A study of the relationship of physical activity with scholastic performance and body mass index in children 12-18 years of age

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Abstract

Background: Studies on relationship between physical activity and academic performance have yielded variable results while its effect on body mass index (BMI) is clearer. There is a paucity of data on the subject in the Indian subcontinent.

Objectives*:* To explore the relationship between physical activity and academic performance in children between 12-18 years by assessing the correlation of physical activity with academic performance and BMI and analysing the association of duration of physical activity with academic performance and BMI.

Method*:* A cross-sectional study was carried out involving a questionnaire based interview of 400 students in the age group of 12-18 years. The data was then analysed using correlation and unpaired t-test by SPSS software version 14.0.

Results: A moderately good positive correlation was observed for physical activity with academic performance with r = +0.49, whereas a mild negative correlation was observed for physical activity with body mass index with r = −0.31. A sub-group analysis using unpaired t–test revealed that students indulging in physical activity of more than 1 hour duration had better academic performance and a healthier BMI as compared to students with physical activity less than or equal to 1 hour duration .

Conclusions: Physical activity exhibits a positive relationship with academic performance and BMI in the adolescent age group.

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(Key words: Physical activity; body mass index; academic performance)

Introduction

Physical activity has a positive effect on children's health. It is also believed that regular physical activity is linked to enhancement of brain function and cognition. There are several hypothesized mechanisms for this such as increased blood and oxygen flow to the brain, increased levels of norepinephrine and endorphins with reduction of stress and an improvement of mood, and increased growth factors that help to create new nerve cells and support synaptic plasticity[1-6]. One meta-analysis showed a positive relation between physical activity and cognitive performance in school-age children in different measurement categories (perceptual skills, intelligence quotient, achievement, verbal tests, mathematic tests, memory, developmental level /academic readiness)[7]. Studies using electro cortical testing and functional MRI have also shown that greater amounts of physical activity are generally beneficial to cognitive processes that are related to the allocation of attentional resources and faster cognitive processing during stimulus encoding[8,9]. The time a student devotes to his physical activity is inversely proportional to his body mass index (BMI). BMI is a reliable indicator to classify an individual as healthy or otherwise. In the current environment, due to the increased syllabus and academic pressure, supplemented by pressure from parents, many students now prefer to study in their play time hours. This trend is fraught with the risk of increasing obesity. A review of literature shows that physical activity is variably correlated with scholastic performance and has a beneficial effect on maintaining BMI[10-13]. However, there is a paucity of data on this subject from our subcontinent.

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Objectives

To explore the relationship between physical activity and academic performance in children between 12-18 years by assessing the correlation of physical activity with academic performance and BMI and analysing the association of duration of physical activity with academic performance and BMI.

Method

A descriptive, cross-sectional study was carried out using a pre-designed questionnaire on students in the age group of 12-18 years, from four schools in Delhi and one college from Pune in India, over a three month period. The schools and college were chosen based on convenience. A sample size of 400 was considered to be adequate based on a correlation coefficient r=0.22 (α =0.05, confidence interval of 95%, and power of 0.8) in the pilot study which was carried out on 100 students. The questionnaire was used to assess the physical activity, academic performance and BMI of the students. Students categorized as not undertaking any physical activity were those who either had no sports, games or other activity as part of their daily regime or their daily physical activity was less than or equal to one hour duration. Student's average academic marks from the previous two years was calculated and this was considered as the index of student's scholastic performance for the study. The mean of the term exams for the school and semester exams for the college were taken for calculating one year's academic performance. Their BMI was calculated from the height and weight measured at the time of the data recording. Both non-government and government aided schools were included in the study. Children with any acute/chronic illness or disability were excluded from the study. Obtained data was analysed with Pearson correlation coefficient and unpaired t-test using SPSS software (Version 14.0). The study was approved by the ethical committee of Armed Forces Medical College, Pune.

Results

In our study of 400 students, 215 boys and 185 girls were interviewed using the questionnaire. They were from the 6th standard to the first year of college and in the age bracket of 12-18 years. The distribution in different age groups showed 40.5%, 26.8% and 32.7% children in the age bracket of 12-14, 14-16 and 16-18 years respectively. Out of the 400 students studied, 170 were from private schools and 180 from government aided schools in Delhi. The remaining 50 students were selected from a college in Pune, Maharashtra. 63.7% of boys and 44.3% girls were engaged in some sort of physical activity or sports more than 1 hour as per definition used. The distribution of academic performance showed that 14% children had more than or equal to 90% marks, 23.7% between 75-89% , 29.3% between 60-74% and 33% had less than 60% marks, with the girls marginally outperforming the boys. The distribution of BMI in kg/m^2 showed 20% children to have BMI more than 30, 26.7% with BMI 25-29.9, 29.3% with BMI 18.5-24.9 and 24% with BMI less than 18.5. On evaluation against the WHO z scores for BMI, 4.8 % children had BMI z score more than 3 indicative of obesity while 25% had z score between 2-3 indicating a high prevalence of overweight children. Box plot analysis of the academic performance and BMI with respect to duration of physical activity showed that students devoting more time to their physical activity had better academic performance and lower BMI (Figures 1 & 2).

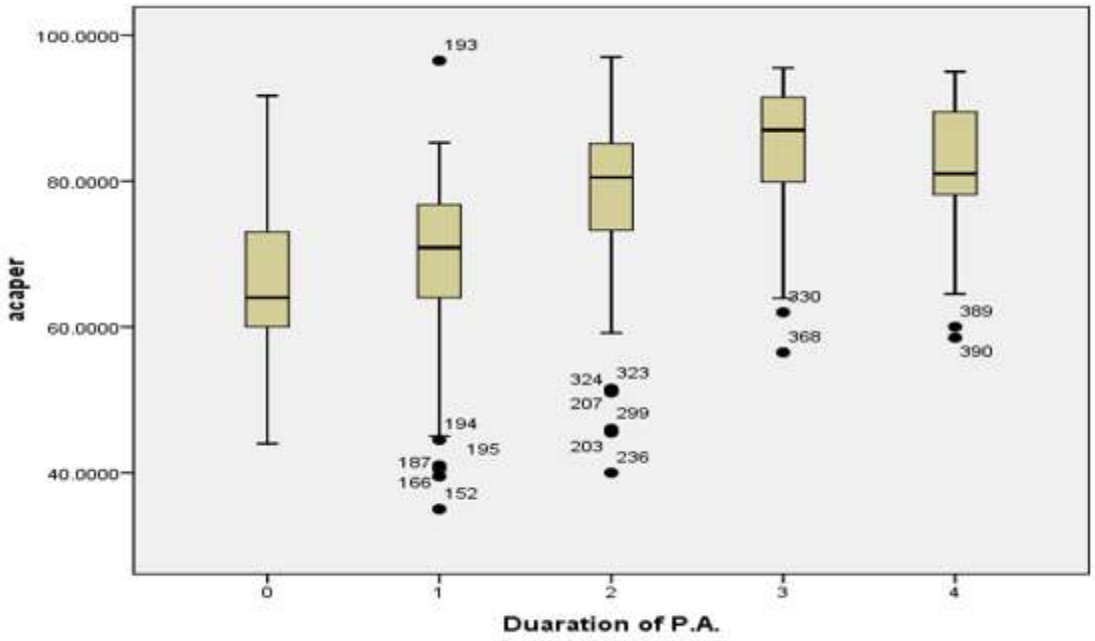

Figure 1: Box plot showing relationship of physical activity (PA) in hours with academic performance

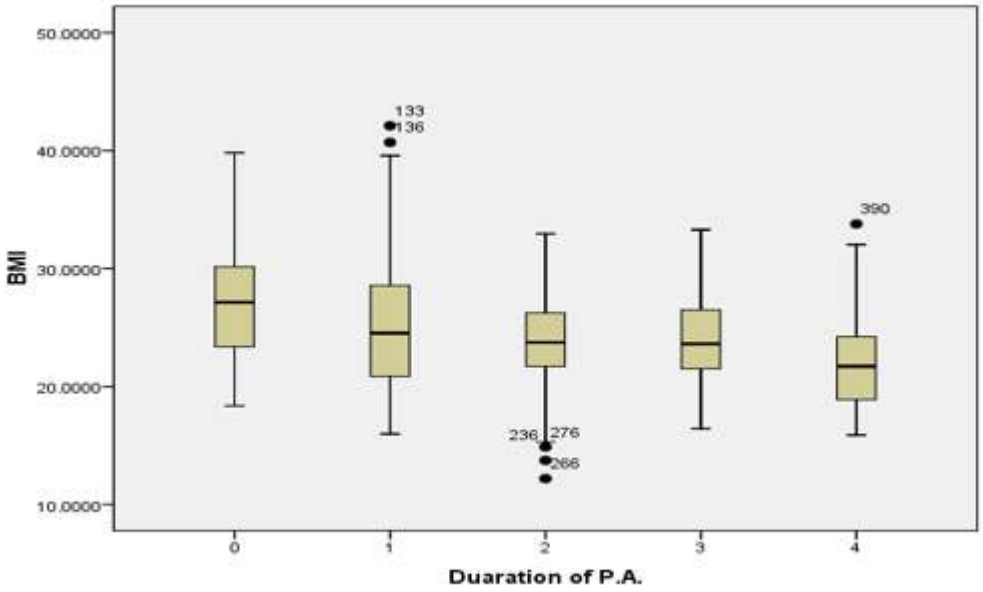

Figure 2: Box plot showing relationship of physical activity (PA) in hours with BMI (kg/m^2)

Correlation coefficient was calculated for physical activity with academic performance and BMI. The correlation coefficient of physical activity with academic performance was r = +0.49 ($p<0.001$), indicating a moderate positive relationship of the two parameters. The correlation coefficient of physical activity with BMI was r = -0.31 ($p<0.001$), indicating a mild negative relationship of the two parameters. Table 1 shows the distribution of mean, standard deviation, standard error and 95% confidence interval of student's academic performance and BMI with different hours of physical activity.

Table 1: ***Descriptive statistics of physical activity with academic performance and body mass index***

Duration of physical activity	n	Academic performance					Body mass index				
		Mean	SD	SE	95% CI		Mean	SD	SE	95% CI	
					Upper	Lower				Upper	Lower
0 hours	181	66.80	11.39	1.01	64.80	68.80	26.90	4.73	0.419	26.07	27.74
1 hour	72	68.75	12.29	1.46	65.82	71.68	25.06	5.72	0.684	23.70	26.43
2 hours	62	77.98	10.17	0.885	76.23	79.73	23.51	3.97	0.345	22.83	24.19
3 hours	48	84.55	8.63	1.15	82.23	86.86	23.81	3.49	0.466	22.87	24.74
4 hours	37	80.22	11.46	2.95	73.81	86.56	22.43	5.13	1.32	19.59	25.27
Total	400	73.82	12.63	0.631	72.58	75.06	24.86	4.78	0.239	24.39	25.33

n= number; SD= standard deviation; SE= standard error; CI=confidence interval

It was observed that academic performance of students increased proportionately up to the 3rd hour of physical activity but showed a marginal decline at the 4th hour. However, BMI of students had a consistent relationship with physical activity. An unpaired t–test was used for data analysis of the two groups with Group 1 consisting of students not taking part in any kind of physical activity or physical activity of less than or equal to 1 hour duration and Group 2 having students taking part in some form of physical activity of more than 1 hour duration (Table 2)**.**

Table 2: Students unpaired t-test for differentiating academic performance and BMI of the 2 groups

Criteria	Group	Number	Mean	SD	p value	95% CI	
Academic performance	Group 1	253	67.49	11.72	0.000	65.85	69.14
	Group 2	147	79.96	10.24		78.54	81.37
Body mass index	Group 1	253	26.25	5.17	0.000	25.52	26.98
	Group 2	147	23.51	3.93		22.97	24.06

SD= standard deviation; CI=confidence interval

It was observed that there was a significant difference in the students with the 2 groups of physical activity with respect to academic performance as well as BMI (p=0.000). The mean academic performance of students in group 1 was 67.49% whereas students of group 2 had a mean of 79.96%. This indicated a positive mean difference of 12.46% favouring physical activity of more than 1 hour duration. Similarly, a mean difference of 2.738 kg/m^2 was observed in comparing the physical activity and BMI of the 2 groups again favouring the group with physical activity of more than 1 hour.

Discussion

Academic excellence is the most sought after priority in a student's life today due to growing competition in schools. Parents too consider academics to be the most important aspect of their adolescent child's life. Many students compromise on their sports and physical activity to concentrate on academics to achieve good grades particularly in high school. In this environment, the role of sports and other physical activities in improving physical and mental wellbeing has been forgotten or ignored. Physical activity not only helps a student remain fit but also helps in his learning process. Study of relationship between physical activity and brain function has been undertaken by researchers globally and has produced variable results[8-10]. On the other hand the relationship between physical activity and BMI is clearer with definite benefits of physical activity[13]. We found numerous studies exploring this relationship but very few were from the Indian subcontinent and none attempted the study model we chose.

Eitle T found that youth whose summer arrangements involved regular participation in organized activities showed significantly lower risk for obesity than other youth[14]. In our study too we found that students who participated regularly in sports had a lower BMI. Coe et al found that students who met or exceeded guidelines for vigorous physical activity earned higher grades[15]. In our study we found out that the academic performance of the students increased proportionately with increasing hours of physical activity till a certain level. Ahamed et al found that school based physical activity did not compromise academic performance[16]. Our study showed that students who participated in physical activity performed better than students who did not. Carlson et al[17] in their study reported a small but significant benefit for academic achievement in mathematics and reading for girls enrolled in higher amounts of physical education but the findings were not similar among boys**.** Sallis et al[18] reported that despite

devoting twice as many minutes per week to physical education compared to controls, the health-related physical education programme did not interfere with academic achievement and pointed out that health-related physical education may have favourable effects on student's academic achievement.

In our study we found out that physical activity was moderately correlated with academic performance (r= +0.49) and had a mild negative correlation with BMI (r= -0.31). We also analysed students by categorizing them into group with no or minimal physical activity and group with physical activity (>1 hour) and found that students with minimal physical activity had a mean academic performance of 67.49%, 95% CI as 65.85-69.14, mean BMI of 26.25 kg/m^2, 95% CI as 25.52-26.98, whereas students with physical activity had a mean academic performance of 79.96%, 95% CI as 65.85-69.14, mean BMI of 23.51 kg/m^2, 95% CI as 78.54-81.37. This showed that students who indulged in physical activity had better academic performance and a healthier BMI.

Our study suggests that there exists a definite relationship of physical activity with academic performance and BMI in students with a favourable effect on both. The main limitation of our study was the sampling method and the size. There could always be an argument that children who were able to multi task and manage their time better were able to indulge in both physical activity and studies and perform better as individuals at the outset. Secondly, it was a relatively small convenience sample and lacked representation from children from various economic backgrounds and hence we recommend similar studies at the community level so that the results can be verified. Once validated, the positive effect of physical activity can be emphasized and promoted at all levels so as to achieve both physical and mental wellbeing in this crucial period in a child's life.

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