ISSN: 2538-5887; Pathobiology Research. . 2022;25(1):51-56

Physical activity reduces the malondialdehyde level in boy children with intellectual disability

ARTICLE INFO

Article Type
Original Research

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ABSTRACT

Introduction: Free radicals in the body create malondialdehyde (MDA), which is one of the most frequent indicators of oxidative stress. Several studies have reported the increase of MDA in inactive persons and individuals with developmental disorders. The purpose of this study, therefore, was to examine whether a program of physical activity reduces MDA in children with intellectual disability.

Methods: Twenty boy stu dents with intellectual disability (7 to 9 years old) voluntarily participated in the study. They were randomly divided into experimental and control groups. The experimental group performed a physical curriculum known as sports, play and active recreation for kids (SPARK) for 12 weeks (3 sessions of 45 minutes per week), while the control group was exempted to participate in the program. The level of MDA in blood samples of all participants 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 pretest ($P = 0.698$, $\eta^2 = 0.009$). However, in posttest, the experimental group had significantly lower level of MDA as compared to the control group ($P < 0.001$, $\eta^2 = 0.555$).

Conclusion: According to the results, it can be argued that the selected SPARK program reduces MDA which may consequently result in less oxidative stress in children with intellectual disability.

Keywords: physical activity, malondialdehyde, Intellectual disability, boy children

Introduction

Intellectual disability is a common developmental disorder and a chronic disease during lifetime. Children with intellectual disability are in the diagnostic category of complex neurodevelopmental disorders that are recognized by damages in cognitive, conceptual, social, and motor skills (1). It has been indicated that individuals with intellectual disability suffer from information processing through different senses and have difficulties in motor abilities because they have lower levels of muscular strength, endurance, agility, running speed, reaction time and balance when compared to their normal counterparts (2). These children have more motor poverty because they are limited at home most of the time or have inactive lifestyle. Because of unconscious compassion are kept as disabled patients, children with mental disabilities tend to isolation and they rarely participate in group programs and therefore these behaviors prevent the flourishing of their motor talents. This may significantly expose them to the risk of chronic disease (3).

Emerging evidence suggests that children with intellectual disabilities have poor physical health. This could be related to inactivity or lack of appropriate physical activity in those individuals, which probably results in the increase of oxidative stress. Oxidative stress, which is often measured by the level of malondialdehyde (MDA) in blood, leads to the increase in the production of free radicals in the body through the lipid peroxidation process (4). Although 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. In fact, oxidative stress is created because of imbalance among free radicals created from ROS and sum of antioxidant mechanisms (5). 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 (6). This situation has been reported in the increase of ROS production in inactive or sedentary states such as elderly groups, 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's syndrome, superoxide dismutase (SOD) which is an anti-oxidation enzyme and is coded in chromosome 21 will increase (7). This increase in SOD activity is not under balance since SOD ratio to accumulated catalase with glutamine peroxidase increases as well (4). It has been mentioned recently that the 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 (8).

It has been shown that oxidative stress 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 (9-11). 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 (12). Also, there is some convincing evidence that oxidative stress has negative effects on skeletal muscle cell contraction (13).

Although our body have a variety of enzymatic and non-enzymatic antioxidants for the protection against ROS production, several studies have reported the increase of MDA in inactive and sedentary individuals such as those with Down's syndrome and intellectual disability (14,15). In fact, it is worth noting that physical activities and exercise can help children with mental disabilities achieve, or even improve, their mental and physical potential. It is obvious that children with intellectual disability are slower in learning and gaining motor skills compared to the children in their age, but the important issue is that such children may not be disabled in doing motor skills and lack of their success is due to having no experience in performing them. Therefore, a regular motor program has an important role in returning people with mental disability to life (16).

Many teachers believe that educational games are effective for their motivation in experiencing skills and new information. They declare that motivational educational games cause a lot of interest, excitement and enjoyment and are necessary for students' involvement in learning activities (17). A curriculum known as sports, play and active recreation for kids (SPARK) is a physical program for living better along with enjoyment. 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 (18). This motor program may be welcomed by children with intellectual disabilities because of its liveliness, freshness and variety of games.

As mentioned above, it has been shown that inactive and sedentary people and also individuals with developmental disorders such as those with intellectual disabilities are encountered with more oxidative stress. Moreover, there is a possibility of relationship between oxidative stress and people's health. Therefore, this study aimed to investigate the effects of a physical program called SPARK on oxidative stress measured by MDA in children with intellectual disability.

Materials & Methods

Participants

The present study was a semi-quasi study with pre-test, post-test, and control group during which the effectiveness of SPARK program on oxidative stress in children with intellectual disability has been 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 into experimental and control groups. The criteria for entering the study included: lack of heart, respiratory or orthopedic infectious and 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. A subject was excluded from the study if he was absent in 3 consecutive or 4 non-consecutive training sessions. To prevent participants from being excluded, however, 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 participants had pretest 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 intervention and they had their normal life and daily routine activities. This study has been approved by the research council of the Islamic Azad University, Tehran's Science and Research Branch.

Biochemical analysis

To measure 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), to make sure that the immediate effects of the intervention are removed (26). 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 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). Bonferroni post hoc test was used in the case of observing any main effect or interaction.

Results

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

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

Parameters	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/m2)	18.3 ± 2.7	18.5 ± 2.1

To investigate the normality of data distribution, the Shapiro Wilk test was used in which the results showed that the measured variable had normal distribution for two groups in both tests. As shown in Table 2, repeated measures ANOVA indicated a significant main effect of test ($F_{(1, 18)}$=72.243, P<0.001, η^2=0.801) and group ($F_{(1, 18)}$=8.545, P=0.009, η^2=0.322) and also a significant test*group interaction ($F_{(1, 18)}$=16.965, P=0.001, η^2=0.485). 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 of groups in pre- and post-test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Test	473.895	1	473.895	72.243	0.000	0.801
Group	78.963	1	78.963	8.545	0.009	0.485
Test*Group	111.289	1	111.289	16.965	0.000	0.322

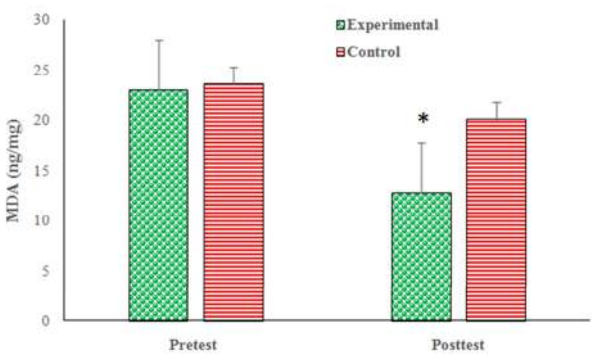

Figure 1. MDA levels in the experimental and control groups in two phases (* means significant differences between groups at P≤0.05).

Discussion

The present study was performed to determine the effects of a SPARK program on MDA, as an indicator of oxidative stress, in intellectually disabled children.

The results of data analysis revealed that MDA level has a significant reduction following 12 weeks of SPARK program in children with intellectual disability that is consistent with the results of other studies (19-24). 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 (19). Ordonez and Rosety- Rodriguez (2007) also showed that fat peroxide level and MDA had a significant reduction in teenagers with Down's syndrome after a 12- week sport activities (20). Meguid et al. (2014) suggested that the reason of reduction of MDA following exercise is the improvement of harmful fats in blood, that is the increase of HDL and reduction of LDL (19). LDL oxidation is a crucial step in atherosclerosis, a process that can be inhibited by HDL through its oxidable components or associated enzymes like paraoxonase (PON) and platelet-activating factor acetylhydrolase (PAF-AH) (21). It is likely that physical activity reduces the LDL oxidation by reducing these enzyme levels; therefore, it increases HDL density. Zambrano et al. (2009) also stated that the level of lipid hydroperoxides in saliva had a significant reduction after a period of aerobic exercise. It has been suggested that aerobic exercise can be considered as an appropriate way to reduce active oxygen species (22).

Moreover, the obtained results from the hypotheses of this study are consistent with the result of the study of Salehi et al. (2007) examining 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 (23,24). As mentioned earlier, intense physical activities can result in the increase of free radicals and, on the other hand, inactivity and being sedentary are the probable factors for the increase of oxidative stress, which is often measured by the level of malondialdehyde (MDA) in blood (4). Although 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. In fact, oxidative stress is created because of imbalance among free radicals created from ROS and sum of antioxidant mechanisms (5). 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. In fact, it has been shown that free radicals would result in many diseases and antioxidant system can stop the damaging process induced by free radicals in the body (6).

In explanation of the results of the present research 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 intervention 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 could be a factor to increase oxidative stress before doing the training program, it has been reduced after the intervention. To explain the obtained results and their consistency with previous studies, it is worth noting that 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 argued 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.

On the other hand, Usefpor and colleague (2017) investigated the effect of a period of intensive interval training on plasma total antioxidant capacity and tissue level of MDA. Their results showed that 8 weeks of the intervention had no significant effect on the plasma antioxidant capacity and also MDA levels in liver tissue of male Wistar rats (26). Moreover, Ahmadi et al. (2022) illustrated no significant effect on liver tissue MDA levels in male rats after 24 sessions of a sprint interval training program (3 sessions per week for 8 weeks; 27).

In explanation of the results which aren't consistent with the results of this study (15,25,26, 27), one can say that because the type of applied training program, its duration, and number of participants are different in previous studies compared to the present study, then there is a possibility that these factors lead to inconsistent results.

Conclusion

According to the results, we can confidently claim that a physical activity program with an average intensity such as SPARK 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.

Acknowledgment

The authors wish to thanks all children who cooperated in this study as participants and their families.

Conflict of interests: The authors have no conflicts of interest to declare.

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