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Review

PHYSICAL FITNESS, PHYSICAL ACTIVITY AND ACADEMIC ACHIEVEMENT IN SCHOOL GOING CHILDREN: A NARRATIVE REVIEW

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ABSTRACT

Objective: The aim of this narrative review is to examine the available literature related to association of physical fitness and physical activity with academic achievement in school going children.

Methodology: Literature was searched with the use of many electronic databases (Google Scholar, CINAHL, Pubmed central and Oxford Press, Science direct, National Library of Medicine (Pubmed), Biomed Central).Additionally, more reference articles were searched to increase the search of accuracy.

Results: Results of most of the studies evaluating the relationship of the physical fitness and physical activity with academic achievement are contradictory. Findings from the most of the studies indicated either a positive or null association. Negative association was found to be very rare. Missing from this literature is a clear understanding of whether individually or collectively physical activity and physical fitness influences the academic achievement & executive function is lacking in current literature.

Conclusion: Most of literature suggests that increasing physical activity and aerobic fitness are often proposed as a way to improve children's health, physical fitness and Academic achievement but there has been some inconsistency across studies concerning the relation between physical activity, physical fitness and academic achievement. This is due in part to measurement and methodological issues (e.g., measuring only physical activity or only aerobic fitness, lack of adequate control for confounding factors).This could be an active topic of future research. So the more studies are necessary for providing definite evidence to confirm this relationship.

KEY WORDS: Physical Fitness, Physical Activity, Academic Achievement, school going children.

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INTRODUCTION

Healthy body is necessary for increasing the working capacity and maintaining physical fitness of any individual to perform his daily tasks vigorously and alertly, with left over energy to enjoy leisure time activities. [1].

Childhood obesity becoming a national health problem and physical education classes dwindling physical health, cognitive functioning, and Academic Achievement (AA) have also become growing concerns [2].

Physical fitness is a set of attributes associated with the capacity to perform a variety of physical activities [3], and consists of several dimensions like muscular strength, muscular endurance, speed, and cardiovascular endurance. While physical fitness has a strong genetic component, regular involvement in

physical activity is essential for promoting physical fitness of children [4]. A variety of health benefits are associated with physical fitness. Being physically fit reduces the risk of cardiovascular disease, colon cancer, diabetes, dying prematurely, and obesity [5]. It promotes development of the cardiovascular and musculoskeletal system. In addition, the physiological stress as a result of physical activity will be present in the brain, and can promote brain function. This has already been demonstrated in research on adults, which shows that physical activity enhances learning and memory [6], and might be even more important when the brain is still developing rapidly, as is the case in school aged children.

Regular physical activity builds healthy bones and muscles, improves muscular strength and endurance, reduces the risk for developing chronic disease risk factors, improves self-esteem, and reduces stress and anxiety. In addition, there is evidence that physical activity promotes intelligence and brain development. Intelligence can be defined as "the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment" [7]. Contemporary educational organizations propose that children's experiences in sport and Physical Education (PE) contribute to the mental acuity, skills, and strategies that are important for navigating challenges faced across the life span.[8] Research has shown that more physical education programs are useful for improving cardiorespiratory fitness, muscular ability, body mass index, bone health, the health of organs, and improving cognitive function [9].

Physical activity has been associated with general and selective benefits in cognitive function; mainly in older adult populations [10]. The relationship of aerobic fitness to underlying aspects of cognition in children is virtually unexplored. However, recent findings have indicated that fitness may be related to academic achievement [11].

Physical activity and fitness are also powerful markers of child and adolescent health [3]. Physical activity and/or aerobic fitness has been associated with reduced fatness[12-20] and blood pressure [14,21,22]and improved bone health [23,24,25]. Relatively strong (observational) evidence indicates the positive effects of physical activity and fitness on mental and emotional health of youth [3,26-31]. Physical fitness and aerobic fitness decline as youth transition from childhood and middle school to adolescence and high school [32-35] and this may be especially true for females, in general [36-41], females who mature early [42,43] and youth who are overweight.[20,35] Males have higher levels of typical physical activity than females; for both, activity tends to decline over the progression from elementary and middle school through grade 12 [33].

Almost two thirds of the nation's high school students do not meet one recommended level of participation in physical activity: being physically active enough to raise heart rate and breathe hard some of the time at least 60 minutes per day on 5 days of the prior week [44].

Executive functions refer to various cognitive processes used to regulate goal directed interaction with the environment, especially in non-routine and unstructured situations. [45] Executive functioning is an umbrella term that includes a wide range of skills and abilities, it is considered to include four core abilities; inhibition, working memory, cognitive flexibility, and strategic planning [46, 47].

Academic achievement is related to school performance, and is most often expressed as academic grade or score on standardized tests of mathematics, reading and spelling. Mathematics, reading and spelling are complex skills that require a child to effectively plan, update working memory, shift attention or inhibit impulsive behaviour [48].

Executive functions are thus essential for academic achievement as well. In addition, the development of executive functioning goes together with the development of language [49].

It is thought that improvements in executive functioning facilitate improvements in academic achievement [48], or that adequate executive functioning develops prior to behaviours affecting academic achievement [49].

Results from cross-sectional studies indicate a positive association between physical activity and academic performance in children [50,51].

Higher levels of physical fitness are generally related to enhanced overall health [4,52] and are also associated with higher academic achievement [53-59].

Findings from interventional studies also show that children in the physical activity intervention group have at least similar academic performance compared with children in the control group, despite a substantial reduction in time devoted to academics [50,51]. The effect that sedentary behaviours have on cognitive performance is of concern. Increased television viewing time is associated with worse academic performance in children [60,61,62] and adolescents [63] yet playing action video games seems to improve cognitive performance in adults [64,65,66].

Beyond the educational setting, measures of standardized testing or grades are representative of cognitive functioning, which has also been associated with physical fitness [59,67]. Research has shown that students who are physically fit tend to perform better academically, as determined by academic grades and standardized test scores, than their less fit peers [53-59].

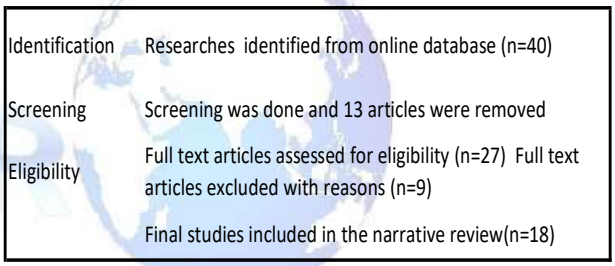
Results from the different studies indicated that overall pattern of findings indicates either a positive or null association between physical fitness, physical activity and academic achievement [56, 68-73]. Rarely a negative association is reported [68, 74-76] Missing from this literature is a clear understanding of how each indicator (physical activity and physical fitness) operate together and separately to influence academic achievement and executive function. This could be an active topic of future research. So the more studies are necessary for providing definite evidence to confirm this relationship.

METHODOLOGY

First author have searched and assessed the literature and it was done by comprehensive computerized search on Google Scholar, CINAHL, Pubmed central and Oxford Press, Science direct, National Library of Medicine (Pubmed), Biomed Central. The key words "physical fitness, physical activity and academic achievement were used. Additionally, reference lists of most important articles were searched to increase the search accuracy, as much as possible. Authors have included all the available literature which is evaluating the relationship of physical fitness and physical activity with academic achievement in school going children.

Second author had reviewed and revised the manuscript. Authors have searched a total of 40 articles. 8 articles were not showing the relationship of physical fitness and/or physical activity with academic achievement in the school children and 5 articles were showing the relationship of physical fitness and physical activity with cognition in the older individuals hence discarded. Out these 27 articles, 4 abstracts, 1 narrative review, 2 Phd thesis, 2 pilot study were excluded with reasons. At the end, authors reviewed 18 articles. (Figure 1)

Fig. 1: Literature search



Does the relationship exist between physical fitness and academic achievement? Jamie A. Donnelly [77] performed study to examine the statistical relationship between physical fitness, as measured by the FitnessGram, and quantitative data on school performance including grades, standardized test scores, school behavior, and attendance among 280 middle school girls of Florida. Author had concluded that a statistically significant correlation was found between Body Mass Index(BMI), grades, and attendance and also stated that interventions to increase physical fitness may be a way to foster greater school performance in middle school girls.

A study to determine the relationship between fitness and health profiles and academic achievement of ITB (Institute of Technology Board)students was done by Didi Sunadi et al [78] Subjects were ITB students of the Matriculation Stage for the study. Their fitness was assessed using a 2.4 km run-test, the health profile using a National Wellness Institute questionnaire, and the learning achievement scores taken from the end of the semester GPA

(Grade Point Average). Authors found that students who participated in a sports course during a semester and those with better fitness levels achieved better GPAs at the end of the semester. Authors concluded that Students with better fitness levels and health profiles showed better academic achievement than those with weaker physical health.

Hassan-Ali Kalantari and Samad Esmaeil-zadeh[79] conducted study to explore the association between academic achievement and physical status including physical activity, aerobic and muscular fitness tests in a sample of adolescents from North West of the Iran. A total 580 adolescent boys of 15-17 years underwent standard anthropometry and various physical fitness tests (e.g., one-mile run/walk, grip strength, run speed, agility, push-ups and sit and reach tests). Physical activity was obtained by questionnaire. Academic achievement of the boys was recorded from the Cumulative Grade Point Averages (CGPA) from school records. Results of their study concluded that only Aerobic fitness (but not physical activity and muscular fitness) was significantly correlated to better academic achievement in adolescent boys.

Aklilu Seifu Adesa et al [80] conducted study to investigate the relationship between physical fitness and academic achievement among Model School students of Haramaya University. The pre and post tests on selected health related physical fitness parameters(nine meter running /walking test, ninety degree push up, trunk lift test, sit and reach test, BMI were administered on two groups (experimental group and control group). For academic achievement the first semester GPA was taken as pre- test and Second Semester GPA was taken as post-test for both groups. The GPA of both the groups was determined by calculating an average of all subjects. The training schedules were for twelve weeks for physical fitness exercises and it was arranged between the first semester final exam and Second Semester final- Exam. The intensity for exercises were low to moderate, for three days per week (Monday, Wednesday and Saturday) after their regular classes for experimental group. Results of their study showed that experimental group was greatly improved from first to second semester while control group's mean GAP value was decreased from first to second semester. Authors concluded significant relationship between physical fitness and academic achievement.

Coral Torrijos-Nino et al[81] did study to examine the association of physical fitness and obesity with academic achievement and the independent association between fitness and academic achievement after controlling for relevant confounders in school aged children of Spain (N=893,aged 9-11 years).Information on Academic achievement (mean of the grades obtained in several core subjects), physical fitness (cardio-respiratory fitness, muscular fitness, and speed/agility), weight, height, and parental education were noted .Authors concluded that academic achievement scores were positively related to fitness levels. Obese boys had lower scores for academic achievement than overweight or normal weight boys. Good cardio-respiratory and speed/agility levels were associated with high academic achievement after controlling for confounders.

J. W. de Greeff et al [82] conducted study to examine differences between children with a low socioeconomic status Socially Disadvantaged Children (SDC) and children without this disadvantage (non-SDC) on physical fitness and academic performance. A total 544 children were recruited and analysed (130 SDC, 414 non-SDC). Physical fitness was measured with tests for cardiovascular and muscular fitness. Academic performance was evaluated using scores on mathematics, spelling and reading. Results of their study showed a significant interaction effect between SDC and Cardiovascular fitness for spelling. Authors concluded a specific link between cardiovascular fitness and mathematics, regardless of socioeconomic status. SDC did moderate the relationship between cardiovascular fitness and spelling.

Anneke G. van der Nieta et al [83] did study to investigate the relationship between physical fitness and academic achievement via executive functioning. Authors examined 263 children (145 boys, 118 girls), aged 7 to 12 years, who performed tests on physical fitness, executive functioning, and academic achievement. Results of the study showed that in a structural equation model linking physical fitness to executive

functioning and academic achievement there was a significant relationship between physical fitness and executive functioning (r = .43, R2 = .19) and academic achievement (r = .33, R2 = .11) Results of their study concluded Executive functioning to be serving as mediator in relation between physical fitness and academic achievement. This highlights the importance of including executive functioning when studying the relationship between physical fitness and academic achievement in children.

Jud C. Janak et al[84] performed study to find out association Between Physical Fitness and Academic Achievement in Texas State House Legislative Districts. The purpose of their study was to describe the association between academic achievement, BMI, and Cardio Vascular Fitness (CVF) in a large sample of elementary, middle, and high school students.2,550,144 students were matched with standardized composite academic test Texas Assessment of Knowledge and Skills (TAKS) results from 2008 to 2009.Results of their study showed that prevalence of students meeting the TAKS standard was significantly higher in the highest fitness category for BMI and CVF compared to all other categories, regardless of sex or grade category (p<.05).

A study performed by Catherine L. Davis and Stephanie Cooper [85] to examine the associations of fitness and fatness with cognitive processes, academic achievement and behaviour, independent of demographic factors. 170 overweight, sedentary but otherwise healthy 7–11 years old were selected for the study. Anthropometric measurements, body fat analysis (whole-body dual energy X-ray absorptiometry scans), Visceral and subcutaneous abdominal fat measurement (MRI), fitness (Graded Treadmill Test), cognition (planning , attention, simultaneous and successive scale), academic achievement (Woodcock–Johnson Tests of Achievement III) and behaviour (ratings by parents and teachers) were assessed for all the children. Results of their study concluded that fitness was associated with better cognition, achievement and behavior, and fatness \with worse scores. Specifically, executive function, mathematics and reading achievement and parent ratings of child behavior were related to fitness and fatness.

Van Dusen DP et al[59] did study to evaluate the relationship between physical fitness and academic performance among school children of Texas. Physical fitness was measured by 6 independent fitness tests using FITNESSGRAM® (aerobic capacity measured by the mile run or PACER(progressive cardio endurance run) test; body composition, as measured by skin folds or BMI); abdominal strength and endurance, as measured by curl-ups; trunk extensor strength and flexibility, as measured by trunk lift; upper body strength and endurance, as measured by push-ups; and flexibility, as measured by shoulder stretch or the sit-and-reach test.) Academic performance was measured using the score of TAKS examination (Reading/English Language Arts, Mathematics, Writing, Social Studies, Science) which is administered to students saccording to grade level. Results of their study concluded that fitness was strongly and significantly related to academic performance.

Does the relationship exist between physical activity and academic achievement? A study conducted by Heidi J. Syväoja et al[86] to investigate the associations of subjectively and objectively measured physical activity and sedentary behavior with academic achievement among the school children throughout the Finland. A sample of 970 children aged 9–15 (52.3% girls) were recruited in the study. Register-based academic achievement GPA as well as self-reported and accelerometer-measured Physical activity/sedentary behaviour were measured. Aerobic fitness, measured by maximal shuttle run test, body composition measured via bio impedance analysis, and self-reported bedtime were collected. Results of their study concluded that participating in physical activity, avoiding excessive screen time, and going to bed earlier may benefit academic achievement.

Suchert V et al [87] conducted study to examine associations of cardiorespiratory fitness, physical activity and weight status with academic achievement among German students (n=1011). Cardiorespiratory fitness was determined with the 20m shuttle run test ,physical activity guidelines was assessed through questionnaire,

weight status was based on body mass index percentiles and academic achievement was assessed with students' self-reported grades in Mathematics and German. Results of their study showed that high fitness in adolescence is associated with higher subsequent academic achievement. The promotion of physical activity might benefit school performance because of enhanced fitness levels in the long-term and positive influences of physical activity in the short term.

Maite Pellicer-Chenoll et al [88] performed study to confirm the relationship among physical activity, physical fitness and academic achievement in adolescents of Barcelona city. Four hundred and forty-four students participated in their study. The physical activity (measured through international physical activity questionnaire) and physical fitness of the participants (BMI, cooper test, counter movement jump and handgrip isometric strength) were measured, and the participants' grade point averages were obtained from the five participant institutions. Results of their study showed that students with higher energy expenditure and better physical fitness exhibited lower BMI and higher academic performance, whereas those adolescents with lower energy expenditure exhibited worse physical fitness, higher BMI and lower academic performance.

Booth JN et al [89] did study to test for cross-sectional (at age 11) and longitudinal associations between objectively measured free-living physical activity and academic attainment in adolescents from UK. A total of 4755 participants (45% male) were selected for the study. Measurement of physical activity by accelerometry was done at age 11.Academic attainment performed by nationally administered school assessments in English, Maths and Science at ages 11, 13 and 16.Findingds of their results concluded that long-term positive impact of physical activity on academic attainment in adolescence.

Wi-Young So et al [90] did study to investigate the effects of various types of physical activity with the academic performance of Korean adolescent students. A total of 75,066 adolescent students (39,612 males and 35,454 females) from the 7th to the 12th grades took part in the study. Physical activity and academic achievement was assessed with questionnaire. Authors concluded from the study that vigorous physical activity was positively correlated with academic performance in the case of boys, and moderate physical activity was positively correlated with academic performance in both boys and girls. However, strengthening exercises were not positively correlated with academic performance in boys or girls. A study was performed by José Morales et al [91] to analyze the relationship between the amount of physical activity and academic performance in 3rd-year secondary education students of Barcelona. 284 students (158 girls, 126 boys) with an average age of 14.7 years participated in the study. The International Physical Activity Questionnaire was used by students to self-report their amount of physical activity. Students' academic records were obtained for comparisons. Results of their study showed that there was a linear relationship between academic performance and physical activity.

Mark S. Tremblay et al [92] did study to find out the relationships between children's reported levels of physical activity, body-mass index, self-esteem, and reading and mathematics scores. A total of 6,923 Canadian children were selected for the study. Results of their study revealed that the relationship between physical activity and academic achievement is weak. For some children, physical activity may be indirectly related to enhanced academic performance by improving physical health and self-esteem.

Dwyer T et al [55] performed study to examine the association of scholastic performance with physical activity and fitness of children.7961 Australian school children aged between 7-15 years were examined. Scholastic ability was assessed on a five point liker scale from school's principal. Physical activity was assessed through questionnaire and fitness was assessed with 1.6 Km run, push ups, sit ups, standing long jump, 50 meter sprint. They concluded that school rating of scholastic ability were associated with physical fitness, capacity and activity.

Summary and future directions:

'The purpose of this article was to search, review and evaluate the existing scientific

literature to examine the relationship of physical fitness and physical activity with academic achievement among school children. 2 out of the 18 articles evaluated the relationship of both physical fitness and physical activity, 8 articles have evaluated only physical fitness relationship and 7 articles have evaluated only physical activity relationship with academic achievement that were included in this narrative review and confirmed the relationship except one study. Although the study of physical fitness and physical activity to academic achievement and scholastic performance is more established in the literature, researchers in this area also need to better characterize the relationship between physical and cognitive health.[93] Different assessment methodologies were utilized for evaluating the physical fitness, physical activity and academic achievement intending to understand the relationship. So there is no gold standard tool yet available to assess the physical fitness, physical activity and academic achievement. Future efforts need to use more crucial designs to causally link physical fitness and physical activity with academic achievement during development.. Future studies can be done to explore various confounding factors associated with academic performance.

CONCLUSION

Most of literature suggests that increasing physical activity and aerobic fitness are often proposed as a way to improve children's health, physical fitness and Academic achievement but there has been some inconsistency across studies concerning the relation between physical activity, physical fitness, and academic achievement. So this could be an active topic of future research to confirm and explore the strength of relationship in detail.

Conflicts of interest: None

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