Research Paper

Effect of Corrective Games and Physical Exercise Packages on Motor Skills of Children With Autism Spectrum Disorder

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ABSTRACT

Objectives: Autism spectrum disorder (ASD) is a neurodevelopmental illness marked by challenges with social interaction and communication, as well as reluctance to change. This study aims to examine the effects of a particular bundle of physical exercises and remedial games on the motor abilities of children diagnosed with ASD

Methods: This experimental study included 36 boys with ASD randomly selected from the Iranian region of Rasht Province. Three groups of 12 boys each were used in the intervention sample, including a control group, a package of physical exercises, and a selection of corrective games. Oseretsky Bruininks' upper-limb coordination and gross and fine motor abilities were assessed using the test of motor proficiency (Bruininks-Oseretsky test of motor proficiency [BOT-2]). SPSS software, version 23 was used for the analysis of variance.

Results: The results demonstrated that the mean gross motor abilities considerably improved after specific remedial games and physical exercises (P=0.01). Additionally, a significant difference was observed in upper limb coordination (P=0.03), gross and fine motor skill total (P=0.02), and fine motor skill differences (P=0.03) between the two groups.

Discussion: The study's results indicate that both programs positively impacted the motor abilities of youngsters diagnosed with autism spectrum condition. Furthermore, the results indicated that the physical exercise program used in this study has a significant impact on the motor abilities of children diagnosed with ASD compared to the chosen corrective games. According to the results of this study, the researcher recommends the physical training program introduced in this study as an appropriate regimen for enhancing the motor abilities of individuals with autism spectrum condition.

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Highlights

- The impact of corrective games on the motor abilities of children with ASD was substantial. However, physical exercise packages yielded significant improvements in these abilities. Physical exercise packages have a more pronounced impact on these abilities than corrective games.

Plain Language Summary

Based on the results of this study and data from the World Health Organization (WHO), the prevalence of autism has significantly risen. Specifically, the number of diagnosed individuals with this illness doubled between 2005 and 2020. Emphasizing engaging in various forms of physical activity is crucial for these individuals. Consequently, drawing on the findings of the current investigation, the researcher proposes optimal workouts for enhancing the motor abilities of those diagnosed with Autism spectrum disorder (ASD).

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental condition consisting of a collection of intricate neurological abnormalities marked by challenges in social interaction and communication, as well as a tendency to resist change [1]. This condition is classified as a neurodevelopmental disease with an unknown cause, characterized by various behavioral symptoms [2]. The etiology of autism is distinct. Autism is linked to several conditions, such as Rett's disorder, childhood disintegrative disorders, Asperger's syndrome, and other pervasive developmental disorders [3]. There has been a notable rise in the occurrence of ASD in children, with the current estimate being that one in every 36 children is affected by this illness [4]. Studies have reported that people with ASD have impairments in fine and gross motor skills [5]. It is estimated that approximately 1 in 100 children worldwide has autism. There are still no accurate statistics on autistic children in Iran. However, Iran's Autism Association has announced that one child with autism is diagnosed for every 150 births in the country.

Physical activity enhances motor abilities by stimulating sensory processes and enabling individuals to better comprehend sensory information [6]. Studies have shown that individuals with ASD have delays in the acquisition of fundamental abilities [7], as well as fine and gross motor skills [8], balance [9], and executive functions [10]. In this context, Bhatt et al [10] found that 86.6% of people with ASD have defects and movement disorders. Wilson et al. investigated the effect of swimming exercises on children with autism and concluded that performing these exercises can be useful in reducing stereotyped behaviors and increasing social interactions. Ruggeri et al [11] reported that simulated horseback riding is recommended to improve motor performance in water sports and motor skills [12]. Many studies have measured the effects of different exercises on different characteristics of these individuals. However, the researcher did not find enough studies comparing movement correction games and physical movement exercises.

Physical rehabilitation games are designed to provide children with physical fitness and motor skills while enjoying high levels of physical activity. Physical rehabilitation games, which have been used in many research studies, are a broad program designed to provide goals, such as increasing physical fitness and motor development. Selective games are related to developing children's basic skills and include sports, games, and active creativity [13]. Therefore, studies show that games and corrective exercise games can significantly impact stereotyped behaviors and communication defects of people with ASD at the lowest cost and with the use of very few facilities [14]. There is another approach to providing exercise programs for people with disabilities. This approach states that training programs should be developed according to the etiology of each disorder [15]. After examining each person's physical, movement, and behavioral characteristics, they should be prescribed sports individually. Kashi et al. [16] conducted a research study in this regard, and taking into account the considerations and approaches of exercise science in people with ASD, they compiled a comprehensive package of physical movement exercises for these people. This training package includes the development of interaction and social skills, communication skills, neuromuscular system preparation, physical fitness, motor development, physical activity, body composition, training with animals, perceptual skills, attention to feelings and emotions, and attention to different senses. Researchers have investigated and confirmed the effects of this exercise pro-

gram on autistic characteristics [16] and motor skills [17]. The researcher is looking to determine whether providing an exercise program based on the needs of a specific community has a greater effect on motor skills or if providing corrective games that children are more inclined to play. Hence, the researcher aims to compare the chosen corrective games and physical exercise package in terms of their impact on the motor skills and other autistic characteristics of children with ASD. This comparison considers factors, such as cost, required equipment, and overall effectiveness. The main objectives of this study are twofold: To examine the impact of an eight-week program consisting of physical exercises and corrective games on the motor skills of children diagnosed with ASD, and to compare the adaptive improvements in motor skills between the two training methods after the eight-week intervention period.

Materials and Methods

Children diagnosed with ASD in Rasht Province, Iran, volunteered to participate in the study. Children diagnosed with ASD were divided into three groups: Physical exercise packages (n=12), corrective games (n=12), and control (n=12). The research team used computer software to generate a table of numbers for quadruple block randomization. A blinded team member performed this process. The sample size was determined using prior research conducted by Baluchi and Babakhani [18], with an alpha level of 0.05 and a power (1-beta) of 0.80. The study conducted using G*Power software, version 3.1.9.2; determined that a sample size of n=12 per group would be enough to detect significant effects between the variables. The inclusion criteria included male students aged between 4.5 and 14.5 years who were not engaged in any professional sports but were only involved in regular physical education sessions offered by the school. The exclusion criteria included the use of neurological medications that affect postural control, recent lower extremity injuries within the past six months, muscular or neural disorders, such as myopathy, myositis, peripheral neuropathy, or muscular dystrophy, abnormal posture in the upper or lower body, recent surgery or fracture within one year before the study, insulin-dependent diabetes, rheumatoid arthritis in the joints, diagnosed cerebrovascular disease, or any other condition that hampers sensory input, lower extremity rotational deformities, such as increased anteversion or tibial torsion, and pes planovalgus. Before the study commenced, the teenagers and their parents were provided information on the research protocols, and their signed agreement was acquired (Figure 1).

The present investigation used an experimental methodology with a pre-test and post-test experimental design, along with a control group. The study's statistical population consisted of children diagnosed with ASD in Rasht Province. The children were divided into three research groups using targeted randomization, depending on specific inclusion and exclusion criteria (Table 1). The 36 boys with ASD were randomly distributed into three groups: Selected corrective games, a physical exercise package, and a control group (12 people in each group).

The research method was such that, initially, a research work permit was obtained from the Department of Special Education and Education of Rasht District, followed by informed consent from parents. During a meeting, they were assured that implementing this protocol would not harm the children's health. Then, based on the diagnostic file compiled through the Gilliam autism rating scale [19], with the coordination and supervision of the psychiatrist and the work of the therapist, considering the ability of the people in the sample group and factors, such as gross and fine motor skills, pre-test and post-test sessions were held in person. After the pre-test, group training programs were conducted during the children's weekly exercise program under the researcher's direct control. The exercise protocol was based on the guidance of previous studies [20, 21]. The 11-week research period was conducted under the following stringent guidelines: First week: Familiarization; second week: Pre-test; third to tenth weeks: Training; and eleventh week: Post-test. A researcher standardized the training processes and communicated with the participants two weeks before the start of the training session. The participants and trainer co-designed three weekly workout sessions. The participants were advised to perform the practices correctly. The control group continued with their regular educational regimens at the same time.

Physical exercises package

The physical exercise package presented in this research was based on the protocol of Kashi et al. [16] This program is specific to individuals with ASD. These exercises were designed and carried out to develop interaction and social skills, prepare the neuromuscular system, develop physical fitness and motor development, develop physical activity and improve body composition, pay attention to different senses, and develop motor skills based on the principles, theories, and recipes specific to these people [20].

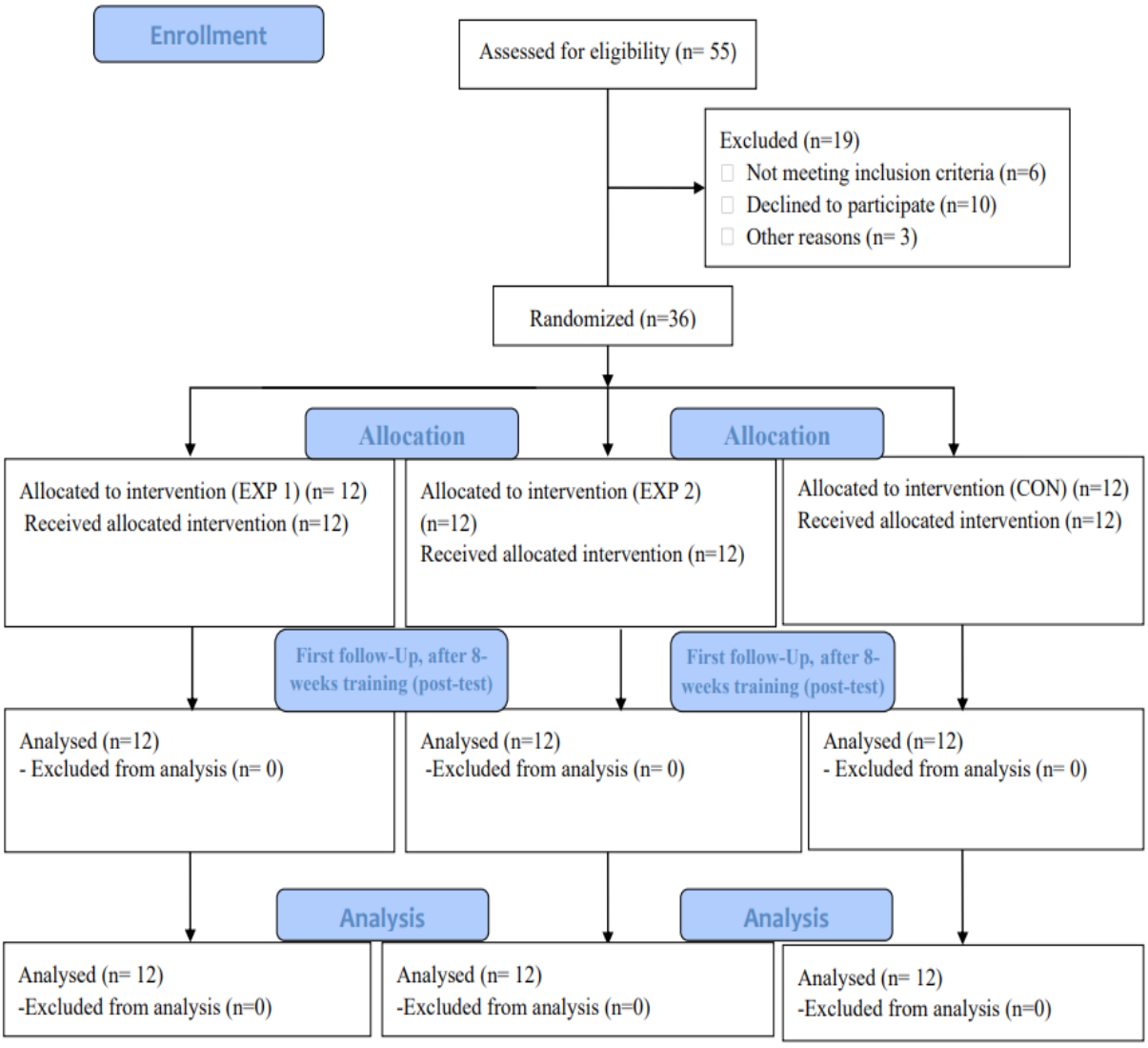

Figure 1. Flowchart of eligibility, inclusion, and exclusion criteria, and analysis

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Corrective exercise game

The exercises selected in this study were taken from the spark motor training program [22]. The program consists of twenty-four indoor sessions and three 60-minute weekly sessions during the school sports bell. This protocol includes ten minutes for warm-up, 40 minutes of balance skills, such as running, jumping, and cat running, ball skills such as catching, throwing, and leaning, and ten minutes of cool down [23].

The Bruininks-Oseretsky test of motor proficiency (BOT-2), a reference norm test set that assesses children's performance between 4.5 and 14.5 years, was used to measure the dependent variable [24]. This exam has eight subscales: Running speed and agility, balance, two-way coordination, strength, upper limb coordination, reaction speed, motor vision control, upper limb speed, and agility. The subtests assess motor competence in both gross and fine motor skills.

Data analysis

Wilk and Shapiro Levine's test was used to verify the homogeneity of the variances, and a test was employed to assess if the data were normal. The data from each group in this study were described using descriptive statistics (age, height, weight, and body mass index). Covariance analysis was performed using the SPSS software, version 21 to compare the experimental and control groups' average pre-test and post-test data.

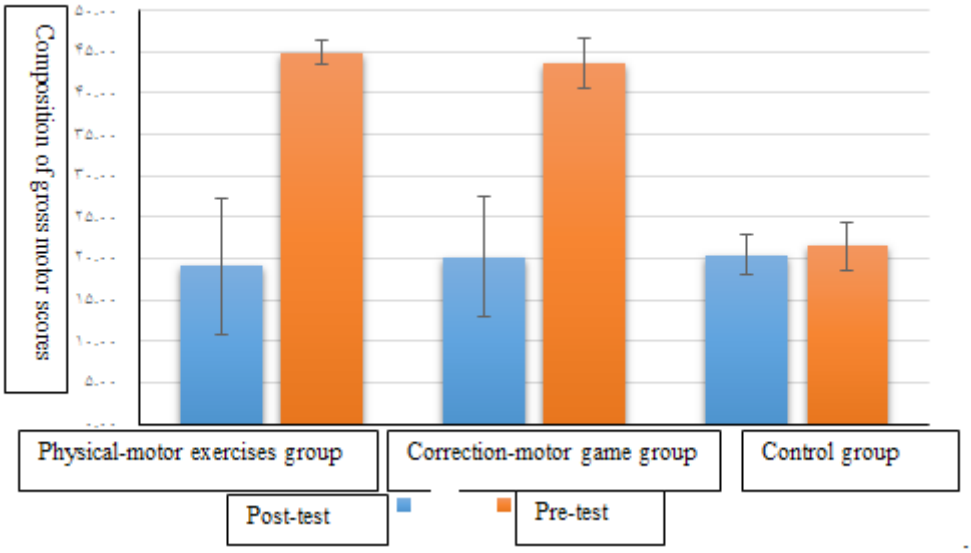

Figure 2. Variable of gross motor skills in three groups

Results

Table 1 displays the participants' characteristics. No discernible differences (P>0.05) were observed in the group characteristics.

Figure 2 shows the differences in gross motor abilities across the groups in the pre and post-test. The study's results demonstrated no difference in the groups' pre-test scores. However, a significant difference was observed between the groups in the post-test, indicating that both the corrective game and physical movement exercises impacted gross motor abilities; moreover, the physical movement exercises had a greater impact than the game (Figure 2).

Figure 3 shows how individuals with ASD's fine motor abilities have been shown to benefit from both movement correction games and physical movement exercises. However, the impact of the corrective movement game extends beyond simple physical training (Figure 3).

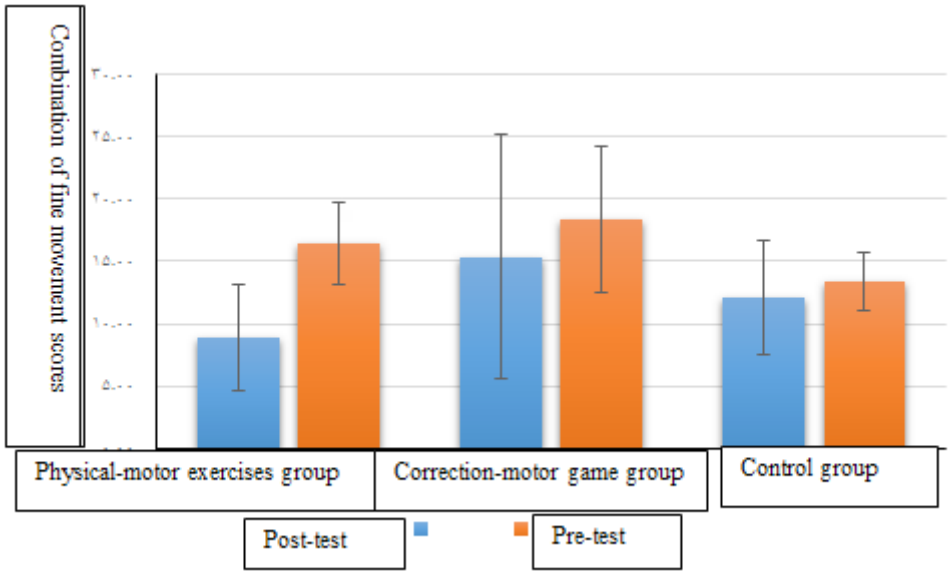

Figure 3. The variable of fine motor skills in three groups

Table 1. Baseline measurements (n=12)

Characteristic	Mean±SD		
	Physical Exercise Packages	Selected Corrective Games	Control Group
Age (y)	9.08±1.67	8.41±0.79	9.5±1.5
Height (m)	1.48±0.06	1.41±0.09	1.46±0.06
Weight (kg)	48.33±4.65	43.5±9.41	48.33±4.67
BMI (kg/m^2)	21.94±1.44	21.64±2.79	22.37±0.69

BMI: Body mass index.

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The results of covariance analysis and the data gathered for this study indicated a significant difference between the physical exercise group's pre-test (28.47±11.24) and post-test (60.7±5.24) average scores for gross and fine motor skills (F=13.709; P=0.01). Analysis of the BOT-MP subscales in gross motor skills showed a significant difference between the pre-test and post-test scores in balance (F=39.316; P=0.01), strength (F=6.675; P=0.04), integration and coordination of the upper limb (F=2.925; P=0.003), agility and running speed (F=80.46; P=0.01). Furthermore, no statistically significant difference was observed between the mean variables of fine motor abilities (F=2.903; P=0.06) and bilateral coordination (F=2.201; P=0.028). The covariance analysis test was used to compare the several subtests' results (Table 2).

Discussion

After completing movement correction game exercises and physical movement exercises, participants in the current research with ASD showed no discernible change in their movement proficiency. This study compared the effects of eight weeks of motor skills training. It was noted that both groups' gross and fine motor abilities improved. However, after the training program in both groups, an improvement in the coordination of the upper limbs in the receiving and throwing parts was observed. However, the coordination of the upper limbs in the throwing part was not significant between the two training groups. However, the coordination of the upper limbs in the receiving part was significant between the two training groups, and physical movement exercises were more effective than the corrective game.

The results indicate that exercises in movement correction games and physical movement exercises improve gross motor skills. However, the difference between physical movement exercises and movement correction games was not significant. The current study's results aligned with those of studies conducted by Dorenjik et al. [25] Castaño et al. [26] and Rougeri et al. [11]. Increasing gross motor abilities enhances the ability to move quickly and maintain static and dynamic body equilibrium. In contrast, gross motor skills depend on bilateral coordination and other components, such as movement plan, speed of response, stability of posture and body balance, body awareness and understanding of spatial relations, coordination of both sides of the body, lateral superiority, and half-body intersection. Therefore, movement correction games affect the variables of speed, static balance, and coordination of both sides of the body, and physical movement exercises affect the variables of dynamic balance and coordination of both upper and lower limbs, stability of balance, and coordination of both sides of the body, which, in turn, improves gross skills.

The evaluation of fine motor skills showed improvement after physical exercise, but the corrective motor game did not improve fine motor skills. Fine motor skills include directional, separate, and skillful movements requiring small and fine muscle groups. This skill is mostly used for communicative and expressive purposes [27, 28]. Based on this, it can be concluded that physical movement exercises effectively improve individual and directional movements, strengthen small muscle groups, and improve fine motor skills. The study showed that the corrective motor game did not improve fine motor skills. One of the reasons for these results is that appropriate physical movement exercises are specific to autistic children and are formulated with special considerations for these people. However, the movement correction game is not a special program designed for people with ASD, and special considerations for these individuals have not been observed. Therefore, this could be the reason for these results. These results were consistent with those of Teixeira et al. [29], who indicated that exercise training may directly contribute to participation in physical ac-

Table 2. Gait parameters change in the groups (n=36)

Conditions	Groups	Mean±SD		Effect Size (95% CI)	
		Timepoint Values			
		Pre-test	Post-test	F	P[&]
Gross motor skills (m/s)	PES	19.08±8.14*	44.92±3.52	32.312	0.001
	SCG	20.25±7.28*	43.58±3.05	269.293	0.001
	CON	20.49±2.51	21.5±2.84	59.908	0.001
Running speed and agility (m/s)	PEP	4.33±3.52*	15±0.0	80.464	0.001
	SCG	2.67±2.1*	43.58±15	319.38	0.001
	CON	3.29±0.68	3.5±1.78	76.805	0.148
Balance (steps/min)	PEP	1.75±0.45*	4.5±0.0	39.316	0.001
	SCG	1.62±0.56*	4.5±0.0	250.31	0.001
	CON	0.02±0.72	1.87±0.67	73.385	0.001
Bilateral coordination (cm)	PEP	1.66±0.57*	2.83±0.24	3.105	0.002
	SCG	1.62±1.08*	2.62±0.6	3.201	0.028
	CON	1.37±0.56	1.16±0.68	0.675	0.500
Strength (cm)	PEP	8.25±4.92*	17±0.0	6.675	0.04
	SCG	11.25±3.1*	17±0.0	72.618	0.01
	CON	10.42±2.57	11.5±2.57	13.39	0.01
Upper limb coordination	PEP	0.91±0.51*	2.29±0.45	2.925	0.003
	SCG	1.08±0.35*	2.08±0.63	2.961	0.003
	CON	1.12±0.48	1.29±0.45	0.758	0.449
Response speed	PEP	5.12±3.45*	4.48±1.27	3.076	0.002
	SCG	9.98±6.73*	10.52±5.28	3.724	0.006
	CON	8.25±3.89	10.13±2.13	1.787	0.075
Control of motor vision	PEP	0.66±0.60*	2.11±0.55	3.068	0.002
	SCG	1.16±0.74*	1.55±0.41	1.916	0.055
	CON	0.83±0.43	0.83±0.59	0.458	0.647
Fine motor skills (steps/min)	PEP	8.9±4.23*	16.45±3.35	2.903	0.069
	SCG	15.39±9.81*	18.42±5.86	20.573	0.001
	CON	12.11±4.59	13.39±2.33	4.586	0.017

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Abbreviations: ANOVA: Analysis of variance; CI: Confidence interval; SCG: Selected corrective games; PEP: Packets for physical exercise; CON: Mastery.
*Significant variations from CON (P<0.05), [&]P ANCOVA.
Note: Significant variations from the pre-state (P<0.05). Significant differences (P<0.05) were observed between PEP and SCG. Where T is time, G is group.

tivity. However, the difficulty of playing with a group and the lack of interest in the equipment in the exercises, which are characteristics of people with autism, may reduce their interest in sports and performing exercises [30] and may not improve fine motor skills.

The results demonstrated that physical motor workouts and motor corrective games increased gross and fine motor abilities. Playing motor corrective games and doing actual motor workouts are quite similar. These outcomes were consistent with the research results of Henderson et al. and Hilton et al. regarding how an exercise program affected the participants' ability to move [31, 32]. Gross and fine motor skills include speed, body balance, spatial awareness, coordination of both sides of the body, lateral superiority, directional, separate, and precise movements requiring a specific muscle group [28]. Movement improvement games and physical movement exercises have strengthened the balance of spatial perception and the sameness of both sides of the body, which has generally improved the sum of these two variables.

This research found no discernible difference in the effects of physical precisemotor corrective games on upper limb coordination during throwing and receiving. Henderson et al. [31] examined the effects of sports activities on autistic children's motor skill performance. They investigated 37 youngsters with ASD aged 5-12. The results revealed that sports training improves receiving and throwing abilities [32]. Ghaziuddin et al. investigated motor clumsiness (clumsiness) in children with autism spectrum, Asperger's syndrome, and pervasive developmental disability. This research found that, although coordination deficiencies were present in all three groups (pervasive developmental disorder, ASD, and Asperger's), children with Asperger's were less impaired than children with autism disorder and pervasive developmental disorder. However, no significant association was observed between coordination and recognition scores after controlling for IQ levels. These results suggest that certain Asperger's patients have weaker gross motor abilities than those with autism, possibly due to their greater intellectual level. According to the current research results, coordination exercises for children on the autistic spectrum may provide acceptable outcomes. According to the current research results, and considering that the population of individuals with autism disorder is growing, the number of persons diagnosed with this illness has doubled between 2005 and 2020, according to World Health Organization (WHO) statistics [33]. For these individuals, it is crucial to pay attention to all forms of physical activity. Thus, the researcher recommends the best workouts for improving the motor abilities of individuals with autism spectrum condition based on the current study findings.

Conclusion

In the present study, the researcher compared these two training programs and concluded that physical movement exercises and movement correction games significantly affected the measured variables, except for bidirectional and upper-limb coordination, which did not significantly affect the movement correction game. However, a significant effect was observed in the upper-limb coordination physical movement exercises.

Ethical Considerations

Compliance with ethical guidelines

The research protocol was approved by the Ethics Committee of the Sport Sciences Research Institute (SSRI), Tehran, Iran (Code: IR.SSRC.REC. 1402.216).

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Authors' contributions

All authors contributed equally to the conception and design of the study, data collection and analysis, interpretation of the results, and drafting of the manuscript. Each author approved the final version of the manuscript for submission.

Conflict of interest

The authors declared no conflict of interest.

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