ISSN: 0974-8369

Biology and Medicine

International, Open Access

Available online at: www.biolmedonline.com

Biology and Medicine

Hajihosseini, Biol Med (Aligarh) 2016, 8:1
http://www.biolmedonline.com

Research Article Open Access

A School-based Physical Activity Intervention to Promote Motor Proficiency among Adolescent Girls: A Randomized Controlled Trial

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Abstract

Physical activity levels decline markedly among girls during adolescence. School-based interventions that are multi-component in nature, simultaneously targeting curricular, school environment and policy, and community links, are a promising approach for promoting physical activity, specifically perceptual motor skills at middle schools. The aim of this study was to design a school-based physical activity program to promote perceptual motor skills among adolescent girls. An experimental research approach and action learning framework were used with measurements at baseline and immediately after four month intervention. Participants are 41 female students whom were selected randomly (21 in control group) from public school of Gonbad/Iran. The mean age, weight and height (SE) of the sample was 12.9 (±0.5) years, 50.4 (±4) kg and 154.2 (±2) m, respectively. The Bruininks-Oseretsky Test of Motor Proficiency was used to evaluate the effectiveness of intervention. Randomization resulted in no differences between intervention and control groups on any of the outcomes. After which, only the experimental group was given school-based physical activity program that consisted of 5 min warm-up, 10 min of health related physical fitness training, 10 min of traditional games, and 5 min of static stretching cool down with theory of the benefits of physical education for 16 (2 × 30 min) weeks. At that time, control group had routine physical education classes. After the end of the intervention, a post-test was taken from both groups by OBT. The data were analyzed by independent *t*-test – differences between means – using SPSS-20 software program. The physical activity program will result in a significantly greater improvement in component scores (measured by BOT) compared with controls when comparing the pre-intervention score with post-intervention score ($p < 0.00$). After the trial, the gross and fine motor skills indexes improved significantly ($p < 0.00$). We hypothesize that our intervention will lead to an increase in perceptual motor competence. Should we be able to confirm these hypotheses, implementation of the physical activity promotion program throughout Iran and in other countries will help to improve health and fitness of our school children with the obvious potential of reduced direct (health care) and indirect (work absenteeism and productivity) costs later in life.

Keywords

Perceptual motor skills; Adolescent girls; Physical education program; Physical activity

Introduction

Physical activity throughout the lifespan may independently enhance the health by reducing the risk of developing chronic disease and improving overall quality of life [1]. The increase in sedentary behavior, that is, physical inactivity, over the last decades is thought to be one of the main risk factors for the development of obesity, diabetes, cardiovascular disease, osteoporosis, and psychosocial constraints. Despite widespread attempts to increase physical activity in the general population, only a minority of adults and children in developed countries engage in physical activity to a degree sufficient to maintain or increase health and physical, as well as psychosocial well-being [2]. School-age youth should participate every day in 60 min or more of moderate to vigorous physical activity that is enjoyable and developmentally appropriate. Interventional studies indicate specific amounts of physical activity necessary for beneficial changes in the skeletal health, aerobic fitness, and muscular strength and endurance of youth, and in adiposity in youth who are overweight [3].

Despite these advantages, evidence suggests that children are not engaging in sufficient physical activity to ensure both short and long-term health benefits [4,5].

Associations between change in physical activity and several biological and demographic variables were examined in some studies at 10-13 years old children. Previous physical activity was consistently positively associated with change in physical activity [6,7]. There was consistent evidence of no association with change in physical activity for parental marital status [8,9] parental support [8,10] parental physical activity attitudes [11,12] parental role modeling [6,7,13], and parental physical activity [12].

But, the WHO specifically identified schools as a target setting for the promotion of physical activity among children and youth [14]. Physical education, a school curricular subject over the past 100 years, has a number of goals, including providing students with the knowledge, skills, abilities, and confidence to be physically active throughout their lifetime [15]. Its activities include the provision of collaboration on the development of health-related curricula; educational policy and guideline development; professional development opportunities for educators and other partners; and, research, evaluation, and knowledge exchange to facilitate the development of evidence-informed policies, programs, and practices [14]. It provides benefit to children from all risk groups, particularly those with limited or no access to play areas; and avoids stigmatization of at-risk children. However, it is not clear what the most effective strategies are to promote lifelong healthy lifestyle behaviors [16]. Although most schools require physical education as part of their curriculum, physical education classes may occur infrequently and children are often relatively inactive in them.

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Received: Feb 2, 2016; **Accepted:** Feb 17, 2016; **Published:** Mar 2, 2016

Citation: Hajihosseini S (2016) A School-based Physical Activity Intervention to Promote Motor Proficiency among Adolescent Girls: A Randomized Controlled Trial. Biol Med (Aligarh) 8(1): BM-165-16, 5 pages.

Increasing the frequency and duration of physical education is not always feasible given the competitive demands of curriculum. It is thus essential to promote physical activity throughout the school day during classes, lunch times, and recess, and to develop strategies to promote more efficient use of physical education class time.

Physical activities of children and adolescents vary with age, type of exercise, and setting. With growth, maturation, and experience, basic movements are integrated and coordinated into more specialized and complex movement skills that characterize the free play, games, sports, and other activities of school-age youth. Guided instruction and supervised practice, specifically by qualified teachers, coaches and others who work with children, are important in learning movement skills [3]. The school routine and the club system shows that movement competence is assumed in children, adolescents and adults for them to be able to participate in organized and informal activities or even to be interested in taking part [17]. It has been proposed that movement skill proficiency in children can influence the amount of physical activity in which they engage [18]. Furthermore, it is assumed that the mastery of fundamental movement skills in infancy not only be directly associated with increased physical activity but also positively influences the activity level in adulthood [17]. As youth move into the pubertal transition (about age 10-14 years, earlier in girls than in boys), these skills are incorporated into a variety of individual and group activities and many organized sports. Health related activities include those that emphasize cardiovascular and muscular endurance and muscular strength and those that involve weight bearing. The setting of physical activity is especially important in achieving positive behavioral outcomes. Although there is less emphasis on the development of motor skills during adolescence, refinement of those skills is important and new movement skills can be learned and can contribute to a physically active lifestyle [3].

Appropriate motor skill development is fundamental to normal physical development. Furthermore, poor motor skills have been linked with childhood obesity and frustration in sports. These problems have been found to emerge early in a child's development with some evidence suggesting that they are present as early as 4 years of age [19]. Yet this area of a child's development appears to have considerably less attention in the school setting than other aspects of development such as cognitive and language development.

So far, there are only few studies examining the causal relationship between the quality of motor proficiency and physical activity, that is, that having high motor proficiency level may increase options for participation in physical activity, as well as increased participation leading to further development of motor proficiency. From this point of view, in the interventional phase of the study, we aimed to provide a low-cost and simple model of developmental-appropriate and low cost facilities for improvement of physical activity with targeted interventions for middle school-age girls through a physical education school program and to determine the changes in perceptual motor indexes after this program.

Methods

This trial was a non-stratified, non-blinded parallel group study with the allocation ratio of 1:1 conducted in Iran. An experimental, descriptive design was used. The participants were 41 girl students (control = 21) 11-13 years old who used to have secondary sexual characteristics. Those who were aware of the project were excluded. The study was held in a feminine guidance school located in public school of Gonbad/Golestan/Iran. Permission was obtained from principals, physical education teachers, and parents. Parents of all participants provided written, informed consent and all of the adolescents provided their written assent. All procedures were approved by the Tehran Medical University's Ethics Committee. Permission to conduct the study was also obtained from the schools' principals.

Data were collected by the primary researcher. Students performed the tests during their regular physical education class time in place of their usual class activities. Bruininks-Oseretsky test of motor proficiency was developed to provide educators, clinicians and researchers with useful information to assist them in assessing the motor skills of individual students, in developing and evaluating motor training programs and in assessing serious motor dysfunctions and developmental handicaps in children [20]. The BOT [21] consists of 46 items grouped as eight different subtests of motor proficiency for children between 4.5 and 14.5 years of age. The BOTMP is a standardized, product-oriented assessment commonly used in the assessment of motor abilities in children. Four of the eight subtests assess gross motor skills (Running Speed and Agility, Balance, Bilateral Coordination, and Strength); one subtest assesses gross and fine motor skills (Upper-limb coordination); three subtests assess fine motor skills (Response, Speed, Visual-motor Control, and Upper-limb Speed and Dexterity) [21]. The students were randomly allocated into two equal groups (by the coin flip). No group difference was found in age, weight, height and overall BOTMP score. After reviewing the articles and consulting the authorities in this field, an appropriate development plan was designed. It was held for the study group for 16 weeks and two 30 min sessions each week in the experimental group. Each session included a 5 min warm-up, 10 min of health-related physical fitness training, 10 min of traditional games, and a 5 min static stretching cool down with theory of the benefits of physical education. The physical education program focused on adolescent's enjoyment of and participation in moderate to vigorous physical activity during physical education classes. The health-related fitness training included muscle strength and endurance, aerobic and flexibility training. Traditional games are those specifically played in Golestan/Iran [22].The control group used to do the routine scholastic physical education activities simultaneously. The control group was also offered the physical activity equipment pack, all developed intervention materials, and the results of the study at the end of the intervention period. The procedure of research was such that after random selection of case and control groups, pre-test was performed on groups in a specific day to evaluate motor proficiency and its dimensions. At the end of intervention, post-test was performed in both groups. In this study, a 5% significance level and a power of 5% for the determination of the sample size was assumed and 41 students (21 in control group) were selected. Dropout percentage was predicted near zero. No blinding was done in this study. Descriptive statistics, mean (M) and standard deviation (SD) were calculated for each of the items of the test. Relevant tests for normality and homoscedasticity were carried out to ensure homogeneity of variance. We calculated the asymmetry and kurtosis indices that were generally close to 0 and <2.0, as recommended by Bollen and Long (1994), indicating similarity to the normal curve. The Kolmogorov-Smirnov analysis confirmed the normal distribution of the sample ($p = 0.2$). A preliminary analysis used the Student's t-test for independent samples, comparing the experimental group with the control group with the aim of checking whether the two groups were homogeneous. The effect of the intervention on outcome measures was determined using independent t-test in $p < 0.05$. SPSS/20 software was exploited to analyze data.

	Group	*N*	Mean	Std. Deviation	*T*	Sig. (2-tailed)
Age	PAP	20	12.9000	0.55251	−0.538	0.594
	Control	21	13.0000	0.63246		
Weight	PAP	20	50.1500	4.47537	−0.498	0.621
	Control	21	50.8095	3.99524		
Height	PAP	20	154.2500	3.33837	−0.093	0.926
	Control	21	154.3333	2.30940		

Table 1: Demographic characteristics of participants in different groups

Results

A total of 41 participants attended baseline testing and were randomly allocated to the Intervention ($n = 20$) or Control ($n = 21$) group. Data were initially screened for outliers and distribution characteristics were also examined. There is no difference in age, weight and height of participants in different groups (Table 1).

To compare the success of randomization, descriptive statistics were used to compare the baseline measurements of the two groups. The primary analysis was a comparison of the change of the primary and secondary outcome factors between the intervention and the control group following the 'intention to treat' principle. Initial power analysis was based on a two-sided *t*-test on the pre-post changes in the primary outcome measures (Compound skills, Fine motor skills, Gross motor skills, Fine and gross motor skills) (Table 2).

The physical activity program will result in a significantly greater improvement in fine and gross motor scores (measured by BOT) compared with controls when comparing the pre-intervention score with post-intervention score. After the trial, the gross and fine motor skills improved significantly (Table 2).

Discussion

The most important finding of this study was that this simple model of physical activity improvement with targeted interventions via school curricula for girls and made several changes in fine and gross motor skills measures of intervention group. Motor performance testing by physical therapists is a major source of evaluation and efficacy data. Performance-based assessments for children and adults are used to guide initial treatment planning and to provide a detailed analysis of motor components that are related to successful rehabilitation outcome. The description of a performance profile for children with mild motor problems is a helpful assessment guideline, especially in these times of expected greater efficiency and accountability [20].

As suggested by world experts who met to define the minimum time spent in physical activity to secure health and to prevent unhealthy weight gain, the school is an ideal setting in which environmental changes to increase physical activity and decrease sedentary behavior in children can be implemented. A public school-based physical activity intervention offers a good opportunity to work with a large group of average children irrespective of their parents' behavior and attitudes towards physical activity and health, and irrespective of their socioeconomic background. This is important for many reasons [2].

The decline in physical activity during adolescence is of special concern. Data from several European countries highlight the importance of involvement in community-based sport clubs during adolescence as an important predictor of physical activity in adolescence. Restoration of intramural sport programs and expansion of the school day for such programs in middle and high schools may provide opportunities for all students to be physically active. Many school-based intervention studies promoting physical activity and a healthy lifestyle have been performed over the last two decades [23].

Middle School Physical Activity and Nutrition (M-SPAN) intervention focused on increasing teacher awareness of the need for active, health-related physical education; designing and implementing active physical education curricula; and developing class management and instructional skills. M-SPAN resulted in students spending approximately 3 min more (an increase of 18%) engaged in MVPA per lesson without increasing lesson length [24]. Many programs such as Sports, Play and Active Recreation for Kids (SPARK) and The Child and Adolescent Trial for Cardiovascular Health (CATCH) are implemented in many states, school districts, and individual schools [25]. This demonstrates the demand for 'active' physical education programs and the feasibility of widespread implementation. Other evidence-based physical education programs have been developed and evaluated at the secondary level, such as the Trial of Activity for Adolescent Girls (TAAG) middle school program [23] and a high school program, Lifetime Education for Activity Program (LEAP) [26], both targeting girls. Results were promising (for example, in LEAP, intervention girls participated in more bouts of vigorous activity than control girls), but these programs have not been widely disseminated. Researchers have also examined the impact of conceptual physical education (that is, focused on student competence and enjoyment of physically active lifestyles) on future physical activity participation of high school graduates. One intervention in Iran which tried to provide a low-cost and simple model of culturally-appropriate and low cost facilities for improvement of physical activity for girls and their mothers through an afterschool program and to determine the changes in anthropometric indexes after this trial. The most important finding of this multicenter study was that this simple model of physical activity improvement with targeted interventions for girls and their mothers facilitated the participation of females in physical activity, and made several changes

OBT indexes	Group	*N*	Pretest Mean	Std. Deviation	Sig. (2-tailed)	Post-test Mean	Std. Deviation	Sig. (2-tailed)
Compound	Control	21	147.28	9.4	0.394	155.57	7.4	0.000
	PAP	20	150.35	13.1		181.70	11.6	
Fine motor	Control	21	59.52	4.1	0.465	64.23	6.4	0.000
	PAP	20	60.65	5.5		76.85	7.3	
Gross motor	Control	21	70.52	7.5	0.676	73.66	6.0	0.000
	PAP	20	71.80	11.5		86.05	9.0	
Fine and gross	Control	21	17.23	2.2	0.327	17.66	1.9	0.031
	PAP	20	17.90	1.9		18.80	1.2	

Table 2: Comparison between changes in OBT before and after intervention in different groups (*t*-test)

in health-related fitness and anthropometric measures of participants of different age groups [1].

Interventions to change lifestyle habits through a change in environment, such as the school environment, are found to be more successful, especially if they take place early in life [27]. However, it seems that the socioeconomically deprived children are those who experience the greatest reduction of physical activity and some of its consequences, and are also most difficult to reach by any preventive measure that is not included in the regular school curriculum [2].

Therefore, we hypothesize that our intervention will lead to an increase in perceptual motor competence. Should we be able to confirm these hypotheses, implementation of the physical activity promotion program throughout Iran and in other countries will help to improve health and fitness of our school children with the obvious potential of reduced direct (health care) and indirect (work absenteeism and productivity) costs later in life.

The main limitation of this study is that we did not assess other health behaviors of the participants, for example, their dietary habits and the possible changes during the study. The other limitation was that we did not have long-term follow up of participants' lifestyle behaviors and the impact on their risk factors.

Conclusion

Even among children and adolescents, an alarming increase in obesity has been noticed [2]. Increasing the level of habitual moderate-to-vigorous intensity physical activity in youth is a health promotion and a disease-prevention strategy [3]. Given the school age children spend a significant amount of their wakeful hours either in transit or in the school setting, and that in many countries, all children attend school until they reach adolescence, school-based physical activity promotion interventions have the potential to reduce chronic diseases in the population. School based interventions can simultaneously increase both knowledge and behavior conducive to healthier lifestyles. The intent of school-based physical activity intervention is to increase the overall percentage of adolescents engaged in physical activity each day and to increase the duration of moderate to vigorous activity engaged in on a weekly basis. The aim is to create a school environment that is more conducive to achieving higher rates of physical activity among children and youth, as well as increasing the time spent engaged in physical activity [14]. The health crisis emboldens us to recommend that education and public health professionals work together with policy makers to optimize the contribution of physical education to health. Furthermore, if proven successful, this program could be trialed internationally. It is quite possible that this program could be easily modified for different cultures. Also, it may be possible to extend the program to higher years of schooling to ensure that appropriate motor skills are practiced and maintained throughout the school years.

Acknowledgment

The authors gratefully acknowledge the financial support of this work from Sport Medicine Research Center of Tehran University of Medical Sciences, Grant No: 4690. We also wish to thank the teachers and students who helped us in this project.

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Citation: Hajihosseini S (2016) A School-based Physical Activity Intervention to Promote Motor Proficiency among Adolescent Girls: A Randomized Controlled Trial. Biol Med (Aligarh) 8(1): BM-165-16, 5 pages.