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The Effect of SPARK on Social and Motor Skills of Children with Autism

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Abstract

This study aimed to evaluate the effectiveness of a selected group exercise known as Sports, Play and Active Recreation for Kids (SPARK) on the motor and behavioral skills of children with autism spectrum disorder (ASD) using a quasi-experimental design with repeated measures. Twenty-eight children with ASD (age range of 5 to 12 years) participated in this study. The participants were examined at baseline, pre-test, and post-test using Bruininks-Oseretsky Test of Motor Proficiency (BOTMP), Autism treatment evaluation checklist (ATEC), and Gilliam Autism Rating Scale-second edition (GARS-2). The results showed that the SPARK program significantly improved balance (static and dynamic), bilateral coordination and social interaction (p < 0.05) in children with ASD. The results of this study suggest that the SPARK's training can be considered as a therapeutic option not only for motor enhancement but also for improving social skills in children with ASD.

Key words: neurodevelopmental disorders; social interaction; balance; coordination; SPARK program
Introduction

Autism Spectrum Disorder (ASD) is a heterogeneous neurodevelopmental disorder with qualitative impairments in social and communication skills, repetitive behaviors and a range of motor sensory difficulties\(^1\). Communication and social interaction skills in children are crucial for their emotional and behavioral development and any impairment can result in poor academic achievement and social integration\(^2,3\).

Previous studies showed that, compared to healthy controls, children with ASD tend to present a higher rate of motor skill impairments such as deficits in coordination during gross and fine motor activities, balance skills, crude gait patterns,\(^4,5\) postural stability, joint flexibility and movement speed\(^6\). Low level of motor skills in individuals with ASD can decrease the chance of their participation in physical activities (PA) and sport\(^7\) and increase the rate of sedentary-related diseases\(^8\). Additionally, recent studies provide empirical evidence that motor impairments in children with ASD can have a negative impact on the development of social communication and social interaction skills in this population\(^8\). Based on this phenomenon, several studies have examined the effect of different kinds of exercise and health promoting interventions on the social skills of autistic children. Bahrami et al examined the effect of karate techniques training on communication deficits of children with ASD and showed a significant improvement in their communication skills\(^9\). A recent study examined the efficacy of an aquatic program on physical fitness and aquatic skills in children with ASD and healthy controls and found that these interventions can promote motor skills and physical fitness in children with ASD\(^8\). Finally, Howarth and colleagues in their recent review of the literature reported a positive role for the effect of different kinds of interventions on social and motor skills in people with learning disabilities\(^10\). Despite the supporting evidence for the effectiveness of exercise program intervention on social skills, there is a dearth of literature on the type of exercise interventions that fit the special needs of children with ASD. In the current study, we aimed to examine the effectiveness of the Sports, Play and Active Recreation for Kids (SPARK) program on balance, coordination and social impairments of children with ASD. SPARK was originally designed and developed by a multidisciplinary group to promote physical activity in schools\(^11\) and seemed to provide simple, regular and predictable play for children with autism. Existing data indicated cardiovascular endurance and fitness benefits related to Spark program as a health-fitness activity and a skill-fitness activity\(^12\). The main of the present study was to examine whether
SPARK program could improve motor skills (i.e., balance and coordination) and social interaction abilities in children with ASD. The main hypothesis was that children with ASD who participated in a 12-week SPARK program (treatment group) would show improvement in their motor and social skills, as compared to children with ASD who were not engaged in this program (control group).
Methods

Participants
Twenty-eight children with ASD with an age range of (5-12) years were randomly selected and recruited from a therapeutic clinic affiliated with Shahid Beheshti University in Tehran, Iran. All the participants had a diagnosis of ASD based on the Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition, Text Revision (DSM-IV-TR) criteria. None had any previous exposure to the SPARK program. Except for two participants who dropped out of the study, the subjects completed training sessions in full. Exclusion criteria were having any serious medical conditions (such as orthopedic or any acute conditions) that contraindicated participation in exercise programs. They were also excluded if they had any recent use (less than 4 weeks) of any psychotropic medications. Patients and their families gave their written informed consent about the process and aims of the study prior to starting any procedure. This study was approved by the Committee for Ethical Considerations in Human Experimentation of the College of Sport Sciences at the University of Tehran.

Measures
We used the social interaction subscale of Gilliam Autism Rating Scale-Second Edition (GARS-2) and Autism treatment evaluation checklist (ATEC) to assess the social interaction deficits of the participants. The GARS-2 is a 42-item scale that can be administered by parents and caregivers in 5 to 10 minutes. It has three subscales (14 items each) that assess social interaction, communication and stereotyped behaviors. Each item is scored on a four-point Likert-type scale (0 = never observed; to 3 = frequently observed).

ATEC is a 77-item checklist designed to be completed by parents, teachers or caretakers to assess the severity of symptoms as well as developmental aspects of ASD. Furthermore, it can also be used to assess the effectiveness of various autism treatments. It covers four main impairment areas seen in children with ASD including communication (14 items), sociability (20 items), sensory cognitive awareness (18 items) and health-physical-behavior (25 items). This scale is freely available and can be scored online with minimal training and resources. In this study, we used a validated Farsi version of this questionnaire.

Finally, we used Bruininks-Oseretsky test of motor proficiency (BOTMP) to assess the motor skills such as balance and coordination. This is a valid instrument that has 8 subscales (53 separated parts) to assess motor functions such as motor skills or fine and gross motor disorders.
of individuals aged (4-20) years old. The abbreviated form of the test consisted of 8 subscales including 14 separated parts. Four of the eight subscales assess gross motor skills, three subscales assess fine motor skills, and one subscale evaluates both gross and fine motor skills. The test-retest reliability of the Bruininks-Oseretsky test was reported to be .87.

Procedure

The participants were randomly assigned into two groups: the treatment (n = 12) and the control group (n = 14). The treatment group underwent selective SPARK programs three times a week while the control group only received their routine non SPARK programs. All participants were assessed by BOTMP at three different time points (baseline, right before starting the program, and 2 to 7 days after final session) by two independent examiners who were blinded to the assignment of children. In addition GARS-2 and ATEC questionnaires were administered by parents and caregivers in two sessions (before start point and (2-7) days after the last session).

Intervention program

The SPARK program consisted of 36 sessions (3 sessions per week, 40 min per session) at an indoor complex. Each session started at 11 am and was divided into 3 parts: (a) the first 10 min part was devoted to warm-up activities; (b) the second part consisted of a 20-min period during which children practiced according to treatment goals; (c) the last 10 min of the session consisted of cool down activities. Sessions were managed by four trained coaches who had at least two years of experience in physical education (PE) of children and adolescents with developmental disorders, in particular children with ASD. The PE sessions were also supervised by an expert psychologist and three PE coaches familiar to children with ASD. The SPARK is an evidence-based PE designed to improve health-related well-being and to maintain the positive socialization and enjoyment of PA or academic achievements. The SPARK discipline is in line with NASPE (National Association of Sport and PE) guidelines. A standard SPARK lesson has two parts: a health-fitness activity and a skill-fitness activity. In the health-fitness activity part, there are 13 activities that include aerobic dance, running games and jump ropes. In this part, the main focus is on developing cardiovascular endurance and promotion by modifying the intensity, duration and complexity of the activities. The activities are mostly aimed to develop abdominal and upper body strength. The skill-fitness activity part includes nine sports such as soccer, basketball, Frisbee games, football and kickball that have the most potential for promoting
cardiovascular fitness and wellbeing. In current study, we chose two parts of the SPARK program: stabilities and displacement movements.

Statistical analysis

Shapiro test and Paired t-test were used, respectively, to check for normality of data and evaluate within group baseline and pretest differences. In order to examine the effect of intervention on participants’ performance across two groups, repeated measures analysis of variance (ANOVA) was applied in which treatment and control were assigned as between-subject variables and evaluation time points (baseline, pretest and posttest) were assigned as within-subjects variable. K-related samples was utilized for nonparametric data such as bilateral coordination. Chi-square effect sizes were computed to interpret the magnitude of group's difference. For exploratory purposes, Wilcoxon and Bonferroni tests were conducted to assess post hoc correlation of variables. We used SPSS 17 for analyzing the data. P value < 0.05 was considered as statistically significant.
Results

Figure 1 shows the timeline for the study procedures. Table 1 shows weight and height of the children in both groups. We found no significant difference at baseline in static (t = 0.685, p = 0.50), dynamic balance (t = 0.993, p = 0.332) or coordination (t = 1.00, p = 0.339) between the treatment and control groups (Table 2).

Results of the repeated measures ANOVA analysis to determine the effects of the selected program of SPARK on balance subscales showed significant differences between treatment and control groups in static (F = 5.18, P = 0.009) and dynamic balance (F = 13.91, p = 0.001) (Table 2).

The results of post hoc analysis showed that in static balance, there were significant differences between baseline vs. post-test (p = 0.001, CI: (345 - 1.71)) and pre-test vs post-test (p < 0.001, CI: (592 - 1.792)). In dynamic balance, there was a significant difference between pre-test and post-test (p = 0.001, CI: (183 - .769)).

We also used K-related samples for coordination subscale of BOTMP which was nonparametric. There was a statistically significant difference in perceived effort depending on which SPARK program was used on bilateral coordination between pretest-posttest and baseline-posttest, \( \chi^2(2) = 6.000, p = 0.049 \). There was also a statistically significant difference in perceived effort \( \chi^2 (2) = 6.00, p = 0.049 \). In addition, coordination values of treatment group in BOTMP test increased from 8.3% to 33.3% at post test.

Repeated measures of ANOVA analysis in ATEC and GARS-2 questionnaire for assessment of "social interaction" subscale showed significant differences in scores between treatment and control groups (Table 3). In term of ATEC questionnaire, SPARK program had a positive effect on social interaction (F=7.86, P=0.01). Additionally, according to GARS-2 questionnaire, intervention had a significant effect on social interaction (F = 7.81, P = 0.01).
Discussion

The primary purpose of this study was to examine the efficacy of a SPARK program on the motor and social skills of children with ASD. The SPARK program that was used in the current study resulted in significant improvement in motor (balance and coordination) and social interaction skills in children with ASD. These findings are in line with other studies on children with ASD showing improvement in motor and behavior skills as result of an exercise program.

Effect of SPARK program on Motor skills

The treatment group showed a significant improvement in the static and dynamic balance as well as bilateral coordination compared to the control group. The play component of the SPARK program (stability and displacement) in the current study may have been sufficiently intense and specific to enhance motor skills in children with ASD. This is in line with other studies showing that exercises could improve flexibility and balance of children with ASD. The ability to control and maintain balance is a crucial element of daily physical activities. Recently, researchers have pointed to the role of the complex interaction between skeletal, muscular and nervous systems in the balance control. They have also indicated that the importance of each system in the balance control depends on the spatial situation as well as the purpose of the activity. In this model, the central nervous system integrates proprioception, vestibular, and visual systems in order to be informed of the body’s center of gravity (COG) relative to body’s base of support (BOS) through the processing of an appropriate response. From that point of view, individuals who regularly exercise or walk for a specific period of time are able to enhance their balance, or even dynamic balance.

In addition, the current study showed that SPARK program also had positive impact on bilateral coordination. Our findings concur with Pan et al and Bremer et al who showed that PA interventions could be a practical therapeutic factor to improve motor skills such as bilateral coordination in individuals with ASD. Participation in exercise programs probably due to more sensory integration and environmental information which may increase the brain activity, improve bilateral coordination in children with ASD. There are several mechanisms whereby exercise can improve motor skill in individuals with ASD: 1) strengthening whole muscle, 2) using repeated exercise for increasing frequency, 3) enhancing motivation through improvement in self-esteem, and 4) using cognitive techniques to sharpen the child ability in a new task.
Data indicated several deficits in the cerebellum of individuals with ASD, including impairment of Purkinje and granular neurons and deficits in the posterior hemisphere and vermis. Moreover, the vital role of cerebellum in controlling motor skills that it serves as a bidirectional pathway between visual, auditory and somatosensory cortices. Yan et al found that treadmill exercise might exert ameliorating effect on neurodevelopmental disorders by decreasing the rate of Purkinje cell loss in the cerebellum. Therefore, SPARK program which consist of activities requiring learning skills, motor control and social engagement, positively improves cortical, subcortical and cerebellar function. Although, in the present study, there is no direct measurement for cerebellar function, the results and findings of studies related to neurological base support our interpretation. Thus, it is reasonable to attribute the prominent improvement of motor skills as well as cerebellar function to participation in the SPARK program.

**Effect of SPARK program on Social interaction**

The further aim of the present study was to examine whether SPARK program to children with ASD leads to improvements in social interaction of children with autism. After receiving exercise related to SPARK program, the participants of the treatment group demonstrated a substantial improvement in social interaction. The potential benefits of physical exercise in promoting social interaction in our study were consistent with the findings reported in recent empirical studies on PA and exercise in children with disabilities. Investigators proposed that participants in PA have a substantial role in psychological and social development in children with and without developmental disabilities. self-esteem, self-confidence and self-competence improvement are crucial factors for socialization. Improving social function in ASD may also be explained from a neurochemical stand point. According to finds of neurochemical investigations, there are abnormal levels of neurotransmitters such as oxytocin and serotonin in individuals with ASD which are related to social functioning. The modulation of complex emotional and social behavior was implemented by oxytocin. According to Chanada and colleagues, there was an inefficient metabolism of serotonin in different brain regions of individuals with ASD. Several studies showed that PA improved metabolism of serotonin and oxytocin in the brain. Thus, it seems that PA may have a significant positive impact on the central oxytocinergic and serotoninergic systems.

**Implications**
As provides opportunities for children with ASD to participate, they can develop social and communication skills with other children. The study has several clinical implications to be integrated into practice. The results of the present study may be used by clinicians to establish strategic plans under which SPARK program can be directed to children with ASD. We concluded that the SPARK program is an effective intervention for children with ASD and their siblings with a disability, and it may be a fun alternative for their families. We also encourage families of children with ASD to have their autistic children participate in physical activities such as the SPARK program.

Limitations
This study has the following limitations. First, our sample sizes were relatively small. However, we observed a significant positive effect for the SPARK program on motor and social skills of children with ASD. Second, due to the nature of the intervention, it was not feasible to blind the participants. Finally, there were different motivation levels in our participants with ASD and there was variety in how much they engaged in physical activities.

Conclusions
This study indicated that a 12-week of SPARK program was effective for improving motor skills including balance (dynamic and static) and coordination in children with ASD with aged (5-12) years. The SPARK program also had positive effects on social interaction in children with ASD.
References


Figure 1 Procedure of enrollment, intervention and assessment.

28 ASD children enrolled

2 excluded

Treatment

Control

Balance and coordination was assessed by BOTMP

Balance and coordination was assessed by BOTMP

Baseline

Pre-test

Intervention

Post-test

Participants were instructed with SPARK program for 36 sessions

Participants did not participate in formal SPARK program

Balance and coordination were assessed by BOTMP

Social interaction was assessed by GARS-2 and ATEC questionnaire

Balance and coordination were assessed by BOTMP

Social interaction was assessed by GARS-2 and ATEC questionnaire