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Original Research Article

EFFECT OF A STRUCTURED PHYSICAL ACTIVITY ON ACADEMIC PERFORMANCE IN 10-15 YEAR OLD CHILDREN OF BELAGAVI CITY

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ABSTRACT

Background: According to WHO, Physical Activity (PA) is defined as "Any bodily movements produced by skeletal muscles that requires energy expenditure". Reducing sedentary behavior and promoting regular participation in physical activity among children is the main goal to prevent various health conditions. Health benefits of regular physical exercises are widely acknowledged, yet physical education classes in schools are considered as extra-curricular activity. Physical activity is beneficial for overall physical, social and academic performance of children.

Aim: To evaluate the relationship between structured physical activity and academic performance among 10-15 year old school children.

Methodology: 100 school going children of 6th, 7th and 9th grades (mean age=13.5 years) were randomized and administered a structured physical activity program consisting of 5 minutes of warm-up and cool down and 20 minutes of exercise. The program was given on 3 non-consecutive days for 2 weeks consecutively. For evaluating academic achievement (AA), Wechsler Intelligence Scale for Children (WISC) test; 4th edition Indian adaptation was administered in addition to the academic grades of the last conducted exam.

Results: Results showed larger statistical difference in Picture Completion component of WISC, compared to Picture arrangement, Block design, Object assembly, Coding and Mazes components. Some children also showed improvement in the grades in the subsequent exam/test conducted at school.

Conclusion: A structured physical activity program (PA) for school going children may be beneficial in improving the academic performance.

KEY WORDS: Physical activity, academic achievement, school children, exercise, WISC

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INTRODUCTION

According to WHO, Physical Activity (PA) is defined as "Any bodily movements produced by skeletal muscles that requires energy expenditure" [1]. Reducing sedentary behavior and promoting regular participation in physical activity among children is the main goal to prevent various health conditions [2].

Very few, school-age children or adolescents meet the recommendations for 1 hour of moderate-vigorous intensity physical activity (MVPA) daily [3]. Daily physical education (PE) class for an hour may provide the opportunity for children to meet Healthy People 2010 guidelines for

physical activity [3]. Many school districts, however, are reducing PE requirements, and some are eliminating programs. The percentage of schools requiring physical education in each grade decreases from approximately 50% in grades 1–5, to 25% in grade 8, to only 5% in grade 12 [4]. Daily participation in PE among high school youth at the national level is 29.1%, and participation declines as students progress through grades 9 (42.1%), 10 (30.4%), 11 (20.0%), and 12 (20.1%) [21]. According to Indian statistics, children are more physically active [Chennai (64.8 %) and Goa (67.3 %)] here compared to children in Matlab and Bangladesh (37 %) [5].

The World Health Organization (WHO) recommends 1 hour of moderate to vigorous physical activity for children everyday [4]. Sedentary activity less than 2 hour per day is not beneficial for physical, social and academic performance of children [6]. 'Active travel to school' such as walking and cycling (versus use of motorized transport) improves cardiovascular fitness and thus is recommended as well [7].

Health benefits of regular physical exercises are widely acknowledged, yet PE classes in schools these days are considered as an extracurricular activity [2]. In an effort to increase the students' academic achievements (AA), PE classes are being replaced with other classes [7]. Inspite of replacing the PE classes, there is no evidence which states that doing this will improve the physical achievement [3]. According to WHO, Academic Achievement (AA) is defined as "the extent to which a student, teacher or institution has achieved their educational goals, commonly measured by examination or by continuous assessment (i.e. grades, percentage)" [1].

There are various standardized methods of formally testing the Intelligent Quotient (IQ) of the children, some of which have been adopted for Indian Children. Wechsler Intelligence Scale for Children (WISC)-fourth edition (WISC-IV^{INDIA}) is one such scale used for the children between 5 years to 15 years 11 months of age. It consists of Verbal tests and Performance tests. Verbal tests include General information, General comprehension, Arithmetic, Similarities and Vocabulary. Performance tests consist of Picture Completion, Picture arrangement, Block design, Object assembly and Coding (Mazes). Internal consistency coefficients across the nine age groups were 0.95–0.96 for the FSIQ and ranged from 0.85 to 0.96 for index scores and from 0.71 to 0.95 for the subtest scores [8]. Normative values for all age groups is also available for the same.

Although physical education programs can be justified on the basis of their health problems alone, it is also important to understand any effects it has on academic achievement [9]. PA is a vital component in students' academic success. Growing expanse of literature documents multiple physical and mental health benefits of physical activity in young people as well as adults [23].

From the past decade, mandates of the Federal 'No Child Left Behind Act' have placed major emphasis on child's test performance and have indirectly reduced their opportunities to engage in physical activities [11]. However, as there is evidence that PE has a direct positive effect on important educational domains such as reading and mathematics, it could be argued that PE is not extracurricular [9].

There have been studies to evaluate the long term effects of PA in children which found that compliance to the activity program was difficult. The Western results cannot be considered in our children due to the differences in culture and education system. Literature regarding association of PA and academic performance is sparse in Indian population. The Indian literature is conflicting in terms of effectiveness of PA on academic performance. Therefore, there arises a need to evaluate the effect of short term PA program on academic performance in order to bridge this gap.

Our study aimed to evaluate the relationship between a structured physical activity program and academic performance among 10-15 year old school going children using the Indian adaptation of WISC-4th edition and academic grades/percentage in consecutive school exams as the outcome measure.

METHODOLOGY

Study design : Study was designed as a single group pre-post experimental type.

Study participants : The **Institutional Ethical Committee** approved the study protocol following which necessary permission was taken from the competent school authorities for enrollment of the students. Parental assent was also taken from the children found suitable for the study.

100 children attending regular school in the age group of 10-15 years were recruited (30 in the 12 year group, 30 in 13 year group, 21 in 14 year group and 19 in 15 year group). The recruitment of participants was done through a 2 stage probability sampling design.

First stage involved the selection of schools which were chosen on a probability proportional to the enrollment number of students aged between 10-15 years. Eligible schools were listed in an ascending postal code order to ensure good geographical distribution and were selected using a random start, constant interval procedure. 5 schools were selected, out of which 2 refused permission and hence were replaced with 2 others from the sampling frame. The second stage of sampling consisted of random selection of 20 boys and girls in each group from each school. The sampling frame for this was the enrollment list provided by each school; consisting of name, gender, grade and age of all the students in the school.

Children with history of a) Recent injury/illness in past 3 months, b) Known physical disability/ locomotor disorders, c) Known neurological condition affecting higher functions, and d) Known contraindications for physical activity were excluded.

Measures / instrumentation :

Wechsler Intelligence Scale for Children (WISC): Indian adaptation (4th edition) of the WISC was used to evaluate academic performance of the children. Children were administered the test items and time taken for each task was noted and compared with the normative values before and after the 2 week intervention program.

Performance tests administered included the following.

1)Picture Completion – Child was shown various pictures on the card and asked to identify the missing parts. Number of attempts taken by the child to identify the missing part were noted and scored accordingly.

2)Picture Arrangement – Child was given few cards and asked to put it together in a sequence, example- first the head of the dog, then the body and lastly the tail. Time taken to arrange the picture was noted and compared.

3)Block Design – Here the child was presented 4-6 blocks and asked to arrange the same as shown to him/her. Time taken to complete the block design was noted and compared with the standardized values.

4)Object Assembly – Child was shown a picture, and then asked to arrange each item. Time and the sequence of the arranged item was noted and compared with standardized values.

5)Mazes – In this, the child was given a maze and a pencil, and asked to form a path out, without lifting the pencil. Overlapping and pencil lifting was noted and scoring done accordingly.

6)Coding – Child was given numbers from 1-20 with various codes assigned to each number. He/she was given 2 minutes to complete the given codes. Number of correct attempt codes were counted and scoring done accordingly.

The academic grades or percentage on the last conducted school exam were noted for each child.

Procedure: Demographic details of each child was noted which included name, age, gender, school name, class studying and their grade or percentage on the previous exam. A 3 part self prepared questionnaire regarding PA and academic performance was administered to each child regarding the child, the parent and their respective class teachers to answer.

Wechsler Intelligence Scale for Children (WISC) - fourth edition (WISC-IV^{INDIA}) was administered to each child in a testing room in their respective schools.

Physical activity (PA) program was conducted every alternate day for 2 consecutive weeks with each session being conducted at the same time of the day.

A session of PA lasted 30 minutes with 5 minutes warm up, 20 minutes exercise and 5 minutes cool down. Exercises were performed under the supervision of investigator, with the children in groups of 5-10 each.

Warm up exercises included with 10 repetitions /session of Arm circles, Hand slaps, Arms overhead, Shoulder rotation, Trunk side bents, Trunk rotations, Lunge walk, Lateral shuffle, Straight leg march, Walking at normal pace for 2 minutes.

Exercise program consisted of 10-15 rounds / session of Shuttle run 10m, Vertical jumps and Full squats.

Cool Down included 10 repetitions /session of Head tilts, Shoulder shrugs, Pelvic rotation, Heel raises, Spot marching and Breathing exercises

It also included walking at slow pace for 2 minutes

Data Analysis: Statistical analysis was performed using SPSS 21 statistical package. Microsoft Excel and Word 2010 was used to generate graphs and tables. Data was evaluated using Wilcoxon matched pair test (non-parametric test) as the difference in scores of pretest to posttest of all components of WISC did not follow a normal distribution curve. Wilcoxon matched pair test was also used to find the interclass difference for each of the components separately.

Descriptive statistics was expressed as mean ± standard deviation for the continuous variables in terms of number of participants and percentage for the categorical variable. Normality of change or difference of scores from pretest to posttest of all the components individually was calculated by Kolmogorov Simonov test. Spearman's rank correlation coefficient was used to find Correlation of pretest and posttest academic performance scores with other variables and also to determine any differences in academic achievement as a function of level of physical activity. Level of significance was considered as $p<0.005$.

RESULTS

In the current study, 30 participants each of 12 and 13 years, 21 participants of 14 years and 19 participants of 15 years were included. The mean age of participants was 13.5 ± 1.29 years. 59 of the 100 participants were males and 49 were females. The demographic and clinical characteristics of the participants are depicted in Table1.

Results suggest statistically significant differences between pre and post scores of IQ, picture completion, picture arrangement and block design ($p<0.005$) wherein the highest change was noted in the picture completion scores (table 2).

Wilcoxon matched pair test showed statistically significant changes for Object assembly, Coding, Mazes as well as for Academic Performance ($p<0.005$) (table-3) Because performance curves for most of the motor performance tests are similar during childhood, data for boys and girls were combined in this study.

Table 1: Demographic characteristics of participants.

	No	%
Class studying		
6th	13	13
7th	50	50
9th	37	37
Age in years		
12	30	30
13	30	30
14	21	21
15	19	19
Gender		
Male	59	59
Female	41	41
Total	100	100

Table 2: Means and standard deviations for IQ scores, picture completion, pictue arrangement and block design at pre-intervention and post-intervention.

	IQ		Picture Completion		Picture Arrangement		Block Design	
	PRE	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**
Mean	97.83	107.87	8.91	11.2	9.49	10.97	10.86	11.74
SD	12.17	12.27	2.5	2.43	2.16	2.2	2.29	2.41
Z-value	8.6732		8.0136		7.8181		6.6404	
P value	0.0001*		0.0001*		0.0001*		0.001*	
%	10.26%		25.70%		15.60%		8.10%	

Table 3: Means and standard deviations for object assembly, coding, mazes and academic performance scores at pre-intervention and post-intervention.

	Object Assembly		Coding		Mazes		Academic Performance	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
Mean	11.28	12.84	11.54	12.51	6.72	7.74	10.86	11.74
SD	2.31	2.28	3.72	3.57	1.96	2.41	2.29	2.41
Z-Value	8.6732		8.0136		7.8181		6.6404	
P Value	0.0001*		0.0001*		0.0001*		0.001*	
%	10.26%		8.41%		15.60%		8.10%	

Table 4: Correlation between pre-intervention and post-intervention academic performnce with other variables pre and post intervention scores.

Variables	Test	N	Pretest academic performance			Posttest academic performance		
			Spearman R	t-value	p-level	Spearman R	t-value	p-level
IQ	Pretest	100	-0.0183	-0.1808	0.8569	0.0349	0.3455	0.7304
	Posttest	100	-0.0051	-0.0508	0.9596	0.0371	0.3679	0.7137
Picture completion	Pretest	100	0.1477	1.4784	0.1425	0.067	0.6646	0.5079
	Posttest	100	**0.221**	**2.2434**	**0.0271***	0.1004	0.9993	0.3201
Picture arrangement	Pretest	100	-0.1362	-1.3611	0.1766	**-0.2634**	**-2.7033**	**0.0081***
	Posttest	100	-0.1597	-1.6018	0.1124	-0.1808	-1.8196	0.0719
Block design	Pretest	100	-0.0469	-0.4651	0.6429	0.0196	0.1938	0.8467
	Posttest	100	-0.0273	-0.2701	0.7877	0.0442	0.438	0.6623
Object assembly	Pretest	100	0.0719	0.7133	0.4773	-0.0895	-0.89	0.3757
	Posttest	100	-0.0326	-0.3229	0.7475	-0.1246	-1.2429	0.2169
Coding	Pretest	100	-0.0667	-0.6619	0.5096	0.1184	1.1808	0.2405
	Posttest	100	-0.0628	-0.6229	0.5348	0.1402	1.402	0.1641
Mazes	Pretest	100	0.0861	0.856	0.3941	0.1158	1.1537	0.2514
	Posttest	100	-0.0111	-0.1095	0.913	-0.0148	-0.1469	0.8835

A positive co-relation in post test scores of Picture Completion component was noted (p=0.0271). while a negative co-relation was found in pre test scores of Picture Arrangement (p=0.0081).

However, there were no statistically significant difference seen in the other 5 components. (table-4)

DISCUSSION

Physical inactivity among youth and its relation to heightened incidences to various diseases has become a national health concern. Nearly half of the young people are not active on regular basis, thereby increasing the risks and incidence many of the diseases. PA also has an influential role to play in academic achievement (AA). Hence, this study was undertaken to correlate PA with AA.

100 participants in the age group 10-15 years were enrolled in the study (mean age = 13.5 ±1.29) comprising of 60 males and 40 females. They received 2 weeks of intervention with one session every alternate day for 2 weeks consequently, which comprised of 5 minutes of warm up followed by 20 minutes of exercise and it ended with a 5 minutes cool down phase.

The mean age of the participants in the study was 11.5 years as in a study by Podulka Coe et al. [9]. This age group is particularly vulnerable as the level of physical activity decreases with school grade increase and children are more stressed with respect to academics and hence was targeted in this study.

A clear male predominance was evident in the current study with 60 male and 40 female participants. This could be attributed to the cause that the schools selected by randomization had higher enrollment of male children which is the case with most Indian schools.

A recent review has shown a positive relation between levels of physical fitness and academic

performance [12] .Few neurophysiological changes have been hypothesized to explain positive influence of physical activity on academics, such as to increase blood flow, improved neuro-electrical functionality and stimulating the release of brain derived neurotropic factors that facilitate learning by improving synaptic plasticity. Physical activity also helps to increase arousal and reduce boredom, which indirectly helps to increase attention, concentration and memory. It also elicits a cascade of neurological changes in the hippocampus and basal ganglia that supports memory and learning [2]. It also increases the level of norepinephrine and endorphins which reduce stress, improves mood, induces relaxation and perhaps improves achievement [13]. Shephard has suggested that increased physical activity during the school day may induce arousal and reduce boredom, which may lead to increased attention span and concentration. It was also suggested that increased activity levels might be related to increased self-esteem, which would improve classroom behavior as well as overall academic performance. It is possible that a threshold level of activity may be needed to produce these potentially desirable effects. This may explain why the increase in Academic Achievement (AA) is not very high in our study as only mild physical activity of short duration was administered [14].

In a comprehensive review, Howard Taras [13] noted several studies demonstrating positive effects of physical activity and student performance at school. Academic achievement in the individual studies were more related to basic skill scores achieved by the participants in Math, English, Science and Reading subsets. These measures of AA differ from those used in the current study. Nevertheless, the results still indicate a slightly positive association between physical activity and academic performance.

A meta analysis by Etnier et al. [22] of the relationship between physical activity and cognition, concluded that potential changes in cognition (e.g., academic achievement) may stem from (a) physiological mechanisms that are independent of aerobic fitness, (b) physiological mechanisms dependent upon attainment of aerobic fitness, or (c) psychological mechanisms that are independent of aerobic fitness. Greater fitness has been associated with changes in neurocognitive function [15], as higher fit children exhibit a more effective neuroelective profile than lower fit children on a stimulus discrimination task. This may explain why an increase in physical activity has beneficial effects on academic achievement in this current study.

A causal connection between physical activity and academic performance is plausible. Regular physical activity may reduce plasma noradrenaline [16]. It may also increase the transfer of the serotonin precursor tryptophan across the blood brain barrier, having a calming effect in children and enabling them to sit and concentrate on academic pursuits. The SHAPE study [10] demonstrated that the classroom behavior of 10 years old was improved in response to a program of daily physical activity. Research has also shown that blood flow to the cortex of the brain was increased following bouts of exercise [18]. In a recent review, McAuley [18] concluded that a positive relationship exists between physical activity and self-esteem in children. Enhanced self-esteem may result in better classroom behavior and a great desire to learn [19]. Nearly all of the studies reviewed by Keays [20] reported significant improvements in the attitudes, discipline, behavior, and creativity of school students following the implementation of physical activity programs.

In the present study, WISC-4th Edition (for Indian population) is used for evaluating academic achievement, which is less commonly used by Indian researchers till date. Performance test was assessed in children, which showed a drastic improvement in the Picture completion component due to following reasons: Children can recall more easily when they use visual stimulation and clue, they can easily remember the missing parts in the picture when once corrected, it is more friendly and all the pictures shown to them can be easily recognized if they are active and alert it in their routine.

Other components like Picture arrangement, Block design, Object assembly, Coding and Mazes showed at least some minimal significant changes. We hypothesized that children enrolled in PA protocol would have better AA

than those not enrolled in physical activity. When the overall academic performance was compared pre and post 2 week physical activity program, we found a consistent positive relationship between physical activity and academic achievement. Data analysis revealed that as overall IQ scores, mean achievement scores of all the components of WISC also increased statistically. Hence it can be concluded that even a short duration PA program can be beneficial in improving academic performance in children.

Clinical implications: Structured and monitored regular PA program can be routinely used in school setting to improve the overall performance of the children.

Limitations and Recommendations for Research: Extravenous variables such as additional PA of the children in the form of recreation could not be monitored/controlled. Carry over effect of the change could not be evaluated over a long term.

CONCLUSION

Structured PA programs are beneficial in improving academic grades/percentage in school going children.

ABBREVIATIONS

PA - Physical Activity
PE - Physical Education
IQ - Intelligence Quotient
WHO - World Health Organization
WISC - Wechsler Intelligence Scale for Children
AA - Academic Achievement

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