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The effects of a SPARK program on oxidative stress in children with intellectual disability

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Abstract

Introduction: The purpose of this study was to determine the effects of a curriculum known as Sports, Play and Active Recreation for Kids (SPARK) on oxidative stress in children with intellectual disability.

Material & Methods: Twenty boy students with mild (educable) intellectual disability aged 7 to 9 years were selected and randomly divided into experimental (N=10) and control groups (N=10). The experimental group performed a selected SPARK program for 12 weeks (3 sessions per week, 45 minutes each) while the control group was exempted to participate in the program. Oxidative stress determined by malondialdehyde (MDA) was measured before

and after the intervention. Repeated measures ANOVA was applied to analyze the data ($\alpha = 0.05$).

Results: Analysis revealed that there was no significant difference between two groups in the measured variable in pretest. However, in posttest, the experimental group had significantly lower MDA level as compared to the control group.

Conclusion: According to the results, it can be argued that the selected SPARK program decreases MDA level in children with mild intellectual disability.

Keywords: Intellectual disability, children, oxidative stress, SPARK, Malondialdehyde

1. Introduction

However, the production of free radicals is necessary for physiologic processes of body to some extent, but their irregular increase which is mostly in the form of oxygen active species (ROS) is harmful for body and results in the demonstration of oxidative stress. Oxidative stress is created because of imbalance among free radicals created from ROS and sum of antioxidant mechanism (1). This is a situation in which there is no balance between the production of free radicals and their exclusion or eradication by body antioxidant defensive system (2). This imbalance involves in the creation of many chronic diseases such as arthrosclerosis, myocardial infarction, respiratory distress syndrome, reproductive damages, skin diseases, cancer, and neurological disorders such as Parkinson, Alzheimer, madness, and tissue hardening (3-5). Damages arising from the occurrence of oxidative stress in body may also result deficits in the aging process, some optical degradation diseases, muscular and lymphoid damages, tissue inflammation, muscular fatigue, disorder in restoring to the initial status, disorder and decrease in the performance of immune system and muscular oxidation status (6). There are some convincing reasons that oxidative stress has negative effects on skeletal muscle cell contraction (7). Previous studies point out the relationship between oxidative stress and human diseases (8). The oxidative stress causes some basic mechanisms in cardiovascular diseases,

free isoprostan-F2 which is explained as an appropriate sigh for the prediction of heart problems (9).

Oxidative stress can be identified by damages to proteins, lipids, RNA, DNA, cell membrane, inactivation of enzymes, damages to RBC, and cell aging (2). Free radicals attack to cell components especially unsaturated fatty acids in cell membrane and cause the increase in the production of free radicals through the lipid peroxidation process in which malondialdehyde (MDA) is the final product of lipid peroxidation (2). Inactivity and lack of appropriate physical activity probably results in the increase in oxidative stress. Several studies have reported the increase of MDA in inactive and sedentary individuals such as those with Autism spectrum and intellectual disability (9,10). Although our muscles have variety of enzymatic and non-enzymatic antioxidants for the protection against ROS production, but sport activities can make a situation of oxidative stress in which ROS production overcomes anti-oxidant defensive system. This situation has been reported in the increase of ROS production in inactive or sedentary states such as elderly group, individuals with motor disorders or motor limitations (such as cerebral palsy, down syndrome, intellectual disability or autism disorder). Studies have shown that in patients with down symptoms, superoxide dismutase (SOD) which is an anti-oxidation enzyme and is coded in chromosome 21 will increase (11). This increase in SOD activity is not under balance since SOD ratio to accumulated catalase with glutamine peroxidase increases as well (12). Therefore, H_2O_2 produces more than catalase and glutamine peroxidase can be catalyzed and analyzed. Proliferation of H_2O_2 causes the production of OH (hydroxide) by affecting O_2 which is on of active oxygen species. It has been mentioned recently that this increase of free oxygen species causes oxidative condition in body which has an important role in down symptom phenotype and observed intermittent side effects in this disease such as neural disorders, arteriosclerosis, diabetes, and cell aging (13).

Intellectual disability is a common developmental disorder and a chronic disease during lifetime. People with intellectual disability tend to isolation and they rarely participate in group programs that this immobility and isolation expose them to the risk of chronic disease significantly (17). Children with intellectual disability are in the category

of diagnostic neurodevelopmental disorders that are identified with the damage in cognitive abilities, conceptual skills and practical skills (18). These children suffered from information processing through different senses and doing motor activities are difficult for them (19). In intellectual disability, maintaining muscular strength and endurance and dynamic balance for a better life and functional independence is important, the ability to keep an independent life is an important factor for these individuals (20). Children with different disabilities have more motor poverty because of inappropriate approach since these children are limited at home or because of unconscious compassion are kept as disabled patients and these behaviors prevent the flourishing of their motor talents. The important issue is that such children may not be disabled in doing skills and lack of their success is because of lack of understanding these motor skills because of having no experience in performing them. However, a regular motor program has an important role in returning people with mental disability to life (21). It is obvious that children with intellectual disability who enter the formal training school program gradually are slower in learning and gaining skill compared to the children in their age. Many teachers believe that educational games are effective for their motivation in experiencing skills and new information. They declared that motivational educational games cause a lot of interest, excitement and enjoyment and are necessary for students' involvement in learning activities (22). SPARK motor program is a physical program for living better along with enjoyment. The number of sessions covers an academic year; this program has been designed in a way that it includes guidelines from the National Association of Physical Education and Sports, a program which is flexible enough and increases the cooperation of participants (23). This motor program may be welcomed because of its liveliness, freshness and variety of games.

According to the previous studies, there is a possibility of relationship between physical activities and oxidative stress, and also possibility of the effect of oxidative stress on people's health especially sedentary people and the problems which intellectually disabled children have in these issues, this study aimed to investigate the effects of one of the

training programs called SPARK on oxidative stress in children with intellectual disability.

2. Material &Methods

Subjects

The present study is a semi-quasi study with pre-test, post-test, and control group during which the effectiveness of SPARK training on oxidative stress in children with intellectual disability has been evaluated and investigated. To this end, twenty boy students ranging from 7-9 years old from Imam Hassan Mojtaba institute in Shiraz voluntarily took part in the present study. Participants were randomly divided in experimental (N=10) and control (N=10) groups. The criteria for entering the study included lack of infection to any heart, respiratory, orthopedic, infectious, epilepsy diseases, not being prohibited to do physical activities, not using any certain medications that may have positive or negative effects on the results of blood samples, and finally having parent or legal guardian's consent form to participate in the research protocol. To prevent samples from being excluded, the program was set to be conducted between class times and a make-up session was considered if necessary.

Study protocol

To perform the study, first the method of doing study and considered objectives were explained shortly to the parents through a letter and they were asked to sign the consent form if they are satisfied with their children's participation in the study. Then, all 20 participants had pre-test blood sample. After that, the experimental group participated in the SPARK program for 12 weeks (3 sessions of 45 minutes each week). This program included 10 minutes of body warm up, 10 minutes of physical activities, 20 minutes of recreational and fun games and 5 minutes of cool-down activities. The control group didn't participate in such training and they lived their normal life and daily routine activities. This study has been approved by the research council of the Islamic Azad University, Science and Research Branch of Tehran.

Biochemical analysis

To measure the amount of MDA, the blood samples were taken from children's forearm vein. The blood samples were taken 24 hours before the start of intervention program (pretest) and 48 hours after the end of this program (posttest). Then, the samples were transferred to the lab and were centrifuged at 3000 rpm for 10 minutes to separate the serum from plasma. After the separation serum from plasma, MDA was measured by ELISA method using a special kit (Eastbiofarm, China) with the accuracy of 0.01 ng/ml.

Statistical analysis

To analyze the data, the statistical software package in social studies version 21 (SPSS-21) was used. To compare mean values of MDA in both experimental and control groups in two phases (pre- and post-test), repeated measures ANOVA was applied (α=0.05). Least significant difference (LSD) comparisons was used in the case of observing any main effect or interaction.

3. Results

Anthropometric measurements related to subjects in both experimental and control groups are shown in Table 1.

Table1. Anthropometric parameters of the subjects in each group (mean ± SD)

	Experimental group	Control group
Height (cm)	143 ± 10.3	141.5 ± 8.8
Weight (kg)	38.3 ± 9.4	37.7 ± 8.3
BMI (kg/m^2)	18.3 ± 2.7	18.5 ± 2.1

To investigate the normality of the data distribution, the Shapiro Wilk test was used in which the results showed that the measured variable had normal distribution in both samples. As shown in Table 2, repeated measures ANOVA indicated a significant main effect of test ($F=72.243$, $P<0.001$) and group ($F=8.545$, $P=0.009$) and also a significant test*group interaction ($F=16.965$, $P=0.001$). Further analysis showed that there was no significant difference between groups in pretest ($P=0.698$). However, as shown in Figure 1, in posttest MDA levels of

experimental group was significantly lower than that of control group ($P<0.001$).

Table 2. Comparison of MDA levels between experimental and control groups in pre- and post-test

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Test	Sphericity Assumed	473.895	1	473.895	72.243	0.001
Group	Sphericity Assumed	78.963	1	78.963	8.545	0.009
Test* Group	Sphericity Assumed	111.289	1	111.289	16.965	0.001

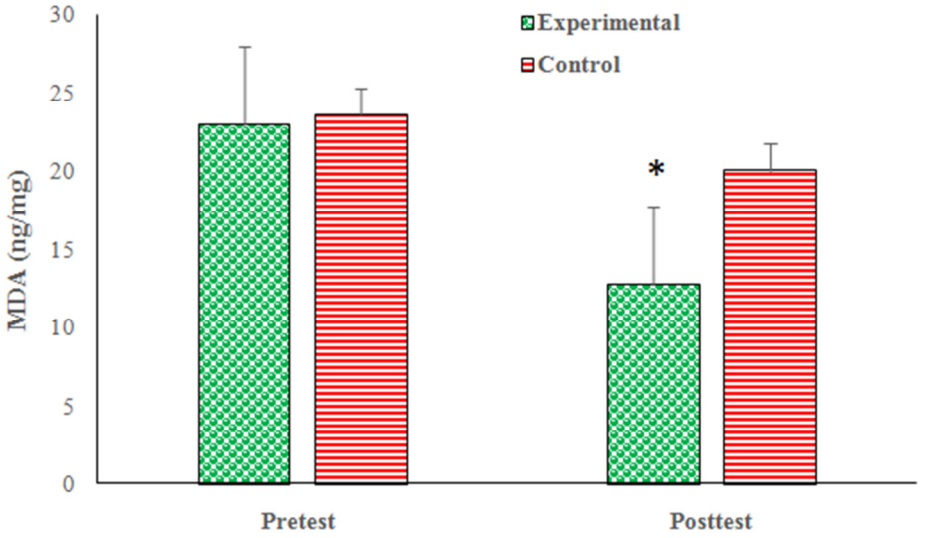

Figure 1. Changes of MDA levels in the experimental and control groups in response to 12 weeks of SPARK program. (* Significant differences between group ($P<0.05$))

4. Discussion

This study is performed to determine the effects of a SPARK program on oxidative stress in children with mild intellectual disability. Findings of analysis of variance with repeated measures indicated that SPARK training causes the reduction of MDA level as an indicator of oxidative stress in intellectually disabled children.

The results of the present study showed that MDA level has a significant reduction following 12 weeks of SPARK training in children with intellectual disability that is consistent with the results of other studies. For example, Meguid et al. (2014) pointed out that MDA level in teenagers suffer from Down Syndrome had a significant reduction after a period of exercise on treadmill (24). Javier Ordonez and Rosety-Rodriguez (2007) also showed that fat peroxide level and MDA content had a significant reduction in teenagers with Down syndrome after 12-week sport activities (25). Meguid et al. (2014) suggested that the reason of reduction of MDA in individuals with Down syndrome following exercise is the improvement of harmful fats in blood that is the increase of HDL and reduction of LDL (24). LDL oxidation is a crucial step in atherosclerosis, process that can be inhibited by HDL through its oxidable components or associated enzymes like paraoxonase (PON) and platelet-activating factor acetylhydrolase (PAF-AH) (26). It is likely that physical activity reduces the LDL oxidation by reducing these enzyme levels; therefore, it increases HDL density in patients with Down syndrome. Zambrano et al. (2009) also stated that the level of lipid hydroperoxides in saliva of individuals with Down syndrome had a significant reduction after a period of aerobic exercise. Researchers have suggested that aerobic exercise can be considered as an appropriate way to reduce active oxygen species in Down syndrome patients (27). Moreover, the obtained results from the hypotheses of this study are consistent with the result of the study of Salehi et al. (2007) regarding the effect of swimming on oxidative stress and that of Ramezani et al. (2014), investigating the effects of interval aerobic training on inactive women's MDA (28,29). As mentioned, intense physical activities can result in the increase of free radical and inactivity and sedentary are the probable factors for the increase of oxidative stress. In explanation of the results of these hypotheses, it seems that the type of intervention program used in this study is neither intense enough for participants to be exhausted nor too light for them to reach sedentary. Therefore, one can claim that the existing difference between MDA level before and after the training in experimental group was due to the balance of this training in terms of intensity. Accordingly, it reduced the amount of oxidative stress. While the inactivity of such children was a factor to

increase oxidative stress before doing the training program, it has reduced after doing this training. In explanation of the obtained results and their consistency with previous studies as it was mentioned before, SPARK program activities are various, fun, lovely, and balanced in terms of intensity (neither too intense and boring nor too light and inactive). Because of its game feature, the motivation for individual's participation to perform this motor program is high enough and they participate eagerly. So it can be said that active participation of samples - because of its average intensity - along with created excitement among children during performing training program - due to its available fun and entertainment - are probably the factors that result in the reduction of participants' MDA level.

In explanation of the results which aren't consistent with the results of this study (10,30,31), one can say that because the type of applied training program and its duration and the number of participants are different in previous studies compared to the present study, then there is possibility that these factors lead to inconsistent results.

5. Conclusion

According to the results, we can confidently claim that a physical activity with an average intensity such as SPARK program can cause the reduction of oxidative stress in children with mild intellectual disability. It is worth noting that we have faced some limitations in the present study. Actually, we couldn't explain the mechanisms underlying the reduction of participants' MDA level. For example, the level of blood fat and enzymes such as PON and PAF-AH could have an effect on MDA's level that were not measured. However, this needs to be clarified in other studies.

Limited number of participants and their sex (only boys were recruited) are some of other limitations of this study. Therefore, we have to be cautious in the interpretation and generalization of the results of this study. The findings of this study can be used by child care centers and institutions that serve children with some special disabilities.

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