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Relationship between Physical Activity and Academic Achievement among School Going Children of Surat City, Gujarat: A Correlational Study

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ABSTRACT

Background and purpose: In the Gujarati culture, Education is so strongly emphasised by parents as well as by school educators. They believe that academic success is only the indicator of success, while too much physical activity (PA) is often discouraged because it drains energy and affects academic performance and concentration. So the present study was undertaken to investigate the relationship between PA and academic achievement (AA) among school children of Surat city, Gujarat.
Methodology: The participants were 210 children (11-14 years) selected from 7 different schools (Gujarat board secondary education) of Surat city. PA was assessed with the Physical activity questionnaire for children (PAQ-C).Students' AA was noted by their recent examination results in core subjects including language (Gujarati and English), mathematics, science and social study provided by the administrative services of the schools participating in the study. Anthropometric data {Height (meters), weight (Kg), BMI (body mass index)} and self-reported socio-demographic data were also recorded.
Results: Mean±SD of PA level among children (n=207) was 2.40±0.78.Finding showed a PA has significant moderate positive correlation with AA.(rho value for the Maths: 0.47, science: 0.44, English:0.50,Gujarati:0.40,Social study:0.42,p value for all the subjects <0.0001).
Conclusion: Present study concluded that PA has an impact on AA of school children, so the PA in school setting as well as outside the school should be promoted by parents and school teachers for 2 main reasons: As PA increases AA and physical fitness too.

Key words: Physical activity, PAQ-C, Academic achievement, School children

INTRODUCTION

Physical activity (PA) is considered a fundamental health component[1]; hence the promotion of PA in children and adolescents is particular important for improving the quality of life.[2]Over the last several years, society has witnessed serious consequences due to the lack of PA among students. The lack of PA is an antecedent condition for several illnesses, such as obesity and diabetes[3]

Children and youth receive numerous physical health benefits from PA, including improved fitness, cardiovascular function, metabolic function, and bonehealth.[4]Despite these health benefits, many children continually fail to meet PA recommendations.[5]To increase PA in a large number of children, experts have targeted schools as a setting for promoting PA.[6,7]One approach has been to associate PA with academic achievement(AA).

AA is referred to as knowledge that is obtained by an individual during the academic period for a subject or group of subjects that one learns in an academic year such as a semester.[3]Vialle et al.[8] claims that academic performance is not merely dependent upon the degree of intellectual energy, but rather on many other constructs, such as motivation, self-esteem, and social factors. This shows that AA is a multi-faceted concept that is covered by several social, emotional, and personality factors.[3]

PA also has beneficial influences on behavior and cognitive functioning that may result in improving students' AA.[9,10,11] Direct indicators of AA include grade-point averages, scores on standardized tests, and grades in specific courses; measures of concentration, memory, and classroom behavior provide indirect estimates[12].

With respect to the consequences of obesity and physical inactivity, there are many studies focused on the relationship between childhood obesity and AA[13,14,15] although the results are inconclusive and the relationship remains unclear. The literature includes contemporary views on the impact of PA on learning procedure among students and recent studies show that regular exercise leads to better mental health.[16] The practice of physical exercise is extremely beneficial to health.[2] It has several health-related benefits for children and adolescents.[17]

Recent literature showed that consistent PA plays a crucial role not only in physical fitness, but also in psychological health.[18, 19]It has been suggested that PA could also exert a positive effect on cognitive function and learning.[20-22] This putative association is based on evidence that PA[23,24] as well as physical fitness[25] are related to different types of changes in the brain relevant for cognitive function and learning. This has led to an increasing interest in the associations between PA behavior and academic performance. Several review articles have evaluated the association between PA and academic performance. The findings emerging from reviews based on numbers of studies suggest that the association between PA and academic performance is mainly positive[22,,26,27,28] but there are other studies reporting no association or even a negative association. In particular, more recent studies using objectively measured PA have tended either to find no association[29,30] or even a negative association[30,31] between PA and academic performance.

Thus, to have more robust results on association of PA with AA among children and adolescents because of small sample sizes; cross-sectional design; failure to take account of confounding factors such as socio-economic status (SES) and gender and school grade,; improper tool for the measurement of PA in the previous studies[32,33], the present study was undertaken to find out relationship between PA and AA among school going children of Surat city, Gujarat. The present study was undertaken as a part of large research study.

METHODOLOGY

Institutional ethical committee of SPB Physiotherapy College, Surat with Reg. no. EC/SPB/011 approved the study before actual the commencement of the study. The study is also registered under the clinical trial registry of India with registration no. CTRI/2018/12/016800. The school authorities and principals were explained about the purpose and procedure of the study in their vernacular language. After obtaining written and verbal permission from school authorities/principals, a total of 7 schools (Gujarat board secondary education) were recruited for the study (one from the each zone of Surat city).Exclusion criteria for the study were child with any history of / diagnosed case of- Diabetes, acute or chronic respiratory disorder, cardio-vascular disorder, neurophysiological disorder, musculoskeletal disorder, any other known medical/systemic condition, on any regular medication and the one diagnosed with any physical problem in annual physical examination conducted by school authorities. A total of 210 children studying in the 6th, 7th and 8th standard were

selected as a sample in the present study. The parents of students received a flyer describing the study, including exclusion criteria and study procedures. Parents of students interested in participation provided their contact information along with parent's education, occupation and monthly income details to the school in the sealed envelope. Because of a large response, a random sample of 30 students (10 from each grade) from each school were selected from those who provided parental consent and child assent to complete the outcome assessments used for this study, including PA and AA. 3 students were absent on the day of survey so they were excluded. A total of 207 children were included in the study. Participants also completed tests of physical fitness (20 meter shuttle run test, hand grip measurement with hand dynamometer, standing broad jump, sit ups in 30 seconds, sit and reach test,10×5 meter shuttle test) for the larger study.The anthropometric measurements (height and weight) were taken for all children. The information regarding demographic data, attending tuition, television viewing/playing video games /use of mobile phones, no. and duration of break (recess) in the school, physical education class details and other school activity details were recorded also.

Measures:

PA measurement:

PA was measured with the self-reported PAQ-C (Physical activity questionnaire-Children) which is a valid and reliable tool.[34,35] Cross culturally adapted English version of PAQ-C was used for the English medium students and cross culturally adapted and translated Gujarati version of PAQ-C [PAQ-C (G)] for the Gujarati medium students. The PAQ-C includes nine items, each scored on a 5-point scale. A score of 1 indicates low PA, whereas a score of 5 indicates high PA. The first question provides a PA checklist including over twenty kinds of sport and exercise activities asking the students how many times they did each in the past seven days. In that some sports activities from the original PAQs (English version) were substituted by sports activities practiced in Gujarat as permitted by Kent C. Kowalski(developer of original PAQ-C).The next six questions examine their activity level in different school settings at certain periods in the last seven days (physical education, recess, immediately after school, evening, weekends).The eighth question requires the students to summarize their general activity levels from among five different statements. The ninth question asks students to report their frequency in PAs for each day of the previous week. The last question asks students about their health. This question was not used to score the PA level but used to present reasons for not participating in PA. Composite score of nine items (out of 10) was taken and PA of each participant was rated by taking mean of those nine items' score which would range from one to five with a higher value indicative of a higher activity level.[36]

Face content validity and test retest reliability of PAQ-C(G) were established before the commencement of the present study. PAQ-C (G) has good face-content validity and reliability coefficient using average-measure intra-class correlation coefficient (ICC) total score of PAQ-C (G) was 0.82 which is strong positive correlation. The test-retest reliability between individual items showed that PAQ-C (G) had moderate to strong correlation with ICC value between 0.78 to 0.91. Internal consistency reliability of PAQ- C (G) was $\alpha = 0.94$ and $\alpha = 0.92$ for assessments one and two (one week apart).[37]

Academic achievement[38, 39]:

Students' AA was measured by their recent examination results including language (Gujarati and English), mathematics, science and social study provided by the administrative services of the schools participating in the study. For analysis, each of the subject grades were rated as follows: Grade A=7,A^+=6,B^+ =5 Grade B =4, Grade C^+=3, Grade C =2, Grade D =1, Grade E= 0.

The researchers obtained the verbal consent of the classroom teachers and students before administering the questionnaire. Purpose and procedure of study along with necessary instructions to fill up PAQ-C were explained to the children, all of the questions were read out loud and any questions if they had were answered. The 15 to 20 minutes were given to fill up the questionnaire in the classroom.

Before the data were collected, a pilot study with one class from 6th standard was performed to test the efficiency of the methodology and to check that participants understood the instructions for completing the PAQ-C. No problems were raised by participants or class teacher. This class was not included in the main study. All participants completed the questionnaire during class time using standardized instruction.

Statistical analysis:

Data analysis was done using SPSS version 21.Descriptive statistics {mean (SD), Frequency (%)} were used to depict the characteristics of the study population and PA levels. Spearmen's correlation coefficient was used to assess relationship between variables. Level of significant was kept as 5%.

RESULTS

Sample characteristics, including average PA, average BMI and the number of students in each grade, gender, timing for watching television, playing videogames and doing homework in the school are shown in Table 1. Correlation of PA with AA is depicted in Table 2.

Table 1: Sample characteristics

Variable	N or Mean	SD
Gender (Boys: Girls)	92:115	-
Age (years)	12.17	1.09
Weight (kg)	37.55	9.82
Height (meter)	1.443	0.09
BMI	18.00	4.37
PA	2.40	0.78
Grade		
Grade 6	69	
Grade 7	68	
Grade 8	70	
Doing homework/study(hour/day)		
None	0	
<30 minutes	29	
< 1 hour	59	
1-2 hours	53	
Hours	39	
>3 hours	27	
Watching television (hour/day)		
None	38	
<30 minutes	62	
< 1 hour	62	
1-2 hours	24	
Hours	10	
>3 hours	11	
Play videogames /use mobiles (hour /day)		
None	36	
<30 minutes	107	
< 1 hour	32	
1-2 hours	10	
Hours	9	
>3 hours	13	

Table 2: Correlation of PA with academic achievement among all students

	AA variable	rho value	P value
PA score (2.40±0.78)	Maths	0.47	<0.0001
	Science	0.44	<0.0001
	English	0.50	<0.0001
	Guajarati	0.40	<0.0001
	Social science	0.42	<0.0001

DISCUSSION

The aim of the present cross-sectional study was to analyze the association of PA with AA. Findings suggest a moderate significant positive

relationship between PA and AA among schoolchildren in the core subjects.

According to the body of literature, the vast majority of studies found positiveassociations[40,41,42,43,44,45] between PA and AA. Likewise, Van Dijk et al (2014)[30] evaluated 255 Dutch students from the 7th and 9th grades, and detected that in the ninth grade students, both the MVPA (moderate to vigorous physical activity) and total PA were positively associated with AA. However in most of the studies, subjective assessment measures were used to measure the PA.

A study done by Syväoja et al.[29] (2013) in Finnish adolescents and a study done by TâniaOliveira et al[46] in Portugal children did not found any significant association between PA and AA. A similar sample found that self-reported PA was directly associated with AA, however when PA was objectively assessed positive associations were not found. A longitudinal study done by Esteban-Cornejo et al.[31], 2014 and a study done by Booth et al[18] (2014) found that PA and AA were negatively associated. However the studies with negative or no association results between the PA and AA, measured PA with objective measure using accelometer or activity graph. Probable reason for the differences in the results (association of PA with AA) with subjective and objective methods to measure the PA was that with the subjective assessment measures of PA may overestimate the time spent in MVPA[47] and may not have the ability to account for activities of less than 10 minutes in duration, while objective measures include mostly all PA independently of its length.[48]

The plausible reasons have been suggested for the moderate positive association of self reported PA and AA. One possible explanation might be that an increase of PA is associated with an increase in general self-efficacy which itself has a positive influence on school performance.[49] On the physiological level, studies have revealed that PA enhances angiogenesis in the motor cortex and increase the blood flow and oxygen[50]to the brain.[31,51,52] PA stimulates neural development by increasing the density of neural synapses[53] and influence the levels of neurotransmitters in the brain, such as serotonin and/or norepinephrine, thereby facilitating information processing.[54]Along with this PA has an important role in the regulation of neurotoxins influencing neurogenesis, namely increased synthesis of catecholamines (dopamine and epinephrine)[50] and brain-derived neurotropic growth factor (BDNF), which has a key role in brain plasticity, learning and memory.[55,56] It should also be highlighted that the benefits of PA have a particular effect on the frontal lobes of the brain that are involved in the regulation of decision-making functions, which could be crucially important in school success. Psychologically it is thought that PA and physical fitness are positively associated with the reduction of stress and anxiety, have beneficial effects on mood due to the increased levels of norepinephrine and endorphins[57], increase self-esteem, and are also positively associated with the improvement of cognitive functions, in particular attention and working memory.[25,58] On a behavioural level, it has been suggested that PA enhances concentration in classroom.[27]PA may also influence fitness, other social cognitive factors, and other health characteristics that may serve as mediators or moderators for this relationship.

The present study has certain limitations. The study is cross sectional in nature. A longitudinal design with a large sample may generate different results. Next, the instrument for assessment of PA measurement used in this study is all subjective measures, as it is a self-report measure of PA. Researchers could measure the underlying constructs with additional objective measures. Another limitation of the study was the AA has only been considered in terms of grades of core subjects in the recent examination. The other aspects of measuring academic

performance could be used. The present study is also limited to the school children of specific grade and age. So, the findings are only represented to that particular grade and age. Additional studies could also be undertaken with students of varying age and grade. Future studies should use strong study designs to examine the types and doses of PA needed to produce improvements in AA. All such limitations could be taken into account in future research.

CONCLUSION

Results of the present study concluded that there was moderate significant positive correlation between PA and AA. These findings suggest that promotion of PA should be a major goal in school setting for 2 main reasons: One is substantial increases in PA appears to be directly associated with increases in AA and students with a substantial increase in PA might achieve higher fitness levels.

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REFERENCES

1. Lotan M, Merrick J, Carmeli E. Physical activity in adolescence. A review with clinical suggestions.
2. Hallal PC, Victora CG, Azevedo MR, Wells JC. Adolescent physical activity and health. Sports medicine. 2006 Dec 1;36(12):1019-30.
3. Kayani S, Kiyani T, Wang J, Zagalaz Sánchez ML, Kayani S, Qurban H. Physical activity and academic performance: the mediating effect of self-esteem and depression. Sustainability. 2018 Oct;10(10): 3633.
4. Centers for Disease Control and Prevention. US Department of Health and Human Services Physical activity guidelines for Americans 2008. Washington, DC. 2008.
5. Eaton DK, Kann L, Kinchen S, Shanklin S, Flint KH, Hawkins J, Harris WA, Lowry R, McManus T, Chyen D, Whittle L. Youth risk behavior surveillance-United States, 2011. Morbidity and mortality weekly report: Surveillance summaries. 2012 Jun 8;61(4):1-62.
6. Pate RR, Davis MG, Robinson TN, Stone EJ, McKenzie TL, Young JC. Promoting physical activity in children and youth: a leadership role for schools: a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism (Physical Activity Committee) in collaboration with the Councils on Cardiovascular Disease in the Young and Cardiovascular Nursing. Circulation. 2006 Sep 12;114(11):1214-24.
7. Pate RR. A national physical activity plan for the United States. Journal of Physical Activity and Health. 2009;6(Supplement 2):S157.
8. Vialle W, Heaven PC, Ciarrochi J. The relationship between self-esteem and academic achievement in high ability students: Evidence from the Wollongong Youth Study.
9. Tomporowski PD. Cognitive and behavioral responses to acute exercise in youths: A review. Pediatric Exercise Science. 2003 Nov 1;15(4):348-59.
10. Coe DP, Pivarnik JM, Womack CJ, Reeves MJ, Malina RM. Effect of physical education and activity levels on academic achievement in children. Medicine & Science in Sports & Exercise. 2006 Aug 1;38(8):1515-9.
11. Sallis JF, McKenzie TL, Kolody B, Lewis M, Marshall S, Rosengard P. Effects of health-related physical education on academic achievement: Project SPARK. Research quarterly for exercise and sport. 1999 Jun 1;70(2):127-34.
12. Strong WB, Malina RM, Blimkie CJ, Daniels SR, Dishman RK, Gutin B, Hergenroeder AC, Must A, Nixon PA, Pivarnik JM, Rowland T. Evidence based physical activity for school-age youth. The Journal of pediatrics. 2005 Jun 1;146(6): 732-7.

13. Trudeau F, Shephard RJ. Physical education, school physical activity, school sports and academic performance. International Journal of Behavioral Nutrition and Physical Activity. 2008 Dec; 5(1):10.
14. Hillman CH, Erickson KI, Kramer AF. Be smart, exercise your heart: exercise effects on brain and cognition. Nature reviews neuroscience. 2008 Jan;9(1):58-65.
15. Tomporowski PD, Davis CL, Miller PH, Naglieri JA. Exercise and children's intelligence, cognition, and academic achievement. Educational psychology review. 2008 Jun 1;20(2):111.
16. Tyson P, Wilson K, Crone D, Brailsford R, Laws K. Physical activity and mental health in a student population. Journal of mental health. 2010 Dec 1;19(6):492-9.
17. Archer T. Health benefits of physical exercise for children and adolescents. Journal of Novel Physiotherapies. 2014; 4(2):203.
18. Booth FW, Roberts CK, Laye MJ. Lack of exercise is a major cause of chronic diseases. Comprehensive Physiology. 2011 Jan;2(2):1143-211.
19. Reiner M, Niermann C, Jekauc D, Woll A. Long-term health benefits of physical activity–a systematic review of longitudinal studies. BMC public health. 2013 Dec; 13(1):813.
20. Biddle SJ, Asare M. Physical activity and mental health in children and adolescents: a review of reviews. British journal of sports medicine. 2011 Sep 1;45(11):886-95.
21. Khan NA, Hillman CH. The relation of childhood physical activity and aerobic fitness to brain function and cognition: a review. Pediatric exercise science. 2014 May 1;26(2):138-46.
22. Mura G, Vellante M, EgidioNardi A, Machado S, Giovanni Carta M. Effects of school-based physical activity interventions on cognition and academic achievement: a systematic review. CNS & Neurological Disorders-Drug Targets (Formerly Current Drug Targets-CNS & Neurological Disorders). 2015 Nov 1;14(9):1194-208.
23. Demirakca T, Brusniak W, Tunc-Skarka N, Wolf I, Meier S, Matthäus F, Ende G, Schulze TG, Diener C. Does body shaping influence brain shape? Habitual physical activity is linked to brain morphology independent of age. The World Journal of Biological Psychiatry. 2014 Jul 1;15(5):387-96.
24. Thomas A, Dennis A, Bandettini PA, Johansen-Berg H. The effects of aerobic activity on brain structure. Frontiers in psychology. 2012 Mar 23;3:86.
25. Chaddock L, Erickson KI, Prakash RS, Kim JS, Voss MW, VanPatter M, Pontifex MB, Raine LB, Konkel A, Hillman CH, Cohen NJ. A neuroimaging investigation of the association between aerobic fitness, hippocampal volume, and memory performance in preadolescent children. Brain research. 2010 Oct 28;1358:172-83.
26. Rasberry CN, Lee SM, Robin L, Laris BA, Russell LA, Coyle KK, Nihiser AJ. The association between school-based physical activity, including physical education, and academic performance: a systematic review of the literature. Preventive medicine. 2011 Jun 1;52:S10-20.
27. Singh A, Uijtdewilligen L, Twisk JW, Van Mechelen W, Chinapaw MJ. Physical activity and performance at school: a systematic review of the literature including a methodological quality assessment. Archives of pediatrics& adolescent medicine. 2012 Jan 2;166(1):49-55.
28. Lees C, Hopkins J. Peer reviewed: effect of aerobic exercise on cognition, academic achievement, and psychosocial function in children: a systematic review of randomized control trials. Preventing chronic disease. 2013;10.
29. Syväoja HJ, Tammelin TH, Ahonen T, Kankaanpää A, Kantomaa MT. The associations of objectively measured physical activity and sedentary time with cognitive functions in school-aged children. PloS one. 2014;9(7).
30. Van Dijk ML, De Groot RH, Savelberg HH, Van Acker F, Kirschner PA. The association between objectively measured physical activity and academic

achievement in Dutch adolescents: findings from the GOALS study. Journal of Sport and Exercise Psychology. 2014 Oct 1;36(5):460-73.).
31. Esteban-Cornejo I, Tejero-González CM, Martinez-Gomez D, Cabanas-Sánchez V, Fernández-Santos JR, Conde-Caveda J, Sallis JF, Veiga OL, Up & Down Study Group. Objectively measured physical activity has a negative but weak association with academic performance in children and adolescents. ActaPaediatrica. 2014 Nov;103(11):e501-6.
32. Van Dusen DP, Kelder SH, Kohl III HW, Ranjit N, Perry CL. Associations of physical fitness and academic performance among schoolchildren. Journal of School Health. 2011 Dec;81(12):733-40..
33. Castelli DM, Glowacki E, Barcelona JM, Calvert HG, Hwang J. Active education: Growing evidence on physical activity and academic performance. Active Living Research. 2015;1:1-5.
34. Crocker PR, Bailey DA, Faulkner RA, Kowalski KC, McGRATH RO. Measuring general levels of physical activity: preliminary evidence for the Physical Activity Questionnaire for Older Children. Medicine & Science in Sports & Exercise. 1997 Oct 1;29(10):1344-9.
35. Kowalski KC, Crocker PR, Faulkner RA. Validation of the physical activity questionnaire for older children. Pediatric exercise science. 1997 May 1;9(2):174-86.
36. Kowalski KC, Crocker PR, Donen RM. The physical activity questionnaire for older children (PAQ-C) and adolescents (PAQ-A) manual. College of Kinesiology, University of Saskatchewan. 2004 Aug;87(1):1-38.
37. Salvi Shah, Dr.Shraddhadiwan. Cross-cultural adaptation, translation and psychometric properties of Guajarati version of physical activity questionnaire for older children.(PAQ-C(G)) under review in journal of Indian association of physiotherapists)
38. Daley AJ, Ryan J. Academic performance and participation in physical activity by secondary school adolescents. Perceptual and motor skills. 2000 Oct;91(2):531-4.
39. Chen ZC, Chen JF, Chang HC. The relationships between physical fitness, emotional intelligence and academic achievement in a junior high school in Taiwan. Asia Pacific Journal of Sport and Social Science. 2012 Aug 1;1(2-3):186-96.
40. Dwyer T, Sallis JF, Blizzard L, Lazarus R, Dean K. Relation of academic performance to physical activity and fitness in children. Pediatric Exercise Science. 2001 Aug 1;13(3):225-37.
41. Kim SY, So WY. The relationship between school performance and the number of physical education classes attended by Korean adolescent students. Journal of sports science & medicine. 2012 Jun; 11(2):226
42. LogiKristjánsson Á, DóraSigfúsdóttir I, Allegrante JP. Health behavior and academic achievement among adolescents: the relative contribution of dietary habits, physical activity, body mass index, and self-esteem. Health Education & Behavior. 2010 Feb;37(1):51-64.
43. Kwak L, Kremers SP, Bergman P, Ruiz JR, Rizzo NS, Sjöström M. Associations between physical activity, fitness, and academic achievement. The Journal of pediatrics. 2009 Dec 1;155(6):914-8.
44. Coe DP, Pivarnik JM, Womack CJ, Reeves MJ, Malina RM. Effect of physical education and activity levels on academic achievement in children. Medicine & Science in Sports & Exercise. 2006 Aug 1;38(8):1515-9.
45. Rees DI, Sabia JJ. Sports participation and academic performance: Evidence from the National Longitudinal Study of Adolescent Health. Economics of Education Review. 2010 Oct 1;29(5):751-9.
46. Oliveira T, Pizarro A, Costa M, Fernandes L, Silva G, Mota J, Ribeiro JC. Cardiorespiratory fitness, but not physical activity, is associated with academic achievement in children and adolescents. Annals of human biology. 2017 May 19;44(4):309-15.
47. Chinapaw MJ, Slootmaker SM, Schuit AJ, van Zuidam M, van Mechelen W.

Reliability and validity of the Activity Questionnaire for Adults and Adolescents (AQuAA). BMC medical research methodology. 2009 Dec 1;9(1):58..
48. Tudor-Locke CE, Myers AM. Challenges and opportunities for measuring physical activity in sedentary adults. Sports medicine. 2001 Feb 1;31(2):91-100.
49. Suchert V, Hanewinkel R, Isensee B. Longitudinal relationships of fitness, physical activity, and weight status with academic achievement in adolescents. Journal of School Health. 2016 Oct;86(10): 734-41.
50. Esteban-Cornejo I, Tejero-Gonzalez CM, Sallis JF, Veiga OL. Physical activity and cognition in adolescents: A systematic review. Journal of science and medicine in sport. 2015 Sep 1;18(5):534-9.
51. Monti JM, Hillman CH, Cohen NJ. Aerobic fitness enhances relational memory in preadolescent children: the FITKids randomized control trial. Hippocampus. 2012 Sep;22(9):1876-82.
52. Etnier JL, Salazar W, Landers DM, Petruzzello SJ, Han M, Nowell P. The influence of physical fitness and exercise upon cognitive functioning: A meta-analysis. Journal of sport and Exercise Psychology. 1997 Sep 1;19(3):249-77.
53. Harriss DJ, Atkinson G. Update–ethical standards in sport and exercise science research. International journal of sports medicine. 2011 Nov;32(11):819-21.
54. Torrijos-Niño C, Martínez-Vizcaíno V, Pardo-Guijarro MJ, García-Prieto JC, Arias-Palencia NM, Sánchez-López M. Physical fitness, obesity, and academic achievement in schoolchildren. The Journal of pediatrics. 2014 Jul 1;165(1):104-9.
55. Dishman RK, Berthoud HR, Booth FW, Cotman CW, Edgerton VR, Fleshner MR, Gandevia SC, Gomez-Pinilla F, Greenwood BN, Hillman CH, Kramer AF. Neurobiology of exercise. Obesity. 2006 Mar;14(3):345-56.
56. Winter B, Breitenstein C, Mooren FC, Voelker K, Fobker M, Lechtermann A, Krueger K, Fromme A, Korsukewitz C, Floel A, Knecht S. High impact running improves learning. Neurobiology of learning and memory. 2007 May 1;87(4):597-609.
57. Fleshner MO. Exercise and Neuroendocrine Regulation of Antibody Production: Protective Effect of Physical Activity on Stress-Induced Suppression of the Specific Antibody Response. International Journal of Sports Medicine. 2000 May;21(Sup. 1):14-9.
58. Hillman CH, Castelli DM, Buck SM. Aerobic fitness and neurocognitive function in healthy preadolescent children. Medicine & science in sports & exercise. 2005 Nov 1;37(11):1967-74..

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