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Research Paper

The Effect of a Physical Exercise Package on Motor Proficiency of Children and Adolescents with Autism Spectrum Disorder

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Abstract

The purpose of this study was to evaluate the feasibility and potential effect of a physical exercise package on the motor proficiency of children and adolescents with autism spectrum disorder. A total of 28 male students out of 32 at a special school for children with autism spectrum disorder, between October 2020 and March 2021, were recruited for the study. participants were in the age of 13 ± 4.02 (range of 7-20) years. Participants were randomly divided and assigned into two groups of 14 for control and intervention groups. The 14 students in the intervention group participated in the exercise sessions, 2 sessions per week for 12 weeks. Pre- and post-tests were performed on both groups. Motor proficiency was measured using the Bruininks Oseretsky Test of Motor Proficiency (BOT-2). The results of the study showed that the designed exercise package was adhered to all the participants attending 91.67% of sessions, and participants significantly improved their total motor proficiency score in terms of running speed and agility, balance, bilateral coordination, strength, fine motor precision, and upper-limb coordination ($P < 0.01$). Findings of this research showed that developing and implementing an individualized exercise package and observing the principles set out in the program have the potential to give significant positive impacts on the motor proficiency of children and adolescents witha spectrum disorder.

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Introduction

Autism Spectrum Disorder (ASD) is a category of neurodevelopmental disorder that results in major impairment in communication or social interaction and it can cause restricted or repetitive behavior patterns (Hyman, Levy, & Myers, 2020). People with ASD generally have difficulty in communicating with others, engaging in social interactions and they might show resistance to change. A systematic review by Bremer et al on people with ASD, reported that maladaptive behavior is common among these individuals that could lead to anxiety, stress, and other mental disorders. According to this systematic review, exercise interventions consisting individually of jogging, horseback riding, martial arts, swimming or yoga/dance can result in improvements to numerous behavioral outcomes including stereotypic behaviors, social-emotional functioning, cognition and attention (Bremer, Crozier, & Lloyd, 2016). Recent studies have shown that the prevalence of ASD is on the rise as 1 out of 59 children (ranging from 13.1 to 29.3 per 1,000 children aged 8 years in different communities) has this disorder (Baio et al., 2018).

Common therapeutic interventions for people with ASD include speech and language therapy, occupational therapy, physiotherapy, and behavioral interventions. These interventions have been the subject of numerous studies, which have been proven their effectiveness, especially if they are done early and with appropriate intensity, in improving the behaviors of ASD patients (Bremer et al., 2016). At present, there is still no definitive treatment for ASD. However, there are a number of treatments and interventions that can help children with ASD to improve their social and communicative skills, and at the same time, help them to improve their physical health and motor functions (Medavarapu, Marella, Sangem, & Kairam, 2019).

Physical activity is one of the most important treatments that could be provided for people with developmental disabilities, as research has shown that they have up to 40% lower level of physical activity than their peers (MacDonald, Esposito, & Ulrich, 2011; Sandt & Frey, 2005; Sorensen & Zarrett, 2014). Children and adolescents with ASD tend to have difficulty participating in physical activities as they often have poor levels of physical fitness and coordination and they also face more barriers to engaging in physical activities because of these limitations (Hyun-Kyoung Oh, 2018). Participation in physical activities allows children with ASD to experience having fun with their peers, which is important for the development of their interpersonal skills (Memari et al., 2015). Furthermore, physical activities can improve their mental health and self-esteem, leading to improved behavior and greater happiness (Biddle,

Ciaccioni, Thomas, & Vergeer, 2019). Physical activity also has a direct impact on the autonomy, cognitive abilities, and adaptability of these children (Zhao & Chen, 2018). Considering the unique behavioral patterns of children with ASD that will cause their health and movement difficulties, these children could benefit from an individualized exercise program that is designed and developed based on their needs (Sorensen & Zarrett, 2014).

In addition to repetitive behaviors and impairment in social and communication skills, children with ASD tend to experience delayed motor development, which usually manifests before the age of 36 months. The occurrence of motor skills deficits in children with ASD has been shown in numerous studies (Berkeley, Zittel, Pitney, & Nichols, 2001; Bittner, Myers, Silliman-French, & Nichols, 2018; Gargot et al., 2022; Lloyd, MacDonald, & Lord, 2013; Yilmaz, Yanardağ, Birkan, & Bumin, 2004). Because of delayed development of motor skills and poor motor control, people with ASD are simply unable to carry out some motor activities; an impairment that results in inactivity and reduced opportunities to participate in social interactions (Lang et al., 2010; Liu & Breslin, 2013; Morin & Reid, 1985). The motor profiles of children with ASD were analogous to those of children with DD (Provost, Heimerl, & Lopez, 2007). Also, fine motor and gross motor skills significantly predicted calibrated autism severity. According to results of research, children with weaker motor skills have greater social-communicative skill deficits (MacDonald, Lord, & Ulrich, 2014).

Several review studies on the effects of physical activity and exercise on people with ASD, all of which have reported that physical activity has a positive impact on the physical and mental wellbeing of these individuals (Adamson, Block, Petrus, Shahnefried, & Harris, 2006; Bremer et al., 2016; Lang et al., 2010; Sorensen & Zarrett, 2014; Sowa & Meulenbroek, 2012). Numerous studies have shown that physical activity has positive effects on metabolic health, autistic traits, and quality of life (Toscano, Carvalho, & Ferreira, 2018), health and fitness (Astorino et al., 2012; Yilmaz et al., 2004), exercise capacity and weight reduction (Pitetti, Rendoff, Grover, & Beets, 2007), muscular endurance (Todd & Reid, 2006), physical health and psychological well-being (Lochbaum & Crews, 2003).

In light of mounting scientific evidence that indicates the positive effect of physical activity and exercise on the physical, mental, and motor functions of people with ASD. In recent years, researchers have shown a growing interest in the use of exercise-based interventions to boost the wellbeing of these individuals and such methods have become increasingly popular. For many people with ASD, exercise and training interventions can produce more cost-effective results than traditional behavioral therapies, although they still require constant support and supervision as well as guidance by specialists. Further,

such exercises can be easily performed at home or outdoors without minimal equipment. However, the field can still benefit from more information about exercise programs developed based on theoretical knowledge to help people with ASD. Although there have been many studies on the effect of exercise on people with ASD, more studies are still needed to ascertain the effects of different exercise methods on different aspects of the physical, psychological, and behavioral traits of people with ASD. Moreover, more information is needed about the exercise programs that can be implemented in schools and sports clubs for people with ASD. For example, more transparency and clarity is needed about how such programs are designed and the parameters considered in exercises. The presence of specific guidelines regarding the type, volume, intensity, duration, and frequency of exercises can increase their benefits for people with ASD (Astorino et al., 2012; Zhao & Chen, 2018).

In this study, after an in-depth review of past studies on the subject, the researchers used the principles of exercise science to develop a physical exercise package specifically for people with ASD and then examine the effect of this program on psychomotor skills in a group of these people. Note that this study was carried out with the presumption that improving the psychomotor skills of people with ASD will increase their physical activity and consequently their social interactions and engagement, which will have a positive impact on the level of autism traits. Therefore, the effectiveness of the exercise package on motor proficiency was measured as a proxy for its effectiveness in reducing the symptoms of ASD and improving the health of these individuals.

Methodology

This study was conducted in two phases: 1- developing the exercise package; 2- measuring the effectiveness of the package and making the necessary modifications. This study was fully funded by the Sport Sciences Research Institute of Iran (SSRI). The research proposal was submitted in advance to the National Committee for Ethics in Biomedical Research at the Ministry of Health and Medical Education of Iran and SSRI, and received permission with the code IR.SSRC.REC.1398.028.

a) Population: Since age is one of the strongest predictors of physical activity in people with ASD, the need for intervention programs increases with age. In this study, the sample was made of people of school age (children and adolescents). This age group was chosen to make sure that the findings are more suited for use in schools. A 2016 review study by Bremer et al. has also recommended that future research projects should focus more on children (0-5 years) and adolescents (12-16 years) to reach a better understanding of the behavioral benefits of exercise programs in this population (Bremer et al., 2016).

b) Design: Randomized controlled trial

c) Sampling method: Based on sample size calculation using GPower, a total number of 14 participants were recruited to give 1-beta =0.7, alpha=0.05 and effect size |ρ|=0.50 and allocated into either the intervention or the control group.

After receiving the approval and funding from SSRI and coordinating with the Special Education Organization of Iran, the researchers visited a school for people with ASD and randomly selected 28 students and divided them into two groups of 14 people to serve as intervention and control groups (After taking the pre-test, the study researchers that was blinded to the assessments, sorted the subjects and then, one of the two was randomly assigned to each group.

The inclusion criteria were school-age children and adolescents with ASD with the capability to understand the rules and follow the study instructions. And participants with any type of physical illness or health condition that were prohibited to exercise or physical activity were excluded from the study.

Table 1- Demographic characteristics of the control and intervention groups

variable	Control group		Intervention group	
	Pre_test	Post test	Pre_test	Post test
number	14	14	14	14
Age	12.71	12.11	13.28	13.61
height	157.03	157.054	161.32	161.26
weight	55.78	56.29	64.00	63.429
BMI	22.62	22.82	24.59	24.39

The intervention group participated in the exercise sessions specified in the package, 2 sessions per week for 12 weeks. Pre- and post-tests were performed on both groups. The control group followed their routine educational programs at school.

d) Development of the physical exercise package for people with ASD

To develop the exercise package, first, an extensive study was conducted on the exercise methods previously proposed for people with ASD to gain a reasonably deep understanding of the existing methods and their effectiveness before creating the exercise package based on the existing theoretical foundations, guidelines, and instructions (by search in Medline, embase, psycinfo, web of knowledge, scopus, Sport Discus). It should be noted that the general principles contained in the ACSM's[1] Guidelines for Exercise Testing and Prescription

1. American College of Sports Medicine

(2014) in relation to prescribing exercise programs for people with intellectual disabilities were used as a general framework for developing the package (naturally, certain adjustments were made with attention to the traits of target patients)(Ferguson, 2014). After reviewing the research conducted in this field, the researchers developed the principles of exercise for people with ASD accordingly and then identified the best exercise methods and planned the details of the exercise program (frequency, intensity, type, time-volume, progressive) according to previous studies.

A: Principles of exercise for people with ASD: After reviewing the past studies carried out in this field, the 12 following items were identified as the basic principles for prescribing exercise for people with ASD:

1. The first step of sports rehabilitation programs for people with ASD is to increase physical activity (Arzoglou et al., 2013; Hyun-Kyoung Oh, 2018; MacDonald et al., 2011; Sorensen & Zarrett, 2014).
2. When designing individual exercises, due attention should be paid to personal traits (individualization) (Astorino et al., 2012).
3. The training period should start with individual exercises and then continue with two-person exercises before proceeding to group exercises (Reid, O Connor, & Lloyd, 2003; Sowa & Meulenbroek, 2012; Wolfberg & Schuler, 1993).
4. It is recommended using appropriate music to make participants relax, motivate them, and control the intensity of exercises (Woodman et al., 2018).
5. When planning exercise for people with ASD, due attention should be paid to environmental challenges, communication challenges, and the possibility of challenging behaviors (Groft-Jones & Block, 2006).
6. Early intervention is the key to the success of programs for people with ASD (Bremer et al., 2016; MacDonald et al., 2011; Rosso, 2016; Sorensen & Zarrett, 2014).
7. It is imperative to explain the benefits of physical activity and exercise to people with ASD and their families in order to increase motivation to participate in exercise programs (Davis et al., 2017; Must, Phillips, Curtin, & Bandini, 2015; Van Bourgondien & Schopler, 1996).
8. It is imperative to pay attention to the principles and recommended methods of education for people with ASD (Einfeld et al., 2018; Hyun-Kyoung Oh, 2018).
9. Educating the families of children with ASD is the key to increasing their interactions and improving family participation in the implementation of the exercise program (Davis et al., 2017; Kanupka et al., 2016).

10. It is recommended introducing competition to sports programs for people with ASD andproviding success in competition for them (Reid et al., 2003).
11. Training the instructors is a key point in the success of exercise programs (Rosso, 2016).
12. In sports rehabilitation programs, due attention should be paid to the development of different dimensions of physical fitness and motor proficiency (Bittner et al., 2018; Hyun-Kyoung Oh, 2018; Lang et al., 2010; Liu & Breslin, 2013).

B: Appropriate exercise for people with ASD (Type: what is the mode of exercise): In the next step, after reviewing the studies that have reported the effectiveness of exercise interventions for people with ASD, eight groups of exercise (listed in Table 2) were selected as the core components of a complete exercise program for these people. These exercises are including Communicative and social interaction skills (Koegel & Koegel, 2006; White et al., 2010; Zhao & Chen, 2018), Neuromuscular training (Arzoglou et al., 2013; Astorino et al., 2012; Bremer et al., 2016; Toscano et al., 2018; White et al., 2010), Physical fitness and motor skills (M. Bittner, Goudy, L., Rocco Dillon, S., Mcnamara, S., Adams, D. , 2018; Bittner et al., 2018; Clare, Wong, Lo, So, & Chan, 2018; Hyun-Kyoung Oh, 2018; Sowa & Meulenbroek, 2012; Toscano et al., 2018; Watters & Watters, 1980; Zhao & Chen, 2018), Physical activity and body composition (Allen, 1980; Bachman & Fuqua, 1983; M. Bittner, Goudy, L., Rocco Dillon, S., Mcnamara, S., Adams, D. , 2018; Bittner et al., 2018; Bremer et al., 2016; Kern, Koegel, Dyer, Blew, & Fenton, 1982; Levinson & Reid, 1993; MacDonald et al., 2011; Sowa & Meulenbroek, 2012), Attention to feelings and different senses (Davis et al., 2017; Kuusikko et al., 2009; Sorensen & Zarrett, 2014), Perceptual-motor skills (Toscano et al., 2018), Exercise with animals (Bittner, Goudy, L., Rocco Dillon, S., Mcnamara, S., Adams, D. , 2018; Bittner et al., 2018; Bremer et al., 2016; Sowa & Meulenbroek, 2012) and other exercise methods (Behar, 2006; Bittner, Goudy, Rocco Dillon, Mcnamara, Adams, 2018; Kanupka et al., 2016; Movahedi, Bahrami, Marandi, & Abedi, 2013; Sorensen & Zarrett, 2014; Sowa & Meulenbroek, 2012; Toscano et al., 2018; Zhao & Chen, 2018).

Table 2- Exercises included in the proposed training package for people with ASD

Communicative and social interaction skills	Neuromuscular training	Physical fitness and motor skills	Physical activity and body composition
Conveying messages, using sign language and shapes, understanding and reacting to the feelings of others, developing communication skills through the use of different sports techniques and tactics, understanding and copying the behavioral patterns of peers, developing two-person exercises and group games after 10 sessions of individual exercise, interacting with others	Muscular training, developing motor functions, improving sports specific skills, recreational activity, using dance and music along with physical activity, balance exercises, using games to improve reaction and response time	Balance and coordination, endurance, cardiovascular endurance, flexibility, developing physical fitness, functional fitness exercises, and developing fundamental movement skills (FMS) in three areas of locomotor skills, manipulation, and stability	Walking, jogging, running, cycling, swimming, skating, high heart rate exercises during the program, interval exercises
Attention to feelings and different senses	**Perceptual-motor skills**	**Exercise with animals**	**Other exercise methods**
Paying attention to all senses and making them all involved in the program, multi-sensory games, Paying attention to the feelings of others, imitating emotions, encouraging the expression of feeling and venting of emotions, teaching different ways of expressing emotions such as using shapes	Participating in activities and games that require strategy, technique, and knowledge of body functions, hand-eye coordination, body-eye coordination, auditory language skills and visual-auditory skills	Horse riding, dolphin therapy, using trained animals, using animal toys and replicas	Aquatic exercise, yoga, exergames, martial arts, snowshoeing and skating, recommending any moderate-intensity physical activity at the gym

C: The FITT-VP Principle for training of people with ASD: ***Frequency*** (how often is exercise done each week), ***Time*** (how long is the exercise duration) and ***Volume*** (what is the total amount of exercise): The review of past studies on the subject (Astorino et al., 2012; Duronjić & Válková, 2010; Toscano et al., 2018) showed that participating in 30-60 minute sessions of physical activity 2-3 days a week for at least 8 to 12 weeks can significantly improve physical and psychosocial characteristics of people with ASD. Therefore, decisions about the duration and frequency of sessions and duration of the program were made accordingly.

Intensity of exercise (how hard is the exercise): There are various reports about the effectiveness of the intensity of different exercises (e.g. walking, warming up, and moderate and intense jogging) on the behaviors of people with ASD,

which indicate that such exercises can positively affect some of the behaviors of these individuals. Some of these effects have been detected even during low-intensity exercises such as warming up (Bachman & Fuqua, 1983). Recent studies suggest that positive health effects can be gained by exercising for a minimum of 10 minutes a day, which is promising because a 10-minute workout is a realistic goal for students with ASD (Bittner et al., 2018). However, some researchers have also made more detailed recommendations in this regard with more focus on moderate to intense exercises (Levinson & Reid, 1993). Also, a review study in this field has reported physical activity and especially moderate to vigorous physical activity (MVPA) has significant therapeutic effects on these individuals, leading to substantial physiological, cognitive, psychological, and behavioral improvements (Sorensen & Zarrett, 2014). Therefore, the exercise package was planned with an emphasis on physical activity, even at light intensities, and on performing moderate to vigorous aerobic exercises. It should be noted that there are many exercises in this package that are not focused on the intensity of the exercise but rather the accuracy of movements, the interactions, and the use of different senses.

Progression (how is the program advanced) in exercise programs: Research has shown that teachers need to use a variety of strategies for communicating with students with ASD and helping them make transition into new activities in such a way as to avoid challenging behaviors. The methods that teachers often use to alert students to new stimuli include limiting distractions and helping students touch new objects (Hyun-Kyoung Oh, 2018). In the proposed program, teachers are instructed to introduce a new challenge each day and to raise the level of challenges as the student progresses. This instruction is given with the intention of improving the adaptability of the students and expanding their physiological, psychological, and social capacities.

Measurement tools

The development of motor proficiency was measured using the Bruininks Oseretsky Test of Motor Proficiency (BOTMP). The Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978) is a standardized, norm-referenced measure used by physical therapists and occupational therapists in clinic and school practice settings. This test recently was revised and published as the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2; Bruininks & Bruininks, 2005). The BOT-2 is an individually administered measure of fine and gross motor skills of children and youth, 4 through 21 years of age. It is intended for use by practitioners and researchers as a discriminative and evaluative measure to characterize motor performance, specifically in the areas of fine manual control, manual coordination, body coordination, strength and agility (Brown, 2019). In a 2009 study by Wuang and Su, where they

examined the reliability and sensitivity of BOTMP for measuring motor development in children with intellectual disability, it was concluded that BOTMP is a standard tool for this purpose (Wuang & Su, 2009). This tool can be used for people with ASD aged 4 to 21. The test-retest reliability and internal consistency of the total scale were excellent, with an ICC of 0.99 (95% confidence interval) and alpha of 0.92. Responsiveness was acceptable for all BOT-2 measures (Wuang & Su, 2009).

Data Analysis Method: The collected data were coded and imported into SPSS (version 28), where they were analyzed using analysis of covariance (ANCOVA). The normality test was measured by Shapiro–Wilk test and the minimum significance level was considered P = 0.05.

Results

As shown in Table 1, the selected students were in the age range of 7-20 years and had a mean age of 13±4.085 (13.285 ± 4.425 in the intervention group and 12.714 ± 3.119 in the control group). Of these students, 16 were in childhood and 12 were in adolescence, but they were placed in intervention and control groups completely at random by a researcher blinded to the study measures.

Adherence to exercise intervention: All the participants completed the exercise sessions with no more than three sessions absent. On average, participants attended 91.67% of the sessions, and 100% completed the pre and post-assessments (figure 1).

Table 3- The effect of the exercise program on motor proficiency of children and adolescents with autism spectrum disorder

variables	test	Sum of squares	df	Mean square	f	sig	Partial Eta Squared	Observed power
Mean Total BOTMP Score	Pre test	2074.323	1	2074.323	280.587	0.000	0.918	1
	variable	191.508	1	191.508	25.905	0.000	0.509	0.998
Running Speed And Agility	Pre test	58.075	1	58.075	121.021	0.000	0.829	1
	variable	1.008	1	1.008	21	0.160	0.077	0.286
Balance	Pre test	140.599	1	140.599	179.854	0.000	0.878	1
	variable	3.227	1	3.227	4.129	0.053	0.142	0.498
Bilateral Coordination	Pre test	33.788	1	33.788	53.760	0.000	0.683	1
	variable	4.772	1	4.772	7.592	0.011	0.233	0.754
Strength	Pre test	114.426	1	114.426	75.845	0.000	0.752	1
	variable	10.611	1	10.611	7.033	0.014	0.220	0.722
Fine Motor Precision	Pre test	82.831	1	82.831	262.660	0.000	0.913	1
	variable	3.795	1	3.795	12.033	0.002	0.325	0.915
Upper-Limb Coordination	Pre test	59.991	1	59.991	108.163	0.000	0.812	1
	variable	3.134	1	3.134	5.651	0.025	0.184	0.627
Manual Dexterity	Pre test	85.625	1	85.625	305.011	0.000	0.924	1
	variable	0.457	1	0.457	1.629	0.214	0.061	0.233

In the control group, the mean total BOTMP score changed from 21.142 ± 3.799 in the pre-test stage to 22.429 ± 3.457 in the post-test stage. In the intervention group, this score increased from 20.357 ± 11.685 to 26.857 ± 12.721. According to this result, while the two groups initially had similar total motor proficiency scores, these scores improved in the subjects who went through the program. The results of the ANCOVA of these data (table 3) also showed a statistically significant difference between the post-test BOTMP scores of the two groups after controlling for the pre-test scores ($P < 0.05$). The eta square obtained in this analysis showed that undergoing the exercise program can explain 51% of the variability in the total motor proficiency score.

The results of ANCOVA for the subscales of BOTMP showed that after controlling for pre-test scores, there are statistically significant differences between the post-test scores of the two groups in terms of balance ($P = 0.043$), bilateral coordination ($P = 0.011$), strength ($P = 0.014$), fine motor -precision, ($P = 0.002$), fine motor integration ($P = 0.018$) and upper-limb coordination ($P = 0.025$) but not in terms of running speed and agility ($P = 0.160$), and manual dexterity ($P = 0.214$). These results showed that among the subscales of BOTMP, those most affected by the exercise program are fine motor precision

(with 32.5% impact), bilateral coordination (with 23.3% impact), fine motori (with 22.7% impact), strength (with 22% impact), upper limb coordination (with 18% impact) and balance (with 14% impact).

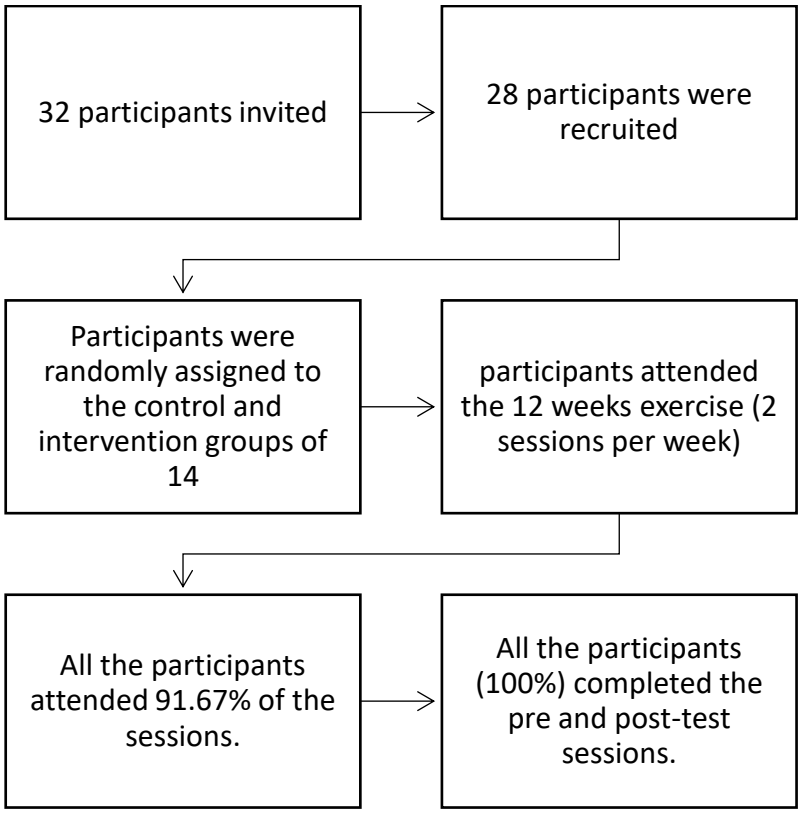

Figure 1- Study Recruitment Flow Diagram

Discussion

In this study, the researchers first reviewed the relevant literature to reach some guidelines for planning physical activity and exercise programs for people with ASD. Then, an exercise program was designed accordingly and tested in an educational facility for these individuals. The analysis of the results showed that the designed exercise package was unable to significantly change the running speed and agility, manual dexterity, attention switching, and imagination of the subjects. Based on these results, the researchers attempted to strengthen the program in areas where it did show a significant impact. The effects of the exercise program on the measured variables are discussed in the following paragraphs.

Children with ASD are prone to delayed and impaired motor skill development. Because of these limitations, these individuals often have fewer opportunities to participate in physical activities. Often, the responsibility to increase the physical activity of these children falls completely for parents. But, unfortunately, many parents are ill-informed about how much training, playing, and activity their child needs to grow properly, and this leads to further problems due to inactivity and motor skills development problems (Davis et al., 2017). According to a study by Han Kyung et al. (2018), because of their impaired motor coordination and poor fitness, people with ASD tend to face major challenges in engaging in commonplace physical activities. This study has reported that research has shown lower levels of physical fitness and physical activity in children with ASD than their peers (Hyun-Kyoung Oh, 2018). This problem usually emerges in both gross and fine motor skills, leading to delayed motor functions in a large portion of these individuals (Bittner et al., 2018; Liu & Breslin, 2013). Regarding the prevalence of these problems, a study by Lang et al. (2010) reported that movement disorders can be observed in 50% of children with autism and asperger syndrome (Lang et al., 2010). However, there are also reports indicating that up to 79% of people with ASD suffer from motor problems. Of course, these motor development problems start during infancy and tend to increase as the child grows (Lloyd et al., 2013). Therefore, it is critical to be sensitive about the emergence of motor development problems in children with ASD and take the necessary measures to boost the development of these skills by increasing their physical activity so as to facilitate their social encounters and their interactions with their peers.

In this study, the subjects in the intervention and control groups initially had relatively similar total motor proficiency scores (BOTMP), but after the exercise program, those in the intervention group showed significantly improved results in BOTMP and its subscales. After examining the motor skills development of the participants, it was found that they mostly fall in the category of poor motor skills development, which was reflected in their poor results in BOTMP. Of course, the type and extent of developmental problems of the subjects were different from person to person, as is the case with ASD. But on average, the subject clearly performed poorly in the aforementioned test. Most of the subjects performed very poorly in parts of the test where they had to properly understand the test instructions and follow those instructions. Also, they had difficulty with bilateral coordination skills, upper limb coordination, running speed and agility and manual dexterity. Unfortunately, some of the subjects were completely unable to perform the tests and received a score of zero accordingly. Even after three months of exercise in the intervention group, some of the subjects were still unable to get a score in some of the subscales.

Motor challenges in ASD are pervasive and highly underrecognized, with up to 87% of the autistic population affected. According to the results of some research, only a small percentage receive motor-focused clinical care. Findings of research suggest that motor difficulties in ASD are quantifiable and treatable and that detection and intervention efforts targeting motor function may also positively influence the social communication (Zampella, Wang, Haley, Hutchinson, & de Marchena, 2021). Given the evident impairment of people with ASD in the development of motor skills (Gargot et al., 2022), many researchers have tried to provide an intervention to boost the motor skills development of these individuals. The interventions that are most successful in this area are those that involve exercises and physical activity. For example, Duronjic and Valkova (2010) examined the effect of an 8-week physical activity program on the development of motor skills in people with ASD. This study reported an improvement in motor skills after eight weeks of exercise and concluded that participating in at least two sessions of physical activity every week can improve the motor and social skills of children with ASD and boost their future motor and social development (Duronjić & Válková, 2010).

Since improving motor skills was the main objective of the exercise program of the present study, the researchers included a series of exercises in the package that intended to strengthen these skills to the extent that improvements can be detected within the three-month period of the program. After implementing the developed program and analyzing the results of the test of motor skills, it was found that even after just three months of exercise, the subjects in the intervention group showed significantly improved results in several subscales of BOTMP including balance, bilateral coordination, strength, fine motor precision, fine motor integration and upper-limb coordination. These results confirming the effectiveness of the exercises package in boosting motor proficiency, demonstrate that following the exercise program for at least three months can make measurable changes in this area. It suggests that continuing the exercise program for a prolonged period alongside other education and rehabilitation programs can have even better effects on the motor development and motor skills of these individuals. It should be noted that given the ineffectiveness of the program in improving some of the target parameters, some parts of the program were modified to avoid the same issue in the final package.

Conclusion

Unfortunately, there is a common misconception that sports activities only benefit physical health as the easiest way to address behavioral and social problems is to use behavioral and psychological interventions. In reality, however, sports activities and exercises are exceptionally effective in alleviating

some of these problems and are indeed highly regarded and recommended by many behaviorists and psychologists. Considering that educational settings provide excellent opportunities for improving the physical activity and social skills of children with ASD, exercise intervention for these children can be implemented in schools, where all these children experience roughly similar conditions. According to Sandt and Frey (2005), PE classes, break times, and after-school hours are among the best time to get children engaged in moderate to vigorous physical activity (Sandt & Frey, 2005). Therefore, physical education teachers and instructors should take maximum advantage of these hours and make the most of this opportunity to rehabilitate these children, as many of these children may not have the opportunity to attend similar programs outside of their school. This is where physical education teachers can have a profound impact on the health of these children.

The existing research literature can be utilized to develop specific exercise programs in order to help teachers pursue the above-mentioned objective more effectively. In this study, the researchers tried to discover and compile the information and findings contained in the literature and transform them into a simple and easy-to-understand program for education settings, or in other words, transfer the scientific knowledge that currently exists on the subject from journals to schools and physical education teachers. Thus, by simply implementing the developed program, teachers of children with ASD can take advantage of the latest scientific findings in this field to achieve more success and effectiveness in helping these children. In conclusion, the results of this study suggest that exercise programs similar to the one implemented in this study can be indeed very effective in improving the motor proficiency of children with ASD and generally reducing the symptoms and complications of this disorder.

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