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RESEARCH ARTICLE

Is There an Effect of the Trampoline Program for Autism Spectrum Disorder Children in Portugal?

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Abstract
Trampoline-based therapies have demonstrated the potential to enhance motor skills in children with autism by promoting the development of control, stability, and muscle power. This research aimed to investigate the impact of different trampoline therapies on motor abilities competency, lower limb muscle power, and body mass index (BMI) in a group of 25 children with autism (aged 6.9 ± 2.3 years old). Respondents were separated into two groups to participate in the experiment: Group A consisted of six children who underwent a 20-week program, while Group B comprised eight children who received a 32-week program. Additionally, an 11-member control group received no treatment. The Bruininks-Oseretsky Test of Motor Ability-2 otherwise stated (BOT-2), the Standing Long Jump test, and MassIndex of Body (BMI) assessments was administered at three time points: baseline (T1), during the program (T2), and after the program (T3). The results showed that both experimental groups demonstrated significant improvements scores in BOT-2 and lengthy standing jump workout performance after 20 and 32 weeks of trampoline-based therapy, respectively, compared to the control group. However, there were no significant changes in mass index of body before and after the programs in any of the three groups. Based on the results of this study, it can be concluded that engaging in trampoline training for a minimum duration of 20 weeks could potentially serve as an efficacious therapeutic approach to enhance motor skills among children diagnosed with autism spectrum disorder.

Keywords
Autism Spectrum Disorder, Inclusion Strategies, Trampoline Program, Children, Motor Abilities

INTRODUCTION

Seventy years ago, Leo Kanner's groundbreaking work set the framework for the diagnosis for early infantile autism (Volkmar, et al., 2012). There have been significant advances in our knowledge of this syndrome since then (Burhaein et al., 2021; Demirci et al., 2022; Volkmar et al., 2014). Autism Spectrum Disorder (ASD) is becoming morerecognized as a more complete description. ASD is distinguished by neurocognitive deficits that hinder speech and social interaction, as well asconfined and repetitive behaviors (Worley et al., 2012). Furthermore, people with autism frequently have sensory processing issues, making it difficult for them to adequately respond to and interpret sensory cues (Kern et al., 2011; Piek et al., 2004).

Over the past two decades, the study has extensively documented the presence of motor

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disparities among children and adolescents diagnosed with ASD. McPhillips et al. (2014) compared to their non-autistic peers. Motor deficiencies, according to (Gizzonio et al., 2015), can be divided into two categories: motor control abnormalities (coordination, strolling standing position, and muscles tone) and motor functioning abnormalities. According to Whyatt & Craig (2012) the unique motor deficiencies associated with autism cannot be generalized as such; rather, the most significant delays are most apparent in the most challenging tasks. According to (Staples et al., 2012), children on the autism spectrum have poor motor ability, which worsens with maturity; however, the magnitudes or sources of the difference between autistic and non-autistic kids remain mainly unknown. For instance, Colombo-Dougovito et al. (2021) highlighted the limits of the existing assessment protocols within the literature measuring motor skills in youth on the autism spectrum; suggesting that without understanding even the best intentioned and designed programs will provide hollow evidence of growth, according to the essential modifications for motor ability evaluation.

Physical activity-based programs maydeliver greater behavioral advantages for autistic youngsters and may provide a more naturalistic environment to practice social-oriented skills (Burhaein, 2022; Dewi et al., 2023; Phytanza et al., 2022). The impact of physical exercise programs like walking and hiking, aquatics, jogging, and biking as well as hippo therapy (Phytanza et al., 2023; Pitetti et al., 2007; Todd & Reid, 2006). Previous research has demonstrated that participation in physical activity-based programs contributes to an increase in motor skills in children on the autistic spectrum, at least in part (Phytanza, Burhaein, et al., 2021; Wrotniak et al., 2006).

Children on the autism spectrum participate in less physical exercise and display more sedentary conduct when compared to non-autistic peers (Jones et al., 2017), it is suggested that therapeutic activities for children be proposed on the autism spectrum be physically difficult, exciting, and enjoyable; otherwise, activities are likely to have a limited influence.

Utilizing a trampoline, for instance, within the program offers such advantages given the playful nature of the task (Lourenço et al., 2015; Phytanza, Purwanta, et al., 2021). More specifically, trampoline use throughout the programme has been linked to enhancements in the children's stability as well as physical abilities, control of posture, as well as power (Apoloni et al., 2013; Giagazoglou et al., 2015).

Trampolines may also provide a motivating, enjoyable, and gratifying element that may entice children on the autistic spectrum to participate while also delivering brain function emotional, motor, balance, and mobility advantages (Schoen et al., 2021; Lourenço et al., 2015). In the current study, the tramp workout was chosen as a therapeutic exercise for children diagnosed with autism. The objective of this research was to examine the impact of a trampoline-based program on the motor skills, body mass index, and jumping distance of children with autism. The study aimed to investigate how participating in this program could potentially enhance the mentioned variables in autistic children. It was hypothesized that following the 20-32-week program, when compared to the control group, children who participated in the experimental group improved their motor competence, jump distance, and body mass index.

MATERIALS AND METHODS

Experimental Design

This study utilized a research design that involved a within-participant repeated-measures approach, incorporating two distinct group of experimental. The Group of Experimental A (EA), that consisted of autistic children in a 32-week interference program, and Group of Experimental B (EB), which consisted of autistic children in a 20-week assistance. The children who were assigned to the group of control (C) did not participate in the conducted program; nevertheless, their participation in third-party motor activities outside of the motor program was not considered in the study design. All participants were evaluated three times: at the start of the trial (considered the baseline time) (t.1), halfway time during the treatment process (t.2), and at the end time of the treatment process (t.3).

Participants

Children with ASD were recruited through the Portuguese Association for Autism Spectrum Disorders. Potential parents were notified by phone, and carers were asked to grant permission for their child to be involved. Before taking part in the experiment, all the youngsters gave their informed permission. Children on the autistic spectrum were assigned to one of three categories in a random manner: experiment group A (EA, n = 6, including the median gender and age), experiment group B (EB, n = 8, including the median gender and age), and group of control (C, n = 11).

There was no conflict of interest, and all the principles of the Declaration of Helsinki were complied with number ethical cleareance is 071/A/VI/2023, with special emphasis on informed consent and the vulnerability of the study population. Participants were exclusively enlisted if they fulfilled the criteria set forth by the (American Psychiatric Association, 2013) categorized them as effective on the ASD and satisfied the diagnostic criteria for autistic disorders or Asperger's disorder as well. Parents with at least one autistic kid, a child aged 4 to 11, no other medical difficulties, and a youngster who could follow directions were considered to take part in the research. The descriptive statistics for the 25 subjects and their diagnoses are shown in Table 1.

Table 1. The groups of experimental consist of (A, B) as well as the group of control, are described

Subject	Gender	Age (years)	Weight (Kg)	Height (cm)	BMI	Percentile BMI
EA						
1	F	4	18.3	104	16.9	90
2	M	6	22.7	119	16	75
3	M	10	42	152	18.2	75
4	M	9	40.3	139	20.9	95
5	M	7	37.2	140	19	95
6	M	8	23.4	125	15	50
Average (DP)			32.1±10.8	129.8±17.2		
EB						
7	M	5	18.9	111	15.3	50
8	M	8	25.3	127	15.7	75
9	M	7	27.4	125	17.5	90
10	M	4	18.9	104	17.5	95
11	M	4	19.6	109	16.5	85
12	M	4	16.6	104	15.3	50
13	M	4	27	119	19.1	97
14	M	5	16.6	111	13.5	3
Average (DP)			21.2±4.5	113.7±8.9		
C						
15	F	6	24.5	123	16.2	75
16	M	6	22.2	113	17.4	90
17	F	7	23.3	121	15.9	75
18	M	11	30.8	134	17.2	50
19	M	9	41	144	19.8	95
20	M	8	28.9	134	16.1	75
21	M	11	37.3	150	16.6	50
22	M	8	28.7	130	17.6	85
23	M	8	38.6	141	19.4	95
24	F	4	13.6	96	14.8	50
25	F	10	54.6	138	28.7	97
Average (DP)		6.9±2.3	34.1±17.1	131.5±18.6		

Source: Primary Data

Training was provided for 32 weeks for the EGA program and 20 weeks for the EGB program. The child who was in both groups of experimental (EGA and EGB) took engaged in a regular 45-minute trampoline workout for between 20 or 32 weeks, while those who were in the group of control did not receive any program. Everyone in the study (including the group of control) continued to attend school.

Parameters Evaluated

Mass Index of Body (BMI)

Mass Index of Body (BMI) is a widely recognized measurement used to assess an individual's body composition and overall health status. It is a numerical value derived from a person's weight and height, providing an indication of whether they fall into the underweight, normal weight, overweight, or obese category. By calculating BMI, healthcare professionals and individuals can gain valuable insights into the potential health risks associated with their weight status. This information can be utilized to inform decisions regarding lifestyle choices, such as diet and exercise, to maintain or achieve a healthier weight.

Anthropometric evaluates were taken in order to gather relevant data and information using global anthropometric evaluation criteria (Esteban-Figuerola et al., 2021). A scale with a digital display was used for the weighing operation (Seca, model 841, Germany) with a precision of 0.1 kg. To determine height, a stadiometer (Seca, model 214, Germany) with a measurement accuracy of 0,10 cm was employed.

Motor Ability

Motor Ability refers to the capacity of an individual to execute and control voluntary movements efficiently. It encompasses a wide range of physical skills, such as coordination, balance, dexterity, and strength. Developing and enhancing motor ability is essential for individuals of all ages, as it directly impacts their overall physical functioning and quality of life. For children, motor ability plays a vital role in their growth and development, influencing their cognitive, social, and emotional development. It allows them to explore their environment, engage in play, and acquire new skills.

In previous studies, Motor Competence Test (BOT-2) served as the chosen method to evaluate motor competence among this specific group (Fransen et al., 2014). The test battery was modified to include a concise collection of 12 structured items, divided into 8 subtests, which allowed for the individual assessment of each child.

Table 2. BOT-2 Motor ability test subtests in condensed form

	Subtests
Subtest 1	-Precision of Fine Motor -Painting in a star -Create a straight line following a spesific path
Subtest 2	-Integration of Fine Motor -Duplicate two circular shapes -Duplicate two inverted rectangles
Subtest 3	-Manual Ability -Hanging activity
Subtest 4	-Bilateral Collaboration
Subtest 5	-Stability -Walk on an single foot
Subtest 6	-Precision and the speed -Hop on a single foot
Subtest 7	-Higher Limb Mobility -Swing and Take the ball -Dribble a ball with both hands alternately.
Subtest 8	-Power -Perform Push-ups

Source: Primary Data

Lower Limb Muscular Power

The measurement and assessment of muscle power in the lower limbs is a crucial component of evaluating an individual's physical capabilities and overall functional performance. It provides valuable insights into the individual's ability to perform various activities such as walking, running, jumping, and maintaining balance.

Muscle power refers to the force generated by muscles during contraction. In the context of the lower limbs, it specifically pertains to the muscles in the hips, thighs, and lower legs that contribute to movements such as flexion, extension, abduction, adduction, and rotation. Assessing muscle power in the lower limbs involves utilizing various techniques and tools. One commonly used method is manual muscle testing, where a trained professional applies resistance to specific movements performed by the individual. This allows for the determination of the individual's strength and the identification of any muscle imbalances or weaknesses that may be present. Additionally, dynamometry, which involves the use of specialized equipment, can provide objective measurements of muscle power. This technique utilizes force transducers or dynamometers to quantify the force produced by the muscles during specific movements. It provides accurate and reliable data that can be used for comparison and tracking progress over time.

The assessment of muscle power in the lower limbs is essential for individuals of all ages and fitness levels. It is particularly valuable in rehabilitation settings, where it can guide the development of tailored exercise programs and monitor the effectiveness of programs. Furthermore, it is widely used in sports performance settings to identify areas for improvement and enhance athletic performance.

Overall, evaluating muscle power in the lower limbs plays a fundamental role in understanding an individual's physical capabilities and informing appropriate programs. It provides valuable information that can aid in promoting optimal function, preventing injuries, and optimizing performance in various contexts.

The thrust horizontally jumped was utilized to assess the strength of the lower limb muscles in young individuals. Every individual involved in the activity was strategically placed along a predetermined line on the surface, ensuring that their feet were slightly apart and aligned in parallel. The objective was for the participant to jump as far as possible while bending their knees and flexing their hips (Dix et al., 2019). A measuring tape was employed to determine the distance between the ground line and the back of the participant's feet. For each participant, three leaps were done and recorded, and the most proficient performance was chosen.

The long-standing leaps are a widely accepted and dependable method for evaluating the strength and endurance of the lower body or more specifically, the strength and endurance of the lower limbs (Wörner et al., 2017). It is recognized as a practical, efficient in terms of time and economically feasible evaluation that requires little equipment. Consequently, this test presents promising applications in education-based programs.

Exercise Program

Experimental Groups

The two investigative groups, EA and EB, engaged in weekly sessions that lasted for 45 minutes. EA had 32 sessions, while EB had 20 sessions. The sessions involved the use of essential equipment, including, one flexible bed, one full-sized trampoline, two mini-trampolines and two trampolines with a combined length measuring 80 cm. Experimental group B only did 20 sessions because it was in accordance with the school year.

The youngsters were initially introduced with the trampolines and given the opportunity to become acquainted with the equipment and various sorts of jumps. Additional items, which included stringa, bows, and balls were used in subsequent sessions. These workouts also featured a variety of synchronized motions that gradually got more difficult. The number of repeats rose, as did the level of difficulty and independence, lowering the need for help. Later sessions incorporated cognitive cues such as colours numerals and counting to connect movement with cognitive and psychomotor responses.

Furthermore, it was critical to show activities so that the children could pay attention and visualize all the demonstrations. A warming up activity was held before to the workouts to raise cardiovascular and respiration rates while warming up the muscles and joints.

Statistical Procedures

Statistical procedures play a crucial role in analyzing and interpreting data. These procedures provide a systematic approach to organizing, summarizing, and making inferences from data. By employing various statistical techniques, researchers and analysts can draw meaningful conclusions and make informed decisions. We used descriptive statistics, specifically the mean and standard deviation, were used to represent the distributions of the variables analyzed. The normality test used Shapiro-Wilk was employed to confirm that these distributions followed a normal pattern, which was found to be true for all variables examined in this study. To compare the BOT-2 scores, BMI, and horizontally leaps distance among the three groups, an analysis of variance (ANOVA) was conducted. Additionally, the program effects in EGA, EGB, and CG children before and after the trampoline-based program were compared using repeated measures ANOVA. The level of significance was set at 0.05. For the statistical analysis, the SPSS statistics software version 21 was utilized.

Ethical Considerations

The research procedures used in this study were subjected to a thorough examination and were approved by the university's ethics council. On an individual basis, each participant was given full information on the study's aims and procedures. Parents provided written consent, and the children involved provided their assent.The key ethical norms relevant to the engagement of children were strictly adhered to throughout the study procedure. All Helsinki Statement standards were rigorously observed, with specific attention paid to securing informed permission and understanding the fragility of the population under inquiry.

RESULTS

Mass Index of Body

The measurement outcomes of the BMI assessment of the three categories examined three times during the study are presented in Table 3. There were no significant differential statistics found in mass index of body (p = 0.222) between the three groups both before and after the program.

Table 3. The results of an ANOVA and mean values (standard deviation) of repeated BMI measurementsin EA, EB, and the C all over three examination sessions

	EA			EB			C			ANOVA repeated measures		
v	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**I**	**G**	**I*G**
BMI	17.6 (2.12)	17.6 (2.06)	17.7 (2.08)	16.4 (1.84)	16.8 (1.98)	16.8 (2.28)	18.1 (3.78)	17.9 (3.57)	17.6 (3.87)	0.706	0.677	0.222

V – variables; BMI – Mass Index of Body; EGA – Group of Experimental A; EGB – Group of Experimental; CG – Group of Control; I – Program; G – Group; I*G – Group and program; 1 – Baseline time; 2 - a halfway through the program time; 3 after the program time

Muscle Power of the lower limbs

Table 4 depicts the fluctuation of the muscle power of the lower limbs following the interference, considering the various stages of evaluation. Descriptive analysis revealed that the greatest values in EA and C were observed at the baseline (0). When compared to the other groups, EB had a shorter leaps distance (23.4 cm). During the program, EB had the greatest gain in leaps distance. EA made advancements as well, which was more noticeable between O and 1. The C improved slightly, but just marginally.

Table 4. The mean values (standard deviation) and ANOVA results of repeated measurements in EA,EB, and the C throughout the three evaluation times are shown.

	EA			EB			C			ANOVA repeated measures		
V	**0**	**1**	**2**	**0**	**1**	**2**	**0**	**1**	**2**	**I**	**G**	**I*G**
MPLL	66.2 (39.15)	80.0 (47.34)	82.6 (55.97)	23.4 (29.73)	47.4 (38.41)	65.7 (41.14)	79.6 (24.75)	83.6 (24.37)	84.9 (21.56)	0.000	0.055	0.011*

V – variables; MPLL – Muscle Power of the lower limbs; EA – Group of Experimental A; EB – Group of Experimental B; C –Group of Control; I – Program; G – Group; I*G – Group and program; 0 – Moment 0, before the program; 1 – Baseline; 2 – after the program.

According to what was found of the repeated measures analysis of variance (ANOVA), children in both the EA and EB groups increased their leaping distances significantly more than children in the control group (p = 0.011)

Motor Abilities

Motor abilities statistics include precision of fine motor (Mot.precis1), integration of fine motor, manual skills, bilateral coordination, stability, agility and speed, upper-body coordination, power, and overall test score. Table 5 demonstrates the differences in fine motor accuracy between the different groups investigated at various levels of analysis.

Table 5. Mean values (standard deviation) and ANOVA results of repeated measures of the fine motor precision in EA, EB and the C, during the three moments of evaluation.

	EA			**EB**			**C**			**ANOVA repeated measures**		
v	**0**	**1**	**2**	**0**	**1**	**2**	**0**	**1**	**2**	**I**	**G**	**I*G**
1.Mot.precis1	1.17 (0.75)	1.50 (0.83)	1.33 (0.51)	1.25 (0.88)	1.50 (0.75)	1.63 (0.51)	2.55 (0.52)	2.55 (0.25)	2.09 (0.53)	0.204	0.001	**0.029***
2.Mot.ptecis2	2.67 (2.65)	2.50 (1,87)	2.50 (1.04)	1.38 (1.50)	2.62 (2.50)	2.38 (1.40)	4.55 (1.63)	5.18 (1.72)	4.18 (1.77)	0.211	0.006	0.212
3.Mot.inte1	3.67 (2.87)	4.67 (1.50)	4.17 (1.60)	3.38 (2.87)	3.88 (2.94)	4.13 (2.16)	5.00 (0.63)	5.18 (0.75)	5.36 (0.67)	0.072	0.216	0.581
4. Mot.inte2	1.83 (2.22)	1.83 (2.22)	1.50 (2.34)	0.87 (1.64)	1.13 (1.64)	3.38 (1.59)	4.00 (1.18)	3.18 (1.53)	3.73 (0.78)	0.046	0.015	**0.001***
5.Man.Dext	2.00 (1.26)	2.67 (1.21)	3.00 (1.09)	1.38 (0.74)	2.13 (1.12)	2.13 (1.12)	3.36 (1.50)	3.55 (1.75)	4.00 (1.34)	0.001	0.029	0.369
6.Bila.Coord1	1.50 (1.97)	2.00 (1.67)	2.50 (1.64)	0.63 (0.91)	1.50 (1.69)	2.87 (1.45)	1.82 (1.60)	1.55 (1.50)	2.00 (1.09)	0.004	0.891	0.102
7.Bila.Coord2	0.00 (0.00)	0.67 (1.21)	1.50 (1.37)	0.13 (0.35)	0.25 (0.46)	1.13 (1.35)	1.55 (1.29)	0.91 (1.04)	1.64 (0.92)	0.001	0.095	0.081
8.Balan	1.83 (0.75)	2.00 (1.09)	3.83 (1.32)	0.75 (1.03)	2.38 (1.40)	2.88 (0.35)	2.09 (1.22)	2.45 (1.12)	2.45 (1.36)	0.000	0.859	**0.003***
9.Agil.Spe	1.33 (1.75)	1.83 (1.72)	3.33 (2.25)	0.38 (0.51)	0.75 (0.70)	1.87 (1.80)	1.55 (1.12)	1.91 (1.04)	1.91 (1.13)	0.000	0.194	0.076
10.Coord.UL1	1.83 (2.48)	2.50 (1.97)	3.17 (2.22)	0.38 (0.74)	0.75 (1.16)	0.75 (1.03)	0.27 (0.46)	0.55 (1.03)	0.73 (1.48)	0.005	0.012	0.557
11.Coord.UL2	1.50 (1.76)	2.33 (2.25)	3.67 (3.01)	0.25 (0.70)	0.50 (0.75)	1.13 (1.72)	1.00 (1.18)	1.36 (1.20)	1.73 (1.42)	0.000	0.079	0.188
12.Strength	2.00 (2.19)	1.83 (2.04)	4.67 (2.16)	0.00 (0.00)	0.50 (1.06)	0.50 (0.92)	0.55 (1.21)	0.36 (0.80)	0.55 (0.82)	0.000	0.001	**0.000***
Total	21.33 (17.68)	26.33 (16.90)	35.17 (17.74)	10.75 (8.36)	17.88 (12.49)	26.50 (12.18)	28.27 (10.00)	28.73 (9.29)	30.27 (7.55)	0.000	0.151	**0.001***

v – variables; EA – Group of Experimental A; EB – Group of Experimental B; C – Group of Control Group; I – Program; G – Group; I*G – Group and program; 1 – Baseline; 2 - a halfway through the program; 3 – after the program.

Some variations identified between both subtests. Notably, over the three evaluation periods, children in the EB demonstrated substantial gains (p = 0.029) in their ability to colour a star. However, none of the three groups improved much on the subtest requiring drawing a line along a path. Table 6 presents the average and variability of the fine motor integration. The integration of fine motor variable consists of two subtests, which produced differing results. Notably, there were no significant changes observed in the "copy two circles" item, referred to as Mot.inte1, within the table. However, throughout the program, the mean values for all three study groups showed improvement.

Following the training, the item consisting of replicating two inverted rectangles greatly improved. The mean values in the EB children showed considerable increases, whereas the other two groups showed less regression. There were no significant changes in manual dexterity across the three groups (p=0.369). The mean values, on the other hand, improved, exhibiting more expressiveness in EA and EB. There were no significant changes observed in either component of lateral coordination. The mean values for both EA and EB demonstrated improvement. Additionally, the C group exhibited a reduction in mean values from baseline measurement to first measurement.

The mean values exhibited notable enhancement in balance, showcasing a significant level of expressiveness in both EA and EB. Additionally, the C experienced marginal improvements from the initial phase to the subsequent phase, which were sustained throughout the entirety of the program. This variable improved significantly (p = 0.003) because of the program. Improvements in EA and EB speed and agility were documented because of the program. The cognitive ability of the participants showed minimal improvement from baseline measurement to first measurement and remained unchanged throughout the duration of the program. No noticeable enhancements were observed. Throughout all levels of examination and across all groups, there was observed improvement in upper-limb coordination as measured by the two items. Both EA and EB groups showed more notable improvements in this area, along with other variables. However, it is important to note that no significant progress was made. Following the program, there was a significant improvement in strength levels (p=0.000). In the analysis of the three groups examined, it was observed that the overall results of the BOT- 2 assessment showed a consistent and progressive improvement from baseline measurement to second measurement. Conversely, the control group (C) demonstrated a slight increase, starting at 28.27 and reaching 30.27. The Early Global Assessment (EGA) score increased from 21.33 to 35.17, and the Early Goal-Based (EGB) score rose from 10.75 prior to the program to 26.50 upon completion of the program.

The program resulted in substantial changes in the MP, with a statistically significant difference observed (p = 0.001). Overall, the Experimental Group B (EB) exhibited lower average values compared to the other groups across most variables included in the MP test. However, it is worth noting that the Control Group (C) displayed the highest average values across all measures, except for upper limb coordination, when compared to the experimental groups. Significant enhancements were observed in all the parameters, with particular emphasis on EA and EB. Encouragingly, both experimental groups exhibited progress in manual dexterity, bilateral coordination, balance, speed and agility, lower limb coordination, and motor ability over the course of the program. However, it is noteworthy that EA did not exhibit any noticeable improvement in motor accuracy or fine motor integration.

DISCUSSION

Mass Index of Body

One of the objectives of the program was to evaluate any changes in the participants' BMI. The study's findings indicate that the program did not have a significant impact on BMI, as shown in Table 3. These results align with Pan's (2011) study, which found no notable decrease in BMI among a group of autistic children who underwent a water program. The trampoline-based programmer’s lack of effect on BMI can be attributed to its low frequency and duration (45 minutes, once per week), as well as the absence of any dietary management component. To achieve a meaningful reduction in body fat, the World Health Organization and the American College of Sports Medicine recommend that adults engage in 150-250 minutes of physical exercise per week (Unick et al., 2017).

However, these BMI findings contradict the results of previous research, who observed a decrease in BMI after 9 months of walking for 30 minutes, three times per week (Ho et al., 2012). Additionally, assert that regular physical activity significantly reduces the risk of cardiovascular problems and waist circumference (Hu et al., 2004).

Therefore, for future studies focusing on BMI, it is recommended to implement three 50-minute training sessions per week to observe any effect on BMI.

Muscle Power of the Lower Limbs

Research studies have consistently shown that lower limb muscle power is lower in autistic children compared to children who are typically developing (Perin et al., 2020). Given that trampoline workout routines are designed to increase lower limb muscular power, it is expected that this variable would significantly change with the implementation of program programs. Consequently, when comparing the three groups, the training plan proves advantageous, with notable changes observed in the control group's progress. Separate research conducted on children without disabilities found notable improvements in lower limb muscle power after a 12-week trampoline exercise course (Atilgan, 2013). Previous studies involving specific populations, have also shown that strength training plans involving jumps can enhance lower limb muscle power, like the trampoline training regimens employed in this study (Aalizadeh et al., 2016).

Although the participants in this study did not receive a specific strength training program, the data collected revealed a significant increase in lower limb muscle power. These findings contribute to a better understanding of the effectiveness of trampoline training programs in improving lower limb strength. It is worth noting that the content of the trampoline program required all children to perform various types of jumps, placing greater demands on their lower limbs, which likely contributed to the observed results. In conclusion, incorporating trampoline activities into physical activity programs for children on the autistic spectrum has been shown to be an effective method for promoting lower limb muscle power.

Motor ability

The motor ability of children is intricately linked to their level of exercise and is detrimentally affected by engaging in sedentary behavior (Wrotniak et al., 2006).

The results of this research indicate that implementing a program led to significant improvements in motor ability. Specifically, the findings suggest that trampoline training can enhance motor ability in children on the autism spectrum, resulting in improved stability, power, and integration of fine motor. Studies in the past has shown that rehabilitation programs centred on sports like swimming can improve numerous elements of motor function in autistic children, including stability, agility, quickness, muscle power, mobility, and endurance of the cardiovascular system (Bodnar et al., 2020).

Upon reviewing the existing literature, no other programs involving trampolines for children on the autism spectrum were found, making it difficult to compare outcomes. However, these findings align with recent research indicating that individuals with intellectual disabilities experience improved balance and motor function, although they may also exhibit developmental coordination deficits (Giagazoglou et al., 2015; Mekić et al., 2022). Significant enhancements have been noted among the elderly participants in a similar manner following trampoline training programs.

Conclusions

In conclusion, it looks plausible to illustrate the potential of trampoline instructional programs that have significantly increased motor skills and leaping distance in autistic children. Because young children have trouble keeping their equilibrium, unique program for autistic children based on movement and motor learning ideas are urgently needed. Trampoline exercise looks to be a great solution to these challenges. In addition to being a high level of enjoyment, which is associated with a child's motor abilities on the autistic spectrum, In addition, it enhances motor performance by effectively improving physical coordination and movement abilities. The suggested workout programs appear to be an excellent method of interacting with these individuals in this area.

Because of our research, the key conclusion is that children on the autism spectrum should practice trampoline exercises at least once a week to improve motor efficiency and power of muscles in the lower part of the body.

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Conflict of Interest

We declare that this article we wrote is not involved in any conflict of interest.

Ethics Statement

The writing of this article has gone through all ethical procedures related to the academic realm. All the principles of the Declaration of Helsinki were complied with number ethical cleareance is 070/A/VI/2023, with special emphasis on informed consent and the vulnerability of the study population.

Author Contributions

Study Design, CCVL, EB, DTPP, EC; Data Collection, CCVL, EB, DTPP, EC; Statistical Analysis, CCVL, EB, DTPP, EC; Data Interpretation, CCVL, EB, DTPP, EC; Manuscript Preparation, CCVL, EB, DTPP, EC; Literature Search, CCVL, EB, DTPP, EC. All authors have read and agreed to the published version of the manuscript.

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