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The Effects of Physical Activities and Educational Games on the Motor Competence, Social Skills, and Psychological Adjustment of Children with Autism Spectrum Disorder.

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ABSTRACT

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that emerges in early childhood and is characterized by deficits in social interaction and communication, as well as restricted and repetitive patterns of behavior. The increasing prevalence of ASD has heightened the importance of effective interventions aimed at improving the quality of life of these individuals. This study was conducted to examine the effects of physical activities and educational games planned within the scope of movement education on the motor competence, social skills, and psychological adjustment of children with ASD. A true experimental design, one of the quantitative research methods, was used in the study. Within the scope of the pilot implementation, experimental and control groups consisting of primary school children diagnosed with ASD were included in the study; two participants who were unable to complete the process due to health problems were excluded from the evaluation. The experimental group participated in a physical activity and educational games program for 12 weeks, three days a week, for one hour each day. Before and after the intervention, the Performance Determination Form for Individuals with Pervasive Developmental Disorders and the BOT-2 Motor Proficiency Test were used. In addition, considering the pandemic conditions, the implementations were transferred to a digital environment through video recordings, allowing families to continue the training in the home environment. It is believed that this research will contribute to supporting the developmental domains of children with ASD, providing guidance for families and professionals, and promoting the wider dissemination of the intervention.

Keywords: Autism Spectrum Disorder, physical activity, educational games, motor competence, social skills

INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by persistent deficits in social communication and interaction, as well as restricted and repetitive patterns of behavior, interests, or activities (APA,2013; Lord, Elsabbagh, Baird & Veenstra-VanderWeele, 2018). According to the DSM-5 diagnostic criteria, individuals diagnosed with ASD experience significant difficulties in social communication processes such as maintaining reciprocal social interaction, sharing emotions and interests, interpreting gestures and facial expressions, and establishing peer relationships (APA, 2013; Bauminger-Zviely, 2014).

These developmental characteristics make it difficult for children with ASD to acquire many skills through natural social interactions and necessitate structured instructional environments and systematic intervention programs (Kırcaali, 2012).

Recent studies indicate that ASD has multidimensional effects not only in the domain of social communication but also in areas such as motor development, social functioning, and psychological adjustment (Fournier et al., 2010; Bhat, 2020). Motor development is considered one of the important domains for understanding the developmental profile of children with ASD, and research has revealed that various delays may be observed in areas such as gross and fine motor skills, balance, coordination, postural control, and motor planning in these children (Liu, Kaarengala & Litchke, 2019; Muthusamy, Padmanabhan, Ninan & Ganesan, 2021; Sakihara, Kita, Suzuki & Inagaki, 2023).In addition, deficiencies in social skills constitute one of the core diagnostic features of ASD and manifest themselves in significant difficulties in areas such as initiating and maintaining social interaction, establishing reciprocity, and developing peer relationships (Colombo-Dougovito & Reeve, 2017; Gitimoghaddam et al., 2022; Rosales et al., 2025). These limitations can directly affect individuals' peer relationships, academic adjustment, and psychological well-being (Colombo-Dougovito & Reeve, 2017; Gitimoghaddam et al., 2022).

Another important developmental domain in ASD is psychological adjustment, which includes individuals' emotional regulation skills, their capacity to cope with stress, and their ability to establish harmonious relationships with their environment (Compas et al., 2017; Gross, 2015; Masten, 2014). Studies show that children with ASD may experience difficulties in emotion regulation and exhibit higher levels of behavioral problems (Bhagat, Haque, Simbak & Husain, 2009; Soares, Pondé, Andrade & Siquara, 2025). The literature emphasizes that motor skills, social skills, and psychological adjustment are closely related developmental domains, and difficulties occurring in one of these areas may negatively affect the others (Dionisio et al., 2024; Da Silva et al., 2025). Therefore, it can be suggested that current research should include holistic approaches addressing the motor, social, and psychological developmental dimensions together when designing interventions for ASD. In this context, the physical activity and play-based intervention approach, which is one of the contemporary intervention approaches, stands out as one of the holistic intervention methods.

Physical activity and play-based interventions are among the important practices supporting the development of children with Autism Spectrum Disorder. Participation in regular physical activities not only contributes to the development of motor skills such as muscle strength, coordination, balance, and flexibility but may also help increase opportunities for social interaction and support emotional regulation skills (Sowa & Meulenbroek, 2012; Bremer, Crozier & Lloyd, 2016; Healy, Nacario, Braithwaite & Hopper, 2018). Indeed, meta-analysis studies conducted in the international literature show that physical activity programs can produce positive effects on the motor skills, social behaviors, and problem behaviors of individuals with ASD (Bremer, Crozier & Lloyd, 2016; Healy, Nacario, Braithwaite & Hopper, 2018). However, when the existing literature on physical activity interventions is examined, it is seen that a significant proportion of studies primarily focus on motor performance or physical fitness variables. In contrast, recent research indicates that motor development, social interaction, and psychological adjustment processes interact with one another reciprocally, and development in one of these domains may influence other developmental areas as well (Dionisio et al., 2024; Da Silva et al., 2025). This situation demonstrates that interventions for ASD should include holistic approaches that address multiple developmental domains together rather than focusing on only a single developmental domain.

When the structure of physical activity programs is examined, it is observed that most interventions consist of exercise-based applications. However, during childhood, play is accepted as one of the fundamental tools of learning and development. Play-based approaches increase children's motivation, encourage their active participation in the learning process, and enrich opportunities for social interaction (Pellegrini, 2009). Developmental research also shows that play-based activities provide important learning contexts that support children's cognitive, social, and emotional development (Ginsburg, 2007). For this reason, play-based physical activity programs are considered effective intervention tools that can support both the motor and social develment of children.

In light of all this information, when the literature is examined, it is seen that there are some research gaps related to physical activity-based interventions. It has been reported that physical activity-based interventions mostly focus on motor performance or physical fitness variables, while studies addressing multiple developmental domains such as motor development, social skills, and psychological adjustment together are limited (Bremer, Crozier & Lloyd, 2016; Healy et al., 2018). In addition, a significant portion of physical activity programs for children with ASD are exercise-based, and research examining the effects of play-based physical activity interventions is relatively limited (Sowa & Meulenbroek, 2012; Pan, 2010). Third, it is stated that studies addressing the reciprocal relationships among motor development, social skills, and psychological adjustment within a holistic conceptual model are not sufficiently represented in the literature (Bhat, 2020; Bremer & Cairney, 2018) In this context, the present study aims to examine the effects of a structured movement education program consisting of physical activities and educational games on the motor competence, social skills, and psychological adjustment of children with ASD within a holistic framework. The conceptual framework of the study is based on the assumption that a physical activity and educational games program can support motor development while increasing opportunities for social interaction, thereby promoting the

development of social skills, and may positively affect psychological adjustment by contributing to emotional regulation processes. In addition, it is assumed that the domains of motor competence, social skills, and psychological adjustment interact reciprocally with each other. In this context, the main aim of the study is to examine the effect of a movement education program consisting of physical activities and educational games on the motor competence, social skills, and psychological adjustment of children diagnosed with Autism Spectrum Disorder.

METHOD

Research Model

The research was designed using a true experimental research model, which is one of the quantitative research methods. Experimental studies in the social sciences are relatively limited (Dilek, Baysan & Öztürk, 2018). Büyüköztürk (2014) states that experimental research is conducted "to determine to what extent a particular intervention will be effective in solving a specific problem under controlled conditions by using a systematic method." In this study, the pretest–posttest control group true experimental design was used. In this context, the research was structured in five stages. These stages are as follows:

First Stage

The physical activity and educational game plans used in the experimental group in the study were prepared based on the curriculum prepared by the Ministry of National Education (MEB, 2020) for students with moderate and severe intellectual disabilities and ASD. In this stage, the teachers/instructors who would provide training to the experimental group regarding the implementation of these plans were also trained.

Second Stage

At this stage, a baseline assessment was conducted to determine the motor competence and social skill levels of students diagnosed with Autism Spectrum Disorder. Within this scope, BOT-2 and the Performance Determination Form for Individuals with Pervasive Developmental Disorders (PDF) were used to obtain pretest scores, and statistical analyses were performed to ensure the equivalence of the experimental and control groups based on these scores.

Third Stage

In light of the obtained data, the prepared physical activity and educational games program was implemented for 12 weeks, three days per week, and one hour per day.

Fourth Stage

After the implementation of the physical activity and educational game plans, the post-test scores of the students in both the experimental and control groups were obtained. In this context, all tests used in the pretest were repeated in the post-test.

Fifth Stage

The collected data were statistically analyzed and the final report was written.

Study Group

The study was conducted with eight male students aged between 6 and 10 who attended the İzle Special Education and Rehabilitation Center in Düzce province. In determining the study group, stratified random sampling and random sampling methods, which are among the probabilistic sampling methods, were used.

The stratified sampling method includes strata determined in accordance with the research purpose. When determining the strata, the inclusion and exclusion criteria of the group intended to form the study group are taken into consideration. In determining the children who would participate in the study during the planned research period, criteria such as age, level of disability, and special education background of the children receiving education at the specified center constituted the strata.

The inclusion and exclusion criteria used in determining the children who would form the experimental and control groups are presented in Table 1.

Table 1. Inclusion and Exclusion Criteria for Participation in the Study

Inclusion Criteria	Exclusion Criteria
Having a medically diagnosed ASD	Not having a medically diagnosed ASD
Receiving education in institutions affiliated with the Ministry of National Education	Receiving private care services
Being enrolled in primary school level education	Receiving private sports training
	Having any disability other than ASD

Data Collection Tools

In the project, the Bruininks–Oseretsky Test of Motor Proficiency (BOT-2) was used to obtain data from students with ASD, and the Performance Determination Form for Individuals with Pervasive Developmental Disorders was used to determine social skill performance. Detailed information about these tools is presented below.

Bruininks–Oseretsky Test of Motor Proficiency (BOT-2)

In the study, the Bruininks–Oseretsky Test of Motor Proficiency (BOT-2), first published in 1978, was used to provide an effective and reliable measurement of fine and

gross motor control skills (Bruininks & Bruininks, 2005). The second edition of the test, published in 2005, was developed to measure the motor functions of individuals aged 4 to 21 years.

This test is designed as a tool to provide therapists, physiotherapists, physical education teachers, researchers, and other practitioners with an effective and reliable measurement of fine and gross motor control skills. While the administration of the full test consisting of 53 items takes approximately 40–60 minutes for one child and the highest possible score is 320, the short form consisting of 14 items, which was used in this study, takes approximately 15–20 minutes, and the highest possible score that can be obtained is 88 (Bruininks & Bruininks, 2005).

Performance Determination Form for Individuals with Pervasive Developmental Disorders (PDF)

The Performance Determination Form for Individuals with Pervasive Developmental Disorders is a standardized assessment tool developed within the scope of the Pervasive Developmental Disorders Support Education Program created by the Ministry of National Education, Directorate General of Special Education and Rehabilitation Services, and is used as a performance assessment tool in rehabilitation centers across the country.

The Pervasive Developmental Disorders Support Education Program, in which the form is used as a standard measurement tool, was prepared to ensure that individuals with pervasive developmental disorders who attend special education and rehabilitation centers benefit effectively and efficiently from educational environments within the scope of special education services.

The preparation of this program is based on Article 25 of Law No. 5793 dated 24/07/2008, which amends certain laws and decree laws, and Additional Article 3 of Law No. 3797 on the Organization and Duties of the Ministry of National Education (Ministry of National Education, 2018).

The Performance Determination Form for Individuals with Pervasive Developmental Disorders is used to determine the performance of individuals with special educational needs in areas such as pre-cognitive skills, self-care skills, daily living skills, social life skills, language and alternative communication skills, psychomotor skills, social life, Turkish language, and mathematics, and to prepare educational plans based on these evaluations.

Implementation Process

In this project, a 12-week physical activity and educational games program designed within the scope of the Games, Sports, and Physical Activities Curriculum prepared for students with moderate and severe intellectual disabilities and ASD by the Ministry of National Education and implemented in 2020 was applied. Within this framework, the study group participated in physical activity and game practices for one hour per day, three days per week, totaling three hours per week for 12 weeks.

Immediately before the implementation of the structured program, in order to determine the existing status of the research group, the Performance Determination Form for Individuals with Pervasive Developmental Disorders was administered to the parents of each participant, the physical activity and games teacher, and the psychological counselor. In addition, BOT-2 pre-test measurements were conducted to determine the existing motor characteristics of the children with ASD. At the end of the 12-week program, post-tests were administered. In accordance with the objectives of the project, during the implementation phase, Physical Activity and Educational Game Plans developed for students diagnosed with Autism Spectrum Disorder were used within the above-mentioned scope and content. While creating the program contents, it was aimed to design them in a way that would meet the needs of the children.

Data Analysis

In the project, SPSS 25.0 statistical package program was used for statistical analyses. In the analysis section, normality distribution tests (Shapiro–Wilk Test, Kolmogorov–Smirnov Test, kurtosis and skewness values) were applied to determine whether the data conformed to normal distribution. Since the data obtained from the Performance Determination Form did not show normal distribution, non-parametric tests (Mann–Whitney U, Kruskal–Wallis, Wilcoxon) were used. However, since the BOT-2 motor skill data showed normal distribution, parametric tests (Independent Samples t-test, Paired Samples t-test, and ANOVA) were applied.

RESULTS

Table 2. Comparison of the Evaluators' Post-Test Scores on the Performance Determination Form for the Control Group

Dimensions	Groups	N	X	Ss	df	p
Imitation Skills	Special Education Teacher	4	11,25	13,83	3	,604
	Physical Education Teacher	4	7,63			
	School Counselor	4	7,13			
	Parent	4	8			
Instruction-Following Skills	Special Education Teacher	4	10,38	7,53	3	,790
	Physical Education Teacher	4	7,25			
	School Counselor	4	7,63			

	Parent	4	8,75			
Matching Skills	Special Education Teacher	4	10,75	9,10	3	,623
	Physical Education Teacher	4	7,75			
	School Counselor	4	6,50			
	Parent	4	9			
Visual Support Skills	Special Education Teacher	4	11,88	6,49	3	,074
	Physical Education Teacher	4	6			
	School Counselor	4	6			
	Parent	4	10,13			
Receptive Language Skills	Special Education Teacher	4	11,50	7,96	3	,509
	Physical Education Teacher	4	6,88			
	School Counselor	4	8,25			
	Parent	4	7,38			
Expressive Language Skills	Special Education Teacher	4	11,25	12,88	3	,584
	Physical Education Teacher	4	8			
	School Counselor	4	7,88			
	Parent	4	6,88			
Play and Music Skills	Special Education Teacher	4	11,75	15,55	3	,446
	Physical Education Teacher	4	6,75			
	School Counselor	4	7,38			
	Parent	4	8,13			
Self-Care Skills	Special Education Teacher	4	12	27,09	3	,375
	Physical Education Teacher	4	8,25			
	School Counselor	4	6,88			
	Parent	4	6,88			
Daily Living Skills	Special Education Teacher	4	10,38	4,28	3	,784
	Physical Education Teacher	4	7,25			
	School Counselor	4	8,75			
	Parent	4	7,63			
Motor Skills	Special Education Teacher	4	10,75	31,92	3	,647
	Physical Education Teacher	4	7,50			
	School Counselor	4	6,75			
	Parent	4	9			
Social Skills	Special Education Teacher	4	12	15,33	3	,372
	Physical Education Teacher	4	6,88			
	School Counselor	4	6,88			
	Parent	4	8,25			
Literacy Skills	Special Education Teacher	4	10,13	17,38	3	,845
	Physical Education Teacher	4	8,25			
	School Counselor	4	7,13			
	Parent	4	8,50			
Mathematical Skills	Special Education Teacher	4	9,25	32,32	3	,784
	Physical Education Teacher	4	7,25			
	School Counselor	4	7,38			
	Parent	4	10,13			

Table 3. Comparison of the Evaluators' Post-Test Scores on the Performance Determination Form for the Experimental Group

Dimensions	Groups	N	X	Ss	df	p
Imitation Skills	Special Education Teacher	4	9,25	10,97	3	,971
	Physical Education Teacher	4	8,50			
	School Counselor	4	7,63			
	Parent	4	8,63			
Instruction-Following Skills	Special Education Teacher	4	7,88	5,35	3	,811
	Physical Education Teacher	4	7,88			

	School Counselor	4	7,75			
	Parent	4	10,50			
Matching Skills	Special Education Teacher	4	10,50	4,17	3	,764
	Physical Education Teacher	4	7,63			
	School Counselor	4	7,25			
	Parent	4	8,63			
Visual Support Skills	Special Education Teacher	4	9	10,03	3	,243
	Physical Education Teacher	4	7			
	School Counselor	4	7			
	Parent	4	1			
Receptive Language Skills	Special Education Teacher	4	7,38	9,54	3	,420
	Physical Education Teacher	4	8,38			
	School Counselor	4	6,50			
	Parent	4	11,75			
Expressive Language Skills	Special Education Teacher	4	8,88	21,49	3	,922
	Physical Education Teacher	4	8,38			
	School Counselor	4	7,25			
	Parent	4	9,50			
Play and Music Skills	Special Education Teacher	4	6,75	16,11	3	,761
	Physical Education Teacher	4	8,50			
	School Counselor	4	8,38			
	Parent	4	10,38			
Self-Care Skills	Special Education Teacher	4	6,88	20,84	3	,214
	Physical Education Teacher	4	9,63			
	School Counselor	4	550			
	Parent	4	12			
Daily Living Skills	Special Education Teacher	4	10,38	12,91	3	,753
	Physical Education Teacher	4	6,75			
	School Counselor	4	8,75			
	Parent	4	8,13			
Motor Skills	Special Education Teacher	4	7,75	21,23	3	,677
	Physical Education Teacher	4	9,50			
	School Counselor	4	6,50			
	Parent	4	10,25			
Social Skills	Special Education Teacher	4	9,63	17,17	3	,441
	Physical Education Teacher	4	6,50			
	School Counselor	4	6,75			
	Parent	4	11,13			
Literacy Skills	Special Education Teacher	4	8,13	15,95	3	,656
	Physical Education Teacher	4	7,88			
	School Counselor	4	7			
	Parent	4	11			
Mathematical Skills	Special Education Teacher	4	7,50	30,60	3	,338
	Physical Education Teacher	4	7,38			
	School Counselor	4	6,88			
	Parent	4	12,25			

The post-test scores of the Performance Determination Form (PDF) for Children with Pervasive Developmental Disorders for the students in the experimental and control groups were compared according to different observers, and no statistically significant differences were found in any of the sub-dimensions ($p > 0.05$). The statistical analysis indicated that the PDF post-test scores were similar across different observers (Table 2-3).

Table 4. Comparison of the Control Group's Pre-Test and Post-Test Scores

Dimensions	Groups	N	$\bar{x}$	Ss	Z	P
Imitation Skills	Pre-Test	4	18,43	13,92	-1,467b	,142
	Post-Test		19,50	13,83		
Instruction-Following Skills	Pre-Test	4	10,56	7,54	-1,930b	,054
	Post-Test		11,43	7,53		
Matching Skills	Pre-Test	4	13,75	9,97	-1,059C	,289
	Post-Test		13,18	9,10		
Visual Support Skills	Pre-Test	4	1,62	3,99	-1,604b	,109
	Post-Test		2,68	6,49		
Receptive Language Skills	Pre-Test	4	10,87	8,77	-2,850C	,004*
	Post-Test		9,81	7,96		
Expressive Language Skills	Pre-Test	4	12,68	12,48	-1,841b	,066
	Post-Test		13,12	12,88		
Play and Music Skills	Pre-Test	4	19,68	15,61	-1,890	,059
	Post-Test		20	15,55		
Self-Care Skills	Pre-Test	4	43,68	27,30	-2,622b	,009*
	Post-Test		41,31	27,09		
Daily Living Skills	Pre-Test	4	4,81	4,53	-,271b	,786
	Post-Test		4,62	4,28		
Motor Skills	Pre-Test	4	41	28,80	-2,446b	,014*
	Post-Test		45	31,92		
Social Skills	Pre-Test	4	19,37	15,24	-1,735b	,083
	Post-Test		21,31	15,33		
Literacy Skills	Pre-Test	4	14,06	17,60	-,921b	,357
	Post-Test		14,56	17,38		
Mathematical Skills	Pre-Test	4	26,12	29,93	-1,433b	,152
	Post-Test		29,56	32,32		

When the comparison of the control group's pre-test and post-test scores in social skills was examined, it was found that there were statistically significant differences in receptive language, self-care skills, and motor skills ($p < .05$). However, no significant differences were detected in imitation skills, instruction-following skills, matching skills, use of visual supports, expressive language skills, play and music skills, daily living skills, social skills, literacy skills, and mathematical skills ($p > .05$)

Table 5. Comparison of the Experimental Group's Pre-Test and Post-Test Scores

Dimensions	Groups	N	$\bar{x}$	Ss	Z	P
Imitation Skills	Pre-Test	4	18,06	13,20	-3,415b	,001*
	Post-Test		26,43	10,97		
Instruction-Following Skills	Pre-Test	4	13,68	8,69	-3,186b	,001*
	Post-Test		20,50	5,35		
Matching Skills	Pre-Test	4	14,62	9,73	-3,078b	,002*
	Post-Test		22,62	4,17		
Visual Support Skills	Pre-Test	4	2,62	6,83	-1,604b	,106
	Post-Test		4,31	10,03		
Receptive Language Skills	Pre-Test	4	14,25	12,64	-3,113b	,002*
	Post-Test		19,93	9,54		
Expressive Language Skills	Pre-Test	4	10,37	15,37	-3,070b	,002*
	Post-Test		16,06	21,49		
Play and Music Skills	Pre-Test	4	15,68	17,05	-3,530b	,000*
	Post-Test		29,68	16,11		

Self-Care Skills	Pre-Test	4	67,18	40,28	-2,358b	,018*
	Post-Test		85,12	20,84		
Daily Living Skills	Pre-Test	4	13,21	13,89	-3,394b	,001*
	Post-Test		20,18	12,91		
Motor Skills	Pre-Test	4	66,21	42,37	-3,408b	,001*
	Post-Test		110,25	21,23		
Social Skills	Pre-Test	4	25,56	20,02	-3,466b	,001*
	Post-Test		38,75	17,17		
Literacy Skills	Pre-Test	4	12,87	15,95	-3,301b	,001*
	Post-Test		19,12	15,95		
Mathematical Skills	Pre-Test	4	19,68	28,88	-3,306b	,001*
	Post-Test		27,75	30,60		

When the pre-test and post-test scores of the experimental group were examined, statistically significant differences were found in imitation skills, instruction-following skills, matching skills, receptive language skills, expressive language skills, play and music skills, self-care skills, daily living skills, motor skills, social skills, literacy skills, and mathematical skills ($p < .05$). However, no significant difference was found in the participants' visual support skills ($p > .05$).

Table 6. Comparison of the Post-Test Scores of the Experimental and Control Groups

Dimensions	Groups	N	X	Ss	Z	P
Imitation Skills	Control Group	4	14,34	12,78	-1,302	,193
	Experimental Group	4	18,66			
Instruction-Following Skills	Control Group	4	11,25	7,90	-3,174	,002*
	Experimental Group	4	21,75			
Matching Skills	Control Group	4	11,44	8,45	-3,704	,003*
	Experimental Group	4	21,56			
Visual Support Skills	Control Group	4	17,16	8,35	-,520	,603
	Experimental Group	4	15,84			
Receptive Language Skills	Control Group	4	11,84	10,06	-2,814	,005*
	Experimental Group	4	21,16			
Expressive Language Skills	Control Group	4	16,81	17,49	-,190	,850
	Experimental Group	4	16,19			
Play and Music Skills	Control Group	4	13,38	16,34	-1,885	,059
	Experimental Group	4	19,63			
Self-Care Skills	Control Group	4	10,16	32,57	-3,828	,000*
	Experimental Group	4	22,84			
Daily Living Skills	Control Group	4	10,31	12,33	-3,744	,000*
	Experimental Group	4	22,69			
Motor Skills	Control Group	4	9,53	42,54	-4,203	,000*
	Experimental Group	4	23,47			
Social Skills	Control Group	4	13,13	18,30	-2,037	,042*
	Experimental Group	4	19,88			
Literacy Skills	Control Group	4	14,34	16,57	-1,304	,192
	Experimental Group	4	18,66			
Mathematical Skills	Control Group	4	16,03	30,97	-,283	,777
	Experimental Group	4	16,97			

As a result of comparing the post-test scores of the experimental and control groups, a statistically significant difference was found in favor of the experimental group in instruction-following, matching, receptive language, self-care, daily living, social, and motor skills ($p < .05$). However, no significant differences were found in imitation skills, use of visual supports, expressive language skills, play and music skills, literacy skills, and mathematical skills ($p > .05$).

BOT-2 Motor Proficiency Test Results

Table 7. Comparison of the Control Group's Pre-Test and Post-Test Scores

Skill Domain	Groups	N	X	Ss	t	df	P
Fine Motor Precision	Pre-Test	4	3,2500	2,06155	-1,732	3	,182
	Post-Test	4	3,7500	2,50000			
Fine Motor Integration	Pre-Test	4	3,2500	2,50000	3,000	3	,058
	Post-Test	4	2,5000	2,08167			
Manual Dexterity	Pre-Test	4	1,5000	1,00000	,000	3	1,000
	Post-Test	4	1,5000	,57735			
Bilateral Coordination	Pre-Test	4	1,0000	2,00000	-522	3	,638
	Post-Test	4	1,2500	1,25831			
Balance	Pre-Test	4	5,5000	1,00000	-522	3	638
	Post-Test	4	5,2500	,50000			
Speed and Agility	Pre-Test	4	,5000	1,00000	-1,000	3	,391
	Post-Test	4	,7500	,95743			
Upper-Limb Coordination	Pre-Test	4	2,7500	,95743	-3,000	3	,058
	Post-Test	4	3,5000	1,29099			
Strength	Pre-Test	4	6,0000	,00000	1,414	3	,252
	Post-Test	4	5,0000	1,41421			

According to the paired-samples test results of he control group, when the pre-test and post-test comparisons were examined, no statistically significant differences were found in fine motor precision, fine motor integration, manual dexterity, bilateral coordination, balance, speed and agility, upper-limb coordination, and strength parameters ($p > .05$).

Table 8. Comparison of the Experimental Group's Pre-Test and Post-Test Scores

Skill Domain	Groups	N	X	Ss	t	df	P
Fine Motor Precision	Pre-Test	4	2,2500	,95743	-12,247	3	,000*
	Post-Test	4	6,5000	1,00000			
Fine Motor Integration	Pre-Test	4	2,0000	1,41421	-4,382	3	,018*
	Post-Test	4	7,0000	,81650			
Manual Dexterity	Pre-Test	4	1,2500	,50000	-8,878	3	,003*
	Post-Test	4	3,5000	,57735			
Bilateral Coordination	Pre-Test	4	1,5000	1,73205	-5,745	3	,001*
	Post-Test	4	5,5000	,57735			
Balance	Pre-Test	4	2,5000	,57735	-13,056	3	,000*
	Post-Test	4	6,7500	,50000			
Speed and Agility	Pre-Test	4	1,7500	1,25831	-17,000	3	,018*
	Post-Test	4	4,5000	,57735			
Upper-Limb Coordination	Pre-Test	4	3,5000	1,29099	-4,700	3	,003*
	Post-Test	4	9,7500	1,89297			
Strength	Pre-Test	4	5,5000	,57735	-15,000	3	,001*
	Post-Test	4	9,2500	,95743			

According to the results of the paired-samples test, when the pre-test and post-test comparisons of the experimental group were examined, the differences were found to be statistically significant in fine motor precision, fine motor integration, manual dexterity, bilateral coordination, balance, speed and agility, upper-limb coordination, and strength parameters ($p < .05$).

Table 9. Comparison of the Post-Test Scores of the Experimental and Control Groups

Skill Domain	Groups	N	X	Ss	t	df	P
Fine Motor Precision	Control Group	4	3,7500	2,50000	-2,043	3,936	,087
	Experimental Group	4	6,5000	1,00000			
Fine Motor Integration	Control Group	4	2,5000	2,08167	-4,025	3,902	,007*
	Experimental Group	4	7,0000	,81650			
Manual Dexterity	Control Group	4	1,5000	,57735	-4,899	6,000	,003*
	Experimental Group	4	3,5000	,57735			
Bilateral Coordination	Control Group	4	1,0000	2,00000	-4,323	3,497	,005*
	Experimental Group	4	5,5000	,57735			
Balance	Control Group	4	5,5000	1,00000	-2,236	4,412	,067
	Experimental Group	4	6,7500	,50000			
Speed and Agility	Control Group	4	,7500	,95743	-6,708	4,927	,001*
	Experimental Group	4	4,5000	,57735			
Upper-Limb Coordination	Control Group	4	3,5000	1,29099	-5,455	5,294	,002*
	Experimental Group	4	9,7500	1,89297			
Strength	Control Group	4	5,0000	1,41421	-4,977	5,273	,003*
	Experimental Group	4	9,2500	,95743			

According to the results of the t-test conducted for the post-test comparisons of the experimental and control groups, no statistically significant differences were found in fine motor precision and balance parameters. However, statistically significant

differences were observed in favor of the experimental group in fine motor integration, manual dexterity, bilateral coordination, speed and agility, upper-limb coordination, and strength parameters ($p < .05$).

DISCUSSION AND CONCLUSION

This study aimed to examine the effects of a structured movement education program consisting of physical activities and educational games on the motor proficiency, social skills, and adaptive behaviors of children diagnosed with Autism Spectrum Disorder (ASD). The findings indicate that the 12-week intervention program resulted in significant improvements particularly in motor performance, daily living skills, and social functioning. These results are consistent with the existing literature demonstrating that physical activity-based interventions can support the multidimensional developmental processes of children with ASD.

Evaluation of Motor Proficiency Findings

The findings obtained in this study indicate that the physical activity and educational game-based movement education program had positive effects on the motor proficiency levels of children with ASD. One of the most significant findings of the study is that students in the experimental group showed notable improvements in the BOT-2 motor proficiency test results following the intervention program. When the pre-test and post-test scores of the experimental group were compared, significant improvements were observed in fine motor precision ($t = -12.247$, $p < .001$), fine motor integration ($t = -4.382$, $p = .018$), manual dexterity ($t = -8.878$, $p = .003$), bilateral coordination ($t = -5.745$, $p = .001$), balance ($t = -13.056$, $p < .001$), speed and agility ($t = -17.000$, $p = .018$), upper-limb coordination ($t = -4.700$, $p = .003$), and strength ($t = -15.000$, $p = .001$). In contrast, no significant changes were observed in any of these parameters in the control group ($p > .05$).

The significant increase in motor performance scores among children in the experimental group suggests that structured physical activity programs may be effective in improving motor skills. These findings are consistent with studies indicating that motor coordination difficulties are common among individuals with ASD and that motor skills

can be improved through appropriate interventions. In a meta-analysis conducted by Fournier et al. (2010), it was reported that motor coordination impairments in individuals with ASD appear across various motor domains with large effect sizes, and motor development is considered an important characteristic of ASD. This finding is consistent with studies indicating that children with ASD frequently experience difficulties in motor coordination and postural control (Fournier et al., 2010; Bhat, 2020). Furthermore, previous research has reported that motor coordination disorders are present in a large proportion of children with ASD and that these difficulties affect both fine and gross motor performance (Green, Baird, & Sugden, 2009). Similarly, studies evaluating motor performance comprehensively have shown that children with ASD demonstrate lower levels of balance, coordination, and overall motor performance compared to typically developing peers (Odeh, Gladfelter, Stoesser, & Roth, 2022). These findings are parallel to the results obtained in the present study.

The improvements observed in motor skills suggest that structured physical activity programs may support motor learning processes. According to motor learning theories, repetition of movements, feedback, and motivation play critical roles in improving motor performance (Schmidt & Lee, 2011). The educational games used in this study may have supported the motor learning process by allowing children to repeat movements and gain movement experience. These results indicate that motor skills in children with ASD can be improved through appropriate intervention programs. In particular, game-based physical activity programs may support motor learning by providing children with opportunities to practice motor skills repeatedly and gain diverse movement experiences. These processes may contribute to improvements in motor coordination. Furthermore, the findings indicate that the experimental group demonstrated notable improvements particularly in motor tasks requiring balance and coordination after the intervention program. This result is consistent with studies indicating that children with ASD often experience difficulties in balance and coordination. In a neuropsychomotor evaluation conducted by Paquet et al. (2016), children with ASD were reported to experience significant difficulties in static and dynamic balance, manual dexterity, and coordination.

The development of balance and coordination skills may increase children's participation in daily life activities and physical play. Therefore, physical activity programs that support motor development may play an important role in children's overall developmental processes. Balance control is closely related to sensorimotor integration processes. It is known that postural control is achieved through the integration of visual, vestibular, and proprioceptive information by the central nervous system. In this context, differences in sensory integration processes in ASD may affect balance and coordination skills.

Evaluation of Social Skills and Psychological Adjustment Findings

Another important finding of the study is the improvements observed in social and adaptive skills. The significant improvements observed in imitation skills, instruction-following skills, receptive and expressive language skills, play skills, self-care skills, daily living skills, and social skills among participants in the experimental group indicate that movement-based interventions may support not only motor performance but also social functioning.

Within this framework, when the results of the Performance Determination Form (PDF) were examined, significant improvements were observed in many developmental domains in the experimental group. Significant improvements were found in imitation skills ($Z = -3.415$, $p = .001$), instruction-following skills ($Z = -3.186$, $p = .001$), matching skills ($Z = -3.078$, $p = .002$), receptive language skills ($Z = -3.113$, $p = .002$), expressive language skills ($Z = -3.070$, $p = .002$), play and music skills ($Z = -3.530$, $p < .001$), self-care skills ($Z = -2.358$, $p = .018$), daily living skills ($Z = -3.394$, $p = .001$), motor skills ($Z = -3.408$, $p = .001$), social skills ($Z = -3.466$, $p = .001$), literacy skills ($Z = -3.301$, $p = .001$), and mathematical skills ($Z = -3.306$, $p = .001$). However, no significant change was observed in visual support skills ($p > .05$). When the post-test results of the experimental and control groups were compared, significant differences were found in favor of the experimental group in instruction-following, matching, receptive language, self-care, daily living, social, and motor skills ($p < .05$).

It is widely emphasized in the literature that motor skills are closely related to social development. Research indicates that motor skill deficits are associated with social play behaviors, physical activity levels, and opportunities for social interaction (Odeh et al., 2022). Furthermore, differences in motor development may influence social communication development and adaptive functioning (Bhat, 2020). Based on these findings, the relationship between motor development and social development has frequently been discussed within the framework of the developmental systems approach in recent years. According to this perspective, motor skills facilitate social learning by increasing opportunities for social participation and environmental interaction (Adolph & Hoch, 2019). Children with higher levels of motor competence are more likely to participate in play and physical activities with their peers, which in turn increases opportunities for social interaction (Stodden et al., 2008). Therefore, improvements observed in motor skills may have indirectly supported the progress in social skills.

Physical activity and game-based activities create natural social environments where children can interact with their peers. Such activities may contribute to the development of children's social communication skills.The neurobiological effects of physical activity may also play an important role in explaining these improvements. Research has shown that physical activity increases brain plasticity, strengthens synaptic connections, and supports cognitive functions

(Hillman, Erickson, & Kramer, 2008). These processes may lead to positive changes particularly in brain regions associated with motor control, attention, and executive functions.

Game-based activities encourage not only motor skills but also social behaviors such as cooperation, turn-taking, and communication. The interactive nature of motor activities may provide children with opportunities to develop their social skills within a natural learning environment. Therefore, physical activity-based interventions may influence not only motor skills but also cognitive and behavioral processes. Similar to physical activity interventions, play-based programs also have the potential to positively support multiple developmental domains in children. An important characteristic of the intervention program used in this study is the integration of physical activity and educational games. Play is considered a fundamental component of child development and provides a natural learning environment that supports cognitive, social, and emotional development (Ginsburg, 2007; Pellegrini, 2009). Game-based physical activities increase children's motivation and encourage active participation in the learning process. This is particularly important for children with ASD because structured play environments may increase opportunities for social interaction (Pan, 2010).

In this context, the findings obtained from this study provide important implications for educational and rehabilitation programs. Most intervention programs designed for ASD focus primarily on behavioral and communication skills. However, the results of this study suggest that movement-based programs may also serve as an important tool in supporting children's development. The implementation of physical activity and game-based programs in schools and rehabilitation centers may enhance both motor development and social participation among children. The literature also suggests that physical activity programs and play can positively influence children's psychological well-being and emotional regulation skills. Consistent with these findings, the results of this study indicate that movement education programs based on physical activities and educational games may be effective in improving the motor proficiency, social skills, and psychological adjustment levels of children with ASD. Improvements in motor development may also positively influence children's social interaction and psychological adaptation processes.

For this reason, it is recommended that structured physical activity programs supporting motor development should be included in intervention programs for children with ASD. It is known that neurotransmitters and endorphins released during physical activity can positively influence individuals' mood. Furthermore, experiences of success during physical activity may increase children's perceptions of self-efficacy. Considering all these findings, it can be stated that this study contributes to addressing an important gap in the field. However, future studies conducted with larger sample sizes may provide stronger evidence regarding the effectiveness of movement education programs. Additionally, examining the long-term effects of intervention programs is also important. Longitudinal follow-up studies may be useful in evaluating the lasting effects of such programs.

Author Contributions

N.T.K.: Data curation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. E.Ü: Investigation, Writing – original draft, Writing – review & editing. S.C.S: Implementation, Data collection. A.D.M.: Data analysis, original draft preparation, review and editing. N.M. Review and editing.

All authors have read and agreed to the published version of the manuscript

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Institutional Review Board Statement

The research was conducted in accordance with the Declaration of Helsinki after obtaining approval from the Marmara University Faculty of Health Sciences Scientific Research and Publication Ethics Committee (Approval date and number: 21.02.2019/44).

Informed Consent Statement

Informed consent was obtained from all subjects involved in this study.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Conflicts of Interest

The authors declare no conflict of interest.

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