nusantara Student Fitness Test (TKPN) is a measurement tool used to assess students' physical fitness levels, with established validity and reliability according to the formula in the Nusantara Student Fitness Test Handbook published by the Ministry of Youth and Sports of the Republic of Indonesia. The validity is 0.471, and the reliability is 0.232 based on research findings (Rusdiana et al., 2022). TKPN consists of several tests, including:

V Sit and Reach: Measures flexibility.

60-second Sit Up: Measures abdominal muscle strength and endurance.

30-second Squat Thrust: Measures strength endurance, body control, balance, coordination, and agility.

Pacer Test: Measures the maximum working capacity of the heart and lungs.

Body Mass Index (BMI) measurement:

BMI is calculated using the following formula (Rusdiana et al., 2022):

$$BMI = \frac{\text{Weight (Kg)}}{\text{Height } (m^2)}$$

Research Procedure

The initial preparation involves obtaining research permits from the school, preparing the necessary instruments and equipment such as digital scales, a stadiometer, and tools for the TKPN. Then, a briefing should be conducted for the research assistants who will help with data collection. Next, the process includes measuring the students' weight and height alternately, recording the weight and height data for each student. Following this, students will be instructed to complete a series of tests according to the TKPN guidelines, with a brief explanation of the procedure for each test given to the students, and recording the results of each test for each student.

Data Analysis

Calculate the BMI for each student using the predetermined formula. Assess the TKPN results according to the applicable assessment standards. Process the data using SPSS 26 statistical software to obtain statistical descriptions (mean, median, standard deviation, and frequency distribution) of the TKPN and BMI results.

Data Analysis Techniques

The collected data were analyzed using descriptive statistical methods to provide an overview of the students' physical fitness levels and BMI status. The analyses performed include; Statistical Description: Calculating the mean, median, and standard deviation for TKPN and BMI results.

Frequency Distribution; Determining the frequency distribution for various fitness and BMI categories (e.g., poor, fair, good, and very good for fitness; underweight, normal, overweight, and obese for BMI). Correlation; Analyzing the relationship between TKPN results and BMI using Pearson correlation coefficients to see if there is a significant relationship between physical fitness and BMI among the students.

RESULTS

Table 1 above shows the data distribution for the age variable of students from grade X to grade XII. This variable was measured by collecting primary data from students' birth dates and years, calculated as of June 1, 2024. The data distribution shows a minimum value of 14 and a maximum of 18 with an average of 16.14 years and a standard deviation of 1.013. These results indicate that the average student is over 16 years old, as seen from the proximity of the average and maximum values. Meanwhile, the data variance is relatively small, as evidenced by the close proximity of the average and standard deviation values.

The weight data for students in grades X and XII, measured using a digital scale in kilograms, show a minimum value of 34 and a maximum value of 120, with an average of 59.9. This indicates that the students' weight is above average, given the large difference between the average and maximum values. The standard deviation is 14.75, indicating that the data variance is relatively large, as evidenced by the large difference between the average and standard deviation values.

The height data for students from grade X to grade XII show a minimum value of 144 and a maximum of 185, with an average student height of 165.52. This indicates that most students' heights are below 165, given the large difference between the average and minimum values, meaning the data variance is relatively large, as evidenced by the close proximity of the average and standard deviation values.

Table 1. Descriptive Statistics research data on BMI and Physical Fitness

	N	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Age	61	14.00	18.00	16.1475	1.01384
Weight	61	34.00	120.00	59.9836	14.75296
Height	61	144.00	185.00	165.5246	6.88623
V Sit and Rest	61	.00	25.00	9.7066	5.76989
Sit Up	61	23.00	58.00	38.8197	7.92992
Squat Thrust	61	2.00	13.00	7.6885	2.04565
Pacer	61	5.00	56.00	31.1311	8.85715
Valid N (listwise)	61				

The above data description will be used to calculate BMI values with the following criteria:

Table 2. Nutrition Status

Indeks	nutritional status category	Threshold (Z-Score)
Age (BMI) of children aged 5 - 18 years	Undernutrition (thinness)	- 3 SD to < - 2 SD
	Good Nutrition (normal)	- 2 SD to + 1 SD
	Overnutrition (overweight)	1 SD to + 2 SD
	Obesity (obese)	+ 2 SD

From the results of calculating the BMI scores for students in classes X to XII at Baruna Sailing Vocational School, Pemalang, it can be described as follows:

Table 3. BMI values of Baruna Vocational School students

Indeks	Nutritional Status Category	Amount
Age (BMI) of children aged 5 - 18 years	Undernutrition (thinness)	11
	Good Nutrition (normal)	35
	Overnutrition (overweight)	11
	Obesity (obese)	4

The calculation of the fitness levels of SMK Baruna Pemalang students was conducted using V Sit and Reach, Sit Up, Squat Thrust, and Pacer tests, as described in Table 1. The V Sit and Reach data show a minimum score of 0 and a maximum of 25 with an average of 9.7066. This means the flexibility level of male students aged 14 to 18 years is categorized as moderate based on the criteria in the Nusantara Student Fitness Test guide, as indicated by the proximity of the average and minimum values. The standard deviation is 5.769, indicating that the data variation is relatively small due to the proximity of the average and standard deviation values.

The Sit Up data, performed for one minute, show a minimum result of 23 repetitions and a maximum of 58 repetitions, with an average of 38 repetitions. This indicates that the average Sit Up ability of SMK Baruna students falls into the low category according to the TKPN Sit Up Test Norms. The standard deviation is 7.929, indicating that the data variation is relatively large due to the significant difference between the average and standard deviation values.

The Squat Thrust data, performed for 30 seconds, show a minimum result of 2 repetitions and a maximum of 13 repetitions, with an average of 7.688 repetitions. This places the Squat Thrust ability of the students in the low category. The standard deviation is 2.045, indicating that the data variation is relatively small due to the proximity of the average and standard deviation values.

The Pacer Test data, a 20-meter shuttle run, show a minimum result of 5 and a maximum of 56 with an average of 31.131. This indicates that the physical endurance of the students is categorized as very low. These results highlight the importance of improving students' physical abilities to perform the physical activities required in the maritime industry.

Based on the V Sit and Reach measurements and the results of the Sit Up, Squat Thrust, and Pacer tests, the criteria can be described as follows:

Tabel 4. Fitness calculation formula

Variable	**Weight**	**Value**	**Value Proportion**
Pacer	50	5	2,5
Squat thrust	20	5	1
Sit Up	20	5	1
V Sit and Reach	10	5	0,5
Total			**5**

Table 5. weight, value, value proportion

Fitness Calculation	Fitness Category	Amount
Indonesian students' fitness test	Very Good	0
	Good	0
	Enough	15
	Less	46
	Very Less	0

DISCUSSION

Body Mass Index (BMI) is a measure used to assess an individual's nutritional status based on weight and height. School children who are underweight or overweight/obese are vulnerable to adverse changes in physical fitness (Yip et al., 2024). The formula to calculate BMI is weight in kilograms divided by height in meters squared. median BMI is relatively low in early life and high at older ages, probably due to its method of construction (Cole & Lobstein, 2012). BMI categories are generally divided into four: underweight (<18.5), normal (18.5-24.9), overweight (25-29.9), and obese (≥30). At SMK Baruna Pemalang, data from 61 male students show that the average BMI falls into the normal nutrition category, but their average fitness level is categorized as low.

Although SMK Baruna Pemalang students have an average BMI within the normal nutrition category, their low physical fitness levels indicate the presence of other factors affecting fitness besides nutritional status. Insufficient or irregular physical activity, potentially unbalanced diets, poor sleep quality, and mental health issues are some factors that can impact fitness levels. Apart from the factors mentioned above, manipulative exercises can be used as an alternative to improve gross motor skills. The success of this may be influenced by several other factors that limit this research, such as social, cultural, and linguistic factors, as well as possibly genetic characteristics (Phytanza et al., 2023). A healthy BMI should ideally support optimal physical fitness, but in this case, these other factors appear to be more dominant in determining the students' fitness.

To improve the students' physical fitness, a comprehensive strategy is needed. One form of fitness testing that can be used is the application of the Naïve Bayes algorithm for classifying physical fitness levels, which can be used to predict VO2Max (Burhaein et al., 2024). Structured and regular exercise programs, including cardio, strength, flexibility, and endurance training, should be implemented. Another alternative for improving training, particularly reaction training, can be the use of audiovisual imagery training and visual imagery training (Burhaein & Riyan Jaya, 2024). Additionally, education on the importance of balanced and adequate nutrition is crucial, as well as providing meal plans that meet the students' nutritional needs optimally. Improving sleep quality and ensuring adequate rest is also important by educating students about the importance of sufficient and quality sleep and ensuring adequate rest periods.

A holistic approach is also needed to manage students' stress and mental health. Counseling, recreational activities, and psychological support can help students manage stress better. Creating an environment that supports a healthy and active lifestyle is also important to achieve optimal fitness levels. With a comprehensive approach and appropriate interventions, it is expected that the fitness levels of SMK Baruna Pemalang students can improve, enabling them to be more prepared for daily activities and intensive training.

Conclusion

The conclusion of this study indicates that the Body Mass Index (BMI) of students falls within the normal nutritional level for 35 students, while the average physical fitness level of students is categorized as poor, with 46 students in this category. These results suggest that there is room for improvement to enhance overall fitness levels. A limitation of this study is the limited sports facilities available at the school to support physical education. The researcher recommends conducting further studies to improve BMI and physical fitness levels at maritime schools.

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Conflict of Interest

We declare that the article we wrote does not involve any specific conflicts of interest and adheres to the Helsinki Declaration.

Ethics Statement

This research was conducted in accordance with the Helsinki Declaration. Ethical approval for this study was obtained from the Ethics Committee of Universitas Negeri Semarang on November 1, 2023, with approval number 411/KEP/EC/2023.

Authors Contribution

Study Design, JY; Data Collection, SR, OWKH, and TH; Statistical Analysis, JY and SR; Data Interpretation, JY and OWKH; Manuscript Preparation, JY and SR; Literature Search, SR and TH. All authors have read and approved the final manuscript version for publication.

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RESEARCH ARTICLE

Evaluation of The Sports Coaching Program in South Sulawesi: an Evaluative Research CIPP Model Program

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Abstract

This research aims to obtain input about the benefits, value and usefulness of a program, as well as the effectiveness of providing coaching and training through the CIPP (contex, input, process and product) model developed by Stufflebeam. Therefore, we use cross-sectional design in this study. The object of this research is the South Sulawesi sports development program, include: availability of infrastructure, availability of human resources, organizational performance and funding sources. Variables are measured through questionnaires, observations, interviews, documents and test results. The results of implementing sports coaching are in the good category, including: (1) context aspects, the average score is 89.2%, which means that the sports coaching program is appropriate and relevant to government goals and policies, (2) aspects of input, planning programs and resources are in accordance with a score of 78.0% of the maximum score, (3) process aspects, assessment of the sports coaching process is in accordance with a score of 86.3% of the maximum score, athlete assessment a score of 86.8% of the maximum score , (4) product aspect, the achievement of athletes' abilities is considered to have increased significantly, the average initial test score is 65% while the average final test score is 84.04%, resulting in an increase in the average athlete score of 19.04%. The measurement of interest a score of 78.1% of the maximum score, while attitude a score of 80.3% of the maximum score, this means that the athlete's assessment of the implementation of sports coaching tends to be positive and good.

Keywords
CIPP Model, Program Evaluation, Sports Development

INTRODUCTION

Sports coaching and development covers all sports in Indonesia. However, due to the existing limited conditions, it is difficult to master all sports to achieve international level achievements which are something to be proud of if you look at the current condition of Indonesia's achievements. Therefore, in accordance with the principles of efficiency and effectiveness and the possibility of achieving impressive achievements, it is necessary to take steps to determine regional maps and priority scales for certain sports branches to be developed more intensively. This is in line with what was expressed by Jean-Loup Chappelet (2018) who stated that to achieve efficiency and effectiveness in sports development, there needs to be a clear roadmap and structured policies. The priority scale is determined based on the level of international achievement targets to be achieved.

Success in the sports development program requires monitoring and evaluation, both carried out by KONI (sports institutions in Indonesia) and institutions involved in sports development in South Sulawesi Province, Indonesia. In line with what Potrac (2016) stated in his study, he found that the sports coaching process involved various stakeholders, including mentors, clubs, athletes and

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parents. Moreover, an overall program evaluation in South Sulawesi has never been carried out. Because to see the effectiveness of the program, we don't just look at the implementation of sports coaching activities, but there are many factors that must be taken into account, in this case how the athletes, organizers, coaches/coaches, activity program structure, facilities and infrastructure, coaching strategies, financing, management and evaluation carried out in these activities. Therefore, the success of a program in achieving its stated goals is significantly influenced by various factors, including context, input, process, and outcomes. Kirkpatrick (2006) states that there are three reasons why program evaluation is needed, namely: (1) to show the existence and funds spent to achieve the goals and objectives of the program being carried out, (2) to decide whether the activities being carried out will be continued or stopped, (3) to collect information on how to develop the program in the future.

Studies related to evaluating sports coaching programs in Indonesia are still lacking. Therefore, we conducted this study to fill the gap in the literature regarding this matter. More specifically, we chose to use the CIPP model developed by Stufflebeam (1985). Because the model as a whole can evaluate a system of activities as a whole starting from context, input, process and product. The subjects in this research include sports coaching organizers, athletes, coaches/instructors, and infrastructure. This research is expected to provide benefits in the form of actual information. The scientific use of this research is to synergize regional development policies with the development of sports that are of interest to the public. The practical use of this research is to provide information for KONI about potential sports to be developed in the research area, to provide information for the parent organization, what potential sports can be developed in the research area and it is hoped that the results of this research will become reference material for further research with hopes can be developed with broader variables and problems. This research aims to obtain input about the benefits, value and usefulness of a program, as well as the effectiveness of providing coaching and training through the CIPP (contex, input, process and product) model developed by Stufflebeam.

Program Evaluation

Evaluation is an inseparable part of a program or activity, because of the strategic function it has. The success of a program cannot be separated from the role of appropriate evaluation, which will produce accurate and useful data to be used as feedback for future improvements. Owen (1993) said that program evaluation is a process of parsing, explaining and obtaining information and discriminating it to be able to explain and understand a program or to justify decisions related to the program. As the results of a study conducted by Tayibnapis (2008) found that program evaluation is an activity of systematically collecting data or information about how the process works, about the impacts that may occur or may answer questions of interest. Thus, program evaluation is a process related to the design of a decision. Therefore, considering the effectiveness of the training program technically and substantively, the program evaluation is carried out at various stages from planning to final assessment which is designed in such a way as to produce the right decision.

From these definitions, it can be concluded that evaluation of training programs provides results as very important input for improving education and training programs, both technical and substantive aspects, through scientific procedures. Technical improvements are improvements that lead to perfecting the implementation of training programs, while substantive improvements are improvements that lead to perfection of training objectives, training materials, training methods and evaluation.

Development of Sports Achievement

The definition of sports coaching is efforts made to advance or perfect athletes so that they can perform well. According to the Big Indonesian Dictionary, coaching is efforts made to make them a little more advanced or perfect. The main characteristic of achievement sports coaching is always being oriented towards the future to achieve high achievements at an international level. This planning can be developed well if it is supported and grown in a solid coaching system, which is organized for integrated and continuous sports coaching (Syarifuddin et al, 1996).

Sports achievements can be achieved with a gradual, directed, systematic and continuous development program. Sports achievements will never be achieved with an instant coaching program, even if there were, these achievements

would definitely not last long. Talking about gradual, directed, systematic and continuous development, it must definitely start from early childhood. Therefore, the development, talent scouting, recruitment and coaching of an athlete must start where the child is in this early childhood education institution. If sports organization parents are just waiting for children to excel at elementary, middle and high school levels, it could be said to be too late.

Facilities and Infrastructure

Sports facilities and infrastructure are a "container" for carrying out sports activities, thus to welcome the future of Indonesian sports, it is necessary to prepare sufficient "containers" so that all people can get the same opportunity to exercise so that they can gain fitness and health in accordance with the concept of "sport for all". The role of regions in efforts to advance their regions, including the field of sports, lies in the ability and commitment of the region itself to determine whether it will move further forward in developing sports achievements.

One of the supports for developing sports achievements is the ability to make optimal use of existing facilities and infrastructure, or tips for optimizing minimal facilities and infrastructure to develop and produce achievements. However, what needs to be prioritized by regions is maintaining and developing existing facilities and infrastructure and the most important thing is the use of facilities and infrastructure according to their intended use. Harsuki (2003) stated that sports infrastructure is a forum for carrying out sports activities. Thus, to welcome the future of Indonesian sports, it is necessary to prepare sufficient forums so that all people can get the same opportunity to exercise so that they can obtain fitness and health in accordance with the concept of "sport for all. The Deputy for Performance and Sports stated that sports facilities are equipment and equipment used for sports activities.

Human Resources

Development of the quality of human resources can be carried out through the main approaches to: physical aspects, spiritual aspects and social aspects. All of them are aimed at achieving the same end result, namely complete prosperity, which means increasing independence in bio-psycho-sociological life, namely increasing independence in physical-spiritual-social life, which means increasing the quality of life. Complete prosperity, which is a healthy concept by the World Health Organization (WHO), states that health is: physical, spiritual and social prosperity, not just freedom from disease, disability or weakness. Therefore, health is: the basic capital for all life activities.

Sports personnel consist of coaches, teachers/lecturers, referees, judges, managers, promoters, administrators, guides, counselors, instructors, medical and para-medical personnel, nutritionists, biomechanics experts, psychologists, or other designations appropriate to their specialty and participate in organizing sports activities. Sports personnel serving in every sports organization and/or sports institution are required to have qualifications from a competency certificate issued by the parent sports organization concerned and/or the authorized government agency.

Organizational Performance

The meaning or definition of organization comes from the Greek organon which means tool or means. Referring to this understanding, adherents of this school view organizations as means (means) to achieve a goal (ends). According to Andreas Budihardjo (2011) an organization is a group of people (social entities) that have a goal and are deliberately designed to carry out activities that are systematically coordinated and open and related to the external environment. All organizations have a vision, mission and targets to achieve; This target is commonly known as organizational effectiveness.

Basically, The definition of an organization can essentially be divided into two categories: the static sense and the dynamic sense. In the static sense, an organization is seen as something stationary or unchanging, typically represented through various charts or organograms. Conversely, in the dynamic sense, an organization is viewed as a living entity, a dynamic organism. This perspective considers not only the structure and form of the organization but also its content and activities.

Source of Funds

In organizational life, finance is a very vital resource. With financial resources, all aspects can run as they should, as a basis for compensation for all existing human resources. Sports funding is a shared responsibility between the Government, regional governments and the community. The government and regional governments are required to allocate a sports budget through the State Revenue and Expenditure Budget and Regional

Revenue and Expenditure Budget. Sports funding sources are determined based on the principles of adequacy and sustainability.

MATERIALS AND METHODS

Research Design

This research is more oriented towards an evaluation system that tries to answer the effectiveness of a sports development program using the CIPP evaluation model. Therefore, we use cross-sectional design in this study. As a study conducted by Kesmodel (2018) determined that the cross-sectional research design has the capacity to offer a broad overview of the phenomenon being investigated. The object of this research is the South Sulawesi Advanced sports development program, respondents include: availability of infrastructure, availability of human resources, organizational performance and funding sources. We have elaborated all these variables and attached the data according to what we found when conducting research.

Participant

The population category in this study is Athletes totaling 100 athletes, coaches totaling 28 and mechanics/staff totaling 7 people. So that the total population of this study is 135 consisting of athletes, coaches and staff). We gave them time to be involved in this study for two times forty-eight hours, where they will first consider the benefits and consequences that they will get when they become participants in this study. We do this as a form of complying with research ethics and providing a sense of security to participants. After they filled in their willingness to become participants in this study, we found that there were 35 athletes willing, 15 coaches 15 and 5 mechanics/staff. So that the total number of participants in this study was 55 participants consisting of athletes, coaches and staff.

Instruments

Variables are measured through questionnaires, observations, interviews, documents and test results. Researchers use questionnaires, which are systematically designed written lists of questions, to collect data from respondents. This questionnaire contains closed and open questions that are designed to measure certain variables according to the research objectives. Respondents are asked to answer questions according to their personal experiences or opinions. In addition to questionnaires, researchers also conduct observations, which are direct observations of certain behaviors, actions, or situations that are relevant to the variables being studied. Observations are carried out in a natural environment or in conditions that have been arranged, and researchers systematically record everything that is observed to obtain accurate and objective data. Furthermore, interviews are conducted as another method for measuring variables, where researchers interact directly with respondents through question and answer sessions. Through interviews, researchers try to dig up in-depth information about respondents' views, attitudes, or experiences related to the variables being studied. Then data collection is also carried out through document analysis, which involves reviewing various written or recorded documents that are relevant to the research. As part of measuring variables, researchers may also use test results, which are assessments carried out through tests or exams that are specifically designed to evaluate the abilities, knowledge, or certain characteristics of research subjects. The results of this test provide quantitative data that can be further analyzed to understand the variables studied.

Procedures

This research was carried out in several stages, namely: the first stage, the researcher conducted a preliminary study to ask for permission and discuss the evaluation to be carried out, the second stage, the researcher evaluated the context which included assessing the program objectives, their relationship to program needs and environment. The third stage, namely the researcher evaluates the input which includes program planning and coaching resources as well as the readiness of the coaching institution's resources, the fourth stage, namely the process researcher which includes the implementation of coaching activities, assessing documents and program activities through observing the training process which assesses the suitability of the presentation with the training program , pre and post tests, assessment of athlete abilities, and coaching service questionnaires. The fifth stage, namely researchers evaluating the product which includes the achievement of the coaching program with skill progress and its influence on the athlete's positive attitude. Where the variables or problems that need to be answered are measured through various data collection tools, namely questionnaires,

observations, interviews, documents and the results of measuring athletes' abilities through tests. Data collection in research has met ethical standards which of course we attach.

This study was conducted after receiving ethical approval from the Sports Research Ethics Committee, Universitas Negeri Makassar, Indonesia, with reference number 453/UN36.3.4/TU/2024. Participants provided informed consent, with a voluntary form that included details of the study, risks, benefits, confidentiality, and participants' rights. This study strictly adhered to the principles of research ethics by prioritizing the rights and welfare of participants in the design, procedures, and confidentiality measures.

Data Analysis

In this study, we used two main data analysis methods, namely t-test and ANOVA (Analysis of Variance), to test hypotheses and analyze differences between groups of variables studied. We used the t-test to compare the means of two different groups in this study. This analysis aims to determine whether there is a statistically significant difference between the two groups related to the variables measured. Then we used the ANOVA (Analysis of Variance) test which we use to analyze data from more than two groups or variables that have several levels of treatment, we use ANOVA. ANOVA allows us to evaluate whether there is a significant difference between the means of three or more groups.

RESULTS

The findings of the evaluation results on the sports coaching program in South Sulawesi are as follows, presenting a summary of the evaluation results of the CIPP model for implementing sports coaching:

Table 1. The descriptive resume statistics context evaluation results

Evaluation	Aspect	% Maximum Score	Assessment criteria
Context	1. Objectives refer to Government policy	93,4%	Very suitable
	2. Implementation based on Government Policy	93,4%	Very suitable
	3. Implementation based on the activity program	93,4%	Very suitable
	Sub Average	93,4%	
	4. Goals of sports coaching berdasar	86,6%	Suitable
	5. Implementation of sports coaching based on needs	93,4%	Very suitable
	6. A needs analysis is carried out before the program	80,0%	Very suitable
	7. The formulation of objectives is related to the results achieved	80,0 %	Very suitable
	Sub Average	85%	
	Total average	89,2%	Suitable

The evaluation component table which concerns the components of the context of implementing sports coaching is considered good where the implementation of activities is based on central policy and the policy of the sports coaching institution. Even though this activity has not yet carried out a Training Needs Assessment (TNA), at the start of each meeting, feedback is carried out between the instructor and the athlete to identify coaching needs. So that the policy context and program objectives can be continued in the future.

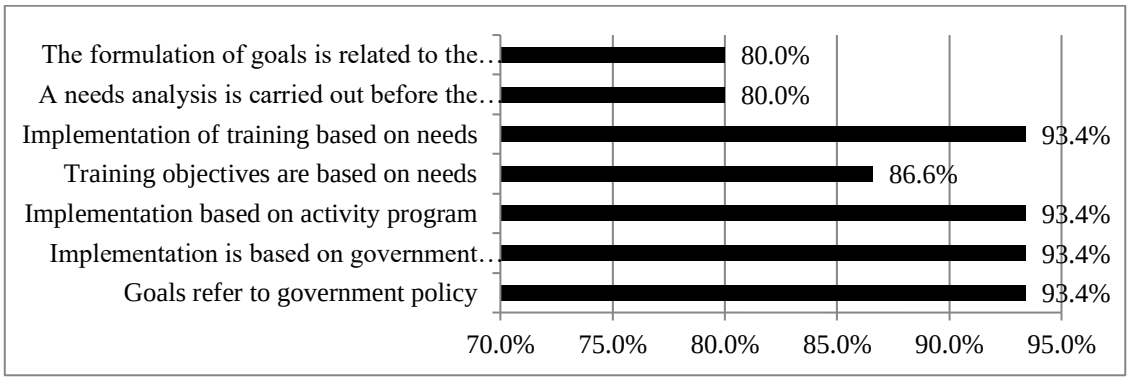

Figure 1. Context evaluation results diagram

Table 2. Descriptive resume statistics of input evaluation results

Evaluation	Aspect	% Maximum Score	Assessment criteria
Input	1. Program planning	86,7%	Good
	2. Resource planning	80,0%	Good
	3. Sports Coaching Curriculum	80,0%	Suitable
	4. Coach/Instructor	86,7%	Good
	5. Implementing staff/facilitators	53,3%	Not good
	6. Sports Coaching Athletes	80,0%	Suitable
	7. Infrastructure	79,0%	Adequate
	Average	78,0%	

Evaluation component table involving input components. Overall program planning has gone well, getting an assessment of 86.7% of the maximum score. Overall program resource planning was well planned and received a score of 80.0% of the maximum score. All sports development program resources that have been properly planned and implemented cover all aspects, but the non-academic measurement instrument aspects are considered inadequate by observers, only getting a score of 40% of the maximum score and need to be improved immediately.

The input training program has been planned and implemented well and obtained a total average score of 80.0% of the maximum score, but there are aspects that are still not well prepared and need to be immediately improved, namely aspects of the prepared training material that are not in accordance with the athlete's needs and only achieved a score of 46 .7% of the maximum score and was the lowest score in the exercise program input group.

Input on the readiness of coaches/instructors in the implementation of sports coaching which includes the involvement of coaches/instructors based on competency and educational qualifications, educational background, coaching experience, use of training tools/media by coaches/instructors, and coaching skills has been well planned and implemented and is appropriate with the needs of sports coaching athletes.

Planning for the involvement of personnel and staff in the implementation of sports coaching as a whole is not good, only reaching an average total score of 53.3% of the maximum score, and the aspect that really needs attention to be corrected and immediately improved is the division of tasks for each facilitator which is still chaotic and confusing. athletes thus only get a score of 40.0% of the maximum score. Coordination and a clearer division of tasks and responsibilities need to be improved in the implementation of future sports coaching.

Overall planning of athlete input and infrastructure has been carried out well and respectively obtained a total average score of 80.0% and 79.0% of the maximum score. Thus, the overall input planning for the sports coaching program aligns with the needs of the athletes being coached.

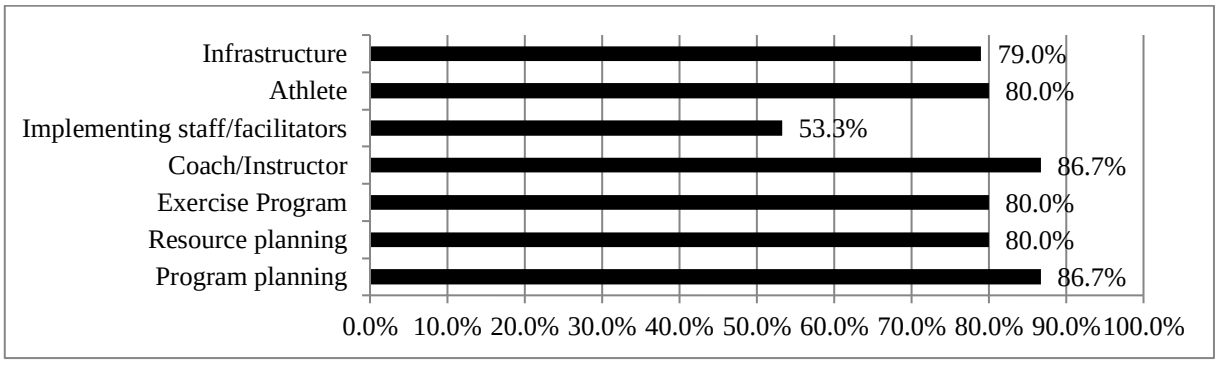

Figure 2. Input evaluation results diagram

Table 3. Descriptive statistical summary of process evaluation results

Evaluation	Aspect	% Maximum Score	Assessment criteria
Process	Evaluation by observer		
	1. Implementation of learning programs	90,5%	Good
	2. Athlete activity	88,9%	Good
	3. Learning strategies	67,8%	Good
	4. Sports coaching services by the organizer	82,8%	Good
	5. Coach/Instructor Appearance	85,0%	Good
	6. Sports coaching facilities	82,9%	Good
	Average	86,3%	
	Evaluation by athletes		
	1. Learning program	85,8%	Good
	2. Sports coaching services	89,3%	Good
	3. Trainer/Instructor	85,3%	Good
	Average	86,8%	

The evaluation of the sports coaching implementation process indicates that, from a procedural perspective, the program has been well planned and executed, aligning with the needs of the athletes.

From an observer's perspective, the process of implementing sports coaching, which consists of implementing training programs, athlete activities, training strategies, coach/instructor performance, and sports coaching facilities, has been assessed as good. However, despite the sports coaching services being generally well-implemented by the organizers, some aspects received lower marks. This was primarily due to the training materials not being distributed to the athletes, which was considered challenging and hindered their participation in the coaching sessions.

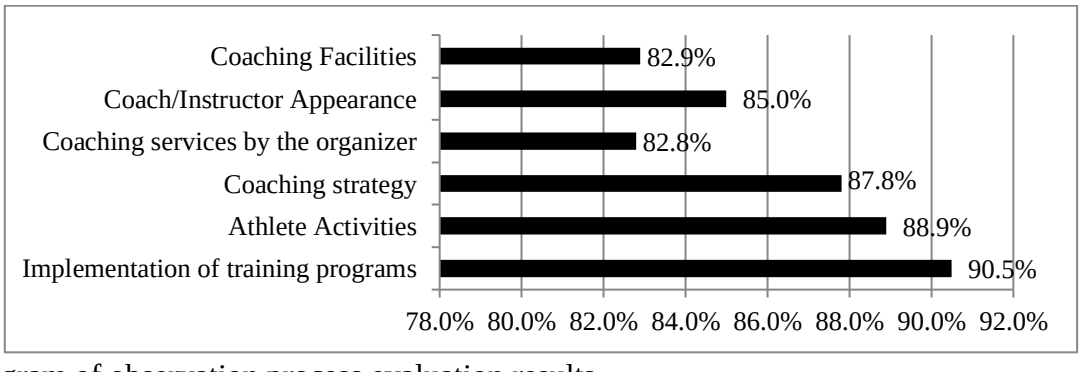

Figure 3. Diagram of observation process evaluation results

From the athlete's perspective, sports coaching evaluates the overall coaching implementation process as good, viewed from the perspective of the training program, sports coaching services, trainer/instructor readiness.

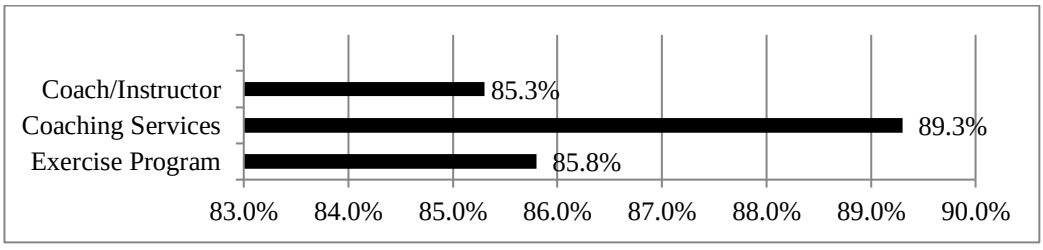

Figure 4. Athlete Process Evaluation Results Diagram

Table 4. Descriptive Resume Statistics of Product Evaluation Results

Evaluation	Aspect	% Maximum Score (mean)	Assessment criteria
Product	Athletes' learning outcomes		
	a. Pre-tes	65%	Enough
	b. Assessment during the process	77%	Good
	c. Post-tes	91,5%	Good
	d. Final grade (average b & c)	84,04%	Good
	e. Increase of pretest to final value (t-test)	19,04%	Significant
Evaluation	**Aspect**	**% Maximum Score (mean)**	**Assessment criteria**
Interest	Results of assessing athlete interest	78,1%	Pretty good
Attitude	Results of athlete attitude assessment		
	a.Questionnaire	80,3%	Good
	b.Interview	Effective	Satisfying

By comparing the results of the athletes' initial tests with the athletes' final tests, in general sports coaching can be said to be effective considering that the product produced is primarily the result of training, in addition to the observers' observations which concluded that the athletes' positive attitudes also contributed to the achievement of the results of the training. The athlete's training results as measured by the initial and final tests as well as the t-test showed a very significant increase from the average pre-test result of 65% to the average final score of 84.04%, which means an increase of 19.04%. This means that athletes experience rapid changes in acquiring competence in the form of increasing abilities and skills.

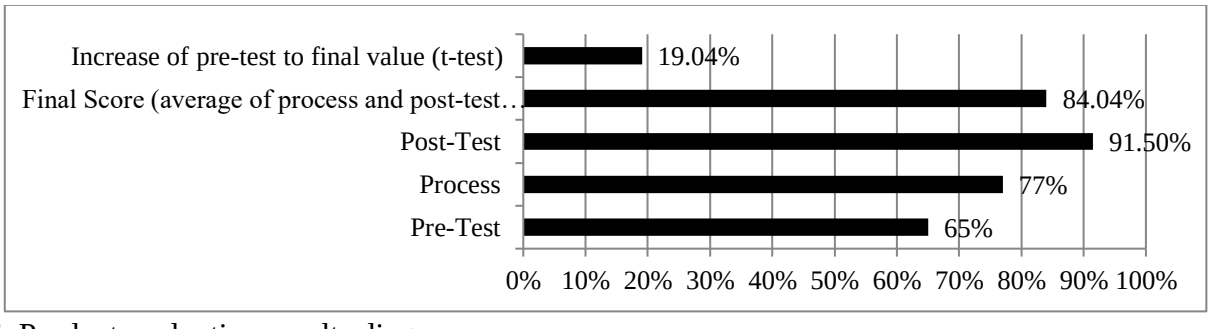

Figure 5. Product evaluation results diagram

The assessment of the athletes' attitudes during the coaching also showed positive things, meaning that sports coaching has helped create positive values for increasing the professionalism of sports coaching athletes. Starting from the high interest of athletes in taking part in sports coaching, supported by good preparation and implementation of sports coaching, the attitude of sports coaching athletes becomes increasingly positive and can be expected to improve their performance. Through the interview instrument, it can also be seen that the athletes gain insight into new skills such as expertise in creating training models and expertise in making training equipment.

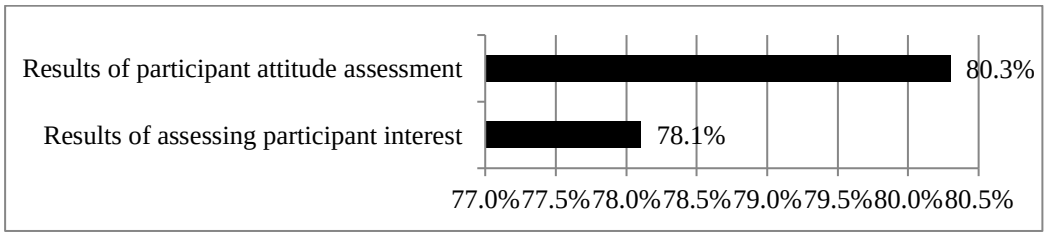

Figure 6. Diagram of evaluation results of athlete interests and attitudes

DISCUSSION

The increase in athletes' knowledge is evidenced by an increase in scores obtained in the initial test and final test. The difference between the initial test and the final test is very significant, indicating that the implementation of sports coaching has been running effectively. Viewed from the perspective of changes in the attitudes of the athletes according to the results of the questionnaire distributed at the end of the sports coaching implementation, it shows good results. This indicates that sports coaching has given rise to a positive attitude of optimism for improving one's career and professionalism as an athlete. In other words, from the perspective of increasing the positive attitudes of athletes, it shows that sports coaching has been taking place effectively. A study conducted by Sawiuk et al (2018) revealed that the most dominant factor in the effectiveness of sports coaching is the influence of social structures, political agendas and power, which can be proven through the formalization of mentoring for sports coaches.

This research is only limited to product research and does not yet include research into the impact of a sports coaching program. However, product measurements show that there has been an increase in athletes' competence and attitudes, showing that sports coaching is taking place effectively. So the implementation of activities in sports development is in accordance with the funds provided, both provided by the South Sulawesi Provincial Government, the Makassar City Regional Government and the Sports Provincial Government. So after receiving assistance funds from the authorities, in this case the South Sulawesi Province KONI, created a coaching design/concept, in order to understand what had to be done in this activity. Therefore, what has been done so far in monitoring activities is more focused on budget use. Of course, it is not optimal to monitor these activities in a coordinated manner, not only in terms of the use of the budget, but what is more important is how the activities carried out in sports coaching are carried out. Published articles evaluating sports coaching programs reveal that there have been positive changes in improving athletes' skills. These improvements are evident in the increased performance and achievement of individual goals (Bukari et al., 2023).

Assessment at the sports coaching context stage shows that the sports coaching program held is considered quite relevant to the needs of sports coaching athletes. Sports coaching programs in Indonesia evaluated using the Countenance Model have been proven to be effective in achieving athlete coaching goals (Fielding & Turner, 2022). Articles that discuss evaluations of sports coaching programs provide positive subjective findings from the discussion in each article, such as levels of satisfaction, motivation and perceptions of coaching (Jaffe et.al., 2018). This was confirmed by Bukari et al., (2023) that the program evaluation provided information that there were positive changes in helping to improve athletes' skills, which were seen in the aim of increasing individual and group achievement.

The implementation of sports coaching is formulated based on government policy and the policies of sports coaching organizers which refer to the needs of athletes in the field. Involvement of various stakeholders including coaches, parents and sports federations in supporting the success of sports development programs (Fraina & Hodge, 2020). Sports development programs are a very important focus, and other research shows that steps have been taken to achieve sustainability and improve future programs (Beattie & Turner, 2022). The needs of athletes are not captured using needs analysis or what is usually called TNA (Training Need Analysis) which is often carried out by KONI of South Sulawesi Province. As an organizer of sports coaching with various implementation models.

Conclusion

Specifically, the conclusions of the sports coaching evaluation results are as follows:

Context

At this stage the sports coaching program is assessed to be appropriate to the needs of athletes in the field. This is illustrated by the results of the assessment of government policy of 93.4% of the maximum score and the results of the assessment of the objectives of implementing sports coaching of 85%, so that the average score obtained by the context evaluation is 89.2%, which means that the sports coaching program What has been implemented is in accordance with and relevant to government policies and KONI policies of South Sulawesi Province based on the needs of athletes in the field.

Input

The program and resource planning carried out in sports coaching is considered to be appropriate and relevant to the stated objectives. This is proven by the average score of 78.0% of the maximum score from program planning, the assessment of coaching resource planning was carried out well according to needs.

Process

Evaluation at the process stage focuses on the training process. Sports coaching was in accordance with the objectives set at the beginning of the activity and obtained a score of 86.3% of the maximum score, which means that observers considered it to be good and appropriate. The athlete's assessment of the training process also received a score of 86.8% of the maximum score, which means it was also considered good.

Products

Athletes' ability achievements are considered to have increased significantly, as shown by the difference between the average initial test score and the average final score. The average initial test score was 65%, while the average final score was 84.04%, resulting in an increase in the average participant score of 19.04%. This means that sports coaching has resulted in significant changes in the abilities obtained by athletes. In measuring attitudes, a score of 80.3% of the maximum score was obtained, which means that the athletes' attitudes after participating in sports coaching tended to be positive and good, while the interest assessment obtained a score of 78.1% of the maximum score, so that athletes' interest in participating in sports coaching was quite high. Overall, the implementation of the sports coaching program has been going well and effectively.

Based on the results of research on the implementation of sports coaching, we recommend; Firstly, in planning sports coaching resources, instruments for measuring non-academic skills need to be prepared clearly. When planning a training program, the training materials prepared need to be adapted to the athlete's needs. In planning, the facilitator's division of tasks needs to be clearer, so that coordination can run well. Then the research focuses on context, input, process and product so that there is a possibility that the data that can be used as a basis for decision making related to sports development programs cannot be collected in its entirety, for this reason it is necessary to carry out further research using other components, especially those relating to evaluation of program planning.

ACKNOWLEDMENT

Our thanks are conveyed to fellow researchers and research participants who have supported the completion of this research.

Conflict of Interest

We declare that the article we have written is not involved in any conflict of interest.

Ethics Statement

This research has met ethical rules. Research ethical approval was obtained from the Sports Research Ethics Committee, Universitas Negeri Makassar, Indonesia, with reference number 453/UN36.3.4/TU/2024

Author Contributions

Study conception and design: SS, AH, MIH, AAM; Data Collection: SS, AH; Analysis and Interpretation of results: AH, MIH, AAM; Draft manuscript preparation: SS, AH, MIH, AAM; All authors reviewed the results and approved the final version of the manuscript.

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RESEARCH ARTICLE

Spiritual Growth and Stress Management of Physical Education Sport and Health Students

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Abstract

The purpose of this research was to identify the spiritual growth and stress management of Physical Education, Health and Recreation students. The method of this research was qualitative. The respondents to this study were students of the Physical Education, Health and Recreation study program at the Faculty of Sports and Health Sciences, Universitas Negeri Surabaya. The sampling technique used was quota sampling, which was determined by researchers to include as many as 170 students. The data collection technique was a survey with a questionnaire filled out online. The research instrument used was the Health Promoting Lifestyle Profile II instrument, which was adjusted to the characteristics of the activities of Physical Education, Health and Recreation students in the sub-questions about spiritual growth and stress management. The research data were processed descriptively and correlatively using Pearson Correlation analysis. The results of the Pearson Correlation test showed a significance value of. 000 < 0.05, so it was stated that the two variables were correlated. Spiritual growth and stress management, with a Pearson Correlation value of.728, have a degree of relationship with a strong correlation. The significance value of.728 is positive, indicating that the relationship between spiritual growth and stress management increases with the assumption that the higher the spiritual growth, the higher the stress management. The conclusion of this study is that the spiritual growth of Physical Education, Health and Recreation students has a positive correlation with stress management. This study contributes to providing recommendations for conducting stress management activities for students.

Keywords
Students, Spiritual Growth, Stress Management

INTRODUCTION

Spirituality is the development of one's inner well-being to achieve happiness, peace, and satisfaction in one's life (Subramaniam et al., 2011). This development will continue continuously, and there is no limit to someone experiencing the peak of spirituality, along with increasing life experience and providing valuable lessons from each experience that is passed. Spirituality is an abstract reality that is difficult to define as a moral compass that gives direction and meaning to humans (Fuertes et al., 2021).

A person's spiritual maturity and prosocial motives will show significant changes with age (Ginting, 2018). A person's spiritual maturity should increasingly develop in a positive direction. Spiritual maturity results from interaction with the environment, where one will be able to filter information and make it a record for oneself. Spirituality in the world of education is a need to be able to improve the quality of teaching and learning,

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which is influenced by personal, social, religious, and cultural factors (Narayanan et al., 2023). A person's personality is different from another's to be able to accept social dynamics as a life lesson. Likewise with religion and culture, which, directly or indirectly, can be a means of improving one's spiritual quality.

Students, as academic beings, are in a learning environment that is conditioned by spiritual values in every lecture activity. Student spiritual development can be drawn from experience and reflection while getting assignments and activities related to spiritual development that are relevant to the study program (Moulin-Stożek, 2020). Spirituality is an excellent psychological resource for managing academic-related stress and plays an important role in shaping student identity, life values, and life goals (Ekwonye et al., 2020). The lecture experience can be a very important and appropriate moment to enrich students' personal growth and development in addition to academic matters. For many students, college is their first step towards living a more independent life without direct supervision from parents, family, or teachers. They are seen as more mature and can be released to be freer and more responsible for themselves (Plante, 2020).

College is a long journey that requires high enthusiasm and struggle to study, complete college assignments, and participate in other off-campus activities. Students must be able to manage various stressors related to academic commitments and social activities, including finances. Students must realize that college requires a lot of assignments that are due in a short time, such as quizzes, exams, term papers, projects, and other practical assignments. If students cannot manage it well, it is certain that many students will experience stress (Kumar et al., 2013). Several factors cause student stress, namely academic matters, workload, relationships with peers, teachers, and parents, work and career aspirations, and financial problems (Goyal et al., 2021).

Stress is experienced by everyone, which can affect decisions by politicians, managers, religious leaders, employees, housewives, students, drivers, or even the unemployed (Mazo, 2015). Stress is a phenomenon that cannot be avoided in human life. Stress is a state of imbalance between a person's physiology and psychology that arises because of demands and the inability to meet these demands. Academic stress is the stress experienced by students when facing every challenge during a long series of lectures. Stress is a personal experience caused by pressure or demand on someone that has an impact on how the individual attempts to cope with the pressure or demand. Stress occurs when there is a mismatch between pressure or demands and the individual's ability to fulfill or resolve them (Dumnar, 2018). Based on research (Mason, 2017), several categories of stress on students include stress due to financial, spiritual, physical, emotional, mental, and institutional problems.

Stress is a condition that causes negative thoughts and feelings in a person. Not everyone considers this situation stressful because the level of stress varies from one person to another (Kassymova, 2018). Stress can have a positive or negative impact depending on the intensity of the stress, the individual's self-management, and the support of the surrounding environment. One can see stress as a response, as a stimulus, and as a transaction (Rana et al., 2019). Students who have good spirituality will be optimistic, reduce stress and anxiety, and support feelings of comfort and calm. With proper stress management, students will be able to manage stress positively and mature as individuals. Physical Education students are prospective Physical Education teachers who are trained to become competent teachers. These competencies include pedagogical competencies, social competencies, personality competencies, and professional competencies, which should be well mastered to become quality educators. These prospective teachers must begin to instill spiritual values and also learn to manage their own stress when dealing with the challenges and demands faced while studying in college. The results of this study provide information about the spiritual growth and stress management of Physical Education, Health and Recreation students in the class of 2022 at the Faculty of Sports and Health Sciences, Universitas Negeri Surabaya, and their correlation.

MATERIALS AND METHODS

Research Design

This research was carried out in the month of June 2024 and with research ethics approval obtained from the Ministry of Education, Culture, Research and Technology, State University of Surabaya with project number B/65592/UN38.6/TU.00.09/2024. The ethical

approval obtained states that this study strictly adheres to the principles of research ethics and guarantees the confidentiality of research subject data. This study used a qualitative descriptive survey research design.

Participants

Respondents in this study were Physical Education, Health and Recreation students in the class of 2022 at the Faculty of Sports and Health Sciences, Universitas Negeri Surabaya. The sampling technique used in this study was a quota sampling of 170 students. This sampling quota was chosen by the researcher for the effectiveness of the research implementation. With a sample size of 170 students, the minimum number of research samples has been met, with a minimum sample size of 164 students calculated using the Slovin formula from a total population of 279 students.

Instruments

The instrument in this study was a questionnaire that used the Google Forms platform to collect data. The spiritual growth and stress management instrument in this study used the Health Promoting Lifestyle Profile II (HPLP-II) questionnaire, which corresponds to the characteristics of student activity in the Health & Recreation Physical Education Study Program with groupings of questionnaire questions that reflect spiritual growth and stress management. Validity spiritual growth and stress management was 0.71. Reability of spiritual growth was 0.811 and stress management was 0.744 (Kuan, et al., 2019).

Data analysis

The data normality test with the Kolmogorov-Smirnov Test was carried out using IBM SPSS version 25. The basic decision-making process for the Kolmogorov-Smirnov Test is:

- If the significance value is > 0.05, then the residual value is normally distributed.
- If the significance value is <0.05, then the residual value is not normally distributed.

The categorization of research results is carried out by establishing criteria based on the guidelines:

Table 1. Categorization of Research Results

No	Category	Criteria
1	Low	X<M-1SD
2	Medium	M-1SD ≤X< M +1SD
3	Hight	X>M+1SD

The correlation between variables in this study was tested with the Pearson Correlation test, which is a simple correlation involving one dependent variable and one independent variable. The Pearson Correlation test can also test the degree of closeness of the relationship between the two variables being tested. The magnitude of the Pearson Correlation value uses the following formula:

$$r_{xy} = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{\left[n\sum x^2 - (\sum x)^2\right] + \left[n\sum y^2 - (\sum y)^2\right]}}$$

Information:

x: first variable

y: second variable

n: the number of observations

The correlation test between the two variables in this study is expressed by the correlation coefficient (r). Furthermore, it is also important to find out whether the relationship between variables is positive or negative. The basis for making decisions for the Pearson Correlation test is:

If the significance value is < 0.05, then it is stated to be correlated.

If the significance value is > 0.05, it is stated that it is not correlated.

The correlation coefficient is a measure used to determine the degree of relationship between variables. The coefficient values are in the negative range of 1 (-1) to 1. The degree of relationship between the Pearson Correlation values is as follows:

Table 2. Classification of Pearson Correlation Values

No	Pearson Correlation Value	Value Degree
1	0.00 - 0.200	No Correlation
2	0.21 - 0.400	Weak Correlation
3	0.41 - 0.600	Moderate Correlation
4	0.61 - 0.800	Strtong Correlation
5	0.81 - 1.000	Perfect Correlation

Source: (Miftahuddin et al., 2021)

RESULTS

The results of the study with a sample size of 170 Physical Health and Recreation Education students' class 2022 Faculty of Sports and Health Sciences, Universitas Negeri Surabaya were distributed to as many as 117 men and 53 women.

Data visualization in this study was carried out using descriptive statistics by presenting some data as in the following table:

Tabel 3. Descriptive Statistics

	N	Range	Min	Max	Mean		SD	Variance
Spiritual growth	170	19	17	36	26.95	.330	4.301	18.500
Stress management	170	18	14	32	20.96	.290	3.778	14.271
Valid N (listwise)	170							

Min:(Minimum), Max: (Maximum), M: (Mean), SD: (Std. Deviation)

The results of the descriptive statistics show that spiritual growth has a minimum value of 17 and a maximum value of 36. The average value of spiritual growth is 26.95, with a standard deviation of 4,301. While stress management has a minimum value of 14 and a maximum value of 32. The average value of stress management is 20.96, with a standard deviation of 3,778.

The data normality test with the One-Sample Kolmogorov-Smirnov Test was carried out using IBM SPSS version 25. The results of the normality test on the data from this study are:

Tabel 4. Data Normality Test Results

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		170
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	2.58902820
Most Extreme Differences	Absolute	.062
	Positive	.046
	Negative	-.062
Test Statistic		.062
Asymp. Sig. (2-tailed)		.200[c,d]
a. Test distribution is Normal.		
b. Calculated from data.		
c. Lilliefors Significance Correction.		
d. This is a lower bound of the true significance.		

The results of the normality test show a significance number of 0.200>0.05, so it is stated that the data is normally distributed. The visualization of data distribution to describe spiritual growth and stress management data in this study in the scatterplot is as follows:

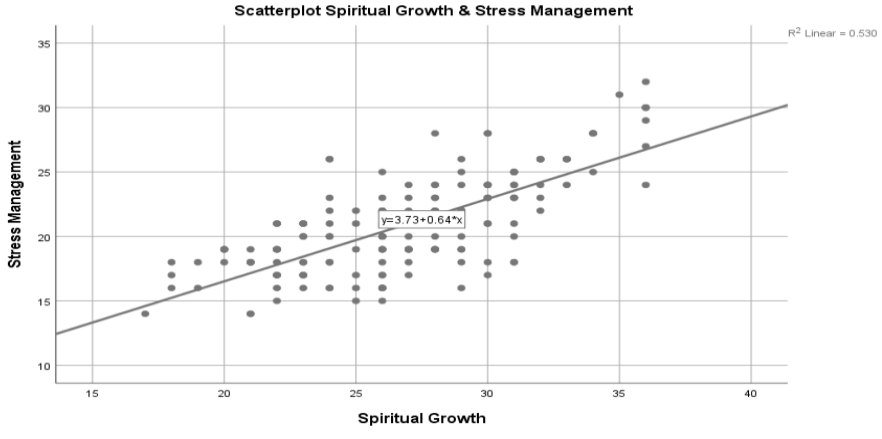

Figure 1. The scatterplot spiritual growth and stress managem

A scatterplot with a diagonal line typically shows a relationship where the values on the x-axis are equal to the values on the y-axis. This diagonal line, often referred to as the line of equality, helps visualize how close the data points are. Spiritual growth and stress management the scatterplot shows the diagonal line: the higher the spiritual growth, the higher the respondent's stress management.

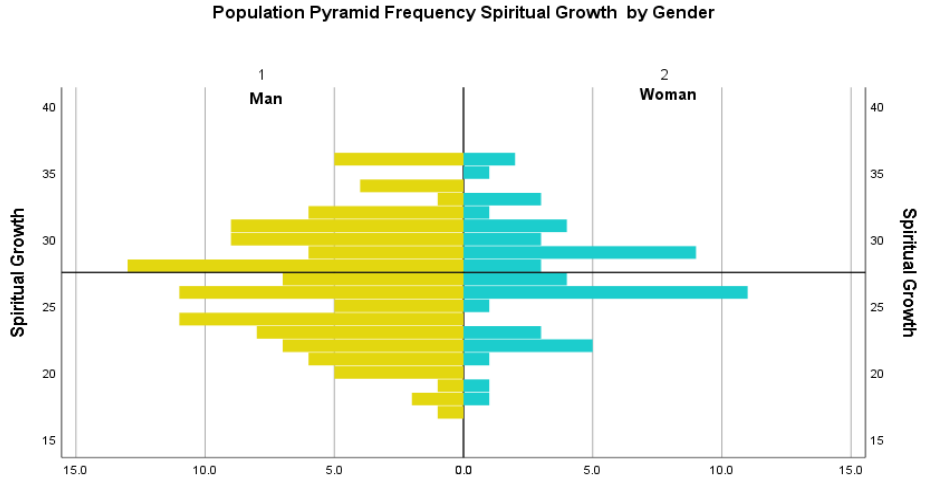

Figure 2. The histogram spiritual growth

The histogram of stress management between male and female students is as follow

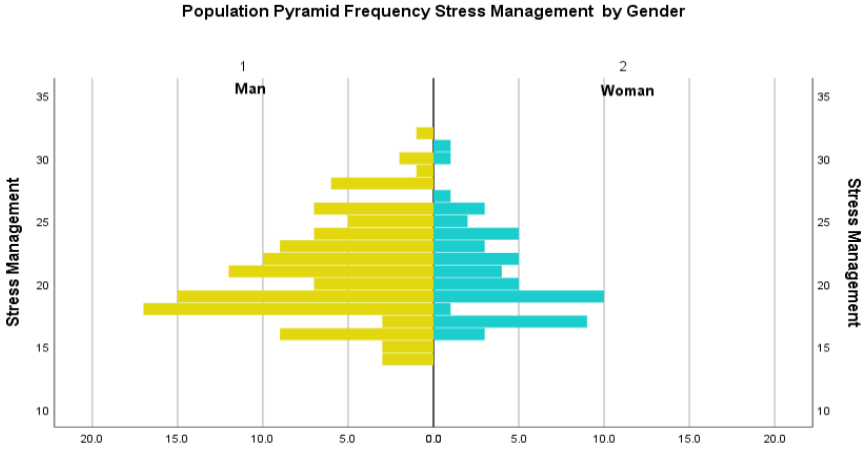

Figure 3. The histogram stress management

The categorization of the spiritual growth results of the respondents is as follows:

Table 5. Spiritual growth categorization

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low	30	17.6	17.6	17.6
	Medium	117	68.8	68.8	86.5
	Heigth	23	13.5	13.5	100.0
	Total	170	100.0	100.0	

In the spiritual growth indicator, the majority of respondents fall into the medium category. The categorization of the spiritual growth results of the respondents is as follows:

Table 6. Stress mangement categorization

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low	30	17.6	17.6	17.6
	Medium	110	64.7	64.7	82.4
	Heigth	30	17.6	17.6	100.0
	Total	170	100.0	100.0	

In the stress mangement indicator, the majority of respondents fall into the medium category. The correlation between variables in this study was tested with the Pearson Correlation test. The results of the Pearson Correlation test on the data from this study are:

Table 7. Pearson correlation test results

Correlations			
		Spiritual growth	Stress management
Spiritual growth	Pearson Correlation	1	.728**
	Sig. (2-tailed)		.000
	N	170	170
Stress management	Pearson Correlation	.728**	1
	Sig. (2-tailed)	.000	
	N	170	170

**. Correlation is significant at the 0.01 level (2-tailed).

The significance value is.000 <0.05, so it is stated that the two variables are correlated, with the Pearson Correlation value of. 728 being at the degree of relationship with a strong correlation. And the significance value of. 728 is positive, indicating that the two variables are positively correlated.

DISCUSSION

Descriptive statistical data from the research results show that the average score on spiritual growth for all respondents is higher than the average stress management score. The minimum value of spiritual growth for all respondents is higher than the minimum value of stress management. Likewise, the maximum value of spiritual growth is higher than the maximum value of stress management. Visualization of data distribution to describe the spiritual growth and stress management data of respondents in the spiritual growth and stress management The scatterplot shows a diagonal line; the higher the spiritual growth, the higher the respondent's stress management.

The results of the research category based on 3 spiritual growth criteria showed that the Low category was 17.6%, the medium category was 68.8%, and the High category was 13.5%. While the category of research results based on 3 stress management criteria shows that in the Low category it is 17.6%, the medium category is 64.7%, and the High category is 17.6%, Identification of student stress from an early age will make it possible to take steps on how to deal with student stress appropriately (Rizzolo et al., 2011). The level and type of stress for early semester students will be different from those for final semester students. At the time of data collection, the respondents were active students taking the second semester. Stress on early-level students does not necessarily have a negative impact because stress can motivate students to stay focused on lectures and try to study, such as by preparing assignments and exams (Istasy et al., 2021).

The Pearson Correlation test in this study was used to test the correlation and the degree of closeness of the relationship between the two variables being tested. The spiritual growth of Physical Education, Health and Recreation students has a positive correlation with stress management to the degree of a strong correlation. Research conducted by (Fahmi et al., 2022) states that individuals who have a high level of spirituality will be able to overcome problems that occur in their lives because spirituality will be able to provide meaning in dealing with stress that occurs.

The spiritual growth category table shows that the low category is 17.6%, the medium category is 68.8%, and the high category is 13.5%. Of the total respondents, the spiritual growth category was dominated by students who were in the medium category. The stress management category table shows that the stress management category is 17.6%, the medium category is 64.7%, and the high category is 17.6%. Of the total respondents in the stress management category, it was dominated by students who entered the moderate category.

Spirituality in education is needed to improve the quality of teaching and learning (Narayanan et al., 2023). The campus provides students with an opportunity to grow intellectually and actualize their potential for the future. But on the other hand, the campus also causes anxiety and stress for students (Tan et al., 2021). Sustained stress will have a negative impact on students' academic performance, learning achievement and performance, quality and quantity of sleep, physical health, mental health, and other impacts. Improving stress management abilities and skills for students is important (Tan et al., 2021). If students can deal with stress effectively, it will be able to provide motivation for progress in achieving goals (Lin, et al., 2020). Stress can be managed, and one of the best ways is counseling (Kaiwart, et al., 2015). Counseling can be done individually or in counseling groups, which are mostly formed among students. In addition, stress can be managed through physical activity (Kassymova et al., 2018).

Stress needs to be managed well, and the process takes practice. Stress management techniques that can be used are relaxation, meditation, and taking deep breaths (Kassymova et al., 2018). Research conducted by (Rizzolo et al., 2011) states that yoga, humor, and reading are simple methods to help reduce stress. Physical Education, Health and Recreation students have many activities in the field, which will provide many opportunities for communication and joking while attending lectures. Especially in courses in the form of game activities where you will feel happy or happy when doing them, such as in football practice courses, volleyball practice, basketball practice, small games, tennis practice, and other game activities, Regular physical activity has a positive impact on student health and reduces stress (Wilson-Salandy et al., 2012). Other techniques such as yoga, skills training, mindfulness meditation, and psychotherapy have proven effective in reducing student stress (Reddy et al., 2018). Physical Education, Health and Recreation students with special characteristics, namely a fondness for physical activity, will support stress

Conclusion

This study contributes to providing recommendations for conducting stress management activities for students. The novelty of this study is that Spiritual Growth and Stress Management in Physical Education, Sports and Health Students have never been studied before. The conclusion of this study is that the spiritual growth of Physical Education, Health and Recreation students has a positive correlation with stress management.

Conflict of Interest

There is no conflict of interest in this research.

Ethical considerations

This research was conducted in June 2024 and with research ethics approval obtained from the Ministry of Education, Culture, Research and Technology, Surabaya State University with project number B/65592/UN38.6/TU.00.09/2024.

Author Contributions

Research Design: SW; Data Collection: SW, HNM, TH; Statistical Analysis: SW, SH; Data Interpretation: AP and LAK; Manuscript Preparation, AP; Literature Search: PBDJR. All authors have read and approved the published version of the manuscript.

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RESEARCH ARTICLE

Integration of Life Skills in Outdoor Education Program Towards Interpersonal Communication

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Abstract

The purpose of the study was to determine and test the differences in the influence of three groups, namely two groups of outdoor education programs and one group of daily activities on interpersonal communication skills. The method used in this study was an experiment with a pretest-posttest control group design with more than one experimental group and a quantitative approach. The sample involved was 42 (21 females and 21 males) who were studying in the physical education department of PGSD level one. The Life Skills Scale for Sport (LSSS) questionnaire as an instrument with a reliability level of 0.92 and a validity of 0.63. Data analysis was carried out using Statistical Product and Service Solution (SPSS) on Windows version 22. The findings of the study showed that the integrated outdoor education life skill program had an effect with a significance value of .000 <0.05, the non-integrated outdoor education program had an effect with a significance value of .026 <0.05 and daily activities had no effect with a significance value of .108> 0.05. simultaneously between the three groups there was a significant difference. The conclusion is that integrated and non-integrated life skill outdoor education programs have an effect on interpersonal communication, but the integrated life skill outdoor education program is better. While in the control group there is no significant effect.

Keywords
Life Skills, Outdoor Education, Social Skill and Interpersonal Communication

INTRODUCTION

Outdoor education is a learning process in various environmental and environmental activities physically and psychologically demanding to create learning in individuals or groups (Bosch & Oswald, 2010). Outdoor education Outdoor education aims to encourage learning through the interaction between emotions, actions and thoughts, based on practical observations in authentic situations (Szczepanski et al., 2006). Outdoor education focuses on the location where an activity occurs and is related to the potential of the outdoor environment to stimulate this type of physical activity (Crompton & Sellar, 2010).

This learning is related to activities outside the classroom and in the wild, through play activities in schools, parks, agricultural villages and activities that are adventurous and the development of aspects of knowledge and concepts that are relevant in the values contained therein. Kathleen & Larry, (2011) show that outdoor play contributes to

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the social, emotional, cognitive, and physical development of learners. The activities can be designed to be done outdoors, require physical activity (running around) and encourage social interaction between learners (Verhaegh et al., 2006). Outdoor education is one of the most powerful and transferable teaching vehicles (Barker, 2006). The transfer process of outdoor education programs involves many physical activities carried out in nature or outdoors. Ewert & Voight, (2012) Adventure Education (AE) programs seek to foster individual growth and development through deliberate planning and implementation of the educational process which often includes perceived or actual risks and typically uses the natural environment as the program setting. Knowledge management is where each individual should be able to feel, see directly and even be able to carry it out himself, so that the transfer of knowledge sourced from experience in nature can be felt, translated, developed based on the abilities possessed is one of the learning processes through nature is seen as very effective as a learning medium. The learning approach through nature hones physical and social activities where a person will carry out more activities that indirectly involve cooperation between friends and creative abilities. The process of communication, problem solving, creativity, decision making, mutual understanding, and respect for differences will arise through outdoor activities (nature). The form of activity is made periodically and programmatically so that the process of change can be seen in real and in accordance with the goals to be achieved.

Recent research has shown that outdoor education experiences such as schoolyards that are often implemented by a trained teacher can result in greater science achievement for students (Martin, 2003). There are indications that show (although not strong enough) that, outdoor education with the experience of hiking activities through experiential learning methods has a positive influence on controlling the anger of female students but does not have a positive effect among male students (Karjono, 2009). In addition, opportunities to spend time outdoors that are not structured can affect the attitudes, behavior, cognition, and physical development of learners (Kolb & Kolb, 2014). Learning through outdoor experiences helps learners build their knowledge and can affect growth, development, learning, and health for the long term (Driessnack & Rhodes, 2009). Outdoor education has diverse perspectives of knowledge and learning whereas traditional education systems, based on theoretical knowledge in a classroom environment and limiting the interaction between emotions, actions and thoughts and have the potential to be a complementary form of education in the tradition of pragmatic and progressive pedagogy can offer students and teachers the opportunity to learn based on observation and experience in authentic situations, then the positive influence of outdoor education related to personal and social development, physical activity and academic achievement (Becker et al., 2017).

Related to previous research and problems that occurred in Indonesia. It is quite clear that outdoor education has a positive influence on the perpetrators. Therefore, the researcher intends to try to explore further research related to the role of outdoor education activities which are designed in such a way as to see the difference in the level of meaning associated with efforts to develop life skills components, especially related to interpersonal communication indicators.

Interpersonal communication skills include social, respect, leadership, family interaction, and communication skills that are considered necessary for youth to possess. In addition, personal skills including self-organization, discipline, independence, goal setting, managing performance results, and motivation, are also considered necessary for youth to possess. But other than all that, social skills were identified as the most important life skills that youth should possess (Jones & Lavallee, 2009).

Based on the results of previous research descriptions, it is hoped that outdoor education programs can improve the components of life skills, especially interpersonal communication to optimize the readiness of subjects in facing the challenges of their daily lives.

MATERIALS AND METHODS

Research Design

The research design used in this study is Pretest-Posttest Control Group Design With More Than One Experimental Group. The use of the research design is adjusted to the characteristics of the research carried out and the subject matter discussed in the research. Quasi-experimental designs are not included in the use of random assignment. Researchers who used this study design

relied on other techniques to control (or at least reduce) threats to internal validity (Fraenkel et al., 2012).

According to Christensen dkk., (2014) that "The design of a pretest-posttest control group with more than one experimental is an excellent experimental design because it does an excellent job of controlling for rival hypotheses that would threaten the internal validity of the experiment." In this study, researchers set 2 (two) treatments in 2 (two) experimental groups and activities in 1 (one) control group. A good idea of the design can be seen in Table 1:

Table 1. Research design

Group	Pretest	Treatment	Posttest
Experimental Group 1	O_1	XT_1	O_2
Experimental Group 2	O_1	XT_2	O_2
Control Group	O_1	XC	O_2

Notes: Pretest-Posttest, Control Group Design with More Than One Experimental Group
Source: (Christensen dkk., 2014)

Information:
O1 : Pretest measurement in experimental class and control class
O2 : Posttest measurement in experimental class and control class
XC : Daily Activities (Control Group)
XT1 : Treatment Outdoor Education integrated life skills (Integrated)
XT2 : Treatment Outdoor Education (Non-integrated)

Participants

The population in this study was the initial level PGSD Physical Education UPI Sumedang Campus students aged 18-21 years with a total of 87 students divided into 2 classes. The reason for choosing entry-level students as the population in this study was the assumption that their physical abilities would not have difficulty carrying out the required tasks. They are students who have taken general physical ability tests, such as endurance, strength and flexibility, before being accepted as students. Likewise, to reduce the possibility of experimenter bias, the sample chosen was first semester students who had just started their course. This means as far as possible the members of the experimental group and the control group have not been much influenced by lecture experiences which are thought to be able to "contaminate" the experimental results.

The sampling technique used is a purposive sampling technique which is also called judgment sampling, namely the deliberate choice of an informant because of the qualities the informant possesses (Tongco, 2007). Simply put, purposive sampling for research can start with a survey, then purposive sampling is carried out based on the survey (Brown, 2007). The procedures carried out in sampling are as follows;

Researchers determined the sample using survey stages and gave anxiety questionnaires via Google Form to students.

After data from students was obtained, the researcher then determined a sample that had characteristics, namely (1) students whose age range was between 18-21 years, (2) students who were active in lectures, (3) students who had never participated in outdoor education activities, (4) have no history of illness, (5) have a low level of anxiety.

Then the researcher divided the group into 3 groups, namely experimental group 1, experimental group 2 and control group. The sample grouping process was carried out through ranking based on sample data that had never done any outdoor education activities, swimming ability, history of illness, had a low level of anxiety (experimental group 1 and experimental 2) and samples that had done one of the outdoor education activities, swimming ability, history of illness, moderate level of anxiety (control group).

The purpose of the sample which has never participated in outdoor education activities in experimental group 1 and group 2 is so that the results of this research (experiment) are not influenced by the previous experience of the sample.

From a total of 87 students divided into 2 classes, a sample of 42 students was obtained with the details as follows in table 2

Table 2. Research sample

Group	Male	Female	Total
Experiment 1	7	7	14
Experiment 2	7	7	14
Control	7	7	14
	Total		42

Data Collection Instruments

The data collection used was in the form of a questionnaire given to research subjects through a pretest as initial data and through giving a posttest as final data. The instrument used in this study is the Life Skills Scale For Sport (LSSS) developed by (Cronin & Allen, 2016). The LSSS questionnaire instrument was developed for vulnerable young sports participants aged 11-21 years. The LSSS questionnaire instrument contains eight main life skill components consisting of 47 question items with closed question types. The vulnerable value scale used is the five-point scale range from 1 (not at all) to 5 (very much) dengan tingkat reliabiltas 0,92 dan validitas 0,63.

Research Flow and Program

The flow of research carried out by the author focuses on considering research problems that occur in general at global, national and regional levels, especially in the area where the author carries out daily activities, then conducts surveys and identifies the results to determine the population and sample. After that, the researcher determined the method and research design that would be carried out on the three groups, then carried out a pre-test to describe the initial condition of the sample before being given treatment, after that the researcher began to develop and implement treatment for three days and then carried out a post-test, the next stage was processing and analyzing the data obtained, so that it reaches the final stage of drawing conclusions on the research results.

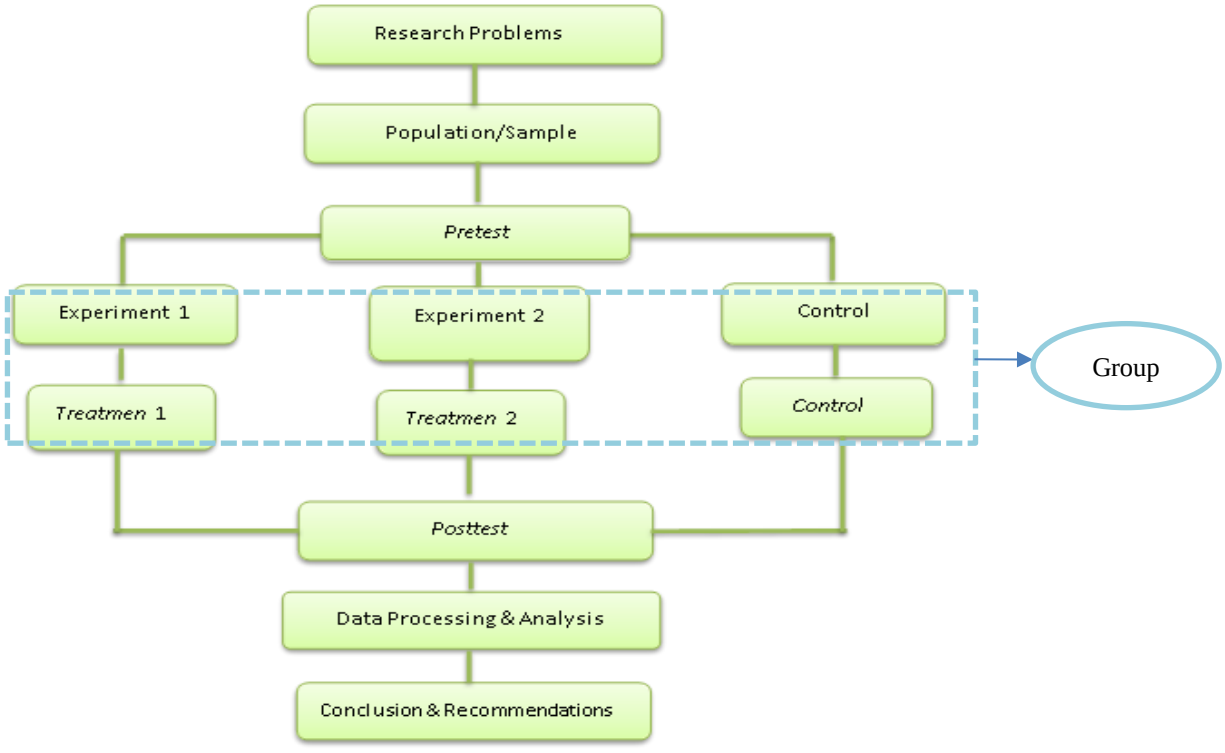

Figure 1. Flow chart of all included participants in study

The research program was adopted from Neill, (2001) who said typical learning activities include land or water expeditions involving hiking, rowing on rivers or lakes, camping, adventure activities that focus on challenges such as rope challenges, initiative tasks, and exercises. group, and personal growth activities such as journaling, solos, communication skills practice and individual

feedback from the instructor. Outdoor education offers many possibilities for learning. Outdoor education has been researched for decades, but the field lacks an integrating framework for its disparate historical, geographic and disciplinary conceptualizations. The outcomes of outdoor education programs are well documented and appear diverse, but also have common attributes that suggest there is room for a unifying approach (Smith & Walsh, 2019). The outdoor education activity program in this research will be carried out for 3 days and 2 nights. The time taken for 3 days 2 nights was based on previous research, namely, Taniguchi et al., (2005) which stated that an adventure-based outdoor education program for 3 to 7 days had a positive influence in several areas on students, namely, the acquisition of technical skills; improvement in life skills and increase in self-awareness.

RESULTS

The calculation of the average score and standard deviation was carried out in two outdoor education programs integrated with life skills, non-integrated life skills and one control, namely controlled daily activities. Calculating the average value and standard deviation is the first step for further testing. Testing mean and standard deviation uses raw data from test results and measurements for interpersonal communication. The following are the results of calculating the average value and standard deviation in the integrated outdoor education life skill program as stated in table 2.

Table 2. Mean value and standard deviation integrated outdoor education program

M		SD	
Pre-test	*Post-test*	*Pre-test*	*Post-test*
14.7	17.2	3.19	2.26

Standard Deviation (SD), Mean (M)

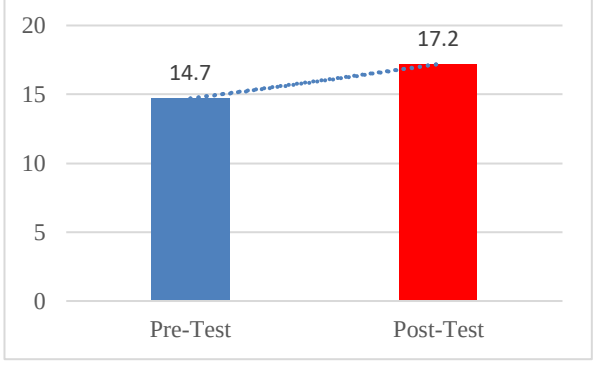

Figure 1. Life skills ıntegrated average value chart

According to figure 1 of the bar chart above, the value in the integrated group obtained a pretest result of 14.7 and a posttest result of 17.2, from these results there was a difference or difference in value of 2.5 points, the difference showed that the average score of the research group from pretest to postest increased. This means that the treatment of integrated outdoor education programs has an impact on interpersonal communication variables. While the results of calculating the average value and standard deviation in the outdoor education non-integrated life skill program are contained in table 3:

Table 3. Outdoor Education Non-integrated Program

Mean		Standard Deviation	
Pre-test	*Post-test*	*Pre-test*	*Post-test*
14.2	14.7	1.31	2.22

Based on table 3, it shows that the average score of pretest and posttest results in the outdoor education non-integrated life skill program shows a change in score, if depicted in a bar chart as shown in figure 2 below:

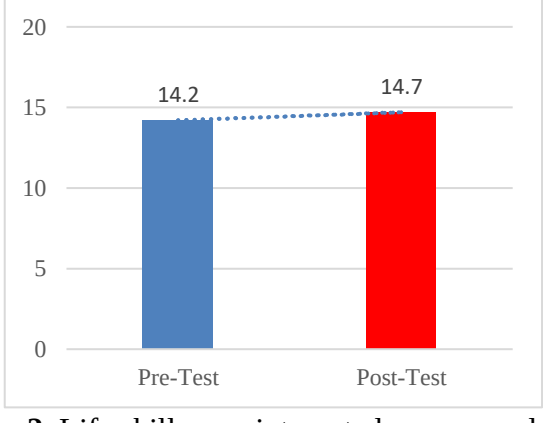

Figure 2. Life skills non-integrated average value chart

According to figure 2 of the bar chart above, the results of the scores in the non-intengration group obtained a pretest result of 14.2 and a posttest result of 14.7, from these results there was a difference or difference in values of 0.5 points, the difference showed that the average score of the research group from pretest to postest increased. This means that the treatment of non-integrated outdoor education programs has an impact on interpersonal communication variables. Table 4,

below are the average scores and standard deviations in controlled learning programs.

Table 4. Mean Value and Standard Deviation Controlled Learning Program

Mean		Standard Deviation	
Pre-test	*Posttest*	*Pre-test*	*Post-test*
13.9	14.3	2.76	1.98

Based on Table 4, it shows that the average score of pretest and posttest results in a controlled learning program shows a change in score, if depicted in a bar chart as shown below in figure 3:

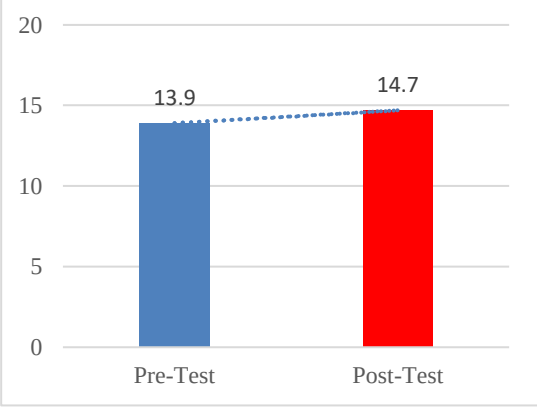

Figure 3. Daily activities average value chart

According to figure 3 of the bar chart above, the average score results in the controlled learning group obtained pretest results of 13.9 and posttest results of 14.3 from these results there was a difference or difference in values of 0.4 points, the difference showed that the average score of the research group from pretest to posttest increased. This means that the treatment of controlled learning programs has an impact on interpersonal communication variables. Furthermore, to see the influence of each group, the first step is to test statistical assumptions as a prerequisite for testing hypotheses through data normality tests, homogeneity tests, paired samples tests and anova tests. Data normality testing is carried out on all research data to determine the normal or abnormal data. The results of the processing are shown in table 5:

Based on table 5, the results of the normality test using the shapiro-wilk test are known data from both groups from pre-test to post-test, when compared at the real level (0.05) showing a significance value greater than α (sig.>0.05) in the intengration group, non-intengration group and control group. Then it can be concluded that in all three groups are normally distributed. Because it fits the decision-making criteria if the value of sig. or probability value P > 0.05 (normal distribution).

Table 5. Research group normality test output results

Group	Variable	Sig value.	
		Pre-test	Post-test
Integrated	Interpersonal Communication	0.057	0.060
Non – Integrated		0.167	0.069
Control		0.205	0.055

Once known to be normally distributed, the next step is to test the homogeneity of two variances from the pretest and posttest of the intengration group, the non-intengration group and the control group. This homogeneity test is used to determine whether the sample of this study comes from a homogeneous population or not, testing homogeneity of variance using the levene test, as for the results of the test in table 6 as follows:

Table 6. Research group homogeneity test results

Group	Levene Statistic	df1	df2	Sig.
Integrated	3.46	1	26	0.07
Non – Integrated	1.63	1	26	0.21
Control	1.16	1	26	0.29

Based on table 6, the homogeneity test results show the probability value (P) for all three groups has a sig value. greater than 0.05. Based on the decision criterion, namely the value of sig. greater than 0.05, thus the homogeneity test results can be concluded data belonging to homogeneous categories or having the same variant. After the data is assumed to be distributed normality and homogeneity of each group, the next step is hypothesis testing with a statistical approach used for testing the hypothesis, namely the t test (paired sample t test) carried out to determine the comparison of the difference between two means from paired samples from pre-test and post-test data in the integrated group, as for the test results in table 7 as follows:

Table 7. Output results of paired samples test tengrated group

Interpersonal Communication	t	df	Sig. (2-tailed)
Pre Test - Post Test	4.660	13	.000

Based on table 7, a significance value (sig.) of 0.000 is obtained. When compared at the real level (α = 0.05) showing a significance value smaller than α (0.000 < 0.05) in accordance with the decision-making criteria, H0 is rejected. So it can be concluded that there is a significant influence of integrated outdoor education programs on interpersonal communication variables.

Next to determine the comparison of the difference between two means from paired samples from pre-test and post-test data in the non-intengration group, the test results in table 8 are as follows:

Table 8. Non-intengration Paired Samples Test Output Results

Interpersonal Communication	t	df	Sig. (2-tailed)
Pre Test - Post Test	2.509	13	.026

Based on table 8, a significance value (sig.) of 0.000 is obtained. When compared at the real level (α = 0.05) showing a significance value smaller than α (0.026 < 0.05) in accordance with the decision-making criteria, H0 is rejected. So it can be concluded that there is a significant influence of non-integrated outdoor education programs on interpersonal communication variables.

Meanwhile, to find out the comparison of the difference between two means from paired samples from pre-test and post-test data in the control group, the test results in table 9 are as follows:

Table 9. Output Results Paired Samples Test control

Interpersonal Communication	t	df	Sig. (2-tailed)
Pre Test - Post Test	1.727	13	.108

Based on table 9, a significance value (sig.) of 0.245 is obtained. When compared at the real level (α = 0.05) shows a significance value greater than α (0.075 > 0.05) in accordance with the decision-making criteria, H0 is accepted. So it can be concluded that there is no significant influence of controlled learning programs having an impact on interpersonal communication variables.

After testing the significance of the three groups, the next step was to calculate the significance of the difference in improvement between the integrated group, the non-integrated group and the control group who both experienced an increase. The results of calculations and significance tests of the two groups can be seen in table 10:

Table 10. One Way Anova Output Results Experimental and control groups

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.
Intergrated	Non-Integrated	1.42857*	.50559	.007
	Control	2.50000*	.50559	.000
Non-Integrated	Intergrated	-1.42857*	.50559	.007
	Control	1.07143*	.50559	.040
Control	Intergrated	-2.50000*	.50559	.000
	Non-Integrated	-1.07143*	.50559	.040

Based on the results of the SPSS output, the sig (2-tailed) value between the indented group and the non-inmackerated group of 0.007 is smaller than 0.05 (0.007 < 0.05), meaning that H0 is rejected, it can be concluded that there is a difference in influence between the indented group and the non-intengration group. While the sig (2-tailed) value between the intengrated group and the control group of 0.000 is smaller than 0.05 (0.000 < 0.05) meaning that H0 is rejected, it can be concluded that there is a difference in influence between the indented group and the control group. Next, the sig (2-tailed) value between the non-intengration group and the control group of 0.040 is smaller than 0.05 (0.040 < 0.05) meaning that H0 is rejected, so it can be concluded that there is a difference in influence

between the non-intengration group and the control group. Based on table 10, it can be concluded as a whole that there are differences in the influence of the integrated group, non-integrated group and control group on interpersonal communication variable.

DISCUSSION

The results of this study revealed that the outdoor education integrated life skills program and the outdoor education non-integrated life skills program can have a significant influence on the development of interpersonal communication. In accordance with research conducted by Sibthorp**,** **(**2003**)** Which reveals outdoor programming has long assumed the development of hard skills, and the effectiveness of learning has rarely been questioned. This is the most questionable transfer of course learning. Students also learn transferable life skills.

Then Cottrell & Cottrell, (2020) We have found that the opportunities provided by teaching outdoor skills in both natural and social settings provide a context in which we can develop positive relationships with ourselves, others, and the environment. This is in line with Akin et al., (2020) in the context of positive youth development (PYD), Children who take part in outdoor educational activities have many positive benefits, such as improving life skills, social interaction, and increasing environmental awareness to protect the natural environment.

The important point of the statement above is that outdoor education can provide hard skills and life skills development that can be applied in everyday life. Outdoor education is defined as education that takes place outside the classroom and involves experiences that require each individual to participate in adventurous challenges. Activities that form the basis of outdoor education in this study are camping, hiking, rowing, rock climbing, repellent activities, and challenge activities. Outdoor education contains philosophical, theoretical and practical from experience and environmental education, By experiencing, observing directly and carrying out these activities, each individual can feel, translate and develop the transfer of knowledge based on his abilities based on his experience of nature. This approach increases individual physical and social activity by doing more activities that indirectly involve peer-to-peer cooperation and exploratory capacities. Through the concept of interaction between individuals and nature through simulations of outdoor activities, it is possible that this context can be very helpful in shaping creative and positive attitudes, mindsets and perceptions of each individual in the group undergoing outdoor treatment education. This creates a deep sense of solidarity, inclusion, tolerance and sensitivity that can inspire new enthusiasm, spontaneity and patterns of empowerment in their lives and will also be able to develop self-potential and life skills, both individually and in groups.

The term interpersonal communication is to open children's thoughts regarding what will be obtained when entering school such as character, education. Outdoor education is a physical activity that can be used as an arena to stimulate all aspects of developing students' life skills as a provision in building teamwork, goal setting, time management, emotional skills, interpersonal communication, social skills, leadership, problem solving and decision making.

The difference between integrated and non-integrated groups according to the researcher's point of view is that in integrated groups, it looks very quick to respond and take a stance to solve the task given, initiatively one of the individuals in the group tries to overcome the given problem by solving it with teamwork and a sense of community. As for the non-integration when getting the task, they were silent for a moment to wait for who would complete the task. Until finally this outdoor education program is completed, halfway through the activity for non-integration just realize how to solve the problem, inversely proportional to stable integration in solving the given problem by doing it together so that in the process of completing tasks, integrated groups always get good results compared to non-integration. This happens because it is integrated at the time of initial delivery has integrated life skills before solving the task given. so to develop interpersonal communication through outdoor education programs is better by integrating life skills in the program than not integrated.

Conclusion

The conclusion of this study shows that integrated and non-integrated out-of-school education programs for life skills have a significant influence on the development of interpersonal communication of PGSD Penjas students and simultaneously there are differences in the

influence between integrated groups, non-integrated groups, and control groups on interpersonal communication variables.

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We are very grateful to experts for their appropriate and constructive suggestions to improve this template.

Conflicts of Interest

The authors have no conflicts of interest to declare.

Ethical Statement

Research is carried out strictly, then Security and welfare. Participants are given priority during study design and implementation and Steps are taken to ensure data confidentiality. Permission to conduct research was obtained from Kementrian Pendidikan, Kebudayaan, Riset dan Teknologi Universitas Pendidikan Indonesia, numbered 1215/UN40.A6/KP/2024. All participants gave their opinions written informed consent. Consent form detailing research procedures, potential risks and benefits, data confidentiality measures, and participant rights.

Author Contributions

Study Design, YA, ARK, ARAR; Data Collection, YA, ARK, DOM, ARA; Statistical Analysis, DOM, ARA, LS; Data Interpretation, DOM, ARA, LS; Manuscript Preparation, YA, ARK, LS, ARAR; Literature Search, YA, ARK, LS, ARAR. All the authors agreed on the final draft of the manuscript before submitting it for publication.

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RESEARCH ARTICLE

Validity and Reliability Testing of the Indonesian Version of the Exercise and Menstruation Questionnaire (EMQ-I) Assessing the Phenomenon of Menstruation in Sports

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Abstract
Menstruation is a natural biological process that occurs in women and is controlled by hormonal fluctuations. This study can support the achievements of female athletes, especially in Indonesia, where communication and perceptions related to menstruation have not been included in the criteria for creating training programs. This study aimed to examine the validity and reliability of the Indonesian version of the Exercise and Menstruation Questionnaire (EMQ-I) measuring the phenomenon of menstruation in sport. The population for this study was female athletes in Malang, Indonesia, aged 18-35 years, who participated in various sports with a total of 57 athletes. This study uses a methodological approach that combines qualitative and quantitative components. The qualitative stage involves translators and experts in the field of menstruation and sports to validate the content. The quantitative stage tests the validity and reliability using statistical analysis with results ranging from 0.628 to 0.909 and reliability ranging from 0.856 to 0.927. The results of the data analysis showed that 88.5% of the question items were valid to be announced to respondents. The total items to be announced were 33 items and had been tested for validity and reliability by experts and in-depth data analysis. This research is expected to be a literature material and input for coaches in Indonesia to create training programs that are suitable for women and improve sports achievements in Indonesia.

Keywords
Validity, Reliability, Exercise Menstruation Questionnaire, Sports

INTRODUCTION

Menstruation is the periodic discharge of blood and mucosal tissue from the inner lining of the uterus through the vagina (Goldstuck, 2020). Menstruation is a natural biological process that occurs in women as part of the menstrual cycle, which is controlled by hormonal fluctuations and is a sign that pregnancy has not occurred (Kiesner et al., 2020). Menstruation is characterized by the shedding of the uterine lining, which is triggered by falling progesterone levels. This process typically occurs every 21 to 35 days, with an average duration of 28 days, and is accompanied by symptoms such as cramps, bloating, and mood changes (Silberstein & Merriam, 2000).

Menstruation is a natural biological process that affects millions of women worldwide, including those who engage in sports and physical activities. Despite its prevalence, menstruation remains a taboo topic in many sports cultures, often leading to stigma, shame, and feelings of isolation among female athletes. The relationship between menstruation and sports is complex, with

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menstruation often impacting athletes' training patterns, performance, and overall well-being (Carmichael et al., 2021; Passoni et al., 2023). Menstruation is a critical aspect of women's health, and its impact on sports performance is multifaceted. Hormonal fluctuations during the menstrual cycle can affect athletic performance, with some studies suggesting that menstruating athletes may experience decreased strength, endurance, and reaction time compared to non-menstruating athletes (Pasaribu et al., 2023). Additionally, menstrual cramps, bloating, and mood swings can disrupt training and competition schedules, leading to decreased motivation and overall performance. The uniqueness of women will not be a hindrance if they get the right treatment, especially in sports performance, in-depth education with adjustments to the conditions on the field is also very important to be carried out by the coach. With the instrument as a connector for female athletes regarding the adjustments felt by female athletes during menstruation and considerations for developing training programs for coaches who are currently holding women's teams. With these considerations, the researcher adopted the Indonesian Version of the Exercise and Menstruation Questionnaire (EMQ-I) is a comprehensive questionnaire that assesses various aspects of menstruation in sports, including the impact of menstruation on training patterns, athlete performance, and overall well-being. The questionnaire has been widely used in various cultural contexts, but its validity and reliability in the Indonesian setting remain untested. This study aims to address this gap by conducting a thorough validation and reliability testing of the EMQ-I in Indonesia.The ability of people in Indonesia to understand foreign languages, especially English, according to the EF English Proficiency Index (EF EPI) 2023 data is still low, namely ranked 79 out of 113 countries, therefore athletes and coaches are expected not to misunderstand the intent and purpose of the adapted question items, so that the research results are valid and can be continued to the next stage. This is very useful for reference in making programs and aligning training programs for coaches and athletes later.

This study aimed to examine the validity and reliability of the Indonesian version of the Exercise and Menstruation questionnaire. This study sought to adapt an existing questionnaire into the Indonesian language. Our findings are expected to contribute to a culturally sensitive research instrument that can be reliably used in Indonesia to explore the implications of menstruation on exercise, thereby facilitating more nuanced health and exercise interventions and research in the domain.

MATERIALS AND METHODS

The methodological approach of this study is in line with the development and validation framework outlined in previous research which combines qualitative and quantitative components (Ahmed & Ishtiaq, 2021; Surucu & Maslakci, 2020). The qualitative phase involved translators and experts in the field of menstruation and sport to conduct content validation to assess the clarity and understandability of the question items. Then, the quantitative phase was conducted by conducting validity and reliability tests using statistical analysis.

Population and Sample

The population in this study was 135 female athletes in Malang, Indonesia. The sampling technique in this study used purposive sampling, where sample selection was carried out based on criteria (Campbell et al., 2020). The inclusion criteria in this study were female athletes aged 18-35 years and participating in various sports. Meanwhile, the exclusion criteria are not willing to be a respondent. The sample calculation in this study was carried out using the Slovin formula so that a sample of 57 female athletes was obtained

Ethics Statement

This research is in the process of ethical testing which will later be issued by the Universitas Negeri Malang, numbered 21.08.4/ UN32.14.2.8/ LT/2024. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Data Collection Tools

Data Collection Tools in this study were demographic questionnaires and the Indonesian version of the Exercise and Menstruation Questionnaire (EMQ-I). Data Collection was conducted with an online survey using Google Forms, with links shared through social media and sports organizations. The data collection period was

six weeks, allowing participants to complete the survey at their own pace.

Data Analysis

Data analysis in this study was conducted to determine the demographic data of the research sample, validity and reliability tests of EMQ-I. Demographic data was analyzed using SPSS (Statistical Package for the Social Sciences) version 26. Validity and reliability analysis were carried out using SmartPLS version 3

RESULTS

Demographics

Table 1. Shows the average age of respondents was 20.98 years, with the youngest being 18 years old and the oldest 29 years old.

Table 1. Distribution of respondents by age

Characteristics	Mean	Min - Max	Std. Deviation
Age	20.98	18.0 - 29.0	2.33

Standard Deviation (Std. Deviation)

Meanwhile, Table 2 shows that most of the respondents are athletes in combat sports (50.9%) and are at the club competition level (42.1%).

Table 2. Distribution of respondents by sports and competition level

Characteristics	n	%
Sports		
Big ball games	14	24.6
Small ball games	10	17.5
Aquatics	3	5.3
Combat	29	50.9
Athletics	1	1.8
Competition Level		
Recreational	11	19.3
Club	24	42.1
National	17	29.8
International	5	8.8

Total (n); Percentage (%)

Evaluation of The Questionare's Validity and Reliability Test

The Indonesian Version of the Exercise and Menstruation Questionnaire (EMQ-I) is a comprehensive questionnaire that assesses various aspects of menstruation in sports. In this study, researchers identified the questionnaire items and divided them into several subscales, namely menstrual characteristics, use of contraceptive drugs, the effect of menstruation on training, discussions with coaches, changes in training patterns, and the effect of menstruation on performance. Items 1 and 2 contained age and age at first menstruation (menarche) questions. The blueprint of these items can be seen in Table 3.

Tabel 3. Blueprint item-item the Indonesian version of the exercise and menstruation questionnaire (EMQ-I)

No	Subscales	Questionnaire Item Numbers
1	Characteristics of menstruation	3, 4, 5, 6, 7, 8, 9, 10, 11
2	History of contraceptive drugs	12, 13, 14, 15, 16, 17, 18
3	Training during menstruation	19, 20, 21, 22
4	Training during menstruation	26, 27, 28, 29, 30
5	Training pattern	31, 32, 33, 34, 35
6	Performance and menstruation	23, 24, 25

Validity testing is a measuring tool that shows the level of validity of an instrument, one of which is by using the loading factor value of the PLS-SEM analysis. The loading factor value shows that there are 40 CBS-S questionnaire items that have been modified into the language ranging from 0.628 to 0.909 (Figure 1). These results indicate that the 40 items are valid. Meanwhile, there are 4 question items that have a loading factor value of less than 0.6, so they are concluded to be invalid namely items K6, K7, and K8 on the latent variable characteristics of menstruation and item O2 on the latent variable training pattern (Figure 1).

Discriminant validity analysis is also carried out using PLS-SEM. Questionnaire items are concluded to have discriminant validity if they have a higher correlation of latent variable values compared to other items. The analysis results show the value of discriminant validity, namely history of contraceptive drugs 0.729, performance and menstruation 0.745, training pattern 0.547, training during menstruation 0.880, characteristics of menstruation 0.775, and discussion with coach 0.768 (Table 4). These results indicate that there is one latent variable, namely head coach, which has lower discriminant validity compared to other item values which are higher than other item values (compared vertically with other latent variable correlations). Therefore, the results of the analysis can be concluded that all items have a relationship with different attribute measurement tools.

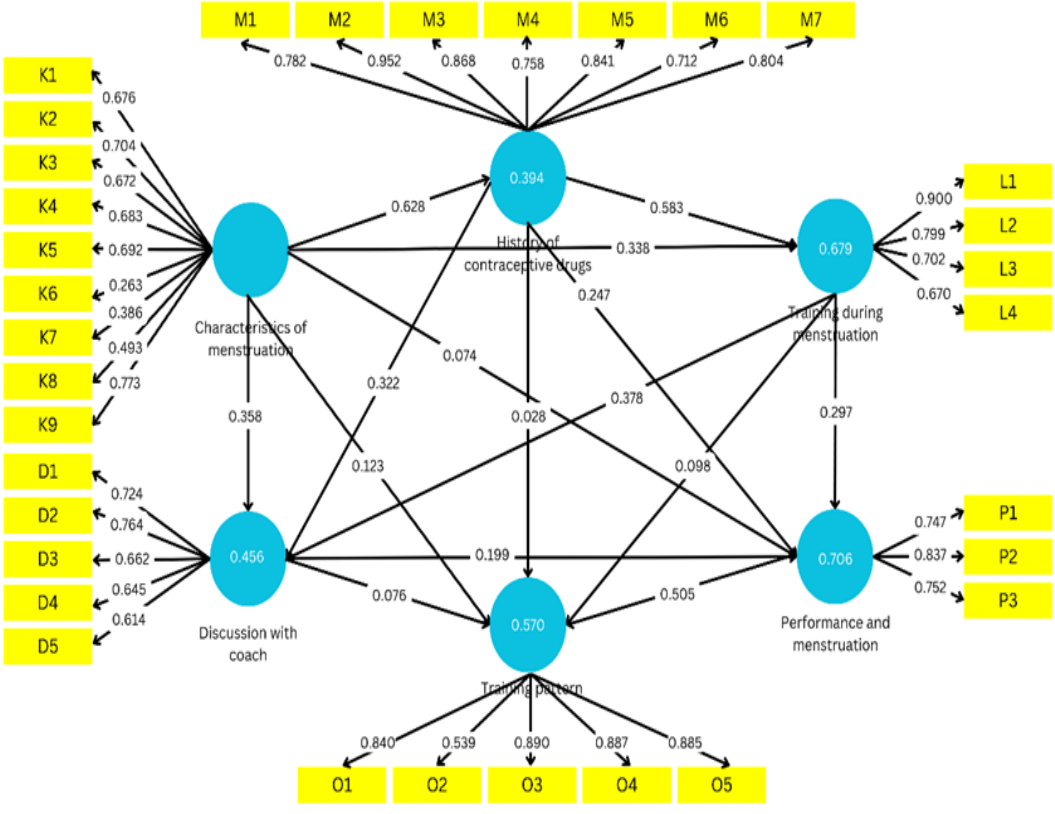

Figure 1. PLS-SEM: validity and reliability testing of the ındonesian version of the exercise and menstruation questionnaire

Reliability is determined by how well an instrument's results can be trusted and how well it can adjust for changes that occur. To put it another way, consistency can be achieved when it is observed by individuals who differ at different times. Data must be adjusted using reliable instruments, such as the Cronbach's alpha coefficient (Table 5). The results of the reliability test on the 47 items compiled to compile the sports coaching behavior scale consisting of history of contraceptive drugs, performance and menstruation, training pattern, training during menstruation, characteristics of menstruation, discussion with coach have cronbach's alpha coefficient values ranging from 0.856 to 0.927 which indicates the reliability of these items.

Tabel 4. Discriminant validity result

	History of Contraceptive drugs	Performance and menstruation	Training pattern	Training during menstruation	Characteristics of menstruation	Discussion with coach
History of Contraceptive drugs	0.792					
Performance and menstruation	0.745	0.835				
Training pattern	0.605	0.738	0.547			
Training during menstruation	0.785	0.763	0.634	0.880		
Characteristics of menstruation	0.628	0.711	0.614	0.688	0.775	
Discussion with coach	0.605	0.660	0.557	0.573	0.611	0.768

Table 5. Reliability test results

	Cronbach's alpha coefficients
History of contraceptive drugs	0.912
Performance and menstruation	0.856
Training pattern	0.927
Training during menstruation	0.887
Characteristics of menstruation	0.900
Discussion with coach	0.901

DISCUSSION

Menstruation is the nature for women, many aspects can affect performance as a female athlete in a state of menstruation. The ups and downs of hormones before, during, and after menstruation can have an impact on psychological, performance, physical, and so on (Jonge, 2003). Previous research has shown that hormonal fluctuations during the menstrual cycle can affect mood, pain, fatigue, and sports performance in female athletes (Marsh & Jenkins, 2002). Therefore, this is very interesting to study and can be a reference and advice for the stable performance of female athletes.

Menstruation is usually expressed in research using sub-phases, such as early follicular, late follicular, ovulatory, early luteal, mid luteal, and late luteal (Pitchers & Elliott-Sale, 2019). Physical performance will change during the menstrual phase due to various mechanisms, such as changes in muscle activation, substrate metabolism, thermoregulation and body composition (Carmichael et al., 2021). Compared with anaerobic and aerobic performance, muscle strength is more affected by the menstrual phase (Carmichael et al., 2021). According to Martínez-Cantó et al. (2018) a significant decrease in strength components occurs during the menstrual period (early follicular) compared to the luteal phase (day 18-20 days). In studies conducted by (Tasmektepligil et al., 2010; Thein et al., 1995) the effect of menstrual phase on strength components was examined in dominant and non-dominant limbs. There was a significant increase in grip strength of the dominant hand in the late follicular phase and a significant but non-phase-specific difference in grip strength of the non-dominant hand. The strength ratio decreased significantly in the follicular phase compared to the luteal phase but there was no change in the dominant limb strength ratio (Thein et al., 1995). Changes in strength components in the menstrual phase appear to differ based on limb or muscle group dominance. Concentrations of female sex hormones can cause changes in power production, which can affect muscle strength. Negative perceptual responses are exacerbated during pre-menstrual (e.g. mood disorders) and during the menstrual period (e.g. menstrual symptoms and decreased strength) compared to the luteal and ovulatory phases. This is in line with research by Cockerill et al. (1992) that athletes experienced

increased mood disturbances and decreased strength components during the pre-menstrual period compared to mid-cycle. Female athletes perceive the menstrual period with feelings of discomfort, pain and mood disorders (Cook et al., 2021). Similarly, a narrative review illustrated that athletes perceived a decrease in their performance during the early follicular phase and late luteal phase compared to the rest of the menstrual cycle (Carmichael et al., 2021). According to Yim et al. (2018) the menstrual phase is a phase prone to risk of soft tissue injury because in that phase the muscles and tendons will experience stiffness.

Research by Paludo et al. (2022) found that some athletes' perceptual responses were better during the ovulatory phase (e.g. motivation and competitiveness) compared to the luteal or follicular phase. The ovulatory phase usually occurs around day 14 of the menstrual cycle, the normal range may vary from day 10 to day 20, depending on individual factors (Direkvand-Moghadam et al., 2014). The ovulatory phase has been shown to play a key role in positive responses to motivation and the desire to compete (Cook et al., 2018, 2021; Crewther & Cook, 2018; Sung & Kim, 2018). This phase also has an important impact on rapid force production. Muscle activation, specifically the rate at which early motor units are activated, is a key determinant of the rapid force production required to perform explosive movements (Vecchio et al., 2019). A positive relationship between ovulation and perceptual responses has been shown previously, with women appearing to exhibit increased libido, energy and competitiveness with partners (Motta-Mena & Puts, 2017). Therefore, it is reasonable to consider the period leading up to ovulation as an advantage for female athletes to maximize their performance in a training environment. From a practical point of view, coaches and practitioners can take advantage of the opportunity to adjust athletes' training load and intensity which can lead to major training adaptations. Validation of practical methods for monitoring menstrual phases may help optimize exercise periodization and link athletes' perceptual responses to exercise performance.

It is important to investigate the relationship between menstrual hormones and training responses in a longitudinally designed manner, to verify possible effects (Kurtoğlu et al., 2024; Koley & Bandyopadhyay, 2024). Elite sports organizations, including Chelsea Football Club and the United States Women's National Soccer and Swimming Team, have recently begun using a commercial smartphone app to track athletes' menstrual phases. The app is used by players to record when menstruation and various menstrual symptoms occur. Coaches and support staff can access the data entered into the app to identify whether changes in the athlete's performance or readiness occur at various phases of menstruation. If cyclical changes in sleep, recovery, and performance occur, individual strategies are developed to address those changes, including modifications to an athlete's sleep habits, training, diet, or lifestyle factors based on guidance provided by the app (Mikaeli Anne Carmichael et al., 2021; Jonge, 2003). Therefore, the Questionnaire that will be distributed in Indonesia is a first step that aims to educate coaches who oversee female athletes, that menstruation is an important thing to pay special attention to because this pattern repeats every month (Clarke et al., 2021). If the impact can be minimized and a solution found, this will be much more effective in supporting the best performance of the athletes being coached later. Previous research has shown that coaches who understand and consider athletes' menstrual cycles can help improve the performance and well-being of female athletes (Meignié et al., 2021).

A person's body and pain scale vary greatly, so coaches cannot generalize about an athlete's condition. The psychological factors of female athletes are also vulnerable because estrogen hormones are more abundant before, during, or after menstruation, which can be further reviewed by coaches and staff who are members of the training team (Mitsuhashi et al., 2023). One of the hormones secreted in the menstrual phase is estrogen which has a neuroexcitatory effect and progesterone inhibits cortical stimulation (Smith et al., 2002), these neuroexcitatory and inhibitory effects result in estrogen and progesterone having positive and negative relationships with power production, respectively (Gordon et al., 2013; Jonge, 2003).

Substrate availability and metabolism are also proposed mechanisms for variations in the various menstrual phases and impact on endurance performance. Estrogen is supposed to increase the availability of free fatty acids as fuel during exercise and promote lipid oxidation in skeletal muscle, and progesterone counteracts the action of estrogen by limiting fat oxidation (Oosthuyse & Bosch, 2010). In a small sample of recreational

athletes, when exercising at high intensity (90% of lactate threshold), carbohydrate oxidation was lower and fat oxidation greater during the mid-to-late luteal phase compared to the early follicular phase. Estrogen concentration is associated with these metabolic changes as estrogen levels are typically lowest during the early follicular phase (Zderic et al., 2001). During submaximal exercise, carbohydrate and lipid oxidation remain similar between the mid-luteal and late follicular phases (Hackney et al., 1994; Vaiksaar et al., 2011). Another study highlighted no changes in free fatty acid availability and peak whole-body lipid oxidation in the three menstrual phases, despite significant changes in estrogen and progesterone (Frandsen et al., 2020). Carbohydrate consumption before exercise also found no menstrual phase differences in the relative oxidation of carbohydrates and lipids during prolonged exercise (Campbell et al., 2001). The results of these studies do not provide a clear indication of how substrate metabolism during exercise may affect endurance performance, but suggest the possibility that metabolism is influenced by menstrual phase during higher intensity exercise.

From the explanation above, it can be seen that endurance performance is likely to be best at the beginning of the menstrual phase, and anaerobic performance and strength are best in the ovulation phase, strength and aerobic performance are worst at the end of the luteal phase and anaerobic performance can be worst at the end of the follicular phase (Carmichael et al., 2021). With complete data, the coach can take the right attitude and treatment during training and even matches, so that the athlete's performance is not problematic and can be overcome properly (Dasa et al., 2021). Previous research has shown that an athlete-centered approach, including open communication and appropriate support, can help female athletes overcome menstrual-related challenges (Brown & Knight, 2022). This questionnaire is specifically for female athletes throughout Indonesia, which is adopted from the Exercise and Menstruation in Australia questionnaire (Armour & Smith, 2023) which has been adapted to language that is easily understood by athletes in Indonesia, the majority of whom use Indonesian, so that misunderstandings in filling out the questionnaire can be minimized (Witkoś et al., 2024). The expected results are also valid and can help analyze the situation in detail, especially in female athletes in Indonesia, so it is hoped that there will be far more female athletes who can achieve maximum performance up to the world arena.

The results of data analysis show that 88.5% of the question items are valid for distribution, there are several invalid items due to essay questions that are not detected in the data analysis system used, and there are two question items that lead to medical which are then deleted because they do not lead to athlete performance and are only general questions whose data are not needed at this time. The total number of items to be distributed is 33 items and has been tested for validity and reliability by experts and in-depth data analysis.

The limitation of this study is that the samples used tend to be homogeneous in terms of age and sports. In this study, the youngest research sample was 18 years old and the oldest was 29 years old. According to the researcher, this age range cannot describe a broader menstrual experience. This refers to the use of contraceptive devices or drugs that will be more often used in female athletes who have a family. In addition, in this study, the respondents' sports were very limited, namely only three sports with the most respondents, namely combat, big ball games, and small games. This has not broadly described the menstrual picture in female athletes. Therefore, the limitations of this study do not generalize a more diverse population of female athletes.

Conclusion

The analysis results showed that there were four invalid question items, of which two questions were still used in the questionnaire by changing the sentence to a scale to make it easier to understand. In addition, another item (item number 32) was changed into an essay form, so that it could clarify the respondent's reasons and statements later. The two omitted items were considered unfamiliar because they used medical and uncommon questions. The results of this study can be used as an instrument to measure the phenomenon of menstruation in the context of sports so that it can help researchers and practitioners understand the impact of menstruation on athlete performance, especially female athletes. The limitation of this study is that the sample used tends to be homogeneous in terms of age and sport, so it cannot generalize a more diverse population of female athletes.

Conflict of interest

In this study there are no conflicts of interest of both the authors and the Universitas Negeri Malang.

Ethical Statement

This research is in the process of ethical testing which will later be issued by the Universitas Negeri Malang, numbered 21.08.4/ UN32.14.2.8/ LT/2024. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Author Contributions

Study Design, PW, MPR, MZMN; Data Collection, PW, MPR, DAP, MZMN; Statistical Analysis, MPR, NJMN; Data Interpretation, MPR, NJMN; Manuscript Preparation, PW, DAP, NJMN; Literature Search, PW, DAP. All the authors agreed on the final draft of the manuscript before submitting it for publication.

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RESEARCH ARTICLE

Acute Effects of High-intensity Circuit Training Using Body Weight on Body Composition Indices in Sedentary Collegiate Females

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Abstract
High-intensity circuit training (HICT) has become increasingly popular for enhancing health and fitness. However, limited research exists on the effects of high-intensity circuit training using body weight (HICTBW) on body composition in sedentary young adults. This study aimed to explore the impact of a 4-week HICTBW program on body composition in sedentary collegiate females. A randomized controlled trial design was employed. Twenty sedentary collegiate females were randomly assigned to either a training group (n=10), which participated in a 4-week HICTBW program, or a control group (n=10), which did not engage in any training. Body composition was assessed using bioelectrical impedance analysis (r = 0.642 to 0.78), measuring body fat percentage, fat mass, muscle mass, waist-to-hip ratio, and body mass index (BMI). Repeated measure ANOVA was used to compare between and within groups. Although no significant differences in body composition variables were observed between pre- and post-training (p>0.05), slight positive changes were noted in all measured parameters. The lack of significant findings may be attributed to the short duration and frequency of the intervention. Future studies with extended training periods are recommended to better understand the potential impact of HICTBW on body composition in sedentary collegiate females. This research highlights the need for more comprehensive studies to validate the effectiveness of HICTBW in improving body composition among this population.

Keywords
HICT, HICTBW, Body Composition, Sedentary, Training

INTRODUCTION

Sedentary behavior has become a pressing public health concern, particularly among individuals with low physical demands, such as those engaged in intensive study (Aktas et al., 2016; Lau et al., 2021). Defined as activities with minimal energy expenditure and insufficient weekly exercise time (less than 150 minutes), sedentary behavior is strongly associated with cardiometabolic diseases, mortality, and reduced cardiorespiratory fitness (Garber et al., 2011; Rezende et al., 2014). Epidemiological and anthropological observations have indicated that women exhibit lower physical activity levels compared to men (Bowen et al., 2011), which correlates with increasing rates of cardiovascular disease in females (Maas & Appelman, 2010).

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Conversely, enhancing physical activity levels in women has been linked to improved health- related outcomes (Raberin et al., 2020).

Physical activity (PA), characterized by skeletal muscle contractions that elevate energy expenditure above resting metabolic rate, is well-established as a preventive measure against chronic diseases and for promoting physical well- being (Yamaner et al., 2024; Ajjimaporn et al., 2019). In contrast, physical inactivity, defined as failing to meet PA guidelines and engaging in sedentary behaviors with low energy expenditure, poses significant health risks and adverse outcomes, including declines in mental health and cognitive function (Ajjimaporn et al., 2019; Zhang et al., 2021). Consequently, physical inactivity and sedentary behaviors have emerged as notable risk factors, imposing a substantial burden on public health.

Of concern, physical inactivity is more prevalent among women, who exhibit higher rates of insufficient PA compared to men (Whiting et al., 2021). Young women face an elevated risk of being sedentary and physically inactive, leading to increased stress, anxiety, reduced cognitive function, and elevated all- cause mortality. This trend may persist with age, as physical inactivity becomes more pronounced among older women. To address this issue and foster improved health outcomes, the implementation of appropriate physical training intervention strategies is crucial in encouraging sedentary young females to adopt, sustain, and enhance their physical activity behaviors.

Recently, high-intensity circuit training (HICT) has gained popularity due to its time efficiency and practicality (Ajjimaporn et al., 2019; Sumpena & Sidik, 2017). HICT entails a combination of aerobic and resistance exercises, involving short high-intensity intervals interspersed with lower intensity recovery periods (Sumpena & Sidik, 2017). In healthy individuals, high-intensity circuit training using body weight (HICTBW) has demonstrated greater improvements in physical fitness within a shorter exercise duration (e.g., 7 minutes) compared to traditional HICT programs (Klika & Jordan, 2013). Studies (Ajjimaporn et al., 2019; Zhang et al., 2021) have shown the favorable effects of HICTBW on cardiopulmonary fitness in overweight middle-aged men and moderately fit women, respectively, with indications of gender-specific response to HICTBW training. Remarkably, HICT appears to offer superior benefits for cardiovascular, mental, and cognitive health compared to alternative training approaches.

Despite the promising results of HICTBW in various populations, there is a paucity of research investigating its effectiveness on body composition indices in sedentary young females. Most existing studies focus on cardiovascular and cognitive benefits, neglecting the critical aspect of body composition which is crucial for overall health and physical appearance. Moreover, the specific effects of short-term HICTBW interventions remain underexplored in this demographic, leaving a gap in the literature that needs addressing.

This study aims to evaluate the acute effects of a 4-week HICTBW intervention on body composition indices, including Body Mass Index (BMI), waist-to-hip ratio, fat percentage, fat mass, and lean mass, in sedentary collegiate females. By addressing this gap, the study seeks to provide insights into the effectiveness of short-term HICTBW programs in improving body composition among young women, ultimately contributing to better health and fitness strategies tailored for this vulnerable population.

MATERIALS AND METHODS

This research has met ethical rules. Research ethical approval was obtained from the UiTM Research Ethics Committee with project number REC/486/2023. A pre-test and post-test randomized design was used in this study in measuring the effects of HICTBW on all body composition indices among sedentary collegiate females.

Participants

This study was conducted following the approval of the research ethics committee at Universiti Teknologi MARA. Volunteer participants were recruited through public advertisements via local media. Inclusion criteria comprised individuals aged between 20 and 25 years, categorized as inactive (defined as engaging in less than 150 minutes of moderate-intensity exercise per week over the past six months), and classified as having a normal to overweight body mass index (BMI, kg·m−2) falling within the range of 18.5 to 25. To ensure eligibility, interested volunteers meeting the inclusion criteria were required to complete a short form of the International Physical Activity Questionnaire (IPAQ), with intraclass correlation coefficients (ICC) reported between 0.71 and 0.89

(Dinger et al., 2006), and a Physical Activity Readiness Questionnaire (PAR-Q) with reliability reported r = 0.99 (Jamnik et al., 2011). Smokers, alcoholics, diabetics, individuals with endocrine disorders, and those using oral contraceptive pills or prescribed medications known to affect body composition were excluded from the study.

Based on a within-subject correlation of 0.70 between pre- and post-intervention measures, a power of 0.80, and an effect size of 0.48 as derived from the primary outcome resulting from high-intensity interval training (Ajjimaporn et al., 2019), the sample size for the high-intensity interval training (HIIT) group was determined to be eight. After the screening phase, a total of 20 eligible participants as shown in Figure 1 were enrolled in the study and provided written informed consent. Subsequently, they were randomly assigned to either the training (TG) group (n = 10) or the control (CT) group (n = 10).

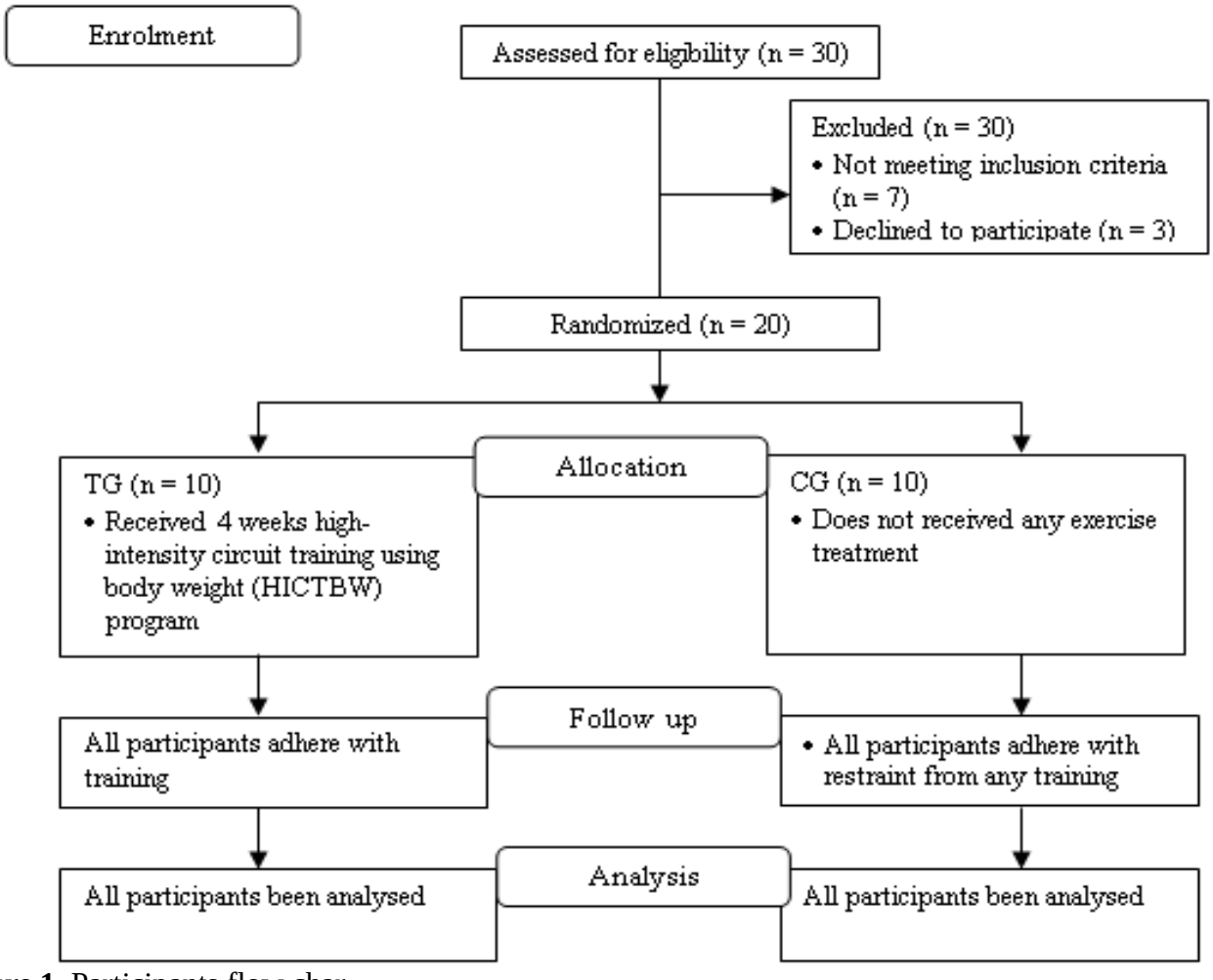

Figure 1. Participants flow char

Experimental Procedures

All participants in the TG group engaged in a four-week high-intensity circuit training using body weight (HICTBW) regimen, while the participants in the CT group did not partake in any exercise intervention. Prior to commencing the training intervention, a body composition analysis assessment was conducted, and the pretraining measurements were recorded within 48 to 144 hours preceding the training intervention. Subsequently, following the four-week training period, a post-training body composition analysis assessment was performed, with all post-training measurements obtained within 48 to 144 hours after the last training session. It is important to note that during the intervention, one participant voluntarily withdrew from the study due to injuries sustained, which were unrelated to the research procedures.

Testing Protocol

Anthropometric and body composition assessments were conducted with participants arriving at the laboratory in the morning. Height and weight measurements were obtained using standard methods, employing a stadiometer (Seca 220; Seca,

Ltd, Hamburg, Germany) and an electronic scale (participants in light clothing and without footwear) to the nearest 0.1 cm and 0.1 kg, respectively. The body mass index (BMI) was calculated by dividing weight (kg) by height (m) squared. The waist-to-hip ratio was determined using the Seca 201 tape (Seca, Ltd, Hamburg, Germany) with a constant pulling tension. Trained personnel assessed body fat percentage, fat mass, and lean body mass using the multi- frequency bioelectrical impedance analysis, BodyStat QuadScan 4000 (Bodystat Ltd.; Isle of Man, UK), following the tetrapolar method as previously outlined by Sbrignadello et al. (Sbrignadello et al., 2022).

In the training (TG) group, participants underwent a high- intensity circuit training using body weight (HICTBW) program adapted from Klika and Jordan (Klika & Jordan, 2013), considered suitable for sedentary individuals to safely perform, and approved by two sports scientists. Following a standardized 5-minute warm-up period, participants completed 12 body weight exercises, each performed for 30 seconds with a 10- second rest interval (approximately 7.5 minutes per circuit). The exercises included step jack, wall-sit, wall push-up, sit- up hand reach, step-up onto aerobic step, half squats, triceps dip onto aerobics step, knee plank, hops, alternate lunges, plank with rotation, and knee side plank. After completing the body weight circuit, participants engaged in a 5-minute cool-down period. The training program consisted of three sessions per week over four weeks, with the volume progressively increasing from one circuit in the first week, to two circuits in the second and third weeks, and three circuits in the fourth week of training, respectively. Details of the total training duration and exercise intensities are presented in Table 1. The percentage of maximum heart rate (%HRmax) was calculated by dividing the maximal heart rate during exercise by the age-predicted maximal heart rate and then multiplying by 100. The exercise intensity levels based on %HRmax were categorized as very light (≤ 57), light (57-63), and moderate (64 – 76).

Statistical Analysis

Data analysis was conducted using IBM SPSS version 28.0 (IBM Corporation, Armonk, NY, USA). The results are presented as mean ± standard deviation (SD). The normality of the data was assessed using the Shapiro-Wilk test. Independent t-tests were utilized to analyze the differences in physical characteristics between the two groups at baseline. To assess the effects of the intervention on body composition measurements over time (0-week versus 4-week), comparisons between the training group (TG) and the control group (CT) were performed using repeated-measures ANOVA. The statistical significance level was set at $p < 0.05$.

Table 1. Detailed of a 4-Week HICTBW Program

Weeks	Circuit	Warm-up, min	Exercise Duration, min	Cool-Down, min	Total Training Duration, min	%HR max
1	1	5	7.5	5	17.5	60 (light)
2-3	2	5	15.5	5	35	66 (moderate)
4	3	5	23.5	5	52.5	68 (moderate)

RESULTS

At baseline, no statistically significant differences were observed in participant characteristics between the training group (TG) and control group (CT), as shown in Table 2 (p >0.05). Throughout the 4-week HICTBW program, no significant changes were detected in bodyweight, BMI, fat percentage, fat mass, muscle mass, or waist-to-hip ratio within either group, as evidenced by Figure 2 and analysis of two-way ANOVA results (p>0.05). Specifically, the training group showed bodyweight changes from 56.89±11.71 kg at baseline to 56.63±10.10 kg post-intervention, while the control group changed from 56.91±10.66 kg to 56.61±10.77 kg ($F(1,17) = 0.0000$, $p = 0.992$). Fat mass in the training group decreased slightly from 18.28±4.76 kg to 17.43±5.54 kg, and in the control group from 16.68±4.42 kg to 15.84±3.45 kg ($F(1,17) = 0.602$, $p = 0.449$). Muscle mass, BMI, and waist-to-hip ratio also showed no significant changes in both groups.

Table 2. Participants Characteristics of Training (TG) and Control (CT) Groups

Parameters	TG	CT	*p* value
Age	22.30±0.949	22.89±1.53	0.323
Weight (kg)	56.89±11.71	56.91±10.66	0.998
Body Mass Index (kg/m2)	22.77±	22.66±	0.946
Fat percentage	31.81±4.37	29.34±3.21	0.183
Fat Mass	18.28±4.76	16.68±4.42	0.459

Training (TG); Control (CT)

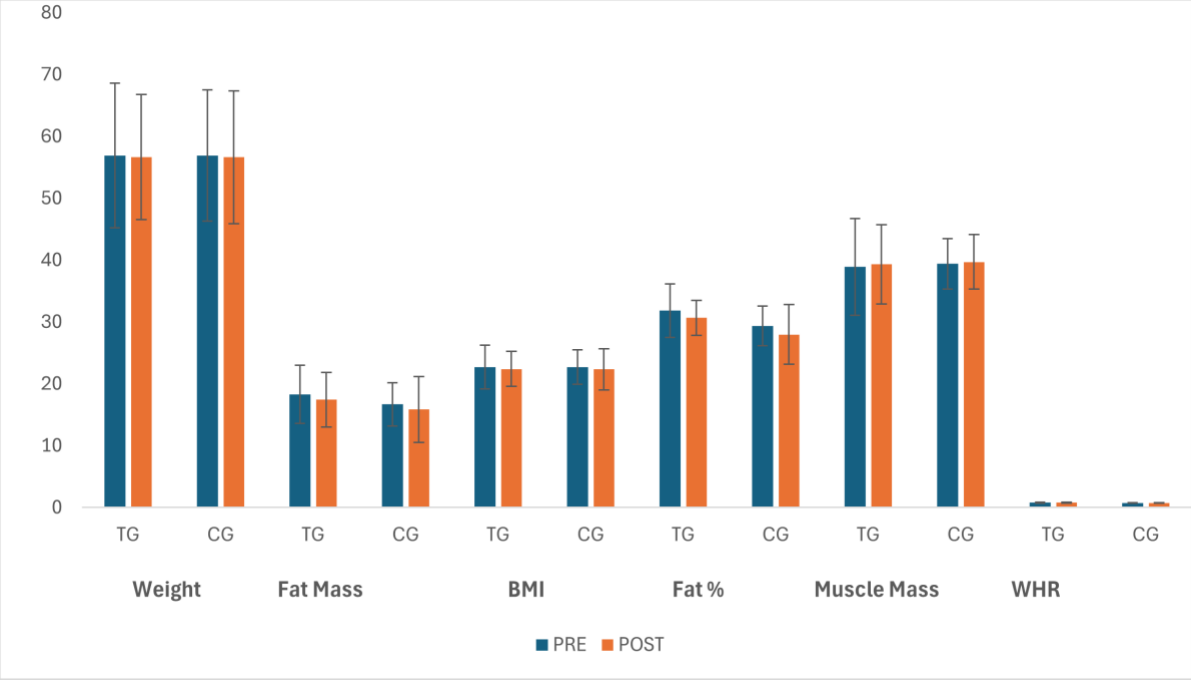

Figure 2. Differences between training groups in weight, fat mass, bmı, fat percentage, muscle mass, and waist to hip ratio before and after hıctbw exercises

DISCUSSION

The outcomes of the current study revealed that a 4-week HICTBW program had no significant effect on body weight and body composition in sedentary collegiate females. Despite observing slight changes in participants' body weights following the 4-week intervention, it is essential to recognize that energy consumption was not controlled during the experimental testing, as all participants were instructed to maintain their current dietary habits. Consequently, the presence of uncontrolled dietary factors may have influenced the observed similarities in body mass measurements after the 4-week training period, potentially masking any potential weight loss (Curioni & Lourenço, 2005; Atasever & Kıyıcı, 2023).

Moreover, we also investigated the impact of the 4-week HICTBW program on skeletal muscle mass and body fat parameters, specifically body fat mass and body fat percentage, and found no significant changes. Interestingly, these results contrast with the findings reported Mattar et al., (2017), who demonstrated that HICTBW program training led to a decrease in body fat percentage and body fat mass in healthy young participants during the initial 3 to 6 weeks of training. The discrepancy in outcomes may be attributed to several factors, including differences in the frequency and duration of training sessions (Friedrich, 2014; Parry & Straker, 2013), as well as variations in the intensity of the training program (Garber et al., 2011).

It is worth noting that the study conducted by Mattar et al. (Mattar et al., 2017) involved a training frequency of 7 days per week over a 6-week duration, while the present investigation implemented a training frequency of 3 days per week for 4 weeks. The dissimilarity in training intensity and duration may underscore the

importance of considering HICTBW training intensity as a critical factor in designing exercise programs aimed at influencing body composition in young adult, sedentary females. Future research exploring the impact of varying training intensities and durations within the HICTBW framework could provide valuable insights into optimizing exercise programs for body composition alterations in this specific population. Furthermore, it would be beneficial to conduct studies incorporating controlled dietary interventions to better elucidate the independent effects of exercise and nutrition on body composition outcomes in sedentary collegiate females.

Limitations in this study include the large sample size, this study had a relatively small sample size of 20 participants. Increasing the sample size increases the statistical power and generalizability of the findings. Previous studies have shown that a larger sample size is more likely to detect a significant effect. Including a control group with dietary modification, this study found that a 4-week HICTBW program resulted in no significant changes in body composition or weight loss among sedentary college women who maintained their dietary habits. Including a control group undergoing dietary modifications will help determine the independent effects of the exercise program on body composition. Have a longer intervention period; this study implemented a 4-week intervention period. Extending the duration of the intervention allows for more substantial changes in body composition. Previous research has shown that long-term interventions are more effective in achieving significant weight loss and changes in body composition. Assess adherence to the training program: Monitoring and reporting on participants' adherence to the training program will provide important information about the eligibility and compliance of the intervention. This information can help interpret the results and determine program effectiveness. Include goal measures of physical activity and sedentary behavior. This study relied on self-reported measures of physical activity and sedentary behavior; incorporating objective measures, such as accelerometers or pedometers, would provide more accurate and reliable data on participants' activity levels and sedentary behavior, and stratifying the analysis by ethnicity, this study involved a multi-ethnic Asian population. Stratification analysis by ethnicity can reveal potential differences in physical activity and sedentary behavior patterns, as well as intervention effectiveness, among different ethnic groups.

Conclusion

In conclusion, the findings of this study suggest that the implementation of a 4-week HICTBW program, consisting of 12 poses per circuit performed three times weekly for 4 weeks, did not result in significant changes in body composition or lead to weight loss among sedentary collegiate females who maintained their existing dietary habits throughout the intervention period. Despite the program's duration and frequency, the lack of observed effects on body composition and weight loss implies that additional factors, such as dietary modifications or alterations in the intensity of the training program, may be necessary to achieve meaningful changes in these parameters in this specific group of sedentary collegiate females.

Conflict of Interest

We declare that the article we have written does not involve any conflict of interest.

Ethics Statement

This research has met ethical rules. Research ethical approval was obtained from the UiTM Research Ethics Committee with project number REC/486/2023.

Author Contributions

Study design, PANKO, AMN and WAMWP; Data collection, NAAMR and MS; Statistical analysis, SMSMP; Data interpretation, MNM and RNJRH; Literature search, MFA and NAAK. All authors have read and approved the published version of the manuscript.

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RESEARCH ARTICLE

Mental Health of PE's Teachers in Indonesia: Analysis between Well-Being Psychological Capital and Social Support with Demographic Factors

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Abstract
Mental health is crucial in education, including physical education. No research has yet profiled the mental health of physical education teachers in Indonesia. This study aims to identify and analyze the mental health conditions of these teachers through well-being, psychological capital, and social support profiles. The sample consisted of 248 physical education teachers in Indonesia. Most participants were male (87.9%), aged 21-40 years (54%), with a sports education background (80.2%), state school status (74.2%), a bachelor's degree (85.9%), and over 10 years of teaching experience (56.9%). The instruments used were the MHC-SF (Mental Health Continuum Short Form), with validity ranging from 0.477 to 0.723 and a reliability coefficient of r = 0.899. The PCQ (Psychological Capital Questionnaire) with validity from 0.233 to 0.49 and r = 0.904, and the MSPSS (Multidimensional Scale of Perceived Social Support) with validity from 0.339 to 0.746 and r = 0.885. The results showed that most teachers' mental health was in the moderate category. In conclusion, no difference in well-being was found among teachers ($p > 0.005$). However, differences in psychological capital were observed between male and female teachers ($p < 0.05$), and social support varied with age, teaching status, teaching experience, and marital status ($p < 0.05$). Further research is needed to explore the causes of these differences to enhance teachers' well-being.

Keywords
Mental Health, Physical Education, Psychological Capital, Social Support

INTRODUCTION

Mental health is defined as a state of well-being in which an individual realizes their abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a meaningful contribution to their community. This comprehensive definition highlights the importance of mental health in enabling individuals to manage stress, achieve personal goals, and contribute positively to society (Mansimranjit Kaur Uppal, 2021). Nowadays, mental health has become a highly significant issue and topic. Mental health is fundamental to overall health, emphasizing that good mental health enables individuals to cope with everyday stresses, work productively, and contribute to their communities (Ahmed, 2019). This situation shows that mental health is very important in creating holistic health. According to the WHO, health encompasses physical, mental, and social well-being, and each domain interacts to influence one another. A comprehensive approach is necessary to foster both physical and mental health, emphasizing the interconnectedness of these domains (Ni et al., 2020). Attention upon the condition of mental health in the world of

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education, particularly related to teachers' mental health condition.

Teachers have a major role in educational world. Competent teachers will determine the quality of education through learning process. Teachers' personality and emotion play a significant role in creating a qualified learning environment by enhancing self-confidence, managing stress, and mitigating depression. Recent studies have found that teachers with high levels of emotional intelligence and self-efficacy can effectively handle stress and create a positive classroom atmosphere, which significantly contributes to student engagement and academic success (Buonomo et al., 2019). By understanding teachers' emotional condition, therefore a number of obstacles and solutions are found within learning process (Simonton et al., 2021). Teachers have major role and challenge to encounter various negative emotions felt, for instance, frustration and desperation that will give influence toward students' learning outcome (Simonton et al., 2022). Positive emotion can generate better social sources, intellectual capacity, and physical condition (Gilchrist et al., 2023; Sun et al., 2023). Teachers' mental health turns out to be important thing to know in creating mental health in school's environment.

Attention to the mental health of physical education teachers is currently minimal. References that specifically address the mental health of physical education teachers are still very limited. For example, a study conducted in Istanbul, Turkey, examined the level of mental health literacy among secondary school students and teachers, emphasizing the importance of awareness and support for mental health issues in educational settings (Karabey & Arslan, 2020). On the other hand, during college years, the candidates of physical education teacher had already experienced a number of pressures to make adaptation, for example, the obligation to do theoretical and practical studies at the same time. If they are unable to anticipate this obligation, it will make difficulties in the beginning of their first semester. Sports students ought to maintain the balance between their physical and mental factors (Juriana et al., 2019).

Teachers' mental health had tight correlation to various potential or both internal and external factors owned by them, for instance, well-being, psychological capital and social support. Well-being is a condition where individuals are able to adapt to their environment, resulting in social acceptance and personal satisfaction. Recent research highlights the importance of social adaptability and psychological well-being as key factors in achieving life satisfaction (Chee et al., 2023). Another study found that life satisfaction and well-being are closely linked to one's ability to adapt socially and maintain positive relationships (Selivanova et al., 2020). Teachers need to be happy, own life satisfaction and free from depression symptoms in order to be able to conduct their duty as educators appropriately. Understanding teachers' well-being becomes crucial due to it gives direct impact to students and eventually will influence upon learning process (Simonton et al., 2021).

Moreover, psychological capital is an important internal factor related to teachers' mental health in addition to well-being. Psychological capital is an ability that makes teachers feel much better in the face of work pressures and encourages them to feel more positive, thus fostering deeper engagement and higher job satisfaction and achievement. A study showed that teachers with higher levels of psychological capital experienced lower levels of burnout and higher levels of well-being (Ferradás et al., 2019). Furthermore, social support is an external factor that is equally important and influences mental health. Social support acts as a protector against stress by providing feelings of being loved, cared for, respected, and entertained. Recent studies highlight that social support significantly improves mental health outcomes, reducing symptoms of depression, anxiety, and stress (Henry et al., 2019). Additionally, social support from family and friends has been shown to enhance overall well-being and life satisfaction, particularly in challenging times (Liu, 2023).

Related research to teachers' mental health in Indonesia is quite a few (Apriningrum & Utami, 2021; Gunawan & Hendriani, 2019) however, it is still limited to merely of study upon physical education teachers' mental health (Juriana et al., 2019; Tahki et al., 2020). There is no research studies toward the health profile of physical education teachers which include several factors altogether, both internal and external factors. This research has aims to: (1) identify and analyze physical education teachers' mental health in Indonesia include well-being, psychological capital

and social support, (2) find differences in well-being, psychological capital and social support of physical education teachers from demographic factors.

MATERIALS AND METHODS

This study followed ethical standards and received approval from the Kementrian Pendidikan, Kebudayaan, Riset dan Teknologi Universitas Pendidikan Indonesia, numbered 1321/UN40.A6/KP/2024. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Design

This research is conducted in the form of survey research utilizing descriptive statistics analysis to explore the well-being, psychological capital, and social support of physical education teachers. Survey research design, as described by (Creswell, 2009), is effective for collecting data from a large population to describe trends, attitudes, or opinions within that population. This method allows researchers to capture a broad overview of the current state of these constructs among teachers.

In addition to descriptive statistics analysis, the researchers use t-tests and ANOVA to determine whether there are differences in well-being, psychological capital, and social support among physical education teachers based on gender, age, educational background, marital status, number of children, and teaching experience. This analytical approach is crucial for understanding the impact of demographic variables on teachers' mental health and support systems (Söderberg et al., 2020).

Participants

The participants in this study were carefully selected through purposive sampling, a method that involves selecting individuals who meet specific criteria relevant to the research objectives. In this case, the primary criterion was that participants had to be physical education teachers who were actively engaged in teaching. This approach ensured that the data collected was pertinent to understanding the current practices and perspectives of active physical education teachers. Additionally, by focusing on actively teaching professionals, the study aimed to capture contemporary insights and experiences that reflect the current state of physical education instruction.

A total of 248 physical education teachers from various regions in and around Jakarta participated in the study. This sample size was chosen to provide a comprehensive and representative overview of the teaching practices across different locales. The inclusion of participants from diverse geographical areas was crucial for ensuring that the findings could be generalized to a broader context. The participants represented a wide array of schools and teaching environments, which contributed to the richness and diversity of the data collected. By employing purposive sampling and focusing on a well-defined group of participants, the study aimed to gather detailed and relevant information that would enhance the understanding of physical education teaching practices in the specified regions.

Instrument

To assess the aspects of well-being, psychological capital, and perceived social support, this study employed three psychometrically validated instruments. First, the Mental Health Continuum-Short Form (MHC-SF) was used to evaluate the emotional, psychological, and social well-being of the respondents (Keyes, 2002). Second, the Psychological Capital Questionnaire (PCQ) was implemented to measure psychological capital, encompassing hope, efficacy, resilience, and optimism (Luthans et al., 2006). Third, the Multidimensional Scale of Perceived Social Support (MSPSS) was used to assess perceived social support from family, friends, and significant others (Zimet et al., 1988). These instruments were selected based on their strong psychometric properties, ensuring accurate and consistent measurement of variables relevant to the well-being of physical education teachers.

The MHC-SF, developed by Keyes (2002) is a widely used instrument designed to measure the three core dimensions of well-being: emotional well-being (e.g., happiness, life satisfaction), psychological well-being (e.g., personal growth, self-acceptance), and social well-being (e.g., social integration, contribution to society). This instrument consists of 14 items that respondents rate based on their experiences over the past month. The MHC-SF has been validated across various populations, with validity coefficients ranging from 0.477 to 0.723 and a high reliability coefficient of

r=0.899, indicating its robustness and consistency in capturing the overall mental health status of individuals. The instrument is particularly suitable for educational settings as it provides a comprehensive measure of mental health, from languishing to flourishing, which is crucial for understanding the well-being of teachers in their professional and personal lives.

The PCQ, developed by (Luthans et al., 2006), is designed to measure an individual's psychological capital, which encompasses four components known as HERO: Hope, Efficacy, Resilience, and Optimism. These components reflect the positive psychological resources that individuals can leverage to overcome challenges and enhance their performance. The PCQ consists of 24 items, with six items dedicated to each component. The validity of the PCQ ranges from 0.233 to 0.49, and it has a reliability coefficient of r = 0.904, making it a reliable tool for assessing the psychological strengths of individuals. In the context of this study, the PCQ is particularly relevant as it provides insights into the internal resources that physical education teachers utilize to manage work-related stress and maintain their effectiveness in the face of challenges.

The MSPSS, developed by Zimet et al., (1988), is a tool used to assess perceived social support from three sources: family, friends, and significant others. This instrument includes 12 items, with four items for each source of support. Respondents rate their agreement with each item on a 7-point Likert scale. The MSPSS has been shown to have validity coefficients ranging from 0.339 to 0.746 and a reliability coefficient of r = 0.885, indicating its reliability in measuring perceived social support. The MSPSS is particularly useful in this study as it highlights the role of social support in buffering stress and promoting mental health among teachers, who often face various stressors in their professional roles. Understanding the level of perceived social support can help in identifying areas where additional support may be necessary to enhance the well-being of teachers.

These instruments were chosen due to their robust psychometric properties, ensuring accurate and consistent measurements of well-being, psychological capital, and social support among physical education teachers. The MHC-SF assesses overall mental health by capturing a broad spectrum of well-being aspects, making it suitable for educational settings. The PCQ's focus on the HERO components provides insights into the internal resources teachers utilize to cope with work-related stress and challenges, which are critical for their professional effectiveness. Meanwhile, the MSPSS evaluates perceived social support from various sources, highlighting its role in mitigating stress and enhancing mental health.

Procedure

The researcher first identified schools that had physical education/sports programs in the Jakarta area and its surroundings. The researcher then contacted the principal/vice principal of each school to obtain research permission and recommend PJOK teachers who were willing to be respondents.

After obtaining recommendations from PJOK teachers, the researcher approached them directly to explain the purpose of the study and asked for their willingness to participate. The researcher registered the identities of PJOK teachers who were willing to participate along with their data, such as name, telephone number, and WhatsApp.

Before collecting data, the researcher first conducted a trial of the instrument on 30 PJOK teachers outside the research sample to test the validity and reliability of each instrument. The trial was carried out by providing the instrument and asking respondents to fill it out independently for 30-45 minutes. Furthermore, the researcher conducted a statistical analysis to calculate the validity and reliability coefficient values using the Cronbach Alpha Formula.

Data Analysis

The data obtained from the results of respondents filling out the questionnaire were then processed for analysis. The researcher first edited and coded the raw data to make it easy to input into the IBM SPSS version 26 analysis program. Editing was done to recheck the data so that there were no input errors while coding aimed to change categorical data into numbers so that they could be processed statistically.

Descriptive analysis was then carried out to determine the general description of the data, including the average value, standard deviation, and maximum and minimum values of each variable. The next step was testing the analysis assumptions to determine the appropriate type of test, including the normality test using Kolmogorov-Smirnov. Based on these results, it was decided whether the data met the parametric assumptions or not.

Inferential testing was carried out to determine whether there were differences between groups. If the data followed the parametric assumptions, the t-test or ANOVA was used. Conversely, if it was not normally distributed, a nonparametric test was carried out. All tests were carried out at a significance level of 95% to draw conclusions. The results were presented narratively and in tables to facilitate data interpretation.

RESULTS

The demographic data shows 248 respondents who participated in this study. The majority of respondents were male, with a percentage of 60.5%. The age group of 31-40 years dominated with a proportion of 45.2%. Most respondents had civil servant status as much as 60.5% and had a bachelor's degree of 72.6%. Respondents with 6-10 years of teaching experience dominated with 35.5%. In general, respondents consisted of men aged 31-40 years with civil servant status, a bachelor's degree, and 6-10 years of teaching experience. This table provides an overview of the sociodemographic characteristics of 248 research respondents (Table 1).

Table 1. Demographic profile of respondents

Category		f	%
Gender	Male	150	60.4
	Female	98	39.5
Age	21-30 Years Old	58	23.4
	31-40 Years Old	112	45.2
	41-50 Years Old	68	27.4
	51-60 Years Old	10	4
Emplowment Status	Civil Servants	150	60.5
	Honorary	78	31.5
	Other	20	8
Level of Education	Associate Degree	40	16.1
	Bachelor	180	72.6
	Master	28	11.3
	Doctor	0	0
Length of Work	1-5 years	70	28.2
	6-10 years	88	35.5
	11-15 years	60	24.2
	16-20 years	30	12.1

Based on the data processing results, the following description of the welfare of physical education teachers is obtained: in general, it can be explained that the average condition of mental well-being, psychological capital, and social support felt by physical education teachers is in the average range. Physical education teachers' average mental well-being condition is at a score of 69.3 with a standard deviation of 10.1, a minimum value of 23.9, and a maximum of 84. The psychological capital of physical education teachers is, on average, at a score of 108.3 with a standard deviation of 10.9, a minimum value of 23, and a maximum of 138. Meanwhile, the social support felt by physical education teachers is, on average, at a score of 70.1 with a standard deviation of 9.7, a minimum value of 12, and a maximum of 84. Thus, overall, the study results indicate that the mental well-being, psychological capital, and social support of physical education teachers are in the average range (Table 2).

Table 2. Mental health of physical education teachers

Mental Health Factor	High		Medium		Low	
	f	%	f	%	f	%
1.Well-being	70	28.2	108	43.5	70	28.2
2.Psychological Capital	74	29.8	104	41.9	70	28.2
3.Social Support	61	24.6	120	48.4	67	27

Moreover, based on test-different, it was found the description on well-being, psychological capital and social support from physical education teachers seen from differences of several demographic factors for instance, gender, age, educational background, spouse status, employment status, educational level, marital status, number of children and teaching experience. In general, the outcome of data processing can be seen from the following (Table 3).

Table 3. Differences of mental health factors from physical education teachers

Demographic Factor	Well-being		Psychological Capital		Social Support	
	Value F	Sign	Value F	Sign	Value F	Sign
1. Gender (male, female)	0.502	0.983 p>0.05	0.881	0.023 p<0.05	0.601	0.055 p>0.05
2. Age (21-40 years old, 41-60 years old	0.279	0.655 p>0.05	0.717	0.322 p>0.05	0.270	0.001 p<0.05
3. Educational Level (D3, S1, S2)	1.049	0.352 p>0.05	1.718	0.182 p>0.05	1.430	0.241 p>0.05
4. Educational Background (Sport, Non-Sport)	0.792	0.395 p>0.05	0.922	0.493 p>0.05	0.109	0.731 p>0.05
5. Employment Status (State, Private)	0.761	0.385 p>0.05	0.797	0.557 p>0.05	0.166	0.005 p<0.05
6. Teaching Experience (1-2 years, 3-5 years, 6-10 years, more than 10 years)	1.412	0.240 p>0.05	0.901	0.441 p>0.05	3.126	0.026 p<0.05
7. Marital Staus (Single, Married, Divorce)	1.772	0.172 p>0.05	0.340	0.172 p>0.05	3.177	0.043 p<0.05
8. Spouse Status (Employed, Unemployed)	0.704	0.641 p>0.05	0.965	0.281 p>0.05	0.719	0.077 p>0.05
9. Number of Children (no chilren, 2 kids, 3 kids, 4 kids, more than 4 kids)	0.891	0.487 p>0.05	0.136	0.984 p>0.05	1.125	0.347 p>0.05

DISCUSSION

Judging from Table 1, there are interesting study results. Although there are still several physical education teachers who exhibit low well-being, the majority of them have medium well-being. This indicates that most physical education teachers experience a moderate level of life satisfaction both personally and socially. This finding aligns with recent studies showing that teachers' well-being is often influenced by various personal and social factors, including job satisfaction, social support, and work-life balance. Understanding these dynamics is crucial for developing interventions aimed at enhancing the well-being of physical education teachers (Landolfi et al., 2021; Van Zyl, 2019).

Individuals who have good psychological prosperity marked by high positive affect and low positive affect (Foroughi et al., 2023). Positive emotions can help build social, intellectual and physical resources, leading to long-term benefits in different areas of life (Stifter et al., 2020). Physical education teachers with good well-being demonstrate their ability to control stress and reduce the risk of depression associated with burnout at work. This is in line with Biernat's research on depression, anxiety, and stress in teachers, his study shows that teachers who maintain high levels of physical activity and emotional well-being are

better equipped to manage stress and prevent depression, which significantly improves their professional performance and overall quality of life (Biernat et al., 2022).

Both internal and external potency had by physical education teachers in the form of psychological capital and social support, majority of them in the medium category. Most of physical education teachers have psychological capital classified in medium around 41.9%. From that condition, it was shown that the majority of physical education teachers in Indonesia have better and positive hope upon themselves and their life. Based on aspects in psychological capital exposed that physical education teachers who have decent psychological capital own high self-esteem and feel competent in conducting their daily physical education work. They are also non-surrender people and always optimist in their life (Zhang et al., 2019). Additionally, most of physical education teachers also own social support in medium category around 48.4%. They have family and close relative who significantly contribute to the feeling of loved, cared, and respected (Masa et al., 2022). This condition protects them from work pressure, adding commitment and satisfaction in work. Social support was proven to have correlation with mental health (Dong et al., 2022).

And then based on the outcome of test different of mental health factors consist of well-being, psychological capital and social support known that there are no differences of well-being from physical education teachers seen from gender, age, educational level, educational background, employment status, teaching experience, marital status, spouse status and number of children. Psychological capital of physical education teachers are also different seen from gender where psychological capital of male physical education teachers are higher in terms of their endurance against pressure, stress, and burnout compare to female physical education teachers (Freire et al., 2020; Zhang et al., 2019). They have more encouragement, self-confidence and more efforts in dealing with challenging tasks (N.A.N. Burhanuddin et al., 2019).

Furthermore, there are differences of social support between physical education teachers seen from four aspects: age, employment status, teaching experience, and marital status. Physical education teachers age 21-40 years have higher social support compare to physical education teachers age 41-60 years (mean = 6.01 > 5.65). Physical education teachers who work in private schools have higher social support compare to physical education teachers who work in state schools (mean = 6.06 > 5.77). Physical education teachers with teaching experience 6-10 years are those who have higher social support compare to physical education teachers who have less or more than 6-10 years of teaching experience (mean = 6.10). Married physical education teachers have higher social support compare to single and divorce physical education teachers (mean = 5.89). Having a life partner means experiencing feelings of being loved, cared for and respected. According to (Sasaki et al., 2023), highlighting that feeling loved in a relationship can significantly improve well-being and reduce destructive behavior . so that it is not surprise that if married physical education teachers have more social support compare to those who single and divorce. Although social support can equally originated from other significant people for instance, friends and other family members (Khatiwada et al., 2021)

Conclusion

Based on the outcome of this research as previously exposed above, several conclusions can be drawn regarding mental health: (1) The mental health of most physical education teachers in Indonesia is classified as medium, based on well-being, psychological capital, and social support; (2) There is no significant difference in well-being among physical education teachers. However, differences in psychological capital were observed between male and female physical education teachers, while social support varied based on factors such as age, teaching location, teaching experience, and marital status. These findings highlight the need for future research to explore the underlying causes of these differences and to develop targeted interventions that enhance well-being and resilience among physical education teachers.

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Conflict of Interest

We declare that the article we have written is not involved in any conflict of interest.

Ethics Statement

This study followed ethical standards and received approval from the Kementrian Pendidikan, Kebudayaan, Riset dan Teknologi Universitas Pendidikan Indonesia, numbered 1321/UN40.A6/KP/2024.

Author Contributions

Study design, D, MJ, J, YH, SMSMP; Data collection, D, J, KT, YH, TA; Statistical analysis, D, YH, TA; Data interpretation, D, YH, TA; Literature search, D, MJ, KT, SMSMP. All authors have read and approved the published version of the manuscript.

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RESEARCH ARTICLE

Investigating Leisure-Time Physical Activity and Depression Among Military University Students

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Abstract
The demands of living as a university student have caused an increasing number of students to experience poor mental health. Failure to adequately address these demands might lead to students suffering from mental health issues including depression. Thus, exploring leisure-time physical activity (LTPA) may play a crucial role in understanding students' depression. The present study is designed to examine the association between LTPA and depression among National Defense University of Malaysia (UPNM) students. A cross-sectional research design was employed, and data was collected via a set of questionnaires among the sample of 381 UPNM students. Self-report questionnaires, consisting of Godin LTPA and patient health questionnaire (PHQ-9) were distributed to the students. Correlation analyses were performed to examine the association between LTPA and depression. The analysis demonstrated a statistically significant correlation between LTPA and depression ($r=0.104$, $p<0.05$). Further studies are warranted to categorize the diverse types of leisure activities prevalent among military university students. Such research could provide valuable. Insights, enabling more information and direction on the selection of leisure activities to mitigate depression. The LTPA is recommended to alleviate depressive levels among military university students. The university and management should offer a few interventions to enhance students' leisure-time physical activity.

Keywords
Leisure-Time Physical Activity (LTPA), Depression, University Student

INTRODUCTION

Physical activity (PA) refers to any bodily movement that leads to energy expenditure, typically measured in kilocalories (Dias et al., 2017). The caloric expenditure associated with PA is contingent upon its intensity, duration, and frequency. The Centers for Disease Control and Prevention (CDC) and the World Health Organization have commonly employed the week and day as time units to indicate calorie expenditure during PA (Piercy et al., 2018). PA can be categorized into various types, including activities performed during sleep, work, or leisure (Piyawat Katewongsa et al., 2021). Maintaining optimal health necessitates engaging in at least 150 minutes of moderate-intensity physical activity per week, or at least 75 minutes of vigorous-intensity physical activity per week, coupled with strength training exercises for major muscle groups at least twice weekly (Bull et al., 2020).

Leisure-time physical activity (LTPA) has been found to alleviate symptoms of loneliness and confer health benefits (Meyer et al., 2020; Özkılıç, & Demirel). Extensive evidence supports the positive impact of physical activity on mental health, including the reduction of depression and anxiety (Stuart et al., 2019). Nevertheless, mental

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health has often been overshadowed by a focus on physical well-being, even though it constitutes a critical aspect of overall well-being (Schwartz et al., 2021). Globally, mental health issues, particularly depressive symptoms, have emerged as significant public health concerns, and they are a vital component of sustainable development strategies for the year 2030 (Patel et al., 2018) and logical discussions in different disciplines.

The World Health Organization (WHO) (2019) defines mental health as a state of well-being, wherein individuals recognize their capacity to cope with life's demands, contribute to their communities, and effectively handle daily tasks and stressors. Mental health significantly influences individuals' interactions with others and their decision-making processes (Kazdin, 2018). The Ministry of Health of Malaysia further characterizes mental health as engaging with the environment, promoting subjective well-being and functioning, and employing cognitive, emotional, or relational skills to achieve individual and collective objectives aligned with justice (Hassan et al., 2018).

The global burden of disease and disability is exacerbated by mental health issues, significantly contributing to the overall burden of illness (Hassan et al., 2018). Mental health problems, including depression, anxiety, and stress, have become more prevalent among university students (Asif et al., 2020). Physical activity plays a pivotal role in promoting mental health and mitigating mental health problems (Hosker et al., 2019). Identifying factors that can reduce mental health issues is crucial, and physical activity is recognized as a key and beneficial behavior in enhancing mental well-being (Rodriguez-Ayllon et al., 2019).

Despite the well-documented mental health benefits of physical activity, recent data indicate a concerning decline in leisure-time physical activity among young adults, including university students. According to the WHO, over 1.4 billion adults globally were not sufficiently active as of 2016, with 23% of men and 32% of women aged 18 and older failing to meet recommended activity levels (Lancet, 2018). This inactivity is particularly alarming among undergraduate students, who often face academic pressures and time constraints that limit their opportunities for exercise. The reduced physical activity in this demographic has been associated with increased rates of mental health issues, such as anxiety and depression, exacerbated by factors like excessive screen time and the challenges of balancing academic and social responsibilities (Ahmad et al., 2015; Nakshine et al., 2022; Othman & Rashid, 2018). Given the significant proportion of young adults experiencing mental health disorders—34.7% among adolescents aged 16-19 and 32.1% among those aged 20-29 (Ahmad et al., 2015)—there is an urgent need to address the gap in leisure-time physical activity among undergraduate students to mitigate the risk of depression and other psychological disorders. This study aims to explore the relationship between leisure-time physical activity and depression among Universiti Pertanan Nasional Malaysia (UPNM) students, highlighting the critical importance of integrating physical activity into daily routines to improve mental health outcomes.

Research Questions and Hypothesis

What is the current level of leisure-time physical activity among UPNM students?

What is the current state of depression among UPNM students?

Is there a relationship between leisure-time physical activity and depression among UPNM students?

A research hypothesis is

There is no significant relationship between leisure-time physical activity and depression among UPNM students.

MATERIALS AND METHODS

Descriptive research design is highly valued for its ability to provide a detailed and systematic portrayal of phenomena, making it a crucial method for understanding various subjects in depth. One of its key strengths is its capacity to offer a comprehensive snapshot of characteristics, behaviors, or conditions without manipulating variables, which is essential when exploring new or under-researched topics. Despite its limitations in establishing causal relationships, descriptive research remains a powerful tool for generating foundational knowledge and guiding subsequent investigations.

The research was conducted at UPNM and employed a correlational approach within the framework of descriptive research, specifically adopting a quantitative methodology. The data collection process involved the utilization of a survey questionnaire administered through an online platform, utilizing Google Forms as the medium.

This study followed ethical standards and received approval from the Faculty of Sports Science and Recreation, Universiti Teknologi MARA with reference number 100-KNS(PJI 9/19) 13 October 2021. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Participant

The target population for this study was UPNM students, encompassing a total of 4,964 individuals, as indicated by higher education statistics. To calculate the proper sample size, the researchers followed the instructions proposed by Krejcie and Morgan Table (Bukhari, 2022), using their table, which advised a sample size of 428 after accounting for a 20% margin to adjust for unreturned or incomplete questionnaires. The sample strategy used in this study was simple random sampling.

Sample	Total	Krejcie & Morgan's sample size	Add 20%	Total
UPNM student	4,964	344	84	428

Procedure

In the conduct of the study, data collection procedures assumed paramount importance. Once the subjects were identified and access to the research sites was granted, the process of data collection encompassed five distinct and indispensable stages, each necessitating prior approval.

Foremost, the researcher sought the imprimatur of the research ethics committee at UiTM, ensuring that the study adhered to rigorous ethical standards and safeguarding the welfare of the participants. Subsequently, the researcher sought permission from the respective supervisor to proceed with the study, a step deemed crucial to ensuring the questionnaire's validity, benefiting from the supervisor's expert guidance and input.

Moving on, upon securing ethical approval, the researcher proceeded to conduct a pilot study to assess the reliability and validity outcomes of the questionnaire. This preliminary investigation allowed for the identification and rectification of any potential issues or ambiguities in the questionnaire, further bolstering the overall robustness of the study instrument.

Following the pilot study, the researcher approached the respondents at UPNM, acquainting them with the study's objectives and rationale. This process served to foster understanding and cooperation among the respondents, thereby enhancing the overall quality of the data obtained.

Furthermore, the researcher employed a combination of quantitative data collection methods. Additionally, efforts were made to minimize potential biases in data collection. The researcher adopted random sampling techniques to select participants, thereby reducing the risk of selection bias and enhancing the generalizability of the study's findings. Moreover, the researcher implemented standardized protocols and procedures during data collection to mitigate observer bias and ensure consistency across data collection points.

In summary, the procedures for data collection encompassed rigorous ethical considerations, validation of the questionnaire through pilot testing, and thoughtful engagement with the participants. By adhering to these systematic and meticulous steps, the study aimed to yield reliable, valid, and comprehensive data, ultimately contributing to the advancement of knowledge in the respective field of research.

Data Collection Tools

Instruments

The questionnaire used for this study is divided into three distinct sections to gather comprehensive data on participants' demographics, physical activity levels, and mental health status. Each section is designed to capture specific aspects of the participants' lives. In the first section of the questionnaire, respondents are required to furnish their demographic information, encompassing gender, age, level of education, student status, marital status, and racial background.

Leisure-Time Physical Activity (LTPA)

In Section B of the questionnaire, focuses on evaluating LTPA, a key factor influencing overall health and well-being. To achieve this, adapted questions from the widely recognized Godin Leisure-Time Exercise Questionnaire (Godin, 2011). This tool has shown commendable reliability, with a Cronbach's alpha coefficient of 0.69, reflecting its effectiveness in capturing

accurate exercise data (Muhammad Awais et al., 2021).

Participants are asked to report the frequency of their engagement in various levels of physical activity—strenuous, moderate, and mild—each lasting at least 15 minutes per session throughout a typical week. This approach allows us to calculate a comprehensive leisure-time exercise score for each respondent. The calculation involves multiplying the number of exercise bouts in each category by their respective metabolic equivalents—3 for mild, 5 for moderate, and 9 for strenuous activities—and then summing these values. The resulting score provides a quantitative measure of an individual's level of leisure-time exercise. Based on this score, respondents are categorized into two groups: those with a score of 24 or higher are classified as "active," while those with a score of 23 or lower are considered "insufficiently active." This classification helps us understand the extent of physical activity among participants and its potential impact on their overall health.

Patient Health Questionnaire-9 (PHQ-9)

The Patient Health Questionnaire-9 (PHQ-9) (PHQ-9 depression scale.pdf (nih.gov) is the questionnaire used in section C. The PHQ-9 showed a good degree of dependability with a 0.88 Cronbach's alpha coefficient (Currier et al., 2020). It is intended to be used as a self-report tool, asking respondents to rate the severity of their depression using nine items. Every item is assigned a number between 0 and 3, where 0 means "not at all" and 3 means "nearly every day." The total values of these nine items are added up to determine each respondent's final score, which yields a numerical assessment of the degree of depression the person is experiencing.

Statistical Analysis

The primary aim of this study was to ascertain the degree of LTPA among UPNM students. Descriptive analysis was employed to examine the collected data. Descriptive analysis was employed in the study to achieve the second goal, which was to determine the degree of depression among UPNM students. The third goal of the study was to investigate the link between UPNM students' leisure-time physical activity and their depression levels by analyzing the data using Pearson Correlation analysis.

RESULTS

In this research study, a total of 381 participants were involved, with 294 (77.2%) being male and 87 (22.8%) females. Among the respondents, 131 (34.4%) were cadets, while 250 (65.6%) were civilians. The participants' ages were categorized into three groups: 18-20 years old, constituting 217 (57.0%) of the students; 21-24 years old, comprising 163 (42.8%) of the students; and only 1 respondent (0.3%) was 25 years old and above.

Regarding the respondents' educational levels, 71 (18.6%) held degrees, 309 (81.1%) had diplomas, and there was 1 (0.3%) respondent with a master's degree. The majority of students were Malay, with 355 (93.2%) participants. Indian respondents constituted 3.1% (12 individuals), followed by 2.1% (8 individuals) from other racial backgrounds, and Chinese respondents accounted for 1.6% (6 individuals).

Table 1. Demographic variables for UPNM students

		Frequency (n)	Percent (%)
Gender	Male	294	77.2
	Female	87	22.8
Students	Cadet	131	34.4
	Civilian	250	65.6
Age	18-20	217	57.0
	21-24	163	42.8
	>25	1	0.3
Education level	Master	1	0.3
	Degree	71	18.6
	Diploma	309	81.1
Races	Malay	355	93.2
	Chinesse	6	1.6
	Indian	12	3.1
	Others	8	2.1
Total		381	

The participants were categorized into three groups for LTPA. The data shows that most people in both the military and civilian groups are "Active," with a higher percentage in the military (88.5%) compared to civilians (79.2%). Only a small percentage of each group is "Moderately Active," with slightly more civilians (1.72%) than military personnel (0.1%). Very few people are "Insufficiently Active," with just 0.01% in the military and 0.04% in the civilian group. Overall, most people are active, indicating that both military and civilian populations generally participate in high levels of physical activity.

Table 2. Level of Leisure-Time Physical Activity (LTPA) among UPNM students

		Total		Military		Civilian	
		Frequency (n)	Percent (%)	Frequency (n)	Percent (%)	Frequency (n)	Percent (%)
Level	• Active	314	82.4	116	88.5	198	79.2
	• Moderately Active	56	14.7	13	0.1	43	1.72
	• Insufficiently Active	11	2.9	2	0.01	9	0.04
		381		131		250	

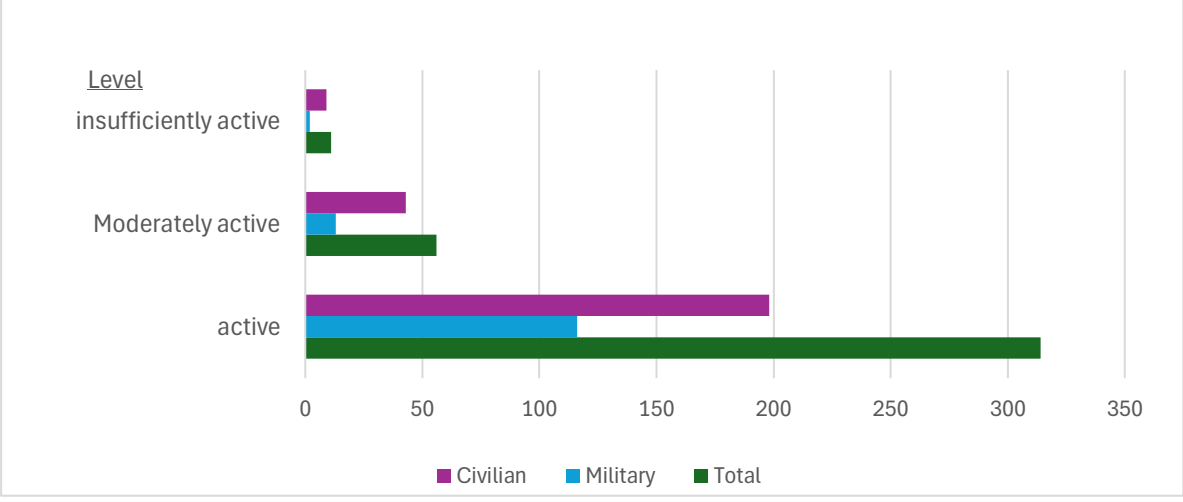

Figure 1. Level of LTPA

Table 3. Depression among UPNM students

		Total		Military		Civilian	
		Frequency (n)	Percent (%)	Frequency (n)	Percent (%)	Frequency (n)	Percent (%)
Level	• None	72	18.9	6	4.6	66	26.4
	• Mild	142	37.3	86	65.6	56	42.7
	• Moderate	106	27.8	29	22.2	77	30.8
	• Moderately Severe	48	12.6	8	6.1	40	16.0
	• Severe	13	3.4	2	1.5	11	4.4
		381		131		250	

The data shows how often and how severe a particular condition is among the military, and civilian populations. Overall, 18.9% of people don't show any symptoms, with a much lower rate in the military (4.6%) compared to civilians (26.4%). The "Mild" condition is the most common, affecting 37.3% of people, with a significantly higher percentage in the military (65.6%) than in civilians (42.7%). The "Moderate" category makes up 27.8% of the total, with 22.2% in the military and 30.8%

among civilians. The "Moderately Severe" level affects 12.6% of the population, with more civilians (16.0%) than military members (6.1%) experiencing this moderately severe. Lastly, the "Severe" category is the least common, found in only 3.4% of cases, with low representation in both military (1.5%) and civilian (4.4%) groups. This data suggests that mild conditions are more prevalent in the military, while civilians experience a wider range of severity levels, especially at the extremes of having no symptoms or severe symptoms.

Table 4. Correlations between LTPA and depression among UPNM students

		LTPA	Depression
LTPA	Pearson correlation	1	0.104*
	Sig. (2-tailed)		
	N	381	

*Sig. at the 0.05 level (2-tailed)

The study examined the link between LTPA and depression levels among UPNM students using Pearson's correlation analysis. The findings demonstrated a noteworthy correlation, with the r-value of 0.104. As per Guildford's Rule of Thumb, a correlation coefficient of 0.104 suggests a moderate positive link (cited in Aswegen & Engelbrecht, 2009). This indicates that although there is a statistically significant correlation between LTPA and depression, the magnitude of this association is very low.

DISCUSSION

In this study, the research findings reveal a notable difference in respondents between female and male students at UPNM. Specifically, the sample comprised n=294 (77.2%) male respondents and n=87 (22.8%) female respondents, with a substantially higher number of males participating in the study. This discrepancy can be attributed to the overall gender distribution at UPNM, where there are more male students than females.

Furthermore, the data indicate a higher proportion of civilian students, n=250 (65.6%), participating in the study compared to cadet students, n=131 (34.4%). As a military university, UPNM primarily consists of cadet officers; however, it also admits a smaller number of territorial and civilian students. The inclusion of mandatory military training in each program can present challenges in obtaining research participation from the students due to their busy schedules (Haque et al., 2019).

Regarding age distribution, the majority of respondents fell within the 18 to 20 years age group, constituting n=217 (57.0%), while those aged 21 to 24 years comprised n=163 (42.8%), and those 25 years old and above constituted only n=1 (0.3%). It is evident that the younger age group (18-20 years old) showed greater willingness and interest in participating in the study compared to the other age groups.

In terms of educational level, diploma students represented a higher number, n=309 (81.1%), compared to degree students, n=71 (18.6%). This observation is consistent with UPNM's role as an institution focused on providing bachelor's degree courses and enhancing the knowledge and academic standing of armed forces personnel. Regarding, the race of the respondents, the majority identifying as Malay in race, with n=355 (93.2%), as opposed to Chinese, Indian, or other ethnicities.

The level of LTPA among university students of UPNM; the number of respondents in the active level category was n=314 (82.4%), the moderately active level category was n=56 (14.7%) respondents, and the insufficiently active level category was n=11 (2.9%) respondents. The current study's findings showed that UPNM, a military university, had a high degree of LTPA among its students. This result is consistent with the nature of the academic setting, which encourages students to lead active lifestyles. According to Sitoayu et al., (2020), a university culture like this gives students the best foundational experience possible throughout their formative years and empowers them to maintain a healthy lifestyle over time.

It is imperative that these students engage in physical exercise during their leisure time, as it not only enables them to meet health recommendations but also aids in the development of social relationships and the adaptation to the social expectations of their university experience. Ma et al., (2020) have found that adolescents' mental well-

being is positively impacted by engaging in physical activity during their leisure time. In order to preserve optimal health, Bull et al., (2020) recommend that adults aged 18 to 64 engage in a minimum of 150 minutes of moderate-intensity aerobic physical activity (PA) or 75 minutes of vigorous-intensity aerobic PA per week, or a combination of both, as recommended by the WHO. This guideline is particularly relevant to college students, who frequently fall within this age cohort and experience a variety of stressors related to their academic and social lives.

The study reveals that the degree of mental health depression among university students of UPNM is categorised as mild. The mild level group had a total of 142 respondents, which accounts for 37.3% of the total. This is greater than the moderate level category, which had 106 respondents, accounting for 27.8%. Talapko et al., (2021) discovered that the COVID-19 outbreak harmed students' mental and physical health due to the difficult living conditions it enforced. They found that poor psychological well-being causes greater stress, which is a known risk factor for developing anxiety and depression disorders. Similarly, Singh et al., (2018) noted that academic stress and lifestyle changes put young people, particularly students, at risk for mental health difficulties. Many students struggle to balance the demands of their academic programs, which can exacerbate psychological issues, endangering their well-being and negatively impacting their academic performance and future employment prospects (Talapko et al., 2021; Singh et al., 2018).

The WHO estimates that approximately 20% of young people are affected by mental health issues, including depression (Singh et al., 2018). This period of youth is pivotal, marked by significant physical, physiological, psychological, and behavioral changes that can create substantial stress and disrupt relationships with peers and adults. Research by Marc-André Bélair et al., (2018) reveals a troubling link between increased screen time and deteriorating mental health among adolescents. Furthermore, a study by Gabal et al., (2022) found that students frequently experience mild to moderate depression, a finding that aligns with our research. Additionally, Talapko et al., (2021) highlighted that the second partial lockdown during the COVID-19 pandemic exacerbated anxiety, depression, and stress among students in health-related fields, underlining the severe impact of such crises on mental well-being.

Although UPNM students engage in significant levels of physical activity, the challenging military setting and the impact of the COVID-19 pandemic exacerbate persistent mental health difficulties. Recent research have found that even engaging in high amounts of physical activity may not completely mitigate the negative effects on mental health caused by stressors (Schuch et al., 2019; Kaya & Demirci, 2024). Although engaging in physical activity offers many advantages, it is not a comprehensive remedy for the mental health challenges experienced by students in these exceptional situations.

According to Ijaz et al., (2020), stress and depression are also more common among those who served in the military. This demographic is prone to these issues because of academic pressure, obstacles encountered during military training, and lifestyle changes. The result contradicts Schuch et al., (2018) study that higher levels of physical exercise are consistently connected with a decreased risk of getting depression in the future. Physical activity had a protective effect on people of any age or gender, and it was significant in all places. Moreover, the result from Jo et al., (2021) also contradicted where the authors' found the amount of physical activity conducted during leisure time; it could significantly reduce depressive symptoms. As a preventive approach to prevent the symptoms of depression, it may be helpful to do appropriate physical exercise during leisure time.

Conclusion

This study conducted at the National Defence University of Malaysia (UPNM) provides significant findings about the levels of leisure-time physical activity (LTPA) and depression among students. The data emphasise that UPNM students generally lead an active lifestyle, with most male respondents and a larger proportion of civilian students. Nevertheless, even when students engage in substantial physical activity, they still encounter mild to moderate depression, mostly impacted by the distinct stresses of military training and the ongoing COVID-19 pandemic.

The research reveals a modest although noteworthy positive correlation between LTPA (Leisure-Time Physical Activity) and mental health. This suggests that engaging in physical activity has a favourable impact on mental well-being. However, it is important to note that physical

exercise alone does not completely alleviate the difficulties faced by students in this demanding setting. This highlights the necessity of having complete mental health assistance in addition to physical training regimens. Further investigation is warranted to delve into these dynamics to enhance the support for student well-being in military and high-pressure educational environments.

Recommendations

Universities can establish a setting that promotes both physical and mental health using technology, specialised support, group activities, awareness-raising, organised sports programs, and facility access. These initiatives can improve students' performance in the classroom and on the battlefield by assisting them in managing stress, lowering their rates of depression, and leading more balanced, satisfying lives.

The National Defence University of Malaysia (UPNM) study's findings suggest that future investigations should concentrate on a number of crucial areas to improve student wellbeing in military and high-pressure learning environments. To find the best combinations of interventions, comparative studies could look at the efficacy of different mental health support programs, like counselling and stress management workshops, in addition to physical activity programs. Studies that follow participants over time can see how consistent levels of LTPA affect mental health, particularly during times of high stress such as military training and major world crises. Qualitative study may also explore the particular stressors that military and civilian students encounter, offering a deeper comprehension of their distinct difficulties and coping strategies.

More investigation into the responses of distinct groups—such as male and female students or military versus civilian students—to various physical and mental health therapies may result in the development of more specialised support networks. A thorough investigation into the incorporation of holistic wellness programs that integrate tactics for physical, mental, and emotional well-being, such as mindfulness and nutrition, may offer comprehensive help. Furthermore, researching how the COVID-19 epidemic has affected stress and mental health may shed light on how social interaction, instructional strategies, and physical activity levels have an influence on students in high-stress settings. By focussing on student well-being, these study directions hope to improve students' mental health and the frequency of their leisure-time physical activity.

Conflict Of Interest

No conflict of interest is declared by the aouthors. In addition, no fanancial support was received

Ethical Statement

This study followed ethical standards and received approval from the Faculty of Sports Science and Recreation, Universiti Teknologi MARA with reference number 100-KNS(PJI 9/19) 13 October 2021.

Author Contributions

Study design: NHMN, RAL, HAM, YNH, CC; Data collection: NHMN, RAL, HAM; Statistical analysis: NHMN, YNH, CC; Data interpretation: NHMN, RAL, HAM; Literature search: NHMN, RAL, HAM, YNH, CC. All authors have read and approved the published version of the manuscript.

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RESEARCH ARTICLE

Body Image and Eating Behaviour in Adolescents Loving Korean Wave Culture

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Abstract
The Korean wave has developed into a popular culture in the global community, especially adolescents in the last two decades. Cultural programs that include idols/bands, movies, dramas, variety shows, and webtoons are in great demand. The image of Korean women can influence adolescents' perceptions of ideal body shapes and eating behaviors. This study aims to analyze correlations between Korean culture viewing habits with body image and eating behavior among adolescents in West Java. This research is a cross-sectional study, conducted in West Java during April 2023 using the online structured questionnaire. The total subjects of this research were 467 adolescents. The results of the study stated that the subjects in this study were women (81.2%), college students (66.6%), Korean show enthusiasts (66.6%), Kpop enthusiasts (68.3%), Kdrama enthusiasts (77.5%), and webtoon enthusiasts (50.3%). Most of them thought that Korean idols were attractive (96.4%), and sometimes they want theirs body shape as their idols (46.5%). There were differences in body image and eating behavior among K-show (p=0.046 & p=0.039), Kpop (p=0.048, p=0.027, p=0.024, & p=0,000), and Kdrama enthusiasts (p=0.026) but there were no differences between enthusiasts of webtoon. Our findings show the Korean wave culture is one of the causes of adolescents experiencing body dissatisfaction, which is an important predictor of eating problems. Awareness of the importance of positive body image and healthy weight control behavior concepts is necessary.

Keywords
Adolescents, Body Image, Eating Disorder, Korean Wave, Kpop

INTRODUCTION

South Korean culture, known as the “Korean Wave” has developed into a popular culture that is very popular with the global community (Kim, 2023). Enthusiasts of K-pop idols abroad, including Indonesia, usually follow their artist's daily life through their artist's official social media to know what their idols are doing or wearing (Novita, 2024). For the example, Field et al., (2001) said in their research that the image of Korean women in magazines influences the perception of female adolescents reaching 69% about the ideal body shape, and 47% are said to be able to make teenagers go on a diet to achieve the ideal body shape. But the media set various information about this ideal body shape in the underweight range (Veggie et al., 2004).

Body shape and people judgment are one of the main issues in adolescence. The viewpoint that someone and/or others have about their body shape is called body image (Tort et al., 2021; Knezevic et al., 2024). Female adolescents are more concerned about body image than male ones (Wu et al., 2022). Female adolescents frequently practice unhealthy eating behavior in order to maintain their diet incorrectly by reducing meal portions, meal frequency, and resist hunger Kim et al., (2023). Recent studies have discovered a significant correlation between body image and eating behavior among adolescents. Autonomous motivations (eg, for pleasure, health, wellbeing)

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and health-focused exercise were associated with positive body image and healthy eating habits/behaviours, whereas exercising for appearance-related and body image perceptions were inversely related to both outcomes (Panao and Carraca, 2019).

Nutritional status is a state in which the body consumes food and utilizes the nutrients contained in the food. There are several ways to determine the nutritional status of adolescents, one of which is by determining body mass index for age (BMI/U). This nutritional status assessment is considered appropriate for assessing the nutritional status of adolescents, because adolescents are still in their infancy. Food can directly affect a person's nutritional status. The food and lifestyle that is usually consumed daily can affect a person's nutritional status. Unbalanced adolescent's body weight also affects adolescent's eating habits. Body weight that is not ideal is caused by the number of calories the body receives does not match the number of calories needed (Almatsier et al., 2011). The implementation of adolescent nutrition must be considered, many adolescents need special nutrition, such as teenagers who are active in sports and to carry out other physical activities (Stielke, 2024).

MATERIALS AND METHODS

Ethical Clearance

This research was carried out in April 2024. Ethical approval by Ethical committee of Gadjah Mada University No. KE/FK/1199/EC/2023. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Participants

This study used a cross-sectional study design. Participants were recruited online through WhatssApp, facebook, and instagram. A total of 467 respondents aged 17-23 years old in West Java Province were taken as subjects using snowball and consecutive sampling. The study held in April 2023. The respondents taken were those who completed the answers until April 30, 2023. Participation was voluntary and the participants were not compensated.

Data Collection Tools

Participants were asked to answer a set of questions regarding socio-demographic variables such as their age, biological sex, level of education, fandom of Korean waves (program/ variety show, K-Pop/ singer idol, K-drama, K-webtoon), perception about the body of Korean artists and idols, and whether the participants wants to have a body like the artists. In addition, participants were also asked to fill out the body image scale for Youth (BISY) and Eating Attitude Test-26 (EAT-26).

Body Image Scale for Youth (BISY)

Body image scale assessed by The Body Image Scale for Youth (BISY) questionnaire, was adopted from the study of Farahani, et.al (2022). The BISY consists of ten themes that were identified 1) emotions and behaviors (15 items), 2) body evaluation (6 items), 3) personal characteristics and strategies (6 items), 4) appearance importance in the future (4 items), 5) social models (5 items), 6) perceived social support (4 items), 7) priority of health and spirituality (4 items), 8) appearance importance in social interactions (3 items), 9) perceived cultural values (3 items), and 8) empowerment (2 questions). The part of these findings with a focus on the psychological aspects. A higher score of BISY indicates a higher confident level of their body.

Eating Attitude Test-26 (EAT-26)

Eating behaviour was taken from Garner, et.al (1982) and validated by Mandiri (2015) in Indonesian version.The EAT-26 questionnaire is a 26-item scale encompassing three subscales including (1) dieting (13 items), (2) bulimia and food preoccupation (6 items), and (3) oral control (7 items). A higher score of EAT-26 indicates a higher risk for the development of eating disorders. For all subscales, a five-point Likert scale from one to five was used for scoring answers for each item, where the choice of an answer for "completely agree" was given a five-point and "completely disagree" was given one point for items. Some questions are in negative statements, so the score are the opposite.

Statistical Analysis

First, descriptive statistics were compiled to describe the participant demographics eg, sex, education background, fandom of Korean waves (program/ variety show, K-Pop/ singer idol, K-drama, K-webtoon), perception about the body of Korean artists and idols, and are they want to have

body shape as their idols sometimes. Second, using the chi-square test, all variables were associated to Korean waves fandom (program, drama, idol, and webtoon). Chi-square test were then utilised to analyse for differences between groups, because the data were abnormal (non-parametric, p-value of normality test $\leqslant 0.05$, using Kolmogorov-Smirnov test). A significance level of $p \leqslant 0.05$ was set for all analysis.

RESULTS

A total of 467 participants filled out the questionnaire. Most participants were girls ages 19-25 years old (81.2%), while the boys were 18.8%. Most of them were college students (66.6%). As many 66.6% liked Korean programs, 68,3% liked K-drama, 77.5 % were K-idol fandom, and the half of participants (50.3%) liked webtoon. Most of them though that Korean artists and idols were attractive, and sometimes they want the same body shape as their idols (Table I).

Table 1. Characteristics of participants

Variables	Characteristics	N=467 (n,%)
Sex		
	Boys	88 (18.8)
	Girls	379 (81.2)
Education		
	High School	63 (66.6)
	College Student	369 (79)
	Labor	35 (7.5)
Do you like Korean program?		
	Like	311 (66.6)
	Dislike	156 (33.4)
Do you like KPop?		
	Like	362 (77.5)
	Dislike	105 (22.5)
Do you like Korean webtoon?		
	Like	237 (50.7)
	Dislike	230 (49.3)
Do you think Korean Idol looks attractive?		
	Yes	434 (92.9)
	No	33 (7.1)
Do you want to have a body and appearance like a Korean Idol?		
	Yes	163 (34.9)
	No	91 (19.5)
	Sometimes	213 (45.6)
Do you think Korean artist/actors looks attractive?		
	Yes	450 (96.4)
	No	17 (3.6)
Do you want to have a body and appearance like a Korean artists/actor?		
	Yes	179 (38.3)
	No	71 (15.2)
	Sometimes	217 (46.5)
Do you want to have the appearance like character in the webtoon you read?		
	Yes	71 (15.2)
	No	284 (60.8)
	Sometimes	112 (24)

Table 2 describe the comparison of body image dan eating attitude between Korean program enthusiasts and not. Based on the analysis ($p \leqslant 0.05$), social models (p-0.046) and dieting (p=0.039) are significantly associated with Korean program enthusiasts.

Table 2. Like/ Dislike of korean programs differences in body ımage and eating behaviour

Variables	Korean Program	Mean	SD	P-value
Emotion and behaviour	Like	55.44	11.92	0.452
	Dislike	57.62	10.92	
Body evaluation	Like	19.97	4.37	0.139
	Dislike	20.80	4.38	
Personal characteristics and strategies	Like	20.03	4.22	0.672
	Dislike	20.16	4.39	
Appearance importance in the future	Like	10.59	3.58	0.624
	Dislike	10.21	3.72	
Social models	Like	15.39	3.46	**0.046**
	Dislike	16.75	3.64	
Perceived social support	Like	12.36	3.36	0.302
	Dislike	12.44	3.41	
Priority of health and spirituality	Like	17.05	2.78	0.772
	Dislike	17.13	2.91	
Appearance importance in social interactions	Like	7.92	2.74	0.532
	Dislike	7.62	2.89	
Perceived cultural values	Like	9.54	2.25	0.180
	Dislike	9.95	2.09	
Empowerment	Like	4.51	1.6	0.869
	Dislike	4.47	1.49	
Dieting	Like	16.29	3.98	**0.039**
	Dislike	15.29	3.65	
Bulimia and food preoccupation	Like	3.11	1.99	0.668
	Dislike	2.86	1.69	
Oral control	Like	5.54	2.74	0.968
	Dislike	5.80	2.89	

Table 3. Like/ Dislike of Korean Pop (Idol) differences in body ımage and eating behaviour

Variables	Korean Pop	Mean	SD	P-value
Emotion and behaviour	Like	55.00	11.96	**0.048**
	Dislike	58.68	10.48	
Body evaluation	Like	19.87	4.30	**0.027**
	Dislike	21.07	4.46	
Personal characteristics and strategies	Like	20.05	4.34	0.756
	Dislike	20.12	4.14	
Appearance importance in the future	Like	10.51	10.36	0.769
	Dislike	3.53	3.82	
Social models	Like	15.35	3.47	**0.024**
	Dislike	16.9	3.59	
Perceived social support	Like	12.35	3.47	0.542
	Dislike	12.45	3.16	
Priority of health and spirituality	Like	16.98	2.85	0.341
	Dislike	17.29	2.73	
Appearance importance in social interactions	Like	7.82	2.73	0.677
	Dislike	7.82	2.94	
Perceived cultural values	Like	9.57	2.21	0.677
	Dislike	9.92	2.19	
Empowerment	Like	4.42	1.62	0.296
	Dislike	4.68	1.42	
Dieting	Like	16.42	3.94	**0.000**
	Dislike	14.96	3.62	
Bulimia and food preoccupation	Like	3.03	1.99	0.415
	Dislike	3.00	1.70	
Oral control	Like	5.57	2.76	0.906
	Dislike	5.74	2.87	

Based on table 3 represents the comparison of body image and eating behaviour between Korean pop fandom and not, there are four indicators associated with. Emotion and behavior (p=0.048), body evaluation (p=0.027), social models (p=0.024), and dieting (p=0.000) are

significantly associated with Korean idol fandoms.

Table 4. Like/ Dislike of korean drama differences in body ımage and eating behaviour

Variables	Korean drama	Mean	SD	P-value
Emotion and behaviour	Like	55.94	11.73	0.651
	Dislike	56.95	11.31	
Body evaluation	Like	20.25	4.42	0.444
	Dislike	20.23	4.28	
Personal characteristics and strategies	Like	20.00	4.28	0.474
	Dislike	20.32	4.26	
Appearance importance in the future	Like	10.43	3.62	0.356
	Dislike	10.57	3.65	
Social models	Like	15.56	3.52	0.309
	Dislike	16.82	3.61	
Perceived social support	Like	12.45	3.38	0.674
	Dislike	12.15	3.32	
Priority of health and spirituality	Like	17.11	2.76	0.691
	Dislike	16.96	3.01	
Appearance importance in social interactions	Like	7.88	2.78	0.659
	Dislike	7.62	2.85	
Perceived cultural values	Like	9.56	2.26	**0.026**
	Dislike	10.09	1.98	
Empowerment	Like	4.53	1.61	0.086
	Dislike	4.4	1.39	
Dieting	Like	16.13	4.03	0.096
	Dislike	15.36	3.34	
Bulimia and food preoccupation	Like	3.09	1.97	0.184
	Dislike	2.79	1.63	
Oral control	Like	5.60	2.85	0.869
	Dislike	5.70	2.59	

Only one indicator related to Korean drama enthusiasts, namely the perceived cultural values (p=0.026) based on table 4 that present the comparison of body image and eating behaviour between enthusiasts and who dislike the Korean dramas.

Table 5. Like/ Dislike of korean webtoon differences in body ımage and eating behaviour

Variables	Korean Webtoon	Mean	SD	P-value
Emotion and behaviour	Like	55.5	12.19	0.149
	Dislike	56.86	10.99	
Body evaluation	Like	20.26	4.56	0.305
	Dislike	20.23	4.21	
Personal characteristics and strategies	Like	20.29	4.39	0.915
	Dislike	19.85	4.14	
Appearance importance in the future	Like	10.53	10.39	0.961
	Dislike	3.82	3.42	
Social models	Like	15.92	3.66	0.129
	Dislike	15.76	3.49	
Perceived social support	Like	12.58	3.52	0.869
	Dislike	12.18	3.2	
Priority of health and spirituality	Like	17.27	2.77	0.132
	Dislike	16.87	2.85	
Appearance importance in social interactions	Like	7.89	2.91	0.319
	Dislike	7.76	2.67	
Perceived cultural values	Like	9.59	2.33	0.906
	Dislike	9.77	2.07	
Empowerment	Like	4.46	1.62	0.542
	Dislike	4.54	1.51	
Dieting	Like	16.23	4.12	0.250
	Dislike	15.67	3.64	
Bulimia and food preoccupation	Like	3.08	2.06	0.906
	Dislike	2.97	1.72	
Oral control	Like	5.7	2.81	0.911
	Dislike	5.55	2.78	

DISCUSSION

In general, nearly half of the respondents were less satisfied with their body shape. Respondents' reflection of how attractive Korean artists/idols (96.4% and 92.9%); most perceived their wants to have a body and appearance same as Korean artists/idols (45.6% and 46.5%) (see table 1). The rapid spread of South Korean culture (Hallyu) has led fans to idolize their favorite celebrities as role models for ideal body shapes and beauty standards. This aligns with a study that found women in Southeast Asia desire tall and slim bodies, similar to those of most Korean celebrities (Natalia & Agustina, 2021). Everyone has opinion about their own body, but sometimes others reveal their appearance as well which can be positive or negative. Female adolescents are highly concerned about their appearance (Dumas and Desroches, 2019). Research shows that women tend to compare their appearance or abilities with others more frequently (Naseem and Afzaal, 2024). One driving factor that plays a role in forming body image is the influence of media which frequently presents people with ideal body shapes as the gold beauty standard (Loeber et al, 2016). If someone's physical appearance does not fit the standards, it will cause body dissatisfaction and wish to reduce their weight (Jiotsa et al, 2021). Furthermore, with limited knowledge and understanding, they might try unhealthy diets. Besides their own opinion, adolescents have a need for others' appreciation in their adolescent development (Jeevarathinam, 2023). The social environments of their inner family (father, mother, or sister) and peers are sources of body judgement (Story et. al., 2002). In 2021 based on a study by Jang et. al., (2021), the Korean wave influenced the lifestyle including the eating habits of *Hallyu* products among Vietnamese. Several manifestations of the Korean Wave that have permeated and become accessible to the public include Korean television programs, Korean pop music (K-POP), Korean dramas, and Korean webtoons (Akıllı & Kim, 2024).

Based on table 2, the comparison between like and dislike Korean programs, social models (p-0.046) and dieting (p=0.039) are significantly associated with Korean program enthusiasts. Social models of health find its roots in the social model of disability and as such is a reaction to the medical model. In this model various factors that play an important role in health, like, social, political, economical, cultural and even environmental are taken in to consideration. This model can be termed as a community based approach where the focus is on prevention of the illnesses/ diseases. Thus, relevance is given to the awareness programmes and policies related to health so as to modify the lifestyle and health related behaviour of the individuals so as to promote their health and wellbeing. The main characteristics of this model are as follows (Yuill et. al., 2010): 1) Social context in which the individual exists has a significant influence on the health related experiences, choices and behaviour of the individual. The social context includes class, ethnicity, gender and so on, 2) The human body is social, psychological and biological simultaneously, 3) Cultural variations exist in the way health and illness are perceived, 4) Though, biomedicine and medicine are relevant in the context of health, 5) Health and social determinants of health are influences by political decisions, 6) The opinions of persons from non-medical background are relevant as they may provide a different perspective on health. Dietary patterns have been shown to significantly influence the interest in Korean programs (p=0.039). Korean programs frequently feature scenes depicting traditional Korean foods such as tteokbokki, bibimbap, ramyeon, bulgogi, and kimchi (Estoque, 2022). The portrayal of these visually appealing and appetizing foods can heighten viewers' desire to try and consume them (Jang et al, 2021). Consequently, these Korean programs can have an impact on the dietary habits of their audience.

Based on table 3, the comparison of body image dan eating behaviour between like and dislike Korean pop, there are four indicators associated with as follows; emotion and behavior (p=0.048), body evaluation (p=0.027), social models (p=0.024), and dieting (p=0.000) are significantly associated with Korean idol enthusiasts. Emotion and behavior closely related with dietary habit. Watching K-Pop/singer idol, K-drama, K-webtoon can be a way to relieve stress for some of adolescent and this is related to emotion and eating habits. In previous study the result shows the focus should be moved somehow from emotional eating and the consumption of unhealthy food to healthy lifestyle (Ljubicic M et. al., 2023).

In other words, by having a positive body image, someone is 2.21 times more likely to practice good eating behavior. Eating behavior in this study was not gradually recalled within 24

hours and seven days a week with detailed information of what and how much participants ate for every single meal. Dieting are significantly associated with Korean program and Kpop enthusiasts. Based on research, adolescents often skip their breakfast commonly occurs, 21.0% of females often and 10.8% always skip breakfast, compared to 15.0 and 8.1% among males, respectively (Sincovich et. al., 2022). Some reasons are intention to diet, school rules of eating fast food, a lack of appetite, and late night meal consumption (Bohara et. al., 2021) that affecting the nutritional status. The study also found that 38% of participants indicated abnormal body mass index (under or overweight). The Indonesian Ministry of Health Regulation Number 41 about balanced nutrition guide for 10-19-year-old adolescents suggest eating a variety of food that contains energy, protein, and micronutrients, e.g., green vegetables and colored fruits (Kemenkes, 2014; Toptaş Demirci & Lourenço, 2024) and consume about 34 bowls (/75 grams each) of vegetables and eight glasses of mineral water a day. The Joint FAO recommends fruits and vegetables containing fiber, protein, and micronutrients. A minimum consumption of 400 grams a day will help prevent chronic diseases, including obesity (WHO-FAO, 2004).

Body evaluation or self-perception of the body image among adolescents does not coincide with the body desire. Two different tendencies emerged: while girls aim for a longer, slimmer body shape, boys, in general apart from having at some time felt overweight like their female peers, admit also to feeling too thin. This apparent contradiction can be explained by the fact that boys would like to have a lean body while at the same time desiring a more robust and muscular constitution (and therefore fatter). This discomfort with one's own body perception can not have anything but obvious repercussions in life. This phenomenon has already been well described in many researches.

Only one indicator related to Korean drama enthusiasts, namely the perceived cultural values (p=0.026) based on table 4 that present the comparison of body image and eating behaviour between people who like and dislike of Korean dramas. Perceived cultural values came from the results of human thought. Culture describes the habits of human life, such as ways of thinking, daily interactions, art, religion, entertainment, and matters related to meeting the needs of human life. Korean dramas have played a significant role in introducing the Korean Wave to Indonesia. Their compelling narratives and the visually appealing performances of the actors contribute to their popularity among Indonesian audiences (Halim and Kiatkawsin, 2021). The heightened interest in Korean dramas has prompted a shift in cultural values among viewers. This phenomenon implicate The Korean government using the Korean Wave as both a domestic and foreign policy tool to strengthen its economic diversification, export profile, and cultural and public diplomacy outcomes through linguistic styles, fashion, and food (Lee, 2022), the Korean Wave popular culture in the digital social media age, representation, circulation and consumption in a global context as a distinctive and complex form of soft power. As a pronounced example of the crossover of culture, economy and politics, the Korean Wave is seen to be an integral resource for the creation of a dynamic image of the nation become global popular culture (Kim, 2021). In recent years, South Korean culture has developed into a popular culture that is very popular and attract the attention of the world community, which ultimately causes the body image of adolescents to also be affected by this Korean Wave.

Following the widespread popularity of K-POP and K-Drama in Indonesia, Korea has strategically utilized the Line WEBTOON platform to promote manhwa, or Korean comics, as an element of its cultural diplomacy. Altough, its development is not as big as Japanese manga or American comics (Jaehyeon, 2020). Digital webtoon and webnovel platforms are rapidly becoming energizing vehicles for transmedia intellectual property (IP) – referring to a network of interconnected media, popular culture and merchandise emanating from a single creative source. Free accessibility and the provision of comics in multiple languages beyond Korean, which facilitates international readers become fans. The active fans, otherwise known as 'cultural intermediaries', have moved to the forefront of creative industry transformations while building trust among their followers and demonstrating loyalty with the platforms on which they circulate their user-created content Shim et. al., (2020). Despite the notable interest in Korean webtoons among Indonesians, this study revealed no significant differences in body image and eating behaviors between individuals who are fans of

Korean webtoons and those who are not, as indicated in Table 5.

Conclusion

Based on this study, most female adolescents who liked Korean programs, K-drama, K-pop, and K-webtoon though that Korean artists and idols were attractive, and sometimes they want the same body shape as their idols. Whereas, by having a positive body image, female adolescents are more likely to engage in good eating behavior than those with a negative one. Intervention for the cognitive an affective areas, which construct body image, should be addressed to initiate behavioral changes in eating behavior. Consistent with the existing findings, an incongruency between perceived body image and body ideal was indicative of body dissatisfaction, as well as body image distortion.

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Conflict of Interest

There is no personal or financial conflict of interest within the scope of the study.

Ethical Statement

Ethics Committee approved the study protocol (Ethical committee of Gadjah Mada University No. KE/FK/1199/EC/2023).

Author Contributions

Conception and design of the study: AMS, IK; Data Collection: AMS, IK; Analysis and Interpretation: AMS, IK; Draft manuscript preparation; AMS, IK, WA, AR; Final Approval of the version to be published: AMS, IK, WA, AR; All authors approved the final version of the manuscript.

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RESEARCH ARTICLE

Psychological Skill of University Basketball Athletes in Each Playing Position in Indonesia

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Abstract
The role of psychological skills in sport is one of the cores of research and practice in sports psychology. Even if there is, especially in basketball sport, it is limited to an overview of the physical aspects. For this reason, this research was aimed of examining whether there is a difference in psychological skills of basketball athletes in each playing position based on five playing positions, namely point guard, shooting guard, small forward, power forward, and center. The study was conducted using a quantitative descriptive method with a retrospective causal-comparative design, or ex-post facto design, on 100 basketball athletes from seven provinces spread across 31 universities in Indonesia, consisting of 38 male athletes and 62 female athletes. All collected data were analyzed using one way-ANOVA technique. The results of the analysis found that there were differences in the psychological skills of university basketball athletes in each playing position of in Indonesia. According to the results of the analysis for psychological skills by playing position in Indonesian university basketball athletes in Table 3, ($F(4,99) = 3.483$, significant at $p = 0.011 < 0.05$. The point guard position shows the highest psychological characteristics, while the lowest score is occupied by the small forward position. Coaches can use the results of this study to better understand the psychological characteristics of athletes in different playing positions as well as developing more appropriate types of psychological skills training interventions to each playing position.

Keywords
Psychological Skills, Playing Position, Basketball

INTRODUCTION

Basketball is one of the most popular games in the world, played in almost every country without exception, involving participants from almost all age levels, including children, adults, and the elderly (Dereceli, 2018). Basketball in the United States is considered as the most favorable level to achieve by most countries. Many teams tried to adopt the United States style of play, including athletes' physiological standards and special training programs. In the last two decades, there has been a significant accumulation of scientific data regarding the physiology and medicine in basketball (Ostojic et al., 2006; Stojanović et al., 2018). As the most popular game in the world, many things can happen every second in the game, for example, in remaining seconds a losing team can win. More than 70 million people play basketball and more than 210 countries are members of FIBA (Kamble et al., 2012; Sampaio et al., 2006).

The basketball game is a team sport that is planned and must be carried out by each player using the tactics according to their positional roles (Bhadu & Poonam, 2017; Trninic, 2006). Playing positions in basketball are classified into three groups that reflect a single entity, namely guards, forwards, and centers. Furthermore, in accordance

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with the development of game rules and tactics, the player's positions are developed more specifically to become point guard, shooting guard, small forward, power forward, and center (Abdelkrim, Castagna, et al., 2010). The five playing positions are an elaboration of the three previous classifications of playing positions where the modern basketball game is dependent on these five playing positions.

The specific position is determined by a predictive classification model that can help coaches to place players in the right position on the field (Pion et al., 2018). Each player's position has different fitness and body composition so that the coaches have to give different treatment in the training process. Guards are the shortest and fastest players on the team who have the best ball control, while centers are the tallest and slowest players on the team (Pojskic et al., 2014).

Recent research examining the differences among player positions shows that centers are taller, heavier, and have a higher percentage of body fat than guards and forwards (Abdelkrim, Chaouachi, et al., 2010; Jelicic et al., 2002), while guards have better aerobic and anaerobic capacities (Cormery et al., 2008; Sallet et al., 2005), including better speed and agility (Abdelkrim, Chaouachi, et al., 2010). The forward and center players are better in terms of strength (Abdelkrim, Castagna, et al., 2010; Jelicic et al., 2002; Pojskic et al., 2014). It has been reported in other studies that there are significant differences between playing positions for body size, speed, agility, vertical jump, and maximum oxygen consumption (Cormery et al., 2008; Hoffman et al., 1996; Ostojic et al., 2006; Sallet et al., 2005). There is also a strong relationship among body composition, aerobic, anaerobic, and playing position in basketball. The physical characteristics of an athlete are important predictive factors of whether the athlete will achieve high performance in the sport they choose (Sallet et al., 2005).

The success of an athlete is influenced by several factors. In general, in the context of training, the factors considered to influence the success of an athlete are physical, technical, tactical, and psychological skills. In accordance with the statement, the success of an athlete is influenced by psychological factors (Nanda & Dimyati, 2019; Weinberg & Gould, 2019). These four factors must be trained and developed synergistically and simultaneously from the beginning of coaching, because each factor complements and strengthens each other (Blumenstein & Lidor, 2007).

The role of psychological skills in sport is one of the cores of research and practice in sports psychology. Various conceptual and empirical studies have been carried out to identify the types and functions of relevant psychological skills and how to apply them in the training process (Vealey, 1988; White, 1993). A number of research results show that the efficacy of the application of psychological skills aims to achieve the best performance (Mahoney, 1989; Mahoney et al., 1987). Weakness in psychological skill aspects is related to a number of psychological qualities needed, including aspects of commitment, self-confidence, and anxiety before competition (Goudas et al., 1998; Williams & Krane, 1992), and others.

Research on the of rugby sport found a relationship between psychological skills and playing position. More specifically, it is proven that the function of psychological skills depends on the playing position and the level of the athlete (Andrew et al., 2007). Each player's position has certain skill requirements that are different from other positions. In contrast to the results of other studies, in football game, it was found that psychological skills were not related to playing position but were correlated with player maturity and level of competition (Jooste et al., 2014). While research on volleyball game found gender to be one of the variables that affect the characteristics of the psychological skills of volleyball players, specifically on their anxiety control skills, mental preparation, and the importance of the team. In addition, it was also found that playing position did not affect the psychological skills characteristics of volleyball players in Indonesia (Khoirul & Dimyati, 2019).

Characteristics of psychological skills are practiced in sport today, especially in team sports. But the results are still inconsistent, including in basketball. Apart from being inconsistent, it is also still limited, especially after the development of more specific player positions. For this reason, this study aimed to explore the possibility of psychological skill differentiation in each player's position, namely point guard, shooting guard, small forward, power forward, and center. Therefore, the purpose of this study was to examine whether there were differences in the types of psychological skills in each playing position in basketball. Allegedly,

there are different types of psychological skills in each basketball-playing position. Each playing position requires certain psychological skill characteristics that are different from other playing positions.

MATERIALS AND METHODS

Methods and Design

The research was conducted using a quantitative descriptive method with a retrospective causal-comparative design or ex-post facto design (Fraenkel et al., 2022). The selection of this research method aimed to identify whether or not there are differences in psychological skills for each playing position of university basketball athletes in Indonesia.

Participant

Participants of this study were 100 basketball athletes, aged 18-24 years ($M=21.7_{years}$, $SD=3.82_{years}$), consisting of 38 male athletes and 62 female athletes. All participants came from seven provinces in Indonesia, namely Banten, Jakarta, West Java, Central Java, Yogyakarta, East Java, and Papua, spread across 31 public and private universities in Indonesia. Participants were selected and determined using a non-probability sampling technique (Fraenkel et al., 2022). The participants involved in this study were participants who had participated in the Student Basketball League in the last four years.

This research has met the ethical rules stated in the Helsinki declaration. Research ethics approval was obtained from the Faculty of Sport and Health Education, Universitas Pendidikan Indonesia with project number 1213/UN40.A6/KP/2024. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Data Collection Tools

Psychological Skills Inventory for Sport (PSIS-R5)

The instrument used in this research was The Psychological Skills Inventory for Sport (PSIS-R5), adopted from Mahoney, Gabriel, and Perkins (Mahoney et al., 1987). PSIS-R5 measures six aspects of an athlete's psychological skills which are elaborated into 44 items, consisting of 8 motivational items, 8 self-confidence items, 8 anxiety control items, 6 mental preparation items, 7 team urgency items, and 7 concentration items. The instrument used was also refer to Tenenbaum, Eklund, and Kamata (Tenenbaum et al., 2012) and validated to suit the language and its use in research. The instrument was assessed by a panel of expert judgments in the fields of language, sports psychology, and material integrity (Nanda & Dimyati, 2019).

Procedure

All the required data were collected using the google form media distributed through the WhatsApp group under the name of PERBASI Java-Bali with a total of 14 group members, including PB administrators of Indonesian Basketball Association (PERBASI). The group members distributed it to WhatsApp groups which consisted of university basketball coaches in Indonesia. Furthermore, with the help of the coaches, the athletes were asked to fill out a google form regarding the PSIS-R5 inventory. From 109 participants who were asked to fill out the Google form, only 100 participants filled it out, while 9 people said they were not willing for several reasons. Next, the data were compiled for further analysis.

Statistical Analysis

All collected data were analyzed using the one-way-ANOVA analysis technique, an analysis technique used to explore more than two average differences with the help of SPPS software version 21 (Field, 2009).

RESULTS

There are three findings that will be presented in this section, namely the results of the validation of the PSIS-R5 instrument (validity and reliability), descriptive statistics, and test results on differences in psychological skills among player positions. These three findings are presented as follows:

Validity and Reliability of Instrument

Table 1 presents the results of the validity and reliability analysis of the psychological skills instrument (PSIS-R5) for 100 participants (basketball athletes).

In accordance with the results of the analysis of instrument validity (Table 1), the obtained validity coefficient index was between 0.636-0.839 All validity values were higher than 0.6. It can be interpreted that, based on these results, all PSIS-R5 indicators are declared valid and can be used. Likewise, with Cronbach's Alpha reliability coefficient index, the obtained results are between 0.731-0.921. All values are higher than 0.7. It can be interpreted that all PSIS-R5 indicators are reliable. Thus, the instrument can be used for data collection because it is proven valid (measures what is to be measured) and reliable (can be trusted because the results are consistent).

Table 1: Validity and Reliability of PSIS-R5

Psychological Skill	Coefficient of Content Validity (Aiken's V)	Coefficient of Reliability (Cronbach's Alpha)
Motivation	0.679	0.792
Self-Confidence	0.636	0.775
Anxiety Control	0.779	0.914
Mental Preparation	0.839	0.921
Team Significance	0.665	0.803
Concentration	0.731	0.731

Source: (Nanda & Dimyati, 2019)

Description of Statistics

The results of the research show that there are different psychological skills for different playing positions of college basketball athletes in Indonesia. These results are presented in Tables 2 and 3. Based on the description of the data in Table 2, it is known that the mean of psychological skills of college basketball athletes in Indonesia range between 144.30-159.50. The mean of each position is 159.50 for point guard, 148.10 for shooting guard, 144.30 for small forward, 147.95 for power forward, and 147.60 for center position.

Table 2: Psychological skills by playing position in ındonesian university basketball

Game Position	N	Mean	Standard Deviation	Standard Error
Point Guard	20	159.50	13.105	2.930
Shooting Guard	20	148.10	13.010	2.909
Small Forward	20	144.30	10.815	2.418
Power Forward	20	147.95	18.900	4.226
Center	20	147.60	12.411	2.775
Total	100	149.49	14.604	1.460

Note: N = Number of participants

Hypothesis Testing

The results of the One Way-ANOVA analysis of the psychological skills of university basketball athletes in each playing position in Indonesia are presented in Table 3.

Table 3: ANOVA results for psychological skills by playing position in ındonesian university basketball athletes

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2700.240	4	675.060	3.483	.011*
Within Groups	18414.750	95	193.839		
Total	21114.990	99			

Note: *p < 0,05*; p < 0,01***

In accordance with the results of the analysis in Table 3, it was found that (F(4,99) = 3.483, significant at p = 0.011 <0.05. In other words, the null hypothesis (Ho), which states that there is no difference in psychological skills of basketball athletes in each playing position, is rejected, and the alternative hypothesis (Ha), which states that there are differences in psychological skills of basketball athletes in each playing position, is accepted. It concludes that the psychological skills of university basketball athletes in each playing position in Indonesia are significantly different. Furthermore, to find out the differences, the results are presented in Table 4 using the Least Significant Difference (LSD) post-hoc test, a test to find out which playing positions are significantly different in terms of psychological skills when the null hypothesis is rejected.

Table 4. Comparison of psychological skills by position in ındonesian university basketball

(I) Playing Position	(J) Playing Position	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Point Guard	Shooting Guard	11.400*	4.403	.011*	2.66	20.14
	Small Forward	15.200*	4.403	.001**	6.46	23.94
	Power Forward	11.550*	4.403	.010*	2.81	20.29
	Center	11.900*	4.403	.008**	3.16	20.64
Shooting Guard	Point Guard	-11.400*	4.403	.011*	-20.14	-2.66
	Small Forward	3.800	4.403	.390	-4.94	12.54
	Power Forward	.150	4.403	.973	-8.59	8.89
	Center	.500	4.403	.910	-8.24	9.24
Small Forward	Point Guard	-15.200*	4.403	.001**	-23.94	-6.46
	Shooting Guard	-3.800	4.403	.390	-12.54	4.94
	Power Forward	-3.650	4.403	.409	-12.39	5.09
	Center	-3.300	4.403	.455	-12.04	5.44
Power Forward	Point Guard	-11.550*	4.403	.010*	-20.29	-2.81
	Shooting Guard	-.150	4.403	.973	-8.89	8.59
	Small Forward	3.650	4.403	.409	-5.09	12.39
	Center	.350	4.403	.937	-8.39	9.09
Center	Point Guard	-11.900*	4.403	.008**	-20.64	-3.16
	Shooting Guard	-.500	4.403	.910	-9.24	8.24
	Small Forward	3.300	4.403	.455	-5.44	12.04
	Power Forward	-.350	4.403	.937	-9.09	8.39

Note: *p < 0,05*; p < 0,01***

DISCUSSION

The purpose of this study was to examine whether there were differences in the psychological skills of university basketball athletes in each playing position in Indonesia. To achieve this goal, a quantitative descriptive study was carried out using a retrospective causal-comparative design or ex-post facto design on 100 university basketball athletes in Indonesia. Participants completed the PSIS-R5 inventory through the Google form media. According to the results of the analysis, there were significant differences in psychological skills in each athlete's playing position in basketball. Research on psychological skills, especially related to playing positions in basketball, is relatively limited, but these previous studies show consistent results, even though these studies were oriented towards other components of playing position. For example, Pion, Segers, Stautemas, Boone, Lenoir, & Bourgois (Pion et al., 2018) reported the results of their research that each playing position in basketball showed differences. Other research that corroborates the results of this study can be found in rugby sport. It is proven that there is a relationship between psychological skills and the playing position of rugby athletes. In particular, there is evidence to suggest that rugby players can be differentiated based on their playing position and level of competition in terms of their psychological skills (Khoirul & Dimyati, 2019). An important implication related to the results of this study is that differences in playing positions indicate differences in the development of ball possession in basketball.

Coaches and players must be aware of the positional demands of each playing position (Wierike et al., 2018).

The results of the study show that there are differences in each playing position, namely point guard, shooting guard, small forward, power forward, and center. In this study, point guards have the best psychological skills. There are significant differences among shooting guards, small forwards, power forwards, and centers. Dereceli (Dereceli, 2018) reveals that there are differences in the psychological skills of basketball players from the aspects of concentration and mental preparation. The Point Guard has the hallmark of a strong leadership character, understanding the personality of teammates, and must develop relationships with teammates. The point guard position usually has a better personality, more stable, and relatively able to control emotions compared to other playing positions (Chartrand et al., 2016; Nanda & Dimyati, 2019). Previous studies (Nanda & Dimyati, 2019) and (Giannini, 2009) explain that the guard must be filled with basketball players who have good shooting skills so that victory points can be achieved.

The Small Forward, in this study, showed the lowest psychological skill scores compared to point guards, shooting guards, power forwards, and centers. This is because the small forward position is a playing position that must have high speed and good shooting accuracy, so that the small forward has a selfish tendency. In basketball, a forward is needed to score (Khoeron, 2017; Nanda & Dimyati, 2019). In addition, the small forward also has the advantage of breaking through the opponent's defense. A basketball team is very dependent on this position and therefore the player who occupies the small forward position must be a scoring machine for his team (Nanda & Dimyati, 2019).

Power Forward, in this study, showed the value of psychological skills that are the same as the center. Physically, this is partly because the height of the power forward is generally the second-tallest player after the center. In addition, the power forward has positional duties taking over rebound situations when opposing players try to score or break through the defensive line. A basketball team is very dependent on this position because it must be able to defend or protect the defense area from opponents who will score (Nanda & Dimyati, 2019). In addition, during a basketball game, the power forward position is better in rebounding, defending, assisting, stealing, and blocking than other positions (Sampaio et al., 2004).

The center, in this study, showed the same psychological skill value as the Power Forward. Center has the highest height compared to other playing positions in basketball. According to Nageswaran, (Nageswaran, 2012), the center's body posture is usually taller than a guard or forward. Then, on certain occasions, the center position is occupied by the tallest player in the team (Kucsa & Mačura, 2015). The center position is responsible for keeping opposing players from shooting in vital areas and passing the ball into vital areas. But no less important, the center position is expected to win rebounds in vital areas (Nanda & Dimyati, 2019).

In accordance with all the results of these studies, each athlete's playing position in basketball game is proven to have certain psychological skill characteristics that are different in each playing position. Implicitly, the magnitude of the psychological skill score for each playing position shows different needs and is hierarchical in nature. One of the practical implications of the results of this research, among other things, is to provide important information for coaches regarding the urgency of understanding the psycho-logical characteristics of each athlete's playing position as well as feedback for designing and developing types of psychological skills training interventions that are in line with the psychological needs of each player (Hidayat et al., 2021; Komarudin et al., 2021).

Conclusion

This study shows that the psychological skills of basketball athletes in each playing position differed significantly. The point guard position has the highest psychological characteristics compared to other positions, the shooting guard position is in second place, the power forward and center positions have the same value in the third rank, while the small forward position has the lowest score. Coaches must understand the different psychological skills possessed by each athlete, in order to provide appropriate treatment according to the unique characteristics of each athlete.

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Conflict of Interest

Authors declare no conflict of interest.

Ethics Statement

This research followed ethical standards and received approval from Faculty of Sport and Health Education Universitas Pendidikan Indonesia with numbered 1213/UN40.A6/KP/2024.

Author Contributions

Study Design, KK, AR, and MYS; Data Collection KK, AR, GN; Statistical Analysis, KK, AR, TJ; Data Interpretation, KK, XQL, AAT; Manuscript Preparation, KK, AR, MYS, GN; Literature Search, KK, and AR. All authors have read and agreed to the published version of the manuscript.

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RESEARCH ARTICLE

Nutritional Status and Cardiometabolic Markers to Determine Athlete's Achievement: A Cross-Sectional Study

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Abstract
The health, physiological, and nutritional status of an athlete is a top priority in achieving success and career sustainability. Information about an athlete's health, such as blood biochemistry, anthropometry, and adequate nutritional intake, might indicate their ability to perform exceptionally well in different levels of competition. Objective: This research objective is to examine the correlation between athletes' sports achievements in Bandung and their anthropometric traits, nutritional status, and blood biochemical indicators. Methods: This study utilised a cross-sectional design and incidental data collection techniques. Participants: The study comprised 84 athletes from 27 different sports who received achievement allowances from KONI Bandung City. Instruments: n this study, we employed reliable and validated techniques to assess anthropometrics, body composition, somatotype, blood biochemistry, nutritional intake adequacy, and energy adequacy. Data analysis: Both the bivariate and multivariate analyses used logistic regression. Results: The findings of the analysis indicate a significant relationship between athlete performance and two variables: blood pressure (p=0.026) and dietary diversity (p=0.048). The findings from the multivariate analysis revealed a significant relationship between blood pressure and dietary variety, which influences the achievement of athletes. The calculation of the odds ratio (OR) revealed that among all the variables examined, the athlete's blood pressure exhibited strongest correlation with their performance. Conclusion: Blood pressure is a physiological measurement that can serve as an indicator of cardiac function and overall well-being. As a result, it is critical to regularly assess the physical well-being of athletes in Bandung to ensure their consistent optimal performance.

Keywords
Athlete, Athlete's Achievement, Blood Pressure, Health

INTRODUCTION

The attainment of optimal health and performance in athletes is contingent upon the crucial consideration of optimal nutrition (Holtzman & Ackerman, 2021). Maintaining good health and enhancing physical fitness, with the aid of proper nutrition, is fundamental to creating a conducive environment for athletes to engage in practical training and achieve successful performance outcomes (Arent et al., 2020). The consumption of appropriate nutrients is associated with optimal athletic performance, while lacking nutrients may result in reduced performance (Hornstrom et al., 2011). Nutrition also plays a great role in injury prevention, skeletal muscle regeneration, health maintenance, and performance enhancement (Holway & Spriet, 2011; Toptaş Demirci & Lourenço, 2024).

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The nutritional requirements of athletes vary based on their specific sport's pursuits. However, athletes must maintain a balanced diet that includes appropriate amounts of macronutrients and adequate hydration to achieve optimal performance and maintain overall health. In addition, evaluating nutritional status is crucial for optimizing performance due to its impact on health, body composition, and overall performance (Mielgo-Ayuso et al., 2015). According to (Bytomski, 2018), it is imperative to evaluate the energy needs of athletes following the specific demands of their respective sports and their training objectives. It is advisable to ensure that athletes consume sufficient macronutrients, including protein, carbohydrates, and fat, from various dietary sources, including unrefined carbohydrates, such as whole-grain bread and cereals, as an essential element in dietary interventions (Seal et al., 2021).

Furthermore, an athlete's vitamins and minerals need to be fulfilled through a balanced and carefully designed dietary regimen, as suggested by Nebl (Nebl et al., 2019). Moreover, it is necessary for athletes to adequately ingest fluids to achieve optimal hydration levels before, during, and after physical activity, thereby sustaining peak performance (Kim et al., 2018). Hence, each athlete needs to comply with personalized nutritional protocols, necessitating the coach and athlete to possess extensive expertise to ascertain suitable caloric, macronutrient, micronutrient, and hydration consumption under the athlete's requirements and training objectives.

In addition to nutritional considerations, elite athletes undergo a range of physiological adaptations that substantially influence their sports performance. Genetic polymorphisms at the physiological level were associated with specific phenotypes characterized by anthropometric and functional traits that impose conditional and physiological requirements on sport performance (Garcia et al., 2022). The adaptations may encompass alterations in muscle morphology, cardiovascular performance, and metabolic pathways, among other variables. Typically, high-performance athletes undergo various physiological adaptations contingent upon their specific sport, exercise regimen, and competitive level (Etxebarria et al., 2019). Utilization of physiological monitoring is employed in individual sports to assess the dose-response, intensity, and performance of the exercise. The study evaluates the efficacy of various equipment coaches use for measuring physiological performance and biochemical parameters (Kiely et al., 2019).

Various biochemical parameters that may be employed include blood glucose levels, hemoglobin (Hb) concentrations, cholesterol levels, and ketone levels. Kiely et.al described a positive correlation between normal sugar levels and enhanced athlete performance, while a negative correlation was observed on individuals experiencing hypoglycemia, suggesting a decline in performance (Kiely et al., 2019). Iron plays a crucial role in oxygen transportation as it is essential for the synthesis of hemoglobin. Iron is an essential element for the efficient operation of oxidative enzymes involved in intracellular metabolism, specifically the electron transport chain and oxidative phosphorylation pathways within mitochondria (Stoltzfus, 2001). According to Rowland, the mechanism is influenced by physical activities of short duration, such as sprints and prolonged aerobic exercise (Rowland, 2012).

Blood pressure measurement is a frequently utilized cardiovascular parameter. The potential of blood pressure response during exercise testing to reveal previously undetectable cardiovascular pathology and predict future cardiac disease risk was acknowledge in both the general population and in pre-participation screenings of athletes (Caselli et al., 2019). Therefore, understanding the parameters that define a typical or atypical blood pressure response during exercise is essential to assessing cardiovascular health.

The limited information on athletes' physiological conditions is a concern in Indonesian sports development, particularly in Bandung. Athletes from the city of Bandung have high potential to win competitions at the international level. The city of Bandung makes various efforts to foster the achievements of its athletes. Evaluations often focus solely on physical conditions, neglecting fundamental aspects like anthropometry, physiological conditions, and nutritional adequacy. Nevertheless, additional research is needed to investigate the importance of additional factors that influence athlete's achievement. The objective of this study was to examine the determinants that are associated with the accomplishments of elite athletes from Bandung.

MATERIALS AND METHODS

Research Design

This study investigates the correlation between athlete performance at both national and international levels and many factors including health conditions, blood biochemistry, anthropometry, and nutritional adequacy. Figure 1 displays the research design used in this study.

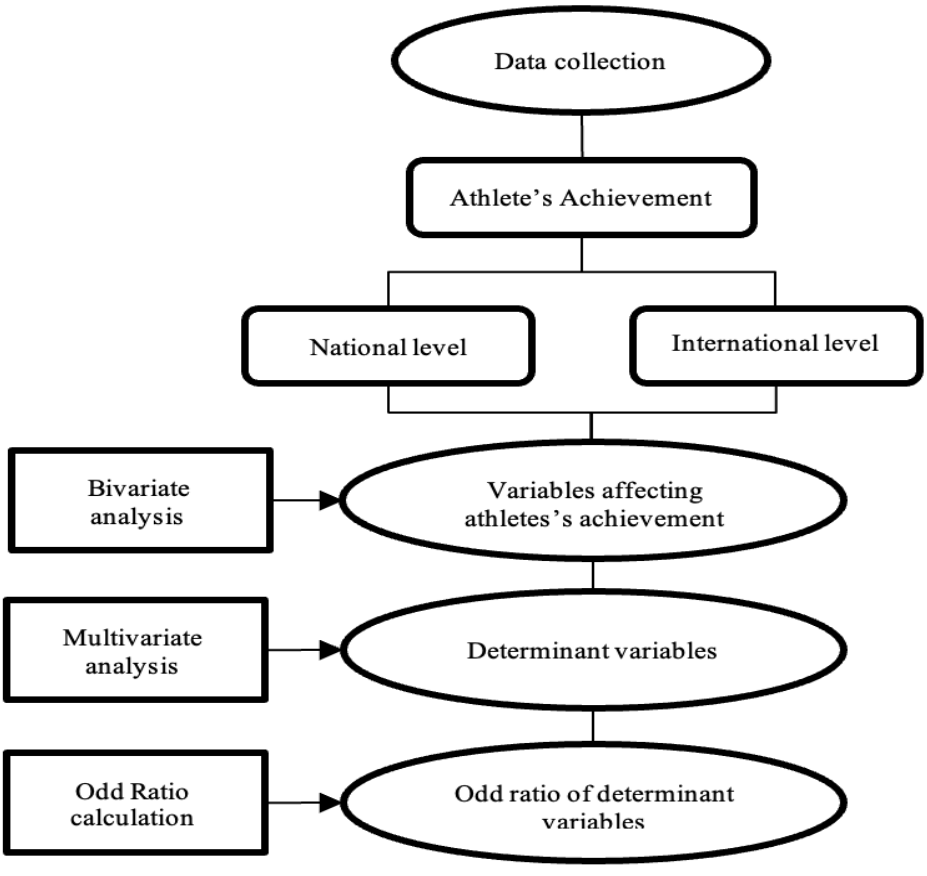

Figure 1. Researh design

Participants

The Medical and Health Research Ethics Committee (MHREC), Gadjah Mada University, Indonesia, granted ethical approval for the study with reference number KE/FK/0962/EC/2022, following the guidelines specified in the Helsinki Convention. Participants provided informed consent via the volunteer form, which included information about the research, potential risks and benefits, confidentiality, and participant rights. The research carefully followed the ethical standards outlined in the Declaration of Helsinki, with a focus on safeguarding the rights and well-being of the participants through careful consideration of the study's design, procedures, and confidentiality measures.

The study included athletes from KONI Bandung City who received an achievement allowance. The reported population consisted of 110 individuals. The Slovin formula determined the sample size, resulting in a minimum sample size of 75 individuals. Furthermore, the total sample size was 84 people, based on an expected dropout rate of 10%. The study employs incidental sampling as its sample technique. The study's inclusion criteria consisted of athletes who were free from infectious diseases, not enrolled in a weight management program, and willing to actively participate in data collection activities. This study excluded athletes who were absent during data collection and athletes who did not fully complete the questionnaire.

Data Collection Tools

There are several instruments used in this study including body scales, stadiometer, measuring tape, and skinfold caliper which are used to measure anthropometric aspects of the body. A digital tensimeter was used to measure blood pressure and pulse rate. Blood biochemical

parameters were measured using a set of readers and test strips from Accutrend and Fora-6. Karada Body Composition Scanner was used to measure body composition. The 24-hour food recall method was used to determine nutritional adequacy (Anderson et al., 2017), while the diversity of athlete's consumption was assessed using the Individual Dietary Diversity Score (IDDS) (Habte & Krawinkel, 2016). The adequacy of energy intake was determined through the Energy Availability calculation (Melin et al., 2019).

Procedures

Professionals with the necessary qualifications and expertise carry out all measurement activities. Data collection procedures were used using interview techniques and direct measurement. Interview techniques were used to obtain data on athlete achievement, athlete characteristics, nutritional adequacy measurements, and diversity of athlete food consumption. Direct measurement techniques were used to measure blood pressure and pulse rate. The same applies to anthropometric measurements such as body mass index, body composition, and somatotype. Measurement of blood biochemical parameters was carried out on capillary vessels to obtain data on haemoglobin values, blood glucose, triglycerides, and ketones. Energy availability is calculated by subtracting the energy spent through physical activity (energy expenditure) from the energy consumed through food and drink (energy intake).

Data Analysis

IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Chicago, IL, USA) was used to conduct a descriptive, bivariate, and multivariate analysis. The variables were subjected to bivariate analysis to identify the independent variable that meets the requirements for conducting multivariate logistic regression analysis. Further investigation was carried out using a multivariate model on independent variables with p-values less than 0.25.

RESULTS

A study was conducted with a sample size of 84 athletes, selected from a population of 110 individuals. The study includes athletes from 27 distinct sports, including aero-modeling, weightlifting, athletics, billiards, bodybuilding, bowling, badminton, chess, hang gliding, wrestling, judo, karate, sailing, diving, open water swimming, archery, rock climbing, pencak silat, swimming, fin swimming, gymnastics, roller skating, water skiing, squash, taekwondo, tarung derajat, and wushu. The independent variable in this research was sports accomplishments, which are classified into national and international level. The study examined several independent variables pertaining to the athlete's nutritional profile. These variables encompassed age, gender, nutritional status, subcutaneous fat, visceral fat, muscle mass, blood pressure, pulse, hemoglobin level, triglyceride level, ketone level, energy availability, nutritional adequacy, and adequacy of protein.

The results of the bivariate analysis conducted using logistic regression are provided in Table 1. The findings suggest that the variable associated with athlete's achievement is blood pressure, with a statistically significant p-value of 0.038. Most participants, encompassing athletes at both national and international levels, exhibit blood pressure within the normal range. The prevalence of hypotension was found to be greater among international athletes, with a percentage of 9%. In contrast, athletes at the national level demonstrated a greater prevalence of hypertension, with a rate of 8%. Additionally, multivariate analysis was conducted by incorporating additional variables that exhibited a p-value of less than 0.25. The variables that were subjected to further analysis using the multivariate analysis model are blood pressure (p=0.038), dietary diversity (p=0.064), subcutaneous fat (p=0.249), ketones (p=0.135), and carbohydrate adequacy (p=0.238).

Table 2 presents the result from multivariate analysis of independent variables, namely blood pressure, dietary diversity, subcutaneous fat percentage, blood ketone level, and carbohydrate adequacy. The findings of the analysis indicate a significant relationship between athlete performance and two variables: blood pressure (p=0.026) and dietary diversity (p=0.048). In addition, the irrelevant variables were systematically removed from the model. Furthermore, the variables with changes in odds ratio values exceeding 10% were reintroduced into the model for further analysis. Nevertheless, final analysis reveals that none of the variables exhibit an odds ratio exceeding 10%. As a result, the blood pressure and food diversity variables are still included in the equation.

Table 1. Association of athlete's characteristics with sports achievement

Variables		Achievement		*p-value*
		National (%)	International (%)	
Age	_ Teen	27 (32.1)	31(36.9)	
	– Adult	11 (13.1)	11(13.1)	0.943
	– Elderly	3 (3.6)	1 (1.2)	
Sex	– Male	22 (26.2)	21 (25)	
	– Female	19 (22.6)	22 (26.2)	0.553
Nutritional Status	– Underweight	2 (2.4)	3 (3.6)	
	– Normal	25 (29.8)	28 (33.3)	0,954
	– Overweight	5 6)	5 (6)	
	– Obese	9 (10.7)	7 (8.3)	
Subcutaneous Fat	– Low	7 (8.3)	11 (13.1	
	– Normal	29 (34.5)	30 (35.7)	0.249
	– High	5 (6)	2 (2.4)	
Visceral fat	– Low	5 (6)	9 (10.7)	
	– Normal	26 (31)	27 (32.1)	0.742
	– High	10 (11.9)	7 (8.3)	
Muscle Mass	– Low	13 (15.5)	9 (10.7)	
	– Normal	26 (31)	32 (38.1)	0.524
	– High	2 (2.4)	2 (2.4)	
Blood pressure	– Hypotension	3 (3.6)	9 (10.7)	
	– Normal	30 (35.7)	32 (38.1)	**0.038**
	– Hypertension	8 (9.5)	2 (2.4)	
Pulse	– Normal	41 (48.8)	40 (47.6)	0.999
	– Fit		3 (3.6)	
Hemoglobin	– Anemia	6 (7.1)	6 (7.1)	0.427
	– Normal	35 (41.7)	37 (44)	
Triglycerides	– Dyslipidemia	7 (8.3)	8 (9.5)	0.787
	– Normal	34 (40.5)	35 (41.7)	
Ketones	– High	27 (32.1)	31 (36.9)	0.135
	– Normal	14 (16.7)	12 (14.3)	
Energy availability	– Low	33 (39.3)	36 (42.9)	0.942
	– Normal	8 (9.5)	7 (8.3)	
Energy adequacy	– Low	25 (29.8)	26 (31)	0.636
	– Good	8 (9.5)	10 (11.9)	
	– High	8 (9.5)	7 (8.3)	
Protein adequacy	– Low	21 (25)	26 (31)	0.297
	– Good	10 (11.9)	8 (9.5)	
	– High	0 (11.9)	9 (10.7)	
Carbohydrate adequacy	– Low	27 (32.1)	29 (34.5)	0.238
	– Good	11 (13.1)	13 (15.5)	
	– High	3 (3.6)	1 (1.2)	
Fat adequacy	– Low	17 (20.2)	18 (21.4)	0.819
	– Good	10 (11.9)	10 (11.9)	
	– High	14 (16.7)	15 (17.9)	
Food diversity	– Less	20 (23.8)	30 (35.7)	0.064
	– Diverse	21 (25)	13 (15.5)	

Table 2. Multivariate analysis of variables associated with athlete's achievement

Variables	B	S.E.	Wald	df	Sig.	OR
Blood pressure	-1.219	.548	4.955	1	**.026**	.295
Food diversity	-.965	.487	3.917	1	**.048**	.381
Subcutaneous fat	-.336	.484	.483	1	.487	.714
Ketones	-.610	.531	1.323	1	.250	.543
Carbohydrate adequacy	-.398	.424	.883	1	.347	.672

Constant	5.798	1.946	8.872	1	.003	329.526

The multivariate analysis results for the variables determining sport performance are shown in Table 3. There is a significant association between blood pressure and athlete performance, with blood pressure showing the highest level of correlation. The odds ratio (OR) of both variables is less than 1, suggesting that they are classified as protective variables. Therefore, this study concludes that blood pressure serves as an important indicator in predicting and protecting the performance of athletes at the international level. Athletes who exhibit limited dietary diversity may experience a 40% reduction in their likelihood of attaining international accomplishments compared to athletes who maintain a diverse dietary intake

Table 3. Association of nutritional parameters and athlete's achievement

Variables	B	S.E.	Wald	df	Sig.	OR
Blood pressure	-1.245	.520	5.723	1	.017	**.288**
Food diversity	-.916	.477	3.684	1	.055	**.400**
Constant	3.795	1.292	8.630	1	.003	44.459

DISCUSSION

An athlete's physical well-being plays an important role in determining their level of accomplishment in sports. This study revealed a significant association between blood pressure and the performance outcomes of elite athletes in Bandung. Blood pressure refers to the measurement of pressure in the primary arterial system of the human body, typically expressed in millimeters of mercury. The measurement is characterized using systolic and diastolic pressure. The diastolic pressure refers to the minimum pressure observed just prior to the subsequent ventricular contraction, whereas the systolic pressure corresponds to the maximum blood pressure recorded during the contraction of the ventricles. Blood pressure is commonly represented as the combination of systolic and diastolic pressure, such as 120/80 mm Hg (Brzezinski, 1990).

Extensive research has been conducted on the cardiac condition and its correlation with the well-being of athletes, with particular emphasis on the role of the left ventricle. The left ventricle is responsible for receiving oxygenated blood from the right atrium and distributing it to various regions of the body. According to previous studies, there appears to be a correlation between vigorous physical exertion and myocardial disturbances, which subsequently heightens the likelihood of sudden death among athletes (Corrado et al., 2003; Kim et al., 2018). Nevertheless, previous research has indicated that the right ventricle undergoes both structural and functional adaptations in response to the workload it encounters (Hauser et al., 1985; Scharhag et al., 2002).

The present study revealed a notable disparity in the occurrence of hypertension between international athletes (2.4%) and athletes participating at the national level (9.5%). Hypertension is a physiological state characterized by a systolic blood pressure (SBP) equal to or greater than 140 mm Hg, or a diastolic blood pressure (DBP) equal to or greater than 90 mm Hg. The threshold for blood pressure in individuals with hypertension, as typically established, is equal to or greater than 130/85 mm Hg (Helzberg et al., 2010). Hypertension, a clinical manifestation, frequently manifests in athletes, with several studies indicating that athletes exhibit elevated blood pressure levels compared to individuals who do not engage in athletic activities. Previous study showed, the occurrence of hypertension among athletes exhibits considerable variation, ranging from 0% to 83% (Berge et al., 2015). This variability is influenced by factors such as gender, race, age, type of sport, duration of exercise, and nutritional status. Sex was identified as a contributing factor to the variation in blood pressure measurements between male and female athletes (Schweiger et al., 2021). Previous investigations into elite volleyball, basketball, and soccer athletes have indicated that male athletes exhibited significantly higher systolic and diastolic blood pressures (Hosseinzadeh et al., 2017). However, there was no significant difference observed in heart rate between male and female athletes. Age is a variable that is recognized to impact the functional capacity of the heart; however, it has been established that young athletes

exhibit equivalent cardiac work capacity when compared to their adult counterparts. Findings from endurance athletes suggest that there were no statistically significant differences observed in the electrocardiogram and blood pressure measurements between child and adult (Pentikäinen et al., 2021).

In this research, data pertaining to athletes from a total of 27 sports, encompassing endurance, strength, and team sports, was gathered. The impact of sports characteristics on blood pressure has been widely acknowledged, with studies indicating that strength-trained athletes exhibit elevated blood pressure levels (Guo et al., 2013). The phenomenon described can arise because of prolonged endurance training, wherein the left ventricle's function, morphology, and cardiovascular function remain unaffected (Pelliccia et al., 2010). In conjunction with athletic attributes, the duration and intensity of physical activity have been identified as factors that influence hypertension. It has been observed that individuals engaged in athletic pursuits for more than 10 hours per week exhibit elevated blood pressure levels (Berge et al., 2015; Hosseinzadeh et al., 2017).

This study also investigated the extent of dietary diversity among athletes. The instrument employed in this study is the Individual Dietary Score, which is designed to assess the overall nutritional sufficiency (Gina Kennedy et al., 2013). The instrument was employed across various age and gender cohorts to establish the validity of assessing macronutrient and micronutrient sufficiency in dietary intake (Doustmohammadian et al., 2020; Isabirye et al., 2020; Shrestha et al., 2021; Verger et al., 2021). The results from this study indicate a correlation between athletes who have a narrow range of food choices and their lower probability of achieving success at the international level. Upon collection of the data, it was observed that the athletes were engaged in a phase of general preparatory phase before competition. During this phase, athletes did not receive adequate nutritional assistance. This is shown by the low variety of athletes' diets and low levels of nutritional adequacy. Moreover, it also affects the sufficiency of macronutrient intake. The insufficiency of carbs, protein, and fat among athletes is demonstrated by the data presented in Table 1.

Numerous studies have reported the significance of meeting the dietary needs for both macronutrients and micronutrients in relation to enhancing athletic performance (Victor Lun et al., 2009). Despite the implementation of nutritional supplementation, its impact on enhancing nutritional adequacy, energy levels, and the nutritional status of athletes is not substantial (Larson-Meyer et al., 2018; Rodrigues et al., 2017). Another consequence of inadequate nutritional intake is the limited energy fueling for the body. The parameter of energy availability is widely recognized as the primary measure utilized in evaluating the nutritional status of athletes (Pereira et al., 2007). Several studies have documented that a significant number of athletes across different sports suffer from energy deficiency, primarily because of inadequate understanding and awareness regarding the significance of nutrients in enhancing sports performance and promoting overall health (De Souza et al., 2019; Melin et al., 2019; Pereira et al., 2007; Taguchi et al., 2020; Thomas et al., 2016). The implementation of nutrition education has been identified as a potential strategy to promote optimal nutritional status and enhance athletic performance (Dewi et al., 2021; Foo et al., 2021; Molina-López et al., 2013). Healthy diet and nutritional awareness are essential components of disease prevention, quality of life, and the well-being of society (Murathan, 2023).

This study found that blood pressure is a crucial determinant of an athlete's success. The role of blood pressure parameters in determining an athlete's success has not been extensively studied. Furthermore, this study has shown that the variety of food types consumed by athletes has an impact on their performance, in addition to their insufficient nutritional and calorie intake. Athletes with a more varied diet have a higher likelihood of achieving success at the international level. Given the need to include a wide variety of foods in athletes' daily diets to improve their nutritional status and maintain optimal energy levels, it is crucial to continuously and regularly provide athletes with nutrition education.

Conclusion

The research revealed that of the variables analyzed in this study, blood pressure was the determining factor for an athlete to achieve at the international level. In addition, food diversity also plays a role in increasing an athlete's chances of achieving higher performance. However, this study is very general in nature because it involves a variety of athletes from different age groups and types of sports. This research can be a reference for

coaches and sports coaching organizations in determining programs and policies to improve athlete performance in the city of Bandung.

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Conflict of Interest

There is no personal or financial conflict of interest within the scope of the study.

Ethics Statement

Ethics Committee approved the study protocol (Ethics committee approval numbered KE/FK/0962/EC/2022.

Author Contributions

Conception and design of the study: SFS; Data Collection: SFS, NAN, MM, NN; Analysis and Interpretation: SFS, NAN; Draft manuscript preparation; SFS, NAN, AP, HJBJM; Final Approval of the version to be published: SFS, NAN, MM, NN, AP, HJBJM; All authors approved the final version of the manuscript.

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RESEARCH ARTICLE

Lifestyle Measurement of Junior Athletes: A Cross-Sectional Study of Food, Cigarette, and Alcohol Consumption in Sumedang, West Java

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Abstract
Sedentary lifestyles, such as consuming foods high in energy, protein, carbohydrates, and fat, sleeping less than 8 hours, smoking and drink an alcohol can approximately double the risk of obesity and hypertension. These factors can affect nutritional status and impact physical fitness and achievement in junior athletes. This study aims to identify the lifestyle and nutritional status of junior athletes aged 11-24 years during the match preparation period. The sample consisted of 110 junior athletes in Sumedang, West Java. This research using a cross-sectional approach. Results showed that the average athlete in Sumedang Regency consumed 2,035 Kcal daily, with male athletes consuming 2,218.8 Kcal and female athletes consuming 1,797.7 Kcal. More than half of the male athletes (64.5%) are smoked but did not consume an alcohol (95.2%). On other hand, most of female athletes neither smoke (85.4%) nor consume an alcohol. The data also shows there is a significant (p-value < 0.05) consumption among male and female athletes on cigarette consumption. Findings indicate that athletes did not meet the nutritional intake adequate even for normal individuals, while athletes require a higher nutritional adequacy due to their intensive training regimens. Athletes in Sumedang Regency are not meeting their nutritional needs and engage in unhealthy behaviors such as smoking and alcohol consumption, which may affect their physical fitness and performance. These lifestyle factors need to be addressed to improve their nutritional status and overall athletic performance.

Keywords
Athletes, Lifestyle, Consumption Patterns, Cigarettes, Alcohol

INTRODUCTION

The President of the Republic of Indonesia (2005) in Law Number 3 of 2005 stated that the scope of sports is divided into three parts: recreational sports, educational sports, and achievement sports. Individuals who have the status of athletes are those who perform sports achievements, either individually or in teams, in sports activities (President of the Republic of Indonesia, 2005). An athlete who desires success, especially a productive athlete at a young age or referred to as a junior athlete, requires a process of practicing and training sports that involves athletes, coaches, and other supporting elements such as the role of government, community participation, management and sports organizations, facilities and infrastructure, and science and technology (Klaperski-van der Wal, 2023).

In addition to these factors, junior athletes also need to pay attention to their lifestyle, including food consumption, smoking and alcohol consumption, sleep duration, and physical activity, which can affect their level of physical fitness and achievement (De Nitto et al., 2020; Daşkesen & Alp, 2024). Exercise itself is an activity carried out by an athlete through various forms of movement,

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directed, repeated, and with increasing intensity to improve competitive ability (Desbrow, 2021).

Unhealthy lifestyles, such as consuming foods high in energy, protein, carbohydrates, and fat, sleeping less than 8 hours, and engaging in sedentary activities for more than 6 hours a day, can double the risk of obesity and hypertension and affect the nutritional status of junior athletes (Oematan & Oematan, 2020; Mokolensang et al., 2016). Nutritional status is an individual's condition resulting from daily nutritional intake, categorized as undernutrition (very thin and thin/underweight), good nutrition (normal), and overnutrition (overweight and obese) (Neglia, 2021). A study suggests that male athletes in Indonesia have normal nutritional status, but female athletes have an obese nutritional status accompanied by excess fat composition compared to recommendations and energy requirements, macronutrients (especially protein and carbohydrate intake), micronutrients, and fluid intake (Penggalih et al., 2018; Tahir et al., 2020; Penggalih & Huriyati, 2007).

The Olympics, held every four years, is a forum for athletes to showcase their best abilities, with more than 12,000 athletes from various countries and sports competing for medals (Gifford, 2012). Before the game, athletes need a match preparation period to enhance their abilities (Desbrow, 2021). Each sport has its own way of training athletes during the match preparation period, tailored to the athlete's age, potential, and training stage (Marques & Chamari, 2023). Competitions are not limited to the Olympics but also include regional events like Regional Sports Week (PORDA), Provincial Sports Week (PORPROV), and National Sports Week (PON). During the preparation period, athletes must maintain a lifestyle that includes managing financial conditions, life scope, food access, food preparation skills, travel, and health conditions.

The importance of maintaining a healthy lifestyle and normal nutritional status for junior athletes during the match preparation period cannot be overstated. Identifying the lifestyle and nutritional status of junior athletes is crucial for maintaining, evaluating, and improving their conditions. This study aims to analyze the lifestyle and nutritional status of junior athletes preparing for the Provincial Sports Week (PORPROV) in Sumedang, West Java.

MATERIALS AND METHODS

This study is a descriptive study using a cross-sectional design that aims to analyze the variables to be identified, including lifestyle and nutritional status of junior athletes in Sumedang, West Java in the preparation period for the Provincial Sports Week.

This research is being carried out in Sumedang, West Java for 8 months, namely March-October 2022 with an ethical permit issued by The Medical and Health Research Ethics Committee (MHREC) Universitas Gadjah Mada number KE/FK/1170/EC/2022. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Participant

The research population were 600 junior athletes in Sumedang, West Java with a minimum sample size of 110 junior athletes to be selected as research samples and the sampling technique used is purposive sampling. The selection of research subjects based on the inclusion criteria in this study were athletes aged 11-24 years at the time of the study which divided into three categorize there are 11-13 years, 14-18 years, and 19-24 years; did not suffer from chronic and congenital diseases; and were willing to be respondents in this study. While the exclusion criteria were junior athletes who did not collect a complete questionnaire

Data Collection Tools

Data collection was carried out in the district sports building in Sumedang, West Java, using the Covid-19 preventive health regulations. Athletes who have gathered at the research location will be asked questions first regarding the fulfillment of the requirements to become respondents, such as age 11-24 years and not having congenital or chronic diseases. If the athlete agrees to be a research respondent, the researcher will provide informed consent to be signed and continued by filling in personal data and questions related to research needs.

The data collection tool in this study used a questionnaire. The questionnaire used in this study consisted of three parts. The first part consists of the characteristics of the respondents (name, date of birth, gender, mobile phone number, occupation

Education and length of service); second, related to lifestyle data referring to the Cigarette and Alcohol Consumption Questionnaire delevoped by Widiansah *et all.*, (2016), the third part presents columns for 24-H Food Recall interviews on training holidays and during training. In the fourth part, the column for filling in the weight measured using a digital scale with a capacity of 150 kg and an accuracy of 0.1 kg will be presented, height using a microtoise with a capacity of 200 cm and an accuracy of 0.1 cm, as well as the percentage of fat and BMI using a digital scale.

Statistical Analysis

Variables that have been selected and stored in the form of a data base program for further analysis using computer software and carried out in several stages, namely univariate and bivariate. Univariate analysis is an analysis that describes the characteristics of each variable. The analysis was carried out by summarizing a data set into the mean, maximum minimum, and standard devicentral tendency (measure of concentration) and then comparing the descriptive results of the data obtained between one group and another according to the objectives to be achieved for the analysis. The form of presentation of univariate analysis can be in the form of graphs or tables. Univariate analysis in this study was used to analyze the dependent variable and the independent variable.

Bivariate analysis in this study was used to analyze each independent variable. The test used in bivariate analysis in this study is ANOVA test or chi-square test if the data was found as a normal data and Kruskall-Wallis test or fisher exact test if the data was found as a non-normal data.

The operational definition in this study consists of research variables, operational definitions, measuring methods, measuring instruments, measuring results, and data scales. The research variables consisted of age, education, occupation, duration of joining, pocket money, food consumption, cigarette consumption and alcohol consumption of athletes obtained by filling out a questionnaire. All variables use a nominal scale, except for the age variable and the allowance variable uses a ratio scale.

Table 1. Distribution of respondents based on the characteristics of the subject and socioeconomic

No	Characteristic	Amounts (n=110)	Percentage (%)
1	Gender		
	Male	62	56.4
	Female	48	43.6
2	Age (n= 110)	16.8 ± 2.6*	
3	Weight	60.8 ± 9.8	
4	Height	167.0 ± 6.1	
5	Allowance (Rp/ day)	22 855 ± 15 479*	
6	Family member	4.3 ± 1.2*	
7	Duration of joining	1.3 ± 0.5*	
8	Education		
	Elementary	6	5.5
	Junior High School	28	25.5
	Senior High School	68	61.8
	Endergraduate Degree	8	7.3
9	Job		
	Student	100	90.9
	Worker	10	9.1

*Description: Score (average±SD)

RESULTS

Respondents were 110 athletes aged 11-24 years domiciled in Sumedang. Table 1 shows the distribution of respondents according to the characteristics and socioeconomic of the respondents. Table 1 shows that more than half of the respondents (56.4%) were male and less than half (43.6%) were female with an average of 1.3 years in a sports club or organization. The average age of the respondents is around 16.8 years with an average number of family members 4 people in 1 house. Database on Badan Pusat Statistik (2019) shows that the average family member in one household in West Java is 3.8 or rounded up to 4 family members. This shows that the number of respondent's family members is the average number of families at the National level. The respondent's pocket money per day is around Rp. 22.855,- with

the number of family members being 4 people in one house. More than half of the respondents (61.8%) are high school students (SMA) and only 9.1% of respondents are working. Residents aged 15 years and over on average have permanent jobs such as laborers or employees (Badan Pusat Statistik 2019)

Univariate Analysis

Univariate analysis was conducted to see the mean and standard deviation of food, cigarette and alcohol consumption as well as the nutritional status of athletes in Sumedang Regency. Table 2 is the distribution of food consumption for all athletes in Sumedang Regency.

Table 2. Distribution of respondents based on food consumption of all athletes

Average Consumption of Nutrients		
No	Nutrition	(x ± Std)
		Athlete
1	Energy (Kkal)	2 035.0 ± 770.5*
2	Protein (g)	60.8 ± 26.9*
3	Fat (g)	59.9 ± 28.7*
4	Carbohydrate (g)	312.8 ± 128.8*
5	Calsium (mg)	552.8 ± 440.5*
6	Phosphorus (mg)	639.4 ± 359.7*
7	Iron (mg)	15.1 ± 12.1*
8	Vitamin A (RE)	798.4 ± 600.5*
9	Vitamin B (mg)	0.7 ± 0.7*
10	Vitamin C (mg)	23.4 ± 51.9*

*Description: Score (average±SD)

Table 2 shows that athletes in Sumedang Regency on average consume food with a calorie count of 2035 Kcal which of course does not meet the calorie adequacy for athletes. The average nutritional content of respondents' food consumption, namely protein, is 60.8 g; fat of 59.9 g; carbohydrates of 312.8 g; calcium by 552.8 mg; phosphorus by 639.4 mg; iron by 15.1 mg; Vitamin A of 798.4 RE; Vitamin B by 0.7 mg; and Vitamin C of 23.4 mg.

Tabel 3. Distribution of respondents based on food consumption of male and female athletes by age

No	**Nutrition**	**11-13 ages**		**14-18 ages**		**19-24 ages**		***P-value***
		Male	**Female**	**Male**	**Female**	**Male**	**Female**	
1.	Energy (Kkal)	2 322.4 ± 505.1	1 639.3 ± 244.8	2 190.7 ± 895.2	1 992.4 ± 697.8	2 269.6 ± 557.7	1 496.6 ± 559.3	0.313[a]
2.	Protein (g)	65.9 ± 22.8	46.9 ± 22.8	63.6 ± 26.3	59.3 ± 26.2	72.2 ± 28.1	48.4 ± 29.0	0.645[a]
3.	Fat (g)	58.0 ± 19.1	60.9 ± 23.0	63.5 ± 34.0	62.1 ± 28.0	59.1 ± 20.7	47.0 ± 22.2	0.479[a]
4.	Carbohydrate (g)	371.3 ± 88.8	243.2 ± 65.1	344.1 ± 147.9	292.9 ± 110.8	352.7 ± 106.0	227.0 ± 92.7	0.319[b]
5.	Calsium (mg)	529.9 ± 348.4	245.8 ± 171.8	658.5 ± 523.4	457.9 ± 287.2	730.9 ± 580.0	380.2 ± 226.6	0.315[a]
6.	Phosphorus (mg)	635.9 ± 349.2	320.0 ± 208.9	636.9 ± 294.9	641.8 ± 368.6	784.6 ± 550.4	614.5 ± 360.5	0.400[a]
7.	Iron (mg)	15.1 ± 6.3	4.5 ± 3.1	16.6 ± 12.0	15.5 ± 15.3	18.8 ± 12.5	10.0 ± 5.0	0.303[a]
8.	Vitamin A (RE)	438.0 ± 449.2	898.5 ± 33.5	802.7 ± 721.8	868.8 ± 465.1	671.3 ± 668.6	868.9 ± 509.8	0.409[a]
9.	Vitamin B (mg)	0.6 ± 0.2	0.4 ± 0.2	0.7 ± 0.5	0.7 ± 0.5	1.4 ± 1.6	0.6 ± 0.2	0.547[a]
10.	Vitamin C (mg)	14.4 ± 15.3	8.5 ± 15.5	21.0 ± 38.6	14.4 ± 21.3	31.5 ± 39.1	46.8 ± 111.2	0.101[a]

*Description: Score (average±SD), [a]Kruskal Wallis test, [b]Anova

Table 3 shows that neither male and female athletes in Sumedang Regency on average consume food with a total calorie of 2218.8 Kcal and 1639.3 does not meet the caloric adequacy for athletes. Most of male athlete nutritional content are twice higher than female nutritional content except Vitamin A's averages among male and female athletes. Female athletes had 898.5 RE of Vitamin A and male athletes has nearly half of female's Vitamin A. The data also describe there are no significant (*P-value* < 0.05) between nutritional content of male and female athletes.

Tabel 4. Distribution of respondents based on cigarette and alcohol consumption

No	Characteristic	Amounts (n=110)		*P-value*
		Male (%)	Female (%)	
1	Cigarette consumption (n= 110)			
	Yes	40 (64.5%)	7 (14.6%)	0.000a
	No	22 (35.5%)	41 (85.4%)	
2	Alcohol consumption (n= 110)			
	Yes	3 (4.8%)	3 (6.3%)	0.532b
	No	59 (95.2%)	45 (93.8%)	
3	Never consume alcohol in past year (n= 110)			
	Yes	2 (3.2%)	1 (2.1%)	0.596b
	No	60 (96.8%)	47 (97.9%)	

*Description: Score (average±SD), a chi-square test, b fisher exact test

Table 4 describe more than half of male athletes (64.5%) are smoked but did not consume an alcohol (95.2%). On other hand, most of female athletes neither smoke (85.4%) nor consume an alcohol. Nearly 100% of male (96.8%) and female (97.9%) athletes did not consume an alcohol in the past year. The data also shows there is a significant (*p-value* < 0.05) consumption among male and female athletes on cigarette consumption, but there are no significant (*p-value* < 0.05) between alcohol consumption and alcohol consumption's time among male and female athletes.

DISCUSSION

The energy adequacy of normal male adolescents is in the range of 2400-2 650 Kcal per day and the energy adequacy of normal female adolescents is in the range of 2050-2 250 Kcal per day, but in athletes, the energy adequacy depends on diet and the type of exercise performed (Hull et al., 2016)). The energy sufficiency of athletes in Sumedang Regency from the results of research that has been carried out does not even meet the adequacy of normal adolescents, while athletes need to fulfill several aspects that will support performance, especially aspects of calorie needs (calorie needs), macro nutrients (macro nutrients), hydration (hydration), timing, and supplementation (Kerksick et al., 2017). In addition, the adequacy of energy, fat, carbohydrates, iron, daily fluid intake, fluid intake before exercise, hydration status and percent body fat are closely related to the level of fitness and performance of an athlete (Condo et al., 2019). Male and female athletes in Sumedang Regency are only able to meet 89% carbohydrate adequacy for normal men and of course cannot meet the carbohydrate needs as athletes which of course have an influence on athletes' energy intake (Gonzalez et al., 2022). Proteins that function to help increase muscle mass in athletes can only achieve normal adequacy in men and only meet 84% of energy adequacy for normal women (Jäger et al., 2017). Other macronutrients such as fat that help increase energy only meet approximately 80% of the fat adequacy for normal adolescents, not athletes (Ministry of Health of the Republic of Indonesia 2019; Almatsier 2011).

On the other hand, lack of carbohydrate, protein, fat and vitamin C intake in female athletes can cause menstrual cycle disorders (Close et al., 2016). In practice, the nutritional management of athletes in Indonesia is not carried out by nutrition professionals but by athletes and their parents who have sufficient nutritional knowledge (Foo et al., 2021). The nutritional status of a good athlete will be influenced by the nutritional knowledge and physical activity of the athlete (Condo et al., 2019). With limitations on various sides, in fact athletes, families and coaches need to master their own

nutritional knowledge and be able to carry out nutritional management without professional assistance and must be able to make special food arrangements in training, games and post-match (Rodriguez et al., 2009)

The results showed that more than half (64.5%) of athletes in Sumedang Regency were smokers. Athletes who do not smoke have better levels of speed, agility, VO2 Max, level of physical fitness and strength when compared to athletes who smoke, so athletes are recommended to reduce or even quit smoking (Chagué et al., 2021). In addition to cigarette consumption, 4.8% of male athletes and 6.3% of female atheletes in Sumedang Regency consume alcohol. Alcohol consumption in athletes is usually influenced by the belief that alcohol can reduce stress as well as the influence or motivation of the surrounding environment such as from parents, peers and seniors at the training ground (Zhou et al., 2015). Athletes should be able to avoid smoking and alcohol consumption and pay attention to food intake and physical activity to maintain body weight and obtain maximum physical fitness so that it can affect the athlete's performance (Osullivan et al., 2022).

Conclusion

The results showed that the average athlete in Sumedang consumed 2035 Kcal. Male athletes consumed 2218.8 Kcal and female athletes consumed 1797.7 Kcal. More than half of the athletes (57.3%) smoked and 5.5% of the respondents smoked. Smoking every day with an average consumption of 38 cigarettes for 30 days. Only about 5.5% of respondents consumed alcohol during their 1.7 years of life with the types of alcohol commonly consumed were wine (33.3%) and ciu (16.7%). The results showed that the respondents had not met the nutritional adequacy intake even for normal individuals, while athletes had special nutritional adequacy that was adapted to the type of sport so that with a high duration of exercise, the nutritional adequacy would be greater than normal individuals. Consumption of cigarettes and alcohol is still a lifestyle among athletes in Sumedang.

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Conflicts of Interest

The authors have no conflicts of interest to declare.

Ethical Statement

This research is being carried out in Sumedang, West Java for 8 months, namely March-October 2022 with an ethical permit issued by The Medical and Health Research Ethics Committee (MHREC) Universitas Gadjah Mada number KE/FK/1170/EC/2022.

Author Contributions

Study Design, MRS; Data Collection, MRS, HMI; Statistical Analysis, MRS, HMI; Data Interpretation, MRS, HMI; Manuscript Preparation, MRS, HMI, AF; Literature Search, MRS, HMI, AF. All the authors agreed on the final draft of the manuscript before submitting it for publication.

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RESEARCH ARTICLE

Impact of Massage Gun on Rating of Perceived Exertion (RPE) in Soccer Players

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Abstract
This study aims to determine the effect of using massage gun media on RPE (Rated Perceived Exertion) in soccer players. The method used is an experimental approach with a one-group pretest-posttest model design. The research instrument used is RPE. The population of this study consisted of 30 athletes from Persib Bandung Academy who were around sixteen years old and attended intensive training four times a week. Using a purposive sampling approach, 18 athletes were selected as research subjects. To determine the RPE scale, subjects underwent high-intensity training using the Yo-Yo Intermittent Recovery Test. After the exercise, a 15-minute massage was performed using a massage gun, and then RPE was measured again. The results of data analysis showed that the massage method using a massage gun had a significant impact on reducing RPE, with a value of p=0.000. This indicates that the use of massage guns can significantly reduce the fatigue level of athletes after intensive training. In conclusion, a massage gun effectively reduces fatigue as measured by RPE. Nevertheless, improving the quality of research is still needed by increasing the number of participants and developing a more structured training program both in time and day.

Keywords
Football athlete, RPE, Massage Gun, Sport Massage

INTRODUCTION

The level of training with increasing intensity can cause physical fatigue and reduce the level of recovery in athletes (Selmi et al., 2022). This has a negative impact on a soccer athlete, because it can reduce the quality of training and competition. According to (Dambroz et al., 2021) physical fatigue felt by soccer players will have a negative impact such as reducing sprint capacity and also reducing technical performance performance such as passing and dribbling. Therefore, rehabilitation or rest is necessary for an athlete to get perfect training results.

An athlete is very susceptible to muscle injury due to high training intensity. According to (Zhao, 2022), muscle injury in an athlete often occurs because the training period is quite consistent and its high intensity makes the muscles work extra. When the muscle works excessively, the sarcomere spasm becomes non-uniform, causing some sarcomeres to be extended beyond the active filament overlap range. This can position certain sarcomeres at a higher risk of structural failure. This means that eccentric contractions in stressed muscles cause more severe tissue damage than in muscles with low tension. This is because high muscle tension increases the risk of injury when the muscle changes in length (Kalkhoven & Watsford, 2020).

A common quantitative indicator of perceived exhaustion during physical activity is the Rating of Perceived Exertion (RPE), which is measured on a scale from 0 to 10 (Ferreira et al., 2023a). According to recent research, RPE remains a critical metric for understanding internal response

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processes, with advancements highlighting its role in various contexts. For instance, the application of differential ratings of perceived exertion (dRPE) has been explored to provide a more sensitive measure of internal training load in team sports, although it may have limitations depending on the exercise or population being studied (Pitt, 2021). Additionally, the relationship between RPE and metabolic as well as hemodynamic responses in high-intensity interval exercise (HIIE) for individuals with type 2 diabetes has been shown to be effective in self-regulation and prescription of exercise (Viana et al., 2019). In addition to its use in quantifying effort and energy expenditure, weariness, and shortness of breath, RPE is highly relevant for health and safety in both work and sport environments. Recent studies have demonstrated that RPE can effectively measure the internal training load and provide insights into fatigue, making it a valuable tool for managing workload and preventing overtraining in athletes (Pind et al., 2021). Moreover, RPE has been shown to correlate with heart rate and oxygen uptake, thereby providing a reliable measure of exercise intensity and helping to ensure safe exercise practices (Losnegard et al., 2021). This is a very basic list of numbers. Participants were asked to rate their exertion during the activity on a scale that took into consideration all physical weariness and symptoms. This number lets the athlete adjust how hard they are working out and allows them to go more quickly or more slowly (Xie et al., 2023a). This scale can be used once or more, requires only a few seconds to complete, and can be self-administered (Vealey et al., 2019). Coaches can now more easily determine whether their athletes are fatigued or still require additional time to recover. Recent studies have highlighted the importance of using subjective and objective measures to monitor athletes' fatigue and recovery status. For instance, the use of perceived exertion scales, heart rate variability, and other biometrics can provide coaches with accurate insights into the athletes' physical condition, helping to optimize training loads and recovery strategies (Kósa et al., 2023).

Recovering means going back to your regular routine and exercising (Daud et al., 2023). Recuperation is necessary for training. Athletes have been presented with a variety of methods and strategies to enhance muscular function following exercise, aside from complete rest along with passive recovery (Turnagöl et al., 2022).

Syarifudin and Roepajadi's (2020) research indicates that local massage therapy applied to the lower extremities can hasten the recovery of leg muscles following exercise. In addition, Ayu et al.'s (2022) study discovered that localized lower extremity massage accelerated the recovery of leg muscles in comparison to passive recovery, which involves simply resting after exercise (Valenzuela et al., 2019). The aforementioned viewpoint states that the quadriceps, hamstrings, gastrocnemius, soleus, and gluteus are among the lower body muscles employed in soccer (Bartolomé et al., 2021). Thus, in order to avoid exhaustion, these muscles need to be strengthened.

The study investigated the utilization of massage bullets as an alternative massage medium to local or manual massage. Massage guns have the ability to enhance muscle flexibility, accelerate the recovery of muscle performance, and alleviate discomfort (Haider et al., 2018). Massage guns also enhance blood circulation, leading to delayed onset muscular soreness or DOMS (Romero-moraleda et al., 2019). Lakhwani & Phansopkar (2022) suggest that employing a massage device post-exercise can enhance the pace of muscular recuperation.

Based on previous research, the author of this study introduces new innovation, one of which is the use of recovery techniques. Passive recovery is achieved through massage using a Massage Gun device. This can serve as one method for muscle fatigue recovery. Gun massage provides significant benefits in reducing pain and speeding up the recovery process (Silva et al., 2023).

Recent studies have shown promising results regarding the contribution of using the Massage Gun tool for recovery from fatigue, as indicated by the Rating of Perceived Exertion (RPE), among football athletes. Research has demonstrated that electric auto-massage therapy can effectively reduce exercise-induced fatigue by enhancing heart rate variability and reducing perceived exertion, making it a valuable tool for post-training recovery (Xie et al., 2023). Additionally, a systematic review found that massage guns can help improve flexibility and reduce muscle stiffness, contributing to faster recovery times (Ferreira et al., 2023b). However, there is no research that examines specifically on soccer players. Based on the description above, the researcher has chosen the title "The Influence of Massage Gun Media on RPE (Rating of Perceived Exertion) in Football Athletes.

MATERIALS AND METHODS

This research was carried out in January 2024. Research ethical approval was obtained from the Ministry of Education and Technology, Universitas Pendidikan Indoensia with project number 1319/UN40.A6/KP/2024. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Design

This study employs a quantitative approach with a descriptive method using the one group pretest-posttest design. The experimental method is chosen to evaluate the treatment due to its effectiveness in assessing changes before and after an intervention within the same group. This design is commonly used in clinical and educational research to measure the impact of interventions on a single group of subjects, thereby providing a controlled environment to observe specific outcomes. According to (Knapp, 2016), the one-group pretest-posttest design, despite its criticisms, remains a widely used method in clinical research for its simplicity and utility in evaluating treatment effects.

Participants

The population of this study consists of 30 athletes from the Persib Academy, all of them are 16 years old.This population was selected due to the intensive and regular training provided, with training sessions conducted four times each week. The sample used consisted of 18 individuals, selected using the purposive sampling technique.

Purposive sampling is a sampling technique that involves selecting certain samples based on predetermined criteria, as defined by Thomas (2021). The reason for using purposive sampling technique is because it allows researchers to intentionally select subjects that best match the objectives of the study, thereby enhancing the rigor and trustworthiness of the data and results, which is particularly useful for studies that do not involve generalization (Campbell et al., 2020). This technique is suitable for quantitative research where specific characteristics of the sample are critical to addressing the research questions effectively (Andrade, 2021).

The following are the inclusion criteria for obtaining samples: Samples are athletes who regularly train for a period of 6 months or more. The sample is in good health with no injury problems in their health history for the last two months, and they have been selected to be part of the core team to participate in the upcoming competition. Further information can be seen in the Table 1.

Table 1. Demographic characteristics of the participants

Demographic		n	%
Gender	Male	18	100
Age	16 Years old	18	100
Height	150-160	3	16.7
	161-170	7	38.9
	171-180	7	38.9
	181-190	1	5.6
Weight	50-60	12	66.7
	61-70	4	22.2
	71-80	2	11.1
BMI (kg/m2)	18.5-24.9	18	100
Injury History in the Last 2 Months	No Injuries	18	100
Training Period	Athletes who have trained for more than 6 months	18	100
Prepared for Upcoming Competition/Tournament		18	100

Exercise Program

The training program will be conducted four times a week, focusing on different aspects of physical fitness. The first session is an interval running workout aimed at improving aerobic and anaerobic capacity, as measured by the Yo-Yo Intermittent Recovery Test, a widely used and valid field test to evaluate aerobic and anaerobic capacity

in sports such as soccer (Zerf et al., 2021). It involves sprinting for 30 to 60 seconds followed by 1 to 2 minutes of light jogging or active rest, repeated multiple times based on the athletes' fitness levels. The second session focuses on endurance training, consisting of continuous running at moderate intensity for 20 minutes to enhance the body's oxygen utilization efficiency and sustain performance over longer periods. The third session is agility training using cones with exercises like zig-zag runs, figure-8 runs, and shuttle runs, aimed at improving agility, coordination, and quick directional changes essential for avoiding opponents and controlling the ball in soccer. The fourth session targets strength development with plyometric and core-strengthening exercises, including box jumps, split squat jumps, and other explosive movements, along with core exercises such as planks, sit-ups, and Russian twists. This comprehensive program provides adequate variety and focuses on different components of physical fitness such as aerobic capacity, endurance, agility, and strength to optimize soccer players' performance. For more details, see Table 2.

Table 2. Training program at each training session

Session	Type Of Training	Description
Session 1	Interval Training	Sprint for 30-60 seconds, followed by 1-2 minutes of light jogging or active rest. Repeat several times based on fitness level.
Session 2	Endurance Training	Continuous running at a moderate intensity for 20 minutes.
Session 3	Agility Training	Agility drills using cones, including zig-zag runs, figure-8 runs, and shuttle runs.
Session 4	Strength Training	Plyometric exercises like box jumps and split squat jumps, along with core exercises such as planks, sit-ups, and Russian twists.

Instrument

The instrument used in this study is Rated Perceived Exertion (RPE) (Zhao et al., 2022). RPE is a subjective scale used to measure the level of fatigue or effort felt over an individual's perception of the intensity of work performed. In determining the RPE scale, researchers use high-intensity exercise activity training using the Yo-Yo Intermittent Test Recovery Test .

The Borg's Rating of Perceived Exertion (RPE) CR-10 scale is a psychophysical rating scale that allows individuals to subjectively rate their perceived physical exertion during exercise (Borg, 1998). It is a valid and reliable tool to quantify exercise intensity based on the physical sensations experienced by the individual during the exercise bout.

The RPE CR-10 scale ranges from 0 to 10, where 0 represents "no exertion at all" and 10 signifies "maximal exertion". Numerical values are complemented with verbal anchors describing the level of effort along the continuum (e.g. 0.5 = "very, very light", 4 = "hard", 7 = "very strong") (Table 3). This dual coding enables individuals to accurately communicate their internal sensations through mapping it onto a standardized scale.

Table 3. RPE (Rated Percived of Exertion)

Score	Level of Exertion
0	No exertion at all
0,5	Very, very light
1	Very light
2	Light
3	Somewhat hard
4	Hard
5	Somewhat strong
6	Strong
7	Very strong
8	Very, very strong
9	Very tough
10	Maximal exertion

(Zhao et al., 2022)

Proper familiarization of the scale anchors and instructions is important prior to its usage. Participants are advised to focus only on sensations arising from the exercising muscles when providing RPE, while disregarding other external factors. RPE can be taken at specific time-points or after completion of exercise sets.

Validity evidence demonstrates strong relationship between RPE and physiological measures like heart rate, blood lactate levels and oxygen consumption. It provides an easily

applicable, inexpensive yet reliable proxy of exercise intensity that can assist exercise prescription and monitoring of training adaptations over time.

Data Collection Technique

The data collection process in this study was organized into three main phases: pre-experiment preparation, intervention implementation, and post-intervention assessment.

The main focus of this study was to evaluate the effect of gun massage therapy on the rating of perceived exertion (RPE) of soccer athletes from Persib Academy. This study used a purposive sampling to select 18 healthy and fit participants. In the pre-experiment preparation stage, the researcher determined the experimental group and ensured all participants fully understood the research procedures and intervention schedule. An initial RPE test was conducted using the Borg CR-10 scale to obtain baseline data for each participant. After that, participants took the Yo-Yo Intermittent Recovery Test, which aimed to measure their physical fitness level before the intervention. The intervention phase involved the application of massage therapy using a massage gun, which focused on the lower extremities for 15 minutes. After the intervention, a subsequent RPE test was conducted to measure changes in perceived fatigue levels, followed by a final Yo-Yo Test to assess changes in physical fitness. The post-intervention assessment phase was dedicated to analyzing the collected data through statistical methods, which allowed for a close examination of the effect of massage therapy on athletes' RPE and physical performance. The findings from this analysis were crucial for drawing conclusions regarding the research hypotheses.

Research Procedure

At the pre-experiment stage, the population and sample assigned to the experimental group are carefully identified. This stage is very important as it is conducted prior to the study and serves as the preparatory phase for the administration of the treatment. During this stage, participants were given an in-depth understanding of the research methodology and the schedule of the treatment.

The research procedure began by conducting a pretest before massage therapy using a massage gun. After that, the Yo-Yo Intermittent Recovery Test was conducted to assess the athletes' physical fitness level. The RPE (Rating of Perceived Exertion) test was also performed as part of the pretest to obtain baseline data.

After the pretest stage was completed, the treatment phase began, where the experimental group underwent a 15-minute massage therapy session focused on the lower extremities using a massage gun. After the treatment, a post-test was conducted by repeating the baseline assessments, namely the Yo-Yo and RPE tests.

The final stage of the research procedure involved thoroughly evaluating the treatment results. This assessment included statistical analysis of the data obtained in the pretest and post-test phases to determine the effectiveness of the massage therapy. This analysis was then used to test the research hypothesis.

Data Analysis

This study utilized descriptive analysis, normality testing, and paired sample t-tests to evaluate the impact of a massage gun intervention on the Rating of Perceived Exertion (RPE) among soccer athletes. Data collection began with a descriptive analysis of RPE data, which was recorded using the Borg scale before (pre-test) and after (post-test) the massage gun intervention. Descriptive statistics, such as the mean and standard deviation, were calculated to provide an overview of athletes' exertion levels at both stages.

The One-Sample Kolmogorov-Smirnov Test was used to determine if the RPE data were normally distributed for normality testing. This test considers the data normally distributed if the Asymp Sig (2-tailed) value exceeds the alpha level of 0.05 (5%). Establishing normality was essential to deciding whether to use parametric or non-parametric statistical methods for further analysis.

Since the data followed a normal distribution, a paired sample t-test was applied to compare the average RPE scores before and after the massage gun intervention. This test was appropriate for evaluating the same group of athletes under different conditions and provided a p-value to indicate the statistical significance of any observed changes.

These steps ensured a robust analysis of the data, allowing researchers to draw meaningful conclusions about the effectiveness of the massage gun in reducing athletes' perceived exertion levels.

RESULTS

The Sig value was determined from the results of the data processing test to determine the effect using a paired sample t-test. The p-value of 0.000, when compared to the alpha value of 0.05, indicates that we reject the null hypothesis (H_0) and accept the alternative hypothesis (H_a). It can be inferred that Massage Gun Media has an impact on the Rating of Perceived Exertion (RPE) in football athletes.

One of the interesting points shown (Figure 1) is that Sample K gets the highest score after treatment which is 9, but in RPE after training he gets a score that is above average as well which is 6. While samples F and G, after training are far below average with a score of 3, but also in RPE after treatment using a massage gun get a low score which is below average which is 6. Sample R gets a balanced score where he gets after treatment and after training is 7. Next, proceed with doing descriptive statistical analyses to determine the mean, minimum, maximum, and standard deviation of the research data. According to the data presented (Table 4), the lowest RPE test score prior to treatment is 3, while the highest score is 8, with a standard deviation of 1.676. After receiving treatment, the RPE test shows a minimum value of 0 and a maximum value of 7, with a standard deviation of 1.756.

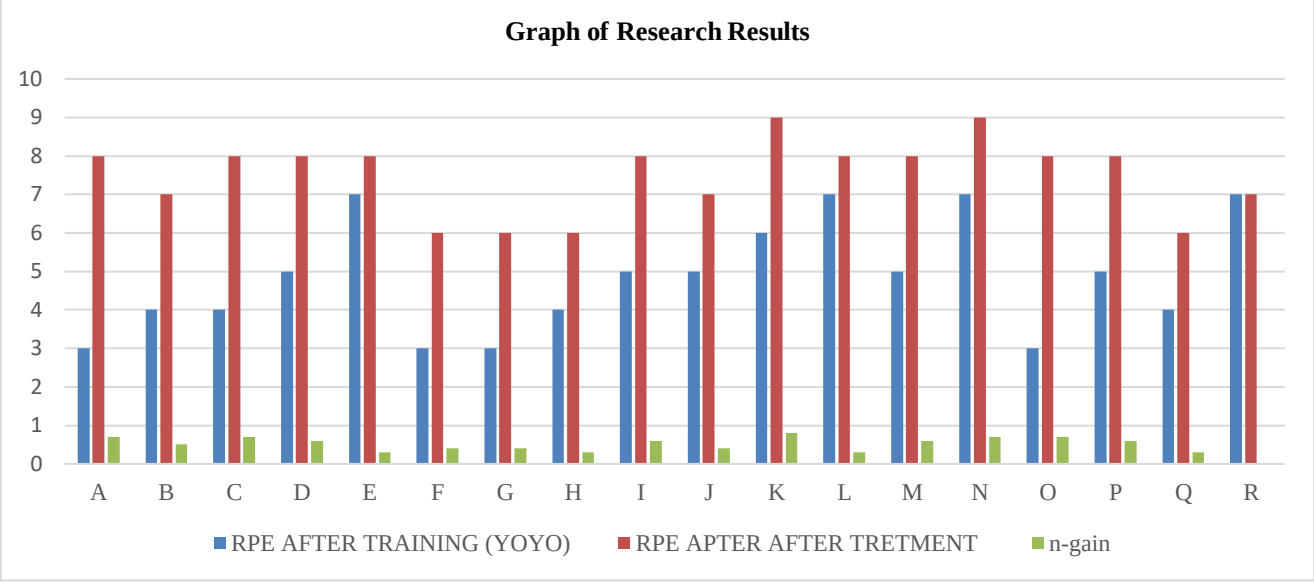

Figure 1. The average difference between the initial test score and the final test RPE (Rated Perceived Exertion)

Tabel 4. Descriptive Statistical Test

	N	Min.	Max.	M	SD
RPE after Yoyo Test	18	3	8	5.11	1.676
RPE after *massage gun*	18	0	7	1.86	1.756
Valid N (listwise)	18				

Std. Deviation (SD), Mean (M), Maximum (Max), Minimum (Min)

The One Sample Kolmogorov-Smirnov Test method was employed to conduct this normalcy test. A test is considered to be normally distributed if the resulting Asmp Sig (2-tailed) value is higher than the alpha value, which is typically set at 0.05 (5%). The results of normalcy testing are displayed (Table 5).

Based on the data in table 5, it can be inferred that the normality test results for the RPE data after the Yoyo Test and RPE after the massage gun were both 0.11. Both variables exceeded the alpha value of 0.05. Both datasets exhibit a normal distribution.

The Sig value was determined from the results of the data processing test to determine the effect using a paired sample t-test. The p-value of 0.000, which is less than the alpha value of 0.05, leads us to reject the null hypothesis (H_0) and accept the alternative hypothesis (H_a). It can be inferred that Massage Gun Media has an impact on the Rating of Perceived Exertion (RPE) in football athletes (Table 6).

Tabel 5. One-Sample Kolmogorov-Smirnov Normality Test

		Unstandardized Residual
N		18
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	1.39779482
Most Extreme Differences	Absolute	.233
	Positive	.229
	Negative	-.233
Test Statistic		.233
Asymp. Sig. (2-tailed)		.011[c]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

Tabel 6. Paired Sample t Test

	Mean	Tcount	Ttable	Sig. (2-tailed)
RPE after YOYO tes - RPE after massage gun	3.25	9.031	2.1098	0.000

DISCUSSION

Fatigue is typically characterized by a decline in muscular function, accompanied by a sensation of weariness throughout the body. Fatigue refers to the diminished ability of muscles to sustain their level of power output (McAllister et al., 2023). Anwar et al., (2023) assert that the accumulation of lactic acid in the tissues leads to weariness. This is because the body is unable to eliminate lactic acid efficiently, which is not proportional to the quick dispersion of lactic acid that is produced as a result of intense physical activity. Fatigue symptoms manifest as diminished work capacity resulting from psychological and physiological factors. These symptoms affect the muscles, leading to muscle contractility impairment, decreased work capacity, and reduced overall physical endurance (Altarriba-Bartes et al., 2021). muscular tiredness hinders muscular performance. Muscle tiredness is present in sports that primarily rely on endurance and high intensity, even if just for a brief duration (Haller et al., 2022).

In measuring the scale of an athlete's fatigue level, recent studies have examined the benefits of massage devices and sports massage. Studies have shown that post-workout muscle massage significantly aids the recovery of muscle strength and endurance compared to passive rest. For example, a systematic review by (Ferreira et al., 2023b) concluded that massage devices are effective in reducing muscle stiffness and improving recovery-related outcomes such as range of motion and strength. However, their effect on performance measures such as power and agility is limited. In this line, Ambarawati et al., (2021) examined the differential Test of Lactic Acid Level Reduction after treatment in between the Two Periods with Paired sample t-test showed p=0.00 ($p<0.05$), which means that the two periods have a significant difference. When viewed from the average difference before and after sports massage treatment was 4.1000 ± .77763 mmol/L, while the difference before and after active resting treatment was 2.8828 ± .53714 mmol/L. It can be concluded that the sport massage treatment is more effective in reducing levels of lactic acid compared to active rest.

Health is the main goal in the medical field. A study by (Wang et al., 2022) explains that the use of a massage gun is also beneficial in accelerating blood flow and providing flexibility to the muscles. The most important effect of high vibration in the use of massage guns is that it can provide both physical and psychological benefits. In the psychological realm, massage guns provide good benefits due to the impact of vibrations that reduce stress levels through the sensation of relaxation (Lurie et al., 2018). Therefore it can be concluded that the use of massage guns has an impact both physically, psychologically, and in relaxing the muscles to be more flexible and also smooth in blood circulation.

Conclusion

Based on the results of the hypothesis test conducted, it can be concluded that the use of Massage Gun has a significant effect in reducing fatigue in soccer players, as indicated by a lower Rating of Perceived Exertion (RPE) value after massage gun treatment. However, the results will be more accurate if the respondents are more participants and the training program is more structured in terms of time and day.

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Conflicts of Interest

The authors declare no conflict of interest.

Ethical Statement

This research was carried out in January 2024. Research ethical approval was obtained from the Ministry of Education and Technology, Universitas Pendidikan Indoensia with project number 1319/UN40.A6/KP/2024.

Author Contributions

All authors RM, DR, K, MM contributed to study design and data collection. Data interpretation was performed by RM and DR. Literature search was conducted by RM. All authors have read and approved the final manuscript.

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RESEARCH ARTICLE

Feasibility Study of Technology Footwork Ability Test on National Disability Badminton Athletes

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Abstract
Technological advances in sports testing and measurement are expanding, but there is a notable gap in research focused on physical conditioning tests for athletes with disabilities. This study aims to evaluate the effectiveness of footwork ability test technology for para badminton athletes. A quantitative descriptive design was employed, involving trials with both the footwork ability test technology and conventional methods. The subjects were National Para Badminton Athletes of Malaysia, selected through purposive sampling for their relevance to the research objectives. The study utilized a footwork ability test device, whose validity and reliability were assessed in comparison to conventional tests. Data were analyzed using percentage calculation techniques to determine effectiveness and error rates. Results indicate that the footwork ability test technology achieved an effectiveness rate of 97.1%, demonstrating superior performance with a lower error rate than conventional tests. This indicates the technology's suitability for athletes with disabilities, including those categorized as lower standing, upper standing, and short stature. The findings suggest significant potential for broader application in various sports disciplines. Future research should explore the technology's adaptability to different sports and environmental conditions, contributing to more inclusive and advanced training methodologies for athletes with disabilities.

Keywords
Athletes, Badminton, Disability, FootWork, Sports Technology

INTRODUCTION

Technological developments today are very complex and permeate all areas of life. In the correct terms, technology refers to all efforts to solve human problems. It means organizing people, events, and machines using knowledge and proven tools, procedures, and techniques (Donthu et al., 2021; Hoehe & Thibaut, 2020; Holland & Bardoel, 2016). The surge of modern technology isn't just for our gadgets and gizmos, it's also revolutionizing the world of sports. Technological advancements are proving to be game-changers in enhancing athletic across the board (Faraidoon Habibi & Mohammad Omid Khairandish, 2023; Haake, 2009).

This exciting link between science and sports achievement, as point out, isn't just for elite athletes (Di Domenico et al., 2019; Stovba et al., 2020; Wilson & Clayton, 2010). Technology is democratizing performance optimization, making it accessible not only to professionals but also to amateur and even disabled athletes (Pramantik & Burhaein, 2019; Rum et al., 2021). The concrete examples of technology have demonstrated significant optimization, particularly in the context of badminton.

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This technology not only aids athletes in refining their techniques but also enables them to surpass previous limitations especially in badminton. Smart sensor systems analyze footwork and swing patterns, empowering athletes to perfect their techniques and push boundaries (Lourenço et al., 2024; Soares, Mollo Tormin, Carvalho, & Alves, 2024). The utilization of visual reaction training systems has also shown positive impacts on the evaluation and monitoring of performance among disabled athletes (Kuo et al., 2022). Biomechanical analyses provide insights into techniques that athletes can utilize for evaluation or feedback for improvement (Purnama & Doewes, 2022). Monitoring vital signs and fatigue levels, optimizing training regimens, and analyzing performance data become more accessible and accurate with this technology (Erick et al., 2024; Rum et al., 2021). With the aid of technology, disabled athletes can reach peak performance and compete at the highest levels, fostering greater inclusion in the sports realm. Thus, technology not only creates wonders in the world of sports but also opens doors for broader advancements, wider inclusivity, and higher performance achievements for all athletes..

Although technology holds immense potential to improve badminton performance for athletes with disabilities, its utilization in this area lags behind (Williyanto et al., 2023). This underutilization is especially evident in the lack of specialized testing and training tools tailored for their needs (Jurczak et al., 2018). Despite this gap, existing research shows that technology can significantly enhance physical and technical aspects in disabled badminton players (Berardi et al., 2021). Therefore, bridging this technology gap through developing and implementing accessible tools and training methods is crucial to unlock the full potential of disabled athletes in the badminton world.

To achieve success, basic badminton techniques are essential for players to master to play well (Rifai et al., 2020). Basic footwork techniques are essential to increasing agility in badminton games (Donie et al., 2023; Malwanage et al., 2022). Footwork techniques are among the most essential skills to master in badminton games (Shedge et al., 2024; Tan et al., 2023). Footwork tests and exercises have many ways and methods, but they are still conventional, and athletes are bored with these methods (Kuo et al., 2022). Therefore, new methods or methods are needed so that athletes have new motivation and enthusiasm for the footwork test, one of which is using technology (Fang & Sun, 2021). Based on FGDs conducted with badminton coaches with disabilities, it turns out that in the footwork test process, they still use the old method, which can be said to be invalid, and there is no parameter technology for measuring practical tests, especially for athletes with disabilities.

The actual footwork test can be varied using technology to maximize the results (Li, 2020). As is the case in badminton, there is already a footwork ability test technology, which is a tool that can facilitate the player's footwork test activities, where initially, it was only manual calculations . However, now this technology can detect footwork movements made by athletes through an embedded camera so they can see the results—score on the footwork test. Several similar studies have been conducted, data was obtained showing an increase in agility caused by the treatment of footwork technology training (Kuo et al., 2020; Yousif & Yeh, 2011). This research shows that technology has a good impact on increasing agility training in badminton athletes. Studies explored the promising potential of electric motor-powered training aids for athletes with disabilities, focusing on boccia players at the Pelatnas training center (Prabowo et al, 2021). The next one is a research from (Fahira et al., 2023), she has implemented a footwork ability test device on athletes with disabilities in Bandung. In his research, Raihan successfully used the test kit, which has been proven effective for mild disabilities at lower standing numbers. While their prototype demonstrated the feasibility of integrating technology into training tools, its heavier weight compared to manual tools presented a limitation that impacted its effectiveness. However, it has not been tested with more severe levels of disability. Therefore, this research aims to conduct a feasibility study of footwork ability test technology in badminton athletes, focusing on its application for disabled Malaysian badminton players. The study will assess the effectiveness of this technology in measuring and analyzing their footwork skills in these specific categories, providing valuable insights for developing tailored training programs and promoting inclusivity in Malaysian badminton.

MATERIALS AND METHODS

Research Design

This study uses a quantitative descriptive research design. Descriptive research aims to describe circumstances, situations, events, and others (Creswell & Creswell, 2018; Jack Fraenkel et al., 2018). Data analysis techniques use percentage calculations.

Participants and Instrument

The participants of this research is the National Para Badminton Athlete of Malaysia. The sampling technique uses a purposive sampling technique in which the researcher determines sampling by establishing unique characteristics of the research objectives. The research subjects were athletes with disabilities in badminton who were proficient and attended training. In this study, the instrument used was footwork ability test technology, a tool to measure agility through testing tools in conducting footwork tests.

Table 1. Gender, Age, Height, Weight & BMI Partcipant

Gender	Age	Height	Weight	BMI
L	26	171	69	23.6
L	24	168	68	24.4
L	25	170	65	22.5

The average age of the participants in the study is 25 years, with a standard deviation of 1 year, indicating that there is little variation in age among the participants. The average height is 169.67 cm, with a standard deviation of 1.53 cm, while the average weight is 67.33 kg, with a standard deviation of 2.08 kg. The average Body Mass Index (BMI) of the participants is 23.5, with a standard deviation of 0.95. These data suggest that the participants have relatively homogeneous physical characteristics, which is important for ensuring the consistency of the research findings.

Research is carried out strictly, then Security and welfare. Participants are given priority during study design and implementation and Steps are taken to ensure data confidentiality. Permission to conduct research was obtained from Kementrian Pendidikan, Kebudayaan, Riset dan Teknologi Universitas Pendidikan Indonesia, numbered 1214/UN40.A6/KP/2024. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Figure 1. Footwork ability test

The picture above shows that the sample performs a footwork test using technology and a manual. The test was carried out in 2 meetings for 60 seconds with two trials, then the amount of footwork contained in the score was recorded according to the results.

Procedure

This research was conducted by applying manual tests and tests with footwork ability test technology devices. The results of the data from calculating the total score of the footwork test are calculated through data analysis of calculating the percentage error value in technology, with the following calculation formula:

Error Percentage Formula:

$$x = \frac{The\ difference\ in\ scores\ with\ and\ without\ test\ equipment}{Score\ count\ without\ tools}\ x\ 100\%$$

Data Collection Procedure

Footwork Test Execution

Participants perform the footwork test, with each participant completing two trials.

Manual Scoring

Examiners manually calculate the footwork test results for each participant.

Data Collection and Preparation

Collect the test results from both the technological device and the manual scoring by the examiners. Prepare the data for analysis to compare the effectiveness and feasibility of the test methods.

RESULTS

The results obtained from the technology trial on three samples of Malaysian National Badminton athletes with disabilities were by doing a footwork test at 2 points, namely the right and left sides. The test was conducted for 60 seconds with two trials using a footwork ability test and a manual test. In

this footwork test tool, the score will appear in the main box with left-right sensor detection, counting the number of steps during the test. The test results can be seen in the Table 1.

Table 2. Footwork Test Data for National Para Badminton Athlete of Malaysia

No	Name	Digital Score	Manual Score	Difference
1	Amyrul Yazid	31	29	2
2	M. Farecz	33	31	2
3	M. Ikhwan	21	18	3
Total Score		85	78	7

The data above is the score acquisition data from the players sampled in the test kit experiment, which is then calculated using the error percentage formula to get the average error data. The data is calculated using the following formula:

$$Percentage\ of\ Errors\ (x) = \frac{7}{78} x\ 100\%$$

= 8.9 %

$$Average\ Percentage\ of\ Error = \frac{8.9\ \%}{3}$$

= 2.9 %

Based on the above calculations, it can be seen that the average error result is obtained for the footwork test with a total error percentage of 8.9% with three athletes as subjects, so the average tool error in the footwork test is 2.9%. The results of the footwork test have an average error because the sensitivity of the tool sensor influences it. When an athlete performs footwork in the wrong direction, the sensor will detect the wrong movement. So it will add numbers to the movement to become a double movement. From the error presentation of the tool that has been tested, the effectiveness of the subject is 97.1%, as illustrated as described in the figure 2. below:

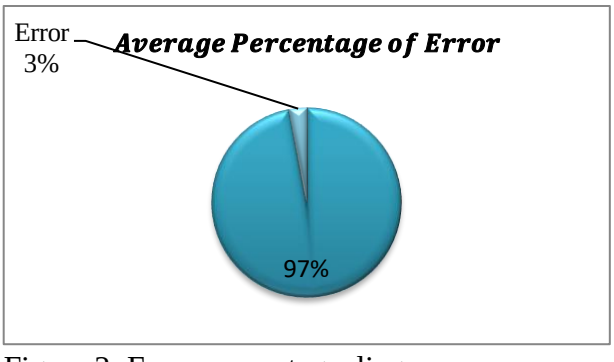

Figure 2. Error percentage diagram

As shown in Figure 2, it can be seen that the percentage of error for the footwork ability test that is applied to athletes with elite disabilities reaches 3%, so this value is included in the category that can be tolerated and effectively used in athletes with disabilities in badminton. The results showed that the technological device had a high level of accuracy, with an effectiveness rate of 97.1%. This finding provides valuable insights for developing tailored training programs and promoting inclusivity in Malaysian badminton by demonstrating the reliability of using technology to measure athletic performance.

DISCUSSION

The results from our footwork ability test technology trial indicate a generally effective measurement tool for athletes with disabilities in badminton. The average error rate observed was 2.9%, which reflects a minor discrepancy between the digital scores provided by the technology and the manual scores recorded. This small percentage of error is primarily attributed to the limitations of the sensor in detecting certain footwork movements accurately. When athletes performed movements that did not align perfectly with the sensor's detection points, the device occasionally misinterpreted these as excessive steps, leading to slight inaccuracies in the recorded scores. Despite these challenges, the overall performance of the footwork ability test technology remains promising, with a high effectiveness rate of 97.1%. The observed discrepancies highlight an important consideration in the use of such technology: the sensor's ability to accurately detect and record footwork movements can be influenced by the athlete's movement patterns. The technology's detection algorithm may not fully accommodate the variability in footwork, especially if the movements deviate significantly from the expected patterns. This limitation is a crucial point for further refinement of the technology to enhance its accuracy and reliability.

Beyond just footwork assessment, it is envisioned that the findings of this research can transcend specific techniques and contribute to wider advancements in badminton and athletic training as a whole. As we know, footwork is a crucial aspect of badminton that can be trained under actual match conditions; this is in line with the opinion by Ngadiman et al., (2020), he states that footwork is a technique that a reliable badminton player must master. By shedding light

on the effectiveness of footwork ability test technology, we aspire to ignite a spark of innovation across various sporting disciplines (Simbolon et al., 2023). Similar to how technology revolutionizes education by facilitating easier learning and driving progress (Mormina, 2019; Rongping & Wan, 2008), we hope this research paves the way for novel training methodologies and technological advancements in sports. Imagine a future where athletes have access to a diverse array of data-driven insights, empowering them to optimize their performance and push the boundaries of human potential. Through rigorous research and the responsible integration of technology, we can unlock a new era of sporting excellence, fostering not only a deeper understanding of athletic movement but also inspiring the next generation of sports tech innovations.

While research demonstrates the immense potential of footwork ability test technology in badminton, several factors require further consideration for broader application. One key limitation relates to the current environmental constraints. As noted by (Seçkin et al., 2023), these tools are primarily designed for indoor settings like sports halls. Their use in outdoor spaces faces challenges, particularly during rainy weather. Moisture can damage sensitive electronic components, and rain droplets can interfere with the accuracy of light sensor readings, impacting data collection and analysis (van der Kruk & Reijne, 2018). Addressing these limitations necessitates further research and development. Optimizing sensor technology for weatherproof functionality would be crucial, as highlighted by previous research, in their study on outdoor training tools (Zhang et al., 2022). Alternative sensor types less susceptible to environmental factors could also be explored. Additionally, designing durable equipment casings capable of withstanding moisture and outdoor conditions is essential for ensuring tool longevity and reliability. Overcoming these challenges would unlock the potential for wider access to footwork ability test technology. Athletes training outdoors or in regions with unpredictable weather patterns could benefit from objective performance assessments and data-driven training guidance. Ultimately, by fostering further research and development aimed at environmental adaptability, we can pave the way for a future where footwork ability test technology empowers badminton athletes regardless of location or weather conditions.

In summary, this research underscores the potential of integrating technology into athletic training and highlights the need for ongoing refinement to address environmental and practical challenges. By advancing these technologies, we can enhance performance assessments and support athletes in achieving their full potential, paving the way for innovative training methodologies and fostering advancements across various sports disciplines.

Conclusion

Our research demonstrates the significant potential of footwork ability test technology for national badminton athletes with disabilities. The technology achieved an effectiveness rate of 97.1%, illustrating its capability to accurately measure and enhance footwork skills. This innovative tool caters to various athlete classifications, including standing lower, upper standing, and short stature, making it a versatile solution for diverse needs. The results suggest that this technology can be instrumental in helping both novice and experienced players refine their footwork, thus supporting their journey towards peak athletic performance.

Implication

The successful integration of footwork ability test technology into badminton training programs highlights its potential to transform how athletes with disabilities are coached. By providing accurate, data-driven feedback, this technology enables personalized training that addresses individual needs and improves overall performance. Its inclusivity ensures that athletes across different classifications have equal access to advanced training methods, fostering a more equitable environment in the sport. This could lead to a broader adoption of such technologies in other sports and training contexts, promoting widespread advancements in athletic training.

Limitation

Despite the promising results, the study has some limitations. The footwork ability test technology's accuracy may be affected by specific movement patterns that deviate significantly from the expected sensor points, potentially leading to minor inaccuracies. Additionally, the current design of the technology is optimized for indoor use, and its effectiveness in outdoor settings is limited. Environmental factors, such as moisture and rain, can impact the reliability of the sensors and the

overall data accuracy. These limitations highlight the need for further refinement of the technology to enhance its robustness and adaptability.

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Conflict of Interest

The authors declare that there are no conflicts of interest related to this research. The study was conducted independently, and no financial or personal relationships influenced the design, execution, or reporting of the research. The footwork ability test technology used in this study was provided by Universitas Pendidikan Indonesia, but this did not affect the objectivity or integrity of the research findings. All authors have disclosed any potential conflicts of interest, and the study adheres to ethical standards for research and publication.

Ethical Statement

This research was carried out in January 2024. Research ethical approval was obtained from the Kementrian Pendidikan, Kebudayaan, Riset dan Teknologi Universitas Pendidikan Indonesia, numbered 1214/UN40.A6/KP/2024.

Author Contributions

Study Design, MF, RHA, STP, HA,MAR, H; Data Collection, MF, STP, MZ, AS, HA, MAR, H; Statistical Analysis, MF, AS, H; Data Interpretation, MF, AS, H; Manuscript Preparation, MF, RHA, MZ; Literature Search, MF, RHA, MZ. All the authors agreed on the final draft of the manuscript before submitting it for publication.

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RESEARCH ARTICLE

Can Static Bicycle Interval Training and Calorie Restriction Affect Lipid Profile in Patients with Dyslipidemia?

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Abstract
The purpose of this study was to determine the difference in effect between static bicycle interval training and calorie restriction diet with static bicycle interval training without diet. Static bike interval training is the independent variable, diet is the moderator variable, and lipid profile is the dependent variable. The research method applied in this study is a true experiment with a pretest-posttest research design with a control group design. Participants in this study were determined by non-probability techniques with purposive sampling, namely dyslipidemia patients consisting of 30 people divided into two groups. The first group received static bicycle interval training treatment and a calorie restriction diet called the experimental group, while the second group only received static bicycle interval training treatment called the control group. instruments in this study through laboratory tests to measure HDL, LDL, Triglyceride, and Total Cholesterol levels. The data analysis technique used the Independent Sample Test. The findings in the study were that static bicycle interval training and calorie restriction diet had a more significant effect in optimizing LDL, Triglyceride, and Total Cholesterol levels sig value (2-tailed) 0.025 <0.05). There was no significant difference between the experimental group and the control group on HDL levels (2-tailed) value of 0.127 > 0.05).There is a significant difference in LDL levels between the experimental and control groups, as indicated by the sig (2-tailed) value of 0.00 < 0.05). In conclusion; static bike interval training accompanied by a calorie restriction diet is recommended to be applied by people with dyslipidemia in optimizing lipid profiles.

Keywords
Exercise, Static Bike İnterval, Calorie Restriction Diet, Lipid Profile, Dyslipidemia

INTRODUCTION

Dyslipidemia is a disorder of lipid metabolism characterized by abnormal levels of fat in the blood (Sharma et al., 2016). This condition includes elevated total cholesterol, triglycerides, LDL (low-density lipoprotein), and decreased HDL (high-density lipoprotein) levels (Maki et al., 2010). Dyslipidemia can increase the risk of cardiovascular disease (Haile & Timerga, 2020; Yao et al., 2022) and has been described as the most common cause of death worldwide (Kendir et al., 2018; Matsushita et al., 2023; Mc Namara et al., 2019; Naser & Al-Shehri, 2023; Sayols-Baixeras et al., 2014). The increasing incidence of dyslipidemia in various countries creates urgency due to its significant impact on health. Therefore, it is important to identify and control the risk factors for dyslipidemia as an effective measure in controlling

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the likelihood of cardiovascular diseases that can increase the risk of mortality.

Previous studies have highlighted several approaches to addressing dyslipidemia. Some of these involve lifestyle modifications (Riccardi et al., 2016), such as healthier dietary changes (Jacobson, Ito, et al., 2015; Jacobson, Maki, et al., 2015) and increased physical activity (Costa et al., 2018; Reljic et al., 2020; Zheng et al., 2016). Awareness-raising programs through health promotion on the importance of a healthy diet and its impact on lipid levels have also been shown to be effective in reducing the risk of dyslipidemia (De Assunção Bezerra et al., 2018; Zhang et al., 2017). In addition, the use of medications, such as statins (Okopień et al., 2017; Ross, 2016; Tarantino et al., 2017), has become standard in the treatment of dyslipidemia to lower LDL cholesterol and the risk of cardiovascular disease.

In recent years, unhealthy lifestyle trends, including unbalanced diets and lack of physical activity, have led to an increase in the number of people with dyslipidemia (Gupta et al., 2016; Hu et al., 2022; Lim, 2018). Although pharmacological treatments are available to address dyslipidemia, physical exercise has been recognized as one of the effective strategies for reducing blood lipid levels and improving cardiovascular health (Baireddy et al., 2018; Boidin et al., 2015; Vasconcellos et al., 2015). By exercising regularly, one can reduce abnormal levels of fats or lipids in the blood, such as total cholesterol, triglycerides, and LDL.

Physical exercise is an important part of the approach to preventing and controlling dyslipidemia and can help reduce the risk of cardiovascular disease (Anderson et al., 2013). Based on its characteristics, physical exercise is divided into two, namely aerobic exercise and anaerobic exercise (Nugraha et al., 2021). Both types of exercise have been applied to optimize lipid profiles (Wulf & Lewthwaite, 2016). Anaerobic exercise such as weight training can increase blood fat metabolism, optimize HDL levels, and effectively reduce body fat (Castro-Vázquez, 2020; Ho et al., 2022). Meanwhile, aerobic exercise, such as brisk walking, running, cycling or swimming, has been proven to improve heart and lung function (Abdelbasset et al., 2018; Ahmed et al., 2022; Sarmento et al., 2017), and reduce triglyceride levels and LDL levels (Ouerghi et al., 2014). Additionally, interval training, which involves high-intensity sequences and short rest periods, has also been shown to be effective in rapidly optimizing blood lipid profiles (Frimpong et al., 2019 ; Racil et al., 2013 ; Rey et al., 2018). Stationary bicycle interval training involves a series of moderate to high intensities interspersed with periods of light recovery, thus before carrying out the prerequisite exercises/exercises that are intended so that later during the interval training process the person's physical condition is already good (Apró et al., 2015; Tsitkanou et al., 2015; Tsitkanou et al. al., 2017). This concept aims to increase endurance, strength and efficiency in cycling (Grace et al., 2018). Apart from physical exercise, a healthy and balanced diet is an important factor in managing lipids in the body and cardiovascular health (Ignarro et al., 2007). A proper diet can help reduce blood fat levels, improve lipid profiles, and maintain a healthy body weight (Gusnedi et al., 2022; Thomas et al., 2023). But until now, no one has applied static bicycle interval training accompanied by a calorie-restriction diet to treat dyslipidemia. This study aims to compare the effect of static bicycle interval training accompanied by a calorie restriction diet with static bicycle interval training without diet on lipid profiles.

MATERIALS AND METHODS

This research, conducted from March to April 2022, adhered to the ethical principles outlined in the Declaration of Helsinki. Ethical approval was granted by the Health Research Ethics Commission of the Faculty of Health Sciences at General Soedirman University, under project number 676/EC/KEPK/II/2022. Prior to participation, all participants were thoroughly informed about the study's details, including potential risks and benefits, and provided their consent by completing a consent form.

Research Design

The research method chosen is included in quantitative research because, in the process, there is a systematic investigation of a phenomenon by collecting data measured using statistical, mathematical, or computational techniques (Freeman et al., 2017). The type of quantitative research applied in this study is experimental research, which aims to examine the effect of a particular treatment on the symptoms of a particular group compared to other groups using different

treatments. The research design used is a pretest-posttest control group design, as found in Table 1.

Table 1. Research design pretest-posttest control group design

Group	Pretest	Treatment	Posttest
Experimental Group	O1	X	O2
Control Group	O3	Y	O4
Information: O1 and O3: Pretest (lipid profile lab test) O2 and O4: Posttest (lipid profile lab test) X: Static Bike interval training and Calorie Restriction Diet Y: Static Bike interval training			

Participants

Participants in this study were male students aged 18 to 21 years who had a total cholesterol level of more than 200 mg/dl, were overweight or obese with a body mass index of more than 27 kg/m2, a fat percentage of more than 25. %, waist circumference more than 85 cm, and have a stable weight for the last 6 months. All participants fill out the questionnaire voluntarily and are screened first using a predetermined flow through a questionnaire distributed via Google Forms. Of the 45 people who filled in, 15 people did not meet the predetermined criteria, leaving 30 people who met the research criteria. Next, random sampling was carried out on 30 participants who were divided into two groups, namely 15 people each in experimental group one who received static bicycle interval training treatment accompanied by a calorie restricted diet and 15 other people in the control group or experimental group two. received stationary bike interval training treatment. The demographic characteristics of the participants in this study can be seen in Table 2.

Table 2. Demographic characteristics

Characteristics	Mean ± SD
Gender	Male (100%)
Age	19,3±1,4
Weight	82,3±8,4
Height	172,5±7,4
BMI	29,3±2,1
Fat Percentage	28,9±3,3
Waist Size	89±3

Treatments

Treatments were given for eight weeks (Teong et al., 2021) at the time after the pretest and before the posttest; the treatments given in this study were divided into two groups: experimental group one received static bicycle interval training and calorie restriction diet, while experimental group two received static bicycle interval training. Static bike interval training was carried out three times a week, with the duration of training in the first week to the second week for 30 minutes, in the third week to the sixth week for 45 minutes, and in the seventh week to the eighth week for 60 minutes. While the calorie restriction treatment participants are limited to their calorie intake by reducing 500 - 700 calories after calculating the Basal Metabolic Rate (BMR) using the harris-benedict formula (Luy & Dampil, 2018), namely:

BMR = 66.5 + (13.75 * body weight (kg) + (5.003 * height (cm) - (6.75 * age)

Furthermore, to determine the number of daily calories when not training is (BMR x 1.2) - (500 to 700 calories), while the number of calories on training days is (BMR x 1.55) - (500 to 700 calories). In addition to the limited number of calories, participants must fulfill macronutrient intake consisting of 40% carbohydrates, 35% protein, and 25% fat, which is monitored through the fat secret application.

Instrument

The instrument used in this study was a blood sampling laboratory test to check the levels of HDL, LDL, Triglycerides, and total Cholesterol conducted by experts at UPTD Laboratorium Kesehatan Kota Bandung. The laboratory test procedure in taking participants' blood to check the levels of HDL, LDL, triglycerides, total cholesterol, and blood sugar:

The medical personnel in charge of taking blood will perform the following steps:

Wrapping an elastic band around the upper arm to stop the blood flow. This makes the blood vessels under the ties dilate, making it easier to

inject the needle into the vessels. Cleaning the body part that will receive the injection with alcohol. Injecting the needle into the vein with a blood draw of 2.7 ml. Blood that has been drawn on the syringe is put into a 5 ml pipette. Removing the ties from your arm when the blood draw feels like enough. Putting gauze or cotton on the injection site, after the medical professional has finished giving the injection. Apply pressure to the area and then apply a bandage.

Results of laboratory measurements of HDL, LDL, Triglyceride, and Total Cholesterol levels can be obtained approximately one day after blood sampling is done.

Statistical Analysis

Data analysis was carried out using IBM SPSS version 25.0. Results are presented as mean ± standard deviation (SD). Independent t-test was used to analyze the mean differences between the two groups. The level of statistical significance was set at $p < 0.05$.

RESULTS

Lipid profile data was obtained from the pretest and posttest laboratory test results, and then the gain score was calculated, as shown in Table 3. To compare the effect of static bicycle interval training accompanied by a calorie restriction diet with static bicycle interval training alone on lipid profiles, first the normality test and homogeneity test were carried out. The results of the calculation of the normality test of the lipid profile of the experimental group 1 and experiment 2 using SPSS were declared normal, then the homogeneity test was declared homogeneous, so to find out the average comparison of the two unpaired groups can use the independent samples test calculation.

Table 3. Average gain score of lipid profile

Lipid Profile Mean	Mean ± SD Experiment	Mean ± SD Control
HDL	3,07±2,1	2,6±1,8
LDL	16,13±3,3	12,87±3,1
Trigliserida	11,60±3,2	10,80±2,9
Total Cholesterol	13,93±2,8	11,67±2,9

Table 4. Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
HDL	Equal variances assumed	1.525	.227	1.571	28	.127
	Equal variances not assumed			1.571	24.210	.129
LDL	Equal variances assumed	.010	.921	10.217	28	.000
	Equal variances not assumed			10.217	27.759	.000
Trigliserida	Equal variances assumed	6.469	.017	2.366	28	.025
	Equal variances not assumed			2.366	22.993	.027
CT	Equal variances assumed	2.442	.129	4.829	28	.000
	Equal variances not assumed			4.829	26.124	.000

The results of calculating the average comparison of lipid profile score gains using the independent samples test statistical test are presented in Table 4. Independent samples test showed no significant difference in HDL levels between the experimental and control groups with a sig (2-tailed) value of $0.127 > 0.05$. When viewed from the average gain score in Table 3, the average HDL in the experimental group increased by 3.07, greater than the control group average of 2.6. There is a significant difference in LDL levels between the experimental and control groups, as indicated by the sig (2-tailed) value of $0.00 < 0.05$. The average gain score in Table 3 shows that the experimental group

is more optimal at 16.13 than the control group at 12.87. There is a significant difference in triglyceride levels between the experimental group and the control group, as indicated by the sig value (2-tailed) 0.025 <0.05. The average gain score in Table 3 shows that the experimental group is more optimal at 11.6 compared to the control group at 10.8. There is a significant difference in total cholesterol levels between the experimental group and the control group, as indicated by the sig value (2-tailed) 0.00 <0.05. The average gain score in the experimental group is more optimal at 13.93, greater than the control group of 11.67.

DISCUSSION

This study aims to explore and compare the effects of two interventions, namely stationary bicycle interval training with a calorie-restricted diet and stationary bicycle interval training without diet on lipid profiles in individuals with dyslipidemia. The main finding of this study is that there is a significant difference between static bike interval training accompanied by a calorie restriction diet and static bike interval training without a diet on changes in LDL, Triglyceride, and total cholesterol levels of static bike interval training accompanied by a diet, but there is no significant difference in HDL levels. The average gain score showed that the experimental group was more able to optimize HDL, LDL, Triglyceride, and Total Cholesterol levels compared to the control group. The findings in this study are in line with research conducted previously by Rumapea and Theodora in 2017, which states that aerobic interval training, including static bikes is a physical activity that if done regularly and according to the capacity of each individual, will be beneficial in regulating blood lipid profiles, one example of which can reduce total cholesterol levels (Hengkengbala et al., 2013; Maryusman et al., 2020; Rachman et al., 2023; Utomo et al., 2012; Wahyuningsih et al., 2018). Similarly, research conducted by (Putri & Herawati, 2018) proves that aerobic exercise effectively reduces cholesterol, LDL, and triglyceride levels while increasing HDL levels in people with hypertension.

Then there are also studies that examine the effect of exercise or physical activity combined with diet on lipid profiles, including research conducted by (Hutchison et al., 2019), which shows the results that diet and exercise interventions for 8 weeks reduce body mass index and lipid profiles. Supported by research conducted by (Maryusman et al., 2020) shows that the combination of diet and aerobic exercise can reduce total cholesterol, LDL cholesterol, and triglyceride levels and increase HDL cholesterol. This study also mentioned that the group given treatment, namely diet and exercise, had a decrease in cholesterol levels compared to the control group. Similarly, research conducted by (Khalafi et al., 2023) examines which is more efficient: diet alone, physical activity/exercise alone, or a combination of the two. The results show that diet and exercise are significantly more efficient in regulating lipid profiles and reducing body fat levels in overweight and obese patients.

Conclusion

The conclusion of this study is that the combination of static bike interval training and calorie restriction diet has a more significant effect in optimizing LDL, Triglyceride, and Total Cholesterol levels. The combination is considered more significant and efficient than if it is not combined. Then, the combination of static bicycle interval training along with a calorie restriction diet is recommended for dyslipidemia patients to optimize lipid profiles. So the results of this research can contribute to being used as a reference for people with obesity and dyslipidemia.

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Conflicts of Interest

The authors have no conflicts of interest to declare.

Ethical Statement

Research ethical approval was obtained from the Health Research Ethics Commission, Faculty of Health Sciences, Jendral Soedirman University with project number 676/EC/KEPK/II/2022. All participants provided their opinions in writing and informed consent.

Author Contributions

Study Design, RN, RDS, S, MNBN, RH, NDD; Data Collection, RN, S, EE, R, MNBN, RH, NDD, AF. MSFNP, NNFK; Statistical Analysis, RN, R, AF, MSFNP, NNFK Data Interpretation, RN, R, AF, MSFNP, NNFK; Manuscript Preparation, RN, RDS, EE; Literature Search, RN, RDS, EE. All the authors agreed on the final draft of the manuscript before submitting it for publication.

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RESEARCH ARTICLE

Validating The Self-Talk Questionnaire of Athletes and How it Affects Athletes' Mental Toughness?

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Abstract
This research could have significant implications for improving mental conditioning practices in sports. By establishing the validity of this questionnaire, researchers and coaches can better understand the relationship between self-talk and mental toughness, leading to more effective interventions and training programs that enhance athletes' resilience and competitive edge. This study aimed to validate its psychometric properties to detect the self-talk of athletes and how it affects their mental toughness. The participants were 93 Athlete in martial arts and game sports (83 Male and 10 Female with Age; M=24.35, SD=7.338) in Bekasi, Indonesian athletes. Data were collected randomly in an online form. Rasch analysis was utilized to evaluate the validity and reliability of the self-talk questionnaire in the Indonesian version with 5 Likert scales, and linear regression was used for hypothesis analysis. The results showed that the self-talk questionnaire in the Indonesian version achieved validity and reliability criteria based on Rasch parameters with five rating scales. The questionnaire data revealed strong positive connections between self-talk and mental toughness. Challenge had the largest effect on negative self-talk, while control had the largest effect on positive self-talk. In conclusion, self-talk has a significant impact on athletes' mental toughness.

Keywords
Self-Talk, Mental Toughness, Athlete, Sport Psychometric

INTRODUCTION

The four training factors that need to be prepared for every sports training program are physical, technical, tactical, and mental (Tudor et al., 2015). In the competition phase, mental factors significantly affect athlete performance (Raglin, 2001). Self-talk is an applicable mental training method (Crust and Azadi, 2010; Kahrović et al., 2014). Internal dialogue, internal monologues, verbal exercises, and all-encompassing self-statements, focusing on oneself automatically and intentionally through thoughts, characterize self-talk (Mohiyeddini et al., 2011), leading athletes to achieve their goals (Hatzigeorgiadis, 2008). In sports, self-talk has been characterized as

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multidimensional verbalizations directed at oneself that provide content information and have at least two functions: instructive and motivating (Hardy et al. 2001; Tangkudung 2018).

Self-talk has been identified as an important psychological approach employed by psychologically tough athletes (Crust and Azadi, 2010). Self-talk can be closed so that it is not heard by others or open, which can be heard by others and addressed by oneself. Self-talk comprises both positive and negative statements. Both have different effects on athlete performance. Some results have shown that self-talk affects other psychological factors, one of which is mental toughness. Mental toughness is a multidimensional concept consisting of cognitive (e.g., attention), emotional (e.g., emotional intelligence), and behavioral (e.g., consistent performance) components. Owing to its apparent importance in athletes' performance in sports, mental toughness has recently become a psychological phenomenon of great interest. Given its recent definition, there is limited literature on mental toughness. Nonetheless, the need for more mentally tough athletes necessitates further study of particular psychological tactics (Georgiadis et al., 2024) that aid in the development of mental toughness in sports. Validating the self-talk questionnaire for athletes is an urgent research priority because self-talk is a critical psychological tool that influences mental toughness, a key factor in athletic performance. Accurate and reliable measurement of self-talk can provide valuable insights into how athletes regulate their thoughts, manage stress, and maintain focus under pressure. By establishing the validity of this questionnaire, researchers and coaches can better understand the relationship between self-talk and mental toughness, leading to more effective interventions and training programs that enhance athletes' resilience and competitive edge.

The present investigation focused on analyzing the self-talk and mental toughness levels of athletes following a coach-led mental toughness intervention. It was anticipated that the intervention would enhance athletes' use of self-talk and mental toughness levels and that there would be a significant correlation between the two. We hypothesized that a customized strategic self-talk approach would prove beneficial for mental toughness.

MATERIALS AND METHODS

Research Questions

This study aimed to evaluate the psychometric properties of self-talk questionnaires and the mental toughness of athletes. The data were analyzed using the Rasch measurement method with the software WINSTEPS 5.2.5.1 software (Linacre, 2022). The following research questions were formulated to guide the research objectives of this study:

1. What is the extent of the reliability and validity of the self-talk questionnaire?
2. How does self-talk affect athletes' mental toughness?

Participants and Procedures

A quantitative method with a Rasch analysis design was utilized in this study, with two-step data collection procedures on 93 Athlete athletes in martial arts and game sports (83 Male and 10 Female with Age; M=24.35, SD=7.338) Bekasi, Indonesian athletes were participated randomly in filling the self-talk questionnaire . The original sentence is rephrased below to improve language quality and clarity while maintaining the same meaning. The questionnaire, administered online, employed a rating scale with five categories ranging from 1 (never) to 5 (always) and targeted athletes in Bekasi, West Java, Indonesia.

Ethical clearance No. E.1.078/UNISMA. LPPM/E/V/2024 for this research was obtained from the LPPM Universitas Islam 45 Bekasi, Indonesia. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Instruments

A background questionnaire was used to collect participant information, such as gender and age. The dimension self-talk questionnaire was used refers to Automatic Self-Talk Questionnaire for Sports (ASTQS) (Zourbanos et al., 2009) consists of 20 items and The mental toughness questionnaire consists of 27 items with 5 Likert scales from 1 (never) and 5 (always) (Haqiyah et al., 2023; Wolter et al., 2022). All instruments were translated into the Indonesian version to address language barriers, clear the ambiguity of meaning,

provide language access, and avoid participants' misunderstandings. All instruments were checked based on content validity by two experts in English language majors before the test administration.

Table 1. Self-Talk Questionnaire

Dimensions of self-talk	Statement
Negative1	I am not as good as the others
Negative2	What will others think of my poor performance
Negative3	I'm wrong again
Negative4	I cannot concentrate
Negative5	I am tired
Negative6	My body is not in good condition
Negative7	My legs/arms are shaking from tiredness
Negative8	I am Hungry
Negative9	I want to take a shower
Negative10	I think "what will I do later tonight"
Positive1	I feel strong
Positive2	I am very well prepared
Positive3	I am not stress
Positive4	I believe in me
Positive5	I believe in my abilities
Positive6	I can make it
Positive7	I can keep going
Positive8	I can concentrate in my goal
Positive9	I can focus on my technique
Positive10	I can focus on what I need to do in competition

Data analysis

SPSS software V26, developed by IBM Corp in 2017, was employed to perform descriptive statistics and generate participant demographic profiles. Furthermore, the WINSTEPS software version 5.2.5.1, utilized (Linacre, 2022), was employed to perform psychometric evaluation and rating improvement using Rasch analysis.

RESULTS

Validity

The validity of the mental toughness questionnaire was evaluated using the Rasch analysis. Item and person parameters were assessed based on the mean of the infit and outfit mean square (MNSQ), with an acceptable range of 0.5 to 1.5. Although 1.6, is still considered acceptable if the point-biserial correlation (PTMA) is positive, it is important to note that this range may vary depending on the specific context and research objectives (Boone et al., 2014; Park & Liu, 2019). In this study, the fit validity criteria can be considered reliable because of the large sample size, which makes it possible to disregard the infit and outfit z-standardized (ZSTD) values for persons and items (Linacre, 2021). To confirm the existence of more than two distinct groups based on both person ability and item difficulty level, it is important for the separation values of items and persons to be greater than 2 logits.

Table 2 summarizes the Rasch parameters for the Indonesian version of the self-talk questionnaire. The fit validity criteria for both the individual and item in both studies were determined based on the infit and outfit mean squares (MNSQ), which ranged from 1.00 1.06. Additionally, item and person separations were both above two logits. The aim was to evaluate the unidimensionality and local independence of the inductive reasoning test to establish its construct validity. The table provided shows the raw variance by measure for all tasks, with any values of raw variance below 30% being accounted for by the measures, and the remaining unexplained variance shown in the first

contrast with a value below 2 (Linacre, 2021). The Yen Q3 statistics were utilized to determine the raw residual correlation (Christensen et al., 2017). The sentence suggests that there is no local independence present, as the raw residual correlation is less than 0.4.

Table 2. The summary of rasch parameters for self-talk questionnaire

Psychometrics Attribute	Subscale		Self-Talk Questionnaire
	Negative	Positive	
Number of Items	10	10	20
Mean			
Item Outfit MNSQ	1.00	0.96	1.00
Item Infit MNSQ	1.00	0.94	1.01
Person Outfit MNSQ	1.01	0.96	1.00
Person Infit MNSQ	1.00	1.13	1.09
Item Separation	2.64	5.61	4.78
Person Separation	1.47	1.95	1.94
Item Reliability	0.93	0.83	0.90
Cronbach's Alpha	0.68	0.94	0.78

To guarantee the validity of the items, an investigation of the item measures and fit criteria is presented in Table 3. The range of the item measures spans from -1.08 to 1.39 logits, while the Outfit MNSQ values range from 0.60 to 1.44 logits. These findings confirm that the self-talk questionnaire was reliable for all items in both studies.

Table 3. Item measure and fit criteria

Item number	Measure (logits)	Outfit MNSQ	PTMA
Negative1	0.47	0.8051	0.32
Negative2	0.72	1.411	0.292
Negative3	0.34	0.5925	0.4335
Negative4	0.3	0.669	0.4256
Negative5	0.41	0.6081	0.5264
Negative6	0.11	0.7407	0.4083
Negative7	-0.17	1.2585	0.4134
Negative8	-0.17	1.3898	0.2946
Negative9	0.5	1.5447	0.3575
Negative10	0.41	1.2498	0.2606
Positive1	0.52	1.5802	0.3626
Positive2	0.24	0.9099	0.6241
Positive3	1.02	2.193	0.2383
Positive4	-0.95	0.7285	0.6024
Positive5	-1.12	0.7395	0.5257
Positive6	-0.63	0.6392	0.6418
Positive7	-0.65	0.8238	0.5579
Positive8	-0.7	0.5672	0.6275
Positive9	-0.3	0.6151	0.7202
Positive10	-0.36	0.8357	0.5374

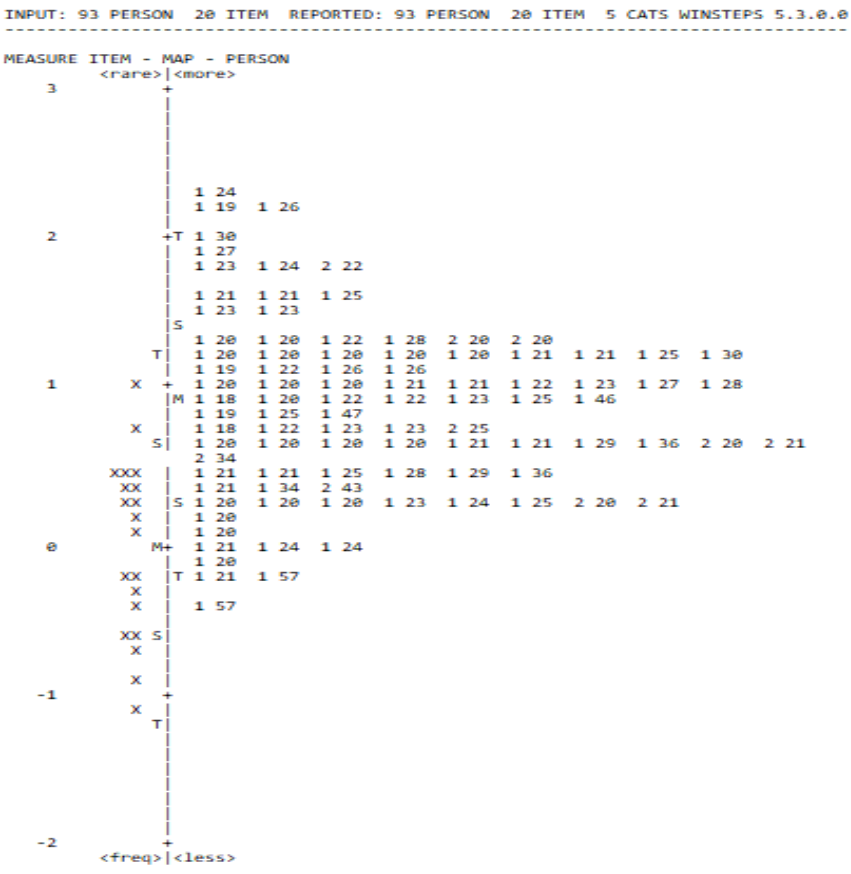

Figure 1. Person-item wright map

The item-person map is a useful tool in studies that aim to investigate the relationship between items and individuals. In Figure 1, it is evident that most participants possessed higher abilities than the item difficulty level, which supports the idea that athletes engage in positive self-talk. Furthermore, we conducted Item Characteristic Curve (ICC) analyses at the instrument level. The ICC plot reveals that both studies align with the Rasch probability model as the empirical and expected lines converge or overlap, as shown in Figure 2.

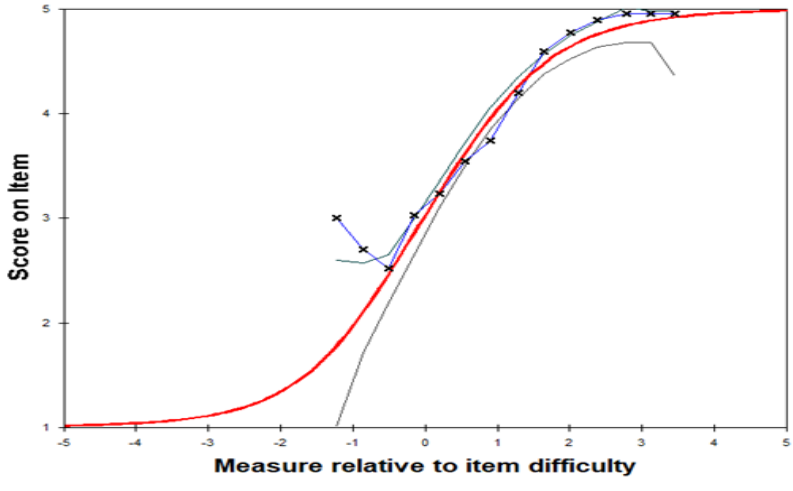

Figure 2. ICC plot*;* category probability of the self-talk Questionnaire

Reliability

The criteria for evaluating item reliability were based on both item reliability and Cronbach's alpha (α). All items in the self-talk questionnaire as well as each dimension were analyzed. The item reliability values for both studies ranged from 0.98 to 0.99, demonstrating a high level of reliability (Fisher, 2007). Cronbach's alpha, denoted by α,

measures the internal consistency of a set of items; in this case, it has a value of 0.87. For clarity, it is important to note that the minimum acceptable value for Cronbach's alpha is 0.6 (Taber, 2018). The outcome validates the dependability that arises from Cronbach's alpha measurements. To answer the second research question, how does self-talk affect an athlete's mental toughness? used linear regression to assess the relative effect of a predictor variable on a certain outcome (Pak & Oh, 2010). Challenge had the greatest effect on negative self-talk, while control had the greatest effect on positive self-talk (Table 4).

Table 4. Output regression

Aspect	Unstandardized B	
	Negative	Positive
Constant	22.443	18.690
Control	.118	.563
Commitment	.163	.479
Challenge	.249	.031
Confidence	.173	.284

DISCUSSION

The research hypothesis was validated by statistical data analysis, and additional investigation is necessary to completely understand the research results. The dependability and legitimacy of the self-talk questionnaire were substantiated by research. Self-talk has been found to have a positive impact on an athlete's mental toughness as it can improve performance quality, self-confidence, concentration, and motivation (Cox et al., 2003). Self-talk is closely related to self-awareness and self-efficacy, and plays a role in self-regulation, personal intelligence, and emotional intelligence (Mohiyeddini et al. 2011). Interventions that include self-talk training have been found to be more effective than those that do not include self-talk training (Hatzigeorgiadis et al., 2011a). Therefore, evidence suggests that self-talk can be an effective strategy for enhancing an athlete's mental toughness and performance (Coulter et al., 2010).

The study found that all three interventions resulted in a performance increase, with the greatest increase found in the assisted positive self-talk condition (Hamilton et al., 2007). A study conducted by Hatzigeorgiadis et al. discovered that instructional self-talk was more beneficial for precise tasks than motivational self-talk (Hatzigeorgiadis et al., 2011b). Fine tasks benefit more from self-talk than gross tasks do. According to a study, self-talk was incorporated into a multi-intervention package that resulted in enhanced skill performance and psychological well-being (Cumming et al., 2006).

Sheard (2010) defined mental toughness as the philosophy behind sports success in a recent book; when presented as an attitude, mental toughness appears to change through mental skills training. The results of the questionnaire revealed strong, positive connections between mental toughness and the use of several psychological strategies (i.e., goal-setting, imagery) (Crust & Clough, 2011) and sel talk (Cooper et al., 2021; Ede et al., 2020). Self-talk is an important aspect of training and competition at all levels, and the athlete's ability to generate positive self-talk is one of the most important elements impacting the performance of many sports skills (Mostafa, 2015), and is one of the methods previously identified as potentially impacting mental toughness (Cooper et al., 2021); however, further experimental research is required.

Self-talk can change or control behavior, and negative thinking can become positive, which increases athletes' concentration and shooting accuracy (Rizal et al., 2021). Positive self-talk, sometimes known as internal conversation, can be carried out either silently or aloud, and serves as a means for individuals to instruct or fortify themselves (Ohuruogu et al. 2022). Studies have found self-talk to be an effective mental training approach that can positively or negatively impact an athlete's performance depending on their emotions (Basset et al., 2022). By contrast, negative self-talk often sends pessimistic messages to the mind, leading to a decline in cognitive anxiety and academic performance (Liu et al. 2021). A study found that positive self-talk can induce physiological changes (Muhamad, M et al., 2019; Tangkudung et al., 2021) and facilitate autonomic regulation of cardiorespiratory function (Basset et

al., 2022). In conclusion, self-talk can significantly impact athletes' mental toughness and performance.

Positive self-talk can increase concentration and shooting accuracy and induce physiological changes, while negative self-talk can lead to a decline in cognitive anxiety and academic performance. Coaches should encourage their athletes' perceptions of autonomy and competence to produce more positive self-talk in competition, which can result in higher levels of performance. (Amado et al., 2019). According to research, self-talk has a significant impact on athletes' mental toughness (Yalçın & Turan, 2021). Self-talk is a mechanism that can help athletes put in more effort, and studies have shown that athletes who engage in task-specific self-talk have a positive effect on their physical performance (Bingöl & Yıldız, 2021). Mental toughness is a person's attitude or self-evaluation, particularly among athletes, to overcome barriers, challenges, and even pressures in order to maintain attention and motivation that decides a positive energy to reach a goal of surviving during the competition (Jannah et al., 2018). Athletes who possess mental toughness have several indicators, including the ability to face challenges, learn from bad experiences, self-confidence, anwithvels of depression, anxiety, and stress. When thletes have good mental toughness, they are expected to increase their commitment to continue playing an active role and strive to improve their inner performance (Faizah, 2021).

The results show that the self-talk questionnaire in the Indonesian version achieves validity and reliability criteria based on Rasch parameters with five rating scales, and there is a relationship between self-talk and mental toughness. This might be because the questions were primarily made up of the four mental toughness characteristics (4C), which are used to identify athletes based on the four aspects of mental toughness: control, commitment, challenge, and confidence (Alshuraymi & Hastie, 2024). Other elements may be included if assessment is required to identify people with other features or conditions. Challenge had the largest effect on negative self-talk, while control had the largest effect on positive self-talk. Athletes have a tendency to see problems and challenges as something they must overcome. The capacity of an athlete to guide and manage himself to attain their goals is referred to as control (Clough et al., 2002). In summary, self-talk has a significant impact on the mental toughness of athletes, and athletes who have good mental toughness have several indicators, including the ability to face challenges, learn from bad experiences, self-confidence, and low levels of depression, anxiety, and stress.

Developing positive self-talk necessitates a strong mental toughness dimension, which refers to an athlete's capacity to guide and control their thoughts and behaviors towards achieving their goals. By expressing optimistic statements, positive responses can be elicited (Weinberg & Gould, 2011). Studies conducted by Wadey and Hanton have explored the relationship between the utilization of fundamental psychological skills, such as goal setting, self-talk, imagery, and relaxation, as well as the direction and intensity of athletes' anxiety levels (Wadey & Hanton, 2008; Weinberg & Gould, 2011).

This study aimed to evaluate the advantages of self-talk and instructional strategies in comparison to a control condition. Studies have provided robust experimental evidence to support the effectiveness of self-talk as a helpful intervention or coping strategy for improving athletic performance (Antonis et al., 2004; Perkos et al., 2002; Theodorakis et al., 2001) and can decrease distraction. Negative self-talk can have a detrimental effect on athletes by eliciting unfavorable emotional responses. Research has shown that negative self-talk can lead to decreased performance in athletes as it creates tension, raises pressure, and fosters anxiety, anger, worry, sadness, despair, and heightened expectations for optimal outcomes. Athletes may also experience a sense of failure that could negatively impact their overall mental toughness, which refers to their ability to view challenges and obstacles as opportunities to be overcome rather than avoided.

Conclusions

The self-talk questionnaire was validated by Rasch analysis, using a rigorous quantitative method. Rasch analysis was used to assess the validity and reliability of the questionnaire. The results showed that the self-talk questionnaire in the Indonesian version achieved validity and reliability criteria based on Rasch parameters with five rating scales. The conclusions of the questionnaire data investigation revealed substantial positive links between self-talk and mental toughness. Challenge had the largest effect on negative self-talk, while control had the largest effect on positive self-talk.

It is recommended to integrate this validated tool into regular assessments of athletes' psychological training programs. Coaches and sports psychologists should utilize the questionnaire to monitor and enhance athletes' self-talk patterns, focusing on strategies that reduce negative self-talk and promote positive self-talk, particularly in areas related to challenge and control. Additionally, incorporating targeted interventions that address specific self-talk patterns could further strengthen athletes' mental toughness, ultimately leading to improved performance under pressure. Future research should explore the application of this tool across different sports and cultural contexts to ensure its broader relevance and effectiveness.

Conflict of İnterest

The authors declare no conflict of interest.

Ethical Statement

Ethical clearance No. E.1.078/UNISMA. LPPM/E/V/2024 for this research was obtained from the LPPM Universitas Islam 45 Bekasi, Indonesia.

Author Contributions

Study Design, AH, SS; Data Collection, DA, BB, DNR, and PP; Statistical Analysis, AH, SS, and YNH; Data Interpretation, MST,; Manuscript Preparation, WDL and PP; Literature Search, RB. All authors have read and agreed to the published version of the manuscript.

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RESEARCH ARTICLE

The Effectiveness of *Centella asiatica* Extract and Aerobic Exercise on Plasma Levels of Amyloid Beta-42 and Phosphorylated Tau in Older Women with Dementia

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Abstract

Urgency: Effect of Centella asiatica (CA) and aerobic exercise on Amyloid beta-42 (Aβ42) and phosphorylated tau (p-tau) as biomarkers of dementia is not yet known. **Objectives:** This study aimed to analyze the effect of CA, aerobic exercise, and their combination on Aβ42 and p-tau in older women with dementia. **Design:** It was a 24-week randomized, double-blind controlled trial. **Partisipant:** Subjects were divided into four groups: the Centella asiatica group (CA, 1x500 mg/day, n = 16), the aerobic exercise group (AE, 3x60 minutes/week, n = 16), the CA-AE combination group (1x500 mg/day and exercise, n = 15), and the placebo group (n = 15). **Instruments:** The dementia screening test used the Mini Mental State Examination (Intraclass correlation coefficients : ranging from 0.60 to 0.93, sensitivity of 88.3%) and Clinical Dementia Rating questionnaires (sensitivity 93.6% and specificity 100%). The Wilcoxon, Kruskal-Wallis, and Mann-Whitney tests were used to analyze the data. **Results:** Plasma amyloid beta-42 showed an increase in all groups: CA ($p<0.001$), AE ($p=0.001$), CA-AE combination ($p<0.001$), and placebo ($p<0.001$). Meanwhile, plasma p-tau also decreased in CA ($p<0.001$), AE ($p<0.001$), and CA-AE combination ($p=0.001$). The Mann-Whitney test showed that Centella asiatica caused the highest increase in Aβ42 ($\Delta=233.5$; $p<0.001$). **Conclusion:** This study indicate that Centella asiatica, aerobic exercise, and the CA-AE combination were effective in improving plasma Aβ42 and decreasing p-tau in older women with dementia. **Contributions:** This study can be an alternative therapy for the prevention and treatment of cognitive decline. Research with a larger sample size is recommended.

Keywords
Amyloid-Beta, Centella asiatica, Dementia, Exercise, P-tau

INTRODUCTION

The number of elderly individuals rises positively in response to increased health sector services. But dementia is also a major danger factor for the elderly. By 2050, there will be 89 million more people living with dementia (Prince et al., 2016; Burhaein et al., 2024). Alzheimer's disease is the most prevalent kind of dementia (Fitriana et al., 2021). Alzheimer's disease is typified by the loss of synapses and neurons as well as the development of intracellular neurofibrillary tangles (NFL) and extracellular amyloid plaques (Yu et al., 2014). The three main biomarkers for Alzheimer's disease are amyloid beta-42 (Aβ42), phosphorylated tau (p-tau), and total tau (T-tau). T-tau, P-tau, Aβ42, and NFL in cerebral fluid are employed in clinical treatment and clinical research because of their

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consistency (Olsson et al., 2016). Patients with mild amnestic cognitive impairment (aMCI) who are developing Alzheimer's disease may have low concentrations of Aβ 1-42 in their cerebrospinal fluid (CSF) or high ratios of T-tau protein to Aβ 1-42 in their CSF (Schneider et al., 2010). Compared to men, women are more likely to have Alzheimer's (Shimizu et al., 2019). There is evidence that women undergo brain atrophy at a faster rate than men because of variations in sexual hormones, life orientation, and estradiol deflation (Davey, 2013).

More efficient and affordable strategies are required because certain pharmaceutical medications are unable to prevent dementia from developing to a considerable degree (Lee et al., 2016). Exercise and Centella asiatica (CA) have been shown to enhance cognitive performance. Because of the active components asiaticoside and madecoside, CA is one of the traditional herbs that has been shown to have neuroprotective, antioxidant, memory-strengthening, and intelligence properties (Sari et al., 2019). By preventing beta-amyloid accumulation, acetylcholinesterase activity, and brain damage, CA enhances cognitive function (Soumyanath et al., 2012). In vitro, CA's antioxidant properties are demonstrated by its ability to scavenge free radicals, lower lipid peroxidation, prevent DNA damage, alter amyloid β pathology in Alzheimer's mouse brains, and modify elements of the oxidative stress response linked to the neurodegenerative changes associated with Alzheimer's disease (Dhanasekaran et al., 2009).

People with dementia benefit from aerobic physical activity (15 minutes of daily cycling for 15 months) because it enhances cognitive function (Cancela et al., 2015). Although the benefits of CA and exercise for enhancing cognitive function have been shown in numerous studies, their combined impact on various biochemical indicators in humans is not very significant. The purpose of this study was to ascertain how exercise, Centella Asiatica, and their combination affected the plasma levels of phosphorylation-tau (p-tau) and amyloid beta-42 (Aβ42) in older dementia-stricken women.

MATERIALS AND METHODS

Research Design

A 24-week, double-blind, randomized experiment with placebo control was the study design employed. The research was carried out in three Indonesian nursing homes. In this study, participants who satisfied the following criteria were included: MMSE value 10-26 (mild-moderate dementia) (Meyer et al., 2016), CSF Aβ42 levels <550 pg/ml (Jensen et al., 2016), absence from brain supplements for at least two weeks prior to the intervention; and exercise attendance of at least 80% of a total of 72 meetings.

After screening test used the MMSE and CDR questionnaires, respondents underwent a physical examination, medical history, daily activities (ADL), education level, and sociodemographic history. The screening results showed that 80 people met the criteria. After that, subjects who met the criteria were randomized and divided into four groups. The research flow chart is presented in Figure 1 as follows:

Participants

Eighty participants who met the eligibility requirements were split into four groups at random. Excel uses random selection to create a random list. The randomization group was unknown to the research staff members who analyzed the respondents. Of the 124 older people, 80 met the inclusion criteria. After that, respondents underwent a physical examination, medical history, daily activities (ADL), education level, and sociodemographic history.

Procedures

Strict standardization, conformance, and quality control procedures are followed in the production of centella Asiatica extract before a dry extract is obtained. By using HPLC, the asiaticoside level was determined to be 1.41 mg/g. Nurses in nursing homes administered up to 500 mg of CA extract every day to the respondents. A daily medication adherence list sheet is used to monitor medication compliance.

The three 60-minute workouts each week included a 10-minute warm-up and stretching period, a 40-minute core training session, and a 10-minute cool-down period. The core workout consist of breathing and some cardio movements together. The respondent's movements are tailored to their capabilities. The orphanage officer/nurse keeps track of attendance.

Participants in the Centella asiatica-exercise (CA-AE) combination group were told to exercise three times a week for 60 minutes and to take 500 mg of CA per day. The personnel of the senior home kept an

eye on adherence using CA diaries and exercise attendance lists. In the placebo group, subjects received 1x500 mg/day of a placebo medication containing starch.

Blood biochemistry was evaluated using HPLC and the ELISA technique. Prior to the intervention, the study participants who were fasting had their brachial veins drained of 3 ml of blood, which was subsequently placed into an EDTA tube. After being kept at ambient temperature for an hour, the tube was transferred to the lab and kept in a cool box at -8ºC. Prior to additional analysis, the tubes were separated and kept at -80ºC after being centrifuged for ten minutes in the lab.

Instruments

The dementia screening test used the Mini-Mental State Examination (MMSE) and Clinical Dementia Rating (CDR) questionnaires. The MMSE test consists of 30 questions. The mild-moderate dementia category has an MMSE score of 10-26 (Meyer & O'Keefe, 2020). The test-retest reliability of the MMSE has been reported with intraclass correlation coefficients (ICCs) ranging from 0.60 to 0.93, indicating good to excellent reliability. In 14 studies, the MMSE had a sensitivity of 88.3% (95% confidence interval [CI], 81.3% to 92.9%) and a specificity of 86.2% (95% CI, 81.8% to 89.7%) for dementia Tsoi, 2015).

While the CDR consists of 5 questions with a five-scale rating score, namely 0: no cognitive impairment; 0.5: very mild dementia; 1: lightweight; 2: moderate; and 3: severe (Nam et al., 2020).

The CDR has high sensitivity (93.6%) and specificity (100%) for detecting dementia, making it a reliable tool for clinical assessments. The CDR exhibits excellent inter-rater reliability, with kappa values ranging from 0.77 to 1.00 across different domains, such as memory (0.95) and personal care (1.00) (Shwe, 2013).

Data Analysis

Data analysis was done using the Mann-Whitney, Kruskal-Wallis, and Wilcoxon tests.

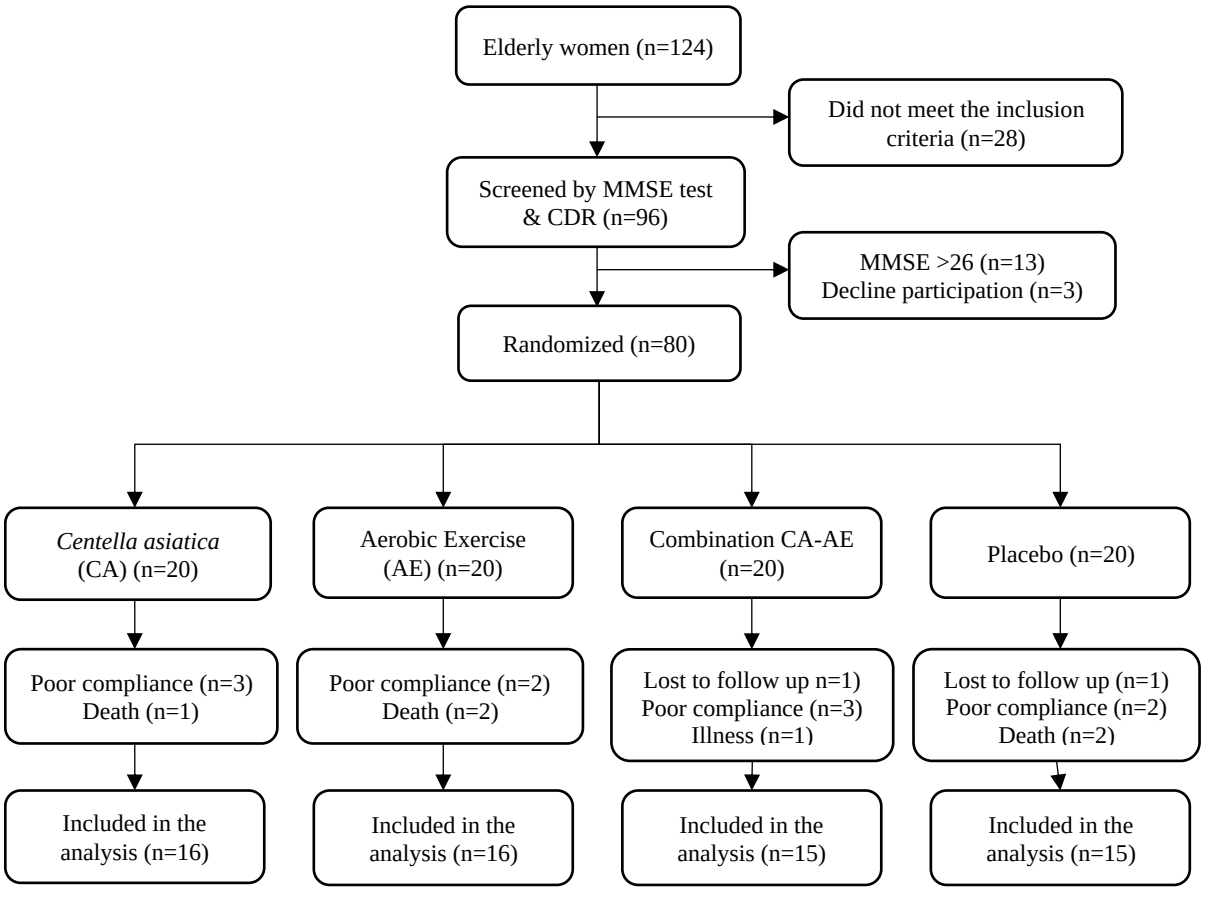

Figure 1. Research flow chart

RESULTS

Out of a total of 80, 62 people were able to complete the intervention over 24 weeks. Sociodemographic examinations including age, MMSE, CDR, blood pressure, weight, height, blood pressure, education, marital status, medical history, and blood biochemistry did not show differences in all groups (Table 1).

Table 1. Baseline data of older women with dementia

Characteristic	Centella asiatica/ CA, n=20	Aerobic Exercise/AE, n=20	Combination of CA-AE, n=20	Placebo, n=20	p-value
Age, mean (SD), yr	74.80 (10.10)	76.45 (8.67)	73.40 (8.79)	75.95 (10.06)	0.744
MMSE, mean (min-max), score	20 (10-25)	23 (12-25)	22 (10-25)	20 (13-25)	0.221
CDR, mean (min-max)	3 (2-8)	3.75 (2-7)	3 (2-7)	4 (2-7)	0.397
Weight, mean (SD), kg	46.50 (38-76)	49.5 (26-68)	47.5 (37-64)	41 (32-64)	0.555
Height, mean (SD), cm	145.50 (7.86)	145.95 (5.45)	146.15 (6.65)	143.80 (9.50)	0.751
Blood pressure, mean (SD)					
Sistole, mmHg	134.50 (19.05)	135.65 (15.13)	134.50 (18.07)	136.00 (1.20)	0.989
Diastole, mmHg	80 (70-90)	80 (60-100)	80 (60-100)	80 (70-90)	0.583
Education, n (%)					
Low	18 (26.5)	15 (22.1)	17 (25.0)	18 (26.5)	0.502
High	2 (16.7)	5 (41.7)	3 (25.0)	2 (16.7)	
Marital status, n (%)					
Unmarried	18 (25.4)	19 (26.8)	16 (22.5)	18 (25.4)	0.498
Married	2 (22.2)	1 (11.1)	4 (44.4)	2 (22.2)	
Disease history, n (%)					
Hypertension	4 (16.7)	8 (33.3)	6 (25.0)	6 (25.0)	0.592
Stroke	19 (25.7)	18 (24.3)	19 (25.7)	18 (24.3)	0.868
Rheumatic	17 (25.8)	14 (21.2)	17 (25.8)	18 (27.3)	0.374
Osteoarthritis	7 (50)	2 (14.3)	3 (21.4)	2 (14.3)	0.117
Blood biochemical, mean (SD), pg/ml					
Aβ-42	129.80 (45.68)	176.99 (105.01)	159.45 (122.26)	151.44 (54.09)	0.124
p-tau	413.17 (764.81)	115.28 (213.85)	170.12 (425.87)	342.40 (649.90)	0.261

*p <0,05

Plasma amyloid beta-42 showed an increase in all groups: CA (p<0.001), AE (p=0.001), CA-AE combination (p<0.001), and placebo (p<0.001). Examination of p-tau also decreased in all groups: CA (p<0.001), AE (p<0.001), CA-AE combination (p=0.001), and placebo (p=0.707). The Mann-Whitney test showed that there was a significant difference in Aβ-42 between the four groups (p = 0.007). CA caused the highest increase in Aβ-42 (Δ=233.5; p<0.001). Meanwhile, p-tau showed no difference between the four groups (Table 2).

Table 2. Comparison of amyloid beta-42 and p-tau between before and after intervention for 24-weeks

Variable	Centella Asiatica/CA (n=16) Median (min-max)	Exercise/E (n=16) Median (min-max)	Combination of CA-E (n=15) Median (min-max)	Placebo (n=15) Median (min-max)	p^b
Aβ-42, pg/ml					
Baseline	142 (65-229)	158.5 (90-209)	144 (62-182)	137 (90-264)	0.007*
After 24 weeks	362.5 (234-767)	315 (180-644)	343 (230-583)	321 (23-790)	
Δ	233.5 (102-671)	151.5 (90-449)	186 (86-495)	184 (-114-526)	
p^a	<0.001*	0.001*	<0.001*	<0.001*	
p-tau, pg/ml					
Baseline	60.5 (47-1682)	69.5 (51-941)	56 (48-277)	66 (49-291)	0.064
After 24 weeks	12.5 (7-998)	23.5 (8-324)	17 (7-197)	34 (9-500)	
Δ	-47.5 (-684-23)	-46 (-617-19)	-42 (-80-25)	-29 (-227-771)	
p^a	<0.001*	<0.001*	0.001*	0.707	

Δ: difference pre and post intervention, p^a: Wilcoxon test, p^b: Mann-Whitney test, *Significant

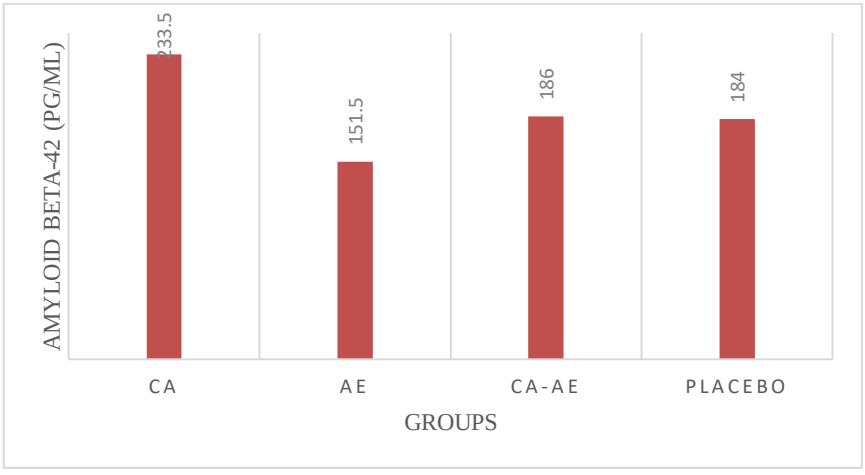

Figure 2. Change of Amyloid Beta-42 plasma after 24-weeks intervention

DISCUSSION

This study showed that all groups had increased plasma levels of amyloid beta-42. However, Centella asiatica scored the highest in elevated amyloid beta-42 in women with dementia. Another study found that Asiatic acid treatment reduced amyloid beta 1–42 in mice (Rather et al., 2018). Centella asiatica cannot inhibit Aβ aggregation of monomers and oligomers and cannot destroy preformed fibrils (Ramesh et al., 2010).

This study follows the study that found exercise for 5–30 minutes per week increased Aβ-42 levels in the elderly (Liang et al., 2010). Another study in mice showed that physical exercise reduced beta-amyloid by increasing the activity of enzymes responsible for regulating beta-amyloid clearance in brain tissue and suppressing apoptotic pathways such as the caspase-9, cytochrome c, Bax, and caspase-3 pathways (Ozbeyli & Cakir, 2017). Physical exercise for 3x60 minutes per week for 16 weeks had no positive effect on global beta-amyloid deposition in Alzheimer's patients (Frederiksen et al., 2015). The mechanism by which exercise affects amyloid deposition remains unclear. However, there is a direct effect on the metabolism of amyloid precursor protein and an indirect effect through the influence of neurotrophic factors, neuroinflammation, cerebrovascular function, and glucose metabolism (Head et al., 2012). The placebo group in this study also experienced a significant increase in plasma Aβ-42, presumably due to the suggestion given by the nurse or officer who gave the drug to the respondent and the positive effect of the placebo on the nervous system.

The results of this study showed that Centella asiatica, aerobic exercise, and a combination of Centella asiatica and aerobic exercise showed a positive effect on lowering plasma tau-phosphorylation levels in women with dementia. The asiaticoside content of 1.41 mg/g in this study is thought to reduce the formation of neurofibrillary tangles in women with dementia. This study in line with the results of a study on transgenic mice showed the effect of 12 weeks of exercise on reducing p-tau levels (Kang & Cho, 2015). Studies show that individuals who actively exercise for 5–30 minutes per week have lower levels of tau phosphorylation (Liang et al., 2010). Another study showed that exercising 3x60 minutes/week for 16 weeks showed no change in p-tau (Jensen et al., 2016). Centella asiatica may alleviate the etiology of dementia. Centella asiatica inhibits p-tau biosynthetic protein and maintains cytoarchitecture (Chiroma et al., 2019).

Respondents, who were all women, were also considered effective in giving positive results because of the homogeneity of the sexes. Based on research, women with Alzheimer's who were given the intervention had more positive effects than men with Alzheimer's (Mielke et al., 2012).

Conclusion

The results of this study showed that Centella asiatica, aerobic exercise, and a combination of Centella asiatica and aerobic exercise showed a positive effect on lowering plasma tau-phosphorylation levels in women with dementia. The results of this study can be an alternative therapy for the prevention and treatment of cognitive decline in women with dementia. The number of samples in this study is still limited therefore that further research can be carried out with a larger number of respondents, both women and men.

Conflict of Interest

We affirm that the article we have authored does not involve any conflict of interest.

Ethics Statement

The Health Ethics Commission of Universitas Padjadjaran has granted ethical permission for this research (No. 1266/UN6.KEP/EC/2018).

Author Contributions

Conception and design of the study, LAF, IKA, KA and IS; Data collection, LAF, ID, PTL; Data analysis and interpretation, LAF, IKA, KA, IS, and NF; Drafting article and critical revision, LAF, IKA, KA,I S, ID, PTL, NF, and EAS. All authors have read and approved the published version of the manuscript.

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RESEARCH ARTICLE

The Locomotor Movement Abilities of Children Aged 5-6 Years in Terms of Geographical Aspects (Coastal and Mountain Areas)

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Abstract
This study examines the differences in locomotor abilities of children aged 5-6 years in two locations, namely coastal and mountainous areas in Kebumen City, Indonesia. This is important because children's locomotor outcomes are still poor and there has been no identification of locomotor abilities judging from previous studies that only examined manipulative movement abilities. Overall, this study contributes greatly to future research by providing important insights into how environmental and geographical factors interact with children's physical development, which in turn can aid in the creation of more effective policies and interventions to support holistic child development. Using descriptive research methods, the population was 40 schools specifically for coastal and mountainous areas, then sampling was carried out in 2 stages, namely using cluster random sampling techniques and then purposive sampling. The sample size was 130 with details of 65 children in coastal areas and 65 in mountainous regions. This instrument has been validated and reliable on 135 children in Indonesia with a validity result of 2.27 > t table 1.65 and reliability of 0.765. The statistical test results showed a p value = 0.013 which means that there is a relationship between children's locomotor abilities with geography in the two different locations, namely mountains and coasts. The average child's locomotor ability in coastal areas was found to be superior compared to mountainous areas.

Keywords
Locomotor Skills, Coastal Areas, Mountainous Areas, 5-6 Years Old Children, Geographical Aspects

INTRODUCTION

Early childhood is a generation that requires special attention for its growth and development (Fitri & Ummah, 2022). Early childhood is ready and has a good level of maturity, namely the age of 5-6 years, besides that it has brought up a significant variety of potential in the developmental dimension (O'Brien et al., 2016a). Regular, well-designed activity in childhood is essential for maintaining health into adulthood. Poor activity in childhood is a predictor of non-participation in sports and a predictor of health-related problems later in life (McGann et al., 2020). Lack of physical activity from preschool age causes 80% of adolescents to become inactive, resulting in a 20-30% higher risk of death (WHO, 2022). Gross motor skill development is an important aspect of early childhood (Webster et al., 2019). Mastery of gross motor skills is fundamental to physical health, cognitive and social development, achievement, and psychosocial development. However, today's children spend more time sitting, playing computer games, and watching TV, while less than 5% of the day is spent on physical skills (González et al., 2017). In addition, most modern children no longer have proficient gross motor skills such as not being able to kick, jump, throw, and even walk properly (O'Brien et al., 2016b). For this reason, physical activities are needed so that children's gross motor skills increase (Morrison et al., 2018).

Many motor skill studies are not very specific. Each stage of child development has different phases. Not only in each stage but also in nutritional status, gender, facilities at school or home, and geographical conditions where the child

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lives. Therefore, problems related to the assessment of gross motor skills are still evident in preschool age (Pelemiš, 2018).

Gross motor development in childhood is strongly influenced by the characteristics of children's growth and maturity (morphological, physiological, and neuromuscular) (Mustafa & Sugiharto, 2020; Ügüten & Ersöz, 2024). This is because motor development occurs within a specific social context, and the environment in which a child is raised is very important. In general, play and learning activities in the surrounding environment and the nutritional status of children can influence children's behavior and activities. Thus early childhood is strongly influenced by its environment, such as children who live in mountainous areas will often walk on uneven road contours and are hilly. Conversely, children who live in coastal areas, and daily activities are accustomed to hot weather conditions and flat areas, this certainly affects their physical development and movement.

In addition to consideration of the location of school institutions, an important thing to note is that the environment will greatly affect physical potential, especially the potential for movement and physicality. PAUD institutions in the Kebumen district are scattered in mountainous areas and also on the south coast.

One example is the potential of children's movement in terms of jumping will be different from the medium and lowlands. The differences in children's movement abilities and physical potential from a geographical point of view should be of concern to teachers and sports talent scouts so that they can pay different attention to handling growth and development and their movement potential (Saparia et al., 2023).

Locomotor movements are significant for children to master because they will continue to be part of children's daily lives in the future, such as for games, physical activities, and sports (Aye et al., 2017). However, some areas in Indonesia still have locomotor abilities such as jumping, jumping, and walking (Djuanda & Suryani, 2021; Muslihin, 2020), teachers and parents are more likely to emphasize their children's numeric than their physical skills. If the child's locomotor ability is not developed, the problem will increase and expand as the child ages (Phytanza et al., 2023). For example, children are not trained to run fast, dodge, jump, and jump which can result in awkward and stiff movements due to a lack of coordination or frequent falls. One of the main focuses in early childhood education is to develop children's gross motor skills, especially locomotor abilities.

From other previous studies, the results of gross motor skills seen from the geographical aspect of the results show that there is indeed a difference between coastal and mountainous areas. From this fact, it is very important to identify the potential of the two geographically different locations so that they can be used as a reference in developing the potential of children's movements in both areas, both coastal and mountainous for locomotor abilities.

This study aims to see the results of the locomotor ability test of children from two different areas, namely mountainous and coastal areas, referring to previous research that has been carried out in a similar way to see the ability of control objects. Asnaldi et al., (2020) and gross motor skills Saparia et al., (2023) from children in two different locations. Another consideration that becomes the basis of why this research is important is the locomotor results of children who are still not good, there has been no identification of locomotor abilities to see from 2 geographically different locations and the results of this study can be used as a reference in developing the potential of early childhood movement in mountainous and coastal areas. Based on this, this study was conducted to examine differences in the locomotor abilities of children aged 5-6 years in terms of geographical aspects of mountains and coasts.

MATERIALS AND METHODS

Methods

The research to be conducted using descriptive quantitative aims to measure and describe the characteristics of a phenomenon objectively and numerically (Babbie, 2010). In the context of research related to locomotor features of 5-6-year-old children in coastal and mountainous areas, this method allows researchers to directly measure children's physical abilities, such as the ability to run, jump, or balance, and describe the distribution of these characteristics among the population under study.

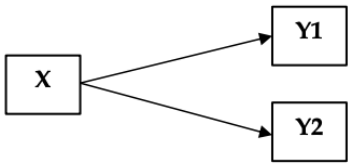

Figure 1. Research design

Instruments Study

The research instrument used the TGMD-2 (Ulrich & Sanford, 2000) with locomotor skill subtests including run, gallop, hop, horizontal jump, skip, and slide. This instrument has been tested for validity and reliability on 135 children in Indonesia and the results for validity were 2.27 > t table 1.65 and reliability was 0.765 (Apriyani et al., 2018).

Participants

In the initial research plan, 40 kindergarten school institutions specialized in coastal and mountainous areas. Sample determination was carried out using several techniques including cluster random sampling and purposive sampling of the number of schools that were reduced based on the location of the sub-district closest to the coast or mountains based on the location of the sub-district. Furthermore, the determination of the number of samples used as testes using purposive sampling techniques with the criteria of children aged 5-6 years, not in conditions of special needs so that the total sample was 130 samples with details of 65 children from coastal areas and 65 children from mountainous regions.

This research has been approved by the Ethics Committee of the University of State Yogyakarta (Reg.No.:T/53/UN34.9/KP.06.07/2024).Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Procedure

The research will be conducted for approximately 2 months starting from initial observations to data collection and drawing conclusions, data collection techniques are carried out in several ways. They start with observation and then measure children's locomotor abilities using the TGMD-2 instrument. After the measurement, data analysis techniques were carried out on the research data using several stages.

First, calculations will be performed based on the norm table that has been determined on the TGMD-2 instrument (Ulrich & Sanford, 2000). Second, descriptive analysis will be conducted to describe the data obtained, provide basic summary statistics such as mean, median, standard deviation, and frequency distribution, and conduct a Chi-Square Test (Gravetter, 2013) with the TGMD-2 results. In the context of this study, the Chi-Square Test can be used to test the relationship of locomotor ability between geographical aspects and the results of the TGMD-2 assessment, and then also statistically describe the locomotor ability of each mountainous and coastal area based on gender, age, height and BMI. Third, concluding the last step that summarizes the research findings and answers the research questions posed (Creswell, 2014).

RESULTS

This research instrument uses the TGMD-2 and has been validated, for which a frequency distribution analysis is carried out to find out the locomotor abilities of children in coastal and mountainous areas. Details are presented in Table 1.

Table 1. Frequency distribution of locomotor movements of children in mountainous areas

Standar Score	Frekuensi		Assesment
	Absolute (Fa)	Relative (%)	
17-20	0	0.00%	Very high
15-16	0	0.00%	High
13-14	20	30.77%	Above average
8-12	20	30.77%	Average
6-7	15	23.07%	Below average
4-5	10	15.38%	Low
1-3	0	0.00%	Very Low
Total	65	100%	

*locomotor categorization TGMD-2

Table 1 shows that the results of children scoring above the average are 20 children equal to the average of 20. Meanwhile, the results of the assessment below the average are 15 children and low are 10 children. Table 2 shows that the results of children scoring above the average are 25 children equal to the average of 20. Meanwhile, the results of the assessment below the average are 12 children and low are 8 children. The results of the two tables' analysis explain that in general, the locomotor abilities of children in coastal areas are better than those in mountainous areas when viewed from the categorization of the TGMD-2 instrument.

Table 2. Frequency distribution of locomotor movements of children in coastal areas

Standar Score	Frekuensi		Assesment
	Absolute (Fa)	Relative (%)	
17-20	0	0.00%	Very high
15-16	0	0.00%	High
13-14	25	38.46%	Above average
8-12	20	30.76%	Average
6-7	12	18.46%	Below average
4-5	8	12.30%	Low
1-3	0	0.00%	Very Low
Total	65	100%	

*locomotor categorization TGMD-2

Table 3 shows some general differences including the maximum score of children's locomotor ability in mountainous and coastal areas. The results show that there is a higher mean difference in the locomotor scores of coastal children compared to the mean scores of children in mountainous areas, namely 34.2612 for coastal areas and 32.8208 for mountainous areas.

Next, explain the results of descriptive analysis of coastal and mountain children from the range of scores, maximum, minimum, average, and standard deviation ranging from age, gender, BMI, and height.

Table 3. Descriptive analysis of total locomotor score of coastal and mountain areas

	N	Range	Min.	Max.	M	SD
Coastal	65	13.00	29.00	42.00	34.2615	2.74589
Mountain Areas	65	19.00	24.00	43.00	32.8308	3.50254

Mean (M), Std.Deviation (SD), Minimum (Min.), Maximum (Max.)

The results from Table 4 to Table 9 show that in terms of gender, age, and height, boys in coastal areas are superior to boys in mountainous areas. Vice versa, girls in coastal areas are superior to boys in mountainous areas. The results of the analysis of these tables explain that the movement skills of children in coastal areas are better than children in mountainous areas when viewed from the categorization of gender, age, and height. However, it looks different in Tables 10 and 11 in the BMI category, the results of mountain children are superior to coastal children.

Table 4. Descriptive analysis of locomotor scores of boys from coastal and mountain areas

	N	Range	Min.	Max.	M	SD
Coastal	33	10.00	29.00	39.00	33.7273	2.42735
Mountain Areas	29	15.00	28.00	43.00	32.3103	3.53658

Mean (M), Std.Deviation (SD), Minimum (Min.), Maximum (Max.)

Table 5. Descriptive analysis of locomotor scores of coastal and mountainous girls

	N	Range	Min.	Max.	M	SD
Coastal	32	13.00	29.00	42.00	34.8125	2.97774
Mountain Areas	36	15.00	28.00	43.00	32.2500	3.46719

Mean (M), Std.Deviation (SD), Minimum (Min.), Maximum (Max.)

Table 6. Descriptive analysis of locomotor scores of 5-year-old children from coastal and mountainous areas

	N	Range	Min.	Max.	M	SD
Coastal	40	13.00	29.00	42.00	34.3000	2.97166
Mountain Areas	44	15.00	28.00	443.00	32.6591	3.47712

Mean (M), Std.Deviation (SD), Minimum (Min.), Maximum (Max.)

Table 7. Descriptive analysis of locomotor scores of 6-year-old children from coastal and mountainous areas

	N	Range	Min.	Max.	M	SD
Coastal	25	9.00	30.00	39.00	34.2000	2.39792
Mountain Areas	21	15.00	24.00	39.00	33.1905	3.61413

Mean (M), Std.Deviation (SD), Minimum (Min.), Maximum (Max.)

Table 8. Descriptive analysis of locomotor scores of children under 100cm height from coastal and mountainous areas

	N	Range	Min.	Max.	M	SD
Coastal	35	13.00	29.00	42.00	34.7143	2.88578
Mountain Areas	36	15.00	28.00	43.00	33.5667	3.61685

Mean (M), Std.Deviation (SD), Minimum (Min.), Maximum (Max.)

Table 9. Descriptive analysis of locomotor scores of children over 100cm tall from coastal and mountainous areas

	N	Range	Min.	Max.	M	SD
Coastal	30	10.00	29.00	39.00	33.7333	2.39792
Mountain Areas	35	15.00	24.00	39.00	32.2000	3.32371

Mean (M), Std.Deviation (SD), Minimum (Min.), Maximum (Max.)

Table 10. Descriptive analysis of locomotor scores of children with a bmi below 13kg from coastal and mountainous areas

	N	Range	Min.	Max.	M	SD
Coastal	37	11.00	28.00	39.00	33.4865	2.65227
Mountain Areas	31	15.00	28.00	43.00	33.6129	3.40272

Mean (M), Std.Deviation (SD), Minimum (Min.), Maximum (Max.)

Table 11. Descriptive analysis of locomotor scores of children with a bmi above 13kg from coastal and mountainous areas

	N	Range	Min.	Max.	M	SD
Coastal	28	10.00	28.00	38.00	33.6786	2.52475
Mountain Areas	34	16.00	23.00	39.00	32.2941	3.40272

Mean (M), Std.Deviation (SD), Minimum (Min.), Maximum (Max.)

Table 12 shows the statistical description of the results of locomotor ability seen from several categories such as gender, age, BMI, and height. The overall P-value results are above >0.05 which indicates that there is no relationship between categories (age, gender, BMI, height) and geographical aspects. This indicates that children's locomotor ability is influenced by the geographical area where the children live.

Table 12. Descriptive analysis of total locomotor score of coastal and mountain areas

	Locomotor Categorization TGMD-2				Total	P-value
	Coastal		Mountains			
	n	%	n	%		
Boys	33	59,7	29	44,6	65	0.598
Girls	32	49,3	36	55,4	68	
5 year Old	40	61,5	44	67,6	84	0.463
6 year old	25	38,5	21	32,4	46	
Under 100cm Height	35	53,8	30	46,2	65	0.380
Over 100cm tall	30	46,2	35	53,8	65	
BMI below 13kg	37	56,9	31	47,6	68	0.292
BMI above 13kg	28	43,1	34	52,4	62	

In contrast, Table 13 shows the results of locomotor ability as seen from the results of the TGMD-2 assessment and mountain coastal geographical conditions. The P-value results also show less than <0.05, which indicates that there is a relationship between the TGMD-2 assessment and the geographical conditions of the mountainous coastline on children's locomotor abilities.

Overall, the data presented in Figure 2 provide valuable insights into children's gross motor development and can help parents and educators adjust the motor learning process so that children's growth and development will be maximized.

Table 13. Descriptive analysis of total locomotor score of coastal and mountain areas and TGMD-2

	Locomotor Categorization TGMD-2				Total	P-value
	Coastal		Mountains			
	n	%	n	%		
Run	13	22,8	8	11,1	21	0.013
Gallop	1	1,7	20	27,7	21	
Hop	8	14,3	13	18,5	21	
Horizontal Jump	11	19,2	10	13.8	21	
Skip	11	19,2	9	12,5	20	
Slide	13	22,8	12	16,6	26	

DISCUSSION

The results showed that the geographical environment has a significant influence on the development of children's motor skills. Children living in coastal areas tend to have better motor skills compared to children living in mountainous areas. This may be explained by differences in the types of physical activities available in these environments. In coastal areas, children may be more involved in activities such as swimming, playing in the sand, and other water activities that can improve their gross motor skills and object control. In contrast, children in mountainous areas may have less access to such physical activities, which may limit the development of their motor skills.

Compared to previous research conducted Asnaldi et al., (2020) and Saparia et al., (2023) provides important insights into the development of children's motor skills in different geographical locations. Asnaldi et al. focused on the ability to control objects, which includes skills such as catching, throwing, and kicking. The study found that children in coastal areas showed better object control ability compared to children in mountainous areas.

The geographical location of where children live varies, thus affecting children's physical abilities (Goodway et al., 2010). The geographical location where children live has a significant influence on their physical and motor abilities. Children growing up in different environments face diverse physical conditions, which affect the type and frequency of physical activity they engage in. Research shows that children who live in coastal areas tend to have better locomotor skills compared to those who live in mountainous areas.

The beach environment offers unique terrain, such as unstable sand and uneven terrain, which naturally challenges and enhances children's motor skills. Children in beach areas are accustomed to playing in the sand, walking along the beach, and engaging in physical activities that demand more

complex motor adaptations. These daily activities improve locomotor skills such as balance, coordination, and muscle strength, which become more developed compared to children living in areas with flatter or uphill terrain such as in the mountains. The more physical activity that is done the level of physical fitness will be higher (Safaringga & Herpandika, 2018).

In addition to these differences, nutritional status also has an effect, children with poor nutrition or obesity will interfere with children's health and movement skills (Yunita, 2021; Hafidah & Nurjanah, 2022). This research has shown that children with good nutritional status tend to have better motor skill development compared to children who are malnourished or obese. Good nutritional status provides the energy and nutrients necessary for the development of muscles, bones, and the nervous system that support motor skills. In addition, children with good nutrition tend to be more physically active, which further strengthens their motor skills.

Children with poor nutritional status will experience direct physical growth barriers which affect the level of children's movement skills. The ability to move in children with good nutritional status will be maximized compared to children with poor nutritional status or obesity. children with poor nutritional status, or obesity. This is because children's movement skills are strongly influenced by individual nutritional status (Sepriadi, 2017).

This study corroborates previous findings that gender has a significant influence on locomotor ability in children (Colombo-Dougovito, 2017). The results show that boys tend to have better locomotor skills than girls, both in coastal and mountainous areas. This phenomenon can be explained by differences in physical activity patterns and play characteristics between boys and girls. However, these sex differences in locomotor skills were consistent across a range of geographical environments, whether in coastal areas with sandy terrain and challenging winds or in mountainous areas with steep and rocky terrain. This suggests that sex factors are more dominant than environmental influences in determining the development of children's locomotor skills (Arifiyanti, 2020).

Moreover, this study provides contrasting results from previous research that the difference is the facilities available at home or school that enable children to develop their potential (Rohyana & Adawiyah, 2018). Children's locomotor skills require a large play area so that children can freely move and move appropriately. It is not limited if the area is indoors or outdoors. If the school provides sufficient facilities for their locomotor abilities, their movement skills will be better. Environmental facilities including schools and homes are a factor in the condition of children's motor skills not developing as they should, an environment that does not have sufficient play facilities will result in stunted child development (Wang et al., 2022).

The results of the study in general both children from mountainous and coastal areas have average locomotor abilities. When viewed from the results of locomotor abilities, children from mountainous areas do not fall into this category, while coastal areas do. This can also occur from the teacher's ability to teach is very influential on children's locomotor abilities. The difference in the quality of teachers in the two regions is also influential. The teacher's ability to teach has a significant effect on children's motor skills. (Nobre et al., 2020), although further research is needed on the quality of teachers in both coastal and mountainous areas.

The implications of this research are expected to be able to provide an overview of children's locomotor abilities in detail from previously conducted research. It was found that the average index of locomotor ability in coastal areas was better. This research is very helpful for further researchers to be able to develop the potential of movement and can also be one of the indicators used to map the direction of motor development in early childhood based on regional potential.

Conclusion

In conclusion, the results of data analysis show that there is a relationship between children's locomotor abilities and geography in the two different locations, namely mountains and coasts. The average child's locomotor ability in coastal areas was found to be superior compared to mountainous areas.

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Conflict of Interest

We declare that the article we have written is not involved in any conflict of interest.

Ethics Statement

This research has been approved by the Ethics Committee of the University of State Yogyakarta (Reg.No.:T/53/UN34.9/KP.06.07/2024).

Author Contributions

Study design, AF, D and YA; Data collection, AF; Statistical analysis, AF; Data interpretation, AF, D and YA; Literature search, AF, D and YA. All authors have read and approved the published version of the manuscript.

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RESEARCH ARTICLE

The Level of Accuracy of the Expert System Training Data Uses the Naive Bayes Algorithm to Measure the Distance of A Ball Kick

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Abstract
The importance of data accuracy in the implementation of long-distance kicking tests as basic data for coaches requires adequate facilities and requires large costs, so technology is needed for facility and budget efficiency. The purpose of this research is to determine the accuracy of expert system training data using the Naive Bayes algorithm to measure the distance of a ball kick. The research design used is a quantitative method with an experimental model. The type of experimental design is pre-experimental design. Participants amounted to 100 male soccer players with saturated sample technique. The instruments were question forms to obtain information on gender and age, while to measure leg muscle strength and leg muscle strength using a tape roll meter and leg dynamometer. Data validity uses calibrated tools. The data analysis technique uses probability (naive bayes) using data testing and evaluation. The results of the study obtained the accuracy level of the expert system training data using the naïve bayes algorithm with the best accuracy of 100%. There is a training data learning model used using the 99 scheme and test 1 and 98 and test 2. The conclusion is that the accuracy level of expert system training data using the naive bayes algorithm is declared to be accountable for use in classifying new data. The contribution for further research is testing using new data to determine the level of accuracy further to improve accuracy in learning training data.

Keywords
Expert System, Naive Bayes, Accuracy of Training Data

INTRODUCTION

The ability to kick long distances of soccer players in soccer matches is an integral part of the match. According to the results of data analysis of one of the soccer leagues in Europe, namely the premier league, it states that in each match an average long pass or long kick occurs an average of 60 times per team, of course this will also determine the sustainability of the playing strategy in the match (Millah et al., 2022). The importance of long-distance kicks for soccer players is the urgency of a team in determining match tactics and strategies, for this reason it is important to develop the ability to kick long distances for players (Nggola et al., 2018). Long distance kick measurements can be taken periodically to measure the development of player abilities. This is certainly an obstacle in itself to control the results of training on the long-distance kicking ability of players (Tohari et al., 2022). The ability to kick long distances is largely determined

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by leg length, muscle strength, age, gender and sex (Baker et al., 2022).

Indonesia Muda Football Academy is one of the outstanding football academies in the city of Kebumen, Central Java, Indonesia. This football academy focuses on coaching football in all age groups and has good management. Preliminary studies have been conducted by researchers at Indonesia Muda Footbal Academy. A number of studies have often been conducted at this club. Research that is often done is limited to measuring leg muscle strength and the length of kicks in soccer training. Objective measurements in sports, especially soccer, are increasingly in demand to improve player performance and match analysis. One of the important aspects in soccer is kicking power. Expert systems with the Naïve Bayes algorithm offer the potential to provide accurate and fast measurements of soccer kicking distance. However, there is limited research that specifically addresses the accuracy of Naïve Bayes-based expert systems in measuring the distance of soccer kicks. Variations in the training data used, selection of relevant features, and algorithm parameter settings can significantly affect system performance.

Long distance kicks need to be taken to assess player performance and player quality. The measurement of long distance kicks requires a soccer field for the test. One important aspect of soccer performance analysis is the player's ability to kick the ball, especially in providing long-distance passes (Latuheru et al., 2022). The analysis of ball kicking distance is key in evaluating player performance, developing game strategies, and improving match results, but doing the analysis manually is often time consuming and not always accurate, therefore a technology is needed to facilitate the data retrieval process, one of which is AI (Artificial Intelligence) technology.

The machine learning process requires an algorithm, the algorithm to be used is the naïve bayes algorithm. Naïve Bayes algorithm is a probabilistic classification algorithm that is simple and easy to understand. It is based on Bayes' Theorem and the assumption of feature independence. Bayes' theorem is a formula used to update the probability of an event based on new information. The feature independence assumption states that all features in the training data are independent of each other. By using Bayes' Theorem and the assumption of feature independence, the Naïve Bayes algorithm can calculate the probability of a data point belonging to a particular class.

The importance of machine learning in training data in expert systems using the naïve bayes algorithm as a reference in the classification of new data. The indicator of machine learning intelligence in the expert system can be seen in the accuracy in the learning process in detecting the distance of the ball kick in a soccer game. For this reason, in order to facilitate measurement without carrying out tests, it is necessary to have an application system that is made to facilitate and predict the long distance kicking ability of players, but the training data is only limited to leg length, age, gender and leg muscle strength. This study aims to measure the accuracy of expert system training data using the Naïve Bayes algorithm to measure the distance of a ball kick. The researcher limits this research problem only to create an application system that is made to predict the ability of long distance kicks and measure the accuracy level of expert system training data using the Naïve Bayes algorithm. In the end, can expert system technology using the Naïve Bayes algorithm be used to measure the accuracy of training data?

MATERIALS AND METHODS

Expert System

Expert system is a system that adopts human expertise and intelligence into computers (Bonicalzi et al., 2023). Expert systems can be used to find out facts from an assumption (Mark S. Fox, 1990) the rules or procedures used are information obtained from human experts, and represent the information in the form of rules, such as IF-THEN. The rules can then be used to perform operations on the data to perform inference to reach the right conclusion (Liao, 2005). Expert systems can be used for verification and validation of a survey (O'Keefe & O'Leary, 1993). Like the problems found by researchers.

Naive Bayes Algorithm

Algortima was first put forward by Al-Khwarizmi who was a mathematician, astronomer and geographer in the 9th century AD (Fadjeri et al., 2021). Algorithms are mathematical procedures or rules made to provide alternative solutions (Fadjeri et al., 2020). Algorithms are compound control structures that are limited, abstract, effective, imperatively given, achieving certain goals under given conditions (Charntaweekhun &

Wangsiripitak, 2006). Algorithms must have input, output criteria, have a clear direction and have limitations with design methods with fundamental algorithms, flow charts, pseudo code (Burhaein et al., 2023). Naïve Bayes Classifier is a classification method rooted in Bayes' theorem. The main feature of the Naïve Bayes Classifier is the very strong assumption (naïve) of the independence of each condition or event (Silahudin et al., 2020). In Bayes' theorem, if there are two separate events (let's say A and B), then Bayes' theorem is formulated as follows:

$$P(A|B) = \frac{P(A)}{P(B)} P(B|A)$$

(Fadjeri et al., 2020)

Bayes' theorem is often extended given the applicability of the law of total probability, to the following:

$$P(A|B) = \frac{P(A)P(B|A)}{\sum_{i=1}^{n} P(A|B)}$$

$$dimana\ A_1 U\ A_2 U \ldots Un = S$$

(Fadjeri et al., 2020)

To explain the Naïve Bayes theorem, it is necessary to know that the classification process requires a number of clues to determine what class the analyzed sample fits into. Therefore, the Bayes theorem above is adjusted as follows:

$$P(C|F_1 \ldots F_n) = \frac{P(C)P(F_1 \ldots F_n|C)}{P(F_1 \ldots F_n)}$$

(Fadjeri et al., 2020)

Where the variable C represents the class, while the variables F1 ... Fn represent the characteristics of the characteristics of the clues needed to classify. Then the formula explains that the probability of a sample with certain characteristics being included in class C (posterior) is the probability of class C appearing.

Algorithm Evaluation

Algorithm evaluation is needed to determine the performance of the algorithm (Debelee et al., 2019), but in this study it is used to determine that the prediction results from training data and testing data. The evaluation in this study uses accuracy (Sunardi et al., 2017). The accuracy formula is as follows:

$$Accuracy = \frac{a+d}{a+b+c+d}$$

(Fadjeri et al., 2020)

Accuracy is widely used in algorithm evaluation.

The method used in this research uses an experimental method. Testing the accuracy results there are two parts, namely the machine learning method and the classification method with the naive bayes algorithm (Woollam et al., 2020). The naive bayes algorithm is used in machine learning and classification because the Naive bayes algorithm gets the best accuracy from research (Diseases et al., 2018; Wibawa, Muhammad, Muhammad, 2018). Machine learning is a method by receiving and analyzing input data to then be able to predict the output value of the research dataset (Borror et al., 2019). Classification is done with new data with methods that have been obtained in the best machine learning mode. The data analysis technique uses probability (naive bayes) by using data testing and evaluation.

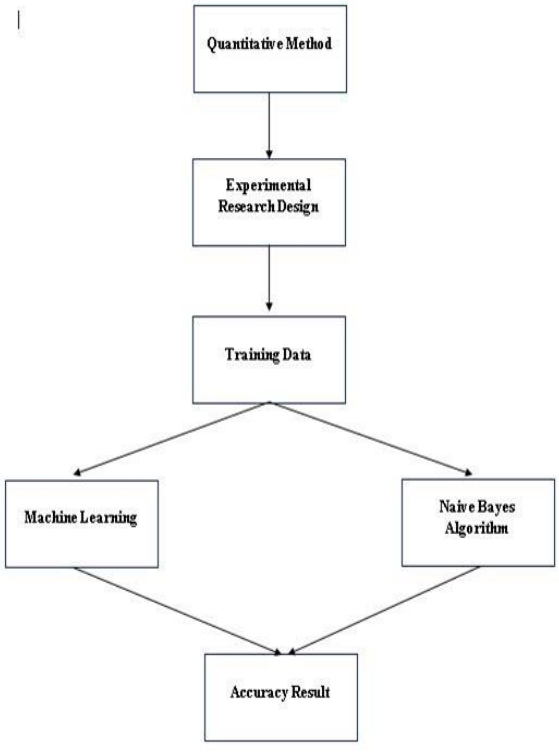

Figure 1. Research design flowchart

Participants

Research participants are subjects who voluntarily give consent to participate in scientific research. Participants are the source of data used by researchers to collect research information from a variety of backgrounds, including different age groups and genders. Before participating in a study, participants are usually given full information about the purpose of the study, procedures, risks, benefits, and their rights. Participants give voluntary consent after understanding the information from the researcher. The population in this study were soccer

players from the Indonesia Muda soccer school, totaling 100 football players.

Based on the ethical clearance letter regarding the determination of the validity of the research data from the Sekolah Sepak Indonesia Muda Kebumen club, it was declared valid for research. The research subjects have provided in-depth, informative, and voluntary consent before being involved in the research. Researchers are responsible for ensuring that research subjects fully understand the purpose, methods, risks, and benefits of the research conducted in accordance with the Helsinki Statement. Additional precautions were taken by the researcher to protect the volunteers in this study.

Data Collection Instruments

Data collection for this study is data on leg length, age, gender, leg muscle strength, and ball kick length tests which involve a series of steps to obtain accurate and representative information through appropriate validity and reliability stages. Validity of measuring instruments is an important aspect in research to ensure accurate and reliable measurement results (Saputra, 2022). All measuring instruments used in this study, namely the tape roll meter and leg dynamometer, are well calibrated. Instrument reliability refers to the extent to which the measurement instruments used in research are consistent and stable in producing measurement results. In this study, the reliability of measuring instruments is important to ensure that the measurement of ball kicking distance and other related variables is accurate and reliable. One of the steps is to test the leg dynamometer instrument used to measure leg muscle strength and the meter for measuring leg length with the same subject to assess the consistency of the measurement results and measure the variables at different times with the same subject, and calculate the correlation between the first and second measurement results to assess temporal consistency.

Participants filled in their biodata by showing their identity card (KTP) or other identity to determine gender and age. Anthropometric measurements to measure leg length using a calibrated tape measure (roll meter), leg muscle strength measured using a leg dynamometer while measuring the length of the kick using a calibrated tape measure (roll meter). Before doing the long kick test, all subjects were briefed first, after which the players warmed up sufficiently. All players were given the opportunity to do 3 long kicks and 1 kick was taken the longest.

Test Design

The test design refers to the process or technique of collecting data which includes leg length data, age data, gender data, leg muscle strength data, and data on the distance of kicking the ball.

Participants fill in age and gender biodata by showing an Identity Card (KTP) or other identification,

Participants measure limb length using a calibrated roll meter tape,

Participants measure leg muscle strength using a calibrated leg dynamometer,

Participants are given an understanding of the technical implementation of the long kick test,

Prepare the tools needed, namely, leg dynamometer, and roll meter.

Exercise Intervention

The treatment is done several times until getting the highest accuracy value in machine learning using the native bayes algorithm. The 100 data will be divided into training data and testing data. With several treatments to get the best accuracy in the machine leaning scheme. Classification is done with new data with those that have been obtained in the best machine learning mode. Data analysis techniques use probability (naïve bayes) using data testing and evaluation. The evaluation used uses accuracy, then the explanation is seen in Figure 2.

Statistical Analysis

The stochastic calculation used uses a confusion matrix consisting of accuracy, precision, recall and F1-score. The analysis results used in the study use accuracy as the accuracy formula that has been raised and becomes a reference. Algorithm evaluation is needed to determine algorithm performance (Fadjeri et al., 2020). However, in this study it is used to determine the prediction results of training data and testing data. The evaluation in this study uses accuracy (Armstrong, n.d.).

The accuracy formula is as follows:

$$\text{Accuracy} = \frac{a+d}{a+b+c+d}$$

(Santra & Christy, 2012).

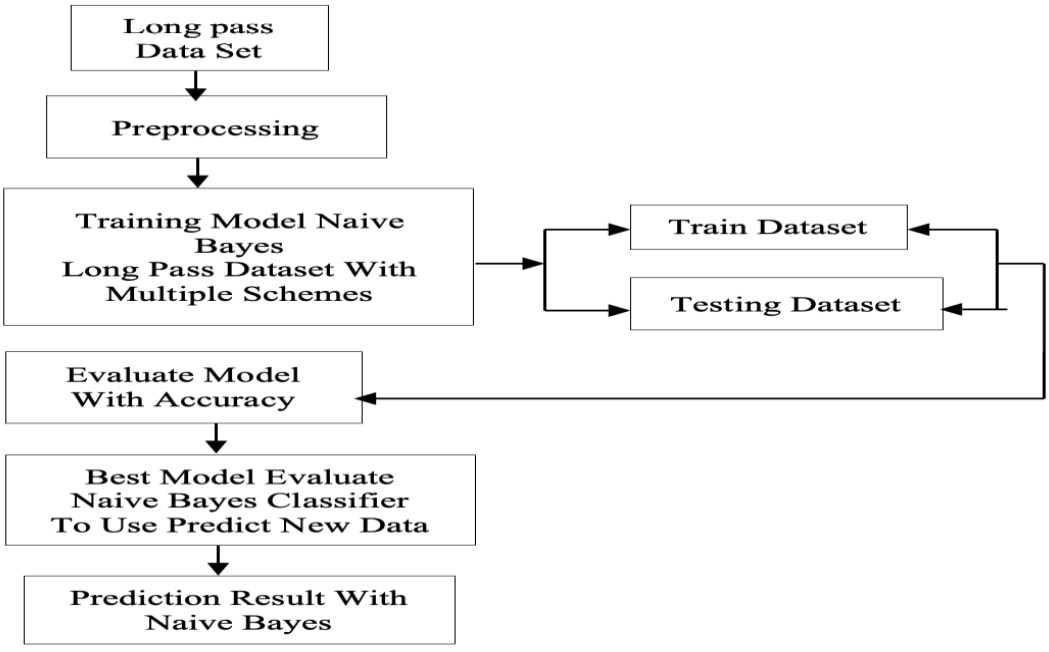

Figure 2. Research flow

RESULTS

The machine learning process uses 100 data as training data that has been validated and has ethical clearance. The training data is the data that will be carried out machine learning in the expert system using the naïve bayes algorithm.

Table 1. Train data of football players

No.	Leg Length	Leg Power	Age	Long Pass (m)	Gender	Height (cm)	Education
1	92	850	24	55	Male	165	Student
2	88	720	19	48	Male	169	Student
3	95	790	23	62	Male	170	Student
4	91	680	22	54	Male	168	Student
5	89	910	22	57	Male	171	Student
*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*
99	93	960	22	60	Male	170	Student
100	90	830	23	56	Male	167	Student

Schemes in machine learning on training data will be carried out several division schemes such as 90:10, 95:5, 99:1, 98:2, 97 :3, 96:4, 94:6, 93:7, 92:8, 91:9. The machine learning results obtained from the training data are shown in Table 2.

Table 2. Machine learning scheme

No	Skema	Training	testing	Train score	Test Score
1	99:1	99	1	54,5%	100%
2	98:2	98	2	54,08%	100%
3	97:3	97	3	54,6%	66,66%
4	96:4	96	4	53,12%	50%
5	95:5	95	5	52,26%	40%
6	94:6	94	6	52,12%	50%
7	93:7	93	7	54,34%	37,5%
8	92:8	92	8	54,34%	37,5%
9	91:9	91	9	53,84%	44,44%
10	90:10	90	10	55,55%	40%

The results of the analysis seen from table 2 state that there is a significant difference in results between the 99:1 and 92:8 schemes with a difference of 62.5%. From the results of table 2 it can be explained that in the 90 scheme: 10 get an accuracy rate of 40%, scheme 91: 9 get an accuracy rate of 44.44%,, scheme 92: 8 get an accuracy rate of 37.5%, scheme 93: 7 get an accuracy rate of 37.5%, scheme 94: 6 get an accuracy rate of 50%, scheme 95: 5 get an accuracy rate of 40%, scheme 96: 4 get an accuracy rate of 50%%, scheme 97: 3 get an accuracy rate of 66.66%%, scheme 98: 2 get an accuracy rate of 100%, scheme 99: 1 get an accuracy rate of 100%. Of the 10 schemes obtained the best results on machine learning schemes in scheme 99: 1 scheme with 100% accuracy rate and 54.5% train score. Figure 2 Line diagram related to machine learning results on 100 train data.

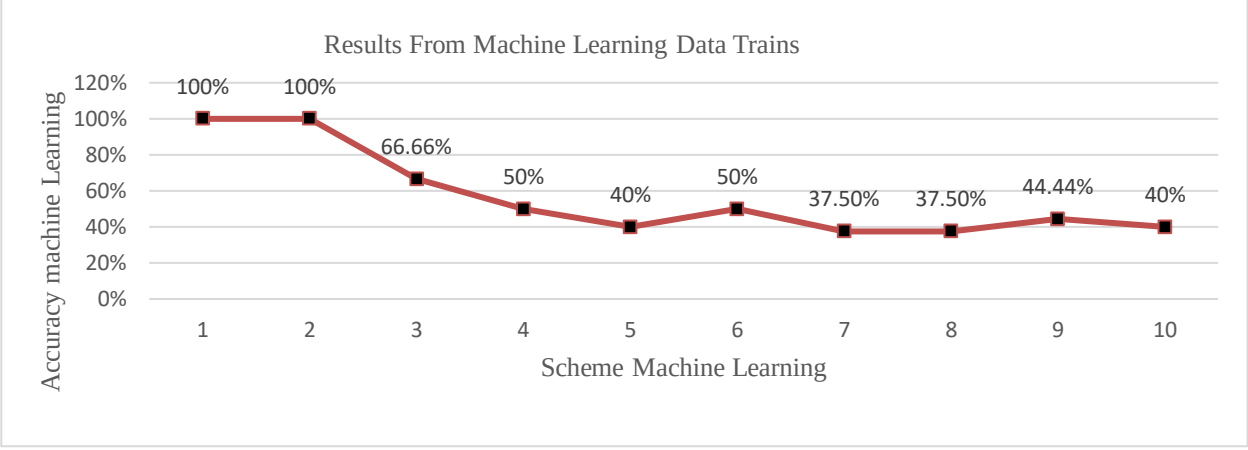

Figure 3. Machine learning results diagram on 100 train data

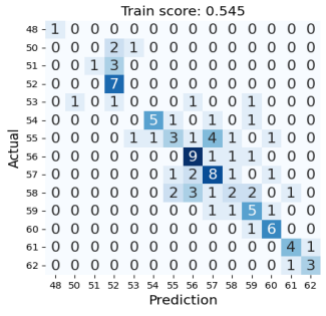

Figure 4. Confusion matrix result of 99:1 scheme

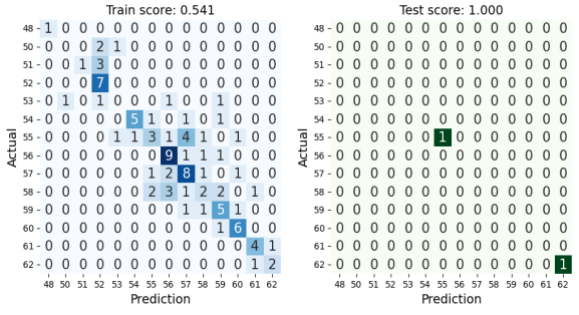

Figure 5. Confusion matrix result of 98:2 scheme

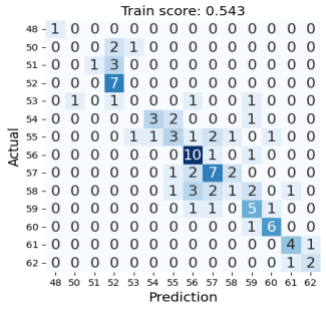

Figure 6. Confusion matrix result of 93:7 scheme

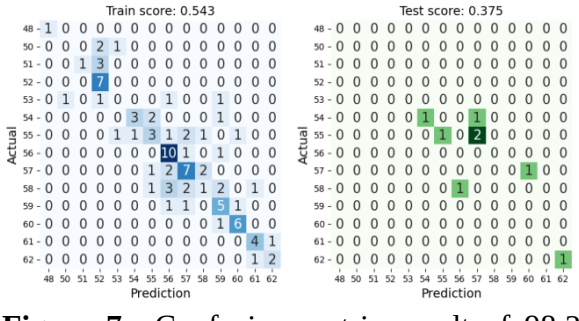

Figure 7. Confusion matrix result of 98:2 scheme

DISCUSSION

The results showed that the 98:2 learning model scheme and the 99: 1 learning model scheme gets 100% accuracy value during training. This is in accordance with the theoretical concept with the naïve bayes treatment carried out several times until the highest accuracy score is obtained in machine learning using the native bayes algorithm. The 100 data will be divided into training data and test data. At least with the best scheme of 90% training data and 10% testing data and several treatment schemes

to get the highest accuracy value (Burhaein, et al, 2023).

Based on the main scientific foundation in the field of sports and technology, the research results can be concluded that the machine learning data train expert system using the naïve bayes algorithm can be used for testing using new data with the highest and best accuracy. The limitations of this research are still up to the machine learning process which is the main part of the expert system and the display still uses native desktop-based. The advantage is that the expert system with the naïve bayes algorithm can classify quickly, efficiently and does not require internet access so that it can be implemented anywhere and anytime.

Research up to the machine learning stage in artificial intelligence, where the results of machine learning as scientific work belonging to (Sreemathy et al, 2023) are used as a reference in the use of new data for the classification of the distance of the ball kick.

Conclusions

The conclusion is that the accuracy level of the expert system training data using the naïve bayes algorithm to measure the distance of the ball kick gets the best accuracy in training data learning with an accuracy score of 100%. The training data learning model used uses 99 schemes and test 1 and 98 and test 2. The accuracy level of expert system training data using the naïve bayes algorithm is declared accountable. The limitations of this study are the research dataset for only 100 participants and other variables that were not included such as kick angle, wind direction speed, field conditions, and body balance when kicking the ball. Contributions to future research are testing using new data and adding participants and adding new variables to get better accuracy results when learning training data.

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Conflict of Interest

We declare that we are not involved in any conflict of interest in this and other scientific articles.

Ethics Statement

This research was conducted in accordance with the Helsinski Declaration. Ethical approval of this study was obtained from Yogyakarta State University on May 15 2024 and numbered 054/A/VI/2024 Ref. 0626118703, 2024

Author Contributions

Research Design, YFI, CCVL; Data Collection, YFI,AF, IPW, and PM; Statistical Analysis, RL, DT, and AF; Data Interpretation, RL, DT, and AF; Manuscript Preparation, YFI, AF, IPW, and PM; Literature Search, YFI, CCVL, AF, IPW, and PM. All authors have read and approved the published version of the manuscript.

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RESEARCH ARTICLE

Mental Fitness and its Relationship to Achievement for Professional Players in the Palestinian Soccer League

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Abstract
The current study aimed to know the mental fitness and its relationship to achievement among the players of the professional soccer league in Palestine, and to achieve the objectives of the study the descriptive analytical approach was used. the researchers designed a questionnaire based on previous studies. It was distributed to stratified random sample consisted of (121) male soccer players from professional clubs, and the study sample was chosen in a stratified random manner, due to its suitability to the nature of the current study. SPSS program was used to analyze the results of the respondents' responses, and the study concluded that there is a high mental fitness in all its fields (the ability to imagine, mental preparation, self-confidence, dealing with anxiety, the ability to focus, motivation, focus and decision-making and the total score),among professional players and similar regardless of the player's position on the field, the study also showed that the players of the clubs that occupied the top ranks have ahigher level of mental fitness. The researchers suggested the necessary of taking care of mental skills and trying to develop them to raise the level of achievement motivation for soccer players, and the need to pay attention to training mental perception of players, and conduct research on the relationship of mental perception with other soccer skills.

Keywords
Mental Fitness, Achievement, Soccer,Professional League

INTRODUCTION

The mental fitness is important for the player, as he makes great and distractive efforts for possession of the ball, as well as knowing the strength and weakness of the opposing player. Mental fitness reflects the health and quality of the overall mental state of the player, with it's simple and complex abilities,thinking and analytical capabilities, interacting with coach, sharing information, summoning what has been stored and making judgments on specific situations (Budeir 2019).

Mental fitness is among the most important factors and determinants in the process of learning and training motor skills, which workers in the sports field have paid attention to for the purpose of studying and knowing the individual differences between people, and that mental fitness is important in the performance of sports skills, as it is what enables the athlete to reach a mental state that prevents the entry of negative and distracting thoughts towards his sporting activity (Aljenabi, 2018).

In order to raise sporting achievement to the maximum level, the athlete needs to develop his mental ability, and mental preparation plays an important role in the ability to think properly and behave well for players during training and matches, the importance of mental preparation increases as the competition between the two teams intensifies and at all times of the match, especially in critical moments during the course of the match.

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Any coach must develop the mental capabilities of the players to help them think properly and act appropriately during the match. The coach must also provide his players with theoretical and applied knowledge and information, such as the rules and laws of play, health aspects, and human characteristics, in addition to the technical and tactical aspects of soccer. To help them understand such matters and deal with them mentally (Banhan, 2016).

The feeling of dread during confrontation remains dominant, and may even become a belief and obsession experienced by players, coaches, administrators, and the public. It is similar to negative customs and traditions in societies, and it is difficult to remove negative belief once one recognizes it, and here comes the role of mental preparation during training periods, and matches, to treat cases, all cases that occur to the player using correct scientific methods that do not contradict the method that the player learned during the stages of development. The coach must know the importance of mental preparation, neglecting this aspect causes the players to not behave properly in difficult situations during the course of the matches, and this may cause the failure of the player and perhaps the failure of the entire team, and the results may be disastrous in some cases. The reason is the coach's lack of attention to the mental preparation and development of the mental capabilities of the players, especially since Mental preparation is an important educational duty of the coach, because developing the player's mental abilities makes him a creative player with principles who knows how to move on the field consciously, and how to use the appropriate basic skills that he possesses for different playing situations, and it is closely linked to tactical preparation (Altoto, 2018).

The athlete's arrival at the highest levels of sport is based on what is called athletic achievement motivation, which means the athlete's readiness to confront situations of sporting competition and try to excel and excel by showing the greatest possible amount of activity, effectiveness and perseverance as an expression of the desire to struggle and strive for excellence and excellence.In sporting competition situations (Sanari,2017).

Halawa, (2017) pointed out that the personal components of sports achievement motivation are:

• Motivation to achieve success: This motivation represents the internal motivation of the player to turn towards certain activities and the motivation to try to achieve excellence and thus the feeling and feeling of satisfaction and happiness. This is not affected by external influences, but rather it can be said that it is an internal state in the individual that directs and moves him to achieve a specific goal that he sets for himself. This motivation can be considered one of the personal characteristics of the player, that is, that Pure individuality, and is completely different from the other player, and this motivation changes with the two variables (the probability of success, the attractiveness of achieving the goal).

• Motivation to avoid failure: This motivation represents the internal motivation of the player to turn towards certain activities and the motivation to try to achieve excellence and thus the feeling and feeling of satisfaction and happiness. This is not affected by external influences, but rather it can be said that it is an internal state in the individual that directs and moves him to achieve a specific goal that he sets for himself. This motivation can be considered one of the personal characteristics of the player, that is, that Pure individuality, and is completely different from the other player, and this motivation changes with the two variables (the probability of success, the attractiveness of achieving the goal).

Mental fitness is one of the psychological matters that plays an important role in the process of learning skills and applying game plans during matches. It is also considered the decisive factor in many cases of playing during matches, and through the researcher's experience and his follow-up of football in general and the performance of players in the partial professional soccer league in Palestine. In particular, he noticed that the process of paying attention to mental fitness and the dimensions it includes, such as the ability to imagine, mental preparation, self-confidence, dealing with anxiety and other mental skills, as well as the type of its relationship with basic skills, were not given sufficient attention by trainers and those responsible for the training process despite its impact on the player's ability to perform optimally if mastered and trained in it, This is often due to the lack of the training curricula developed by coaches in the part related to psychological preparation, and this is the root of the problem (Daşkesen & Alp, 2024). Therefore, the researcher decided to study the mental fitness of the players of the partial professional soccer league in

Palestine and the impact of that fitness on the level of achievement of these players.

Many studies have been conducted in the field of mental fitness (Budeir, 2019; Majeed et al., 2018; Hawari, 2017; Abu-Tame, 2015; Awwad, 2015; Hidayat, 2014; Bervoets, 2013), While a number of those interested in studying sports achievement motivation (Salama, 2023; Bahri & Kharmoush, 2021; Amer & santaresi, 2021), There are, as far as the researcher knows, no studies to find the relationship between them, so this study seeks to identify:

The level of mental fitness among players in the professional soccer league in Palestine.

Differences in fitness level among professional players depending on player position(goalkeeper, deffender, midfield, striker).

The relationship between mental fitness and achievement among professional players in Palestine league.

MATERIALS AND METHODS

To achieve the objectives of the study descriptive and relational survey model", one of the quantitative research methods was used.

Study Group

A total of (121) male players representing professional clubs in Palestine, selected in a stratified random manner were included in the study

Table 1. The characteristics of the study sample according to the variables of age, hight,and body weight

Variable	Measuring Unit	Arthmetic Mean	Std.Dev	Minimum	Maximum	Skewness
Age	Year	24.7	4.46	18	33	.339
Weight	Kg	73.8	4.94	65	83	.220
Hight	M	1.77	.053	168	190	.220
BMI	Kg\M^2	23.42	1.97	18.01	27.73	.220

It is evident from Table.1 that the results of skewness for (age, weight, hight, and BMI) came between (-3 and +3) which indicates the achievement of homogeneity between the study group, and their subjection to a normal equilibrium distribution.

Ethics Statement

Regarding the ethical appropriateness of the study, consent was obtained at the meeting of Faculty of physical education and sports sciences, Palestine Technical University – Kadoorie dated 24.06.2024 and numbered 2024/06. Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Data Collection Tools

A questionnaire was designed based on many studies and expert opinion, It included eight areas of mental fitness (the ability to imagine, mental preparation, self-confidence, dealing with anxiety, the ability to focus, The ability to relax, motivation, focus and decision-making). In line with the objectives of the study, a five-point response scale was developed for the questionnaire items, and a score was assigned for each response as follows: To a very much agree (5 marks), to a highly agree (4 marks), to a moderately agree (3 marks), to a slight agree (2 marks), and to agree very small extent (1 degree). The researchers relied on judging the level of responses of the study sample using the criterion that relies on the true limits of the degree of response levels according to the following table (2).

Table 2. Actual limits of the degree of response levels according to the five-point Likert scale

Persentage%	Mean	Level
84-100	4.2-5.0	Very high
68- less than 84	3.4 – less than 4.2	High
52 – less than 68	2.6 – less than 3.4	Moderate
36- less than 52	1.8 less than 2.6	Low
Less than 36	Less than 1.8	Very low

Data Analysis

A statistical program was used in the statistical analysis of the data obtained. Arithmetic mean, standard deviation, percentage were used to find the level of mental fitness. One-Way Anova were used in the analysis of differences in the mental fitness between professional players regarding there position in the field (goal keeper,defender,midfield,and striker). Spearman's correlation coefficient was used in the analysis of the relationship between mental fitness and achievement of professional clubs in the palestinian league. Data were collected using the statistical package for social sciences-SPSS version 20.0 software (IBM,USA)

RESULTS

The results related to Table (3) in the areas of mental fitness showed that the field of focus and decision-making came in first place and obtained the highest percentage, reaching (80.4%) at a high level, then the field of motivation, with a percentage reaching (74.6%), at a high level. The field of self-confidence, the field of dealing with anxiety, and self -confidence came at a moderate level, with a percentage of (66.6%, 57.2%, , respectively, while the field of ability to focus came in last place, with a percentage of (50%) and a low level, and the total score for mental fitness came in a high level, with a percentage (69.4%).

Table 3. Arithmetic means, standard deviations, and percentages for areas of mental fitness n=121

Rank	Field	Mean Square	Std.Dev	Percentage%	Level
1	Focus and decision making	4.02	.49	**80.4**	High
2	Motivation	3.73	.79	74.6	High
3	Mental preparation	3.72	.73	74.4	High
4	The ability to imagine	3.5	.44	70	High
5	The ability to relax	3.44	.46	68.8	Moderate
6	Self confidence	3.33	.45	66.6	Moderate
7	Dealing with anxiety	2.86	.97	57.2	Moderate
8	The ability to focus	2.5	.87	50.0	Low
	Total	3.47	.29	69.4	High

Table 4 & 5 showed that there are no statistically signifigant differences at a signifigance level ($\alpha \leq 0.05$) in the mental fitness between professional players regarding there position in the field (goal keeper, defender, midfield, and striker)

Table 4. Arithmetic means, standard deviations of mental fitness for professional players n=121

Position of player	N	Mean Square	Std.Dev
Goal keeper	14	3.47	0.32
Defender	41	3.52	0.28
Midfield	43	3.39	0.27
Striker	23	3.51	0.29

Table 5. ANOVA results for mental fitness between professional players n=121

	Sum of Square	df	Mean Square	F	P
Between groups	380.027	3	126.676	1.689	**.173**
Within groups	8775.940	117	75.008	0.075	
Total	9155.967	120			

***p<.05**

Table 6. results showed that the players of clubs that were in the lead at the end of competition were mentally fit at a high level, the champion of the competition was Jabal Al-mukaber club with the most level of mental fitness and with average (3.86),then came Hilal Al-quds club,which finished runner-up in second place in terms of mental fitness and with average(3.73).while Al-amary club and Islami Qalqelya came in last and last in terms of fitness with an average of (3.17),(3.07) respectively and were the last two teams in the final league standing and dropped to the lower level.

Table 6. Arithmetic means, standard deviations, and percentages for the professional clubs and their rank in the league

No.	club	mean	Slandered deviation	Percentage%	level	Rank in league
1	Jabal AL-Mukaber	3.86	.15	77.2	high	The Champion
2	Hilal Al-quds	3.73	.23	74.6	high	2
3	Shabab al-khaleel	3.63	.24	72.8	high	3
4	Al-thahria	3.64	.17	72.6	high	4
5	Balatta	3.56	.13	71.2	high	5
6	Wadi al-nees	3.51	.20	70.2	high	7
7	Thaqafi tulkarim	3.49	.07	69.8	high	6
8	Al-beireh	3.36	0.8	67.2	moderate	9
9	Al-samouh	3.35	.07	67.0	moderate	8
10	Ahli al-khaleel	3.21	.20	64.2	moderate	10
11	Al-amary	3.17	.16	63.4	moderate	11
12	İslami qalqelya	3.07	.35	61.4	moderate	12

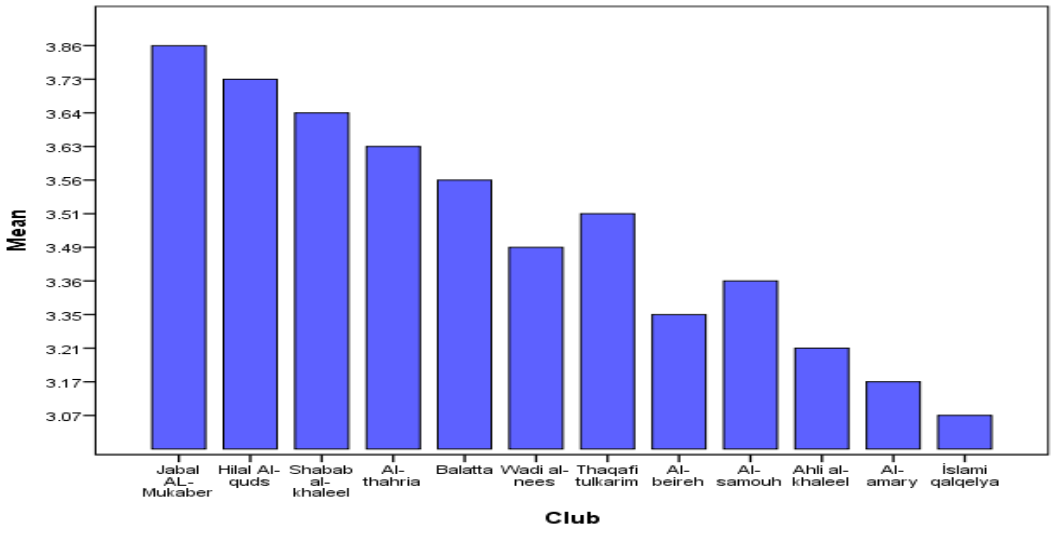

Figure 1. The means of mental fitness for the professional players regards to the rank in the league

Table 7. showed the correlation coefficient and the signifigance value for mental fitness and the rank of professional clubs in the palestinian league.

Variables		Correlation coefficient	P value	Sig
Mental fitness	Achievment(Rank in the league	.993**	.000	significant

DISCUSSION

The present study aimed to Identifying the level of mental fitness among players in the professional soccer league in Palestine, the results showed that the players have high mental fitness, especially in the field of focus and decision-making and motivation, as high mental fitness is caused by preparing the players and this leads to a high level of skill, physical, tactical, psychological and mental performance of the players in terms of their possession of high capabilities and skills (Köse & Atlı, 2020) . They enjoy a good physical level and develop their collective thinking. Progress in the game results from the development of offensive and defensive game plans, as it represents one of the pillars that the team relies on to achieve the best results. The researchers attributes this result to the fact that mental fitness has become essential for soccer players, along with other components, “because of its impact on the player’s intellectual excellence on the field when implementing the required tactic and helping to develop the necessary skills for the player and the ability to analyze tactical situations appropriately in matches. Mental fitness It is useful for treating the psychological stress that the player is exposed to as a result of narrow-mindedness and the inability to find solutions to some of the opposing team’s tactical situations, or the player’s inability to implement the tactics required of him due to his inability to analyze tactical situations or think quickly about finding solutions to them because carrying out duties in matches. It requires acquiring some mental skills that qualify the player with the mental fitness required in the world of soccer.

The study showed that there were no fundemental differences between professional players depending on the playing position, which may be due to the similarity of the training programms and the mental preparation of each club regardless of the player,s position in the field.

The study concluded that there was a positive correlation between the club's end-of-league ranking and the level of mental fitness of its players.the researchers believe this is due to the fact that players who had acheived advanced league ranking were fully prepared to train all the time without getting tired or bored due to their great confidence, that training constantly enhanced their skills and increased their self-confidence and thus this enhanced their mental fitness, and all of this contributed to It is in the interest of the player and achieved victory for the team, and here the players will be satisfied with their sports performance. This is consistent with what (**salama,2023., Amer, m., & santaresi,2021., Kunvarsing,2020., Budeir,2019**) found that individuals who are "high achieves" choose difficult or challenging tasks (they will see value in their success in difficult challenges),it also explains that a "low achiever" will choose easier tasks because they are less likely to fail and are therefore usually guaranteed success. Coach have to balance both (need to achieve) and (need to avoid failure) in his coaching so players improve their performance and achieve goals.

Conclusion

The result obtained in the present study suggest that the level of mental fitness of players of professional soccer clubs in Palestine was high, and is simillar regardless of the player's position in the field, and there is also a relationship between mental fitness and achievement among players of professional soccer clubs in Palestine.

Studies that show the relationship between mental fitness and achievement are still few, Therefore, it is necessary to include mental fitness skills in scientific research and the training process as a major and indispensable part in training soccer players, emphasizing interest in training players’ mental imagery, and conducting research on the relationship of mental imagery to other soccer skills.

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Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics Statement

This study was approved by the scientific and ethics committee of the Faculty of Physical Education and Sport Sciences, Palestine Technical University- Kadoorie (PTUK) written informed consent was obtained from all participants before starting the study. (Approvel Number: 06.2024).

Author Contributions

Study Design, AQ, JA, Data Collection, AQ, OD; Statistical Analysis, AQ and JA; Data Interpretation, JA; Manuscript Preparation, OD; Literature Search, AQ, OD, JA. All authors have

read and agreed to the published version of the manuscript.

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REVİEW ARTICLE

Bibliometric Profile of Research on Physical Activities in Special Education

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Abstract

The aim of the research is to understand the bibliometric profile of physical activity research in special education. The researchers first decided on the database to be searched. Then, keywords were determined and the data were converted into a form suitable for analysis. Then, data analysis was carried out. As a result of the research, a series of keywords were decided to ensure that publications containing research on physical activity in special education were included: "(AB= ("special education")) AND AB= ("sport" or "physical activity" or "exercise") In the first search, 255 articles were reached. After excluding the excluded articles, 137 articles were analysed. Using the restriction options of the WoS database, the search was restricted to consist only of articles and to be between 1992 and 2024. Articles and early access were selected and all languages were selected as the language of publication. VOSviewer, Microsoft Excel 2016 and the open source Biblioshiny package program created in R programming language for bibliometric analyses were used in the analysis of the research data. In this study, the number of publications was taken into account to determine the effective journals in the field, and the number of local and global citations was evaluated to determine the effective publications. In order to evaluate the historical development of research on physical activity in special education, the frequency of publication by years was used. Likewise, in order to determine the publication efficiency of the countries, the number of publications of the relevant authors according to their countries was evaluated. Common word analyses and strategic diagrams were used to identify thematic research areas.

Keywords
Physical Activity, Special Education, Exercise

INTRODUCTION

Special education practices aim to enable individuals with special needs to gain the skills that will enable them to live as an independent individual and then to adapt to their environment. One of the most effective education programmes carried out in line with these objectives is physical activity programmes in special education (Verschuren et al., 2007). Physical activity can be defined as all physical movements that lead to energy consumption as a result of the activity of the muscles on the skeletal system and exceed the pulse level at rest (Department of Health, 2011).

Physical activities in special education play a critical role in the development of individuals with special needs. Physical activity is important for the health and psychological well-being of individuals with special needs at all ages, including childhood and adolescence. The benefits of such activities for individuals with special needs may be even more striking. Because adapting physical activities to individuals with special needs can play a critical role in their education and rehabilitation processes. Such programmes designed by considering individual differences and needs support the social, emotional and physical development of individuals with special needs (Healy et al., 2016; Mcnamara et al., 2022; Burhaein et al., 2024).

Special education practices involving physical activities increase the self-efficacy, self-esteem and quality of life of individuals with special needs and reduce their stress levels (İlhan, 2008). Especially since individuals with special needs who

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participate in inclusive education participate in education in the same environment with their typically developing peers, their social interactions with their typically developing peers are at the forefront (Bakkaloğlu et al., 2019). Physical activities in inclusive classrooms develop both the physical and social skills of students with special needs and reveal interaction and social harmony with peers with typically development. As in all education programmes prepared for individuals with special needs, physical activities should be adapted to individuals with special needs and arranged according to their needs (Hutzler, 2011).

Physical education is an indispensable part of education programmes specially designed for students with special needs. For this reason, physical activity programmes in special education are recommended to be offered in special education schools. Physical education programmes offered in special education institutions aim to increase the abilities of students according to their developmental areas, taking into account the biological age and physical skills of the student. Although it is very important to improve the skills of individuals with special needs through physical activity, it is very important to have expert personnel to carry out these activities, suitable place for activities and tools and equipment to be used (Takahashi et al., 2023; Yılmaz & Soyer, 2018).

Research shows that individuals with special needs who regularly perform physical activity positively affect their health status. At the same time, it is known that the social skills of individuals with special needs who regularly perform physical activities also improve (Aljadeff-Abergel et al., 2012; Alpözgen & Özdinçler, 2016; Görgün & Melekoğlu, 2016). It is emphasised that physical activities in special education have positive effects especially on communication skills, social interaction and behavioural adaptation (American Psychiatric Association, 2013).

It is recommended that children and young people with special needs engage in moderate or vigorous physical activity for at least 60 minutes a day (Baran, et al., 2020). This level of activity is very important not only for improving physical health, but also for improving cognitive function, increasing muscle strength and general well-being. Participation in physical activities can also promote greater social participation and reduce feelings of isolation by establishing better social interactions and relationships (American Academy of Pediatrics, 2021; Jacob et al., 2020).This is because when individuals with special needs have access to special education environments with physical activities that support their individual differences and maximise their potential, significant improvements are observed in their social, emotional and physical development (Gabler-Halle et al., 1993). In addition, physical activities provide important gains in areas such as self-confidence, self-esteem and independence for individuals with special needs. The use of such activities in the special education process improves individuals' motor skills and general physical health, while improving their social skills and providing stress management (Ochsner Health, 2020; Pan, 2010).

Physical activity programmes, whether in the field of special education or for individuals with typically development, also positively affect academic skills. Academic studies suggest that evidence-based physical activities increase general academic achievement. In the study conducted by Latino & Tafuri (2023), the effect of physical activity on individuals' cognitive functions and academic skills was examined. According to the results obtained, physical activities support individuals' brain health and increase their cognitive development. It is stated that these results can increase the academic performance of individuals. The results of the research emphasise that the health to be achieved through physical activities will positively affect the cognitive achievements of individuals (Latino & Tafuri, 2023).

Considering the differences and types of needs of individuals with special needs, their participation in physical activities may also differ. Individuals with special needs often encounter different environmental and social barriers. These barriers may greatly restrict individuals with special needs who are not very willing to participate in physical activities. For this reason, it is seen that individuals with special needs are not willing to participate in physical activities in the society in general (Kirchner et al., 2008).

With the special efforts and support of special education institutions and teachers working in these institutions, individuals with special needs can provide a healthy and more active participation in physical activities (Kirchner et al., 2008; Lambert et al., 2001). In this respect, studies on physical activities in special education are considered important. However, there is no research on

bibliometric analysis of studies on physical activities in special education. The aim of this study is to reveal the bibliometric profile of the studies on physical activities in special education.

In this direction, it is not to interpret the quality of research or the definitions of certain terms, but to contribute to a comprehensive understanding of the literature. In this study, answers to the following research questions were sought regarding the literature on physical activity in special education:

What is the distribution of studies according to years?, What are the top 10 journals according to the number of publications and local citations?, What is the author productivity according to Lotka's law?, What is the distribution of author publications related to physical activity in special education? , What are the ten countries where publications related to physical activity in special education are the most productive?, What are the 10 most cited articles among publications on physical activity in special education?, What are the trending topics among publications on physical activity in special education?, What is the network of interconnected terms in studies on physical activity in special education?

With this research, it is expected to increase the awareness of educators, parents and society in general about the studies on physical activity in special education. It is thought that the compilation and bibliometric analysis of the studies on physical activities in special education will provide important contributions to special education specialists and researchers who conduct research in the field of special education. By revealing the researches on physical activities in the education of individuals with special needs, the studies conducted in this field will become clearer.

MATERIALS AND METHODS

Keyword Identification and Screening

In the research, bibliometric methods are included in order to examine previous research on physical activity in special education. Bibliometric methods allow a research study to be examined objectively without making any subjective judgement based on bibliographic data and to understand the existing gaps in that field (Zupic & Čater, 2015). However, bibliometric analysis differs significantly from systematic reviews and meta-analyses. Systematic reviews and meta-analyses cover a relatively limited number of studies. Bibliometric methods are more advantageous for analysing comprehensive data. In addition, since bibliometric analysis is based on objective data and objective measurements, it contains reproducible results (Kacmaz & Kaçmaz, 2024; Kaçmaz et al., 2024). In the analysis of the articles examined within the scope of the research, the strategies recommended in the literature were used (Fahimnia et al., 2015). The researchers first decided on the database to be searched. Then, keywords were determined and the data were transformed into a form suitable for analysis. Afterwards, data analysis was carried out. As a result of the research, a set of keywords was decided to ensure that publications containing research on physical activity in special education are included: "(AB=("special education")) AND AB=("sport" or "physical activity" or "exercise") In the first scan, 255 articles were reached. After the excluded articles were removed, 137 articles were analysed.

Firstly, a trial study was carried out using search titles, keywords, abstracts and topics. As a result of the search, it was decided to use the keywords "(AB=("special education")) AND AB=("sport" or "physical activity" or "exercise") because it includes relevant and comprehensive studies. The researchers reached 255 articles as a result of the first search. The screening process was finalised on 27.04.2024. Using the restriction options of the WoS database, it was limited to consist of only articles and to be between 1992 and 2024. Articles and early access were selected and all languages were selected as the language of publication. The titles and keywords of the articles were analysed in detail by two researchers and the articles related to physical activity in special education were included in the study. Articles related to psychological well-being, migrant culture, sports coaching, healthy living and obesity, but not related to physical activity in special education were excluded. As a result of these analyses, 137 articles remained. Thus, the bibliographic data of these articles (title, keywords, abstract, year of publication, authors, references and countries) constitute the data set of the study.

Analysing and Controlling the Data

In order to improve the data, the bibliographic data of 137 articles were downloaded from the WoS database as a simple text file. Afterwards, the data file was converted to CSV format and missing data were checked in detail by analysing author names,

publication titles, country names and keywords. A thesaurus and keywords file was created to be used in the analyses and saved to the computer as a .txt file. Afterwards, the data were made ready for analysis.

Analysing the Data

In the analysis of the research data, VOSviewer, Microsoft Excel 2016 and the open source Biblioshiny package program created in R programming language for bibliometric analyses were used. It is known that the number of publications and citations and keyword frequency are frequently used measures in bibliometric analyses (Ucar et al., 2023). VOSviewer is compatible with the WoS database and is used for visualisation in data analysis (Van Eck & Waltman, 2010). In this study, the number of publications was taken into account to determine the effective journals in the field, and the number of local and global citations was evaluated to determine the effective publications. In order to evaluate the historical development of research on physical activity in special education, publication frequency by years was used. Local citation refers to the citations made to the study in the articles included in the analysis, while global citation refers to the total number of citations in the relevant database (Sabancı Baransel et al., 2023). In the research, co-author analysis, which allows the determination of international collaboration networks, was used (Sun & Rahwan, 2017). Likewise, in order to determine the publication productivity of countries, the number of publications of the relevant authors according to their countries was evaluated. Trend analyses can identify more current topics in a research area (Aria & Cuccurullo, 2017). Common word analyses and strategic diagrams were used to identify thematic research areas. Keyword frequencies and trend analyses were used to identify commonly studied topics and current research trends.

RESULTS

General information about the publications related to 137 articles on physical activity in special education between 1992 and 2024 is given in Table 1. Considering the research data, findings are obtained from various sources in the field of physical activities in special education, covering a wide time period. The annual growth rate of articles was 4.81%, indicating a consistent expansion of research over time. It is seen that an average of 9,341 citations are made per article. The number of references totalled 8333.

Table 1. Table of general information about publications on physical activity in special education

Description	Results
Main Information About Data	
Timespan	1992:2024
Sources (Journals, Books, etc)	178
Documents	255
Annual Growth Rate %	4,81
Document Average Age	8,15
Average citations per doc	9,341
References	8333
Document Contents	
Keywords Plus (ID)	455
Author's Keywords (DE)	678
Authors	
Authors	771
Authors of single-authored docs	36
Authors Collaboration	
Single-authored docs	38
Co-Authors per Doc	3,33
International co-authorships %	10,98
Document Types	
Article	249
Article; early access	6

It is seen that single-authored and co-authored articles are included in the researches. Together with all these, the participation of 771 authors shows the status of research in this field. The

international co-authorship percentage of 10.98% indicates the co-operation of research in the field of physical activity in special education.

Figure 1. Distribution of publications on physical activity in special education by years

Figure 1 shows the distribution of publications on physical activity in special education between 1992 and 2024. While there were only 2 publications in 1992, it is seen that 10 publications were reached in 2010 and 15 publications in 2020. It is seen that the total number of publications in 2023 is 30. It is seen that publications on physical activity in special education are increasing very rapidly after 2019.

Table 2. Top 10 journals according to the number of publications and local citations related to physical activity in special education

Journal	Number of publications	Journal	Local citation
Palestra	9	Adapted Physical Activity Quarterly	191
RETOS. Nuevas Tendencias en Educación Física, Deporte y Recreación	7	Research in Developmental Disabilities	123
Research in Developmental Disabilities	6	Journal of Autism and Developmental Disorders	95
International Journal of Disability, Development and Education	5	Developmental Medicine & Child Neurology	81
Physical Education and Sport Pedagogy	5	Medicine & Science in Sports & Exercise	79
Adapted Physical Activity Quarterly	4	Thesis	78
Disability and Health Journal	4	Exceptional Children	50
Ankara University Faculty of Educational Sciences Journal of Special Education	3	Disability and Rehabilitation	49
Comunicacoes	3	Sport, Education and Society	44
International Journal of Developmental Disabilities	3	Research in Autism Spectrum Disorders	40

Looking at the number of publications and citations in Table 2, it is seen that journals such as Palestra, Adapted Physical Activity Quarterly and RETOS contribute to research in the field of physical activities in special education. However, while the number of publications in Research in Developmental Disabilities and International Journal of Disability, Development and Education is high, the number of citations in Research in Developmental Disabilities and Journal of Autism and Developmental Disorders is high.

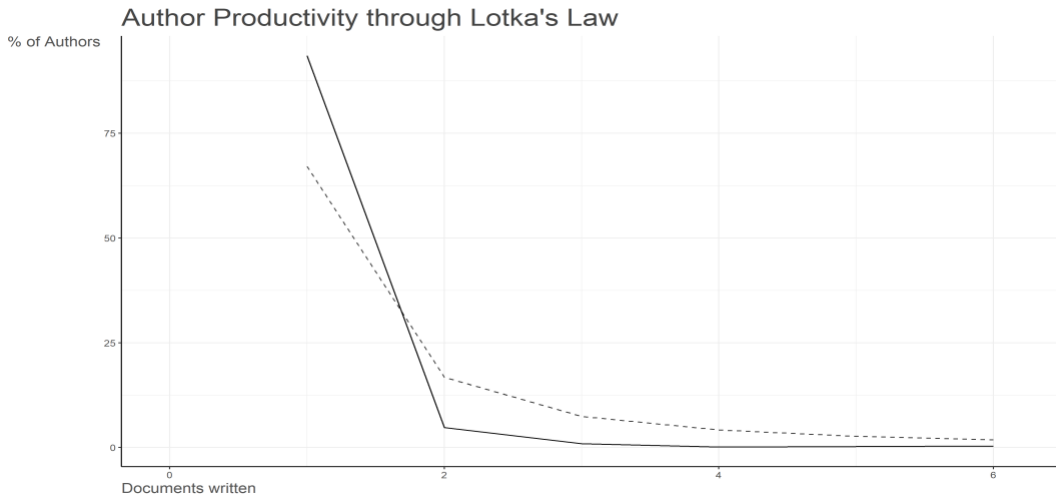

Figure 2. Author productivity according to Lotka's law for publications on physical activity in special education

When Lotka's law author productivity is analysed in Figure 2, it is seen that the majority of the authors have written a single article on physical activity in special education. However, it is seen that a very small number of authors have publications between 2 and 6 articles.

Table 3. Distribution of author publications related to physical activity in special education

Documents written	N. of Authors	Proportion of Authors
1	721	0,935
2	37	0,048
3	7	0,009
4	1	0,001
5	2	0,003
6	3	0,004

Table 3 shows information about the distribution of articles according to the number of authors. The majority of the publications (721) are single-authored and constitute approximately 93.5% of the total. This shows that there is a widespread tendency towards single-author studies in the field of research on physical activity in special education There are 37 articles with two authors. Articles with 2 authors constitute approximately 4.8% of the total. Collaborative studies with three authors are present in 7 articles. Articles with 3 authors constitut approximately 0.9% of the distribution. It is seen that articles with four authors (1 article, 0.1%), five authors (2 articles, 0.3%) and six authors (3 articles, 0.4%) are quite few. In general, the data show the intensity of single-authored studies in the literature.

Table 4. Ten countries with the most productive publications on physical activity in special education

Country	Articles
USA	75
BRAZIL	23
SPAIN	23
TURKEY	21
CHINA	9
GERMANY	8
NETHERLANDS	8
UNITED KINGDOM	6
AUSTRALIA	4
CHILE	4

Table 4 shows the top ten most productive countries for research in the field of physical activities in special education. The United States of America has the highest number of publications with 75 articles. This is followed by research conducted in Brazil and Spain with 23 articles each. Researchers in Turkey have written 21 articles on physical activity in special education.

Table 5. Ten highly cited articles among publications on physical activity in special education

Author(s)	Title	Publication date	Number of local citations	Method
Verschuren, O., Ketelaar, M., Gorter, J. W., Helders, P. J., Uiterwaal, C. S., & Takken, T.	Exercise training program in children and adolescents with cerebral palsy: a randomized controlled trial	2007	201	Experimental
Vuijk, P. J., Hartman, E., Scherder, E., & Visscher, C.	Motor performance of children with mild intellectual disability and borderline intellectual functioning	2010	114	Cross-sectional
Frey, G. C., & Chow, B.	Relationship between BMI, physical fitness, and motor skills in youth with mild intellectual disabilities	1993	113	Cross-sectional
Williams, D., & Coles, L.	Teachers' approaches to finding and using research evidence: An information literacy perspective	2007	109	Mixed research
Lin, J. D., Lin, P. Y., Lin, L. P., Chang, Y. Y., Wu, S. R., & Wu, J. L.	Physical activity and its determinants among adolescents with intellectual disabilities	2010	93	Cross-sectional
Wei, X., Wagner, M., Christiano, E. R., Shattuck, P., & Yu, J. W.	Special Education Services Received by Students with Autism Spectrum Disorders from Preschool through High School	2014	75	Cross-sectional
Borovoy, A.	Japan's hidden youths: mainstreaming the emotionally distressed in Japan	2008	75	Review research
Yarımkaya, E., & Esentürk, O. K.	Promoting physical activity for children with autism spectrum disorders during Coronavirus outbreak: benefits, strategies, and examples	2020	65	Review research
Block, M. E., & Rizzo, T. L.	Attitudes and attributes of physical educators associated with teaching individuals with severe and profound disabilities	1995	57	Cross-sectional
Gabler-Halle, D., Halle, J. W., & Chung, Y. B.	The effects of aerobic exercise on psychological and behavioral variables of individuals with developmental disabilities: a critical review	1993	45	Critical review

Table 5 provides information on various aspects of the 10 most cited publications in the field of physical activities in special education. At the beginning of Table 5 is a randomised controlled trial by Verschuren et al. (2007) investigating the effectiveness of an exercise training programme for children and adolescents with cerebral palsy. It is followed by studies examining motor performance in children with mild intellectual disabilities (Vuijk et al. 2010), the relationship between BMI, physical fitness and motor skills in young people with mild intellectual disabilities (Frey & Chow, 1993) and teachers' motor skills. Approaches to the use of research evidence in education (Williams & Coles, 2007), physical activity research in adolescents with intellectual disabilities (Lin et al. 2010) and special education services received by students with autism spectrum disorders (Wei et al. 2014) are also among the most cited studies.

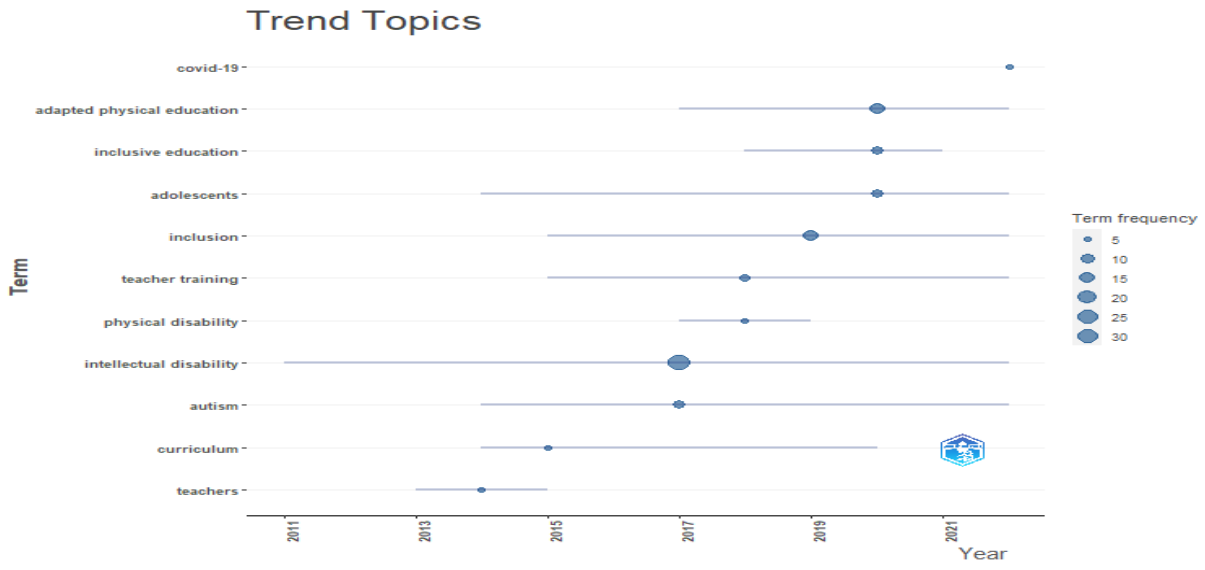

Figure 3. Trending topics among publications on physical activity in special education

The graph in Figure 3 shows the bibliometric analysis of publications related to physical activities in special education from 2011 to 2021. It is seen that there are various terms related to the field, such as "COVID-19", which is on the rise in 2021 and indicates a significant increase in discussions or studies. "Adapted physical education" has been consistently present in the literature over the years.

There is an increase in interest in "inclusive education" and this term seems to have peaked in 2019. Other terms such as "adolescents", "inclusion" and "teacher education" are similarly prominent. The terms "physical disability", "intellectual disability" and "autism" each have different trends and frequencies. The terms "curriculum" and "teachers" were trending in 2013 and 2015.

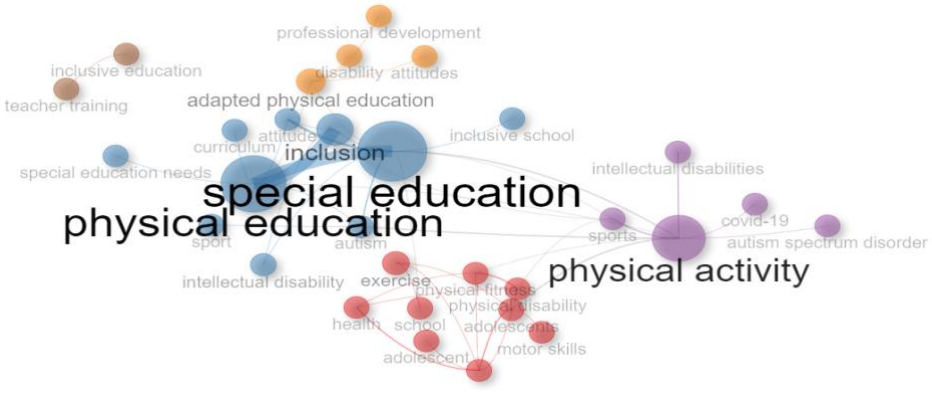

Figure 4. Network of interconnected terms in studies on physical activity in special education

Figure 4 shows an interconnected network of terms. Terms such as "special education" and "physical education" are clearly visible. Other related terms such as "physical activity", "inclusion" and "adapted physical education" are interconnected and indicate a focus on inclusion in physical education for special needs. Terms such as "intellectual disability", "autism" and "COVID-19" indicate specific areas of interest in this field.

DISCUSSION

In this study, bibliometric information about research in the field of physical activities in special education is presented. In the research findings, the top 10 journals according to the number of publications and local citations related to physical activity in special education were expressed. The 4.81% annual growth rate of the research shows that the scientific outputs in this field have increased consistently over time. The average of 9,341 citations per article emphasises the impact and

importance of research within the academic community. In addition, the presence of 455 unique Keywords Plus and 678 Author's Keywords shows the rich diversity of topics and terminologies addressed in the research.

When the findings of the study are analysed, it is seen that certain journals in the field of physical activities in special education play important roles in disseminating research and promoting scientific discussions. It is understood that these journals contribute greatly to the research in this field with the number of publications and local citations. These journals play important roles in expanding the knowledge on physical activity in special education and supporting academic studies in this field.

It is seen that publications on physical activity in special education have increased very rapidly after 2019. This situation shows that issues related to physical activities in special education are among the trend topics of recent years. When the Lotka law author productivity in the research findings is examined, it is seen that the majority of the authors related to physical activity in special education have written a single article. This situation shows that most of the researchers do not specialise in the subject of physical activity in special education. Researches indicate that there is a tendency towards multi-authorship in scientific communication, although there are differences between disciplines (Al, 2005). It is understood that this situation has not yet been reflected in the research on physical activities in special education.

These findings show that the research culture in the field of physical activity in special education is largely progressing with independent studies. It reflects that the studies conducted in the field are less preferred to be carried out in a collaborative manner. Publications to be made in this field should be enriched by carrying out more cooperation and interdisciplinary studies. Only in this way can the quality and innovation potential of publications be increased. Because co-authorship can enable individuals to think from different perspectives and will also help to minimise possible errors that may be overlooked by a single person. Especially researchers who do not have much research experience collaborating with people who have specialized in this type of research for years will contribute to the quality of future research (Al, 2005).

The research findings show the most cited articles on physical activities in special education. The prominent study is the research conducted by Verschuren et al., (2007). Vuijk et al., (2010) on motor performance in children with mild intellectual disabilities, Frey & Chow (1993) on the relationship between BMI, physical fitness and motor skills in young people with intellectual disabilities are important topics related to physical activities in special education and are among the most cited articles. These articles will make significant contributions to the field of physical activities in special education. They are considered as important resources for the practices and studies of special education experts and researchers.

In the research findings, the geographical distribution of publications in the field of physical activity in special education was included. The geographical distribution is concentrated in certain countries. The United States of America plays a leading role in research in this field. It is known that this situation is similar in research on different topics (Karaca et al., 2023). Afterwards, it is seen that the intensity of research on physical activities in special education is in Brazil and Spain. Turkey also makes significant contributions to research on physical activities in special education. It is seen that other countries either have limited or no studies in this field. In order to better understand the situation in these countries, it is recommended to intensify studies on physical activity in special education. Since scientific research requires a certain budget, funding or other support may affect the quantity and quality of research in certain fields. Providing funds and resources for scientific research in developed countries may have contributed to more research. In addition, the political priorities of countries, for example, the importance given to special education, may have led to more intensive research in this field.

Research trends of terms related to physical activity in special education are included in the research findings. The term "COVID-19", which came to the fore in 2021 in connection with the COVID-19 pandemic and experienced a significant increase in research, emphasises the importance of research on physical activity practices in special education. It is seen that the term "Physical Education Adapted for Individuals with Special Needs" has experienced a continuous increase over the years. This may indicate that this term is an important topic in special education programmes. It

is known that the term "inclusive education" is an important issue in special education (Karaca, 2018). This term reached its peak in 2019, underlining its important understanding in the field of special education. In addition, the research findings reveal the changing interest levels of terms such as "inclusion", "adolescents" and "teacher education" over time. The prominence of these terms may lead to policy and practice changes needed to make physical activities in special education more effective and inclusive.

In the research findings, a visual network diagram of the relationships between the basic concepts and terms in the field of physical activity in special education is presented. It is seen that the central terms such as "special education" and "physical education" have a great importance in the studies. Especially in inclusive and separate special education practices, physical education activities involving individuals with special needs come to the fore. The importance of physical education practices for individuals with special needs is known (Cristea et al., 2020; Wu et al., 2021). Concepts such as "physical activity", "inclusive education" and "adapted physical education", which are shaped around these terms, provide information on how physical activities can be made more inclusive and accessible in special education. Especially in special education practices, instructional adaptations through Individualised Education Programmes are considered extremely important (Vural & Yıkmış, 2008). Terms such as "autism", "COVID-19", which deals with pandemic situations, and "intellectual disability" indicate special interest or concern in these areas. This visual structure in the research findings suggests disciplinary approaches to researchers from various disciplines by revealing how to establish multidimensional collaborations.

Conclusion

The findings of this study show that scientific studies on physical activity in special education are gaining more and more importance. The annual growth rate and high number of citations reveal that the studies in this field are widely recognised and valued in the academic community. Research trends indicate changes in terms related to physical activity in special education over time and necessary changes in policies and practices in this field. Especially after the COVID-19 pandemic, it is seen that studies in this field have increased.

In conclusion, studies on physical activity in special education increase the knowledge of the field and provide important resources to academics and practitioners working in this field. Enriching research with more collaboration and interdisciplinary approaches will increase the quality and innovation potential of scientific studies in this field. This approach will contribute to making physical activity practices in special education more inclusive and effective.

Limitations

This research was conducted using only Web of Science (WoS) database. Therefore, data from other large databases (e.g. Scopus, PubMed) were not collected. The fact that there are different articles that can be included in this scope in different databases limits the generalisability of the findings.

Conflict of Interest

No conflict of interest is declared by the authors. In addition, no financial support was received.

Ethics Committee

This is a review article. There was no need to apply to the ethics committee for this article.

Author Contributions

Study Design, OTÇ, MAK; Data Collection, MAK, OTÇ, Statistical Analysis, MAK, OTÇ; Data Interpretation, MAK OT; Manuscript Preparation, MAK, OT; Literature Search, MAK, OTÇ. All authors have read and agreed to the published version of the manuscript.

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REVİEW ARTICLE

Scientific Production on Para Athletics: A Bibliometric Review

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Abstract

The aim of this bibliometric review was to perform a quantitative and qualitative bibliometric analysis using science mapping techniques, to investigate publication trends, author network clusters, and keyword occurrence linked to the scientific production in the sport of Para Athletics (PA). Studies related to PA were identified throughout a search across the databases PubMed, Scopus, and Web of Science (Core Collection). From an initial pool of 2,350 documents, 149 were deemed eligible and incorporated into the study. Most studies were published in the last 10 years, mainly in journals related to the fields of sport sciences and rehabilitation. The keyword analysis revealed 364 unique keywords, 8 distinct clusters, 287 connections. Bibliometric examination unveiled 21 authorship network clusters, comprising 260 links. Countries that contributed with most research (75.7% of all published articles) includes United States, Canada, Brazil, United Kingdom, Germany, Netherlands, Spain, South Africa, Japan, and Australia. Research related to PA has increased exponentially in recent years, particularly in the fields of sport sciences and rehabilitation. Collaborative research (authorship network clusters) seems prevalent, and all continents demonstrated participation in published studies, albeit with different relative contributions.

Keywords
Bibliometrics, Para-Athletes, Paralympic Athletes, Adaptive Sports, Para Sport

INTRODUCTION

In recent years, the undeniable growth of Paralympic sports has become increasingly apparent, reflecting a surge in participation, expanded sports offerings, and heightened global recognition (Dehghansai et al., 2020). Despite this increasing field of study, there is a deficiency in progress and a significant knowledge gap regarding the development of Paralympic athlete programs, particularly at the long-term (Patatas et al., 2018). This gap is particularly evident in Para Athletics (PA), the adapted version of athletics and the most widely practised Paralympic sport (Kim & Hong, 2022). Specifically designed for athletes with visual, intellectual, or physical impairments (IPC, 2022), PA includes various athletic events modified to meet these athletes' unique needs and capabilities (Holdback et al., 2024).

PA made its debut as a Paralympic sport in Rome in 1960 featuring 25 medal events and 31 para athletes in total. The sport has been featured in every subsequent edition and is currently under consideration for inclusion in the Games of Paris 2024 (IPC, 2024), where PA will award 164 medal events involving ~1069 athletes (IPC, 2024). The evolution and continuous development of PA has evidenced the need to conduct collaborative research to optimize sport classification, health, performance, and rehabilitation of paraathletes (Thompson & Vanlandewijck, 2021; Tweedy et al., 2018).

With the upcoming Games of Paris 2024 on the horizon, a bibliometric analysis of PA can help to obtain a comprehensive overview of the available

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research by mapping the cumulative scientific knowledge and thus providing valuable guidance for future investigations in the field (Andrade et al., 2013; Donthu et al., 2021). Therefore, this study aims to perform a quantitative and qualitative bibliometric analysis using science mapping techniques to investigate publication trends, author network clusters, and keyword occurrence linked to the scientific production in the sport of PA.

MATERIALS AND METHODS

Registration

The bibliometric study protocol was registered on the Open Science Framework (OSF) platform on January 22, 2024 (https://dx.doi.org/10.17605/OSF.IO/Y9284).

Search Engines

The bibliographic search was conducted on January 23, 2024, in the PubMed, Scopus, and Web of Science (Core Collection) databases.

Search Strategy

The following keywords were selected in English: “Paralympic,” “Paralympian,” “disabled athlete,” “para-athletics,” “para-athlete,” “para athletics,” “para athlete,” “adapted athletics,” “adaptive athletics,” “adapted athlete,” and “adaptive athlete”. Keywords in Spanish included: “para atletismo,” “para-atletismo,” “atletismo adaptado,” “atleta adaptado,” and “paraatletismo”. These keywords were combined using AND/OR boolean markers with no date restrictions up to January 23, 2024. The detailed search strategy is provided in Table 1.

Eligibility Criteria

As inclusion criteria, all articles published in peer-reviewed journals focusing on PA were selected. Exclusion criteria involve documents i) not directly relevant to the field of PA (e.g., those only mentioning PA but not addressing topics related to this specific area), ii) centred on other Paralympic sports, iii) that provided non-specific information regarding PA (e.g., studies that mixed PA participants with other sports presenting data in a way that impeded the extraction of specific information regarding PA), iv) published as notes, letters to the editor, conference proceedings, books, and editorials. Review articles were not included in the final selection, although they were examined to identify potential eligible articles. Documents in English and Spanish were included.

Table 1. Full search strategy for each database.

Database	Search Strategy	Results retrieved
PubMed	((((("paralymp*" OR "disabled athlete*"[Title/Abstract]) OR ("para-athlet*"[Title/Abstract]) OR ("para athlet*"[Title/Abstract]) OR ("adaptive athlet*"[Title/Abstract]) OR ("adapted athlet*"[Title/Abstract]) OR ("para-atlet*"[Title/Abstract]) OR ("para atlet*"[Title/Abstract]) OR ("atletismo adaptado"[Title/Abstract]) OR ("paraatletismo"[Title/Abstract])) AND ("track and field" OR "track & field" OR "paralymp*" OR "paralimpic*")))	1,536
Scopus	(TITLE-ABS-KEY ("disabled athlete*" OR "para-athlet*" OR "para athlet*" OR "adaptive athlet*" OR "adapted athlet*" OR "para-atlet*" OR "para atlet*" OR "atletismo adaptado" OR "paraatletismo")) AND ("track and field" OR "track & field" OR "paralymp*" OR "paralimpic*")	598
Web of Science	(((TS=("paralymp*" OR "disabled athlete*" OR "para-athlet*" OR "para athlet*" OR "adaptive athlet*" OR "adapted athlet*" OR "para-atlet*" OR "para atlet*" OR "atletismo adaptado" OR "paraatletismo"))) AND ALL=("track and field" OR "track & field" OR "paralympi*" OR "paralimpic*"))	216

Bibliometric Analysis

Utilizing bibliometric techniques (Donthu et al., 2021) we navigated through databases to reveal patterns, trends, key insights, authors, and keywords associated with PA. Advanced science mapping was used to explore networks and clusters within publications, authors, and keywords, visually representing the scientific scenario in PA. Performance analysis was utilized to examine total publications, top ten journals, and foremost contributing countries. The findings of the bibliometric analysis were interpreted to discern emerging trends, highlight prolific authors, and identify critical thematic clusters following the

BIBLIO guidelines (Montazeri et al., 2023). The bibliometric analysis was conducted using the VOSviewer software 1.6.19 (Leiden University, Leiden, The Netherlands).

RESULTS

Study Identification And Selection

The preliminary search produced 2,350 titles and was imported into the EndNote™ reference manager software 20.6 (Clarivate Analytics, Philadelphia, PA, USA) for further processing. Duplicates (n = 435) were then manually reviewed and removed. The remaining 1,915 titles underwent screening for relevance, considering abstracts and titles. Out of these, 1,761 titles were excluded. Additionally, 18 records identified by inspecting the references of review articles identified during the database search were added. Figure 1 provides a summary of the final inclusion of 149 articles.

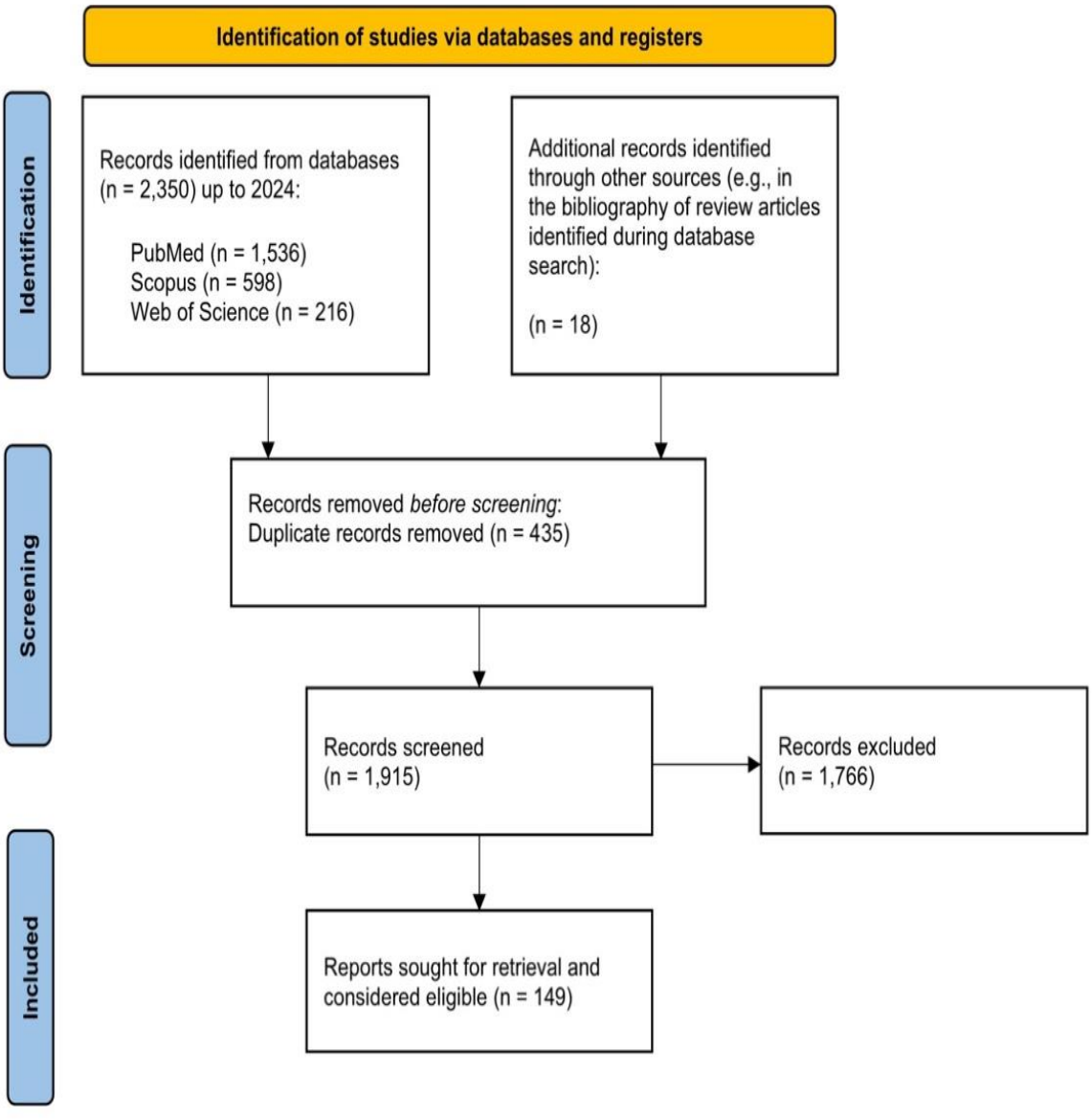

Figure 1. Flow chart of study selection in the review

Trends in Publication in Para Athletics

Figure 2 shows a graph of the scientific production related to PA over the years (i.e., from 1979 to early 2024). Additionally, it illustrates the cumulative count of publications over time. The top ten journals (by number of publications) where PA articles were published is shown in Table 2.

Keywords Analysis

The keyword analysis utilized the predetermined threshold, necessitating a minimum of two appearances for each keyword in the dataset (Figure 3). A total of 364 unique keywords were recognized, resulting in the creation of 8 distinct clusters. These clusters comprised 287 connections, contributing to a cumulative link strength of 365.

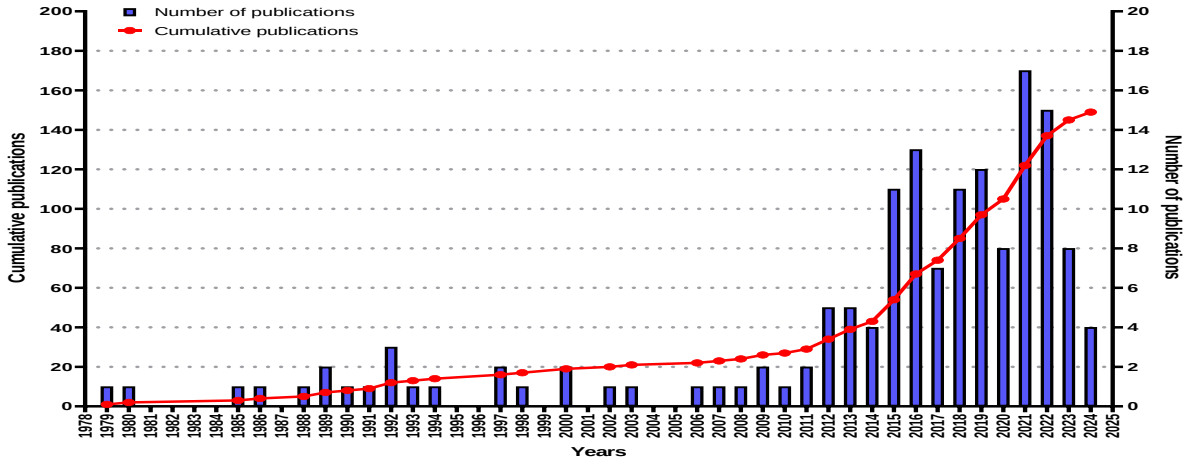

Figure 2. Yearly publication count and cumulative publications on Para Athletics over the years 1979-2024

Table 2. Ranking with the top 10 journals featuring publications on Para Athletics

Rank	Journal	Impact factor	Documents	Citations	Citations per document
1	Prosthetics and Orthotics International	0.8	12	107	8.9
2	Adapted Physical Activity Quarterly	1.7	10	136	13.6
3	Medicine & Science in Sports & Exercise	4.1	10	370	37.0
4	Paraplegia	2.1	6	119	19.8
5	British Journal of Sports Medicine	11.6	5	241	48.2
6	American Journal of Physical Medicine & Rehabilitation	2.2	5	128	25.6
7	Sports Biomechanics	2.0	5	20	4.0
8	PLoS ONE	2.9	4	41	10.3
9	International Journal of Sports Physiology and Performance	3.5	3	31	10.3
10	Journal of Sports Sciences	2.3	3	17	5.7

Note: data obtained from Scopus database.

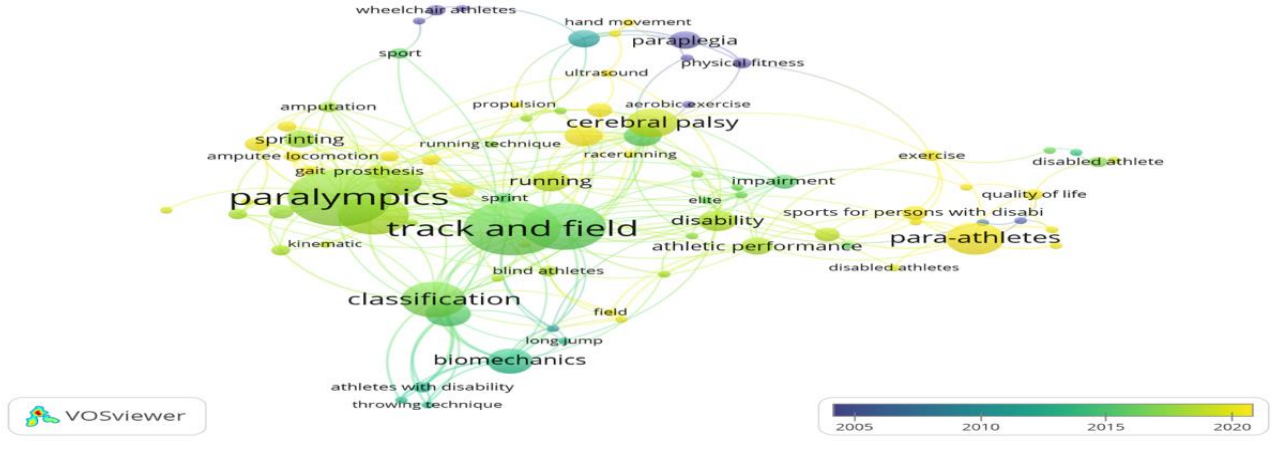

Figure 3. Keyword network visualization in Para Athletics research

Notes: the size of the bubbles denotes the number of times a keyword appears in published documents. Bubble colours represents the years of publication. Lines between bubbles denotes keyword co-occurrence in the same document.

Authorship

Applying the association strength method with a cluster resolution set at 1.00 and considering co-authorship connections involving a minimum of 2 documents per author (out of a total of 540 authors, 104 authors surpassed this threshold), our examination unveiled 21 clusters (taking into consideration the association strength method for normalization). These clusters comprised 260 links in total, contributing to a cumulative link strength of 576. Figure 4 provides a visual representation of the authorship network evolution over time. Connection weights are determined by document count. Details about the countries contributing to scientific articles related to PA can be found in Figure 5.

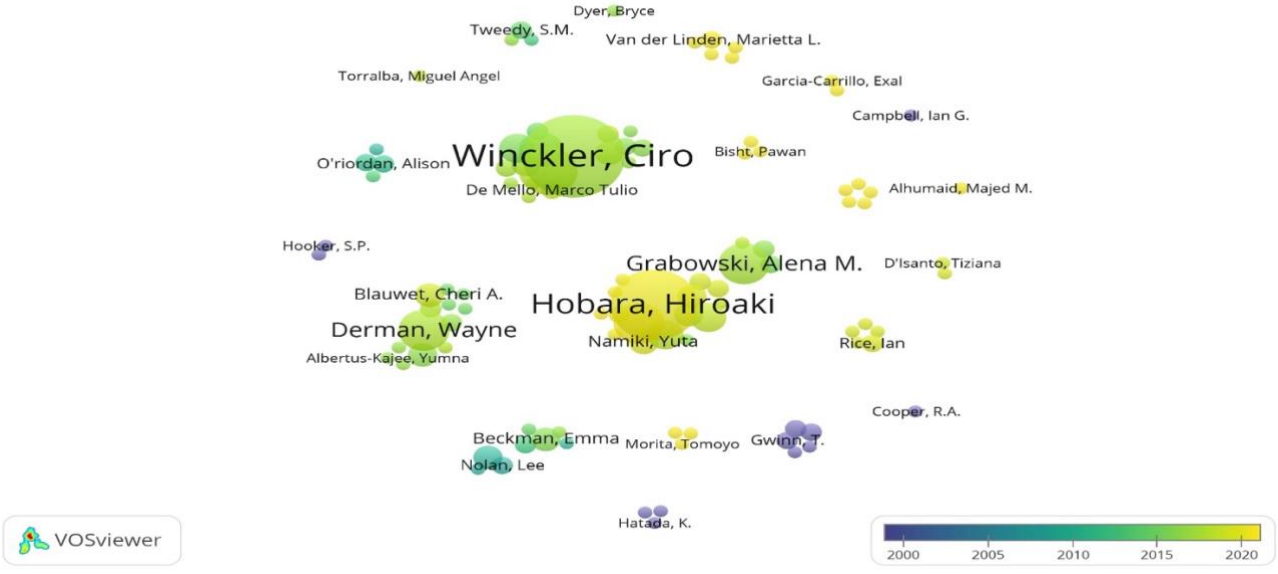

Figure 4. Visual representation overlaying authorship of publications on Para Athletics.
Notes: the size of the nodes indicates the publication output of authors.

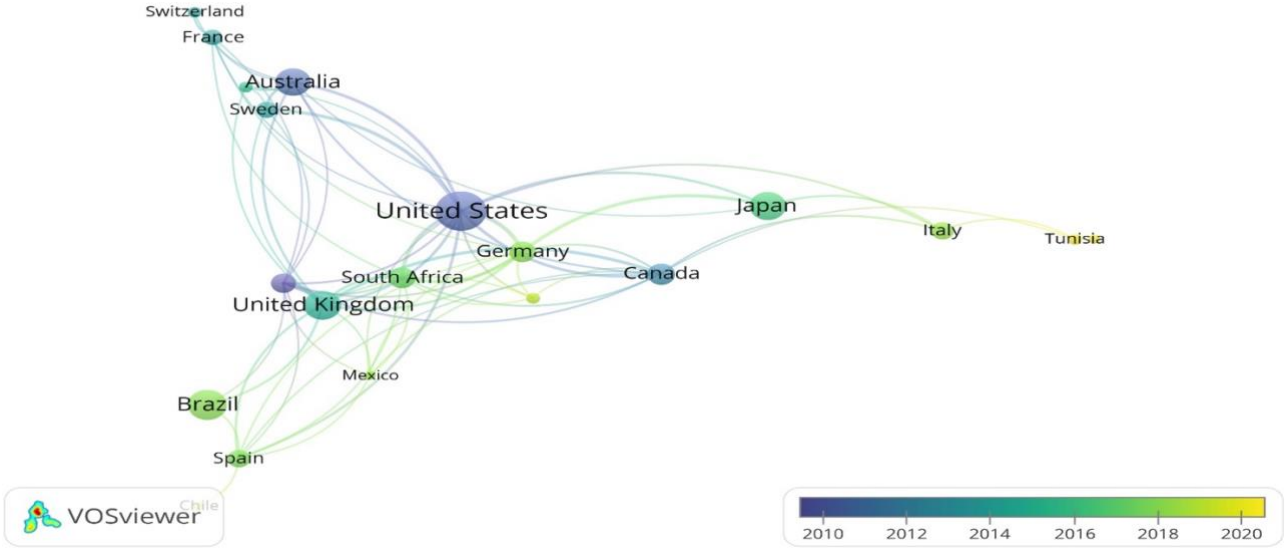

Figure 5. Image overlay representing countries contributing with publications related to Para Athletics
Notes: each color-coded country node indicates the volume of publications, indicating the international scope of research contributions. Connecting lines reveal collaborative efforts among different nations.

DISCUSSION

Growth in Paralympics is evident not only with the notable 10-fold rise in competitors from Roma in 1960 to London in 2012 (400–4237) (Leprêtre et al., 2016), but also in the scientific interest and the advancement in technology supporting para athletes (e.g., prostheses and wheelchairs) (Burkett, 2010). This development is also reflected in our examination of PA scientific publications over time, revealing a significant increase, particularly since 2010. Moreover, the quantity of PA articles is higher compared to other Paralympic sports, such as Para Cycling or Para Rowing (Puce et al., 2023; Umar et al., 2023). Specifically, between 1979 to 2010 it was observed a mean of 1.3 yearly publications related to PA, increasing to 9.1 yearly publications from 2011 to 2023. Remarkably, the publications in the top ten journals with the higher number of published studies (Table 2) received a mean of 19.2 citations per document (between 4.0 to 48.2 citations per document). A plausible explanation for this evolution could be linked to the Rio 2016 and Tokyo 2020 Paralympic cycles, given that two of the clusters of authors with the highest productivity are from the host countries of these games (Figure 4). The development of the evidence-based sports classification system, started in 2007 is a further important milestone for para sport. This process, led by the Australian research cluster, has been key in shaping best practice for Paralympic classification. It was essential to ensure that these classification systems have been developed and improved significantly in order to be a level playing field throughout all different types of impairments. In addition, these initiatives have helped to improve the knowledge of optimal performance indicators and functional abilities alongside impairments in athletes (Connick et al., 2018; Tweedy et al., 2014).

An exploration into the evolution of keyword patterns revealed characteristic trends. Leading up to 2023, there is a noticeable increase in the frequency of keywords associated with the terms “para-athletes” or “sports for persons with disabilities”. In contrast, during the earlier publication years, starting from 2014, common keywords included terms like “paraplegia” and “wheelchair athletes”. This shift observed in keyword patterns is in line with the observed social transformations among individuals with disabilities, evolving their identities from disabled to Paralympians (Le Clair, 2011). Notably, this transition can also be associated with the coined term of the “Paralympic paradox”, reflecting the ongoing dilemma in characterising Paralympians as impaired athletes or simply as athletes with a disability (Purdue & Howe, 2012). This analysis not only aids in recognizing the prevalent themes but also guides future research directions considering that keywords play a crucial role in transmitting academic concepts, ideas, and knowledge (Lu et al., 2020).

Our bibliometric analysis revealed the structure of 21 clusters of authorship networks. This remarks on the global and collaborative nature of PA research. Based on the top 10 countries with the higher number of published studies on PA, there is participation from North America (United States and Canada, 22.5%), South America (Brazil, 9.9%), Europe (United Kingdom, Germany, Netherlands, Spain, 21.6%), Africa (South Africa, 4.8%), Asia (Japan, 8.7%), and Oceania (Australia, 8.2%). However, the connections are largely closed to specific topics such as classification or local (i.e., region-based) aspects of athlete performance. Moreover, from the 21 clusters of research groups identified, most of these groups are isolated from each other, with no inter-group participation. The identified clusters and links offer a broad networking scenario. Such findings might urge researchers for future collaborative efforts in conducting PA research, and to understand the scientific progress, barriers, and collaborative dynamics within the PA community.

The substantial rise in publications, which has been especially noticeable since 2010, suggests an increased academic interest in PA. Not only do keyword patterns continue changing in tandem with society’s perceptions of athletes with impairments, but they also reveal complex stories inside the research domain. The collaborative and global character of authorship networks highlights the convergence of varied skills in PA research, and indicates a global-distributed contribution to the PA literature.

Although the current bibliometric review provides relevant and novel findings, its interpretation should consider some potential limitations. Firstly, although PubMed, Scopus, and Web of Science (Core Collection) databases were included in the search for documents, logistical restrictions precluded acces to SportDiscus, a potentially relevant source of additional documents.

Secondly, due to language restrictions, only documents in English and Spanish were included. Finally, the current bibliometric review was limited in the use of more robust strategies to mitigate the potential influence of publication bias (e.g., contact with relevant authors to discuss results). Considering the increased rate of publications in the field (see Figure 2), an update of the current bibliometric review is warranted, probably in the next 5 years. Additionally, researchers should aim to strengthen collaborative efforts (see Figure 4). Moreover, the potential limitations identified in this bibliometric review should be adressed in future investigations.

Conclusion

Research related to PA has increased exponentially in recent years, particularly in the fields of sport sciences and rehabilitation. Collaborative research (authorship network clusters) seems prevalent, and all continents demonstrated participation in published studies, albeit with different relative contributions. An interesting finding is the widespread continental collaboration research networks. This cooperation could potentially help to explain the global development of knowledge in PA. Mapping the evolution of research themes and key contributors, this study will serve as a basis for future studies while also guiding evidence-based practice within PA.

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Conflicts of interest

The authors declare that they do not have any conflicts of interest.

Author Contributions

Conceptualization and Methodology of the Study, EGC; Data Collection, EGC, RRC; Data Analysis and Interpretation, EGC and CW; Drafting the Article, EGC, RRC, CW. All authors have read and approved the final version of the manuscript.

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REVİEW ARTICLE

Stress Level Instrument in Disabled Athletes: A Bibliography Analysis in Database Scopus, Pubmed, and Crossref 2018-2024

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Abstract

The study of theoretical analysis of stress measurement instruments in athletes with disabilities has high urgency in the context of sports science and practice. Athletes with disabilities face unique challenges that are different from non-disabled athletes, both physically, psychologically, and socially. This study chose the Scopus, PubMed, dan Crossref database (the leading databases in the world) as the research sample and data source to be used in bibliometric analysis, covering the spectrum of publications from 2018 to 2024. Through this meticulous process, a subset was screened until finally 552 papers were selected, representing the pinnacle of rigorous research methodology and the basis for subsequent analysis and interpretation. To explore and identify key thematic areas as well as emerging topics using keyword co-emergence analysis. To support the process of visualization and analysis of the data obtained, the Vosviewer application is used. The findings in bibiometric analysis showed that these five clusters, namely: (1) athlete; (2) disability; (3) instrument; (4) patient; (5) stress level. One of them is the keyword "stress level" found in cluster 5. If the keyword is focused on networking, connections will appear on other keywords across the cluster. It can be seen that there is no connection to the keyword "athletes of disability", so this is a novelty and even a new finding in research in the present and the years to come.

Keywords
Instrument of stress level, Disability, Athlete

INTRODUCTION

Athletes with disabilities are such an important part of the sports world that often don't get enough attention. Despite their exceptional ability and potential, disabled athletes often face a variety of challenges that are different from those of non-disabled athletes (Yazicioglu et al., 2012). One of the main challenges faced by athletes with disabilities is high levels of stress that can affect their performance in competition and can also negatively impact the mental and physical well-being of athletes, and can hinder their ability to reach their maximum potential in sport (Belinchón-deMiguel et al., 2019). Therefore, it is important to have an instrument that can measure stress levels in disabled athletes so as to provide the right support to improve their performance.

Athletes with disabilities often face stigma and discrimination, and have physical or mental

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limitations that can affect their performance. In addition, they also have to face pressure from themselves and from others to prove their abilities. In dealing with stress, athletes with disabilities need to have a strong and confident mentality. They also need to have good enough support from the coaching team, family, and friends. In addition, it is important for athletes with disabilities to have effective coping strategies, such as meditation, visualization, or relaxation exercises.

Stress according Kupriianov & Zhdanov (2014) is a common problem that occurs in the lives of all humans and is a physical reaction to life problems experienced and if the function of body organs is disrupted called distress. The rules are confusing, for example, we don't know when this pandemic ends, when children can reunite with their friends and practice again, instead there are friends who have left and haven't, so they get bored. This long period of time eventually causes discomfort that makes children feel uncomfortable and become stressed.

The study of theoretical analysis of stress measurement instruments in athletes with disabilities has high urgency in the context of sports science and practice. Athletes with disabilities face unique challenges that are different from non-disabled athletes, both physically, psychologically, and socially (Mira et al., 2023; Ramsden et al., 2023). Accurate and reliable measurement of stress levels is essential to understand the psychological burden they are experiencing, as well as to design effective interventions to support their mental health and performance. Without the right instruments, there is a risk of underdiagnosis or misdiagnosis of stress problems in this group, which can ultimately hinder their performance and well-being. Today, there are a variety of instruments to measure stress levels, but most are designed for the general population or non-disabled athletes. These instruments may not be entirely relevant or valid when applied to athletes with disabilities, given the differences in experience and conditions they face. For example, stress experienced by athletes with physical disabilities may have different characteristics compared to stress in athletes without disabilities, both in terms of the source of stress and its physiological and psychological manifestations (Dehghansai et al., 2021; Stults-Kolehmainen & Sinha, 2014). This poses a significant gap in research and practice, where there is an urgent need to develop or adapt instruments capable of accurately measuring stress levels in disabled athletes.

In addition, theoretical understanding of stress in athletes with disabilities is still relatively limited. Most of the existing literature focuses more on the general population or athletes without disabilities, so the theoretical concepts developed may not be fully applicable or need to be adapted for the context of disability. This gap points to the need for more in-depth research to develop theoretical models that can comprehensively explain stress dynamics in athletes with disabilities. Without a solid theoretical foundation, attempts to create effective measurement instruments will face difficulties in ensuring their validity and reliability. Finally, the importance of this study is also supported by significant practical implications. By having valid and reliable stress measurement instruments, coaches, sports psychologists and relevant professionals can more effectively monitor the mental state of disabled athletes and provide the necessary support. This not only contributes to the improvement of athletes' performance, but also to their overall quality of life. Conversely, without the right instruments, the interventions provided may be inappropriate or less effective, potentially exacerbating stressful conditions and hindering the athlete's development. Thus, research in this field is not only an academic contribution, but also has a real impact in supporting the success and well-being of disabled athletes.

MATERIALS AND METHODS

This study chose the Scopus, PubMed, dan Crossref database (the leading databases in the world) as the research sample and data source to be used in bibliometric analysis. To approach the implementation actions of the Helsinki Statement framework, one of the key activities that build capacity is to build research capacity. It states, important efforts are applied to multi-skills as well as easy access to quality data and technical assistance in various sectors (WHO, 2014).

The sources and samples used to conduct this bibliometric analysis study include a comprehensive selection of databases, including Scopus, PubMed, and Crossref. The data acquisition process begins on March 14, 2024, using carefully selected keywords embedded in the title and abstract, with a particular focus on the

theme *"Stress level instruments, athletes, disabilities"*. The goal is to compile a rich and diverse data set that represents the scientific contributions in this domain.

The researchers' painstaking efforts resulted in a substantial corpus consisting of a total of five thousand three hundred and thirty-six papers (5336 papers), derived from various repositories. Among them, Scopus donated 1225 papers, PubMed donated 1017 papers, and Crossref contributed 3094 papers, covering the spectrum of publications from 2018 to 2024. The next phases of the analysis involve careful research to ensure the integrity and reliability of the data. This includes rigorous checks for duplication and assessment of conformity between the content of each paper and the specified keywords. Through this meticulous process, a subset was screened until finally 552 papers were selected, representing the pinnacle of rigorous research methodology and the basis for subsequent analysis and interpretation.

Research Design

To get article metadata, researchers searched for keywords on the Scopus, PubMed, and Crossref databases that included searches for Titles and Abstracts related to "Stress Level Instruments in Athletes with Disabilities". There are 552 publications indexed in the Scopus, PubMed, and Crossref databases. The tracing procedure is presented in Figure 1. This study used bibliometric analysis using publication mapping and keyword emergence analysis, which is a type of shared word analysis (Kaparthi, 2005). The researchers mapped search results based on Harzing's Publish or Perish followed by input on the VOSviewer app. Next, researchers conduct a keyword co-occurrence analysis to determine publication trends, and trace the main themes or topics that appear in the publication. At the stage of presenting data, researchers visualize with the help of the VOSviewer application. The app was developed by affiliated researchers at Leiden University (van Eck & Waltman, 2010). Researchers use several parameters in VOSviewer in obtaining article metadata, including 1) Type of analysis (Co-occurrence analysis), 2) Unit of analysis (All keywords), 3) Calculation method (Full counting), and 4) Minimum number of author documents (10 documents).

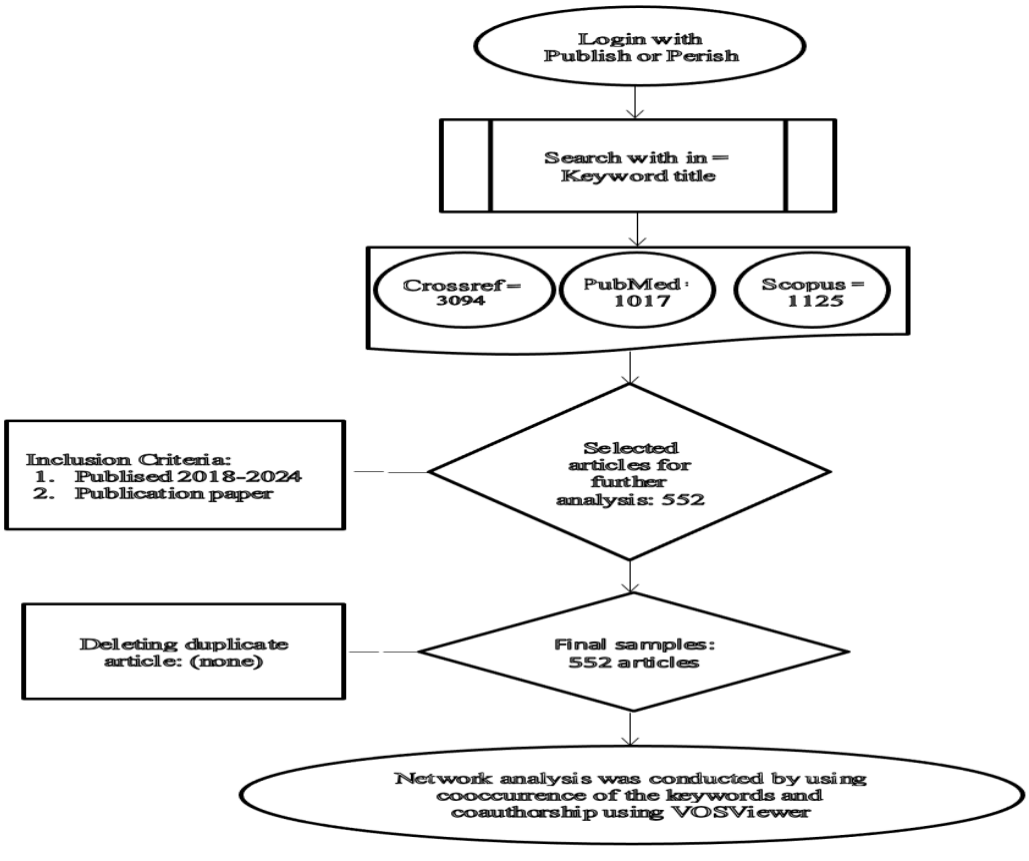


Figure 1. Search design of article metadata

RESULTS

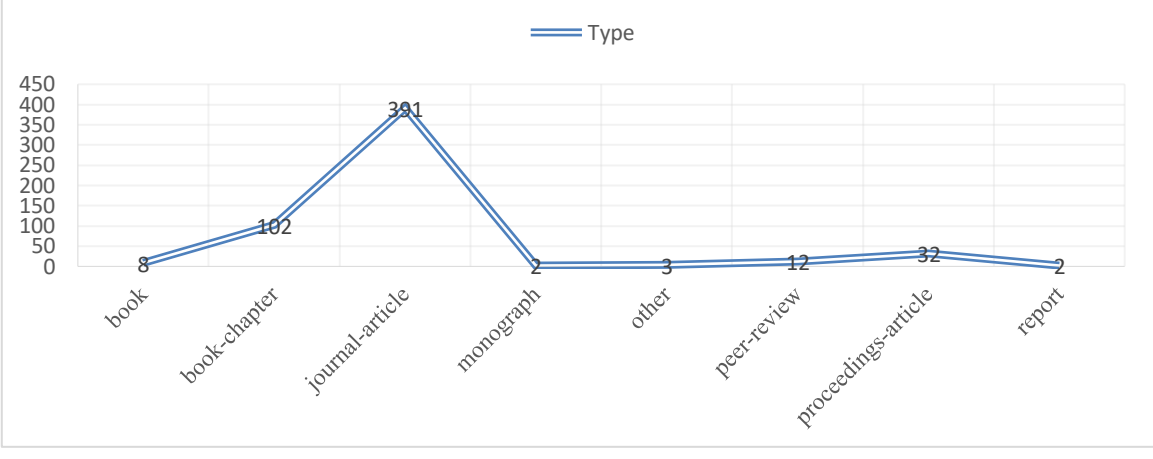
Stress Level Instrument in Athletes with Disabilities reviewed by Publication Map

The search for the publication of articles with the title "Stress Level Instruments in Disabled Athletes" and using the keywords "Stress level instruments, athletes, disabilities" published in the period 2018-2024 (for 6 years) has been carried out carefully. In 2018-2019 with the discovery of one hundred and sixty-three (163) publications of journal articles. There was an increase in 2020-2021 of 32 articles with a total of 195 journal articles. From 2022-2023, there has been a decrease in the use of around 33 articles with a total of 162 journal articles published. Currently in 2024 with a total of 27 journal article publications. The dynamics of changes (year range) in the number of publications can be seen in Figure 2.

Source: Research data taken from pubmed database by publish or perish

Figure 2. Productivity of the publication of scientific papers entitled "Stress Level Instruments in Athletes with Disabilities" in 2018-2024.

From the recorded publications, there are several types / research designs from 1000 publications on Stress Level Instruments in Athletes with Disabilities in Scopus, PubMed, and Crossref databases. The majority of article types are "journal-article", i.e. 391 publication articles. There is a "book" of about 8 publication articles. "Book chapter" there are 102 articles, "monograph" there are 2 articles, "other" there are 3 articles about the design of this study. Furthermore, about 12 articles use the "peer-review" type, 329 articles use "proceedings article". The last, is with the type of "report" a number of 2 publication articles. More details can be seen in more detail as in Figure 3.

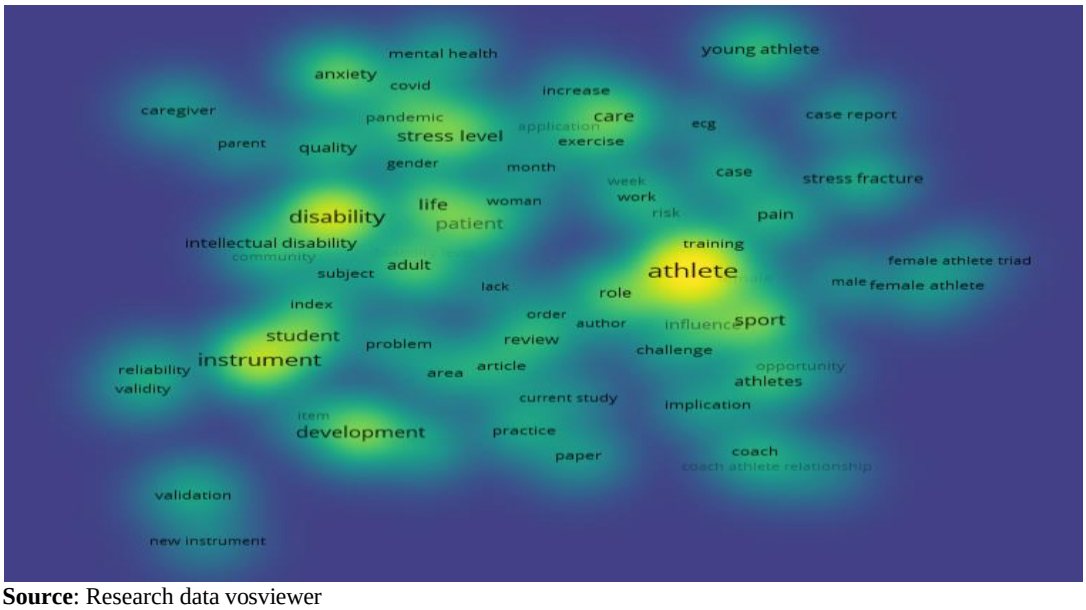


Source: Research data taken from pubmed database by publish or perish

Figure 3. Jenis/desain penelitian berjudul “Instrumen Tingkat Stress Pada Atlet Disabilitas” pada tahun 2018-2024.

Stress Level Instrument in Athletes with Disabilities as a Thematic Cluster

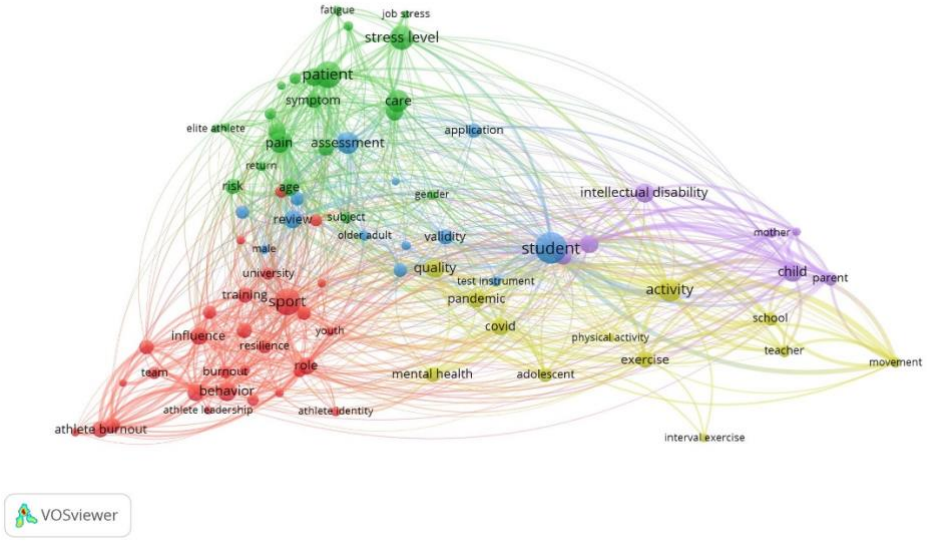
The results of data visualization using VOSviewer involve the analysis of keywords that appear predominantly from search keywords, especially in the context of "Stress Level Instrument in Disabled Athletes". VOSviewer's analysis focused on the dense keyword density visualization part, and its presentation is presented in Figure 4.



Source: Research data vosviewer

Figure 4. The item density visualization of high keywords

From the results of the co-occurrence analysis, it can be observed that the keywords seen as high frequency will form a thematic cluster in the field of Physical Education that is adapted to ASD. The groups are shown in detail as shown in Figure 5.



Source: Research Data Vosview

Figure 5. High-frequency keyword emergence network in "Instrumen tingkat stres, Disabilitas, dan Atlet"

The analysis output keywords can be seen that have been grouped based on their relevance, this is presented in Figure 5. The relationship between keywords will be higher (closer) if followed by the proximity of these keywords. The line that appears between the keywords is a manifestation of a higher (closer) correlation. Then the circle on the keyword that is getting bigger, refers to the meaning that the keyword appears bigger in the publication.

The visualization in Figure 5 can be identified into 5 thematic clusters. These five clusters are in Table 1, namely: (1) athlete; (2) disability; (3) intrument; (4) patient; (5) stress level. Bolded keywords are those with the highest numberof occurrence frequencies.

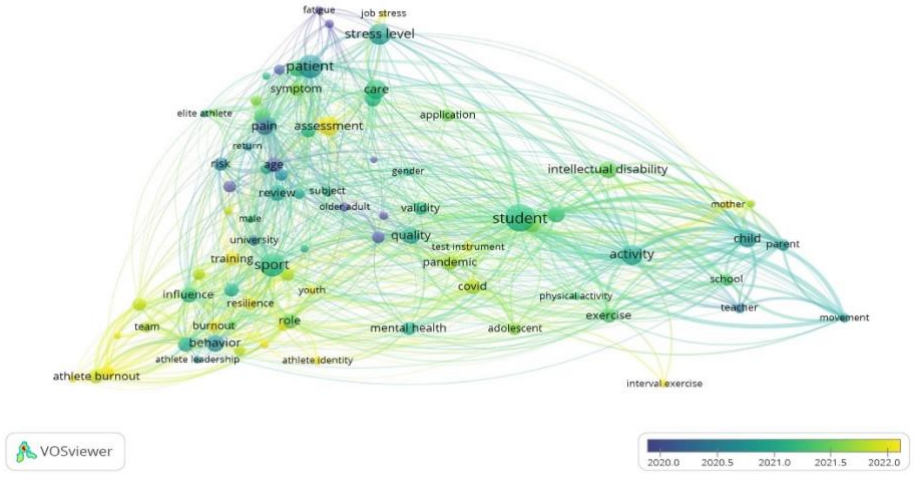
Table 1. Kelompok kata kunci frekuensi tinggi yang terkait dengan publikasi Instrumen tingkat stres, Disabilitas, dan Atlet

Cluster	Number of keywords (items)	Keywords
Cluster 1/Disorder/ Red Athlete	19	(1) athlete (2) athelete burnout (3) athletes (4) author (5) Challenge (6) coach (7) coach athlete relationship (8) current study (9) experience (10) implication (11) importance (12) influence (13) opportunity (14) participation (15) practice (16) risk (17) role (28) sport (19) training
Cluster 2/service/green Disability	18	(1) adolescent (2) anxiety (3) caregiver (4) child (5) comparison (6) covid (7) depression (8) disability (9) exercise (10) gender (11) life (12) mental health (13) pandemic (14) parent (15) physical activity (16) quality (17) significant difference (18) woman
Cluster 3/quality/blue Instrument	18	(1) adult (2) article (3) community (4) development (5) evalution (6) index (7) instrument (8) intellectual disability (9) item (10) new instrument (11) order (12) part (13) reliability (14) student (15) subject (16) systematic review (17) validation (18) validity
Cluster 4/student/yellow patient	14	(1) case (2) case report (3) disability level (4) female (5) female athele (6) female athele triad (7) male (8) month (9) pain (10) patient (11) posttaraumatic stress disorder (12) review (13) stress fracture (14) week
Cluster 5/intervention/purple Stress Level	6	(1) application (2) ecg (3) incrase (4) nature (5) stress level (6) work

Source: Research Data Vosviewer

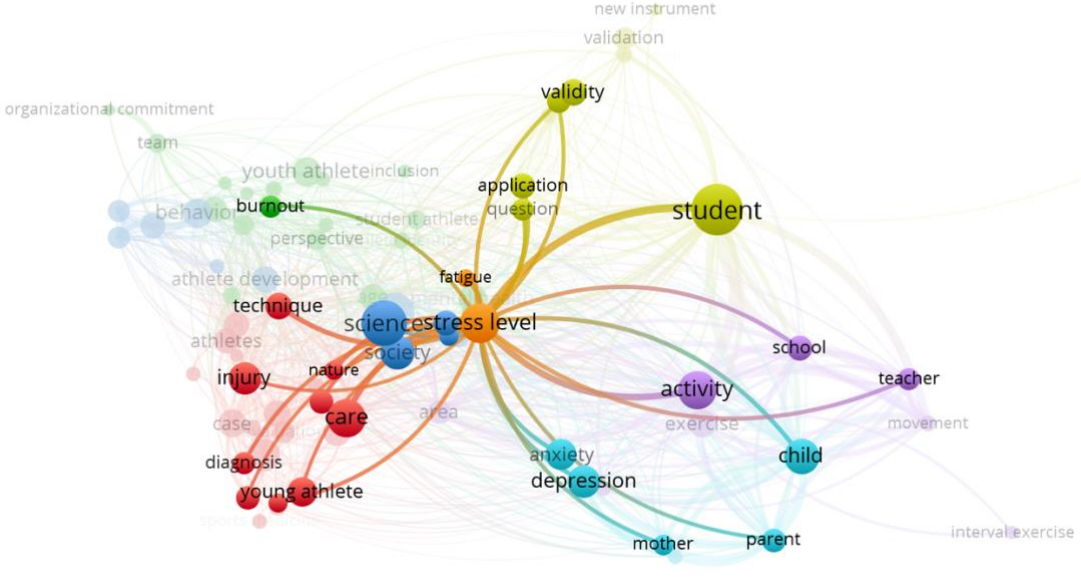
Emerging Topic: Stress Level Instruments in Athletes with Disabilities

The output of data analysis using Vosviewer as shown in Figure 6 can be visualized with at least three colors. The colors include yellow, green, and blue. These visualizations show different meanings according to the color. Blue indicates the period of the beginning of the year of publication. Furthermore, the visualization of the transition from green to yellow gives meaning to the last year of publication. Overlay visualization means the dominance of "old" to "latest" publication update keywords, whose "latest" trends (2022-present) are visualized in yellow (dominant on the left side of the map, but Some appear on the middle side, on the top side, and on the right side of the map). The publication of the novelty "medium" (in 2021) is dominant on the right side of the map and the others are scattered on the left, middle, and top sides of the map with visualizations in green. While classifying keywords with the average "old" published year (2020 and below) visualized in dark blue. More detail is seen in Figure 6 and Figure 7.



Source: Research Data Vosviewer

Figure 6. Average year of publication with high-frequency keywords in the publication "Stress Level Instrument in Disabled Athletes"



Source: Research Data Vosviewer

Figure 7. Analyze the keyword connection "Stress Level"

DISCUSSION

The stress level instrument in disabled athletes is a measurement tool specifically designed to evaluate the level of stress experienced by athletes with physical or mental limitations. Stress in the world of sports can arise from a variety of factors, including competition demands, intense training, and expectations from coaches and yourself (Endo et al., 2023). For athletes with disabilities, these factors are often compounded by additional challenges associated with their disability, such as accessibility, social stigma, and special adjustment needs. Therefore, it is important to have the right instruments to measure and manage this stress effectively. This instrument usually covers various aspects that affect stress levels, such as physical, emotional, and environmental factors. For example, a rating scale might include questions about how athletes feel about their performance, interactions with teams and coaches, and how they cope with the day-to-day stresses associated with training and competition. The emotional aspect may include an assessment of

feelings of anxiety, depression, or self-confidence (Esatbeyoğlu & Campbell, 2018; Trigueros et al., 2019). In addition, environmental factors such as support from family, access to adequate training facilities, and inclusion policies within the team are also very relevant.

The methodology of developing this instrument must go through several important stages, starting from the initial data collection through interviews or surveys of disabled athletes, coaches, and sports psychologists (Esatbeyoğlu & Campbell, 2018; Martin, 2005). The data is then analyzed to identify key indicators of stress and developed into valid and reliable question items. After that, instrument trials were carried out on a small sample of disabled athletes to ensure that the instrument could measure stress levels accurately and consistently. Adjustments and refinements are made based on the results of trials before the instrument is applied more widely.

The application of this stress level instrument has several important benefits. First, by identifying the source and level of stress experienced by athletes, coaches and team managers can design more effective intervention programs to help reduce stress. For example, if stress stems from an inability to manage time between exercise and education, then a time management or tutoring program can be implemented. Secondly, these instruments also assist in continuous monitoring, so that changes in stress levels can be detected and treated proactively.

In addition, the use of this instrument can also raise awareness of the importance of mental health among athletes with disabilities. Many athletes may feel reluctant to express their feelings of stress for fear of being perceived as weak or incompetent. With systematic and structured instruments, it ishoped that it can create a culture where talking about mental health becomes more accepted and supported (Committee on Psychological Testing, 2015; Krishnamurthy et al., 2022). It can also help reduce the stigma often attached to mental health issues.

However, there are some challenges in the application of this instrument. One is to ensure that the instrument is truly inclusive and takes into account different types of disabilities. For example, athletes with hearing loss may need instruments adapted to visual or cue formats. Likewise, athletes with cognitive limitations may require simpler, easier-to-understand instruments. Therefore, instrument development must take into account the diversity of disabilities and ensure that all athletes can participate in a fair and meaningful way.

Based on the bibliographic findings (see Table 7), one of them is the keyword "stress level" contained in cluster 5. If this keyword is brought closer to crusor, connections will appear on other keywords across the cluster. It can be seen that there is no connection to the keyword "athletes of disability", so this is a novelty and even a new finding in research in the present and future years on instrument stress levels, especially in athletes with disabilities.

Finally, the stress level instrument in disabled athletes is a very important tool in supporting their mental and emotional well-being. With these tools, we can not only help athletes better manage stress, but also promote a more inclusive and supportive sporting environment. It is important to continue to develop and refine these instruments to remain relevant and effective in addressing the challenges faced by disabled athletes in the future.

Conclusion

The findings in bibiometric analysis showed that these five clusters, namely: (1) athlete; (2) disability; (3) instrument; (4) patient; (5) stress level. One of them is the keyword "stress level" found in cluster 5. If the keyword is focused on networking, connections will appear on other keywords across the cluster. It can be seen that there is no connection to the keyword "athletes of disability", so this is a novelty and even a new finding in research in the present and the years to come.

Declaration of Conflicting Interests

All authors declare no conflicts of interest in this research.

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Ethics Statement

This research has passed the ethical clearance test with the field of social humanities research. The ethics commission for the social humanities sector of BRIN, Indonesia stated that the research had met the existing requirements and conditions, supported by the ethics clearance letter Number: 764/KE.01/SK/12/2023. Furthermore, the publication of this paper is one part of the research stages of the approved whole research.

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Author Contributions

Conceptualization and Methodology of the Study, EB, DTPP, MA and RH; Data Collection, EB, DTPP, MA, RH and EM; Data Analysis and Interpretation, MA, RH and EM; Drafting the Article, EB, DTPP, MA, RH and EM. All authors have read and approved the final version of the manuscript.

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