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Corresponding Address
Pamukkale Üniversitesi Spor Bilimleri Fakültesi Dekanlığı
Kınıklı Kampüsü 20700, Denizli/Türkiye
Phone: +90 258 296 12 77.
E-mail: pjss.online@gmail.com

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CONTENTS

PAMUKKALE JOURNAL OF SPORT SCIENCES
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Pamukkale J Sport Sci, 15(2), 253-276, 2024 Research Article

Relationships Between Service Quality, Customer Loyalty and Customer Repurchase Intention: The Example of Health and Fitness Clubs

Ali Çağrı GÜCAL[1*] Bülent GÜRBÜZ[2]

[1]*Department of Recreation, School of Physical Education and Sports, İstanbul Nişantaşı University, İstanbul, Türkiye*
[2]*Department of Sports Management, Faculty of Sports Sciences, Ankara University, Ankara Türkiye*

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* **Corresponding Author**:
Ali Çağrı GÜCAL
E-mail Address:
alicagri.gucal@nisantasi.edu.tr

ABSTRACT

This study was conducted with the aim of testing the relationships between service quality perceptions, customer loyalty levels, and customer repurchase intentions of customers in health and fitness clubs. The sample group for the study comprised 476 individuals (233 female, 243 male) exercising in health and fitness clubs. Participants answered the Turkish version of the "Service Quality Assessment Scale (T-SQAS)", the Turkish version of the "Loyalty Scale in Sport Services (T-LSSS)" and the Turkish version of the "Repurchase Intention Scale (T-RIS)." For the analysis, t-test, MANOVA, ANOVA, and Pearson correlation statistical methods were used. The most substantial gap between participant expectations and perception scores concerning service quality was observed in the "program" subscale, while conversely, the "locker room" subscale had the smallest difference. The means subscale scores for the "(T-LSSS)" of female participants were identified as being higher than those of male participants. There was a positive relationship between service quality, customer loyalty, and repurchase intention. Finally, it was evident that members were dissatisfied with the services offered, indicating an inconsistency between their expectations and the actual service delivery. Managers of health and fitness clubs should make the necessary effort to increase the service quality of their clubs to the highest level. Positive effects of service quality on the formation of repurchase intention, the first stage of creating loyal customers, will increase the competitive power of health and fitness clubs in the market.

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INTRODUCTION

In recent years, industrialized and developing countries have consistently increased the value placed on leisure activities (Haw et al., 2023; Tapps & Wells, 2019). Leisure activities comprise an environment that increases the quality of life of individuals and ensures that they gain new benefits (Gürbüz & Henderson, 2014). Participation in leisure activities appears to be an antidote to working life (Forde et al., 2014). In line with this, individuals have oriented toward health and fitness clubs to enjoy leisure quality and healthily (Jones et al., 2020). Activities in health and fitness clubs involve many benefits for individuals like weight control, development of the cardiovascular system and protection from non-infectious diseases in physical terms; development of self-esteem, motivation, acquiring self-confidence and communicating with individuals in cognitive terms; and increased cohesion and solidarity in social terms (Sheehan, 2015).

The interest and demand for participation in leisure activities have begun to increase due to many things, like social and psychological reasons, led by the increase in health awareness around the world worldwide (Li et al., 2020; Matic et al., 2020). The competitive environment created by this increased demand has made it necessary for businesses offering recreational activity services and their managers to make more intense and different efforts to keep up with the competition (Alexandris et al., 2012). At this point, it is imperative for businesses operating in the leisure sector to elevate customer satisfaction levels and cultivate loyalty by enhancing the quality of their services (Yoshida, 2017). Increasing customer loyalty brings concepts like service quality, customer loyalty, and customer repurchase intention to the forefront.

As per the literature by Smith et al. (2014), health and fitness clubs have strived to create a diverse range of strategies geared towards retaining customers, ensuring that individuals receive services, and fostering long-term membership within the business. Much research (Chiu et al., 2019; Theodorakis et al., 2019) indicates that the service quality factor plays a critical crucial role in affecting customer intention to become a member of the business or to repurchase services (Phonthanukitithaworn & Sellitto, 2018).

Numerous studies, particularly in the international literature, investigate the relationships between service quality, customer loyalty, and customer repurchase intentions (Gürbüz et al., 2012). These studies concluded that there was a strong and positive relationship between service quality, customer loyalty, and repurchase intentions (Chiu et al., 2019). A

study titled "Perceived Service Quality and Customer Loyalty among Health and Fitness Club Members" by Tsitskari et al. (2017) concluded that there was a positive and high degree of relationship between service quality and customer loyalty. Another study investigated the relationship between service quality and customer repurchase intention and identified a positive relationship between the variables. As the business's service quality increases, customers' repurchase intentions increase. In line with this, customer loyalty and satisfaction will increase (Armbrecht, 2021).

Finally, the third concept for health and fitness clubs is repurchase intention. For businesses to compete and make a profit, they must display the necessary effort in relation to the repurchase intention concept (Lianopoulos et al., 2021). Entrepreneurs would like customers to continue purchasing from them. Within this framework, higher quality standards and customer loyalty are required. There is a clear and strong link between repurchase intent and customer loyalty (Zopiatis et al., 2017).

In line with this, health and fitness clubs must increase service quality, develop customer loyalty, and ensure customer repurchase intentions. For this, they must make long-term strategic plans. For businesses to develop customer loyalty, it is necessary to measure customer attitudes and expectations and to meet their demands in time. The final purpose of businesses is to steadily increase service quality, develop customer loyalty, and ensure repurchase behavior (Armbrecht, 2021).

In conclusion, there are many scientific studies in the international literature examining the relationship between service quality, customer loyalty, and repurchase intention in health and fitness clubs (Aizat et al., 2023; Wang & Chiu, 2023). However, it can be said that such an important issue is rarely addressed in the national literature. In addition, Turkey also determined the service quality, customer loyalty, and repurchase intention levels of customers in health and fitness clubs. Therefore, this study aimed to test the relationship between the perception of service quality, customer loyalty, and customer repurchase intention of health and fitness clubs' members.

Theoretical Framework and Hypotheses

Service Quality

Service quality, defined as "activities creating value and ensuring benefit" for consumers, is a concept with popularity increasing from the past to the present (Jeaheng et al., 2020; Peitzika et al., 2020). Service quality plays vital role in businesses' ability to build

customer loyalty and repurchase intent, as well as maintain a steady existence (Obeidat et al., 2012). For this reason, service quality in association with different variables has been the topic of many studies (Byon et al., 2013; Theodorakis et al., 2019). Among these variables, concepts like customer loyalty, customer satisfaction, repurchase intention, and quality of life come to the forefront (Leutwiler-Lee et al., 2023).

As outlined by Prentice et al. (2020), service quality encompasses multiple contributing factors, with the foremost importance placed on the quality standard set by the firm. Quality is a phenomenon that can be achieved with long-term strategic planning and transforms into a behavioral effort among customers (Ma & Kaplanidou, 2018). Service quality is "the direction and degree of difference between customer expectations and perceptions" (Parasuraman et al., 1985). Service quality is an essential marker in terms of the sustainability and profitability of businesses. It is important to identify the difference between customers' expectations about a service and their perceptions after receiving it and to develop the necessary strategies to increase satisfaction based on the emerging results (Zopiatis et al., 2017). Within this scope, the following hypothesis was developed:

H_1: A statistically significant difference exists between the expectation and perception scores for service quality among health and fitness club members.

A review of the literature reveals a substantial number of studies investigating the interplay among service quality, customer loyalty, and the intention of customers to repurchase (Tian et al., 2021). Moderate and high-level positive relationships were found between service quality, customer loyalty, and customer repurchase intention. From this perspective, it is possible to assert that as business service quality improves, so does customer loyalty and repurchase intention. For businesses to maintain their existence, take their place in the market, and increase profit rates, they should increase service quality to be in line with customer expectations and create customer loyalty (Yoshida, 2017).

Customer Loyalty

Customer loyalty is a concept emphasized by businesses, a criterion in strategic planning, and offers inferences about success (Lianopoulous et al., 2021). Customer loyalty is the primary goal for businesses because of the positive outcomes in terms of customer repurchase intention, long-term relationships, and profitability (Prentice et al., 2020). Businesses aim to create a cognitive and affective bond with customers. The bond formed with

customers also determines the life of the business. If a direct link is established, the business will have a long life; if there is no proper link, the business will fail very quickly.

Customers' bonds play an important role in businesses gaining an advantage (Baek et al., 2020). Customers' repurchase behavior is closely associated with their loyalty to the business. Regarding attitudinal loyalty, loyal customers consistently repurchase from the brand or business with which they have an emotional bond. As an emotional bond is created with the business, loyal customers will not change their choice and will continue to display repurchase behavior even if an attractive alternative emerges (Lianopoulos et al., 2021).

The effective management of customer loyalty is essential to developing long-term customer relationships, and this is precisely what companies need to be doing. The definition of customer loyalty is qualified as "customers having positive attitudes to the business and the intention and non-coincidental desire to repurchase their services" (Pappu et al., 2005). Businesses make extensive efforts to create customer loyalty and development of customer loyalty takes a long time. For this reason, businesses must continuously renew, keep up with technological developments, and steadily meet customer demands (Avourdiadou & Theodorakis, 2014).

In conclusion, for the successful creation and continuation of customer loyalty, customers must trust the business. Creating and maintaining a sense of trust between the company and its target audience are very important (Tian et al., 2021). For the creation of a feeling of trust, it is necessary for the business to fulfill their commitments made to customers, offer missing or promised services in time, continuously increase the quality of services, and meet demands by accurately analyzing the target audience (Leutwiler-Lee et al., 2023).

Repurchase Intention

With the growth of the sports industry, the concept of repurchase intention plays an important role in businesses being able to take their place in the market, preserve their place, and compete with other businesses (Um & Yoon, 2020). Repurchase intention is a positive marker of customer loyalty. A situation involving behavior related to the quality of services or products received by customers from a business or related to the loyalty levels resulting from this quality is referred to as repurchase intention. One of the most pronounced features of repurchase behavior status is individuals making recommendations and publicizing the business (Li et al., 2020). The concepts of loyalty and repurchase are highly interdependent elements (Shukla, 2009).

Repurchase intention occurs within the framework of business strategies as a result of strong customer loyalty created with customers (Ma & Kaplanidou, 2018). For customers to repurchase, businesses must improve service quality, accurately manage strategic action plans, continuously monitor the agenda, and build the business image and loyalty (Ferrand et al., 2010).

Within this framework, customers display repurchase behavior from the same business. There are many reasons for the creation of repurchase intention. These include the business responding to expectations in time, keeping promises, offering quality service, and creating long-term action plans (Li et al., 2020). When the international literature is examined, it is possible to see the positive effect of the importance businesses give to strategic planning and their success in practice (Vieira & Ferreira, 2017).

Communication with customers is another important factor that businesses must pay attention, and this is an element emerging in repurchase behavior (Tian et al., 2021). Communication can form strong bonds between the business and the target audience. This situation will lead to profitability for the business in the long term and increase company's image. If communication is disrupted between business and customer, this will negatively affect the institution and customers may not display repurchase behavior (Grönroos, 2004). Strengthening of communication between business and customers plays an effective role in public relations activities within the institution. For compatibility of staff and customers, a variety of leisure activities should be planned and completed. Outside the institution, customers should be drawn to the institution using advertising and media channels and then made permanent customers. Communication with the customer and public relations programs play important roles in terms of repurchase behavior. As a result, necessary effort must be displayed to create a strong bond between the customer and business and to offer quality services (Leutwiler-Lee et al., 2023).

Relationship Between Service Quality, Customer Loyalty, and Customer Repurchase Intention

Service quality, customer loyalty, and repurchase intentions comprise businesses' strategic framework (Shulman & Bullock, 2019). Recreational businesses target increasing the value of and respect for the business by developing these variables (Um & Yoon, 2020). Furthermore, to successfully manage service quality, health and fitness clubs must respond to customer expectations and actively listen to and analyze their audience continuously. A

feeling of trust must be created between customers and management and this trust should not be lost (Jasinskas et al., 2013).

Establishing a cognitive and affective connection is crucial for fostering customer loyalty, representing another critical aspect. The bond with customers also determines the longevity of health and fitness clubs. If the correct bond is created, it will continue to exist, while a mistaken bond will lead to closure in a short duration. Businesses must improve service quality, accurately manage strategic action plans, consistently follow the agenda, and create a business image and loyalty for customers to repurchase (Ferrand et al., 2010). Some variables affect service quality, customer loyalty, and customer repurchase intentions for health and fitness clubs. Many researchers have drawn attention to the importance of these variables (Armbrecht, 2021; Baek et al., 2020).

In this sense, the "gender" variable is one of the critical independent variables frequently used in the literature (Jeaheng et al., 2020; Phonthanukitithaworn & Sellitto, 2018). Measurement of the service quality, customer loyalty, and repurchase intention concepts, as well as the identification of the differences and associations of these concepts with the gender variable, play important roles in business planning (Theodorakis et al., 2019). As a result, identifying the expected and perceived service quality levels of men and women, and the associated customer loyalty and repurchase behaviors was deemed an important variable in this study. In light of this knowledge, the following hypothesis was created:

H_2: There is a statistically significant difference in the service quality perceptions, customer loyalty levels, and customer repurchase intentions of health and fitness club customers according to the gender variable.

Another independent variable in the study is "facility usage frequency." This variable was assessed as an important parameter in many studies about measuring service quality expectations of customers and the development of loyalty (Matic et al., 2020). Additionally, the facility usage frequency of customers is a factor affecting the emergence of repurchase intentions. Identification of results related to the facility usage frequency variable is an important marker for health and fitness clubs displaying successful and effective management approaches (Vieira & Ferreira, 2017). In the study, an attempt was made to identify the expectations and perceived service quality levels and link customer loyalty and repurchase behavior of customers with low or high facility usage frequency. In accordance with this, the following hypothesis was developed:

H_3: There is a statistically significant difference in the service quality perceptions, customer loyalty levels, and customer repurchase intentions of health and fitness club customers according to the facility usage frequency variable.

Our study includes concepts like service quality, customer loyalty, and repurchase intentions. Several studies observed a positive relationship between these concepts (Chiu et al., 2019). Businesses were observed to attach much importance to the service quality, customer loyalty and repurchase intention concepts (Tian et al., 2021). Service quality is the first element requiring attention for the business's reputation and customer satisfaction (Peitzika et al., 2020). Along with creating a strategic framework, businesses increase service quality with long-term strategic plans (Vieira & Ferreira, 2017).

Businesses must improve service quality, increase customer loyalty, and develop repurchase intentions to achieve competitive superiority. In this way, they will follow a successful strategic policy (Um & Yoon, 2020). Additionally, businesses must create programs adopting a continuous development policy related to service quality, customer loyalty and repurchase intention to create a brand identity and strengthen corporate image (Armbrecht, 2021).

Examining the connection between service quality and the intention to return, it becomes evident that both factors are crucial for health and fitness clubs (Peitzika et al., 2020). For these factors to have a positive effect on businesses, customer loyalty is necessary (Gürbüz & Gücal, 2020). Adequate service quality is likely to lead to higher repurchase intention. In this situation, individuals will display a tendency not to change their business, price sensitivity, or complain (Phonthanukitithaworn & Sellitto, 2018). When the other two elements of customer loyalty, and repurchase intention are investigated, loyalty and repurchase intention are two associated concepts. For businesses to sustain their existence in the long term, it is necessary to create customer loyalty and customer repurchase intention (Barshan et al., 2017). Customers' intent to repurchase is strongly related to their loyalty to the company. Several researchers emphasized that the elements determining the repurchase intention of customers involved service quality and customer loyalty (Alexandris et al., 2012; Gürbüz et al., 2012). This led to our hypothesis with the aim of determining the direction and intensity of the relationship between these three concepts;

H_4: There is a statistically significant relationship between the service quality perceptions, customer loyalty levels, and customer repurchase intentions of health and fitness club customers.

METHODS

Participants

The study employed a quantitative research approach, specifically utilizing the correlation method. Individuals in the sample group were determined using the 'quota sampling method', one of the non-probability sampling methods. In this method, some basic characteristics of the study population are determined. Then, quotas are determined to include these features in the sample and data collection continues until the determined quotas are filled (Creswell 2017). The sample group in the study was created from customers who have been members of the same club for at least one year in five different private health and fitness clubs located in Ankara with at least 1000 members and have been operating regularly for the last five years. The sample group comprised a total of 476 (M_{age} = 28.13± 8.21) participants with 233 female (M_{age} = 27.81± 8.32) and 243 male (M_{age} = 28.44± 8.10).

This research complies with the Declaration of Helsinki. The research, permission was obtained from the Ethics Committee Chair (Ankara University Ethics Committee, Issue Number: 56786525-050.04.04/21643, Date: 21/03/2019) about the ethical suitability of the study. Additionally, necessary permissions were obtained from the corresponding authors to use the scale tools in the research. After receiving ethics committee permission and scale use permission, informed consent forms and data collection tools were applied to participants by paying attention to principals of volunteerism and privacy.

Procedures

Before beginning the research, permission was obtained from the Ethics Committee Chair about the ethical suitability of the study. Additionally, necessary permissions were obtained from the corresponding authors to use the scale tools in the research. After receiving ethics committee permission and scale use permission, informed consent forms and data collection tools were applied to participants by paying attention to the principles of volunteerism and privacy.

The research included members of health and fitness clubs in Ankara who were older than 18 years. Data were obtained face-to-face by the researcher before and after exercise in the health and fitness clubs with the consent of the members. It took approximately three months (March-April-May 2019) to access all the data. The study participants were requested to complete a survey form comprising two sections. The first section included a variety of

questions about the participants' personel information. The second section included three different scales, which were explained in detail below.

Service Quality Assessment Scale

The Turkish version of the "Service Quality Assessment Scale (T-SQAS)" was used to assess the service quality expectations and perceptions of health and fitness club members. It was developed by Lam et al. (2005) and adapted to Turkish by Gürbüz et al. (2005). Cronbach's Alpha internal consistency coefficients were calculated to test the reliability of the scale. The Cronbach's Alpha internal consistency coefficients ranged from 0.75 to 0.92 for the sub-dimensions. The scale comprises 34 items and has a 4-factor structure. The factors on the scale are "staff," "program," "locker room," and "facility." Items on the scale are ranked from 'not at all important (1)' to 'extremely important (7)' and organized on a 7-point Likert scale.

Loyalty Scale in Sport Services

The Turkish version of the "Loyalty Scale in Sport Services (T-LSSS)" developed by Bodet (2012) and adapted to Turkish by Çimen et al. (2016) was used to measure the loyalty of customers participating in the research to their health and fitness clubs. Cronbach's Alpha internal consistency coefficients were calculated to test the reliability of the scale. The Cronbach's Alpha internal consistency coefficients ranged from 0.52 to 0.86 for the sub-dimensions. The scale comprises 23 items with 8-factor structure. The scale factors are "behavioral intentions," "resistance to change," "overall satisfaction," "perceived value," "position involvement," "informational complexity," "importance-hedonism," and "sign." The scale items have 5-point Likert rating. The Likert choices are ranked from 'definitely disagree (1)' to 'definitely agree (5)' and scores are given accordingly.

Repurchase Intention Scale

In this study, the items on the "Repurchase Intention Scale (T-RIS)" developed by Özcan and Argan (2014) were adapted for use. To test the validity and reliability of the scale, the data collection phase was carried out with a total of 211 participants, 91 (43.1%) women and 120 men (56.9%). To determine the suitability of the data for factor analysis, Kaiser-Meyer-Olkin (KMO), and Bartlett Sphericity test, exploratory factor analysis (EFA) were performed to determine the factor structure of the scale, and confirmatory factor analysis (CFA) was performed to confirm the factor structure. Cronbach's Alpha internal consistency coefficients were calculated to test the reliability of the scale. The Cronbach's Alpha internal consistency

coefficient 0.82 for the factor. The scale comprises four items and a single factor. Participants rate the items on the scale from 1-definitely disagree to 7-definitely agree with assessments requested on a 7-point Likert scale.

Data Analysis

The SPSS 20.0 statistical program was used for statistical analysis of data collected for the research. For the analysis of data, first, the normal distribution was examined with skewness and kurtosis values, and data were between -3 and +3, indicating normal distribution (Byrne, 2010). As a result, the skewness and kurtosis values for all items supported normality for parametric tests. Analysis of data used descriptive statistics, paired samples t-test for determination of differences between variables, independent samples t-test, multivariate analysis of variance (MANOVA), one-way analysis of variance (ANOVA), and simple linear Pearson correlation analysis. Cronbach Alpha internal consistency coefficients were calculated to test the reliability of scales. The internal consistency coefficients for the T-SQAS found that all subscale scores were highly reliable, with scores varying from 0.75 to 0.92. The internal consistency coefficient for the T-RIS identified a high level of reliability (0.82). Finally, the internal consistency coefficients for the T-LSSS calculated that all subscale scores were moderately and highly reliable, with scores identified to vary from 0.52 to 0.86.

RESULTS

According to the results of analyses performed to test whether there was a statistically significant difference between the expectation and perception scores of participants about service quality offered by facilities to members, there were statistically significant differences between the mean difference scores of participants for all subscales of the T-SQAS. The greatest difference between the mean scores for expectation and perception of service quality was for the 'program' (0.64) subscale, with the lowest difference identified for the 'locker rooms' (0.42) subscale (Table 1).

Table 1
Descriptive Statistics and Mean Differential Scores Among the T-SQAS Subscales

Subscales	N	Mean	SD	Differential Score	t	p
Staff - Expectation	476	6.87	0.23	-0.520	23.359	**0.000*** **
Staff - Perception	476	6.35	0.54			
Program - Expectation	476	6.87	0.24	-0.635	22.818	**0.000*** **
Program - Perception	476	6.23	0.63			

Table 1 (Continues)

Subscales	N	Mean	SD	Differential Score	t	p
Locker Room- Expectation	476	6.87	0.26	-0.419	17.988	**0.000*** **
Locker Room- Perception	476	6.45	0.58			
Facility - Expectation	476	6.54	0.46	-0.445	21.156	**0.000*** **
Facility - Perception	476	6.09	0.56			

Note. *p<0.05, **p<0.01, ***p<0.001

MANOVA results indicated the main effect of the gender variable on the T-LSSS [λ = 0,844, F(8, 467) = 10.814, p<0.01] and T-SQAS [λ = 0.950, F(4, 471) = 6.141, p<0.01] subscales was significant. ANOVA analysis results found the subscale mean scores for the T-LSS position involvement [F(1, 474) = 77.370, p<0.01] and T-SQAS program-difference [F(1,474) = 13.445, p<0.01] subscales statistically significantly differed in terms of the main effect of gender.

For both scales, the mean scores of female participants were higher than the mean scores for male (Table 2). According to the results of an independent samples t-test analysis (Table 3), the T-RIS (t_{474} = -0.551; p>0.05) mean scores of participants did not differ statistically significantly by gender. The facility usage frequency variable had no significant main effect on the T-LSSS [λ = 0.975, F(16, 932) = 0.750, p>0.05] subscales but had a significant main effect on the T-SQAS [λ = 0.951, F(8, 940) = 2.964, p<0.01] subscale mean scores. Analyses found that the T-LSSS (p>0.05) subscale scores of participants did not statistically significantly differ. The T-SQAS scores of participants were identified to be statistically significantly different for the staff-difference [F(2, 473) = 6.241, p<0.01], locker room-difference [F(2, 473) = 4.423, p<0.05] and facility-difference [F(2, 473) = 3.275, p<0.05] subscales. Participants using the facility three days, or more were found to have higher mean scores compared to other participants (Table 4).

Table 2
Descriptive Statistics and MANOVA by Gender Results Among the T-LSSS and the T-SQAS Subscales

Subscales	Gender	N	Mean	SD	F	p
Behavioral Intentions (T-LSSS)	Female	233	4.53	0.47	0.009	0.925
	Male	243	4.54	0.44		
Resistance to Change (T-LSSS)	Female	233	4.42	0.47	0.860	0.354
	Male	243	4.38	0.44		
Overall Satisfaction (T-LSSS)	Female	233	4.42	0.45	1.144	0.285
	Male	243	4.38	0.40		
Perceived Value (T-LSSS)	Female	233	4.32	0.50	0.053	0.818
	Male	243	4.33	0.45		
Position Involvement (T-LSSS)	Female	233	4.13	0.64	77.370	**0.000*** **
	Male	243	3.44	1.01		

Table 2 (Continues)

Subscales	Gender	N	Mean	SD	F	p
Informational Complexity (T-LSSS)	Female	233	4.26	0.56	1.069	0.302
	Male	243	4.21	0.44		
Importance-Hedonism (T-LSSS)	Female	233	4.27	0.52	0.744	0.389
	Male	243	4.23	0.49		
Sign (T-LSSS)	Female	233	4.07	0.65	1.033	0.310
	Male	243	4.00	0.67		
Staff - Difference (T-SQAS)	Female	233	-0.55	0.51	2.000	0.158
	Male	243	-0.48	0.45		
Program - Difference (T-SQAS)	Female	233	-0.73	0.63	13.445	**0.000*** **
	Male	243	-0.53	0.56		
Locker Room - Difference (T-SQAS)	Female	233	-0.40	0.53	0.237	0.626
	Male	243	-0.43	0.48		
Facility - Difference (T-SQAS)	Female	233	-0.41	0.46	2.606	0.107
	Male	243	-0.47	0.44		

Note. ***p<0.001

Table 3

Descriptive Statistics and T-test by Gender Results for Independent Groups Among the T-RIS

Scale	Gender	N	Mean	SD	t	p
T-RIS	Female	233	6.30	0.48	-0.551	0.451
	Male	243	6.33	0.47		

Table 4

Descriptive Statistics and MANOVA Results of Frequency of Facility Usage Among the T-LSSS and the T-SQAS Subscales

Subscales	Frequency	N	Mean	SD	F	p
Behavioral Intentions (T-LSSS)	1-2 days	88	4.56	0.45	0.340	0.560
	3 days or more	388	4.53	0.46		
Resistance to Change (T-LSSS)	1-2 days	88	4.37	0.50	0.271	0.603
	3 days or more	388	4.40	0.45		
Overall Satisfaction (T-LSSS)	1-2 days	88	4.38	0.39	0.189	0.664
	3 days or more	388	4.40	0.43		
Perceived Value (T-LSSS)	1-2 days	88	4.31	0.49	0.106	0.745
	3 days or more	388	4.32	0.47		
Position Involvement (T-LSSS)	1-2 days	88	3.65	0.90	2.128	0.145
	3 days or more	388	3.81	0.92		
Informational Complexity (T-LSSS)	1-2 days	88	4.21	0.51	0.196	0.659
	3 days or more	388	4.24	0.50		
Importance-Hedonism (T-LSSS)	1-2 days	88	4.26	0.49	0.004	0.952
	3 days or more	388	4.25	0.51		
Sign (T-LSSS)	1-2 days	88	4.03	0.65	0.000	0.992
	3 days or more	388	4.03	0.66		
Staff - Difference (T-SQAS)	1-2 days	88	-0.37	0.43	10.030	**0.002** **
	3 days or more	388	-0.55	0.49		
Program - Difference (T-SQAS)	1-2 days	88	-0.56	0.68	1.430	0.232
	3 days or more	388	-0.65	0.58		
Locker Room - Difference (T-SQAS)	1-2 days	88	-0.32	0.48	4.107	**0.043***
	3 days or more	388	-0.44	0.51		
Facility - Difference (T-SQAS)	1-2 days	88	-0.34	0.48	5.667	**0.018***
	3 days or more	388	-0.46	0.45		

Note. *p<0.05, **p<0.01, ***p<0.001

According to independent samples t-test analysis results, the weekly facility usage frequency was identified not to cause a statistically significant difference in mean T-RIS [F(2, 473) = 0.082, p>0.05] scores of participants in terms of the main effect (Table 5).

Table 5
Descriptive Statistics and T-test Results of Frequency of Facility Usage for Independent Groups Among the T-RIS

Scale	Frequency	N	Mean	SD	t	p
T-RIS	1-2 days	88	6.32	0.44	0.220	0.826
	3 days or more	388	6.31	0.49		

According to Pearson correlation analysis, there were positive statistically significant correlations between the T-RIS with all subscales of the T-LSSS (p<0.01). Similarly, there were positive, low-moderate level, statistically significant correlations found between the T-RIS with the 4 subscales of the T-SQAS (p<0.01). In general, there were low-level significant correlations between the T-LSSS subscales and the T-SQAS subscales (Table 6).

Table 6
Scale Scores Correlation Among the T-RIS, the T-LSSS, and the T-SQAS Subscales

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13
F1	**1**												
F2	0.29**	**1**											
F3	0.31**	0.38**	**1**										
F4	0.24**	0.30**	0.22**	**1**									
F5	0.25**	0.31**	0.35**	0.37**	**1**								
F6	0.10*	0.17**	0.31**	0.12**	0.19**	**1**							
F7	0.21**	0.26**	0.22**	0.30**	0.32**	0.13**	**1**						
F8	0.23**	0.21**	0.24**	0.28**	0.28**	0.12**	0.28**	**1**					
F9	0.18**	0.19**	0.25**	0.14**	0.16**	0.23**	0.20**	0.42**	**1**				
F10	0.48**	0.16**	0.11**	0.24**	0.14**	0.01	0.09*	0.19**	0.08	**1**			
F11	0.46**	0.19**	0.14**	0.15**	0.21**	-0.02	0.05	0.12**	0.05	0.49**	**1**		
F12	0.35**	0.08	0.08	0.11*	0.12**	0.01	0.19**	0.15**	0.08	0.40**	0.31**	**1**	
F13	0.31**	0.10*	0.05	0.05	-0.01	0.02	0.00	0.07	0.08	0.35**	0.33**	0.31**	**1**

Note. F1: T-RIS, F2: Behavioral Intentions (T-LSSS), F3: Resistance to Change (T-LSSS), F4: Overall Satisfaction (T-LSSS), F5: Perceived Value (T-LSSS), F6: Position Involvement (T-LSSS), F7: Informational Complexity (T-LSSS), F8: Importance-Hedonism (T-LSSS), F9: Sign (T-LSSS), F10: Staff-Difference (T-SQAS), F11: Program-Difference (T-SQAS), F12: Locker Room-Difference (T-SQAS), F13: Facility-Difference (T-SQAS)

DISCUSSION

This research aimed to identify the relationships between the service quality perception, customer loyalty level, and customer repurchase intention of customers in health and fitness clubs located in Ankara. The study analyzed the variables by associating service quality, customer loyalty, and customer repurchase intention perceptions with facility usage frequency of health and fitness clubs and the gender of participants.

Difference Between Expected and Perceived Service Quality

The service quality levels of health and fitness clubs were analyzed. This study included 303 customers from eight health and fitness clubs. In conclusion, the service quality of health and fitness clubs was below expectations. It is necessary to improve service quality and respond to customer expectations (Ying, 2015). Another study investigated the service quality of health and fitness clubs in Türkiye. The research findings revealed a negative gap between sports and fitness club members' expectations and perceptions, as well as a failure to meet customer expectations. In conclusion, the service quality offered by health and fitness clubs in Ankara did not meet customer expectations. Customers found the service they received inadequate and lacking quality. Businesses should keep service quality high and meet customer expectations to develop customer loyalty and to ensure they display repurchase behavior (Gürbüz et al., 2012).

Gender, Service Quality, Customer Loyalty, and Repurchasing Intentions

When research findings are investigated according to the gender variable, the subscale scores for the T-LSSS showed that mean scores for female participants were higher than mean scores for male participants. Female customers can be said to develop and display loyalty due to the health and fitness clubs they are members of being close to their lifestyle or due to strong communication between business and customers. Customers see businesses that are close to their lifestyles, with dynamic and energetic appearance and value shown by staff, as important, and this plays a key role in terms of customer loyalty. Accordingly, when studies in the literature are investigated, similar results are seen. For example, Tsitskari et al. (2017) used a service quality and customer loyalty scale in their study. The research results found a difference between individuals for the environment, interaction, and output quality offered within service quality and a statistically significant difference in the subscales for service quality and customer loyalty according to the gender variable. Females were concluded to

have higher mean scores for service quality perceptions and customer loyalty levels compared to males.

The T-SQAS subscale mean scores for female participants were found to be greater than those for male participants when the research findings are examined with respect to gender. Females attached importance to the 'program' quality of health and fitness clubs and found the content, quality, and suitability of the programs not to be adequate. To increase the service quality standards, health and fitness clubs need to display the necessary care for diversity, suitability, and quality of programs. Customers attach much importance to care in program preparation and implementation and this is a factor with a large share in the service quality perceptions of a business.

A study about the service quality perception of a health and fitness club indicated significant differences in T-SQAS subscale mean scores based on the gender variable when the literature is examined. Female participants were concluded to have higher mean expectation and perception scores compared to male participants. It was observed that the mean expectation scores were higher than the mean perceived scores for all subscales of service quality. There were negative differences, especially for the 'program' subscale, and customers were identified as not finding the program quality of businesses adequate and as not satisfied. Female customers had higher expectations about the service offered by businesses and can be said to attach more importance to service quality. The study results appear to support our research findings (Gürbüz et al., 2012).

Facility Usage Frequency, Service Quality, Customer Loyalty, and Repurchasing Intentions

According to the weekly facility usage frequency of health and fitness club customers, the mean scores of participants using the facilities three days or more per week were higher compared to those using the facilities oneto two days for the T-SQAS subscale scores (Table 4). Tsitskari et al. (2017) separated exercise participants into sections according to participation frequency in a study entitled The Perceived Service Quality and Customer Loyalty of Health and Fitness Club Members. The motivation for participation in the exercise scale and service quality assessment scale were used. They identified a positive relationship between exercise participation frequency and service quality. As the participation frequency of participants increased, customer satisfaction levels increased.

Another study included in the literature investigated the strategic framework based on quality dimensions for health and fitness clubs. There was a positive relationship between

the participation frequency variable and service quality, and participants were concluded to give more importance to facility and program quality. Businesses should pay attention to and develop facility quality and program quality (Vieira & Ferreira, 2017). Studies in the literature support our findings. Another study by Gürbüz et al. (2012) involved research on measuring service quality levels and developing solution proposals.

Similar outcomes were observed in our research findings. Participants using the facility three days or more were identified to have higher scores for the program and locker room subscales compared to participants using the facility one or two days. Participants felt program content, suitability and quality were important and saw them as deficient. Additionally, the presence of locker rooms, distance, hygiene and safety were effective elements for participants using the facilities three days or more per week. It appears that studies in the relevant literature support our findings (Gürbüz & Gücal, 2020).

Relationship Between Service Quality, Customer Loyalty, and Repurchase Intentions

Based on the correlation analysis results for mean scores of T-SQAS, T-LSSS and T-RIS (Table 6), it can be inferred that there exists a positive statistical relationship. Service quality, customer loyalty and repurchase intentions comprise the basic qualities when businesses create strategic plans. With the increase in service quality, customer loyalty is developed (Gürbüz & Gücal, 2020) and customers display the intention to repurchase the same service. As a result, businesses make a profit, and the corporate image is enhanced. In the literature, several studies and researchers support this result. For example, a study of a health and fitness club identified a positive and high degree relationship between service quality and customer loyalty (Jeaheng et al., 2020).

Ma and Kaplanidou (2018) investigated the relationships between quality of life, service quality, and behavioral intentions in a study about recreational runners. In this study, the service quality, quality of life, and behavioral intention scales were used. In conclusion, service quality was found to positively affect the behavioral intentions of individuals. The effect of service providers' perceptions on customer loyalty as perceived by customers of health and wellness clubs was investigated. The aim of the research was to test how important the empathy factor was for the personal presentation of services and the effect on customer loyalty. It was accepted that empathy, one of the five components of the SERVQUAL model, represented service quality. They found a significant relationship between empathy and

customer loyalty. Empathy was revealed to be one of the elements increasing service quality and developing customer loyalty (Marandi & Harris, 2010).

With the increase in service quality, there is increased participation by individuals in exercise in the future. Individuals participating in regular exercise appear to have increased quality of life. We can say that regular exercise positively affects quality of life. Another study investigated the relationship between quality, satisfaction, and repurchase intention. The results of the research identified a positive relationship between service quality and repurchase intention. With the increase in service quality, customer satisfaction increased, and customers had increased repurchase intentions (Zopiatis et al., 2017).

Another study in the literature investigated the effect of service quality of health and fitness clubs on satisfaction, loyalty, and repurchase intentions. The study included 361 customers. It was identified that attitudinal and behavioral loyalty had an impact on customer repurchase intentions. They concluded that there was a strong and positive relationship between customer loyalty and repurchase intent. Customers' intent to repurchase increased as customer loyalty increased (Barshan et al., 2017). Several studies in the literature revealed similar results. Alexandris et al. (2001) used service quality and behavioral intention scales in a study with the participation of 300 individuals. The results showed a significant and strong relationship between service quality and repurchase intention. As the service quality of businesses increased, repurchase intentions increased. Service quality and repurchase intention play key roles in businesses making a profit and sustaining a permanent presence. Businesses should have high-quality standards and should ensure customers display repurchase intention. In this way, they will be successful and the corporate image will increase. This situation appears to support our research results.

Limitations

This study has some limitations, such as the fact that it only included members of private health and fitness facilities in Ankara that have served 1000 individuals on a regular basis over the course of five years. To increase the generalizability of the study, larger populations and samples may be used. Comparisons may be performed for businesses in different service sectors. It may be advised to employ qualitative research methodologies to investigate the reasons behind the study's findings. Future studies may ensure the participation of individuals with different socioeconomic statuses.

CONCLUSION

The study identified differences at a negative level between the service quality expectations and perceptions of health and fitness club members. According to this result, the participants' service quality expectations were not met. Females had higher mean scores for service quality and customer loyalty compared to males. In conclusion, females were identified to have higher loyalty to the business and higher service quality received from businesses compared to males.

As the frequency of usage of health and fitness clubs increased, customer loyalty scores of participants increased; however, this did not create a statistically significant difference. Contrary to this, individuals using facilities more frequently had higher expectations related to service quality and repurchase intention. When generally assessed, when the service quality expectations of participants were met, their loyalty to health and fitness clubs and repurchase intention increased.

Our research addresses several theoretical gaps. For example, it aids in the identification of gaps to improve services in recreational and sports enterprises (Aizat et al., 2023). Furthermore, our research contributes by grounding consumer service quality perceptions in health and fitness clubs using the gap model, one of the main theories of service quality, and assisting in the formulation of customer acquisition and retention strategies for businesses (Wang & Chiu, 2023).

The recent study not only contributes to our understanding of the subject matter but also carries profound theoretical implications. Above all, the research adds to the existing body of understanding regarding service quality, customer loyalty, and repurchase intention. The current study, revealing the relationship between service quality, customer loyalty, and repurchase intention, provides theoretical implications for addressing the concept and its meaning in a changing and transforming service sector.

PRACTICAL IMPLICATIONS

It is necessary for health and fitness clubs to create long-term strategic plans. Policies should be determined to increase service quality and customer loyalty and to create and sustain the corporate image so customers display repurchase behavior. To sustain the existence of health and fitness clubs, customer expectations should be identified by performing research and measuring customer satisfaction with the business at certain periods.

For the long-term success of health and fitness clubs, they should adopt a customer-focused understanding of quality and determine policies accordingly. Public relations activities should be organized to attract customers to the business from within and outside the business or to ensure permanence, and good intention and understanding should be created between the organization and the target audience. Activities related to customer satisfaction, company image, communication tools, and public relations that affect service quality should be prepared in advance to foster and enhance customer loyalty, and alternate solution suggestions should be made for times of crisis.

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Authors' contribution

The first author contributed to research design, data collection, interpretation of the data, and preparation of the manuscript; the second author contributed to research design, statistical analysis, and preparation of the manuscript.

Declaration of conflict interest

Authors have declared that no competing interest exists.

Ethics Statement

This research complies with the Declaration of Helsinki. The research, permission was obtained from the Ethics Committee Chair (Ankara University Ethics Committee, Issue Number: 56786525-050.04.04/21643, Date: 21/03/2019) about the ethical suitability of the study. Additionally, necessary permissions were obtained from the corresponding authors to use the scale tools in the research. After receiving ethics committee permission and scale use permission, informed consent forms and data collection tools were applied to participants by paying attention to principals of volunteerism and privacy.

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Transformational Leadership on Performance of Selected Ethiopian Sport Federations

Samson Wondirad TADESSE[1*] Tesfay Asgedom HADDERA[1] Aschenaki Taddese TESSEMA[1]

[1]*Department of Sport Science, Addis Ababa University, Addis Ababa, Ethiopia*

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[*] **Corresponding Author**:
Somson W. TADESSE
E-mail Address:
samson.wondirad@ju.edu.et

ABSTRACT

Transformational leadership may not be positively and significantly affects the performance of sports federations, because sport organization unique nature is competitiveness and result-driven organization. The purpose of this study was to assess the impact of transformational leadership practices on the organizational performance of some Ethiopian sports federations. Cross-sectional design was used to collect transformational leadership and organizational performance variables. The study was conducted in Addis Ababa City Administration, Ethiopia. The data was collected from Ethiopian sports federations participants (n = 95). Transformational leadership as a predictor variable measured by multifactorial leadership questionnaire and sport federation performance was measured by Australian national Olympic sporting organizations effectiveness. SPSS version 26 was used to process the data; robust method of multiple regression analysis was used to analyze the data $p < 0.05$. The result of the study shows that idealized influence was statistically significantly predicted organizational performance (β = .26, p = .00). However, that inspirational motivation (β = .03, p = .54), intellectual simulation (β = .11, p = .12) and individualized considerations (β = -.05, p = .49) did not significantly predicted organizational performance. The finding of the study shows that transformational leadership idealized influence enhanced the performance of selected Ethiopian sports federations through inspiring trust, fostering commitment, promoting excellence, and cultivating a positive organizational culture. Ethiopian Sports Federation managers were advised to consider transformational leadership style dimensions such as inspirational motivation, intellectual simulations and individual considerations in their leadership.

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INTRODUCTION

Transformational leadership style has positive and significant impact on enhancing individual, group and team performance (Mach et al., 2021), employee performance (Gary, 2017; Grace, 2015), organizational performance (Akparep et al., 2019; Djoko, et al., 2017; Islami & Mulolli, 2020), organizational commitment (Mohamed, 2012), job satisfaction (Kılıç & Uludağ, 2021), financial performance (Devie et al., 2015) and overall performance (Bandana et al., 2018; Roger, 2008).

In sporting scenario, most of sports organizations which exercised transformational leadership style reduces athletes turnover and enhance coaches-athletes relationship (Hu & Wang, 2017), job satisfaction (Aminuddin, 2002), values opinion of athletes and enhancing athletes sense of pride in their national and international sporting achievements (Oh & Yang, 2023), enhance team effectiveness within sporting environments (Cotterill & Fransen, 2021), positively predict the well-being of athletes (Liu, et al., 2022), the performance of sports organizations (Petrus & Hedvig, 2017; Yaqub, et al., 2021) and improved overall performance Bandung City Youth and Sports Office (Oh & Yang, 2023).

Transformational leadership dimensions including idealized influence, inspirational motivation, intellectual simulation and individualized consideration registers different outcomes on performance of sport organizations. Individual consideration alone promotes teamwork, fostering acceptance of group goals, setting high performance expectations (Callow et al., Hardy, 2009)

Sports leaders can enhance organizational performance by demonstrating individual consideration towards their employees (Saima et al., 2021). This involves addressing their needs and concerns, providing coaching and guidance, actively listening to their perspectives, and offering mentorship. Additionally, leaders can contribute to organizational performance by exhibiting idealized influence. This entails serving as a role model, upholding ethical standards, fostering trust, and showing respect. Furthermore, leaders can further elevate organizational performance by employing inspirational motivation. This includes displaying confidence, having a visionary mind-set, being receptive to thoughts and ideas, demonstrating commitment to goals, and fostering team cohesion. While leaders can also achieve some level of organizational performance by employing intellectual stimulation, such as encouraging creativity and innovation, fostering good relationships, promoting critical thinking, problem-solving, and involving employees in decision-making processes, and the impact may be

relatively modest (Modeste, 2020). Measuring organizational performance is different across the countries and organizational context. The measurement of sports organizational performance of National Australian Sports Association may be different from the context Ethiopian Sports organizational performance.

Numerous articles have been published on the topic of transformational leadership and its impact on organizational performance in the sports environment (Gang et al., 2011; Kao & Tsai, 2016; Mach et al., 2021; Namrata et al., 2019; Sadia & Aman, 2018). Ethiopia has a notable track record of success in athletics and football on the global stage. The nation has produced a multitude of exceptional athletes and has achieved significant milestones in both sports (Hizkiyas, 2018).

The leadership provided by the Ethiopian government, Ethiopian Athletics Federation, Ethiopian Football Federation, coaches, and athletes has played a pivotal role in these international accomplishments. In the context of Ethiopian sports, there were very few leadership theories and leadership styles were investigated few sports discipline, either leadership theories or leadership styles were conducted independently or together, few researches were also conducted in private and government offices, transformational leadership relation with employee performance in sport industry in Ethiopian scenario makes this research different from other previous research works. Therefore, this study was focused to investigate the impact of transformational leadership on organizational performance of selected Ethiopian Sports federations. This research specifically focused to test the below mentioned research hypothesis.

- Ho: Idealized influence did not significantly predict performance of Selected Ethiopian Sport Federations.
- Ho: Inspirational motivation did not significantly predict performance of Selected Ethiopian Sport Federations.
- Ho: Intellectual simulation did not significantly predict performance of Selected Ethiopian Sport Federations.
- Ho: Individual consideration did not significantly predict performance of Selected Ethiopian Sport Federations.

METHODS

Participant

The participants of the study demographic information such as age, gender, marital status, monthly income, educational level, work experience, coaching certificate and referee or officiating certificate was taken from Ethiopian Football and Athletics Federation.

Procedure

The research employed a cross-sectional research design, wherein the participants were approached and administered the questionnaire only once. The utilization of cross-sectional research designs in this study holds significant importance as it allows for a momentary depiction of the characteristics and dynamics within a population during the year 2022. This design offers valuable insights into the prevailing traits and associations between variables, such as transformational leadership and organizational effectiveness. However, it is imperative for the researchers to conscientiously acknowledge the limitations associated with this design when interpreting the findings and drawing conclusions.

The two organizations chosen for the study were the Ethiopian Football Federation (N = 59) and the Ethiopian Athletics Federation (N = 67). N = 126 people were the total number of target subjects. Referees, coaches, and other support staff from sporting organizations were included in this study. A stratified sampling strategy was used to choose the study's population. The snowball sampling method was used to select the higher officials of the Ethiopian Athletics Federation (N = 3) and the Ethiopian Football Federation (N = 3).

The formula for estimating sample size (n) when population size (N) is known was used to determine the sample size. A simpler formula to calculate sample sizes is provided by the Taro Yamane formula (1967:886). Using a 95% confidence interval and a population attribute variability maximum of 5% (0.05), the sample size was calculated (Kizito & Schumacher, 2021). As shown in Table 1, the required sample size determination has been determined and accepted.

Table 1
Sample Size Determination of Studied Population

S.n	Sport Federations	Population	Sample
1	**Ethiopian Football Federation**	59	44
2	**Ethiopian Athletics Federation**	67	51
	Total	126	95

Data Collection Tools

The outcome variable of the study was selected Ethiopian Sports federation organizational effectiveness. A psychometric property of organizational effectiveness subscale includes flexibility, resources, planning, productivity, information, stability, and skilled labor. This questionnaire was used in Australian national Olympic sporting organizations. The psychometric properties of the subscales developed within each of the four quadrants composing the competing values approach, seven subscales and 56-items. A 5-likert scale questionnaire was used to measure the perception of employees on effectiveness of selected Ethiopian Sports federation (Shilbury & Moore, 2016).

The standardized multifactorial leadership questionnaire developed in Germany was used the Transformational leadership subscale individualized influence, inspirational motivation, intellectual simulations, and individual considerations. The primary component of the transformational scales is Inspirational Motivation, wherein the leader articulates and embodies a vision, fostering followers' motivation through a positive outlook on the future. Idealized Influence involves attributing charisma to the leader, leading followers to form strong emotional bonds based on the leader's positive traits, thus cultivating trust and confidence. This element underscores a shared sense of purpose and principles, along with the translation of these principles into action. Moreover, Intellectual Stimulation involves questioning followers' beliefs, analysing the problems they encounter, and evaluating the solutions they propose. Lastly, Individualized Consideration entails acknowledging the unique needs of followers and nurturing their individual capabilities (Jens, 2005). The construct validity was checked. The measurement of this behavior was done using a 5-point Likert scale and the respondents were urged to provide honest and conscientious responses to ensure the significance of the research. Oromia Football Federation and Oromia Athletics Federation (n = 20) were subjected to a pilot test. Customizing the standardized questionnaire to fit the existing contextualization was a crucial justification for the pilot test.

Employees of the Oromia Football Federation and Athletics Federation received the standardized surveys. This aids in evaluating the questionnaire response's internal consistency. Within a one-week period, the questionnaire was distributed twice at the same time on the same day. This helps the researcher comprehend how consistently things have been over a longer length of time. Before the final questionnaire was modified, the consistency was determined using the Cronbatch alpha method (Table 2). Due to the uniformity of the

participant responses, the researcher was able to understand the how, why, and to-whom the questions were directed.

Table 2
Pilot Test Preparation

Sn	Variables	Cronbach's Alpha	No of Items	No of participant
1.	**Individualized Influence**	70	3	20
2.	**Inspirational Motivation**	.78	3	20
3.	**Intellectual Simulations**	.67	3	20
4.	**Individual Considerations**	.69	3	20
5.	**Organizational Performance**	.81	56	20

Data Analysis

The data was entered and processed using SPSS version 26. The demographic information of the study was crosstab with types of sports participation including athletic and football participation. In addition to cross-tabulation, chi-square test of association was used to test the association between demographic information of participants and types of sports participation. The data normality assumptions were checked using Kolmogorov-Smirnov normality tests (KS) and the results revealed that individual influence (KS = .23, P = .00), inspirational motivation (KS = .22, P = .00), intellectual simulation (KS = .21, P = .00), individualized considerations (KS = .19, P = .00) and organizational performance (KS = .24, P = .00). In addition to this, mean, median, variance, standard deviation, Skewedness and kurtosis was visually checked and the data were not normally distributed. In order to reverse the normality assumptions, data were normal distribution was transformed using log10 data. Transforming data using the log10 function helps normalize skewed distributions and reduces the impact of extreme values on analysis. These benefits make it an essential tool for researchers to analyze the data and interpret the result. As a result, Generalized Linear Model, Univariate statistics, Robust Regression Method, robust standard error was used to identify the impact of transformational leadership on performance of Selected Ethiopian Sports Federation.

RESULTS

The demographic information study sample of categorical variable shows (age, gender. Marital status, monthly income, educational level, work experience, coaching certificate and referee or officiating certificate) and types of sport participation categorical data (football and

athletics) crosstab analysis were found in the Table 3. The predictor variable of the study transformational Leadership subscale such as idealized influence, inspirational motivation, intellectual simulation and individual consideration impact on the outcome variable of the study performance of Selected Ethiopian Sport Federations was regressed using robust method of multiple regressions in the Table 2.

Table 3
Crosstab of Samples of Demographic Information Across Types of Sports Participations

Variables	Choices	Football		Athletics		Total		X^2	df	p
		n	%	n	%	n	%			
Age	18-24	9	17.6	9	20.5	18	18.9	1.90	3	0.59
	25-34	20	39.2	22	50.0	42	44.2			
	35-44	10	19.6	6	13.6	16	16.8			
	45-54	12	23.5	7	15.9	19	20.0			
Gender	Male	44	86.3	42	95.5	86	90.5	2.32	1	0.12
	Female	7	13.7	2	4.50	9	9.50			
Marital status	Single	15	29.4	23	52.3	38	40.0	5.14	1	0.02
	Married	36	70.6	21	47.7	57	60.0			
Monthly Income	‹2500 ETB	6	11.8	2	4.5	8	8.4	13.51	4	0.00
	2501-5000	11	21.6	18	40.9	29	30.5			
	5001-7500	10	19.6	3	6.8	13	13.7			
	7501-1000	17	33.3	7	15.9	24	25.3			
	›10001	7	13.7	14	31.8	21	22.1			
Educational Level	Certificate	4	7.8	0	0.0	4	4.2	6.37	3	0.09
	Diploma	15	29.4	8	18.2	23	24.2			
	First degree	23	45.1	23	52.3	46	48.4			
	Master's degree	9	17.6	13	29.5	22	23.2			
Work Experience	<5year	9	17.6	11	25.0	20	21.1	5.31	4	0.25
	6-10years	11	21.6	8	18.2	19	20.0			
	11-15years	15	29.4	13	29.5	28	29.5			
	16-20years	9	17.6	2	4.50	11	11.60			
	>21years	7	13.7	10	22.7	17	17.9			
Coaching Certificate	Level One	5	9.8	3	6.8	8	8.4	7.50	4	0.11
	Level Two	30	58.8	36	81.8	66	69.5			
	Level Three	8	15.7	1	2.3	9	9.5			
	Level Four	5	9.8	2	4.5	7	7.4			
	Level Five	3	5.9	2	4.5	5	5.3			
Referee (Officiating) certificate	Level One	8	15.7	11	25.0	19	20.0	15.28	4	0.00
	Level Two	22	43.1	21	47.7	43	45.3			
	Level Three	10	19.6	8	18.2	18	18.9			
	Level Four	11	21.6	0	0.0	11	11.6			
	Level Five	0	0.0	4	9.1	4	4.2			

Note. Df = Degree of freedom. n = number. X^2 = chi-square

The result of the study indicates that the majority of participants in this study were adults, male, married, first degree holders, experienced, second level coaching certificate and second level referee certificate for both football and athletics participant demographic information. However, the income of football participants' income level was greater than

athletics participants. Moreover, marital status, monthly income and referee certification level of athletics participants have an association with football participants.

Robust regression was run to predict selected Ethiopian Sport Federation organizational performance from transformational leadership behaviour subscale such individual influence, inspirational motivation, intellectual simulation and individualized considerations (Table 4). This resulted in a significant model, $F(3, 284) = 8.45$, $p < .05$, adjusted R2 = 095. Individual influence was statistically significantly predicted organizational performance ($\beta = .26$, $p = .00$). Therefore, the null hypothesis was rejected and there was evidence that idealized influence significantly predict organizational performance of selected Ethiopian Sports Federation. The Ethiopian sport federation's leaders make employees felt good to be around him/her. Ethiopian sports federation employees were proud to work in the association with their leaders and the leaders providing appealing images about the works to be done in the sports federation.

It was found that inspirational motivation did not significantly predicted organizational performance ($\beta = .03$, $p = .54$), therefore, the null hypothesis was accepted that inspirational motivation did not significantly predict organizational performance of selected Ethiopian Sports Federation. This indicates that employees did not have a complete faith on their supervisors, supervisors did not express what to be done in t = a few words and couldn't find a way to help employees. These could not improve the performance of selected federations.

It was found that intellectual simulation did not significantly predicted organizational performance ($\beta = .11$, $p = .12$), therefore, the null hypothesis was accepted that intellectual simulation did not significantly predict organizational performance of selected Ethiopian Sports Federation. Moreover, the supervisors unable provide employees to think about old problems in another way, new way of looking into things and rethink ideas that had never questioned before. Probability, these negatively impacted the sport federation performance.

It was found that individualized considerations did not significantly predicted organizational performance ($\beta = -.05$, $p = .49$) therefore, the null hypothesis was accepted that individual consideration did not significantly predict organizational performance of selected Ethiopian Sports Federation. Furthermore, supervisors couldn't help others to develop themselves, lets others develop know what organization was doing and provide attentions for employees seems rejected.

Table 4
Robust Regression Summary of Predictor Variables on Outcome Variable

Predictor Variables	β	Robust Std. Error[a]	t	p	95% CI
Intercept	.22	.04	5.49	.00	[.14, .30]
Idealized Influence	.26	.07	3.54	.00	[.11, .41]
Inspirational Motivation	.03	.06	.60	.54	[-.08, .15]
Intellectual Simulation	.11	.07	1.52	.12	[-.03, .26]
Individualized Consideration	-.05	.07	-.68	.49	[-.19, .09]

Note. Adjusted R2 = .095. CI = Confidence Interval. b = beta coefficient. t = t-value. Df = 284. F-test = 8.45

Nevertheless, several factors hindered the successful implementation of transformational leadership within the context. These factors include a shortage of investors willing to contribute to the necessary expansion of athletic facilities, a lack of robust monitoring, evaluation, and support systems for sport training and competition, limited utilization of modern technology and information systems, the impact of the global economic downturn, and the failure to adequately meet the demands of athletes, coaches, and officials in delivering sports services. In light of these challenges, the study proposes that selected Ethiopian sports federations and stakeholders take proactive measures to alleviate the obstacles impeding sport organizational performance.

One of the respondents said that there were major barrier to such as employees' resistance to change, lack of financial resource, weak performance management system, political influence, political instability, and rapid technology development which affected the performance of Ethiopian Football Federation.

DISCUSSION

In the present research setting, the implementation of transformational leadership specifically idealized influence has been found to have a positive impact on the performance of the chosen Ethiopian Sports Federation. In agreement to this, there were previous studies supported this study. For instance, in Nigeria and Kenya idealized influence predicted both organizational performance and commitment (Angela et al., 2017; Murage et al., 2017; Victor & Ogbulu, 2022). In congruent to this study, individual consideration, inspirational motivation, and idealized influence significantly and positively influence the Organizational Performance in the Ministry of Sports, Ministry of Youth and Culture, and the Ministry of Gender and Family Promotion (Merriman et al., 2013; Modeste, 2020). In addition to this, study

conducted in Nigeria reveals that inspirational motivation has insignificant effect on project success (Al Shanqaiti & Farea, 2021). This implies that idealised influential leadership practices fostered teamwork and a collective sense of mission and made employees feel valued. It was further found that the character of the leader was a very important attribute, as this considered their moral and ethical conduct (Mdletshe & Nzimakwe, 2023).

In contrast to this study, previous study conducted in Jordan, Saudi Arabia and Indonesia suggested that idealized influence, inspirational motivation, intellectual stimulation and individual based consideration enhance organizational learning (Rabia et al., 2010), influencing progress (Al Shanqaiti & Farea, 2021), organizational effectiveness (Linda et al., 2021) and enhance employee's performance (Arafat et al., 2021). In contrary to this study, there were studies in Nigeria, Kenya and Ethiopia reported that Inspirational motivation significantly predicted the performance of senior managers (Murage et al., 2017), predicted employ performance (Benta et al., 2018) and performance of the organization (Haymanot, 2019). The various dimensions of transformational leadership, including idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration, have a positive impact on team communication, cohesion, and conflict management (Dionne et al., 2004).

Limitations

In Ethiopia, currently there are 35 Ethiopian national federations among them only Ethiopian Football federation and Ethiopian Athletics Federation was part of this study. This study was used cross-sectional design during data collection and it is preferred if it will use longitudinal research design. The study used survey method and it will be advisable if it will be experimental. The study used small sample size, large sample size will be preferred.

The application transformational leadership theories and principles at international level improve organizational effectiveness. Before applying transformational leadership principles the Ethiopian sport federation leaders better to consider Ethiopian cultural context, sport federation norms, staffs resistance to change, resource constraints, change management processes, political interference affecting governance structures, inadequate training for current leaders on transformational principles and resistance from stakeholders accustomed to traditional methods.

CONCLUSION

The study suggests that among transformational leadership style only idealized influence positively contributes in in shaping the performance of selected Ethiopian sports federations by inspiring trust, fostering commitment, promoting excellence, and cultivating a positive organizational culture. Nevertheless, transformational leadership style constructs such as inspirational motivation, intellectual simulations and individual considerations could not enhance the performance of selected Ethiopian sports federations. To this effect, individuals within the organization unable to develop unity, confidence, growth mind-set, accountability, professionalism, excellence, inspires and motivates athletes to unleash their full potential can lead to outstanding achievements on the field as well as personal growth off the field. As well as unable to providing valuable insights, optimizing strategies, and enabling data-driven decision-making. In addition to this lack of considering individuals affects individual in the organizations motivation, communication, teamwork, and talent development individuals in the selected Ethiopian Sports Federation. To this effect, selected Ethiopian Sports Federation managers were advised to consider in their leadership implementation transformational leadership style constructs such as inspirational motivation, intellectual simulations and individual considerations.

PRACTICAL IMPLICATIONS

Practical implications of transformational leadership within selected Ethiopian sport federations, organizations can foster a culture of excellence, teamwork, innovation, and continuous improvement leading to enhanced performance outcomes of Ethiopian Football and Athletics Federations across all levels. Both Sports federations were advised to exercise in their daily activity transformational leadership constructs such as inspirational motivation, Intellectual simulation and individualized consideration, since it has significant contribution for enhancement of both sport federations.

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Authors' contribution

In this manuscript, author contribution was conception and design of the study, data collection, data analysis and interpretation, drafting the article and final approval of version to be published.

Declaration of conflict interest

Author of this manuscript is Doctorate student in Sport Science from Department of Sport Science, Addis Ababa University, Addis Ababa, Ethiopia. Author has been academic staff of Jimma University, Jimma Ethiopia. Department of Sport Science, Addis Ababa University funded the research.

Ethics Statement

The informed consent form was prepared by the researcher and then approved by the Institutional Review Board Committee of Addis Ababa University, College of Natural and Computational Sciences at the meeting on February 2, 2022 with reference number IRB/04/14/2022. On this basis, the researcher received an ethics clearance letter dated February 7, 2022 with reference number CNCSDO/433/14/2022. Participants provided written informed consent to participate in this study. The researcher then informed the participants of the study about the research objectives, benefits and associated risks. After this declaration, the participants of the Ethiopian Athletics and Football Federation voluntarily signed and completed the questionnaire on the transformational leadership and performance of the selected Ethiopian Sports Federation.

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Body Composition, Nutrition and Hydration Profile of Paralympic Athletes

Tuğba KAHVECİOĞLU[1*] Şule AKTAÇ[2]

[1]*Postgraduate Education Institute, Nutrition and Dietetic Department, Istinye University, Istanbul, Türkiye*
[2]*Faculty of Health Sciences, Nutrition and Dietetic Department, Marmara University, Istanbul, Türkiye*

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* **Corresponding Author**:
Tuğba KAHVECİOĞLU
E-mail Address:
tkahve@gmail.com

ABSTRACT

Paralympic athletes are separated from healthy athletes by having various diseases/disabilities and using auxiliary equipment. This study was planned to compare paralympic athletes' hydration, body composition, and nutritional status. For this purpose, a comparison of branches, sex, and nutritional habits on training day and non-training day were examined by 66 professional athletes from the Turkish Physically Disabled Sports Federation included in the research. Demographic characteristics, anthropometric measurements, nutritional habits, and physical activity data of individuals were collected. Dietary, physical activity, and water balance scale records were determined to evaluate the nutritional, physical activity, and hydration status of these athletes, respectively. Food consumption data were analyzed with the Nutrition Information System (BeBis) in detail; energy, carbohydrate, protein, fat, water, vitamin D, vitamin B12, calcium, magnesium, and iron were examined. Measuring mid-upper arm circumference (MUAC) is a good indicator of skeletal muscle protein mass. While women's MUAC was 28.9±3.8 cm and men's MUAC was 30.7±7.0 cm, respectively. When the reference values recommended for healthy athletes are met, it has been observed that protein, carbohydrate, iron, and calcium didn't meet the recommendations. Carbohydrate, dietary vitamin D, calcium and magnesium values were found to be higher on the training day than on the non-training day ($p<0.05$). There was no difference between spesific gravity, fluid intake during exercise or the amount of sweating of the athletes ($p>0.05$). The hydration status of the athletes was found to be inadequate in all conditions of gender, branch and the presence or absence of training.

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INTRODUCTION

The word "Paralympic" was originally a combination of the words "Paraplegic" and "Olympic", but with the closer association of the Paralympic Movement with the Olympic Movement, it was formed from the combination of the Greek preposition "Para" (parallel) and "Olympic" (Tweedy & Howe, 2011). Paralympic athletes have less muscle tissue in energy expenditure during activity than healthy athletes (Goosey-Tolfrey et al., 2014). As there is reduced nutrient intake, nutrient-dense foods should be included in the athlete's diet to meet macro and micronutrient intake. Gastric emptying is slower in athletes with spinal cord injury than in healthy individuals. This should be considered when planning the number and frequency of meals. When planning the nutrition of Paralympic athletes, it is necessary to consider the time spent with the athlete and coaches, the energy spent by the athletes in training, and the health problems of the athlete (Goosey-Tolfrey et al., 2014).

Nutrition assessment is necessary to ensure adequate nutrition and hydration intake (Kesari & Noel, 2023). The primary purpose of nutritional assessment in Paralympic athletes is to define energy and nutrient intake, identify nutrition errors, and make the necessary changes to design the most appropriate nutrition plan. Hydration status, muscle fuel, and energy utilization should be considered when creating a nutritional strategy for Paralympic athletes (Das et al., 2019). The energy and nutrient needs of Paralympic athletes differ according to the region and type of physical disability (Crosland & Broad, 2011). In athletes with spinal cord injuries, changes in serum insulin and cholesterol levels as a result of overwork of the cardiovascular system and changes in nervous system responses can cause changes in the utilization of fats and carbohydrates (Das et al., 2019; Flueck & Perret, 2017). The importance of these two nutrients as fuel sources in disabled athletes is the same as in healthy athletes (Van de Vliet et al., 2011). An athlete's hydration status plays an important role in determining sports performance. Hydration status depends on factors such as the type of exercise, the athlete's muscle and fat mass, gender, age, and climatic factors such as temperature and humidity (Baysal, 2018). The hydration requirements of Paralympic athletes are similar to those of healthy athletes (Van de Vliet et al., 2011). When hydration is not provided, not only sports performance but also the life of the athlete can be jeopardized due to heat-related diseases (Ersoy, 2016; Özdemir & Ersoy, 2009). For example, in athletes with spinal cord injuries, hypothermia or hyperthermia can be seen in moderate body temperature

changes. With appropriate hydration, athletes can be protected from this situation (Buchholz et al. et al., 2003).

Anthropometry is the measurement of weight, body size, and proportions, and it is a precious adjunct in assessing nutritional status (Çıtar Dazıroğlu & Köksal, 2023; Lee & Nieman, 2012). However, there are some difficulties in measuring the height and body weight within the scope of the evaluation of nutritional status in these individuals (Çıtar Dazıroğlu & Köksal, 2023). When it is impossible or difficult to take a patient's body weight directly, body weight can be estimated using various anthropometric measurements such as mid-upper arm circumference (MUAC), knee height, subscapular skinfold thickness, and calf circumference (Lee & Nieman, 2012). Waist circumference is also an indicator of visceral abdominal adiposity and is more related to the cardiovascular disease (CVD) risk than body mass index (BMI). It was stated that the relationship between CVD and waist circumference is higher in individuals with spinal cord injuries individuals compared to BMI (Buchholz & Bugaresti, 2005).

This study aimed to determine the body composition, nutritional status and hydration status of professional Paralympic athletes affiliated with the Turkish Sports Federation of the Physically Disabled and to evaluate the results obtained. For this purpose, a comparison of branches, sex, and nutritional habits on training day and non-training day was examined. In the literature, no study has been found that evaluates the body composition, nutritional, and hydration status of Turkish paralympic athletes together. The data obtained will be vital as it's the first study to be conducted on this subject.

METHODS

Participant

The professional athletes in Istanbul reached 25 swimmers, 4 archers, 20 amputee footballers, and 17 wheelchair basketballers due to the COVID-19 pandemic and the cancellation of the leagues. The sample of the study consisted of 66 participants. All participants were informed about the study and asked to sign a Voluntary Consent Form. Athletes over the age of 18 who agreed to volunteer with the consent form and who were not hearing impaired, licensed, or affiliated with the Turkish Sports Federation for the Physically Disabled were included in the study. Individuals who did not meet the inclusion criteria and had missing data in the food consumption record and physical activity record were excluded from the study.

Ethical approval for this study was obtained from the Marmara University Faculty of Medicine Clinical Research Ethics Committee on November 1, 2019, with protocol code 09.2019.956. Written informed consent to participate in this study was provided by the participants. The study was conducted in accordance with the Declaration of Helsinki.

Procedure

The study is a cross-sectional study planned to determine the nutrition and hydration status of Paralympic athletes. Study permission was obtained from the Turkish Physically Disabled Sports Federation for its execution. This study was conducted between November 2020 and June 2021 with licensed athletes affiliated with the Turkish Sports Federation for the Physically Disabled.

The study's data were collected through a structured questionnaire via the face-to-face interview method. The questionnaire consisted of open-ended and multiple-choice questions prepared by the researchers based on the literature review. In the general information part of the questionnaire, players were asked about their ages, clubs, educational level, and marital status.

Data Collection Tools

Determination of Nutritional Status

In the continuation of the questionnaire, various questions measuring the level of nutrition knowledge and nutritional habits were asked. Food consumption data were analyzed with the Nutrition Information System (BeBis version 8.1). This program examined energy, carbohydrate, protein, fat, water, vitamin D, vitamin B12, calcium, magnesium, and iron in detail.

Determination of Physical Activity

The researchers took physical activity and 24-hour food consumption records on the teams' training and non-training days. The participants' daily energy expenditure was calculated by multiplying the recorded activity times by the Physical Activity Ratio (PAR) values and basal metabolic rate-min (BMR) values determined for physical activity.

Determination of Hydration Status

To determine the hydration status, the Water Balance Scale (Şen & Aktaç, 2021) was applied and urine samples were collected. The Water Balance Scale has been used as a non-invasive screening tool to determine the amount of water lost through sweating, urine, and

defecation and the amount of water intake through drinking water, beverages, and food (Malisova et al., 2012). It was aimed at evaluating the water balance, water intake, water loss, and fluid consumption habits of athletes with the Water Balance Scale, urine sample, and food consumption record. Urine samples were collected from the participants in disposable sterile urine containers before training. After sampling, the sample was allowed to reach room temperature (15-30 degrees). The results were evaluated according to the color scale indicated on the urine strip box. If the urine pH was seven or above, a value of 0.005 was added when reading the density.

Determination of Body Composition

Anthropometric measurements (knee height, MUAC, waist, and hip circumference) of the players were taken. Knee height was measured with the participant sitting on a stool suitable for his/her height, with his/her feet 25-30 cm apart and the knee in 90° flexion. The heights of the players were calculated by using the demi-span lengths with the help of the formulas in Table 1.

Table 1
Estimated Height and Weight Calculation via Knee Height and Mid-Upper Arm Circumference (Chumlea et al., 1994; Lee & Nieman, 2013)

Gender	Estimated Height (cm)
Male	(NH x 1.88) +70.85 (±7.9 cm)
Female	(NH x 1.87) - (Age x 0.06) + 70.25 (±7.2 cm)
Gender	**Estimated Weight (kg)**
Male	(NHx1.19)+(MUACx3.21)-86.82(±11.42 kg)
Female	(NHx1.01)+(MUACx2.81)-66.04 (±10.60 kg)

Note. NH: Knee Height, MUAC: Mid-upper arm circumference

Skinfold thickness measurement, which is an important method in determining body fat ratio, is performed using a caliper, and the accuracy and reliability of the results are negatively affected because of compliance issues in mentally disabled individuals (Casey, 2013). There are some errors in estimating body density when various anthropometric measurements are used, and these errors can be minimized when the equation that requires more variables (four instead of two) is used, and more attention is paid to measurement techniques (Lee & Niemann, 2012). Determination of the body density skinfold thickness measurements are taken from four regions (abdomen, triceps, suprailiac, and thigh) with a

caliper, and the Siri equation (% Body Fat = (495 / Body Density) – 450) was used to determine body fat percentage.

Due to the COVID-19 outbreak, uniforms, gloves, masks, and visors were used while taking measurements, and the instruments to be measured were sprayed with disinfectant between measurements. The following conditions were observed during the measurements:

- Taking measurements before training
- The person being measured should be wearing as little clothing and no shoes as possible
- Flat surfaces to stand, support, and sit on during measurement
- Taking measurements from the same side of the body whenever possible
- Care was taken not to take measurements from the limb-deficient side.

Data Analysis

The data were evaluated statistically using the SPSS (Statistical Package for the Social Sciences) 22.0 package program. While evaluating the study data, the conformity of the parameters to normal distribution was evaluated by the Shapiro-Wilks test. In addition to descriptive statistical methods (mean, standard deviation, and frequency), the one-way ANOVA test was used for comparisons of parameters with a normal distribution between groups, and the Tukey HDS test was used to determine the group causing the difference. The Kruskal-Wallis test was used for intergroup comparisons of parameters that did not show a normal distribution, and Dunn's test was used to determine the group causing the difference. Significance was evaluated at the $p<0.05$ level.

RESULTS

The research involved 66 paralympic athletes, 50 of them (75.8%) men and 16 (24.2%) women, aged 18 to 54 (mean 27.5±9.4). The branch distribution of the athletes in the research is as follows: 37.9% (n = 25) to swimming, 30.3% (n=20) to amputee football, 25.7% (n = 17) to wheelchair basketball, and 6.1% (n = 4) archery. Limb deficiency in 48.5%, muscle strength, and coordination disorders in 18.2%, spinal cord paralysis in 16.7%, mental disability in 9.1%, spina bifida in 3%, ataxia, short stature, and mental disability in 1.5% of athletes are observed. Anthropometric measurements of athletes are shown in Table 2. Comparison of anthropometric measurements by branches of athletes are shown in Table 3.

Table 2
Anthropometric Measurements of Athletes by Gender (n = 66)

Parameters	Female			Male		
	Mean±SD	Min	Max	Mean±SD	Min	Max
Estimated Body Weight* (kg)	62.2±11.9	49.0	86.9	72.0±15.1	50.6	125.0
Fat Mass (kg)	13.5±3.7	6.0	20.8	12.6±9.4	1.5	61.4
Fat Free Mass (kg)	49.6±10.2	35.7	69.9	59.3±12.1	25.5	102.2
Fat Percentage (%)	21.7±5.6	9.4	29.4	16.7±9.9	2.8	70.6
Estimated Body Height (cm)	166.3±15.3	125	185	170.1±15.8	95	205
Knee Height (cm)	50.9±5.4	42	60	49.7±8.6	0	62
Waist Circumferance (cm)	77.6±11.0	62	99	86.3±12.70	64	121
Hip Circumferance (cm)	91.7±9.9	79	112	96.5±10.6	72	122
Waist/Hip Ratio	0.8±0.08	0.75	1.01	0.9±0.07	0.78	1.1
Mid-Upper Arm Circumference (cm)	28.9±3.8	23.0	35.0	30.7±7.0	0.0	42.0

Note. *Body weight calculation via knee height and mid-upper arm circumferance

Table 3
Comparison of Anthropometric Measuraments by Branches (n = 66)

Parameters	Branch				p
	Swimming (n=25)	Wheelchair Basketball (n=17)	Archery (n=4)	Amputee Football (n=20)	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Estimated Body Height (cm)	148.3±34.2	178±10.8	174.3±7.8	164.7±17.1	[1]0.000*
Waist Circumferance (cm)	76.6±9.2	94.5±12.2	101.3±2.9	81.5±9.3	[2]0.000*
Hip Circumferance (cm)	89.6±7.6	102.4±9.9	106±6.1	94.6±10.2	[2]0.000*
Waist/Hip Ratio	0.85±0.06	0.92±0.09	0.96±0.08	0.86±0.05	[1]0.001*
Mid-upper arm circumferance (cm)	26.8±6.8	36.3±4.1	33.25±1.0	28.9±4.1	[2]0.000*

Note. [1]Oneway Anova Test; [2]Kruskal Wallis Test; *p<0.05

The answers given by the athletes in the study to the questions about measuring their nutritional knowledge levels and nutritional habits are shown in Table 4.

Table 4
Nutritional Knowledge and Nutritional Habits of Athletes (n = 66)

Questions/Answers		Branch				p
		Swimming (n=25)	Wheelchair Basketball (n=17)	Archery (n=4)	Amputee Football (n=20)	
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Meal skipping situation	Not skipped	15 (%60)	11 (%64.7)	1 (%25)	15 (%75)	[1]0.309
	Skipped	10 (%40)	6 (%35.3)	3 (%75)	5 (%25)	
Meals usually skipped (n=24)	Breakfast	6 (%60)	1 (%16.7)	1 (%33.3)	2 (%40)	[2]0.565
	Lunch	2 (%20)	2 (%33.3)	1 (%33.3)	3 (%60)	
	Snack	2 (%20)	2 (%33.3)	1 (%33.3)	0 (%0)	
	Dinner	0 (%0)	1 (%16.7)	0 (%0)	0 (%0)	
Reason for skipping (n=24)	Lack of time	4 (%44.4)	3 (%50)	1 (%33.3)	2 (%40)	[3]0.825
	Be late	2 (%22.2)	1 (%16.7)	1 (%33.3)	2 (%40)	
	Other	1 (%11.2)	1 (%16.6)	1 (%33.3)	0 (%0)	
	Lack of habit	1 (%11.1)	0 (%0)	0 (%0)	1 (%20)	
	Anorexia	1 (%11.1)	1 (%16.7)	0 (%0)	0 (%0)	
Eating speed	Fast	14 (%56)	12 (%70.6)	2 (%50)	14 (%70)	[1]0.677
	Slow	11 (%44)	5 (%29.4)	2 (%50)	6 (%30)	
Macronutrient consumption status	Consume	24 (%96)	16 (%94.1)	2 (%50)	16 (%80)	**[1]0.043***
	Not consume	1 (%4)	1 (%5.9)	2 (%50)	4 (%20)	
Paying attention to nutrition status	Paying attention	17 (%68)	14 (%82.4)	1 (%25)	19 (%95)	**[1]0.012***
	Not paying attention	8 (%32)	3 (%17.6)	3 (%75)	1 (%5)	
Relationship between eating habits and success in sports	Very close relationship	16 (%64)	15 (%88.2)	4 (%100)	18 (%90)	[3]0.208

Note. Correct answers are indicated in bold. *[1]Fisher Freeman Halton Test, [2]Fisher's Exact Test, [3]Ki-Kare Test. *p<0.05*

Table 4 (Continued)

Questions/Answers		Branch				p
		Swimming (n=25)	Wheelchair Basketball (n=17)	Archery (n=4)	Amputee Football (n=20)	
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Hours stop eating before competition	**No idea**	8 (%32)	2 (%11.8)	0 (%0)	1 (%5)	[3]**0.038***
	No relationship	1 (%4)	0 (%0)	0 (%0)	1 (%5)	
	1-2 hours	17 (%68)	4 (%23.5)	4 (%100)	10 (%50)	
	3-4 hours	6 (%24)	12 (%70.6)	0 (%0)	8 (%40)	
	Not paying attention	2 (%8)	1 (%5.9)	0 (%0)	2 (%10)	
Type of food consumed before training/competition	**Rich in carbohydrates**	8 (%32)	4 (%23.5)	0 (%0)	7 (%35)	[3]**0.015***
	Not paying attention	9 (%36)	4 (%23.5)	2 (%50)	3 (%15)	
	Rich in protein	5 (%20)	4 (%23.5)	0 (%0)	8 (%40)	
	Rich in carbohydrates and protein	0 (%0)	2 (%11.8)	1 (%25)	0 (%0)	
	Rich in carbohydrates and vitamins	1 (%4)	0 (%0)	0 (%0)	2 (%10)	
	Rich in carbohydrates, protein and vitamins	1 (%4)	1 (%5.9)	0 (%0)	0 (%0)	
	Rich in vitamins	0 (%0)	2 (%11.8)	0 (%0)	0 (%0)	
	Rich in protein and vitamins	1 (%4)	0 (%0)	0 (%0)	0 (%0)	
	Rich in carbohydrates, protein and fat	0 (%0)	0 (%0)	1 (%25)	0 (%0)	
Hours start eating after competition	**1-2 hours**	18 (%72)	8 (%47.1)	2 (%50)	8 (%40)	[3]**0.027***
	3-4 hours	5 (%20)	9 (%52.9)	2 (%50)	6 (%30)	
	Not paying attention	2 (%8)	0 (%0)	0 (%0)	6 (%30)	

Note. Correct answers are indicated in bold. [1]*Fisher Freeman Halton Test,* [2]*Fisher's Exact Test,* [3]*Ki-Kare Test. *p<0.05*

Table 4 (Continued)

Questions/Answers		Branch				p
		Swimming (n=25)	Wheelchair Basketball (n=17)	Archery (n=4)	Amputee Football (n=20)	
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Type of food consumed after training/competition	**Rich in protein**	13 (%52)	4 (%23.5)	1 (%25)	10 (%50)	[3]0.298
	Not paying attention	9 (%36)	3 (%17.6)	2 (%50)	4 (%20)	
	Rich in carbohydrates and protein	2 (%8)	3 (%17.6)	0 (%0)	2 (%10)	
	Rich in protein and vitamins	0 (%0)	2 (%11.8)	0 (%0)	2 (%10)	
	Rich in carbohydrates	1 (%4)	2 (%11.8)	0 (%0)	1 (%5)	
	Rich in carbohydrates, protein and fat	0 (%0)	1 (%5.9)	1 (%25)	0 (%0)	
	Rich in carbohydrates, protein and vitamins	0 (%0)	1 (%5.9)	0 (%0)	0 (%0)	
	Rich in vitamins	0 (%0)	1 (%5.9)	0 (%0)	0 (%0)	
	Rich in fat	0 (%0)	0 (%0)	0 (%0)	1 (%5)	

Note. Correct answers are indicated in bold. *[1]Fisher Freeman Halton Test, [2]Fisher's Exact Test, [3]Ki-Kare Test. *p<0.05*

While 21.2% of athletes use nutritional supplements, 78.8% do not use any product. 7.1% of athletes use supplements to build muscle, 28.6% to improve performance, and 64.3% to improve health. 71.4% of athletes who use supplements believe that the supplements are useful. (Not shown in the table.) The hydration status of athletes is shown in Table 5.

Table 5
Hydration Status of Athletes (n = 66)

Questions		Mean±SD	Min-Max
Sweat score when physically active		6.7±2.3	2-10
Sweat score when not physically active		4.2±2.6	1-10
Density (g/mL)		1016.9±6.7	1005-1030
Amount of water drink during training (mL)		892.8±539.4	180-3000
Amount of sports drink during training (mL) (n=11)		490.9±30.2	400-500
		n	**%**
Paying attention to fluid intake before and after training or competition	Paying attention	56	84.8
	Not paying attention	10	15.2
Fluid intake before training or competition (mL)	0-500	15	22.7
	501-1000	31	47.0
	>1001	20	30.3
Fluid intake after training or competition (mL)	0-500	10	15.2
	501-1000	34	51.5
	>1001	22	33.3

The amount of sweat excreted from the body, obtained from the Water Balance Scale, and fluid losses through urine output and fecal output were calculated. The sweat score lost with physical activity was 6.7 out of 10. The calculated sweat amount is 1666 ml. While the sweat score during the period when not physically active was 4.2 out of 10, the calculated sweat amount dropped to 501 ml. The amount of water lost through urine and feces was calculated as 925 ml and 150 ml, respectively. As a result of the analysis of the athletes' 24-hour food consumption records, the daily energy, nutrient intakes, and comparison with International Society of Sports Nutrition (ISSN) Recommendations are shown in Table 6.

Table 6
Energy and Nutrient Intakes Meet ISSN Recommendations by Gender (n = 66)

Parameters	Gender	Numbers analyzed on training day	ISSN[a] Recommendations	Percentage of meeting ISSN recommendations (%)	Numbers analyzed on non-training day	p
Energy (kcal)	Female	1395.5	-[b]	-	1302.7	[1]0.400
	Male	1579.5	-	-	1487.4	[1]0.380
Water (ml)	Female	2191.5	-	-	1605.4	[1]0.139
	Male	2759.6	-	-	1957.9	[1]0.566
Protein (g)	Female	73.5(1.15 g/bw[c])	1.4-2 g/bw	68	61.6	[2]0.110
	Male	71.4(1.02 g/bw)	1.4-2 g/bw	60	70.1	[2]0.544
Protein (%)	Female	%22	-	-	%19	[1]0.654
	Male	%19	-	-	%19	[1]0.602
Fat (g)	Female	66.9	-	-	63.9	[1]0.977
	Male	74.1	-	-	69.0	[1]0.227
Fat (%)	Female	%43	%20-35	125	%44	[2]0.373
	Male	%42	%20-35	117	%41	[2]0.525
CHO[d] (g)	Female	122.2 (2 g/bw)	8-12 g/bw	20	116.7	[2]0.637
	Male	153.1(2.13 g/bw)	8-12 g/bw	21	142.4	[2]0.164
CHO (%)	Female	%36	-	-	%37	[2]0.834
	Male	%40	-	-	%39	[2]0.554
Vitamin B12 (mcg)	Female	4.4	-	-	4.6	[2]0.940
	Male	5.2	-	-	4.8	[2]0.708
Vitamin D (mcg)	Female	5.1	-	-	2.1	[1]0.785
	Male	2.7	-	-	1.8	[1]0.554
Iron (mg)	Female	9.6	18	53	8.6	[1]0.397
	Male	9.8	8	122.5	9.4	[1]0.677
Calcium (mg)	Female	749.2	1500	50	677.0	[1]0.797
	Male	766.8	1500	51	637.5	[1]0.425
Magnesium (mg)	Female	224.5	-	-	207.5	[1]0.568
	Male	251.0	-	-	224.5	[1]0.960

Note. [a]ISSN: International Society of Sports Nutrition, [b]No ISSN value, [c]bw: body weight, [d]CHO: Carbohydrate. [1]Student t Test; [2]Mann Whitney U Test

Protein intakes on training days for both genders are lower than ISSN recommendations. Female athletes received 68% of the ISSN recommendations for protein,

while male athletes received 60% of the protein. Fat intakes in both genders are approximately 1.2 times higher than ISSN recommendations. Carbohydrate intake on training days for both genders is lower than ISSN recommendations. Female athletes received 20% of the ISSN recommendations for carbohydrates, while male athletes received 21%. While the iron intake of female athletes is 53% of the ISSN recommendations, this increases to 122.5% for male athletes. Calcium intakes on training days for both genders are lower than ISSN recommendations. Female athletes received 50% of the ISSN recommendations for calcium, while male athletes received 51%. There is no statistically significant difference between men and women regarding food consumption record data values on training days and non-training days ($p>0.05$). While the athletes' PAL value was 2.3 on the training day, it was calculated as 1.5 on the non-training day. (not shown in the table) A comparison of energy, macro and micro nutrient intakes by branches and whether it is a training day is given in Table 7.

Table 7
Comparison of Energy, Macro, and Micro Nutrient Intakes by Branches (n = 66)

Parameters		Branch				p
		Swimming (n=25)	Wheelchair Basketball (n=17)	Archery (n=4)	Amputee Football (n=20)	
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Energy (kcal)	**Training**	1611.0±566.3	1399.6±573.6	1489.3±418.1	1600.3±493.7	[1]0.606
	Not training	1489.6±389.7	1400.0±616.5	1261.7±502.2	1517.1±509.6	[1]0.747
Protein (g)	**Training**	74.4±23.1	77.4±34.8	63.5±39.9	67.8±24.8	[1]0.652
	Not training	68.3±18.7	77.4±32.0	70.9±3	65.4±22.0	[1]0.507
Protein (%)	**Training**	19.6±4.1	22.1±7.23	25.3±8.7	17.3±4.2	[2]0.091
	Not training	19.2±4.6	24.8±12.8	23±5.4	18.0±4.5	[2]0.089
Fat (g)	**Training**	80.2±36.2	60.0±27.8	71.5±21.6	68.6±25.2	[1]0.212
	Not training	74.6±22.6	59.7±27.3	60.9±23.6	63.4±22.8	[1]0.199
Fat (%)	**Training**	43.2±8.5	38.7±9.2	42.8±3.4	41.2±6.8	[1]0.368
	Not training	45.2±9.1	41.2±9.4	43±2.9	40.1±7.7	[1]0.230
CHO[3] (g)	**Training**	144.4±57.8	136.8±87.5	118.6±50.8	164.1±64.5	[2]0.273
	Not training	132.7±60.3	128.2±93.4	103.4±45.9	152.8±71.5	[2]0.275
CHO (%)	**Training**	37.3±8.2	42.0±15.5	32±7.4	41.8±7.5	[2]0.125
	Not training	35.7±10.8	39.52±16.94	33.75±5.5	41.95±8.64	[2]0.210
Liquids (ml)	**Training**	2621.5±1235.5	2556.0±1512.4	3084±1168.6	2287.2±572.2	[2]0.650
	Not training	2053.5±838.9	1649.8±1306.0	1934.5±717	1664.7±739.9	[2]0.156
Vitamin D (mcg)	**Training**	5.0±7.5	2.3±1.9	1.5±1.0	1.7±1.3	[2]0.425
	Not training	1.8±1.2	2.4±1.6	1.5±1.0	1.5±1.4	[2]0.262
Iron (mg)	**Training**	9.9±3.1	9.2±3.2	11.0±3.9	9.8±3.0	[1]0.768
	Not training	8.7±3.0	9.6±3.4	9.9±4.4	9.5±3.5	[1]0.752
Vitamin B12 (mcg)	**Training**	5.9±2.9	4.3±2.4	5.8±2.3	4.5±2.8	[1]0.193
	Not training	5.0±2.2	4.9±2.6	5.8±2.3	4.1±2.3	[1]0.479
Ca (mg)	**Training**	826.4±421.2	686±262.3	706.1±172.7	762.2±373.8	[1]0.652
	Not training	690.3±294.8	625.8±299.4	657.9±184.7	620.8±302.2	[1]0.852
Mg (mg)	**Training**	253.9±83.8	222.8±76.7	249.1±64.4	253.8±63.5	[1]0.555
	Not training	221.6±70.8	216.6±68.8	222.9±83.4	233.6±87.6	[1]0.918

Note. [1]Oneway Anova Test, [2]Kruskal Wallis Test, [3]CHO: Carbonhydrate

DISCUSSION

Body Composition

Paralympic athletes differ from healthy athletes by having various diseases/disabilities, the auxiliary equipment (crutches, wheelchairs, etc.), the muscle groups used in the sport, and the prolongation of muscle glycogen regeneration (recovery) time. This study aimed to determine the nutritional status, hydration status, and some anthropometric measurements of professional-level disabled athletes affiliated with the Physically Disabled Sports Federation and to evaluate the results obtained. When BMI was calculated by adjusting for limb losses using the Amputees Coalition calculator, it was found to be inconsistent for lean and muscular lower limb amputees, and the ratio of the body segments is different from Osterkamp (Frost et al., 2017; Osterkamp, 1995). While BMI underestimates body weight in individuals with unilateral amputations, it overestimates it in individuals with bilateral amputations due to low height (Meyer & Edwards, 2014). In this study, the BMI of the athletes was calculated at 23.9±4.1. Since the number of athletes with unilateral limb deficiency was high and the number of athletes with bilateral amputation was low in the study, the average BMI may have been underestimated.

In athletes with disabilities, 23.5-32 cm MUAC is classified as usual, MUAC >32 cm is classified as overweight (Bhurosy & Jeewon, 2013). In this study, the participants' MUAC value found was 30.3±6.4 cm, and according to classification, the athletes were normal. Wheelchair basketball athletes had higher MUAC values than swimming and amputee soccer athletes. This may occur when these athletes perform exercises such as pull-ups to increase arm muscle strength. It is known that although stroke length does not change with age, it is closely related to height (Yaraşır et al., 2011). The results of the study support this relationship between height and stroke range. Swimming athletes had a lower stroke range than wheelchair basketballers.

While 27.3% of the athletes did not pay attention to the food consumed before training or competition, 28.8% consumed carbohydrate-rich foods, and 25.8% consumed protein-rich foods. In the literature, 300-400 grams of carbohydrate intake (ACSM, 2016) or 1-2 g/kg/day carbohydrate intake (Kreider et al., 2010) approximately 3-4 hours before training/competition is recommended for healthy athletes. While no protein-rich foods are consumed before training or competition at the archers, this rate is 40% in amputee footballers. It was observed that the athletes' level of knowledge about how to eat before training or competition was low.

The rate of paying attention to nutrition in amputee footballers (95%) was higher than the swimmers (68%) and archers (25%). There is no statistically significant difference between other branches in terms of paying attention to nutrition. It can be thought that football is more prominent in the Turkish sports culture, and athletes are more careful about their nutrition to meet the expectations of the public and maintain their success.

Energy and Macronutrients

Wheelchair athletes have reduced muscle mass and sympathetic nervous system compared to healthy athletes. Therefore, they are expected to have lower energy requirements (Price, 2010). In this study, training day energy intakes by branch were 1399.6±573.6 kcal for wheelchair basketball and 1489.3±418.1 kcal for archery. Compared to other studies in the literature, the energy intake of wheelchair basketball athletes in this study was found to be low 4284 kcal (Bescos-Garcia & Rodriguez-Guisado, 2011), 2497±362 kcal (Ferro et al., 2017), 2060 kcal (Goosey-Tolfrey & Crosland, 2010). Egger and Flueck (2020) found that the energy intake of female wheelchair athletes was 1377±337 kcal/day. Therefore, they suggested that wheelchair athletes and possibly other para-athletes may be at risk for low energy availability. In this study, the daily energy intake of men on training day (1577.6±549.8 kcal) was higher than that of women (1447.1±492.5 kcal). On a non-training day, the energy intake of men was 1491.3±523.6 kcal, and that of women was 1366.3±374.3 kcal, and the energy intake of men was higher than that of women. The findings suggest that female athletes are in a more risky position regarding low energy availability as in the literature.

The mean energy intake of the athletes on training day was 1545.9±535.7 kcal, and the non-training day was 1461.0±491.8 kcal. Energy intake on the training day was found to be higher compared to the non-training day, but it was lower than the literature (Madden et al., 2017: 2092 kcal; Penggalih et al., 2019: 1627 kcal; Sasaki & Da-Costa, 2021: 2128 kcal). In the literature, energy expenditure of 1500-2900 kcal/day was higher (3990.9±1247.7 kcal) than all other studies involving wheelchair athletes (Eskici & Ersoy, 2016; Grams et al., 2016; Innocencio da Silva Gomes et al., 2006). However, it should be interpreted by considering the calculation errors that may occur if the energy expenditure of Paralympic athletes is calculated from formulas. Shaw et al. (2021) compared the energy intake of disabled athletes before (male 2819 kcal, female 2034 kcal) and during (male 2878 kcal, female 1760 kcal) the COVID-19 pandemic. When the data taken during the COVID-19 pandemic were compared with the

research findings, the energy intake of the athletes in this study (male 1579 kcal, female 1395.5 kcal) was lower than the literature.

An optimal carbohydrate intake maintains body weight, replenishes glycogen stores, repairs muscle tissue through protein synthesis, and provides fat, essential fatty acids, and fat-soluble vitamins (Kreider et al., 2010; Rodriguez et al., 2009; Thomas et al., 2016). Inadequate carbohydrate intake decreases oxygen transport and concentration, resulting in negative effects such as muscle cramps, fatigue, and an increased risk of injury (Skolnik & Chernus, 2010). In this study, carbohydrate intake on training day in all branches was found to be higher than on non-training day but lower than in the literature (Shaw et al., 2021: men: 387 g, women: 247 g men; Madden et al., 2017: 252 g, women: 209 g). A higher carbohydrate intake on the training day may positively affect the replenishment of muscle glycogen stores and recovery time. The carbohydrate intake of men on training day (152.6±71.3 g) was higher than that of women (128.9±54.6 g). When the training day carbohydrate intake data obtained from food consumption records were compared with the ISSN recommendations, men met 21% of the recommendations, while this rate decreased to 20% in women.

Standardization of nutrient recommendations for athletes with physical disabilities is difficult as the athlete's nutritional needs vary depending on their disability. Carbohydrate recommendations for healthy athletes suggest that nutrient intake should be based on body weight and is typically recommended between 3-12 g/kg/day depending on exercise type, volume, etc. (Burke et al., 2011). In the study, the carbohydrate intake of women (2 g/kg/day) was lower than that of men (2.1 g/kg/day). Carbohydrate intake in both genders was lower than the recommendations for healthy athletes.

Protein intake is important to produce enzymes and hormones, repair damaged tissue and compensate for protein breakdown due to increased protein catabolism during exercise (Knuiman et al., 2018). In both genders, protein intake on the non-training day (man: 69.6±24.6 g, women: 66.8±25.5 g) was lower than on the training day (man: 70.9±25.4 g, women: 81.5±35.1 g) and protein intakes in both genders were lower than the literature (man: 121 g, women: 81.7 g Madden et al., 2017; man: 136 g, woman: 86 g Shaw et al., 2021). When training day protein intake from food consumption records is compared with ISSN recommendations, men meet 60% of the recommended level, while women meet 68%. Protein recommendations for healthy athletes range from 1.2-2.0 g/kg/day depending on the type, duration, and intensity of physical activity (Thomas et al., 2016). In the present study, the protein intake of women (1.2 g/kg/day) was higher than that of men (1 g/kg/day). Protein intake in both genders was

lower than the recommendations for healthy athletes. When the data taken from Shaw et al. during the COVID-19 pandemic were compared with the research findings, the protein intake of the athletes in this study (man 71.4 g, woman 73.5 g) was lower than the literature (man 136 g, women 86 g, Shaw et al., 2021).

Dietary fats are important for health and athletics as they provide the body with energy, aid in the absorption of fat-soluble vitamins, and are a component of cell membranes (Thomas et al.,2016). Fat recommendations for healthy athletes are that 20-35% of daily energy intake and less than 10% should come from saturated fats (IOM, 2017; Thomas et al., 2016). In this study, the daily energy coming from fats was 42%, which is above the recommendations for healthy athletes. Men's fat intake was higher on the training day (71.9±31.13 g) than on the non-training day (65.6±25.1 g), while it was the opposite for women (67.9±30.5 g on training day, 69.3±22.2 g on non-training day). When the results of the study were compared with the literature, it was found that men's fat intake was lower than the literature while women's fat intake was higher than the literature (Men: 75.7 g women: 57.4 g Madden et al., 2017). When training day fat intake from food consumption records is compared with ISSN recommendations, men meet 117% of the recommended, while women meet 125%. When the data taken from Shaw et al. during the COVID-19 pandemic were compared with the research findings, men's fat intake (71.9 g) was lower than the literature, while women's fat intake (67.9 g) remained higher than the literature (man 89 g, women 52 g, Shaw et al., 2021). Lower fat intake was found in the literature than in the study results (51g, Penggalih et al., 2019). According to the ISSN, 10-20% of the daily energy requirement of healthy athletes should come from proteins, 20-35% from fats and 45-60% from carbohydrates (Kreider et al., 2010). In the study, 19% of the daily energy requirement on the non-training day came from proteins, 43% from fats, and 38% from carbohydrates.

Micronutrients

Iron indirectly plays a role in antioxidant activity and oxidative metabolism (Sasaki & Da-costa, 2021). Iron intake of men on training day (9.7±3.2 mg) was lower than that of women (9.9±3.0 mg). Iron intake of men and women on the training day was higher compared to the non-training day. When the training day iron intake obtained from food consumption records was compared with the ISSN recommendations, men met 122.5% of the recommended rate, while the rate decreased to 53% in women. When the data taken from Shaw et al. during the COVID-19 pandemic were compared with the research findings, the iron intake of the athletes

(man 9.4 mg, women 8.6 mg) in this study was low (Shaw et al., 2021: man 28 mg, women 18 mg). Athletes have lower iron intakes than other studies in the literature (Eskici & Ersoy, 2016: 15.7 ± 4.2 mg; Krempien & Barr, 2011: man: 14.5 ± 4.2 mg, women: 15.2 ± 7.1 mg). Iron deficiency can increase anemia, which can cause weakness, fatigue, poor concentration, and limit physical performance (Longo & Camaschella, 2015; Rowland, 2012). In this study, women were more prone to anemia than men. Female athletes have a higher risk of iron deficiency than men due to losses from menstruation and lower energy intake (Parnell et al., 2015; Sasaki & Da-costa, 2021; Sandström et al., 2012).

Vitamin D deficiency can decrease neuromuscular function (Flueck & Perret, 2017). Furthermore, individuals with spinal cord injuries are at increased risk for sublesional osteoporosis, characterized by excessive bone resorption and reduced bone formation (Doubelt et al., 2015). The vitamin D intake of men on training day (2.8±4.4 mcg) was lower than that of women (4.2±6.6 mcg). Although men's and women's vitamin D intakes on training day were higher than on non-training day, they are lower than in the literature (Madden et al., 2017; Shaw et al., 2021). Similar to the study results, women had lower intakes of vitamin B12, vitamin D, and iron compared to men in the literature (Shaw et al., 2021).

Vitamin D deficiency causes a decrease in calcium (Ca) absorption (Rakıcıoğlu, 2008). Disabled athletes are at higher risk of stress fractures when they train intensely and experience loss of bone mineral density (Blauvet et al., 2017). On the training day, the calcium intake of men (770.0±379.8 mg) was higher than that of women (743.2±287.4 mg). When the training day Ca intake obtained from food consumption records is compared with the ISSN recommendations, men meet 51% of the recommended rate, while the rate decreases to 50% in women. When the data taken from Shaw et al. (2021) during the COVID-19 pandemic were compared with the research findings, the Ca intake of the athletes in this study (man 749.2 mg, women 766.8 mg) was lower than the literatüre (man 1447 mg, women 1081 mg, Shaw et al., 2021). Increasing dietary Ca intake may not replace the deficiency, as 30-40% of dietary calcium can be absorbed (Rakıcıoğlu, 2008; Sasaki & Da-costa, 2021). Low levels of micronutrients involved in bone health, such as calcium, magnesium, and vitamin D, may negatively affect wheelchair athletes susceptible to osteoporosis (Calvo & Tucker, 2013; Miyahara et al., 2008). It is important to note that these values only come from dietary sources, and supplement use can improve them.

Pre-exercise dehydration and vigorous post-exercise fluid replacement are vital to ensuring timely recovery (Jepson et al., 2012). In the study, 84.8% of the athletes paid attention

to fluid intake before/after training or competition. It was observed that the participants generally had 500-1000 ml of fluid intake before and after training. While 51.5% of them used bottles, 48.5% used glasses. In amputee athletes, the skin surface area is reduced to dissipate the heat released due to limb deficiency. Additional heat may be released by contact of the prosthesis or prosthetic liners with the skin surface (Andrews et al., 2016). Such conditions are important to ensure proper hydration for the athlete (Shirreffs & Sawka 2011).

Skinfold thickness measurement is a simple and easy tool that can be used to determine body fat. BIA and LCD measurements can be used interchangeably (Kaner et al., 2015). Since the disability status of the athletes made it difficult to determine their body composition by BIA, body fat was determined in the study by taking skinfold thickness measurements. Innocencio da Silva Gomes et al. (2006) used the equation of Jackson and Pollock (1978) by taking skinfold thickness measurements from three different regions for body fat percentage determination. In the present study, for the determination of body fat percentage, skinfold thickness measurements were taken from four different regions. Body fat weight and fat percentage were determined by Jackson and Pollock (1978) and Siri (1961) equations. Since Jackson and Pollock (1978) did not develop this formula based on a sample of amputated athletes, it is questionable whether the equation is appropriate for this population (Meyer & Edwards, 2014).

There are no published MET values for people with disabilities that can estimate energy expenditure during daily activities and exercise. There are also no guidelines that can be used to adapt the MET values of healthy individuals to an athlete with an amputation, significantly lower body amputations (Ainsworth et al., 2011). There is no gold standard method for determining energy expenditure in Paralympic athletes. Due to the COVID-19 pandemic during the study period, we could not reach a sufficient number of athletes for profiling in the wheelchair basketball branch.

Limitations

The findings of this study should be interpreted with caution because of several limitations. First, the participants were young soccer players with amateur backgrounds. Therefore, the findings may not be generalizable to other age groups, skill levels, and competitive contexts. Second, the study only used psychological and technical responses in 2-a-side and 4-a-side game formats. These results may not fully represent the effects of physiological and kinematic parameters. Third, this study only assessed immediate responses

during and shortly after game sessions. However, the long-term implications of these observed differences have not yet been explored.

CONCLUSION

As a result, it was determined that the energy, carbohydrate, vitamin B12, Ca, Mg, and fluid intakes of Paralympic athletes in swimming, archery, amputee football, and wheelchair basketball branches were below the recommended levels, while daily protein, fat, and vitamin D intakes were above the recommended levels. It was found that dietary iron intake was above the recommended intake in men and below the recommended intake in women. In the study, it was determined that the rate of attention paid to the eating time of athletes was low. The hydration status of the athletes was found to be inadequate in all conditions of genderand branch, as well as in the presence or absence of training.

PRACTICAL IMPLICATIONS

In this study, it was observed that the hydration status of the athletes was inadequate in all conditions, such as gender, branch, and training. This result suggests that all coaches should be careful with athletes' hydration monitoring. Special modules should be created for coaches and athletes on nutrition, hydration, and supplement use, considering the special needs of paralympic athletes. These findings suggest that female athletes can prevent iron deficiency if they monitor regularly. Future research should identify barriers to good nutrition in athletes and determine how they relate to their body composition and daily energy intake and expenditure. Considering the disabilities and special needs of Paralympic athletes, a guideline should be established. For disabled athletes participating in sports, professional sports nutrition counseling should be applied by a dietitian specializing in the effect of nutrition on performance and the importance of fluid intake.

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Authors' contribution

The study's design was contributed to by the first and second authors, while the first author managed the data collection. The data analysis and interpretation were completed by

the first and second authors, while the drafting or critical revisions of article's was done by the first author. The article's final version has been approved of both authors.

Declaration of conflict interest

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

Ethics Stament

Ethical approal for this study was obtained from Marmara University Faculty of Medicine Clinical Research Ethics Committee on 01.11.2019 with protocol code 09.2019.956. Written informed consent to participate in this study was provided by the participants.

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Interaction of Overweight and Pronated Foot on Ground Reaction Force Frequency Content During Running

Amirali JAFARNEZHADGERO[1*] Ehsan Fakhri MIRZANAG[1] Hamed SHEIKHALIZADEH[1] Hamed PARSA[1]

[1]*Department of Sport Biomechanics, Faculty of Educational Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran*

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* **Corresponding Author**:
Amirali JAFARNEZHADGERO
E-mail Address:
Amiralijafarnezhad@gmail.com

ABSTRACT

Being overweight can influence the occurrence of pronated feet (PF). This research aimed to assess the interaction effect of overweight and PF along with sex on the frequency content of ground reaction forces (GRFs). 104 young male and female adults were allocated to four groups: normal body-mass-index/normal feet, normal body-mass-index/PF, excessive weight/normal feet, and excessive weight/PF. Subjects ran at constant speed over the walkway while an embedded force plate was located at the midpoint of the walkway. GRFs were recorded during 20 running trials. Findings demonstrated the significant main effect of "sex" ($P<0.001$; $\eta 2 = 0.392$) and "group" ($P<0.001$; $\eta 2 = 0.264$) and "sex-by-group interaction" ($P<0.001$; $\eta 2 = 0.442$) for an essential number of harmonic in the vertical direction. Overall, our results showed sex, body mass index, and foot type could possibly affect GRF frequency content while running. The paired-wise comparison demonstrated lower Ne in the vertical direction in the females than in the males. The paired-wise comparison demonstrated the greatest Ne in the vertical direction in the normal weight/normal foot group than the of other groups. These findings could be used for designing rehabilitation protocols (e.g., strength training) for individuals with overweight/obesity or PF and or both of them.

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INTRODUCTION

Obesity/overweight (OB/OW) is a risk factor for lower extremity injuries (Browning & Kram, 2007; Powell et al., 2005). Anecdotally, most of the people who are OB/OW have taken up running for recreation. Running exercise improves well-being, weight loss, and cardiovascular health (Hazell et al., 2014; Lee et al., 2017). Severe OB/OW could alter running biomechanics and it could lead to greater rear foot motion (Ghait et al., 2020; Sarkar et al. , 2011). Greater rear foot motion may be associated with a flat foot, loss of postural stability, and change in the gait pattern (Ghait et al., 2020; Sarkar et al., 2011).

Pronated feet (PF) are associated with a decrease of medial longitudinal arch during weight-bearing tasks such as running. The prevalence of foot pronation is also high in OB/OW adults (Wu, 2015). OB/OW walking was associated with higher rearfoot eversion. A high association between rearfoot eversion and greater body mass index (BMI) was reported (Wearing et al., 2006). PF is problematic in OB/OW versus healthy ones (Browning & Kram, 2007; Ghait et al., 2020). It has been reported that PF function affected the whole lower limb kinematic chain during gait (Dodelin et al., 2020). Anterior-posterior pelvic tilt range of motion, peak knee internal rotation, forefoot dorsiflexion range of motion, peak forefoot abduction, and rearfoot eversion were all increased in those with PF (Dodelin et al., 2020).

Ground reaction force (GRF) is one of the kinetic variables that is useful for evaluating running mechanics (Gottschall & Kram, 2005; Zadpoor & Nikooyan, 2011). It has been used in a variety of experiments. High lateral GRF values could lead to over-pronation during running or vice versa (Rodrigues et al., 2013; Willems et al., 2006).

OB/OW affects the GRF magnitudes during running (Sylvestre, 2019). Sylvestre et al. reported greater abduction of the knee during the running in OB/OW children than healthy ones (Sylvestre, 2019). Therefore, impact forces cause changes in the lower limb mechanics while running (Dicharry, 2010; Dugan & Bhat, 2005; Rodrigues et al., 2013; Willems et al., 2006). For example, greater GRF amplitude altered the peak rear-foot eversion angle, which may lead to an increase in stress on more proximal structures (Dierks et al., 2011; Mousavi et al., 2019; Munteanu & Barton, 2011). The GRF frequency content provides evidence for running-related injuries (Gruber et al., 2017; Matijevich et al., 2019). Therefore, it is important to evaluate these variables in order to find potential instruments to improve running mechanics in individuals with both OB/OW and PF. It was hypothesized that individuals with both OB/OW and PF have greater ground reaction force frequency content than other groups during running.

METHODS

Participant

Total of 104 male and female participants were allocated into 4 groups. NN: Participants with normal body mass (e.g., 20≤BMI<25 kg/m²) and normal foot (e.g., foot posture index between 0-6); NP: individuals with normal body mass and PF (e.g., foot posture index >10); ON: individuals with OB/OW (e.g., 35≥BMI≥25 kg/m²) with the normal foot; OP: individuals with both OB/OW and PF (Table 1). The study protocol was affirmed by the local ethics committee (IR.UMA.REC.1401.095 and IR.UMA.REC.093 for both females and males, respectively), and samples were provided their written informed consent in order to participate in the research.

Procedure

Participants were familiarized with the runway at the first. All GRFs during twenty running trials (~ 3.2 m/s) were recorded and filtered with a 20 Hz cut-off frequency and normalized to the subjects' body mass.

Data Collection Tools

A Bertec force plate (Bertec et al., 4060-07 Model, OH, United States) embedded at the runway midpoint was used for data collection. The sampling rate of Bertec force plate was 1000 Hz.

Frequency content

The GRF values (Fx, Fy, Fz) were analysed. The MATLAB software used an FFT to extract the frequency content of GRF data (Winter, 2009). The full description of the Fourier series of GRF data can be found in other sources (Giakas & Baltzopoulos, 1997; White et al., 2005). The frequency with a power of 99.5% (F99.5%) contains 99.5% of the power of the signal (Eq. (1); McGrath et al., 2012).

$$\int \int_0^{f99.5} P(f)\, df = 0.995 \times \int_0^{fmax} \times P(f) df \quad (1)$$

Where P is the frequency power against amplitude, F_{max} is the peak frequency, and P (f) is the power at frequency f (McGrath et al., 2012). The essential number of harmonics (Ne) showed for 99.5% possibility of reconstruction of data (Eq. (2); Schneider & Chao, 1983). In this equation n showed the number of harmonic; An and Bn demonstrated coefficients of Fourier.

$$\sum_{n=1}^{n_e} \frac{\sqrt{A_n^2 + B_n^2}}{\sum_{n=1}^{m} \sqrt{A_n^2 + B_n^2}} \leq 0.995 \qquad (2)$$

Data Analysis

The normal distribution of data was confirmed through the Kolmogorov-Smirnov test. All analyses were done using MATLAB software. The group (four groups) and sex (male versus female) effects were assessed through two-way ANOVA with repeated measures test. Effect size values were calculated through η^2 ($0.01 < \eta^2 <= 0.06$: small); $0.06 > \eta^2 < 0.14$ = moderate; $\eta^2 >= 0.14$: high). The Alpha value was $p < 0.05$. All analysis were done using SPSS 23.

RESULTS

Findings showed a significant main effect of the "sex" ($P<0.001$; $\eta 2 = 0.217$) and "group" ($P<0.001$; $\eta 2 = 0.530$) for the weight (Table 1). The paired-wise comparison demonstrated greater weight in males compared with females. Moreover, paired-wise comparison demonstrated the greatest value of the weight in overweight groups than that of other groups (Table 1). Significant effect of "sex" ($P = 0.011$; $\eta^2 = 0.069$ and "group" ($P<0.001$; $\eta^2 = 0.672$) and "sex by group interaction" ($P = 0.005$; $\eta^2 = 0.129$) for BMI was found (Table 1). The paired-wise comparison demonstrated greater BMI in females compared with males. Moreover, paired-wise comparison demonstrated the greatest value of the BMI in overweight groups than that of other groups (Table 1). Findings demonstrated a significant effect of the "sex" ($P<0.001$; $\eta 2 = 0.366$) on heart rate. The paired-wise comparison demonstrated greater heart rates in females compared with males (Table 1). Findings demonstrated a significant main effect of the "sex" ($P<0.001$; $\eta^2 = 0.813$) and "group" ($P = 0.001$; $\eta^2 = 0.017$) for navicular drop. The paired-wise comparison demonstrated a greater navicular drop in males compared with females. Moreover, paired-wise comparison demonstrated the greatest value of the navicular drop in pronated foot groups than that of other groups (Table 1).

Findings revealed a significant main effect of "group" for frequency 99.5 in the mediolateral direction ($P = 0.017$; $\eta^2 = 0.104$). The paired-wise comparison demonstrated the lowest frequency of 99.5 in the mediolateral direction for the normal weight and normal foot group and the greatest values in overweight and normal foot group. Significant effect of "group" ($P<0.001$; $\eta^2 = 0.190$) and "sex-by-group interaction" ($P<0.001$; $\eta^2 = 0.332$) for Ne in the mediolateral direction (Table 2). The paired-wise comparison demonstrated the greatest Ne in the mediolateral direction for normal weight and normal foot group than that of other groups.

Post-hoc analysis showed greater Ne in the mediolateral direction in males than in females in the normal weight and normal foot group. However, post-hoc analysis showed greater Ne in the mediolateral direction in females than in males in other groups.

Findings demonstrated a significant main effect of the "sex" ($P<0.001$; $\eta^2 = 0.248$) and "group" ($P = 0.027$; $\eta^2 = 0.094$) for frequency 99.5 in the anterior-posterior direction (Table 2). The paired-wise comparison demonstrated a lower frequency of 99.5 in the anterior-posterior directions in females compared with the males. Moreover, paired-wise comparison demonstrated the greatest value of frequency 99.5 in the anterior-posterior directions in overweight with normal feet group than that other groups (Table 2).

There was a significant effect of "sex" ($P<0.001$; $\eta^2 = 0.258$) and "group" ($P<0.001$; $\eta^2 = 0.242$) and "sex" by group interaction" ($P<0.001$; $\eta^2 = 0.202$) for Ne in the anterior-posterior direction (Table 2). The paired-wise comparison demonstrated greater Ne in the anterior-posterior direction in the females than in the males. The paired-wise comparison demonstrated the greatest Ne in the anterior-posterior direction for the overweight/pronated foot group than that of other groups. Post-hoc analysis showed greater Ne in the anterior-posterior direction in females than in males in the overweight/pronated foot group (Table 2).

Results din not demonstrate any significant difference for Fz (99.5) between groups during running ($P>0.05$). Significant effect of "sex" ($P<0.000$; $\eta^2 = 0.392$) and "group" ($P<0.001$; $\eta^2 = 0.264$) and "sex by group interaction" ($P<0.001$; $\eta^2 = 0.442$) for Ne in vertical direction (Table 2). The paired-wise comparison demonstrated lower Ne in the vertical direction in the females than in the males. The paired-wise comparison demonstrated the greatest Ne in the vertical direction in the normal weight/normal foot group than the of other groups. Post-hoc analysis showed greater Ne in the vertical direction in males than in females in the overweight/normal foot group. Post-hoc analysis showed greater Ne in the vertical direction in males than in females in all groups except for the normal weight/normal foot group (Table 2).

Table 1
Mean and Standard Deviation of the Demographic Characteristic

Demographic Characteristics	Normal weight normal foot		Normal weight pronated foot		Over weight/Obesity normal foot		Over weight/Obesity pronated foot		Gender Sig (Eta)	Group Sig (Eta)	Gender by Group interactions Sig. (Eta)
	Male	Female	Male	Female	Male	Female	Male	Female			
Age (years)	22.30 ± 2.71	24.15 ± 3.02	23.92± 4.48	23.25 ± 4.18	24.58± 4.81	25.38±4.29	25.50± 5.83	27.33±5.74	0.291(0.012)	0.057(0.078	0.725(0.014)
Weight (kg)	68.84 ± 7.36	56.78±4.55	70.15±8.99	58.29±5.83	84.58±7.70	80.45±10.06	89.58±15.92	78.41±12.64	**0.000(0.217)***	**0.000(0.530)***	0.414(0.030)
Height (cm)	179.69±5.70	161.23±6.35	178.30±5.89	163.54±5.45	179.25±5.75	161.53±5.65	175.58±9.18	162.75±7.65	**0.000(0.617)***	0.810(0.010)	0.401(0.031)
Body mass index (kg/m²)	21.30±1.39	21.88±1.52	22.03±2.18	21.69±1.83	26.29±1.41	30.92±4.48	28.85±3.15	29.40±3.07	**0.011(0.069)***	**0.000(0.672)***	**0.005(0.129)***
Harte Rate (beat per minute)	117.47±9.48	132.53±14.08	114.08±9.61	135.87±15.98	111.53±12.57	141.56±21.16	118.96±18.12	139.67±15.40	**0.000(0.366)***	0.716(0.015)	0.364(0.034)
Navicular drop(mm)	6.69±1.10	5.07±1.115	12.69±1.60	11.25±1.13	7.00±1.53	6.53±1.6	12.91±2.10	12.25±1.54	**0.000(0.813)***	**0.001(0.017)***	0.444(0.029)

Note. *Stand for significant difference $p<0.05$

Table 2
Mean and Standard Deviation of the Frequency of Three Medio-lateral (Fx), Anterior-posterior (Fy), and Vertical (Fz) Ground Reaction Force Components During Running

Direction (Component)	Normal weight normal foot		Normal weight pronated foot		Over weight/Obesity normal foot		Over weight/Obesity pronated foot		Gender Sig (Eta)	Group Sig (Eta)	Gender by Group interactions Sig. (Eta)
	Male	Female	Male	Female	Male	Female	Male	Female			
Fx (99.5)	15.34 ± 4.25	20.27' ± 4.52	21.42± 9.83	16.68 ± 2.81	20.70± 7.13	20.41±2.62	18.29± 3.65	19.02±3.42	0.882(0.000)	**0.017(0.104)***	0.314(0.128)
Fx (Essential)	22.69 ± 6.74	12.68±4.29	12.76±7.50	14.76±2.29	11.04±3.48	14.00±1.92	9.70±3.20	15.65±3.06	0.806(0.001)	**0.000(0.190)***	**0.000(0.332)***
Fy (99.5)	21.84±8.48	9.38±1.77	17.34±6.39	17.69±4.68	23.45±5.42	17.54±2.22	20.54±9.35	12.86±3.25	**0.000(0.248)***	**0027(0.094)***	0.002(0.149)
Fy(Essential)	10.03±4.81	13.24±3.29	12.38±6.33	14.30±2.02	13.54±5.97	15.92±1.38	11.95±5.42	24.32±2.91	**0.000(0.258)***	**0.000(0.242)***	**0.000(0.202)***
Fz(99.5)	12.53±5.81	15.30±2.92	9.98±3.62	12.37±1.28	9.85±1.81	14.03±2.05	15.33±3.10	9.12±3.10	0.233(0.015)	0.025(0.096)	0.000(0.292)
Fz(Essential)	20.98±4.60	25.00±1.74	23.28±3.12	15.60±1.38	24.25±2.3	15.75±2.32	21.54±3.50	15.25±3.55	**0.000(0.392)***	**0.000(0.264)***	**0.000(0.442)***

Note. *Stand for significant difference p<0.05

DISCUSSION

The study aimed to evaluate the interaction effect of OB/OW and PF on GRF frequency content during running. The finding demonstrated the lowest frequency of 99.5 in the mediolateral direction for the normal weight and normal foot group and the greatest values in OB/OW and normal foot group. Jafarnezhadgero et al. reported that the excessive body weight groups with and without PF presented lower mediolateral loading rates and peak lateral forces when compared to the non-overweight groups with and without PF (Jafarnezhadgero et al., 2023). A previous study reported that the load values imposed on the knee joint alter in the presence of overweight (Harding et al., 2012). Results demonstrated the greatest Ne in the mediolateral direction for normal weight and normal foot group than that of other groups. It is stated that frequency 99.5 and Ne in the mediolateral direction, the frequency spectrum of GRF components that occur during stance, has a high effect on running injury prevalence (Gruber et al., 2017). Results showed greater Ne in the medio-lateral direction in males than that female. It has been reported that female athletes had weaker thigh muscles (Huston & Wojtys, 1996). Moreover, our results showed greater ne in the medio-lateral direction in females than that males in other groups. Consistent with our results, literature reported that vertical GRFs frequency values show less variability than in both the anterior-posterior and mediolateral directions (White et al., 1999). It has been showing that females had larger ankle eversion, knee abduction, and internal rotation than males (Hunter et al., 2005). Phinyomark et al. (2014) demonstrated that females show higher hip internal rotation and adduction and greater maximum abduction of the knee than that males. Also, it has been mentioned that the tibia internal rotation and maximum eversion during running were greater among females (Sinclair & Taylor, 2014).

Findings demonstrated a lower frequency of 99.5 in the anterior-posterior directions in females compared with the males. It is stated that a decrease in frequency values of anterior-posterior GRFs component may be caused by the alteration in the gait speed (Stergiou et al., 2002). These authors reported that walking mostly occurs in the sagittal plane, and differences in speed are mostly reflected in the anterior-posterior GRF component (Stergiou et al., 2002). However, in our study participants' running velocity was similar. Moreover, results demonstrated greatest value of frequency 99.5 in the anterior-posterior directions in overweight with normal feet group than that other groups. Jafarnezhadgero et al., reported individuals with excessive body weight presented lower peak amplitude of braking and propulsion forces (Jafarnezhadgero et al., 2023). However, these authors did not evaluate the frequency content of GRF components.

Findings demonstrated greater ne in the anterior-posterior direction in the females than in the males. Results demonstrated the greatest ne in the anterior-posterior direction for the overweight/pronated foot group than that of other groups. Findings showed greater ne in the anterior-posterior direction in females than in males in the overweight/pronated foot group. Results demonstrated the greatest ne in the vertical direction in the normal weight/normal foot group than in the other groups. Obesity was related to a longer time of activation in the quadriceps and gastrocnemius muscle (Amiri et al., 2015), which can result in lower ne in the vertical direction of OB/OW groups.

Findings showed greater Ne in the vertical direction in males than in females in all groups except for the normal weight/normal foot group. Stergiou et al. (2002) reported that the less frequency content are associated with less vertical displacement of the center of mass (Wurdeman et al., 2011). Frequency content of GRFs could be applied as a suitable tool for introducing pathological running pattern in different sex (Wurdeman et al., 2011). A suitable treatment (e.g., training) could lead to a better frequency value of the GRF data. Further researches are needed to evaluate the use of GRF frequency values in individuals with OB/OW or different sexes as dependent variables for rehabilitation and its application as a screening method (Wurdeman et al., 2011).

The limitations of this study include; Firstly, the absence of kinematic data and the relatively homogeneous age group of participants may limit the generalizability of the findings. Secondly, all participants were young. This caution is necessary when discussing our results because our results may not be generalized to the general population.

CONCLUSION

Overall, our results showed that sex, body mass index, and foot type could possibly affect ground reaction force frequency content while running. These findings could be used to design rehabilitation protocols for individuals with overweight/obesity or pronated feet or both. These findings could be used for designing rehabilitation protocols for individuals with overweight/obesity or pronated feet and or both of them.

Limitations

This sudy had limitatiotions that should be regarded. Firstly, we did not record kinematics data. Secondly, we did not record electromyography data. Future studies were needed in regard to the both kinematic and muscle activity data to better establish this issue.

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Declaration of conflict interest

No potential conflict of interest was reported by the author(s).

Authors' contributions

The first, second and third authors collected the data, analyzed the data, and wrote the manuscript; the first author analyzed the data and wrote the manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Ethics Statement

The study protocol was affirmed by the local ethics committee (IR.UMA.REC.1401.095 and IR.UMA.REC.093 for both females and males, respectively), and samples were provided their written informed consent in order to participate in the research.

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Pamukkale J Sport Sci, 2024, 15(2), 328-348, 2024 Research Article

8-Week Online Fitness Intervention on Muscle Strength, Flexibility, Body Composition and Physical-Self Perception: A Randomized Controlled Trial

Günay YILDIZER[1*] Feridun Fikret ÖZER[2] Caner ÖZBÖKE[1] Burak SÖĞÜT[3] Didem ŞAFAK[3] Dilara Ebru UÇAR[4]

[1]*Department of Physical Education and Sport, Eskişsehir Technical University, Eskişehir, Türkiye*
[2]*Department of Coaching Education, Eskişsehir Technical University, Eskişehir, Türkiye*
[3]*Faculty of Sport Science, Eskişsehir Technical University, Eskişehir, Türkiye*
[4]*Department of Healthcare Services, Anadolu University, Eskişehir, Türkiye*

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* **Corresponding Author**:
Günay YILDIZER
E-mail Address:
gunayyildizer@eskisehir.edu.tr

ABSTRACT

This research examines the effect of an online physical fitness intervention plan on health-related components, and self-perception with randomized controlled trial. A total of 43 individuals completed the study, 21 of them were in the experimental group, and 22 were in the control group. Muscle strength was assessed using push-ups and sit-ups, while flexibility was determined through sit-and-reach tests. Fat and muscle mass in the arms, legs, trunk, android, gynoid regions, and total body were measured in grams by using Dual Energy X-Ray Absorptiometry. Health, body fat, strength, flexibility, endurance sub-dimensions of Marsh Physical Self-Description Inventory was used for self-perception. Results showed that group and time interaction had a significant effect on self-perception of body fat and push-ups, flexibility left and right, total fat, body fat mass in the arm, leg, and gynoid regions. Although the muscle mass of the experimental group increased in the 8-week period, this situation was not statistically significant. The implemented physical fitness intervention program has a significant impact, particularly in terms of fat burning. The findings obtained in strength tests can be associated with a decrease in fat mass, especially in the upper body. In conclusion, these findings underscore the potential of online fitness interventions in achieving positive health outcomes, emphasizing the multifaceted benefits of such programs on both perceived and measured physical well-being.

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INTRODUCTION

Physical fitness is one of the leading concepts of health and well-being at all stages of life (Corbin et al., 2000). The components of health-related physical fitness, namely flexibility, cardiovascular endurance, body composition, muscular strength, and endurance are important components of overall health and associated with numerous health benefits (Pescatello et al., 2014). Increased physical activity level is associated with improved health-related fitness (Jaakkola et al., 2019), positive effects on blood pressure, metabolism, and body weight (Pedersen & Saltin, 2015) mental health benefits such as reduced anxiety levels and stress (Codella et al., 2017; Zou et al., 2022). Although the relationship between participating in regular exercise to increase physical fitness and health is evident, the prevalence of sedentary behavior is high among people from all age groups (Bauman et al., 2018). Sedentary lifestyle is a global issue, and a considerable amount of people inveterately engage in various sedentary activities such as playing video games, watching TV, and using computer for a long time. Sedentary behavior is defined as any waking behavior, such as sitting or leanin with an energy expenditure of 1.5 metabolic equivalent task (MET) or less (Tremblay et al., 2017). A sedentary lifestyle is utterly related to various chronic health problems such as cardiovascular diseases, diabetes, cancer, hypertension, obesity, depression, musculoskeletal diseases and premature mortality (Park et al., 2020). Sedentary behaviors are not just associated with negative health outcomes, but there is also consistent evidence that sedentary behavior is associated with lower physical fitness in various age groups (Guo et al., 2022; Mateo-Orcajada et al., 2022).

In certain contexts, individuals tend to engage in prolonged sedentary behaviors, and these contexts are considered sedentary-promoting environments (Biddle et al., 2016). Specifically, sedentary activities encompass activities that involve extended periods of sitting, such as smartphone usage, computer-based work, or long hours of study. Environments that facilitate and encourage these sedentary behaviors can be categorized as sedentary-promoting environments. These environments may have detrimental effects on individuals within them, including university students who are expected to be physically active based on their age group (Guo et al., 2022; Yoo et al., 2020). Indeed, university students and office workers who predominantly engage in sedentary behaviors, such as prolonged sitting and computer-based work have consistently shown associations with various aspects of diminished physical fitness (Li et al., 2022; Prieske et al., 2019; Prince et al., 2019; Yoo et al., 2020). Activities entailed with

sitting in the classroom paradigm should be replaced with standing desk activities in the classroom to improve cardiometabolic health of university students (Butler et al., 2018). Therefore, sedentary behavior associated with study and work is a matter of public health concern, given its detrimental effects on both health and physical fitness (Dewitt et al., 2019). Although environmental factors in university campuses are generally sufficient to promote a physically active lifestyle, work demands employees and students might mitigate the physical activity participation and increase the time spent as sedentary (Castro et al., 2020; Deliens et al., 2015; Lusa et al., 2020). To illustrate, university employees spend most of their workday sitting (Faghy et al., 2022), and an individual may spend more than half the day sedentary on an ordinary workday in office settings (Wahlström et al., 2023). Similarly, university activities that students engaging are also highlighted as generally sedentary, with an average of 7.30 hours per day sitting (Castro et al., 2020). Hence, universities can be categorized as a key setting where sedentary behavior is typical, and individuals in university settings engage in high levels of sedentary time with several hours per day, which have been linked to negative health outcomes, such as obesity, type 2 diabetes, and cardiovascular disease (Vainshelboim et al., 2019).

METHODS

Research Design

The study employed a randomized controlled trial to assess the effectiveness of the developed interventions on fitness components, body composition, and perceived physical self-concept. Simple randomization was used. Time and the group variables were the independent variables, while physical fitness components (push-ups, sit-up counts and sit and reach distance, fat and muscle mass in the arms, legs, trunk, android, gynoid regions and total body), and physical self-concepts (perceived health, body fat, strength, flexibility) were the dependent variables of the study. The research was completed in 10 weeks. The pre-tests of the study were conducted in first week, and the exercise program was completed in between weeks two and nine. After the completion of the exercise program, the participants attended the post-tests in the same order as in the pre-test. The review board approved this study of the Eskişehir Technical University with Protocol No.: 63349 (06.04.2022) The study commenced in July 2022 and concluded in October 2022.

Participants

A priori sample size was calculated via G*Power version 3.1.9.7 for Mixed Design ANOVA, which determined effect size 0.25, power 0.80, two groups (intervention and control) and two measurements (pre- and post-test). The basis on which values were determined were the recommendations of Cohen (1988) on statistical power and the manual of G*power software for the selected design and the appropriate analysis. The sample size was calculated to be a total of 34 participants. The inclusion criteria were determined as follows: a) working or studying at the university; b) having no health problems that would prevent participation in exercise; c) not being involved in another exercise/training program during the research process; d) voluntary participation. University employees and students were invited to participate in this study via e-mail. A total of 67 individuals replied and wanted to participate in the study. However, the results of the Physical Activity Readiness Questionnaire (PAR-Q) and the reported medical conditions indicated that only 49 participants were eligible for the intervention protocol. The eligible participants were invited to the laboratory for the implication of the data collection protocols. The study sample was randomly assigned to intervention (n = 24) and control groups (n = 25) by using randomization software. The randomization wasn't blind, as all participants work or study in the same university campus. A pretest group differences in all variables were checked by using independent sample t-tests, and there were no group differences. Three participants from the intervention group didn't complete the protocol and were excluded from the post-tests and three participants in the control group didn't attend the post-test measurements. Finally, the study sample comprised 21 participants in the intervention group 147 (M_{Age} = 30.90, SD = 8.04; M_{Weight} = 65.36, SD = 10.87; M_{Height} = 167.57, SD = 9.01, M_{BMI} = 23.25, SD = 3.26) and 22 participants in the control group (M_{Age} = 26.12, SD = 7.71; M_{Weight} = 67.54, SD = 14.34; M_{Height} = 170.24, SD = 9.95, M_{BMI} = 23.15, SD = 3.76). The group differences were rechecked for the possible covariance variables, however, there were still no differences in all dependent variables.

Procedures

Physical Fitness

All measurements were practiced in one day at Eskişehir Technical University Laboratory of Kinanthropometry. The Kinanthropometry Laboratory was includes Dual Energy X-Ray Absorptiometry (DXA), sit and reach box, stadiometer, scale, and other measurement materials. Push-up and curl-up tests were used to evaluate endurance and strength of the upper body. The sit-and-reach test were used to assess lower body flexibility.

To evaluate body composition, body mass (kg), height (cm), fat percent, muscle mass, and fat mass were measured. Before measurements, participants were informed about test procedures. Each session was administered by the same two researchers who are experienced in the field and are graduate students. After the body composition tests, participants followed in randomized order to complete physical fitness tests. Testing was preceded by a standard warm-up (five minutes of walking and five minutes of dynamic stretching). Before each session, practitioners demonstrated the test. After participants performed the tests one time for familiarization, the test was performed twice, and the best score was recorded by the practitioner. Participants allowed to rest for five minutes between all tests.

Push-Up

Participants were asked to place their hands flat on the ground under their shoulders, with a straight, slanted line on shoulders, back, and legs. While performing the test, participants were expected to lower the torso until the elbows are in line at 90 degrees angle with upper arms and shoulders were parallel to the ground, while the body was lifted up until the arms are straight at the lifting part. Participants were asked to perform push-ups every three seconds and an auditory stimulus was utilized; they were instructed to do each repetition with, their body moving rigidly in a roughly straight line. Following the familiarization, the participants were asked to complete as many push-ups as possible. The test was terminated once the individuals had completed consecutive repetitions with a restricted range of motion, and the most recent completed repetition was recorded.

Curl-Up

The participants were told to lay supine on a mat with the knees bent at a 90-degree angle, the legs spread apart, and the arms completely extended at the sides with the middle finger of, both hands contacting a piece of tape. The zero point was marked with the first piece of tape, and a second piece was placed 10 cm away. A metronome was set to 20 repetition rate per minute. In time with the metronome, the participant was directed to curl up until his middle finger reached the second piece of tape. Following the familiarization, the participants were asked to complete as many curl-ups as possible. Participants were required to keep the palms of their hands and the heels of their feet are in contact with the mat, while the shoulders and head were raised and returned to the mat, and the middle finger to the zero marker (Beck et al., 2015). The total number of repetitions that were successfully completed was noted.

Flexibility

A sit-and-reach box (Lafayette Instrument Company, USA) with a scale marked on the upper sides were placed against the wall. The participants were seated barefoot, with their legs fully extended and hip-width apart from the testing box. Participants were instructed to slowly reach forward and slide their fingers along the scale on top of the box by placing one hand over the other. The goal was for participants to maintain the position for about three seconds with their knees as straight as they could (Belkhir et al., 2021). The final position that the participant reaches were recorded to the nearest centimeter and set as the score for the test.

Body Composition

Participants' height was measured by a stadiometer (SECA, Hamburg) with an accuracy of 0.1 cm. In a standing still position, their arms at their sides, feet together, and toes touch to platform. Body mass (kg) was measured barefoot by a scale (SECA, Hamburg) with a precision of 0.1 kg. The whole-body composition (fat percentage, bone mass, muscle mass, and fat mass) was evaluated with DXA using a scanner (Lunar Prodigy Pro; GE, Healthcare, Madison, WI, USA). Prior to the measurements, the scanner's calibration was completed in accordance with the manufacturer's standard operating procedures. Before the scanning procedure, participants were requested to take off any metal from their bodies. Afterwards, participants were then instructed to lay down on the DXA mat. The participant's back was aligned with, the mat's center line, and both arms are placed to the side of the body. Height and weight pieces of information were entered into their form on the DXA software. Participants' knees and ankles were tied with a hook and pile strap to serve as a standard. Once participants were properly place, and the scanning process was started. Participants were instructed to keep still throughout the entire scanning procedure.

Physical Self-Concept

Turkish version of the Physical Self-Description Questionnaire was used to collect physical self-perception data. The 7-Likert type data collection tool was found valid and reliable among Turkish adults (Marsh et al., 2002). The inventory consists of 11 subdimensions and 70 items. However, only 27 items representing perceived body fat, flexibility, strength, and health subdimensions were used in this study. The higher scores obtained in the subdimensions represent higher physical self-perception. To illustrate, obtaining a higher score in body fat subdimension reflects perceived lower-level adipose tissue. The internal

consistency values were found 0.845 for body fat, 0.790 for strength, 0.887 for flexibility, and 0.876 for the health subdimensions.

Exercise Protocol

The physical fitness intervention lasted for eight weeks, three days a week, and 20-35 minutes a day as recommended by ACSM (Garber et al., 2011). The exercise program has been designed according to the progressive overload method (See in appendix). Therefore, the volume of the exercise program increased as the weeks progressed. Exercise videos were uploaded to YouTube on mondays, wednesdays, and fridays and send to participants via a message group to follow the program. The attendance of the participants in the program was followed up regularly through the message group. The videos have undergone some adjustments to be more entertaining and support participation. The videos featured the experts' explanations of the movements for each exercise. Also, there were images of the movements from different angles, information about the exercise time, and the music in the background. The equipment that the participants should use in the training sessions was selected from the materials available at home (eg., use of water bottles instead of weight dumbbells). The exercises have been replaced with difficult versions in the following every two weeks of the program within progressive overload exercise. The exercise sessions are divided into three parts: warm-up (2-4 min. average), main part (14-19 min. average), cool-down (3-5 min. average). The warm-up includes movements to increase the heart rate and warm-up the muscles to be worked on for that session. While the central part covered the whole-body exercises in the first weeks, and regional exercises were applied in the following weeks. The main part of the exercise program also included rest breaks when the participants were asked to move and stretch. Flexibility and stretching exercises are included in the cool-down sessions.

Data Analysis

The independent samples t-test was used to analyze the pre-test group comparison, and the results didn't indicate any significant differences in independent variables between experimental and control groups. Data were analyzed with the 2x2 (Time x Group) Mixed Design Analyses of Variance (Mixed ANOVA) for each independent variable. The normality of the independent variables were checked by using Shapiro-Wilk's test, and the results indicated that only muscle mass in legs distributed non-normally in the posttest for the control group, and muscle mass in arms non-normally in the pre-test for the experimental group. For

those non-normal distribution, the histograms, ratios between standard errors and actual skewness and kurtosis statistics and coefficient of variation were examined (Hayran & Hayran, 2020). As the data had a fairly skewed distribution, the skewness and kurtosis data were in the normally accepted range (Kline, 2011), and the coefficient of variation was less than 30 (Hayran & Hayran, 2020), the muscle mass in the legsgs, and muscle mass in arms were accepted as normally distributed. The analyses were carried out with Mixed ANOVA. The Levene's test confirmed the assumptions of homogeneity of variances for all independent variables ($p>0.05$). The partial eta squared effect sizes were also reported for the magnitude of the detected effects. All analyzes were conducted with originally assigned groups.

RESULTS

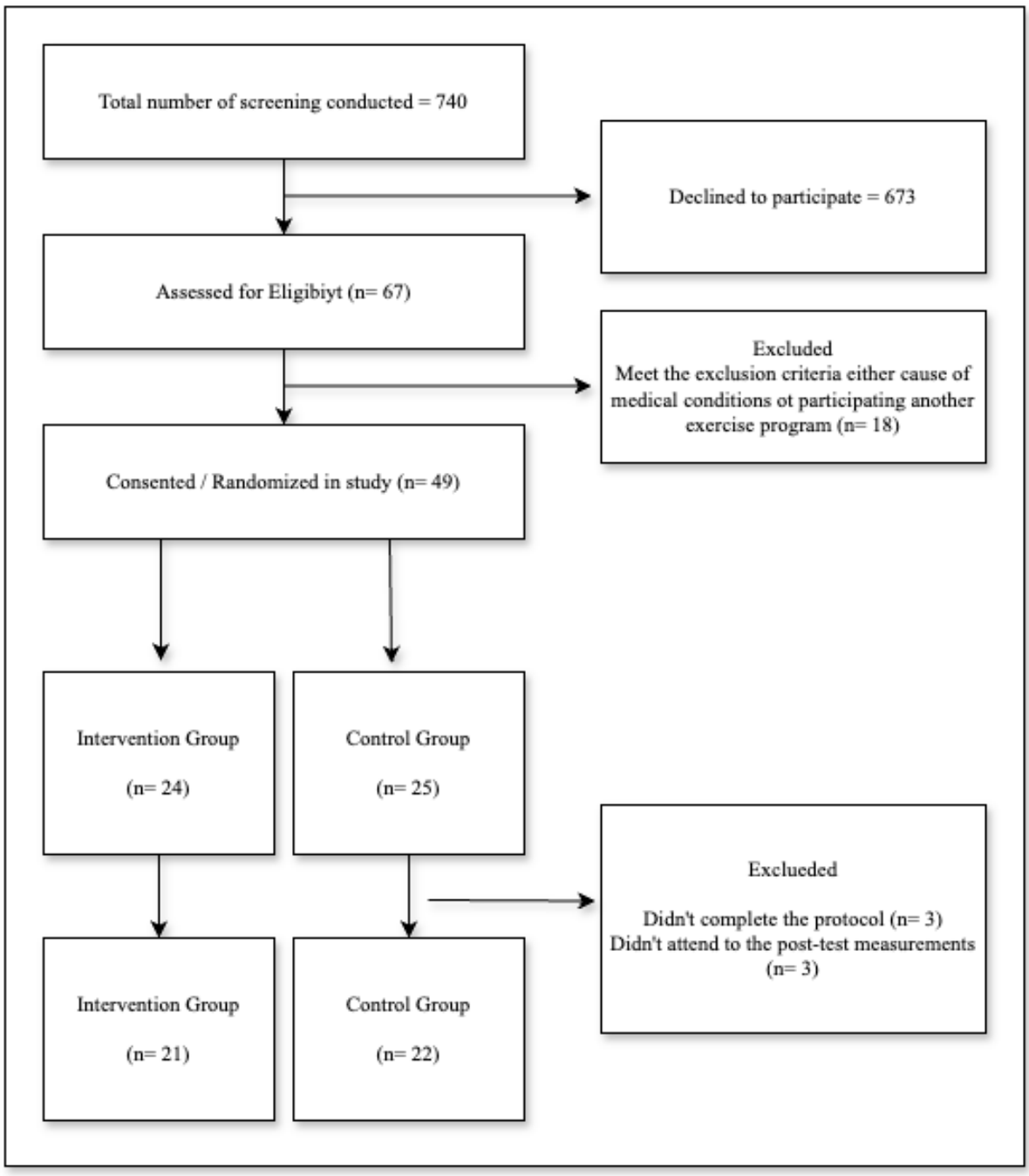
A participants' flow diagram, illustrating the number of individuals who were randomly assigned, and those who dropped out are depicted in Figure 1. The 2-way Mixed ANOVA results indicated a significant interaction between time and intervention on push-up performance [$F(1,41) = 5.877$, $p = 0.20$, $\eta2 = 0.125$], sit and reach performance with right leg [$F(1,41) = 25.586$, $p = 0.000$, $\eta2 = 0.384$], and left leg [$F(1,41) = 247.679$, $p = 0.000$, $\eta2 = 0.386$] for fitness test components. The simple main effect of time on push-ups performance [$F(1,41) = 15.555$, $p = 0.00$, $\eta2 = 0.275$], sit-up performance [$F(1,41) = 11.260$, $p = 0.02$, $\eta2 = 0.215$], and sit and reach performance with a left leg [$F(1,41) = 4.939$, $p = 0.032$, $\eta2 = 0.108$] was also found and shown in Table 1.

Table 1
Descriptive Statistics and Mixed ANOVA Results for Fitness Components

Variables	Group	Pre-test x (SD)	Post-test x (SD)	Time		Group		Time x Group	
				F	p	F	p	F	p
Push-ups	Exp	4.61 (4.88)	9.00 (2.30)	15.555	0.000	0.076	0.784	5.877	0.020
	Con	5.77 (6.13)	6.81 (2.38)						
Sit-ups	Exp	8.09 (8.52)	12.19 (9.96)	11.260	0.002	0.000	0.990	0.094	0.761
	Con	8.40 (6.91)	11.81 (8.42)						
Flexibility-right	Exp	20.83 (9.43)	25.35 (9.28)	1.474	0.232	0.032	0.858	25.586	0.000
	Con	24.04 (6.29)	21.27 (7.92)						
Flexibility-left	Exp	21.45 (9.12)	26.33 (9.71)	4.939	0.032	0.854	0.361	25.781	0.000
	Con	22.56 (6.36)	20.65 (9.23)						

Note. Exp: Experiment, Con: Control; F: Mixed ANOVA

Figure 1
Flow Diagram



The mixed ANOVA results also indicated significant interaction between time and intervention on total fat mass [$F(1,41) = 7.349$, $p = 0.010$, $\eta^2 = 0.152$], fat mas in arms [$F(1,41) = 7.310$, $p = 0.010$, $\eta^2 = 0.151$], in legs [$F(1,41) = 7.340$, $p = 0.010$, $\eta^2 = 0.152$], in trunk [$F(1,41) = 5.199$, $p = 0.28$, $\eta^2 = 0.113$], in gynoid region [$F(1,41) = 5.560$, $p = 0.23$, $\eta^2 = 0.119$] for the body composition variables shown in Table 2.

Table 2
Descriptive Statistics and Mixed ANOVA Results for Body Composition Components

Variables	Group	Pre-test x (SD)	Post-test x (SD)	Time		Group		Time x Group	
				F	p	F	p	F	p
Total Fat Mass	Exp	21060.00 (5953.47)	20002.04 (5771.52)	2.940	0.094	0.004	0.947	7.349	0.010
	Con	20285.81 (6582.56)	20523.95 (5771.52)						
Fat Mass in Legs	Exp	7917.66 (2527.76)	7558.14 (2665.08)	2.762	0.104	0.025	0.876	7.340	0.010
	Con	7577.63 (2245.29)	7663.77 (2367.41)						
Fat Mass in Arms	Exp	4801.16 (1428.64)	4854.00 (1460.09)	0.118	0.733	0.457	0.503	0.581	0.450
	Con	5152.27 (1604.78)	5132.27 (1623.92)						
Fat Mass in Trunk	Exp	10173.47 (3330.37)	9590.04 (3215.13)	2.147	0.151	0.003	0.958	5.199	0.028
	Con	9760.13 (3908.12)	9887.09 (3949.20)						
Fat Mass in Android	Exp	1470.09 (699.14)	1400.19 (651.42)	0.212	0.648	0.003	0.956	0.397	0.532
	Con	1417.95 (770.22)	1428.81 (756.13)						
Fat Mass in Gynoid	Exp	4016.47 (1240.95)	3864.66 (1248.71)	0.682	0.414	0.076	0.784	5.560	0.023
	Con	3799.63 (1203.62)	3872.68 (1313.34)						
Total Muscle	Exp	44148.28 (8506.59)	44788.76 (8973.18)	2.005	0.164	0.622	0.435	2.265	0.140
	Con	46835.13 (10611.12)	46815.59 (10877.78)						
Muscle in Legs	Exp	14838.66 (3206.03)	15067.90 (3257.52)	2.402	0.129	1.174	0.285	0.358	0.553
	Con	16115.22 (4054.56)	16216.72 (4085.39)						
Muscle in Arms	Exp	4801.19 (1428.64)	4854.00 (1460.09)	0.118	0.733	0.457	0.503	0.581	0.450
	Con	5152.27 (1606. 78)	5132.27 (1623.92)						
Muscle in Trunk	Exp	21016.80 (4030.69)	21382.47 (4392.82)	0.353	0.556	0.303	0.585	3.467	0.070
	Con	22072.59 (4969.24)	21883.77 (5124.58)						
Muscle in Android	Exp	3080.23 (709.19)	3053.28 (729.69)	0.487	0.489	0.021	0.886	0.028	0.868
	Con	3109.36 (847.23)	3092.81 (852.11)						
Muscle in Gynoid	Exp	6923.61 (1453.20)	6993.47 (1617.95)	0.745	0.393	0.447	0.507	0.303	0.585
	Con	7321.31 (2029.34)	7336.77 (2086.23)						

Note. Grp: Group; Exp: Experiment; Con: Control; F: Mixed ANOVA

Finally, a significant interaction between time and intervention on physical self-concept was found in body fat perception [$F(1,41) = 6.999$, $p = 0.012$, $\eta 2 = 0.146$], and significant main effect of time on flexibility perception [$F(1,41) = 5.556$, $p = 0.023$, $\eta 2 = 0.119$]. The physical self-perception components shown in Table 3.

Table 3
Descriptive Statistics and Mixed ANOVA Results for Physical Self-perception Components

Variables	Group	Pre-test x (SD)	Post-test x (SD)	Time		Group		Time x Group	
				F	p	F	p	F	p
Body fat	Exp	21.95 (6.02)	23.95 (5.81)	1.371	0.248	0.017	0898	6.999	0.012
	Con	23.09 (7.06)	22.31 (7.12)						
Strenght	Exp	21.80 (2.35)	21.85 (2.59)	0.727	0.399	0.002	0.968	0.981	0.328
	Con	22.18 (2.55)	21.54 (3.15)						
Flexibility	Exp	18.52 (2.52)	19.33 (3.10)	0.438	0.512	1.625	0.210	5.556	0.023
	Con	20.22 (3.16)	19.77 (2.72)						
Health	Exp	37.80 (6.12)	38.61 (5.77)	0.181	0.673	0.082	0.776	0.452	0.505
	Con	37.68 (8.86	37.50 (8.66)						

Note. Exp: Experiment; Con: Control; F: Mixed ANOVA

DISCUSSION

The purpose of this research was to examine the effect of online exercise programs on the physical fitness and physical self-perception in university employees and students. The online exercise program was delivered to the participants weekly via online platform. Although the health benefits of regular exercise participation were well-established (Pedersen and Saltin 2015; Zou et al. 2022), individuals, especially those working at universities, and students sit for most of the day and exhibit sedentary behaviors (Castro et al., 2020). Online exercise programs recommended to be an option to improve physical fitness (Jaakkola et al., 2019; Pedersen & Saltin, 2015). Therefore, within the scope of the research, it was planned to promote exercise participation by providing an online exercise program for university employees and students. Online exercise program basically designed according to the progressive overload method and consists of exercises lasting an average of 25 minutes to develop physical fitness components. As a result, improvements were determined in all physical fitness components (upper-body strength, flexibility and body composition) except abdominal strength and endurance. It was also found that the perception of body fat percent, one of the sub-dimensions of physical self-perception, decreased compared to the control group. However, there was no significant difference in strength and health sub-dimensions of physical self-perception.

The findings of the study indicated that there was a significant improvement in upper body strength of both groups, but the differences were insignificant. However, the flexibility on both sides were significantly different in favor of the experimental group. The research findings show some similarities with the studies in the literature. In a study conducted a home-based online resistance exercise program was used for middle-aged individuals for eight

weeks, two days a week, 60 minutes a day. It was determined that the participants improved in the upper body strength and endurance tests after the resistance exercise program, including nine movements but did not show improvement in terms of flexibility (Kikuchi et al., 2023). A possible explanation for this situation is that the exercise program in the research consists of resistance training (Kikuchi et al. 2023). In this study, especially the use of pilates exercises may have contributed to improving flexibility. The effect of an online exercise program performed one day a week for 60 minutes on physical fitness components such as upper body strength and flexibility were examined in the elderly individuals. The findings of the research showed that improvement was found in upper body strength and flexibility of the participants, similar to this study (Aksay, 2021). The effects of home-based online resistance exercises and walking intervention performed two days a week for 24 weeks on physical fitness components such as strength, power, and aerobic function in individuals with severe obesity were investigated. According to the results of the study, home-based online resistance exercises improved strength in severely obese individuals (Orange et al., 2020). Research findings similarly show that online exercise done at home or in a different environment significantly affects physical fitness.

While variations exist among the exercise programs featured in the studies; it is noteworthy that there is a consistent improvement in upper body strength and flexibility following the interventions. Considering the key factors (time, cost, transportation, and lack of facilities) affecting participation in regular physical activity, it is important an online exercise intervention can apply at home, easily accessible and less costly. Also, online exercise programs have started to be used more intensively especially after COVID-19 restrictions. Therefore, online exercise program has an important place for the development of physical fitness components. Body composition is another essential component of physical fitness. Body composition plays a crucial role in assessing obesity, which stands as one of the foremost health challenges in both Turkey and globally today (Lopez-Jimenez et al., 2022; Turkish Ministry of Health 2019). This study also assessed the impact of an online exercise program on body composition. While the 8-week online exercise program resulted in only a modest increase in fat-free mass demonstrated a notable reduction in total fat mass. According to the results total fat mass of the intervention group decreased in legs, trunk, and gynoid region and total fat mass, but not in arms and android region. Moreover, these decreases were significantly different from the control group. Similar to our findings, a study in which pilates exercises were performed for eight weeks, three days a week and 60 minutes a day for

participants consisting of students and staff at the university, found that the body fat of the participants decreased (Rogers & Gibson, 2009). As the protocol implemented in our study was including the variety of Pilates exercises, it may be concluded that consistent pilates participation might be effective in decreasing fat mass over an eight-week period. There were also resistance-type exercises in this study. According to the results of another study using resistance exercises, the body fat of the participants decreased, but no significant difference was found in body mass and BMI values (Zavanela et al., 2012). Also, Colakoglu was found that 12 weeks of calisthenic exercises had no effect on the body fat of sedentary women (Colakoglu, 2008). Main reasons for the differences between studies may be that aerobic exercises were not included in the studies (Colakoglu, 2008; Zavanela et al. 2012). In this research, the exercises were designed to include some aerobic exercises with progressive overload intensity. Both aerobic exercises and strength exercises were included in the study may have been effective on the decrease of the total fat mass results. Although the time, group, and interaction differences were insignificant, muscle mass in all measured regions was increased in the intervention group. Similarly, an increase in the muscle mass of overweight/obese individuals were determined after an eight-week Pilates program (Rayes et al., 2019). In Colakoglu's (2008) study, no increase in muscle mass was found after a 12-week program of callisthenic exercises. The reason participants did not gain significant muscle mass can be associated with the fact that no exercise materials were provided to the participants. Therefore, the participants completed the exercises with their body weights and home equipment. Another possible explanation may be the weights used by the participants may not be optimal enough to increase muscle mass. In future studies, it can be regulated and participants can work with weights suitable for them. In addition, since the primary purpose of the online exercise program was designed within the scope of the research was not to increase the muscle mass of the participants; no structuring was made for this in the program. Overall, we may conclude that the implemented eight-week protocol was more effective in terms of decreasing the fat mass, while its effect on the muscle mass increase was limited. Moreover, the insignificant differences between groups in fat and muscle mass changes in the arms and trunk can be associated with the insignificant differences in push-up and sit-up tests. As the implemented program did not significantly differ the muscle or fat mass in these regions of the body, participants performed similarly regardless of which group they were in.

CONCLUSION

In conclusion, it was determined that online exercise had positive effects on physical fitness components (upper-body strength, flexibility, and body composition) and physical self-perception. The findings of this study revealed that the pattern of change in the actual fitness and physical self-perception was similar to each other. During the eight-week intervention period, the intervention group experienced a reduction in adipose tissue across nearly all body regions, this might be leading to an improved perception of body fat. To put it more succinctly, participants reported a reduced perception of body fat after completing the eight-week exercise program, aligning with the findings from DXA measurements. Similar to many research results, the eight-week exercise program did not contribute positively to the physical self- perception of the participants (Aşçı, 2003; Kim & Ahn, 2021; Zhang et al., 2022). However, the findings of these previous studies and the current research show differences between the sub- dimensions of self-perception. The main reason for this situation is the differences in exercise programs. For example, in the exercise program design applied in this study, the inclusion of activities that will train the cardiovascular system more actively may have resulted in a more developed body fat perception. Secondly, perceiving less fat might be attributed to their heightened awareness and vigilance about the exercise program. In progressive overload exercises, the volume of the exercise is gradually increased by making some changes on the frequency, duration or intensity of the exercise program. Thus, it can be said that the participants had difficulties during the program in the last period of the research, and this could have fostered the positive evolution of their physical self-perceptions as they coped with the increased level of difficulty.

PRACTICAL IMPLICATIONS

The study's findings underscore the significance of online exercise methods as valuable alternatives for enhancing various fitness aspects and fostering positive self-perceptions of physical fitness. Notably, exercise approaches tailored to participants' proficiency levels, incorporating progressive overload, prove effective in enhancing physical fitness. Consequently, implementing online exercise programs in settings characterized by prevalent sedentary lifestyles, such as universities and similar environments, hold the potential to promote the adoption of healthier lifestyle habits. Another notable advantage is that the exercise program utilizes a minimal set of readily available household items (e.g., substituting

a water bottle for dumbbells or using a sofa for elevation). Overall, the online program eliminates the necessity for access to a gym or an extra trainer, offering participants the benefits of convenience, time efficiency, and cost savings.

Limitations

This study has certain limitations. Notably, a portion of the participants discontinued the exercise program, potentially influenced by the initial lack of motivation, especially considering their sedentary background. Therefore, future studies could benefit from incorporating motivational support to enhance participant engagement and further improve physical self-perception. Additionally, it is essential to note that the online video-based exercise programs lacked individualized prescriptions. Last but not least, the blinding protocols were as a suggestion for future research, the conditions under which this study was conducted were not conducive to the implementation of any blinding protocol, and one of the possible consequences of this situation is that the group of exercise participants may have been extra motivated by the needs of the group they were in. Incorporating personalized exercise prescriptions within online home-based programs could should be considered to address this limitation.

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Declaration of conflict interest

The authors have no relevant financial or non-financial interests to disclose.

Authors' contributions

Günay Yıldızer was responsible for the research design, data collection, data analysis and interpretation, writing the manuscript and approval of the final version; Feridun Fikret Özer and Caner Özböke were responsible for data collection, data analysis and interpretation, writing the manuscript and approval of the final version; Burak Söğüt and Didem Şafak were responsible for data collection and writing the manuscript; Dilara Ebru Uçar was responsible for research design, data analysis and interpretation, writing the manuscript and approval of the final version.

Ethics Statement

This study was approved by the review board of Eskişehir Technical University with Protocol No. 63349 at 06.04.202

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Appendix A
Exercise Program of Progressive Overload Method

	1. Session	2. Session	3. Session
1. Week	Total Time: 21. Warm Up: 2 Min., Leg: 2 Min., Back: 1 Min., Core Exercise: 5.5 Min., Rest: 5.5 Min., Cool Down: 5 Min.	Total Time: 20.5. Warm Up: 2.5 Min., Leg: 2.5 Min., Arm: 1.5 Min., Shoulder: 1.5 Min., Core Exercise: 2 Min., Chest: 30 Sec. Rest: 5 Min., Cool Down: 5 Min.	Total Time: 20.5. Warm Up: 1.5 Min., Leg: 4.5 Min., Core Exercise: 4 Min., Chest: 30 Sec., Rest: 5 Min., Cool Down: 5 Min.
2. Week	Total Time: 21.5. Warm Up: 2 Min., Leg: 4 Min., Arm: 1 Min., Core Exercise: 3 Min., Chest: 30 Sec., Shoulder: 1 Min., Rest: 5 Min., Cool Down: 5 Min.	Total Time: 22. Warm Up: 2 Min., Leg: 2 Min., Core Exercise: 6 Min., Chest: 1 Min., Rest: 6 Min., Cool Down: 5 Min.	Total Time: 22.5. Warm Up: 2 Min., Leg: 4 Min., Chest: 1 Min., Core Exercise: 4 Min., Rest: 5.5 Min., Cool Down: 5 Min.
3. Week	Total Time: 24. Warm Up: 2 Min., Leg: 5 Min., Core Exercise: 6 Min., Rest: 6 Min., Cool Down: 5 Min.	Total Time: 23.5 Warm Up: 2 Min., Arm: 6 Min., Back: 3 Min., Core: 1 Min., Rest: 5.5 Min., Cool Down: 5 Min.	Total Time: 21.5 Warm Up: 2 Min., Shoulder: 4.5 Min., Chest: 4 Min., Core Exercise: 30 Sec., Rest: 5.5 Min., Cool Down: 5 Min.
4. Week	Total Time: 23. Warm Up: 3.5 Min., Leg: 4.5 Min., Arm: 6 Min., Rest: 6 Min., Cool Down: 3 Min.	Total Time: 22. Warm Up: 3.5 Min., Back: 3.5 Min., Core Exercise: 6.5 Min., Rest: 5.5 Min., Cool Down: 3 Min.	Total Time: 23.5. Warm Up: 3.5 Min., Chest: 5 Min., Shoulder: 5.5 Min., Rest: 6.5 Min., Cool Down: 3 Min.
5. Week	Total Time: 25. Warm Up: 3.5 Min., Leg: 6.5 Min., Arm: 6.5 Min., Rest: 5.5 Min., Cool Down: 3 Min.	Total Time: 23. Warm Up: 3.5 Min., Back: 4.5 Min., Core Exercise: 6.5 Min., Rest: 5.5 Min., Cool Down: 3 Min.	Total Time: 21.5. Warm Up: 3.5 Min., Chest: 4 Min., Shoulder: 6 Min., Rest: 5 Min., Cool Down: 3 Min.
6. Week	Total Time: 25. Warm Up: 3.5 Min., Leg: 6 Min., Arm: 7 Min., Rest: 5.5 Min., Cool Down: 3 Min.	Total Time: 23.5. Warm Up: 3.5 Min., Back: 4 Min., Core Exercise: 7.5 Min., Rest: 5.5 Min., Cool Down: 3 Min.	Total Time: 24.5. Warm Up: 3.5 Min., Chest: 6 Min., Shoulder: 6.5 Min., Rest: 5.5 Min., Cool Down: 3 Min.
7. Week	Total Time: 24.5. Warm Up: 3.5 Min., Leg: 6 Min., Arm: 7 Min., Rest: 5.5 Min., Cool Down: 3 Min.	Total Time: 25. Warm Up: 3.5 Min., Back: 4.5 Min., Core Exercise: 8.5 Min., Rest: 5.5 Min., Cool Down: 3 Min.	Total Time: 25.5. Warm Up: 3 Min., Chest: 8 Min., Shoulder: 6 Min., Rest: 5.5 Min., Cool Down: 3 Min.
8. Week	Total Time: 25.5. Warm Up: 4 Min., Leg: 7.5 Min., Arm: 6.5 Min., Rest: 4.5 Min., Cool	Total Time: 26.5. Warm Up: 4.5 Min., Back: 4.5 Min., Core Exercise: 9 Min., Rest: 5.5 Min.,	Total Time: 25.5. Warm Up: 3 Min., Chest: 7 Min., Shoulder: 7.5 Min.,

Appendix A (Continued)

Warm Up	Leg	Arm	Core	Back	Shoulder	Chest
Twist Up/Twist Up With Jumping Arm Circle/Jogging With Arm Circle Lunge Tap/Lunge Tap With Jumping Sumo Squat Dip Shoulder Butt Kicks Jog in place Twist March in place Scissors Step Lateral/Front Hop March in place twist Overhead Reach High knee Cross body toe touch Cross Jacks Squat Cross Arms Jumping Jack	Bridge One Leg Hold Bent-Knee Fire Hydrants Bridge One Leg Raise Plie Squat Calf Raises Calf Raise Squat Hold Jumping Squat Lunge Side Lunge Glute bridge Bridge toe touch Quad hip extension Squat Sumo Squat Side Leg Raises Reverse Lunge	Single Arm Triceps Kickback Bent Over Triceps Kickbacks Lying Overhead Triceps Extension Isolated Single Arm Curl Zottman Curl W Curl Cross body Curl Concentration Curl Hammer Curl Biceps Curl Triceps Extensions Plank Triceps Kickback Biceps ReverseCurl Triceps Dips	Single Straight Leg Stretch Double Straight Leg Stretch Mountain climbers Single Leg Stretch Bicycle Crunch Frog Crunch Chest LiftPlank Tuck up Hollow Hold Hundred Side plank Scissors Russian Twist Flutter Kick Navasana Superman Bird Dog Crunch	Double-Arm Dumbbell Rows Plank with Lateral Arm Raise Elevated Plank Row Renegade Row Kettlebell Swings Shrug High Pull	Push-up plank with shoulder tap External-Internal Rotation Inchworm hand walkout Raise and pull-apart Shoulder Press Prone Y's and T's Dumbbell Cardriver Lateral shoulderrise Arnold Press Front ShoulderRise	Pullover on the floor Wide Hands Push Up Spiderman Push Up Diamond Push Up Dumbbell Press Chaturanga Hold Chaturanga Active Shuffle Push Up Incline Push Up Decline Push Up Burpee Push Up Dolphin Push Up Dumbbell Fly

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The Psychometric Properties of the Perceived Available Support in Sport Questionnaire: Validity and Reliability of the Turkish Version

Ender ŞENEL[1] Derya SAKALLI[1*]

[1]*Faculty of Sport Sciences, Muğla Sıtkı Koçman University, Muğla, Türkiye.*

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[*] **Corresponding Author**:
Derya SAKALLI
E-mail Address:
deryasakallii@gmail.com

ABSTRACT

Social support research in sports has attracted considerable attention in recent years. There are limited sport-specific support perception measurements to measure Turkish athletes' support perceptions. The present study was conducted to adapt the Perceived Available Support in Sport Questionnaire developed by Freeman et al. (2011) into Turkish and examine the measurement's psychometric properties. A total of 300 athletes aged between 18-22 years were included in the study. The factor structure of the measurement was tested using confirmatory factor analysis. The obtained data revealed significant factor loadings and produced acceptable fit indices. Both internal consistency and composite reliability values were found to be high, thus supporting the validity and reliability of the measurement. The results show that the measurement retains its original structure consisting of 4 dimensions (esteem support, emotional support, information support, and tangible support) and 16 items, each containing four items. Accordingly, it was concluded that the Perceived Accessible Support in Sport Questionnaire is a valid and reliable measurement tool for Turkish athletes.

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INTRODUCTION

Social support research in sports emphasises the importance of social support in overcoming various challenges athletes face. Lu and Hsu (2013) found that increasing the perception of hope and strengthening social support during rehabilitation improved athletes' rehabilitation behaviours and subjective well-being. Yang et al. (2010) found that injured collegiate athletes trusted coaches, athletic trainers, and physicians more for social support and were more satisfied, suggesting that athletic trainers play a vital role in meeting these needs. In addition, it was also found that social support has a critical role in quitting sports and that athletes expect attention and understanding from family and peers, who are the most important sources of support (Brown et al., 2018). Social support is crucial in optimal functioning in various performance contexts in sports, workplace, school, and home (Fletcher & Sarkar, 2012; Freeman & Rees, 2009; Sarkar & Fletcher, 2014). Indeed, the research emphasises the importance of supportive families, coaches, and social networks in athletes' talent development (Rees et al., 2016). This support from meaningful interpersonal relationships (coaches, parents, peers) in sports is an essential resource for athletes. These interpersonal relationships provide necessary social support to athletes and shape their sports experiences positively and negatively (Sheridan et al., 2014).

In sports, athletes believe they can receive social support from people they consider significant others in their environment. It also refers to the emotional, tangible, informational, and esteem support that individuals or groups provide in the context of sports (Hartley et al., 2020). Emotional support refers to others being there for comfort and safety, thus making the person feel loved and cared for; tangible support refers to others providing material and instrumental help. Esteem support means that others support one's sense of competence or self-esteem, and informational support indicates that others offer advice or guidance (Cutrona & Russell, 1990). Social support is a broad term that includes positive (i.e., encouragement, personal growth, improved mental health) and negative (i.e., conflict, loss of individuality, and social pressure) aspects of relationships and is a coping resource for psychological adjustment (de la Haye et al., 2014; Holahan et al., 1997). Therefore, the contextual dynamics of the concept should be considered when defining social support (Ladin et al., 2019; Williams et al., 2004).

Research shows that athletes experience all four dimensions of social support (emotional, informational, esteem, and tangible; Newman & Weiss, 2017; Rees & Hardy, 2000;

Sullivan et al., 2022). Emotional support entails making athletes feel supported regardless of performance outcomes, whereas esteem support encourages the belief among athletes that they are talented. Informational support is a type of support that suggests strategies to cope with competition anxiety. In contrast, tangible support involves providing practical assistance to athletes, such as transporting them to competitions by car or helping them prepare their equipment (Hartley et al., 2020).

Some measures of perceived available support used in sports psychology were initially developed to measure support in social psychology (Cohen et al., 1985; Sarason et al., 1983; Zimet et al., 1988). The adequacy of these measures in sports has been questioned due to their limited resemblance, as they predominantly evaluate generic everyday support concerns and fail to address support issues that might be particularly pertinent to elite athletes (Rees et al., 1999). Measurement tools that measure Turkish athletes' perceptions of social support are limited. Adopting a sport-specific measurement is essential for measuring social support perception in sports. One of these measurement tools is the TASS-Q: The Team-Referent Availability of Social Support Questionnaire, which was developed by Coffee et al. (2017) to determine the sources and types of support available to athletes in a team environment and adapted into Turkish by Şenel et al. (2018). In addition, the Social Support in Physical Activities Scale (Farias et al., 2014) was adapted to Turkish culture (Küçükibiş & Eskiler, 2019). Among the studies on social support in Turkey, the perception of support for physical activity in the school environment was also addressed (Akgül & Karafil, 2021).

The social support literature advises that social support assessments must be suitable for the specific target population and the situational context in which they are applied (Bianco & Eklund, 2001; Wills & Shinar, 2000). The research has been constrained by the necessity for a measure of perceived available support in sports that is context-specific and psychometrically robust (Holt & Hoar, 2006). For this reason, examining and clarifying the dimensions, providers, and contexts of social support, which is widely accepted as necessary in the sports field, can significantly contribute to our knowledge of how we can support athletes (Katagami & Tsuchiya, 2017). In this sense, comparing a measurement adapted to Turkish with international studies is better, and it allows for more effective analysis and comparison of studies conducted in different cultures on similar topics. Therefore, there is a need for sport-specific measurement tools to assess the perception of support in the sports environment more accurately, to increase social support research in Turkish literature, and to examine the support sources and dimensions of Turkish athletes. As a result, this study aimed

to explore the psychometric properties of the Perceived Available Support in Sport Questionnaire, developed by Freeman et al. (2011), to measure the perception of sport-specific general social support.

METHODS

Participants

While researchers recommend at least 300 independent samples for cross-case validation (Tabachnick et al., 2013), participant selection in structural equation modelling (SEM) studies emphasises analysing power (Muthén & Muthén, 2002). Choosing between insignificant statistical results or incorrect model assumptions may be challenging if statistical power is low. However, in the case of high statistical power, it may not be necessary (Moshagen & Erdfelder, 2016). Moshagen and Erdfelder (2016) proposed balancing with a fixed error probability α and α=β to strike a balance between false positive and negative results.

The power analysis was performed when the desired power was 80%, the error probability α was 0.05%, the effect measure was RMSEA, and the effect size was 0.05, and showed that the required sample size was 164 (Moshagen & Bader, in press). Three hundred athletes were included in the study, which is higher than recommended in the power analysis. Considering this situation, the calculation was made again, and it was determined that the latent power was 0.98 for a sample of 300 people. Overall, these results suggest that the model has low alpha and beta error rates, a high power, and an excellent fit to the model with specific measures of influence.

The research was approved by the higher education institution's social and humanities research ethics committee (230143/134, 04/12/2023). Participants aged 18 and 22 ($\bar{X}$age 19.97± 1.43; 130 females and 170 males). The participants reported they competed in soccer (n=70, 23.3%), basketball (n = 70, 23.3%), handball (n = 50, 16.4%), volleyball (n = 70, 23.4%) and hockey (n = 40, 13.6%).

Procedure

Athletes were asked to indicate their age, gender, and sport for demographic information. The original version of Perceived Available Support in Sport Questionnaire (PASS-Q) was developed by Freeman et al. (2011) in two related studies. The measurement has four dimensions consisting of 16 items: Emotional support (4 items), esteem support (4

items), information support (4 items), and tangible support (4 items). Participants prefixed each item of the measurement with the statement "If needed, to what extent would someone..." and rated it on a measurement of 0 (not at all) to 4 (very much). There are no reverse-scored items in the measurement. The emotional support dimension refers to the emotional support such as comfort, safety, and care that the athlete believes he/she can reach (...always be there for you?). Esteem support increases the confidence, competence, and self-esteem the person believes he/she can reach (...enhance your self-esteem?). Information support includes tactical advice, constructive criticism, and feedback on performance (...give you tactical advice?). Tangible support is the type of support that the individual believes he/she can obtain to access the necessary opportunities to continue with the sport (...help with travel to training and matches?). The analyses conducted with the original version of the original measurement tool had excellent fit indices [Satorra-Bentler $\chi 2$ (100) = 185.52, $p < .01$; RMSEA = 0.07; SRMR = 0.08; CFI = 0.91; NNFI = 0.89] and the final [Satorra-Bentler $\chi 2$ (98) = 120.56, $p < .01$; RMSEA = 0.04; SRMR = 0.04; CFI = 0.98; NNFI = 0.98] (Freeman et al., 2011).

Data Analysis

In this study, confirmatory factor analysis (CFA) was used to test the factor structure of the PASS-Q Turkish. Research suggests using CFA as a more appropriate approach for testing previously developed or discovered models (Fabrigar et al., 1999; Hurley et al., 1997; Kline, 2023). CFA is a statistical strategy designed to identify and explore hypothetical constructs and test detailed hypotheses using a deductive approach (Hoyle, 2000). This method allows researchers to determine the number of principal factors and verify the pattern of item-factor relationships (Brown, 2015). In this stage, a CFA was conducted using maximum likelihood estimation with IBM SPSS Amos (Version 24) to confirm the factor structure of the PASS-Q Turkish. The missing data analysis of the raw data showed no missing data. After that, it was examined whether the data met the assumption of normal distribution. For this, Mardia's multivariate average distribution coefficient was taken into consideration. Since Mardia's multivariate normality coefficient showed that the data did not meet the assumption of normal distribution, the bootstrap method was applied (Mardia coefficient: 320.137).

Chi-square statistic ($\chi 2$), comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardised root mean square residual (SRMR) are recommended indices for reporting model fit (Hu & Bentler, 1999). However, research has shown that the chi-square value is sensitive to sample sizes (Brown, 2015).

Therefore, this index was used to calculate the $\chi 2/df$ value. Research suggests the following scores for model fit indices: CFI and TLI ≥0.95 = good fit, 0.90-0.95 = acceptable fit; RMSEA ≤0.05 = good fit, 0.05-0.08 = acceptable fit, 0.08-0.10 moderate fit; SRMR<0.06 excellent fit (Bentler, 1990). Reliability values of scales and sub-dimensions are generally assessed through Cronbach's alpha coefficient. In cases where errors are independent and certain assumptions are met, Cronbach's Alpha internal consistency coefficient can be calculated accurately. However, when these assumptions are unmet, Cronbach's Alpha internal consistency coefficient may be biased and different from the universal coefficient (Rae, 2006). Thurber and Bonynge (2011) argue that composite reliability may be a more appropriate alternative. Composite reliability is usually calculated using factor loadings and error variances obtained from CFA (Yang & Green, 2011). This method is a measure used to assess the overall reliability of the measurement.

Translation and Content Validity

Invitations were sent via e-mail to academics specialised in their fields to assess the translation and content validity of the research. For the translation process, the method of Beaton et al. (2000) was followed, and two academics were invited, one who was informed (T1) and one who was not informed (T2). While T1 studied abroad in English and specialised in sports and exercise psychology based on sports sciences, T2 was from the field of English language education. For the back translation process, a similar approach was followed by experts who knew the concept (BT1) and experts who did not (BT2).

After T1 and T2 translated the items, the authors examined two Turkish translations and included the appropriate ones in the synthesis form (T12). The synthesis form was then sent for back translation. After the back translation process was concluded, T1, T2, BT1, BT2, and T12 forms were sent to the academics, and feedback on the process and measurement items was asked for. After this stage, the measurement items were scored for content validity by the same expert included in the evaluation process of the forms. Experts were also sent the sub-dimensions (emotional, esteem, information, and tangible) and definitions of perceived available support. Six expert academics with international sports psychology studies were invited to assess the measurement's content validity. These experts independently rated the measurement's items 1 and 2 (not appropriate), 3 and 4 (appropriate) in line with the target feature.

The experts gave each item a score between 1 and 4 on the form prepared by the researchers. Scores 1 and 2 on this form indicate that the relevant item is inappropriate for assessing the related aspects of social support. In contrast, scores of 3 and 4 indicate that the item is appropriate for evaluating social support. The experts were requested to provide feedback for the items with scores of 1 and 2, while the request for feedback for the items with scores of 3 and 4 was left to the experts' preference.

The Universal Agreement Calculation Method was used to calculate the Content Validity Index (CVI) (Lynn, 1986; Waltz & Bausell, 1981). This method calculates item-level Content Validity Index (I-CVI) and scale-level Content Validity Index (S-CVI). The C-VI is calculated by dividing the agreement of the experts on the item by the number of experts. The average of the I-CVIs determines the S-CVI/average. Another method used is the ratio of the number of items on which the experts agree to the number of items. If the experts give an item a score of 3 or 4, it indicates complete agreement. Another method, the Content Validity Ratio (CVR), involves experts' ratings of the importance of each item in the measurement instrument. A higher score represents a greater agreement among experts. The CVR is calculated by a formula that subtracts the number of experts rating an item as "important" from half of the total number of experts and divides by half (Ayre & Scally, 2014; Lawshe, 1975) should be explained in this part. In the section, the statistical methods used in the research, the software used, content analysis, etc., should be described explained in detail.

RESULTS

Content Validity

The authors prepared a synthesis form after the invited experts translated the items. This synthesis form was returned to the experts for feedback, and the content validity of the translations was evaluated. All experts stated that the items were translated correctly and rated between 1 and 4. The results obtained are presented in Table 1.

Table 1 includes the results of the PASS-Q Turkish content validity analysis. When the content validity index (I-CVI) values of the items are examined, it is seen that the values vary between 0.83 and 1.0. These values indicate that items have content validity. According to the standards recommended in research, an I-CVI value higher than 0.79 indicates that an item is appropriate for measuring the relevant trait. In contrast, a value below 0.78 suggests that the item should be revised and the relevant item should be removed. In this context, the values in this study are at a level that meets the recommended standards (Davis, 1992). Since the index

obtained for TAN 3 in the tangible support dimension was partially low, it was adjusted based on expert evaluation and feedback. The content validity (S-CVI/Ave) value was calculated as 0.97, indicating that the measurement has high content validity. In addition, the content validity (S-CVI/UA) calculated by the Universal Agreement Calculation Method was found to be 0.83. These results indicate that the measurement has excellent content validity (S-CVI/UA ≥ 0.8 and S-CVI/Ave ≥ 0.9; Shi et al., 2012). These values indicate that the measurement has content validity.

Table 1
Content Validity Analysis Results of the Perceived Available Support Questionnaire in Sport

Item	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Number of Agreement	I-CVI
EM 1	3	4	4	2	4	3	5	0.83
EM 2	3	3	4	3	4	3	6	1
EM 3	3	4	4	3	4	3	6	1
EM 4	3	4	4	3	4	3	6	1
EST 1	3	4	3	3	3	4	6	1
EST 2	4	3	4	4	4	2	5	0.83
EST 3	3	4	3	4	4	4	6	1
EST 4	3	3	3	4	3	3	6	1
INF 1	4	3	3	4	3	4	6	1
INF 2	3	4	4	4	4	4	6	1
INF 3	3	4	3	2	3	4	5	0.83
INF 4	3	4	4	4	4	4	6	1
TAN 1	2	3	4	4	3	3	5	0.83
TAN 2	3	2	1	3	4	3	4	0.66
TAN 3	3	3	4	3	3	4	6	1
TAN 4	3	3	4	4	3	3	6	1
							S-CVI/Ave	0.93
							Agreements	11
							S-CVI/UA	0.68
							CVR	0.90

Note. I-CVI: Item-level content validity index; S-CVI: Scale-level content validity index; CVR: Content Validity Ratio, EM: Emotional Support, EST: Esteem Support, INF: Information Support, TAN: Tangible Support

Construct Validity

CFA results confirmed the factor structure in the original instrument. The analysis revealed statistically significant factor loadings and produced acceptable fit indices [$\chi 2$ = 321.85, df = 98, $\chi 2/df$ = 3.28, CFI = 0.95, TLI = 0.93, RMSEA = 0.08 (95%CI: 0.07-0.09), SRMR = 0.05, n = 300]. No adjustment was needed since the factor loadings were relatively high ($\lambda i>0.55$).

Table 2 presents the factor structure, mean, standard deviation, composite reliability, and internal consistency values of the Perceived Available Support in Sports (PASS-Q Turkish). This tool aims to measure perceived support elements in

sports in four dimensions. The factors defined as emotional support (F1), esteem support (F2), information support (F3), and tangible support (F4) constitute the basic building blocks. Internal consistency coefficients (Cronbach Alpha) for each dimension were relatively high (Emotional Support: 0.93; Esteem Support: 0.89; Information Support: 0.88; Tangible Support: 0.91). These results show that each dimension and the measured elements are evaluated consistently and reliably. Composite reliability coefficients range from 0.77 to 0.93. Additionally, when the mean and standard deviation values were examined, it was revealed that the participants perceived these support elements at a high level (Tangible Support mean: 4.37, standard deviation: 0.77). When the composite reliability and convergence values are examined, it is seen that the composite reliability of all dimensions and the total value is high, supporting the general validity and reliability. Pearson correlation coefficients between the factors are high (emotional - esteem: 0.88; emotional - information: 0.73; emotional - tangible: 0.63; esteem - information: 0.77; esteem - tangible: 0.65; information - tangible: 0.67).

Table 2
Factor Structure, Mean, Standard Deviation, Composite Reliability, and Internal Consistency Values of PASS-Q Turkish

	Items	Error Variances	F1	F2	F3	F4	CR	α	$\bar{X}$	SD	Skew.	Kurt.	AVE
Emotional Support	1	0.39	0.78 (.86)	r=0.88	r=0.73	r=0.63	0.93	0.93	4.34	0.93	-1.65	2.39	0.78
	2	0.20	0.89 (.92)										
	3	0.11	0.94 (.94)										
	4	0.13	0.93 (.94)										
Esteem Support	1	0.24		0.87 (.88)	r=0.77	r=0.65	0.89	0.89	4.32	0.89	-1.60	2.26	0.67
	2	0.27		0.85 (.88)									
	3	0.34		0.81 (.87)									
	4	0.45		0.74 (.83)									
Information Support	1	0.69			0.55 (.74)	r=0.67	0.87	0.85	4.31	0.88	-1.70	2.90	0.63
	2	0.22			0.88 (.88)								
	3	0.24			0.87 (.86)								
	4	0.26			0.86 (.87)								
Tangible Support	1	0.36				0.80 (.72)	0.91	0.91	4.37	0.77	-2.02	4.80	0.68
	2	0.34				0.81 (.76)							
	3	0.15				0.92 (.81)							
	4	0.20				0.89 (.80)							

Note. Mean score = 4.33, standard deviation: 0.77, PASS-Q Turkish α = 0.94, CR = 0.97; AVE = 0.69 F1: Emotional Support, F2: Esteem Support, F3: Information Support, F4: Tangible Support. *Item-factor correlations are displayed in brackets under each factor column.

DISCUSSION

In sports studies, the effect of social support on sports performance is increasingly understood, and studies on this subject are becoming increasingly important. In this context, existing measurement tools to measure perceived attainable support in sports have some limitations. This research was conducted to adapt the PASS-Q, developed by Freeman et al. (2011), to Turkish to meet the need for a valid and reliable measurement tool that will measure the level of generally accessible social support perceived as context-specific in the sports environment and the psychometric analysis was carried out to examine its properties.

PASS-Q Turkish examines perceived social support in the sports environment in four sub-dimensions: emotional, concrete, esteem, and information support, and it consists of a total of 16 items. In adapting the measurement to Turkish, its content validity was first tested, and, in line with expert opinions, it was found that the measurement was both suitable for the sports environment and understandable by the athletes. PASS-Q Turkish factor structure was examined with CFA. The sample size must be sufficient for CFA (Tabachnick & Fidell, 2007). Since it was stated in the original measurement that the low number of samples could affect the power and stability of the analysis (Freeman et al., 2011), a sufficient number of athletes for factor analysis were included in the current study. CFA results revealed statistically significant factor loadings for the measurement.

Additionally, it was determined that the fit indices were at an acceptable level. It was found that the internal consistency coefficients for each dimension varied between 0.88 and 0.93, and the composite reliability coefficients varied between 0.77 and 0.93. The correlation values for the factors included in the model tested in the current research were calculated at medium to high levels. The correlation values between the dimensions in the original measurement were medium to high, and the internal consistency and composite reliability coefficients were determined to exceed 0.70 (Freeman et al., 2011). The data shows that the measurement maintains its original structure, consisting of 4 dimensions and 16 items.

Social support encompasses the presence of social connections and the interconnections between them. Functional support pertains to the distinct roles fulfilled by interpersonal relationships, with perceived and actual support being its two facets (Wills & Shinar, 2000). Perceived support often stems from personal evaluation processes rather than specific supportive behaviours (Kaul & Lakey, 2003). This perception of support revolves around the potential access to social support, involving a subjective judgment that individuals

in the environment (such as friends, family, teammates, and coaches) will offer assistance when needed. Support received generally denotes the specific aid provided by these individuals over time. Support constructs typically exhibit low to moderate correlations and may have distinct associations with outcome variables (Barrera, 1986; Uchino, 2009).

Due to this, scholars (Holt & Hoar, 2006) propose the importance of precision in conceptualising and gauging social support. Creating scales that effectively evaluate social support is also deemed crucial for addressing theoretically significant inquiries (Cohen et al., 2000). Furthermore, it is emphasised that these measurements should be tailored to the specific target population and the situational context in which they are applied (Bianco & Eklund, 2001; Wills & Shinar, 2000).

PASS-Q Turkish assesses athletes' general perceptions of current support without specifying the sources of their social support. Moreover, it exclusively evaluates perceived support and does not encompass other social support constructs, such as the structural aspects of social networks or recently received functional support (Freeman et al., 2011). Bianco (2001) underscores the importance of understanding the impact of social support from specific sources. Wills and Shinar (2000) argue that measurements gauging general support from various sources can predict significant outcomes, but they need to identify the sources of support. Perceptions of supportive behaviours may also vary depending on the context in which they occur, influenced by factors such as the characteristics of the support provider, the provider-recipient relationship (Lakey & Drew, 1997), and the broader cultural environment (Badr et al., 2001). Burleson and MacGeorge (2002) contend that the same supportive behaviour often serves multiple functions, and different supportive behaviours can achieve similar goals. There is usually an overlap between support dimensions in natural settings (Cohen & Wills, 1985). For instance, an attempt to provide advice and guidance (informational support) can also be interpreted as a display of care (emotional support). These complexities can make it challenging to isolate the distinct effects of various support dimensions on performance. In this context, the current study employed a measurement tool that captures aggregate evaluations of perceived support. However, the instructions of the measurement tool can also be used by specifying a specific source of social support (family, coach, manager, peer). In this way, whether the measurement tool shows different structural features can be tested according to the mentioned support sources. At the same time, PASS-Q Turkish can be applied to a group at various times, and thus, athletes' time-dependent evaluations of a particular source of social support can be measured.

CONCLUSION

The analyses carried out to adapt the Perceived Available Support in Sports Questionnaire, which was prepared based on the findings and suggestions in the literature, into Turkish showed that the measurement is a valid and reliable measurement tool that can be used to investigate the effects of perceived available support in sports contexts. Interpersonal relationships and interactions may affect the perception of social support. For this reason, future studies can also examine the quality of interpersonal relationships or the role of expectations in interpersonal relationships in the perception of social support. In addition, since perceived social support can affect essential variables such as mental health and performance outside the sports environment, these variables can also be addressed in the sports environment.

This research involves adapting the measurement tool developed to fill an essential gap in evaluating social support dimensions in the sports environment. Although content and structure validity analyses were performed in the study, criterion-related (convergent and divergent) validities are missing. Future studies can conduct various validity and reliability analyses of the measurement tool by considering this limitation. Additionally, the participants included in the study were team athletes. The structure of the measurement tool can also be tested in different groups of athletes. Additionally, measurement equivalence analysis was not included in this study. Future research can report the characteristics of the measurement tool in Turkish culture by examining structural characteristics between groups such as team and individual sports, men, and women.

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Authors' contribution

The first author contributed to the conception and design of the research, data collection, data analysis and interpretation, drafting of the article and the critical interpretation of the final draft. The second author took part in the conception and design of the study, drafting the article and its critical revision, and approval of the final draft.

Declaration of conflict interest

The authors declare that they have no conflict of interest.

Ethics Committee

The research was approved by Mugla Sıtkı Kocman University Social and Humanities Research Ethics Committee (230109/120, 14/12/2023).

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The Predictive Effect of Technology Follow-up and Professional Competence on Job Satisfaction of Physical Education Teachers

Nurullah ÇELİK*[1] Oğuzhan YILDIZ[1] Şehima AKSU[1]

[1]*Department of Physical Education and Sport, Sakarya University of Applied Sciences, Sakarya, Türkiye*

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* **Corresponding Author**:
Nurullah ÇELİK
E-mail Address:
nurullahc@subu.edu.tr

ABSTRACT

The study aimed to determine the predictive effect of technology follow-up and professional competence on the job satisfaction levels of physical education teachers. A correlational survey was used in the study. The study sample consists of 217 physical education teachers. Participants in the study were determined by the convenience sampling method. To collect data, the "Personal Information Form," "Teachers Self-Efficacy Scale," and "Job Satisfaction Scale" were used in the study. Descriptive statistics, Pearson correlation analysis, and hierarchical regression analysis were used for analysis. According to the results, a significant positive relationship was found between the frequency of technology follow-up and job satisfaction ($r = .230$, $\beta = .25$, $p<0.05$). Included in the model in the third step, the contribution of professional competence to job satisfaction is significant and explains 16.5% of job satisfaction. As a result, it was revealed that teachers perceive themselves as more professionally competent when they closely follow technological developments related to their fields, and as a result, they have a higher level of job satisfaction. For future studies, it may be suggested that similar studies in this field should be conducted on an intercultural basis.

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INTRODUCTION

Physical education, which is accepted as an integral part of the education system in modern societies (Alqarani, 2022; Göktaş, 2007), is the process of deliberately changing behavior by participating in physical movements. In this process, physical education teachers undoubtedly play the most important role in students' success (Demir, 2015; Ünlü & Aydos, 2010). Therefore, it is necessary to increase the qualifications of physical education teachers, one of the most critical components of the education system (Gupo & Patena, 2022; Zhou, 2024).

The physical education teacher, who works in line with the contemporary education and training approach, should not only be a person who realizes the teaching process related to his/her course but also should have many qualifications (Arı & Mat, 2021; Ünlü & Aydos, 2010). It is assumed that teachers gain the expected qualifications in terms of general culture, field knowledge, and professional knowledge in the physical education teacher training program as in teacher training programs (Bulca et al., 2012). Providing these qualifications effectively affects teachers' job satisfaction (Klassen & Chiu, 2010).

Job satisfaction is a person’s overall evaluation of his or her job as favorable or unfavorable (Judge et al., 2020). Locke et al. (1983) defined job satisfaction as "a pleasant or positive feeling that arises as a result of a person's evaluation of work or work experience.” Job satisfaction is an important factor for the continuity of teachers' professional careers. In this context, controlling the factors that cause job dissatisfaction and increasing job quality is important (Keser, 2005).

From a theoretical aspect, two prominent theories that underscore the significance of job satisfaction are Maslow's hierarchy of needs and Herzberg's dual-factor theory. Maslow's theory refers to the hierarchical structure of needs and suggests that after a lower need is fulfilled, the need in the upper rung emerges (Sun, 2002).

According to the theory, the lowest-ranked need is the fulfillment of physiological needs. Subsequently, the hierarchy includes needs for security, belonging, acceptance, love, and self-actualization. (Franc et al., 2011). When Maslow's theory is applied to the work environment, "payments for physiological needs, social security for the need for security, working in harmony with colleagues for the need for belonging and love, having a title for the need for prestige and advancement in the organization for self-actualization can be given as examples (Cherrington, 1991).

Herzberg stated that Maslow's views were the basis for explaining the motivation factors related to job satisfaction. However, he tried to explain job satisfaction with the motivation-hygiene theory by suggesting that a different explanation was necessary due to employees' individual differences (Hampton, 1972). Intrinsic factors make the employee happy in the work environment and connect them to the work environment. These motivators include success, approval, work, responsibility, progress, and development. Extrinsic factors are defined as hygiene factors. These are factors related to the work environment that reduces the level of job satisfaction (Smerek & Peterson, 2007).

In addition, many factors have an impact on teachers' job satisfaction. One of these factors is a good knowledge of technology (Teo, 2008). Good technology knowledge is an advantage for teachers as it helps them improve their knowledge in their fields. Teachers' proficient utilization of information and communication technologies in educational settings holds significant significance for their development and the advancement of their profession (Ulucan & Karabulut, 2012). Furthermore, educators' incorporation of contemporary technologies enables them to enhance their professional growth and elevate their fulfillment within their field (Özişli & Bağcı, 2022).

Teachers who regularly incorporate technology are more effective in designing instructional materials, preparing targeted content, and using technology proficiently. They also perceive themselves as more professionally competent to teachers who use technology less frequently (Özgür & Gül, 2022).

At this point, efficacy is a personal belief about how well individuals can perform the necessary actions to cope with possible situations, which first emerged in Albert Bandura's social learning theory (Bandura, 1982). A strong sense of efficacy increases a person's achievements and personal well-being in many ways, and people who are confident in their abilities approach, complex tasks not as a threat to be avoided but as a challenge to be overcome. Such a strong perspective encourages intrinsic interest and deep immersion in activity (Bandura, 1995).

A strong sense of efficacy enhances a person's achievements and personal well-being in many ways. People who are confident in their abilities approach difficult tasks not as a threat to be avoided but as a challenge to be overcome. Such a strong perspective encourages intrinsic interest and deep immersion in the activity (Bandura, 1995).

Considering the learning-teaching process, one of the factors that directly affect the quality of education is teacher efficacy (Konokman & Yelken, 2013). The professional

competence of teachers refers to the knowledge, skills, attitudes, values, and behaviors expected from teachers (Şişman, 2009). The fact that teachers are the primary implementers of learning and training activities shows the importance of teacher efficacy in order to achieve the goals set in the field of education (Özgül et al., 2022).

In parallel with Bandura's social learning theory, Maslow's hierarchy of needs theory, and Herzberg's Motivation-Hydrogen Theory, teachers who feel professionally competent as a result of following technological developments related to their profession feel confidence, success, and enjoyment. This situation results in job satisfaction (Kalkan, 2020; Tohan et al., 2022).

Kopcha and Alger (2010) found that technology plays a crucial role in positively influencing the self-efficacy of novice teachers. Nurgaliyeva et al. (2023) reported significant correlations between educators' technological proficiency and job satisfaction. Özişli and Bağcı (2022) found a moderate and favorable outcome when examining the correlation between educators' information and communication technology competencies and job satisfaction. Consequently, it can be inferred that enhanced personal information and communication technology skills among educators correspond with increased levels of job satisfaction.

Kalkan (2020) stated that job satisfaction increased as the level of professional competence of secondary education teachers increased, and Tohan et al. (2022) stated that pedagogical efficacy emerged. As the level of pedagogical efficacy increases, the level of job satisfaction of teachers also increases. Klassen and Chiu (2010) found that teachers with high professional expertise have high job satisfaction. Caprara, Barbaranelli, Borgogni, and Steca (2003) found a significant relationship between self-efficacy and job satisfaction.

Studies indicate that integrating technology into the classroom enhances learning outcomes and positively impacts teacher job satisfaction and efficacy (Lee & Lim, 2020). The literature encompasses research investigating physical education instructors' job satisfaction levels and professional competence. Similarly, studies have revealed the influence of technology utilization on job satisfaction. However, the current study deals with the effect of the frequency of following technological developments and innovations related to physical education (such as new materials and new methodological approaches) and professional competence on job satisfaction. This kind of research was not found in the related literature. It is thought that it is essential that the increasing use of technology is realized in line with academic purposes (which will contribute to the development of the field). In this context, the hypotheses of the research are given below:

H1. There is a positive relationship between the frequency of following technological developments and job satisfaction.

H2. Following technological developments and professional competence frequently has a positive effect on the job satisfaction levels of physical education teachers.

In line with the hypothesis mentioned above, the study's purpose was to determine the predictive effect of technology follow-up and professional competence on the job satisfaction levels of physical education teachers.

METHODS

Participant

The research group consisted of 217 physical education teachers aged between 22 and 60 (Xage = 40.92±7.63). The convenience sampling method was used in the study. In this sampling type, the researcher determines the sample by choosing among the most accessible participants (Büyüköztürk, 2016). The research group was selected among physical education teachers actively working in public and private schools at primary and secondary education level in Sakarya province.

Procedure

This study is a descriptive study examining the predictive effect of technology follow-up and professional competence on the job satisfaction of physical education teachers. It is also a correlational study exploring the correlation between variables (Büyüköztürk, 2016). The second and third researchers contacted the participants face to face and had the scales filled out. This study was found ethically appropriate with the decision of Sakarya University of Applied Sciences Ethics Committee. Additionally, the study was conducted within the framework of the principles of the Declaration of Helsinki.

Data Collection Tools

The researchers explained to the physical education teachers how to fill in the scales used in the study. The process of applying the scales in the study took approximately 5 minutes.

Personal Information Form

In the study, the age, gender, and school types of the participants (teachers) were collected via the personal information form. Besides, the independent variable of the study, which is mentioned as “technology follow-up” in the study, was used in this form to reveal

how often the physical education teachers follow the technological developments related to their fields. In the form, physical education teachers were asked to answer the question, “How often do you follow the technological developments related to your field?” (Never, rarely, once a week, 1-3 times a week, every day). The technological developments include “new technological teaching methods including distance education, new materials used in physical education, new educational approaches.

Teachers Self-Efficacy Scale

In the study, "Teachers Self-Efficacy Scale was used in order to determine the perceptions of professional competence levels of physical education teachers. The scale was developed by Schwarzer et al. (1999) and adapted into Turkish by Gülebağlan (2003). The Turkish form of the scale consists of 9 items and one dimension. It is a 4-point Likert-type scale and its rating ranges from "1-Not true at all" to "4-Totally true". The highest score that can be obtained from the scale is 36, and the lowest score is 9. There are no reverse-scored items in the scale. High scores obtained from the scale indicate that the level of perception of teaching professional competence is high. The internal consistency coefficient of the scale is .76. In this study, Cronbach's alpha reliability coefficient for this scale is 89.

Job Satisfaction Scale

To assess the job satisfaction levels of the physical education teachers in the study, the short version of the Job Satisfaction Scale, which was developed by Judge et al. (1998) was used. The scale was adapted into Turkish by Keser and Öngen Bilir (2019). The scale is a 5-point Likert-type scale. High scores indicate high job satisfaction. The Cronbach Alpha value of the scale is, 72. In the current study, this value was determined as 82.

Data Analysis

Hierarchical regression analysis was done to determine the variables predicting the job satisfaction levels of physical education teachers. The power of the sample to represent the universe was calculated with the G-Power 3.1 program. Power analysis has not been found in studies similar to the current study in the relevant literature. Therefore, in the study, the moderate-level value of 0.15, one of the effect sizes recommended by Cohen (1988), was considered for the regression analysis. For power analysis, R^2 effect size = 0.15, α error = 0.05. According to the results, the minimum sample size with power ($1-\beta = 0.95$) was calculated as n = 119. A sample above this number was reached (217) in the study considering situations

such as missing data and incorrect filling. Accordingly, in the first step, gender was included in the model as a control variable. In the second step, the frequency of following technological developments related to their fields, and in the third step professional competence was included in the model. In the study, a question with four answers was formed about the frequency of physical education teachers following technological developments. This question, which was a categorical variable, was transformed into a continuous variable in SPSS as a Dummy variable before regression analysis. In regression analysis, dependent and independent variables must be continuous variables. However, the effect of some discontinuous independent variables on the dependent variable needs to be examined. In order to do this, a new artificial variable called as a dummy variable was created, which was produced as one minus the number of levels by excluding one of the levels of the classified variable in the analysis (Çelen, 2018). In the regression analysis, normality and multicollinearity of the data were examined (Tabachnick & Fidell, 2007). In this direction, it was observed whether there were outliers in the data, and the skewness and kurtosis values in all expressions were in the range of -2<,...,<+2 (George & Mallery, 2010).

RESULTS

The findings of the research have presented below. According to Table 1, the study consists of 65 female participants aged between 22 and 52 (40.92±7.63) and 152 male participants aged between 23 and 60 (41.85±7.96). The age mean average of all participants was 40.92.

Table 1
Descriptive Statistics of Participants' Age Variables

Participants	n	Age			
		Min.	Max.	$\bar{X}$	Std. Dev.
Female	65	22	52	38.74	6.36
Male	152	23	60	41.85	7.96
Total	217	22	60	40.92	7.63

According to Table 2, it was found that the participants' professional competence scores were between 11 and 25 (mean = 20.16±3.86), and their job satisfaction scores were between 9 and 36 (mean = 30.11±4.90).

Table 2
Descriptive Statistics Related to Professional Competence and Job Satisfaction Scores

Variables	n	Min.	Max.	$\bar{X}$	Std. Dev.
Professional Competence	217	11	25	20.16	3.86
Job Satisfaction	217	9	36	30.11	4.90

According to the Table 3, a positive significant relationship was found between frequency of technology follow-up and professional competence ($p<0.05$, $r = .206$), and job satisfaction ($p<0.05$, $r = .230$).

Table 3
Results of Correlation Analysis Between Frequency of Technology Follow-Up, Professional Competence, and Job Satisfaction

Variables		Job Satisfaction	Professional Competence
Frequency of technology follow-up	**r**	.230**	.206**
	p	.001	.002
	n	217	217

**p<.01

In the first step of the hierarchical regression analysis, it was determined that gender, which was included as a control variable in the analysis, did not have a significant contribution in this model ($p>0.05$). Frequency of technology follow-up, which was included in the analysis in the second step, predicted job satisfaction significantly, and its contribution to the model was 5.1%. There is a significant positive relationship between the frequency of following technological developments and job satisfaction ($\beta = .25$, $p<0.05$). Included in the analysis in the third step, the contribution of professional competence to job satisfaction is significant and explains 16.3% of job satisfaction. There is a significant positive relationship between professional competence and job satisfaction ($\beta = 0.41$, $p<0.05$).

Table 4
Regression Results Regarding Frequency of Technology Follow-Up and Professional Competence Predicting Job Satisfaction

Model 1	**β**	**t**	**p**
Gender	.073	-1.066	.288
R = 0.073, Adjusted R2 = 0.001, F = 1.136, p > 0.01			
Model 2	**β**	**t**	**p**
Gender	-.084	-1.261	.209
Frequency of technology follow-up	.234	3.524	.001*
R=0.245, Adjusted R2 =0.051, F=6.807, p < 0.01			
Model 3	**β**	**t**	**p**
Gender	-.065	-1.078	.282
Frequency of technology follow-up	.147	2.386	.018*
Professional competence	.415	6.727	.001*
R = 0.474, Adjusted R2 = 0.214, F = 20.559, p < 0.01			

DISCUSSION

The findings of the study aiming to reveal the predictive effect of technology follow-up and professional competence on job satisfaction levels of physical education teachers have been discussed below. According to the findings of the study, the increase in physical education teachers' level of following technological developments related to their field predicts their job satisfaction in a positive and significant way.

In parallel with the fourth stage of Maslow's hierarchy of needs theory, the teachers who feel professionally competent as a result of following the technological developments related to their profession were found to feel more satisfaction in their job (Kalkan, 2020; Tohan et al., 2022). It is possible to say that they exhibit behaviors such as taking responsibility and not avoiding responsibility (Cherrington, 1991). As a matter of fact, it is not possible to say that all teachers follow technological developments in the same way. At this point, it can be said that teachers who need to follow technology have more technological tendencies. It has been concluded that with increasing competence, the job satisfaction of teachers who meet this need also increases.

Similarly, in Herzberg's motivation-hygiene theory, motivational tendencies (success, approval, work itself, responsibility, and progress) of teachers who love their job, have no expectation of reward, and attach importance to individual development are dominant. In other words, it was revealed that the job satisfaction levels of teachers whose intrinsic motivation increased also increased (Smerek & Peterson, 2007).

The current study indicated that job satisfaction levels of physical education teachers who actively engage with technological developments in their professional domains also experienced an increase. In other words, they feel more job satisfaction for keeping up with the latest technological advances in their working field. Similarly, in the study conducted by Ak et al. (2016), a teacher said, "The most valuable item in my teaching profession is to follow the developments related to my field. In my opinion, not only the teachers in our branch but all teachers should closely follow all kinds of studies and changes in their branches or fields. In this way, all teachers can update their knowledge and perform their profession better. The frequency of teachers' following the technology related to their own branch is directly proportional to the timeliness of their lessons because the more frequently teachers follow the technology, the earlier they can access up-to-date information about their field, and they can use this situation in their lessons". As a result, the teacher will positively affect the level of

professional competence. In their study, Güneş and Buluç (2017) analyzed the prediction of professional competence level of technology follow-up. Supporting the findings of the current study, they concluded that there is a positive, moderate, and significant relationship between technology follow-up and professional competence belief.

In the study, teachers' perceived professional competence positively predicted their levels of job satisfaction. Namely, the greater the teachers' perception of professional competence, the higher their perceived job satisfaction. "Similarly, Aydın et al. (2022) concluded that teachers' professional competence significantly predicted the level of job satisfaction in their study to determine the extent to which teachers' professional competence predicted their job satisfaction. In a study conducted by Altınkurt and Yılmaz (2014), it was concluded that as the participants' positive views about professional competence increased, their job satisfaction levels also increased. In the studies of Teltik (2009) and Baltacı (2017), it was determined that there was a positive and significant relationship between job satisfaction level and professional competence level. In other words, it was determined that physical education teachers with high levels of job satisfaction also have high levels of professional competence perception. According to the study conducted by Buluç and Demir (2015), it was reported that there was a positive and significant relationship between teacher professional competence and job satisfaction levels, and teacher professional competence level was a significant predictor of job satisfaction level.

Ünal (2015) determined that as the professional competence levels of secondary school teachers' increase, their job satisfaction levels also increase. Kalkan (2020) revealed that there is a moderate and positive relationship between teachers' professional competence and job satisfaction. Tohan et al. (2022) also revealed that pedagogical efficacy is directly proportional to job satisfaction; that is, if the level of pedagogical efficacy increases, the job satisfaction levels of teachers will also increase. Gamsız (2013) revealed that the increase in teachers' self-efficacy and professional competence beliefs positively affected their job satisfaction. Klassen and Chiu (2010) found that among the subjects of instructional technologies and classroom management, teachers with higher levels of professional competence also had higher levels of job satisfaction. Caprara et al. (2003) found a significant relationship between professional competence and job satisfaction levels in a study involving 2688 teachers in 103 secondary schools in Italy. As the professional competence levels of the classroom teachers participating in the study increased, their job satisfaction levels also increased.

CONCLUSION

In this study, the predictive effect of technology follow-up and professional competence on job satisfaction levels of physical education teachers was investigated. It can be concluded that the perception of professional competence alone positively predicted the job satisfaction levels of teachers, and together with the frequency of following technological developments, it predicted job satisfaction levels at a higher rate. As a result, it has been observed that teachers perceive themselves as more professionally competent when they closely follow technological developments related to their fields, and as a result, thus they have a higher level of job satisfaction.

PRACTICAL IMPLICATIONS

In accordance with the obtained results in this study, some suggestions for practitioners, researchers, and physical educators are presented. It may be suggested that similar studies in this field should be conducted on an intercultural basis. Also, the researchers may examine the frequency of technology follow up of physical education teachers with different variables. In-service training for physical education teachers can be organized, especially for artificial intelligence applications that have become popular in recent years. Physical education teachers can be encouraged to participate in large-budgeted foreign projects to ensure that they have the latest technological software and hardware used in the field of physical education. In particular, training on technological literacy can be provided by both national education and school administrators, thus making it more attractive for physical education teachers to follow technological developments in the field. In addition, the number of cross-cultural educational mobilizations in schools can be increased, and on-site observation of technological applications used in physical education abroad can be encouraged. With all these suggestions, physical education teachers' job satisfaction levels can be increased.

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Authors' contribution

The first author's contribution to the study is on the study design and methodology. The second author's contribution to study is on the data collection and literature review. The

third author's contribution to study is on the data collection, discussion and references sections.

Declaration of conflict interest

All authors state that the manuscript submitted is unpublished and original; that another person's ideas, processes, results, or words are appropriately credited and that no fabrication or falsifications have been made. The paper has not been published previously or has been taken for consideration for publication elsewhere.

Ethics Statement

This research was found ethically appropriate with the decision of Sakarya University of Applied Sciences Ethics Committee dated 07.07.2023 and numbered E.89321.

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Pamukkale J Sport Sci, 15(2), 381-398, 2024 Research Article

The Effect of Lower Body Compression Tights on the Running-Based Anaerobic Sprint Test in Young Male Basketball Players

Mustafa Can ÜSTER[1] Cem KURT[2*] İlbilge Ö. NEBİOĞLU[3]

[1]*Division of Physical Education and Sport, Health Sciences Institute, Trakya University, Edirne, Türkiye*
[2]*Division of Movement and Training Sciences, Kirkpinar School of Sport Sciences, Trakya University, Edirne, Türkiye*
[3]*School of Sport Sciences, Division of Movement and Training Sciences, Uşak University, Uşak, Türkiye*

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* **Corresponding Author**:
Cem KURT
E-mail Address:
cemkurt35@gmail.com

ABSTRACT

This study aims to assess the influence of lower body compression tights on performance in the Running-Based Anaerobic Sprint Test (RAST) in young male basketball players. Twenty male basketball players participated in the study (age = 16.5±0.5 years, height = 176.8±5.71 cm, weight = 68.5±8.98 kg, basketball experience = 2.35±0.49 years). Players performed the RAST, comprising 6 x 35 m sprints with 10-second intervals, wearing regular shorts or compression tights, with a one-week interval between conditions. Before each test, a 24-hour dietary record was used to calculate the total calorie intake and the percentage of calories from carbohydrates to account for dietary variations. The Hooper Index was used to assess fatigue levels before each test. The RAST, conducted using a Newtest Powertimer photocell (300 Series, Oulu, Finland), determined maximal power (Pmax), minimum power (Pmin), average power (AP), and fatigue index (FI). Perceived exertion after each RAST was assessed using the Borg Scale (20-point system). Paired-samples ttest results showed no statistically significant difference ($p>0.05$) between the means from the two test sessions. The study suggests that lower body compression tights did not significantly impact RAST performance in young basketball players. Considering the study design, applying it to more experienced players after familiarization sessions with compression tights may yield different results.

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INTRODUCTION

Basketball, a globally popular team sport played by men and women in over 200 countries, holds a significant position in athletics (Garcia et al., 2022; Scanlan et al., 2012). The popularity of basketball derives from high-intensity, short-term acyclic movements performed with the ball (dribbling, passing, shooting, etc.) and without the ball (jumping, sprinting, change of direction, agility, etc.; Gottlieb et al., 2021; Masanovic et al.,2018; Puente et al.,2016).

Gottlieb et al. (2021) stated that many movements in basketball last between six seconds and one minute. Therefore, basketball is marked by periods of intermittent activity, encompassing brief bursts of high intensity and more extended intervals of moderate intensity and recovery (Gottlieb et al., 2021; te Wierike et al., 2014).

Song et al. (2023) reported that basketball players perform an average of 105 high-intensity runs during a match, repeated every 21 seconds and lasting two - six seconds each. Puente et al. (2017) stated that basketball-specific movements, such as jumping and sprinting, are of great importance for scoring. Based on the explanations of Song et al. (2023), Puente et al. (2017), and Attene (2016), it is reported that repeated sprint ability (RSA) should be considered a critical component of physical fitness in team sports like basketball. As defined by Stojanovic et al. (2012, p.375), RSA refers to the capability of executing repeated sprints with minimal recovery. In simpler terms, it denotes the ability to achieve the best possible average sprint performance across a sequence of sprints, each separated by brief recovery periods. Mokou et al. (2016) and Castagna et al. (2008) suggest that the ability to repeat high intensity effort, including sprint and change of direction as in RSA, may be a major determinant of performance in basketball. Like other team sports, basketball players' RSA ability is improved through several training modalities, including maximal strength training, traditional sprint training, plyometric training, and complex training are mostly preferred by coaches (Borges et al., 2016; Buchheit et al., 2010; Ramirez-Campillo et al., 2021; Torres-Torrelo et al., 2018).

Though not current, some researchers suggest that the use of compression garments can increase performance and that compression garments can also be used for regeneration purposes (Driller et al., 2021; Franke et al., 2021; Hooper et al., 2015; Kraemer et al., 1996; Loturco et al., 2016). In one of the pioneering studies in this area, Kraemer et al. (1996) showed that volleyball players displayed improved capacity to maintain power output during a repeated jump test when utilizing compression tights instead of control garments (regular

gym shorts). Nevertheless, the maximal jump power in the best attempt remained unaffected by compression. Duffield et al. (2007) reported that neither throwing nor repeated sprint performance was improved by a compression garment in cricket players. Higgins et al. (2009) also reported that compression garments did not affect 20 m sprints and countermovement jumps in netball players. Regarding the potential performance-enhancing effects of compression garments during training or competition, some researchers have suggested that wearing such garments could reduce muscle oscillation, enhance peripheral circulation and venous return, improve blood flow velocity, increase arterial perfusion, alleviate post-exercise muscle soreness, facilitate the clearance of blood lactate and creatine kinase (Davies et al., 2009; Driller et al., 2021; Franke et al., 2021; de Glanville & Hamlin, 2012;). Some of the benefits of power performance have been suggested to be due to improvements in proprioception (Kraemer et al., 1996). Born et al. (2013) asserted that compression garments might enhance proprioception, thereby potentially providing better feedback regarding limb movements' direction, acceleration, and velocity. Some authors argue that the effectiveness of wearing compression garments is more pronounced in endurance/aerobic-based performance or recovery compared to anaerobic and intermittent activities such as jumping, sprinting, agility, change of direction, etc. (Ballmann et al., 2019; Davies et al., 2009; de Glanville & Hamlin, 2012; Driller et al., 2021; Franke et al., 2021).

Therefore, this study aims to evaluate the effectiveness of compression tights on Running-Based Anaerobic Sprint Test (RAST) performance in young male basketball players. The study hypothesizes that the components of the RAST, including maximal power (Pmax), minimum power (Pmin), and average power (AP), will be more significant when the test is performed with compression tights.

METHODS

Participant

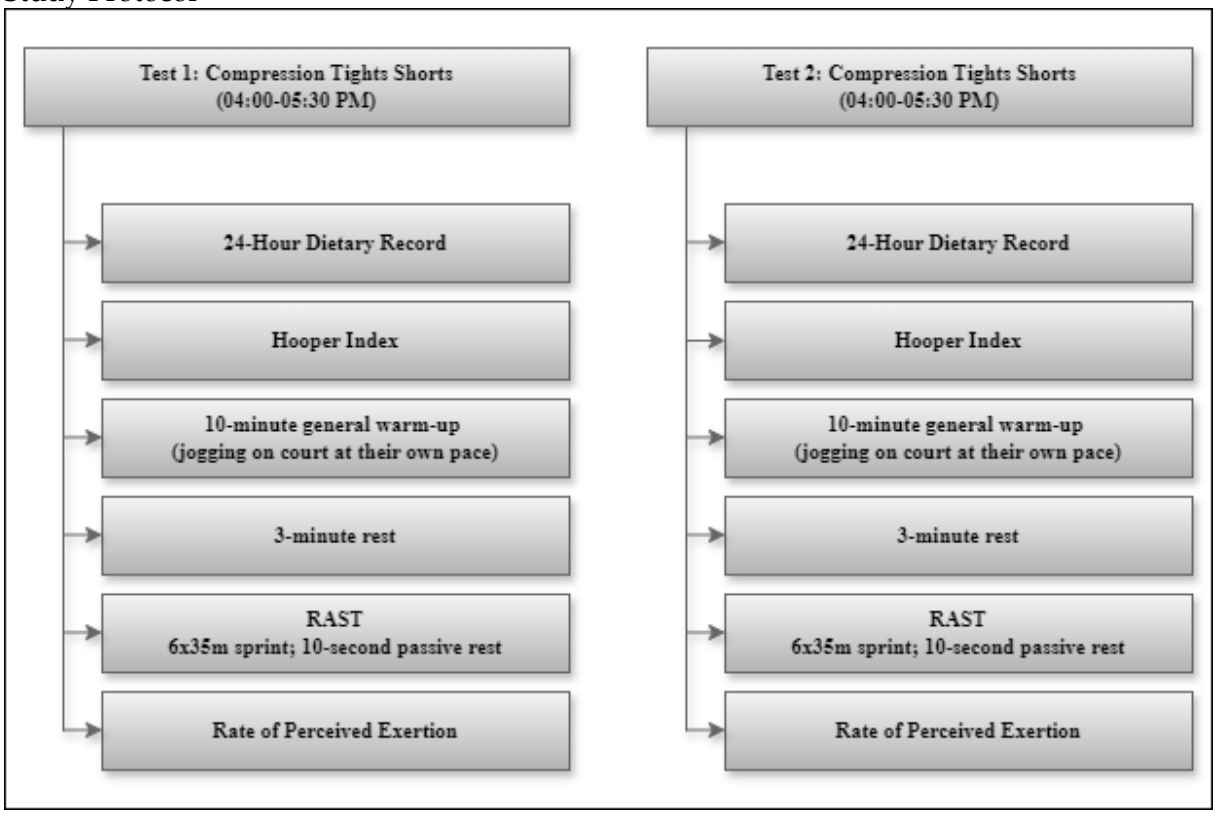
This study was conducted with the participation of 20 male basketball players who actively play basketball in four different clubs operating in amateur leagues in Istanbul. In sample selection, statistical power was determined using G*Power version 3.1.9.2. In the study by Ballmann et al. (2019), it was determined that the study could be performed with the participation of 20 athletes, considering the perceived rate of exertion scores (control = 7.9±0.6, lower body compression tights = 7.4±0.7; p=0.032), and the effect size d = 0.72 and significance $\alpha = 0.05$ (statistical power = 0.85). However, considering there may be participant losses for

various reasons, 20 people were included in the study. The criteria for inclusion in the study were determined as having at least two years of basketball experience, being between the ages of 16 and 18, having a license for the 2022-2023 basketball season, being healthy following the medical examination required to obtain a basketball license for the 2022-2023 basketball season, and not having an acute musculoskeletal system injury. Our study was approved by the Trakya University Scientific Research Ethics Committee on 12.07.2021 with the protocol number TÜTF-BAEK 2021/321. The study was conducted by the principles of the Declaration of Helsinki.

Procedure

The study was designed as a randomized crossover trial. Participants attended two test sessions between 16:00 and 17:30, one week apart, wearing either normal sports shorts or lower body compression tights. The sessions took place between October 13, 2023, and October 20, 2023, at the Beylerbeyi Sports Club Basketball Court and the Well Club Sports and Life Center Dudullu OSB Basketball Club Court.Before each test, 24-hour dietary record forms were collected from the participants, and their daily calorie intake and the percentage of total calories obtained from carbohydrates were calculated to exclude the effects of nutritional variables on the study results. Applying the Hooper Index before each test session made an attempt to eliminate different results that might be obtained from the two different test sessions due to fatigue in the athletes. Each test session began with a warm-up session consisting of 10 minutes of general warm-up (jogging) and 10 minutes of dynamic stretching, with the athletes performing at their own pace on the basketball court. After the warming-up, the athletes were given three minutes of passive rest before beginning the running-based anaerobic sprint test (RAST). The participants' repeated sprint performances were assessed with the RAST (6 x 35 m, 10 s rest). The RAST test was conducted on a wooden surface. Sprint times were measured with the Newtest Powertimer 300 device during this test. After each test session, the perceived exertion level was evaluated with the Borg Scale (20-point system). Basketball players using supplements (creatine, amino acids, etc.) were excluded from the study. Before each test session, the basketball players were given information on avoiding strenuous physical activities, maintaining regular sleep habits, not changing their eating habits throughout the study, and avoiding excessive caffeine intake 6 hours before the test.

Figure 1
Study Protocol



Body weight measurement

Volunteer athletes' body weight was measured using an electronic scale (Seca 769, Türkiye) while wearing shorts and a T-shirt and without shoes.

Height measurement

Volunteer athletes' height was measured with a mechanical height meter (Seca 769, Türkiye) without shoes, heels together, body upright, and paying attention to the Frankfort horizontal plane.

Assessment of 24-hour dietary intake

Before each test session, basketball players' 24-hour dietary intake was collected using a 24-hour dietary record form. The total calorie intake and the percentage of total calories obtained from carbohydrates were determined using the classical method with the support of a dietician.

Hooper Index

The Hooper index was used for basketball players before each RAST to exclude changes in performance that might result from fatigue. The Hooper index is a test that

subjectively assesses athletes' sleep quality, stress levels, fatigue levels, and muscle pain on the day before a test. In evaluating the scale, each question is scored from 1 (very, very low, or good) to 7 (very, very high, or bad), and a high total score from the scale indicates that the athlete is tired (Haddad et al., 2013; Hooper et al., 1995).

Warm-up Session

Each test session began with a 10-minute general warm-up followed by 10 minutes of dynamic stretching exercises. The dynamic stretching session consisted of front kicks and hand reach, side kicks, back kicks, butt kicks, high knee skipping, and walking lunge movements. Each exercise was performed at a rhythm of 80-100 bpm, with 10-second intervals, in an area of 20 m. The tempo of the stretches was determined by an electronic metronome.

Compression Tights

In the study, Mediven Duomed Series CCL2 (Medi GmbH, Bayreuth, Germany) compression tights were utilized. These tights extend from the waist to the ankles and comprise 80% nylon and 20% spandex. They exert a pressure of approximately 15-20 mmHg at the ankle and 6-10 mmHg at the thigh (Ballmann et al., 2019; Şahin et al., 2022).

Figure 2
Appearance of a Compression Thight

Running-Based Anaerobic Sprint Test

The RAST consists of six maximal sprints of 35 m, separated by 10 seconds of passive rest (Zagatto et al., 2009). The RAST provides trainers and athletes with information about maximal (peak) power (Pmax), minimum power (Pmin), average power (AP), and fatigue

index (FI) (Draper & Whyte, 1997). The RAST is regarded as an anaerobic power test suitable for sports branches that involve repeated sprints (Zagatto et al., 2009). Zacharogiannis et al. (2004) stated that the RAST can be used instead of the Wingate test to evaluate anaerobic performance in team sports such as basketball and that the RAST has high reliability (r = 0.90) (Balčiūnas et al., 2006). The components of the RAST, namely maximal power (Pmax), minimum power (Pmin), average power (AP), and fatigue index (FI), are determined after formulating the running times obtained after 35 m sprints (Balčiūnas et al., 2006), or automatically by the software of the test equipment used after using the photocell system, as in our study. This study determined 35m sprint times with a photocell (Newtest Powertimer 300-Series, Oulu, Finland) placed at the beginning and end of the 35m distance. The RAST components, Pmax, Pmin, AP, and FI, were calculated automatically using the latest Powertimer software.

As is known, peak power (PP) is defined as the greatest power achieved among the six efforts, mean power (MP) is defined as the average power among the six efforts, and minimum power (Pmin) is defined as the minimum power achieved among the six efforts (Zagatto et al., 2009). On the other hand, two formulas were used for the calculation of Power and FI, as represented below (Santosa et al., 2019; Zagatto et al., 2009).

(P = total body mass × distance2)/time3) and [FI (%) = ((PP – Pmin)/ PP) × 100].

Rate of Perceived Exertion

After the RAST, which was run with both compression tights and normal sports shorts, the degree of exertion perceived by the athletes was assessed with the Borg RPE Scale (6-20).

Borg scale

The degree of exertion perceived by participants is expressed as no exertion (6), extremely light (7-8), very light (9-10), light (11-12), somewhat hard (13-14), hard (15-16), very hard (17-18), extremely hard (19), and maximal exertion (20) (Williams, 2017).

Data Analysis

Statistical analysis of the data in our study was performed with IBM® SPSS® Windows Version 23.0 statistical software package (IBM® Corp., 2016, Armonk, NY). To understand whether the data were normally distributed, in the first step, the difference scores between the data sets obtained during the use of compression tights and normal tights were calculated for each variable. The Shapiro-Wilk test was used to test whether the data set, consisting of the

difference scores calculated for the variables whose means were compared using the t-test for related samples, showed a normal distribution (Ak, 2008), and it was determined that all variables were normally distributed ($p>0.05$). Statistical analysis results are shown in the tables with mean and standard deviation values. To demonstrate the power of the statistical analysis, effect sizes for all relevant tests were included (Geen & Salkind, 2005; Morgan et al., 2004). The statistical significance level was set at $p<0.05$.

RESULTS

Participants' values for age (years), height (cm), body mass (kg), basketball experience (years) and weekly training frequency (hours/week) are shown in Table 1 with mean and standard deviation values (Table 1). Before each RAST, test performance was evaluated by collecting the Hooper Index and 24-hour dietary record to exclude deviations in test performance that might result from fatigue, total calories consumed, and amount of carbohydrates consumed. The Hooper Index score, the total calories consumed 24 hours ago, and the percentage of calories obtained from carbohydrates are shown in Table 2. Comparison of the arithmetic means of the RPE, Pmax, Pmin, AP and FI scores obtained after the RAST run with both compression tights and normal shorts is given in Table 3.

Table 1
Descriptive Statistics of Participants

Variables	Mean ± SD
Age (years)	16.5 ±0.51
Height (cm)	176.8 ±5.71
Body mass (kg)	68.5 ±8.98
Basketball Experience (years)	2.35 ±0.49
Training frequency (hours/week)	3.0 ±0

Note. SD: Standard Deviation

Following the t-test for related samples, which was performed to determine whether there was a difference between the arithmetic means of the Hooper Index scores, total calorie intake values, and calorie intake from carbohydrates values obtained on the day of the RAST run with compression tights and the RAST run with normal shorts, when the scores were compared no statistically significant difference was found in any parameter ($p>0.05$). This was interpreted asan indication that the participants' nutrition and general fatigue status did not have any statistically significant effect on the RAST (Table 2).

Table 2
Comparison of Mean Scores of Hooper Scale, Total Calorie Intake and Calorie Intake from Carbohydrate Variables Determined before the RAST Run in Compressive Tights and Normal Shorts

Variables and Tools	Mean ± SS (N=20)	Percentage difference between using compression tights and sports shorts (%Δ)			
	Sport shorts	Compression tights	%Δ Mean ± SD	p	ES
Hooper Index	11.3 ± 2.77	11.8 ± 1.73	10.4 ± 30.5	0.504	0.15
Total calories (kcal)	2052.8 ± 701.0	2062.8 ± 648.2	7.31 ± 41.1	0.942	0.016
Calories from carbs (kcal)	897.0 ± 314.1	869.5 ± 286.4	5.71 ± 47.0	0.718	0.08

Note. Δ: Change; SD: Standard Deviation; ES: Effect Size for Related Samples t-test (d; 0.2 = small, 0.5 = medium, 0.8 = large effect size) p<0.05*

RPE, Pmax, Pmin, AP, and FI scores obtained after the RAST performed with both compression tights and normal shorts were not statistically different from each other (p>0.05).

Table 3
Comparison of Values Obtained after RAST Run with Compression Tights and Normal Shorts

Components of RAST	Mean ± SD (N=20)		Percentage difference between using compression tights and sports shorts (%Δ)		
	Sports shorts	Compression tights	%Δ Mean ± SD	p	ES
RPE	16.1 ± 3.02	15.6 ± 2.96	- 2.42 ± 11.7	0.268	0.26
Pmax	637.0 ± 203.2	627.7 ± 220.3	- 2.12 ± 17.6	0.692	0.09
Pmin	279.0 ± 166.8	287.7 ± 174.6	110.5 ± 351.4	0.857	0.04
AP	437.3 ± 142.9	437.3 ± 169.5	2.73 ± 36.0	1.000	0.00
FI	8.19 ± 3.10	8.27 ± 3.63	16.3 ± 74.7	0.929	0.02

Note. Δ: Change; SD: Standard Deviation; ES: Effect Size for Related Samples t-test (d; 0.2 = small, 0.5 = medium, 0.8 = large effect size); RPE: Rate of perceived exertion; Pmax: Maximal power, Pmin: Minimum power, AP: Average power; FI: Fatigue index; p<0.05*

DISCUSSION

This study aimed to evaluate the effectiveness of compression tights on repeated sprint test performance in young basketball players through the RAST. The main finding of the study is that compression tights did not affect any of the performance parameters including maximal power (637.0± 20.3 Vs.627.7± 220.3, p>0.05), minimum power (279.0±,166.8 Vs. 287.7± 174.6, p>0.05) average power (437.3±,142.9 Vs.437.3 ±169.5, p>0.05) fatigue index

(8.19±,3.10 Vs. 8.27± 3.63, p>0.05) and RPE (16.1±.3.02 Vs. 15.6± 2.96, p>0.05). Based on this result, we can infer that the hypothesis of the study (that the components of the RAST, including maximal power (Pmax), minimum power (Pmin), and average power (AP), will be greater when the test is performed with compression tights) is rejected.

Our results are inconsistent with the study by Ballmann et al. (2019), who reported that mean power output (CON = 684.5 ± 146.3 watts, LBC = 738.8 ± 155.3 watts; p = 0.028; d = 0.35), anaerobic capacity (CON = 7.5 ± 1.3 watts/kg, LBC = 8.1 ± 1.4 watts/kg; p = 0.18; d = 0.45) and total work (CON = 20.533.3 ± 4392.2 joules, LBC = 22.165.4 ± 4661.3 joules; p = 0.027; d = 0.36) were higher when collegiate basketball players wore a lower body compression garment. Ballmann et al. (2019) also reported a lower RPE score (CON = 7.9 ± 0.6, LBC = 7.4 ± 0.7; p = 0.032; d = 0.72) with a lower-body compression garment compared to control after 2 x 30 second Wingate Anaerobic Tests (WAnTs). Doan et al. (2003) argued that wearing custom-fit compression shorts increased vertical jump performance (CON = 0.461 Vs., CGs = 0.485 m, p = 0.015) but not 60 m sprint performance. Doan et al. (2003) also speculated that custom-fit compression shorts may affect longer-distance sprinting than 60 m such as 100-400 m. In contrast with Doan et al. (2003), Faulkner et al. (2013) reported no significant differences in 400 m performance time, individual 100 m split times, heart rate, or blood lactate profiles between the control group and subjects who wore a lower limb compression garment.

In a separate study, Ali et al. (2011) found that the utilization of compression stockings of varying grades (GCS; low: 12-15 mmHg, medium: 18-21 mmHg, and high: 23-32 mmHg) did not affect 10 km running performance, mean heart rate, blood lactate profile, or perceptual scale scores (pain, comfort, tightness). However, low- and medium-grade GCS enhanced counter-movement jump performance (CMJ) after endurance exercise. Ali et al. (2011) also proposed that the rise in CMJ observed after wearing GCS could be attributed to improved proprioceptive mechanisms linked to jumping skills or a reduction in muscle oscillations that might result in muscle exhaustion or damage. Another investigation conducted by Loturco et al. (2016), aimed at evaluating the impact of compression garments on speed and jump performance among elite sprinters with visual impairment, revealed that jump squat (SJ) performance (placebo: = 39.49 ± 5.75 cm; compression = 41.19 ± 5.09 cm) was superior when participants wore compression garments compared to the control condition. However, no significant differences were observed in 20 m (placebo = 3.24 ± 0.20 s; compression: 3.27 ± 0.11 s) and 70 m sprinting performance (placebo = 9.12 ± 0.44 s; compression = 9.07 ± 0.39 s) between the compression and control conditions. The observed

improvement in SJ performance among individuals with visual impairment when using compression garments could be attributed to these garments' beneficial effects on proprioceptive cues (Hooper et al., 2015; Kraemer et al., 1996).

Consistent with our study, Duffield et al. (2007) reported no significant differences in repeated sprint or throwing performance in cricket players wearing a compression garment. Another study by Duffield et al. (2010) reported no performance enhancement, including 20 m sprinting (Total sprint time = 35.2 ± 3.4 vs. 35.2 ± 3.0 s, p = 0.70) and bounding distance (total bound distance = 171.2 ± 14.0 vs. 172.1 ± 17.0 m, p = 0.90) performance between compression garment and control condition in trained team sport athletes, as in our research.

The divergent findings observed concerning the efficacy of compression apparel on athletic performance could be attributed to various factors, such as disparities in study methodologies, the fitness profiles of the participants, the properties of the compression garments, and the specific performance assessments employed in the studies, among other variables. The results of our study might be affected by our participants' age and training status. With regards to the age of athletes and the effectiveness of compression garments, Driller and Brophy-Williams (2016) reported that there was a significantly greater perceived benefit of compression garments ($p < 0.05$) in athletes under 20 years old compared to those over 20 years old. Regarding training status, Lee et al. (2023) reported positive effects of compression sportswear on endurance and functional motor performance (e.g., countermovement jump and visuomotor tasks) were observed in moderately trained adults, while no significant effects were observed in athletes. This result can be attributed to improvements in endurance and functional motor performance being greater for moderately trained adults due to the potential physiological and neuromuscular benefits from compression garments, compared to highly trained athletes who may already have competitive levels of neurophysiological functions. As can be seen, the majority of studies designed to test the effect of compression garments seem to be focused on endurance or aerobic-based activities (Ali et al., 2011; de Glanville & Hamlin, 2012; Franke et al., 2021; Hill et al., 2014; Hamlin et al., 2012). To the best of our knowledge, this is one of a few studies aiming to evaluate the effectiveness of compression garments on basketball players' performance, including jumping, sprinting, repeated sprint ability, etc. (Ballmann et al., 2019; Driller et al., 2021; Zamporri et al., 2018). Specifically, there is a lack of sufficient studies aboutto interpret the results pertaining to team sports thoroughly. In this context, a study by Driller et al. (2021) found that, although there were no significant interactions between trials

for pre (wearing lower-body compression garments) to post (no lower-body compression garments - control) measures ($p>0.05$), compression garments were linked to slight improvements in lower-body power during two stair-climb tasks and slightly but significantly faster repeated-sprint times over 6 meters in the exercise circuit. However, Wong et al. (2020) found that upper-body (top) or full-body (top + bottom) compression garments significantly improved the accuracy of basketball free throws. The increase in free throw performance after wearing upper body or full body compression garments has been explained by reduced range of motion (ROM) of head flexion and lateral bending of the trunk and increased trunk stability. Otten et al. (2019) reported that zoned high-compression shorts decrease groin pain, increase pelvic stability, and improve performance on the Illinois Agility Test in soccer players with groin pain compared to normal sports clothes. A study by Ravier et al. (2018) argued that wearing full-leg length compression garments during handball-specific circuit exercises did not improve 15-meter sprint times, jump heights, and ground contact times compared to regular gym shorts. Duffield et al. (2008) found that wearing a compression garment did not affect the performance of male rugby players in simulated team-sport exercises, which involved high intermittent activities such as sprinting, peak power, and repeated sprint performance.

CONCLUSION

The research findings conclude that extended-length compression leggings worn on the lower limbs did not impact the performance of young basketball players in the Running-Based Anaerobic Sprint Test (RAST), including measures such as Pmax, Pmin, AP, and FI. Different results might be obtained from the same research design when a familiarization session is allocated to players.

PRACTICAL IMPLICATIONS

Although the results of our study failed to show any positive effects of using compression tights on repeated sprint test performance, there are also studies in the literature revealing positive effects of using compression tights on short-term, high-intensity activities such as jumping, changing direction, etc. Many researchers state that the use of compression tights is effective in increasing performance through regeneration. The results of this study reflect the average of a group, and therefore, compression tights should be used by athletes individually for increasing performance, regeneration, and reducing muscle pain and tension, and their effects on athletes' performance should be assessed individually.

Limitations

The study's major limitation is that we did not allocate a familiarization session for the players to facilitate adaptation to the repeated sprint test with compression tights. Players might have experienced discomfort when wearing compression tights during the RAST, potentially negatively affecting their performance. Another limitation is that players participated in two different test sessions; one with a long-length lower limb compression garment (hip to ankle) and the other without compression. Long-length tights (hip to ankle) without compression should have been used in the control instead of shorts.

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Authors' contribution

All authors carried out the research design together. The first and second authors were involved in the data collection. The third author took responsibility for the data analysis and interpretation of the data. The second author supervised and reviewed the original draft. All authors took responsibility for all writing process beginning from the manuscript preparation to approval of the final draft.

Declaration of conflict interest

The author(s) declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

Ethical Committee

Our study was approved by the Trakya University Faculty of Medicine Scientific Research Ethics Committee on 12.07.2021 with the protocol number TÜTF-BAEK 2021/321.

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Pamukkale J Sport Sci, 15(2), 399-415, 2024 Review

Effects of Plyometric Exercise of Adolescent Male Volleyball Athletes: A Systemic Review

Henri G. PRATAMA[1*] Deva IMANDAQURANI[1] Danang A. SANTOSO[2] Arya T. CANDRA[2] Indra G. PRATAMA[3]

[1]*Pendidikan Jasmani Kesehatan dan Rekreasi, STKIP PGRI Trenggalek, Trenggalek, Indonesia*
[2]*Universitas PGRI Banyuwangi, Banyuwangi, Indonesia*
[3]*Universitas Nahdlatul Ulama Blitar, Blitar, Indonesia*

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[*] **Corresponding Author**:
Henri Gunawan PRATAMA
E-mail Address:
henrigunawan92@stkippgritrenggalek.ac.id

ABSTRACT

By looking at previous literature, this study aimed to analyze the construct of plyometric exercise variation. Comprehensive methods are used for these articles, such as searching for articles in database research journals. Semantic, Scopus, Scholar, and Crossref are the data sources for this database. The variety of plyometric exercises and vertical jump skills are the main themes. Fifty-one articles were verified, and then 12 articles were evaluated based on objectives, topics, sample size, research protocols, and results. Plyometric exercises are exercises in which the movements are explosive and, besides being practical, also train muscle strength, muscular endurance, flexibility, and agility. The purpose of volleyball training is so that players can acquire good basic techniques, strengthen physical strength, and develop interests and talents. To improve jumping ability, various exercises are performed from the beginner level. Therefore, the ability to jump and jump is essential for the volleyball game. The novelty in this study is the using a form of plyometric exercise that is varied according to the characteristics of athletes aged 14-17 years that have never previously been applied in volleyball clubs, which is the focus in this study of plyometric exercise variation methods, namely plyometric squat jump, skipping and hurdle hopping. The intensity of the exercise will be adjusted to the characteristics, and physiological development of male athletes aged 14-17 years.

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INTRODUCTION

Today, every sport of achievement has grown, especially regarding exercises, provided with increasing exercise tools and increasingly sophisticated methods. Like volleyball, the sport is play. However, to play well, many physical parts must be trained. Every sport requires physical exercise to achieve maximum achievement. Physical exercise in each sport is the primary basis for improving technical and tactical training (Edwan et al., 2017). The quality of a volleyball athlete's physical condition, the techniques he uses, the influence of techniques in competing, maturity in competing, and maturity in performing these techniques are all factors that can affect the success of a volleyball athlete in a match. The most important thing that must be mastered is the basic techniques often used by volleyball athletes in matches and the maturity in performing those techniques (Zubaedi & Muhafid, 2023). A volleyball player must be proficient in various techniques, such as serve, passing, setting, spikes, and blocks, while playing volleyball (Suprianti & Paripurna, 2017). Based on the applicable rules of the game of volleyball, the proper movements in the game of volleyball are always based on theories of science such as biomechanics, anatomy, physiology, kinesiology, and other sciences that support the technique (Yanti et al., 2021).

Jumps are significant in volleyball; many people want to learn to make high jumps to reach the ball in a ball game. To improve the ability to jump and jump, a wide variety of exercises are performed from the beginner level. The basic skills of balance, locomotive motion, and manipulation are enhanced, combined, and trained in various situations. So, with proper training based on the characteristics of the athlete, then the exercise will affect and improve the basic technique (Khoirudin et al., 2023). So, the ability to jump or jump is essential in volleyball (Helaprahara, 2017). In addition to practical athlete training in coaching, quality training methods are also needed to support athlete training, one of which is the practice of basic volleyball game techniques (Khoirudin et al., 2023).

The jump smash technique is very dependent on the quality of the leg muscles, and successfully performing the jump smash movement requires the strength and speed of the muscle groups that support the movement. Among these muscle groups, the leg muscle group is the most dominant muscle group supporting a jump. With leg muscle strength, better jumping ability, and easier to smash and block will increase (Indrayana, 2018). When increasing vertical jump exercises, the exercise of developing the explosive power of the leg muscles must be paid attention to. Therefore, good results in vertical jump are influenced by good mastery of technique and good physical condition, one of which is explosive power,

according to Irmansyah (Syahputra et al., 2023). Power is the product of strength and speed; therefore, power training must start with strength and speed training. This means that strength and speed training have been trained first, although there is already an element of power in every strength and speed training (Pratama, 2016). One of the training methods to increase explosive power is the plyometric exercise method.

Plyometrics is an ideal exercise for people trained to become athletes because it helps them improve strength, speed, and stepping (Nugroho & Gumantan, 2020). Plyometrics is an exercise in which the movements are explosive and compelling, and muscle strength, muscular endurance, flexibility, and agility are trained. The study by Dawes (2009) indicated that athletes typically use plyometric exercises to increase their explosive power or ability to generate force rapidly. Ebben's reserach (2002) also corroborates these findings, demonstrating that the combined method of plyometric exercises can improve stepping height better than other methods. The findings of Dawes and Ebben are further supported by Gomez et al. (2008), who show that leg muscle strength can be enhanced through plyometric and physical exercises. This muscle strength has an impact on the ability to jump vertical jumps. In addition, plyometric training can positively impact physical attributes, such as strength and endurance. Commonly used variations of plyometric exercises include movements of varying intensity, ranging from low, medium, to high (Firmansyah et al., 2024).

This relatively new methodological approach provides a way to systematically synthesize evidence of the impact of several different interventions on specific outcomes (Higgins et al., 2022) like vertical jump. Therefore, this study aimed to synthesize the findings of other systematic reviews investigating the effect of plyometric exercise variation training on the vertical jump ability of male volleyball players aged 14-17. This plyometric variation needs to be done if this exercise is applied to athletes aged 14-17 years, where this exercise needs to consider the sports experience, readiness, and physiological development characteristics of individual athletes. It is also essential that the training program includes other components (e.g. strength and speed training, nutrition advice, and mental health) that may affect the force of the explosion.

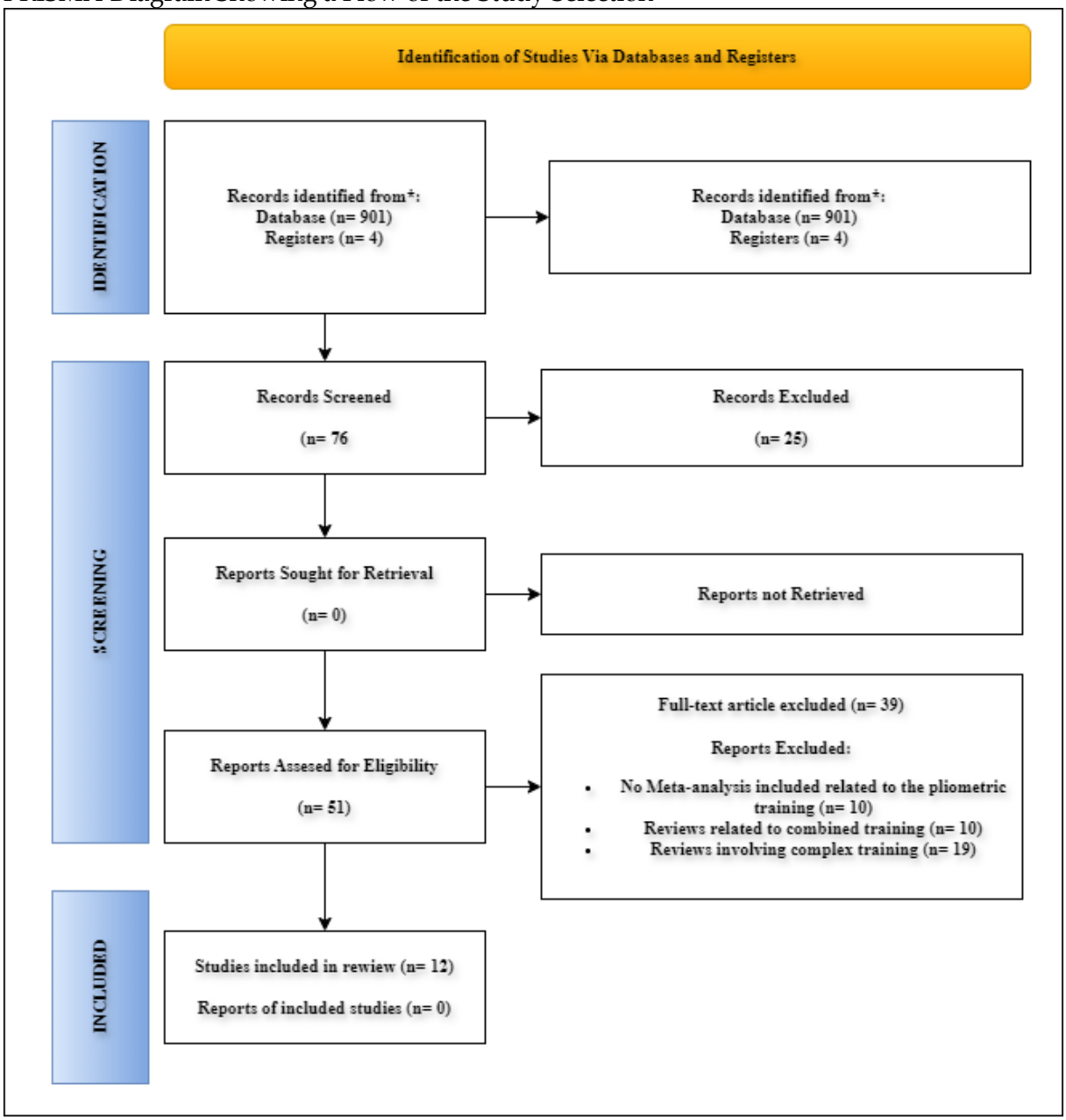
METHODS

Data obtained from the results of literature studies have fulfilled the systemic review stage by making PRISMA (Preferred reporting items for systemic review and meta-analysis). A systematic review will be very beneficial for combining various relevant research results.

This will make the information presented to those who set the policy more complete and balanced. According to (Creswell & Creswell, 2017), a literature review explains the results of other people's research related to the research to be discussed (Figure 1).

Figure 1

PRISMA Diagram Showing a Flow of the Study Selection



Procedure

Researchers used systematic and comprehensive strategies to search research results from databases, combining search terms such as "plyometric exercise," "physical condition," "vertical jump skills," and "volleyball." For this review study, the databases used were

Semantic, Scopus, Scholar, and Crossref. The inclusion criteria for this study were articles discussing plyometric exercises, physical condition, skills, and volleyball. Articles published in the last ten years (2019–2023) are included. The study involved male volleyball athletes between the ages of 14 and 17. All study participants actively played volleyball regularly.

Selection Criteria

This study selected questions, keywords, and search strategies using the PICO format (population, intervention, comparison, and results). The analysis is done by dividing the study's results into groups, displayed in tabular form below. The journal search method uses the PICO format (population, intervention, comparison, and results) to find queries and keywords. The analysis was carried out by grouping the results of the study. The goal was to gather information on how different types of plyometric exercises impact improving the vertical jump ability of volleyball club male athletes.

Quality assessment

The Methodological Quality Assessment Checklist for Systematic Review uses the Checklist Abstract Prism Statement, a checklist of 12 items considered essential for accurate reporting of observational studies. This checklist includes the relationship between the article title (item 1), introduction (item 2), method (items 3 to 6), results (items 7 to 8), discussion (items 9 to 10), sections, and other information (items 11 to 12).

Table 1
Quality Score of The Selected Studies

Study	Quality Score %	Study	Quality Score%
(Cojocaru & Cojocaru, 2019)	50.0	(Tai et al., 2021)	83.3
(Fischetti et al., 2019)	66.7	(Darusman et al., 2022)	75.0
(Medeni et al, 2019)	66.7	(Febriadi et al., 2022)	75.0
(Nugroho & Gumantan, 2020)	50.0	(Brito et al., 2023)	83.3
(Khan & Singh, 2021)	58.3	(Ozon & Sistiasih, 2023)	75.0
(Durahim & Sarman, 2021)	50.0	(Santana et al., 2024)	66.7

RESULTS

After eliminating duplicates, a systematic search identified 76 potentially relevant studies in the electronic database sought. The full text of 51 articles has been read, and 39 were issued based on predetermined selection criteria. Finally, 12 systematic reviews with meta-analyses are eligible for inclusion in this review.

Table 2
Review of Research Results on Plyometric Exercises

Author	Sample	Design	Training Model Plyometric	Result
Cojocaru & Cojocaru, 2019	15 – 19 Years Female	Experiment Study	Training programs for the development of containment are applied, focusing on the development of thigh and calf muscles and plyometric exercises.	The vertical jump development program confirmed the working hypothesis that specific parameters of a vertical jump increase
Fischetti et al., 2019	24 boys, 12–14 years old	Randomized Controlled Study	They were followed by resistance training or resistance training groups (RT, n = 12) who performed static stretching exercises (~20 minutes) followed by the same resistance training program. Both groups conducted exercise sessions twice a week for 90 minutes. At the beginning and after training, all participants were tested on the 20-m sprint (time) and Squat Jump (strength, speed, force, and height))	Attempting to induce specific acute adaptations in vertical jumping and acceleration capacity in the lower extremities, adolescent boys may benefit more from exposure to a combination of plyometric and resistance training methods.
Medeni et al., 2019	35 National Youth Volleyball Female Players	Randomized controlled trials	The participants were allocated to two groups: a study group (lower extremity plyometric training combined with jumping rope exercises; n = 18) and a control group (standard volleyball training; n = 17). All subjects were evaluated before and after the 12-week training.	The results of this study show the benefits of adding plyometric exercises to standard training in young female volleyball players. This study will be the basis for developing a training program.
Nugroho & Gumantan, 2020	20 students out of 25 students who attended Basketball extracurricular activities	Experiment Study	Training plyometric jumps to the box is an exercise. You make jumps by going through block. Each block is 30 cm high and 40 cm long, with a track length of 10 meters.	There is a significant influence on vertical jump ability in students who take extracurricular activities basketball at SMAN 1 Show After participating in plyometric exercises with significance values of 0.000 < 0.05.

Table 2 (Continued)

Author	Sample	Design	Training Model Plyometric	Result
Khan and Singh, 2021	24 Males ages 18 to 25	Randomized Controlled Trials	Three meetings: experiment I, exploration II, and control group Elected members have been created. During the six-week, three-day substitute training group each week, test group I blended plyometric training with exploratory meeting circuit training group II.	The review findings showed that among male volleyball players, there was a significant difference between the post-test method change for the trial group and the control group for some physical and physiological characteristics.
Durahim & Sarman, 2021	30 people aged 12-15 years	Randomized ontrolled Study	The intervention was given two times a week for two months, with 15 people each for the treatment group and 15 for the control group.	Jump height change occurs on volleyball players on giving plyometric exercise
Tai et al., 2021	Ten sons aged 21	Experiment Study	The participants wore their exercise shoes and shorts, performing a series of Dynamic stretching, warming up for 20 minutes, and practicing spike jumps several times. Then, RSJ-1L and RSJ-2L were performed randomly. Three trials of each spike-jump were collected for each participant.	Current research contributes to understanding the biomechanical differences of volleyball spike jumping and can be used to adapt for volleyball training.
Darusman et al., 2022	Twelve people aged 17-20 years.	Experiment Study	Observations made before the experiment (01) are Pre-test values and post-experiment observations (02), -values Test.	It can be concluded that the Plyometric Method Training (Skipping) affects Leg Muscle Power at the Muara Ngamu Conga Youth Association Volleyball Club (IRC).
Febriadi et al., 2022	14 male athletes and 12 female athletes aged 18-23	Randomized Controlled Study	The study was conducted for four weeks with a frequency of exercise, four times a week given plyometric exercises.	There are influences that. Significance of the plyometric training method to the enhancement of power capability Volleyball athlete's limb muscle blast

Table 2 (Continued)

Author	Sample	Design	Training Model Plyometric	Result
Brito et al., 2023	13–15 years	Randomized Controlled Trials	Studio design is similar in style. Experiments in which traditional interventions are implemented. A period of sweet weeks of national and experimental research, with demonstrations. In total, 25 males were in the group. Cuenca volleyball team, located in Ecuador. They are analyzed. The experimental and control groups were used to compare the effects of the plyometrics course. Training plan.	The results of this study suggest that modified plyometric storage with added load or resistance through the use of tools has a statistically significant effect on the Abalakov test,
Ozon & Sistiasih, 2023	16 male athletes	Randomized Controlled Study	The sample was divided into two groups: the experimental and the control groups. The experimental group will Plyometric standing jump training treatment was given, while the control group was not given any treatment.	Plyometric Exercise Standing jump has a significant influence in improving the vertical jump ability of volleyball players in the club
Santana et al., 2024	30 adolescents, aged 11 to 14.	Randomized Controlled Trials	The volunteers were divided into a control group, a plyometric training group, and a sprint training group, and they underwent six weeks of training (two sessions per week). Their repeatable sprint capabilities were assessed using photocell technology, and their vertical jump capacity was evaluated on a platform with an interrupt system.	Repeated sprint training has shown its efficacy in enhancing both repeated sprint and vertical jump abilities.

DISCUSSION

Effect of Plyometric Exercise Variations on Vertical Jump

Meta-analysis is shown by (Campillo et al., 2020) Considering the principle of specificity, 14-year-old volleyball players systematically involved in the plyometric training program showed a positive impact with an 11% improvement over six weeks. In addition, an eight-week plyometric training intervention in 24-year-old male and female volleyball players showed a substantial increase in vertical jump of 6%. The number of jumps performed by volleyball players during training and games varies according to the player's position, with an average of 45 jumping actions performed by players (Chaturvedi et al., 2023). An experimental study of measurements involving observation during six weeks of exercise to

athletes participating in exercise routines for seven training sessions per week and training varied between 60 and 120 minutes (Martinez et al., 2023).

Variations of plyometric exercises are given independently or combined with other exercise programs and performed at varying intensity levels. Various studies have explored the role of plyometric training independently in combination with different training methods. Combination plyometric exercises include depth, countermovement, and squat jumps (Sari et al., 2020). Research conducted by (Ziv & Lidor, 2010) shows that a plyometric depth jump exercise with an intensity of 4 sets with 12 repetitions has a smaller effect than a plyometric depth jump exercise with an intensity of 5 sets with 12 repetitions. Higher exercise intensity in longer workouts can increase the effectiveness of vertical jumps. In addition, exercise with a high intensity in a short period has a more significant effect than exercise with a moderate intensity in a more extended period. Plyometric training effectively improves vertical jump performance in athletes; plyometrics can be applied during annual training, including during the season (Slimani et al., 2016). Plyometric training provides positive changes in neuromuscular structure, increased stretching cycle speed, nerve locomotion, and myotic reflexes, which are responsible for jumping and depend on the duration of the program (Junior et al., 2020).

Information obtained from these studies suggests that repetitive vertical jump ability should be part of volleyball athlete planning. This can contribute to increased vertical jumps, wich are an important physical quality for exercise. Coaches are encouraged to identify athlete performance and control or observe plyometric training, considering individual athlete responses.

The Effect of Plyometric Exercise on Physical Performance Improvement in Male Volleyball Players

Volleyball athletes can achieve optimal performance and achievement when they have a sound physical condition. A player must be supported by physical abilities and follow guidance when playing volleyball. The ability to maintain physical condition can be improved according to each sport. According to experts in this field, the necessary physical components include circulatory, heart, respiratory, cardiovascular endurance, explosive power, agility, muscular endurance, reaction, balance, coordination, and flexibility (Dhani, 2023). The elements of physical condition that must be possessed in the game of volleyball are strength, flexibility, agility, speed, and endurance (Is & Rusliadi, 2023). To ensure the ability to perform jumps required during serve, smash, and defense (block), the motor power components of the

limbs and coordination must be appropriately trained and sustained. This exercise perfectly strengthens leg muscles when jumping upwards without a prefix. This is similar to the block movement performed when playing volleyball without a prefix. Because of the movement of this split squat jump exercise, jumping up only uses the strength of the leg muscles, such as swinging the arms to increase lift. After returning to the starting position, bend the front knees to dampen the shock. Once the position is stable, realign as it was (Hardovi, 2019).

Often, this movement is used to connect jumping and jumping movements so that you can stretch the muscles involved in the movement so that an explosive reaction occurs immediately before the muscle contracts again. When performing this plyometric exercise, one factor that significantly affects the ability of the limb muscle is the increase in muscle elasticity (Haetami and Awanis. 2021). In addition, the plyometric exercise design created by the trainer is also adjusted so that training goals can be achieved, which means that the exercise can sustain the athlete in the short term (Fachreza et al., 2023). Therefore, based on the discussion and supported by some of the references above, researchers think that plyometric training is one of the most effective forms of exercise to improve the physical condition of volleyball athletes, especially regarding leg muscle strength.

The Effect of Plyometric Exercise on Physical Performance in Different Age Groups

This overview suggests that plyometric interventions can improve the physical fitness of children and adolescents beyond levels that can only be achieved through growth and maturation. In addition, plyometric interventions improved the physical fitness of middle-aged adults who did not exercise. Plyometric training has been shown to benefit untrained children and adolescents, especially in terms of increased vertical jump height, running speed, and muscle strength (Behm et al., 2017). Planning a four- to five-week pre-workout focusing on low- to moderate-impact running and jumping is essential. Plyometric exercise builds muscle and bone strength to withstand weights and strenuous workouts (Konukman et al., 2018).

Lesinski et al. (2020) recently observed that plyometric training had a small to moderate impact on the lower extremity muscle strength of child and adolescent athletes. Kids can learn plyometrics in a fun way by playing obstacle course games. In this game, they can perform various plyometric techniques over and around various objects (Konukman et al., 2018). Other research also supports that plyometric training improves exercise performance in non-athlete adolescents (Peitz et al., 2018). However, the effects after plyometric exercise appeared to be

influenced by moderation variables such as maturity, sex, and age in the youth group (Clemente et al., 2021; Lesinski et al., 2020). Age and biological maturity greatly influence sex differences in youth volleyball players. The birth quartile appears to have less impact (Saura et al., 2022). Therefore, subsequent research should consider these aspects.

Verification regarding plyometrics carried out by (Vetrovsky et al., 2019) whether plyometric training positively impacts older adults' muscle strength, vertical jump ability, and functional abilities. The six-week plyometric exercise regimen significantly improved all test parameters, including strength, fitness, and agility (Krishnan & Rajawadha, 2020). Therefore, plyometric training can be considered a viable and safe alternative to improving the physical fitness of older adults. Future reserach should further study moderation variables, such as age, conditioning level, and body composition.

CONCLUSION

Based on a review of existing research, the authors of this study aimed to clarify the impact of plyometric exercise variations on young male volleyball players. A well-structured plyometric training program has significant potential to improve the physical performance of volleyball players, with the most notable improvement seen in lower extremity explosive strength, specifically in leg strength. Repetitive vertical jump skills should be part of volleyball athlete planning, which can contribute to increased vertical jumps; this is an important physical quality for exercise, and coaches are encouraged to identify athlete performance and control or observe plyometric training while considering individual athlete responses. Plyometric exercise is one of the most effective forms of exercise to improve the physical condition of volleyball athletes, especially in the aspect of leg muscle strength. Therefore, plyometric exercise variations can be considered a viable and safe alternative to improve the physical fitness of older adults. Moderation variables, such as age, conditioning level, and body composition, should be further studied by future research.

PRACTICAL IMPLICATIONS

A contribution to the application of this literature was to develop and test variations of plyometric exercises that improve young male athletes' vertical jump ability. This plyometric variation exercise program can be used by coaches in adolescents aged 14-17 to improve the vertical jump ability of male volleyball athletes.

Limitations

The findings of this study should be interpreted with caution because of several limitations. First, the participants were young soccer players with amateur backgrounds. Therefore, the findings may not be generalizable to other age groups, skill levels, and competitive contexts. Second, the study only used psychological and technical responses in 2-a-side and 4-a-side game formats. These results may not fully represent the effects of physiological and kinematic parameters. Third, this study only assessed immediate responses during and shortly after game sessions. However, the long-term implications of these observed differences have not yet been explored.

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Authors' contribution

All authors did a joint research design. The first author is involved in the process of data collection, writing and interpretation of the data as well as approval of the final draft. The second author is involved in the process of data collection, writing and interpretation of data and approval of the final draft. Third, the author of data interpretation and critical review of the original draft as well as approval of the final draft. The fourth author is the interpretation of the data and critical review of the original draft as well as the approval of the final draft. The fifth author is the interpretation of the data and critical review of the original draft as well as the approval of the final draft. All authors contribute to the discussion of the results and preparation of the manuscript.

Declaration of conflict interest

The authors declare that they have no conflict of interest.

Ethics Statement

In the research carried out, we applied honesty in searching for data. We were open to all the references we obtained so that we could carry out a literature review responsibly and correctly according to existing scientific principles.

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A Comparative Study of the Effects of Small-Sided Game Formats on Internal Load and Technical Responses in Soccer

Osman YILMAZ[1*] Yusuf SOYLU[2]

[1]*School of Physical Education and Sports, Osmaniye Korkut Ata University, Osmaniye, Türkiye.*
[2]*Faculty of Sports Sciences, Tokat Gaziosmanpasa University, Tokat, Türkiye.*

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* **Corresponding Author**:
Osman YILMAZ
E-mail Address:
osmanyilmaz@osmaniye.edu.tr

ABSTRACT

This study aimed to evaluate the influence of game formats on soccer players' internal load and technical responses during small-sided games (SSGs) of the 2-a-side and 4-a-side. Twenty-four male soccer players played three SSGs: possession, mini-goal (MG), and goalkeeper (GK). The SSG interventions were randomly allocated to six training intervention groups using SSGs performed in possession, MG, and GK game formats. The internal load was assessed using the perceived exertion (RPE), enjoyment scale, and visual analog scale (VAS) rating during each SSG session. Mental Readiness Form-3 (MRF-3) was evaluated pre- and post-game for mental preparedness. Technical actions were also conducted using video footage captured during all SSG sessions. A one-way repeated-measures analysis of variance was performed to evaluate any significant differences in performance across the different SSGs. Following the interventions, RPE and VAS scores differed considerably between the possession, MG and GK games in the 2-a-side game ($P<0.05$). Enjoyment varied significantly among the GK, Possession, and MG games ($P<0.05$). The MRF-3 showed no significant difference between the games ($P>0.05$). The technical performance indicated significantly better passes and interceptions in possession games ($P<0.05$). In the 4-a-side games, RPE was markedly higher in possession than in MG and GK ($P<0.05$), with no significant differences in VAS, enjoyment, and MRF-3 scores ($P>0.05$). Technical performance favoured possession of games with more successful passes ($P<0.05$). The findings suggest that analyzing psychological, cognitive and physical aspects together when designing game formats can optimize player performance and promote soccer players' integral athletic and multidirectional skill development.

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INTRODUCTION

Small-sided games (SSGs) are a highly effective training method with modified rules for smaller pitches to optimize the demands of modern soccer matches (Arslan et al., 2021; Clemente et al., 2014a; Hill-Haas et al., 2011). As a high-intensity training method in soccer, SSGs increase physiological and psychological responses while providing long-term biological adaptation (Arslan et al., 2020; Davids et al., 2013). Evidence shows SSGs are more enjoyable, effective, and time-efficient training strategies to improve players' aerobic endurance performance than traditional running-based aerobic training (Clemente et al., 2014b; Los Arcos et al., 2015). Consequently, the application of SSG training is a comprehensive approach employed by coaches to foster the development of athletes' multiple attributes while also providing them with exposure to competitive environments to which they are typically subjected (Impellizzeri et al., 2006; Köklü et al., 2011; 2015; Soylu et al., 2022).

SSGs are played with varying numbers of player contacts (Dellal et al., 2011), smaller pitch areas (Köklü et al., 2011), modified rules (Silva et al., 2023), and goalkeepers' roles (Guard et al., 2022; Köklü et al., 2015; Sanchez-Sanchez et al., 2017), including actual movement patterns, technical skills, tactical awareness, and physical fitness, under simulated game conditions (Bujalance-Moreno et al., 2019). Specifically, different task manipulations and game formats employed in SSGs can enable players to achieve the desired level of effort in their physical, physiological, technical, tactical, and cognitive development (Hammami et al., 2018; Junior et al., 2023). Previous studies indicate that modifying the dimensions of a pitch can have significant effects on various aspects of player performance (Olthof et al., 2017; Castillo-Rodríguez et al., 2023; Castillo et al., 2021; Fernández et al., 2018). For instance, incorporating goalkeepers in SSGs with varying pitch sizes can influence players' workload, with smaller pitches resulting in increased workloads (Hůlka et al., 2016). Halouani et al. (2014) stated that the playing field dimensions in SSGs can influence player performance and game intensity. Furthermore, smaller field sizes and a reduced number of games have been associated with increased occurrences of technical actions, such as passing, dribbling, and shooting (Castelao et al., 2014; Soylu et al., 2022), while contrasting observations indicate a decrease in technical actions during games played on larger field dimensions (Casamichana & Castellano, 2010; Teoldo da Costa et al., 2011). SSGs are highly influential in determining player performance, encompassing various aspects, and the game's configuration is a crucial determinant of player performance.

Köklü et al. (2015) reported that in 2-a-side, 3-a-side and 4-a-side SSGs played with and without a goalkeeper, the without-goalkeeper format caused a higher workload and intensity. In another study, it was observed that in a 4-a-side game played in ball possession and mini-goal formats, possession games resulted in more workload and intensity than mini-goal games (Silva et al., 2023). In another study comparing mini-goal and goalkeeper formats, mini-goal games were more intense than goalkeeper games (Sarmento et al., 2018). In young soccer players, possession-based games concentrating on ball control instead of goal scoring can affect running performance and technical abilities (De Sousa Neto Segundo et al., 2021). By contrast, mini-goal games, which involve scoring through smaller goals, have been demonstrated to offer a training stimulus that is adequate and superior to other formats, effectively combining workload and recovery considerations (Giménez et al., 2017). Furthermore, games featuring goalkeepers, mainly when played on diverse pitch sizes, can affect external and internal loads experienced during small-sided contests, resulting in fluctuations in player workloads contingent upon goalkeepers' presence and the playing field's dimensions (Bergmann et al., 2022). Consequently, the game format can influence the intensity of play, with variables such as the number of players, game design, and goal type affecting the overall intensity of SSGs (González-Rodenas et al., 2015).

According to Smith et al. (2018), soccer players must have a high mental capacity to ensure that physical load does not affect their technical and tactical skills and decision-making processes. Cognitive states during performance cause reluctance to decrease attention levels and fail to achieve expected results (Boksem & Tops, 2008). Enjoyment from soccer-specific training methods has been associated with the number of players during training and their psychological reactions to the training (Carraro et al., 2014). Enjoyment and satisfaction are key factors that can improve positive behavior during training (Rhodes & Kates, 2015) and increase exercise motivation (Carraro et al., 2014; Los Arcos et al., 2015). Moreover, mental fatigue, preparation, and mood during training are essential to soccer players' performance. Research has indicated that mental fatigue impacts several aspects, including mood state (Lorist et al., 2000), cognitive task performance (Boksem et al., 2005), and physical task performance (Lew & Qu, 2014). According to Tauer and Harackiewicz (2004), an increased mood state during training can increase motivation and focus on creative thinking, thus enabling soccer players to perform more successfully. For this reason, the formats of SSGs used in training should be prepared by considering cognitive states such as technical skill and enjoyment, perceived exertion, mental fatigue, mental preparation, and physical capacity.

Therefore, this study examines the effects of possession, mini-goal (MG), and goalkeeper (GK) game formats on the indices of internal load and technical responses in 2-a-side and 4-a-side SSGs in soccer. We hypothesized that the possession game format would increase soccer players' internal load responses and technical actions during SSGs.

METHODS

Participant

24 young male amateur soccer players (age = 21.00 ± 1.47 years; height = 175.92 ± 2.98 cm; weight = 66.58 ± 3.54 kg; body mass index = 21.51 ± 0.79 kg/m−2) voluntarily participated in this study. All participants regularly trained five days a week and played at least once in an official competition. The study was conducted at the beginning of the season, during the preparation period. Players who had not experienced physical or psychological fatigue, injury, discomfort, or illness before the study voluntarily participated. The participants were verbally informed about the study's content, methods, procedures, benefits, and possible risks. The research was conducted following the Declaration of Helsinki and was approved by the Ethics Committee of Tokat Gaziosmanpasa University (2022-05-01).

Procedure

An observational, cross-sectional study design was used to test the hypotheses. The current study examined the consequences of three different game formats (possessions, MG, and GK) on soccer players' internal load and technical abilities in two SSGs (2-a-side and 4-a-side). The participants underwent a two-week pre-season training program. During the initial session, the participants were informed of the study's details and were briefed on Borg's scale for perceived exertion, enjoyment, and mental fatigue. Before SSGs, the players' fitness (Yo-Yo Intermittent Recovery Test Level-1) was evaluated before assigning them to SSG teams based on test results to ensure equal teams. Internal load and technical actions were recorded for all SSGs. Certified soccer coaches (UEFA B) provided various forms of encouragement during the game. Additionally, players reported perceived exertion, enjoyment, and mental fatigue between bouts and after each SSG session. Mental Readiness was recorded both before and after each game. All testing and SSGs were performed on an artificial soccer pitch at similar times to minimize the influence of daily rhythms (chronobiological characteristics) on the results. Following a standardized warm-up, the players randomly performed each SSG format. A minimum of 72 hours of rest was allowed between each SSG session to minimise

the impact of fatigue on performance. The detailed features such as game design, field size, number of sets, duration, and rest interval of SSGs are featured in Table 1 based on of previous study (Köklü et al., 2015).

Table 1
The Features of All Small-Sided Games

Variables	2-a-side SSGs			4-a-side SSGs		
	Possession	Mini-Goal	Goalkeeper	Possession	Mini-Goal	Goalkeeper
Number of Bouts	4	4	4	4	4	4
Bout Duration (min)	2	2	2	4	4	4
Resting Duration (min)	2	2	2	2	2	2
Pitch Dimension (mxm)	15x27	15x27	15x27	25x32	25x32	25x32
Relative Pitch Size (m^2)	1:100	1:100	1:100	1:100	1:100	1:100

Data Collection Tools

Psychophysiological Responses

In the current study, psychophysiological measurements were used, including the rating of perceived exertion (RPE), enjoyment, visual analogue scale (VAS) and mental readiness form-3 (MRF-3), which are cost-effective, user-friendly and practical tools. RPE, VAS and enjoyment were collected between bouts and after in all games, and MRF-3 was measured before and after the games by researchers in five minutes. Players' perceived exertion was assessed using a validated 20-point Borg scale following each session of the SSGs to determine internal training intensity (Foster et al., 2021). A previous study demonstrated the validity and reliability of this scale to estimate the intensity of effort (Impellizzeri et al., 2004). A standardised question (How was and how did you feel the exercise?) was used to ensure consistency. To preclude potential bias, players provided their responses individually and were acquainted with the scale before their answers, thereby enhancing the reliability of their responses. The RPE scale ranged from 6 to 20, with higher scores indicating greater exertion. Participants evaluated their level of enjoyment during the exercise regimen using a 1-7 Likert scale, which assessed their enjoyment during the rest intervals between sets and at the end of the session. The enjoyment scale was validated by Raedeke (2007) and Soylu et al. (2023) as a marker of exercise enjoyment among Turkish adolescents and adult athletes. The VAS is a self-report scale that assesses mental fatigue during exercise sessions. The VAS scale consists of an 11 mm horizontal line labelled 'not tired at all' at one end and 'extremely tired' at the other. MRF-3 was used to assess cognitive anxiety during SSGs. The MRF-3 questionnaire, with three 11-point Likert scales, measured cognitive anxiety, somatic anxiety, and self-confidence.

Studies have shown strong correlations between MRF-3 and the Competitive State Anxiety Inventory-2, making it a reliable alternative (Krane, 1994).

Technical Responses

The SSGs were captured with a high-resolution digital video camera (Canon LEGRIA HF R806, Tokyo, Japan), positioned at a height of two meters and located in the midfield area of the pitch. The video files were subsequently transferred to a computer, where a notational analysis was conducted using the eAnalyze Soccer (Espor Digital, Ankara, Türkiye) software. Technical activities were analysed by an expert, highly qualified, experienced, and certified match and performance analysis coach. The collected data included successful passes, unsuccessful passes, lost balls, and interceptions.

Data Analysis

The statistical package SPSS for Windows version 26 (IBM SPSS Statistics, Chicago, IL, USA) was used to analyse the data. The Kolmogorov-Smirnov test was used to verify the normality of the variables, and the results showed that they were normally distributed. The collected data underwent temporal standardisation and were subjected to comparative analysis among the experimental conditions using one-way analysis of variance (ANOVA) with repeated measures. The effect size was quantified by calculating the partial eta-squared ($\eta 2$) value (Hopkins et al., 2009). The level of significance was set at $P < 0.05$.

RESULTS

This section of this study presents the statistical results of the psychophysiological responses and technical actions of SSGs played in different formats. Table 2 indicates the values of the soccer players' psychophysiological responses according to the different Possession, MG, and GK formats on the 2-a-side SSGs. The results revealed that the RPE and VAS scores in the possession game were more significant in the MG and GK. Enjoyment significantly differed between the GK game, Possession, and the MG. The MRF-3 showed no significant differences between the games.

Table 3 shows the psychophysiological responses of soccer players in different formats of possession, mini-goal, and goalkeeper in the 4-a-side SSGs. The results revealed that the RPE value in the possession game was significantly higher than in the mini-goal and goalkeeper games. However, there were no significant differences in the VAS score, enjoyment, or MRF-3.

Table 2
Psychophysiological Performance Variables for 2-a-side SSGs (possession, mini-goal, and goalkeeper)

2-a-side	RPE	VAS	Enjoyment	MRF-3
Possession	16.83 ± 2.94*	4.83 ± 1.84Ω	46.21 ± 6.23	3.46 ± 2.12
Mini-Goal	14.05 ± 3.33	4.00 ± 1.70	46.34 ± 6.77	3.61 ± 2.84
Goalkeeper	13.92 ± 2.94	4.08 ± 1.85	49.40 ± 4.99✤	3.26 ± 2.49
Statistical Differences	Poss > MG, GK (F=18.355, p < 0.000, η^2 = .444)	Poss > MG, GK (F=4.575, p < 0.043, η^2 = .166)	GK > Poss, MG (F=10.963, p < 0.003, η^2 = .323)	(F=0.410, p > 0.528, η^2 = .017)

Note. * = significant differences(p<0.05); Poss = Possession game; MG = Mini-goal game; GK = Goalkeeper game; RPE = Rate of perceived exertion; VAS = Visual analogue scale; MRF = Mental readiness form

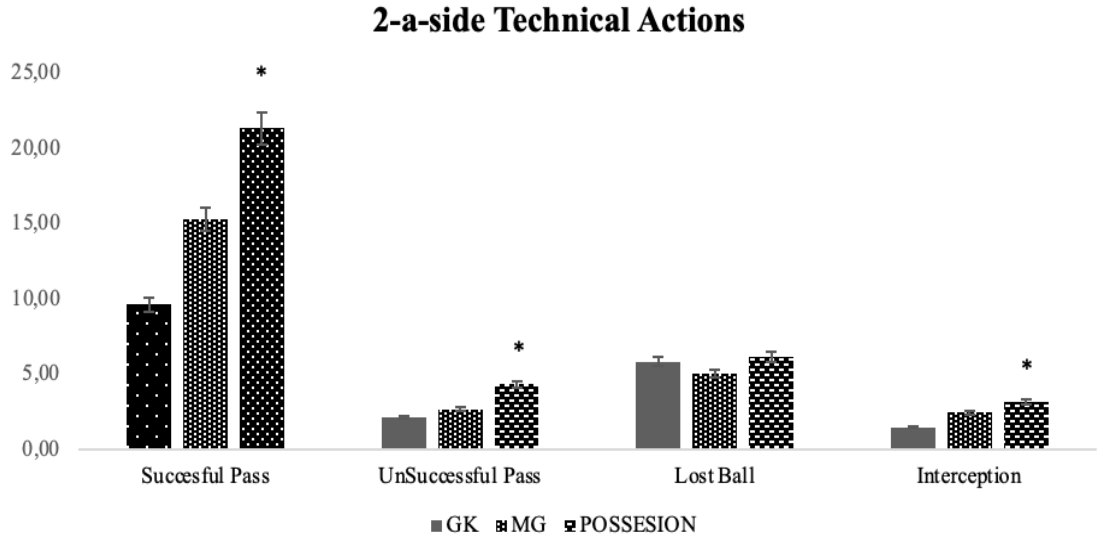
Table 3
Psychophysiological Performance Variables for 4-a-side SSGs (possession, mini-goal, and goalkeeper)

4-a-side	RPE	VAS	Enjoyment	MRF-3
Possession	13.28 ± 2.13*	4.26 ± 1.69	50.13 ± 3.52	3.36 ± 1.89
Mini-Goal	12.80 ± 2.58	4.48 ± 2.13	50.86 ± 3.37	3.40 ± 2.11
Goalkeeper	12.01 ± 3.33	4.34 ± 2.44	50.58 ± 3.09	3.60 ± 2.26
Statistical Differences	Poss > MG, GK (F=9.574, p < 0.005, η^2 = .294)	(F=0.29, p > 0.865, η^2 = .001)	(F=0.441, p > 0.513, η^2 = .019)	(F=0.635, p >0.434, η^2 = .027)

Note. * = significant differences(p<0.05); Poss = Possession game; MG = Mini-goal game; GK = Goalkeeper game; RPE = Rate of perceived exertion; VAS = Visual analogue scale; MRF-3 = Mental readiness form-3.

A repeated-measures ANOVA revealed a statistically significant difference in 2-a-side SSGs technical actions for successful pass (F = 81.109, p < 0.000, η2 = .779), unsuccessful pass (F=19.234, p < 0.000, η2 = .455), and interception (F=81.109, p < 0.000, η2 = .779), but not for lost ball (F=.177, p > 0.678, η2 = .008). Post-hoc tests showed significantly better successful passes, unsuccessful passes, and interceptions from possession games than from mini-goal and goalkeeper games (Figure 1).

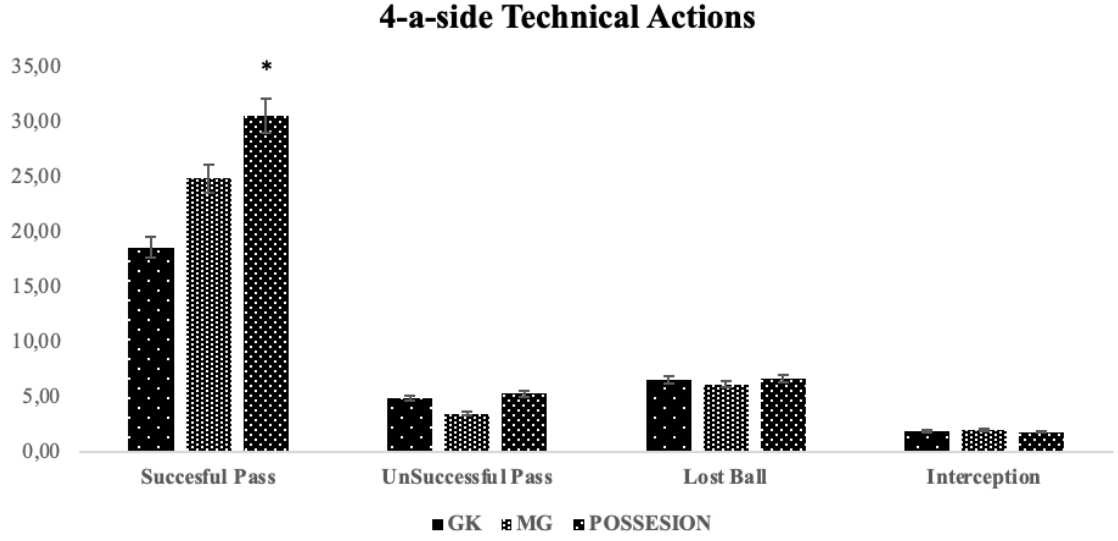
Figure 1
Technical Performance Variables for 2-a-side SSGs (Possession, mini-goal, and goalkeeper)



Note. * = significant differences($p<0.05$)

Figure 2 shows that a repeated-measures ANOVA revealed no statistically significant differences between possession, mini-goal, and goalkeeper SSGs in 4-a-side technical actions for unsuccessful passes ($F = .396$, $p > 0.535$, $\eta2 = .017$) and lost balls ($F = .048$, $p > 0.829$, $\eta2 = .002$). and interception ($F = .009$, $p > 0.927$, $\eta2 = .000$), but not for successful pass ($F = 67.069$, $p < 0.000$, $\eta2 = .745$). Post-hoc tests showed significantly more successful passes from possession games than from MG and GK games.

Figure 2
Technical performance variables for 4-a-side SSGs (Possession, mini-goal, and goalkeeper)



Note. * = significant differences($p<0.05$)

DISCUSSION

In this study, the 2-a-side SSGs game results revealed that the RPE and VAS scores in the possession game were more significant in the mini-goal (MG) and goalkeeper (GK). Enjoyment is different in the GK game, Possession, and the MG. The MRF-3 showed no significant differences between games. The technical action results of the 2-a-side SSGs' showed significantly better successful passes, unsuccessful passes, and interceptions from possession games than the MG and GK games. In the 4-a-side game, the RPE value in the possession game was significantly higher than in the MG and GK games. However, there were no significant differences in the VAS score, enjoyment, or MRF-3. The 4-a-side SSGs technical action results showed significantly better successful passes from possession games than from MG and GK.

The study showed that the possession format resulted in higher RPE values than the mini-goal and goalkeeper formats in 2-a-side and 4-a-side SSGs. The results of different studies in the literature are similar to those of our study. A similar study on semi-professional players reported that games without a GK resulted in higher heart rates than those with a goalkeeper (Castellano et al., 2013). Köklü et al. (2015) reported that in 2-a-side, 3-a-side, and 4-a-SSGs played with and without a GK, the without-goalkeeper format caused a higher RPE. In a 4v4 SSG study performed with and without GKs' in different field sizes, the participation of GKs' in the game caused a decrease in the maximum heart rate and mean heart rate values (Santos et al., 2021). Similar studies have shown that including GKs' results in lower RPE values (Mallo & Navarro, 2008; Sassi et al., 2005). In another study, in a 4-a-side SSG played in ball possession and MG formats, possession resulted in more RPE than MG (Silva et al., 2023). A similar study found that the RPE values of possession games were higher than those of MG games (Bujalance-Moreno et al., 2022). In another study comparing the MG and GK formats, the MG game resulted in a higher RPE than the GK game (Sarmento et al., 2018). In MG and GK format games, the time the ball stays in play is less than in the possession game because the ball leaves the field of play during goals scored or missed goal positions. For this reason, it can be said that RPE values are lower in MG and GK games than in possession games, as it can allow players to recover physiologically during periods when the ball is out of play.

The results of the present study on enjoyment and mental fatigue showed that 2-a-side SSG possession games resulted in more mental fatigue than MG and GK. By contrast, GK games resulted in more enjoyment than possession and MG games. In possession games, the

increase in physical demands in the effort to possess the ball may cause players to experience more mental fatigue than in mini-goal and goalkeeper games. Badin et al. (2016) state that mental fatigue does not impair physical performance despite increasing effort perception. In contrast, mental tiredness hampers offensive and defensive techniques. Competing in an intensive match and training program may cause athletes to experience mental fatigue with increased psychological demands, resulting in decreased performance (Coutts, 2016; Smith et al., 2018). Arslan et al. (2020) reported that SSGs were more enjoyable than high-intensity interval training. Since small-sided games require more technical demands than large-field games, such games result in more enjoyment (Los Arcos et al., 2015). Goalkeeper games are physiologically less intense than MG and possession games. However, preventing the opponent's goal positions in defense, assisting, and scoring goals in an attack can increase the players' motivation. Therefore, the GK game results in more enjoyment than the possession and MG formats.

Considering the technical performance of the 2-a-side *SSGs*' possession game, technical action results showed better successful passes, unsuccessful passes, and interceptions from possession games compared to the MG and GK games. In the 4-a-side SSGs, technical action results showed significantly better successful passes from possession games than from MG and GK. In the possession game, players' constant effort to possess the ball causes more successful passes, unsuccessful passes, and interceptions than in the MG and GK games. However, the number of technical actions may increase parallel because possession time is higher in possession games than in MG and GK games. Therefore, technical actions may occur more often in possession than in MG and GK games.

CONCLUSION

In conclusion, the analysis of the 2-a-side and 4-a-side SSGs results revealed exciting insights into the effects of different game formats on various parameters. In the 2-a-side SSGs setting, there were significant differences in the RPE and VAS scores during possession games compared with the MG and GK games. Enjoyment levels also differed significantly among GK, possession, and MG games, suggesting that each format had a unique experiential dimension. Surprisingly, the MRF-3 scores showed no significant variation, indicating that players' psychological readiness was consistent regardless of game configuration. Technical action results further highlight the impact of game formats. There were significant improvements in successful passes, unsuccessful passes, and interceptions during possession

games, which suggests that players' technical execution and strategic awareness were enhanced compared to MG and GK games. This research informs coaches and practitioners seeking to optimize training regimens and underscores the intricate connections between game type and player responses. Further research on the complicated dynamics between game structure and player development could yield more profound insights and potentially redefine training paradigms within the sports domain.

PRACTICAL IMPLICATIONS

The players frequently enjoyed using goalkeepers in SSGs. Soccer coaches can design SSGs with goalkeepers to make training more enjoyable. In the current study, players performed more technical actions and were exposed to higher visible loads during the ball possession of SSG. The study results demonstrate that coaches can improve players' technical and physiological capacities using the possession game format. Recently, soccer training has evolved towards more integrated physical training methods that prioritize the quality and density of players' specific actions and inter-communication over pure physical development. Therefore, coaches should consider using different game formats to increase the number of high-intensity actions players perform.

Limitations

The findings of this study should be interpreted with caution because of several limitations. First, the participants were young soccer players with amateur backgrounds. Therefore, the findings may not be generalizable to other age groups, skill levels, and competitive contexts. Second, the study only used psychological and technical responses in 2-a-side and 4-a-side game formats. These results may not fully represent the effects of physiological and kinematic parameters. Third, this study only assessed immediate responses during and shortly after game sessions. However, the long-term implications of these observed differences have not yet been explored.

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Declaration of conflict interest

The authors declare no conflict of interest concerning this article's authorship and/or publication.

Authors' contributions

The first and second authors contributed conception and design of the study. The first author collected data. The first and second authors contributed data analysis and interpretation, drafting the article and/or its critical revision and final approval of the version to be published.

Ethics Statement

The research was conducted following the Declaration of Helsinki and was approved by the Ethics Committee of Tokat Gaziosmanpasa University (2022-05-01).

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