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The relationship between physical activity and academic performance among adolescents in India

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Abstract

Indian adolescents are under immense pressure from competitive examinations while experiencing reduced opportunities for physical activity. Evidence from Indian studies suggests that structured physical activity improves executive functions, aerobic fitness correlates with scholastic achievement, and school-based physical education does not hinder academic success. National initiatives such as CBSE's "Mainstreaming Health and Physical Education" and the Fit India Mission provide frameworks to institutionalize these benefits. This paper synthesizes Indian findings and emphasizes the need for longitudinal, curriculum-integrated studies with standardized academic performance measures.

Keywords: Adolescents, physical activity, academic performance, India, health and physical education

Introduction

Adolescence, typically spanning the ages of 10 to 19 years, represents a crucial period of rapid physical, psychological, and social transitions. In India, this group constitutes nearly one-fifth of the total population, highlighting the importance of their health and educational outcomes for the nation's future development. Education, particularly academic achievement, is highly valued in Indian society and is often perceived as the primary pathway to social mobility. This creates an environment where adolescents face significant academic pressure, frequently at the expense of their physical and psychosocial well-being.

Physical activity (PA), broadly defined as any bodily movement produced by skeletal muscles that requires energy expenditure, has long been established as a determinant of good health. The World Health Organization recommends that children and adolescents engage in at least 60 minutes of moderate-to-vigorous physical activity (MVPA) daily to sustain optimal growth and development. However, Indian adolescents fall strikingly short of this benchmark. The 2022 India Report Card on Physical Activity for Children and Youth revealed that adolescents in India average only about 16 minutes of daily school-based physical activity, a figure considerably below global standard.

Table 1: Adolescents key Physical Activity Levels

Region	Average Daily Physical Activity (Minutes)	Global Standard (Minutes)	Shortfall (Minutes)
India	16	60	44

This deficit reflects systemic barriers, including an exam-oriented educational culture, limited infrastructure for physical education, and the persistent perception that PA is secondary to academic work. International research has consistently highlighted that PA not only improves physical health but also plays a key role in enhancing cognitive performance and academic outcomes. Studies in neuroscience and developmental psychology demonstrate that regular PA enhances executive functions such as working memory, attention control, and inhibitory regulation, all of which are vital for effective learning and scholastic success.

Mechanisms Linking Physical Activity and Academic Performance

The link between physical activity (PA) and academic performance (AP) can be explained through several interconnected pathways. These mechanisms operate at neurobiological,

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cognitive, psychological, and social levels, showing that physical activity not only strengthens the body but also enhances the capacity to learn.

Cognitive Mechanisms

One of the strongest explanations for the positive effect of PA on learning comes from neuroscience. Regular aerobic exercise stimulates brain plasticity, particularly in the hippocampus and prefrontal cortex-regions vital for memory, attention, and problem-solving. Exercise has been shown to increase blood flow, oxygen supply, and the production of brain-derived neurotrophic factor (BDNF), which promotes the growth of new neurons and strengthens synaptic connections. These biological changes create a brain environment more receptive to learning and memory formation. Research in both animals and children has consistently confirmed that adolescents who remain active

demonstrate better structural and functional brain development compared to their sedentary peers.

Psychological Mechanisms

Physical activity not only boosts cognitive functions but also plays a significant role in enhancing psychological well-being. Adolescents face stress from academic pressure, peer competition, and family expectations. Physical activity helps regulate stress hormones such as cortisol and improves mood through the release of endorphins. In addition, regular activity is associated with better sleep quality, which is essential for memory consolidation and classroom alertness. By reducing anxiety and depression while boosting self-esteem, PA creates the mental and emotional conditions necessary for effective learning. These outcomes have been reported consistently across different school settings.

Table 2: Comparison of Academic Performance based on Physical Fitness

Region	Adolescents with High Physical Fitness	Adolescents with Low Physical Fitness	Subject (Best Performance)
Karnataka	Better performance in Mathematics and Science	Lower performance in the same subjects	Mathematics, Science

This table demonstrates the relationship between physical fitness and academic performance. In Karnataka, adolescents with higher physical fitness levels performed significantly better in subjects such as Mathematics and Science, which require memory and problem-solving skills. These findings support the notion that physical fitness can have a direct impact on cognitive performance and academic outcomes.

Gender Disparities in Physical Activity Participation

Physical activity (PA) participation varies significantly across gender lines, particularly in cultures with traditional gender expectations. In India, gender disparities in PA are widely observed, with adolescent girls often facing barriers to

engaging in outdoor play and sports activities. These barriers include societal norms, safety concerns, and perceptions about femininity, which restrict girls’ access to the cognitive and psychological benefits of physical activity. Adolescent girls are often discouraged from participating in physical activities, especially in rural and conservative areas, where gender roles are more rigidly enforced. These societal norms contribute to the lower participation rates of girls in physical education and sports, limiting their exposure to the cognitive and health benefits that come with regular physical activity. In contrast, boys are typically given more freedom to engage in sports and outdoor activities, contributing to their higher participation rates.

Table 3: Gender Disparities in Physical Activity Participation

Region	Boys' Participation (Percentage)	Girls' Participation (Percentage)	Main Barriers for Girls
Uttar Pradesh	80%	50%	Societal Attitudes, Safety Concerns

This table shows the significant gender gap in physical activity participation, with boys participating at much higher rates compared to girls. In Uttar Pradesh, for example, 80% of boys engage in physical activity, while only 50% of girls do so. The primary barriers for girls are societal attitudes that restrict their involvement in outdoor play and sports, as well as concerns over safety and traditional gender expectations. Such disparities not only affect the physical well-being of adolescent girls but also limit their cognitive development and academic performance. The reduced opportunities for physical activity can exacerbate gender inequalities in both health and education, reinforcing the need for more inclusive and supportive policies to ensure that both boys and girls have equal access to the benefits of physical activity.

Global Evidence beyond India

The relationship between physical activity (PA) and academic performance (AP) has been widely explored across different parts of the world. Research from developed as well as developing countries consistently points to the benefits of PA on cognition and scholastic achievement, though the strength of the association varies depending on context, measurement tools, and intervention design. Global syntheses of the literature offer some of the strongest evidence. Several systematic reviews and meta-analyses have

concluded that regular physical activity is positively related to academic outcomes. For example, Donnelly and colleagues conducted a comprehensive review of intervention studies and reported that structured PA programs improve not only physical fitness but also classroom behavior, executive functions, and standardized test scores. Importantly, the effects were most noticeable when activities were delivered consistently and integrated into the school day. Similarly, Álvarez-Bueno and collaborators examined dozens of studies and concluded that children and adolescents engaging in sufficient levels of PA performed better in academic subjects such as mathematics, reading, and spelling. Their findings suggested that PA has both immediate and long-term cognitive benefits, reinforcing the importance of maintaining active lifestyles throughout adolescence. These reviews also highlight that while the overall effect size is modest, it is robust across different populations, making PA a reliable contributor to educational outcomes. Beyond reviews, individual intervention studies provide valuable insights into how PA influences learning in real time. In the United States, Hillman and colleagues demonstrated that even a single 20-minute session of treadmill walking improved attentional control and academic test performance in preadolescents. Other school-based interventions that incorporated daily PA breaks into classroom schedules

reported improvements in students' concentration, on-task behavior, and readiness to learn.

European research has also contributed significantly. Studies in the Netherlands and Sweden found that children attending schools with extended physical education lessons performed better academically than those with standard curricula. The improvements were attributed to enhanced attention span and better classroom participation, suggesting that PA creates a positive learning environment rather than detracting from academic instruction.

While short-term interventions are useful, longitudinal studies provide stronger evidence by tracking children and adolescents over several years. One of the most influential reviews by Singh and colleagues analyzed longitudinal data and concluded that consistent PA was associated with higher grades and test scores in later schooling ^[4]. This suggests that the academic benefits of PA are cumulative and may contribute to sustained educational attainment over time.

In Canada, research following adolescents into young adulthood revealed that those with higher fitness levels during school years were more likely to graduate and pursue higher education. Such findings underscore that PA contributes not only to immediate classroom performance but also to long-term academic trajectories.

Despite these positive results, global research also reports variability. Some studies find no significant relationship between PA and academic outcomes, often due to methodological differences. For instance, studies relying solely on self-reported activity or single exam scores sometimes fail to detect associations, whereas those using objective measures of fitness and broader indicators of academic performance are more likely to find positive effects. It is also worth noting that excessive training, especially among elite athletes, can sometimes compete with academic time and result in neutral or even negative outcomes. However, such cases are exceptions rather than the norm and typically arise when balance between sports and academics is not maintained.

The global evidence has influenced educational policies in several countries. The United States' "Let's Move!" initiative and the European Union's recommendations for daily school-based PA are examples of how governments have responded to research linking PA with academic achievement. These policies emphasize that PA should be integrated into the school curriculum, not reduced in favor of additional academic instruction.

The consensus from global evidence is clear: physical activity supports academic learning. While the effect sizes reported in meta-analyses are modest, they are consistent and meaningful at the population level. Small improvements in attention, behavior, and cognition, when experienced across millions of students, translate into substantial gains in educational outcomes and long-term societal benefits.

Evidence from India

Although research examining the relationship between physical activity (PA) and academic performance (AP) among adolescents in India is still emerging, available studies provide valuable insights into how PA influences educational outcomes in the Indian context. These studies not only highlight the direct benefits of PA on academic achievement but also identify the unique barriers that prevent Indian adolescents from fully engaging in physical activity.

The India Report Card on Physical Activity for Children and Youth, published in 2022, reveals that the physical activity

levels of Indian adolescents are strikingly low. According to the report, only 64.3% of adolescents engage in school-based PA, with an average of just 16 minutes of PA per day. This figure is considerably lower than global standards, which recommend at least 60 minutes of moderate-to-vigorous physical activity (MVPA) daily for children and adolescents ^[1]. Several studies have identified the root causes for this deficiency in physical activity, including academic pressure, lack of infrastructure, and cultural norms that discourage participation in physical activities, particularly for girls.

Several Indian studies have explored the relationship between PA and academic performance. A notable study in Karnataka found that high school boys with better physical fitness scores performed significantly better in academics, particularly in mathematics and science, compared to their less fit peers. This study suggests a positive correlation between physical fitness and cognitive functioning, providing preliminary evidence that physical activity may have an indirect effect on academic outcomes by enhancing cognitive performance.

In Uttar Pradesh, a study examining adolescents aged 12-14 years revealed that physical activity levels varied according to gender, with girls reporting lower levels of participation in PA. This was attributed to societal attitudes that limit girls' opportunities for outdoor play and sports, as well as the increasing academic pressure placed on both boys and girls. These findings align with broader global evidence showing that gender disparities in PA participation are particularly pronounced in cultures with strong gender norms and expectations.

A more recent study conducted in Delhi found that PA positively influenced academic performance among children from low-income families, suggesting that exercise can play a role in leveling the playing field for disadvantaged students. These studies support the hypothesis that PA could enhance academic performance by improving cognitive function, mental health, and overall well-being. However, the evidence remains limited, and further research is needed to establish clearer causal links between PA and academic performance in diverse Indian contexts.

Several unique barriers in India contribute to the low levels of physical activity observed in adolescents. One of the most significant is the academic pressure that adolescents face, particularly in the years leading up to important examinations such as the 10th and 12th-grade board exams. In a survey conducted by the Indian Journal of Community Medicine, more than 70% of students reported that academic stress left little time for extracurricular activities, including physical education. This emphasis on academic achievement, often at the cost of physical education, reflects a broader societal tendency to prioritize intellectual pursuits over physical health.

Gender-based cultural norms also limit participation in physical activity, particularly for girls. According to a study by Sharma and Singh, adolescent girls in rural areas are often discouraged from engaging in outdoor sports or physical education due to safety concerns and societal expectations around femininity ^[7]. These gendered perceptions further exacerbate inequalities in PA participation and contribute to poorer academic outcomes for girls, as they miss out on the cognitive and psychological benefits of physical activity.

Infrastructure deficits are another significant barrier. In many government and rural schools, there are inadequate sports facilities, poorly trained physical education teachers, and a lack of structured PE programs. A report by the National Council of Educational Research and Training (NCERT)

highlighted that the quality of physical education in Indian schools varies widely, with many schools offering no physical education classes at all ^[8]. This lack of infrastructure and trained personnel severely limits adolescents' opportunities to engage in regular PA, which in turn impacts their academic performance.

Cultural factors also play a role in shaping attitudes toward physical activity and academic performance. In many Indian households, there is a strong emphasis on academic success, and sports or physical activity are often viewed as secondary or non-essential activities. Parents, particularly in middle-class and upper-middle-class households, may encourage their children to focus solely on academics in order to secure future employment opportunities, thus deprioritizing physical education and sports.

Socioeconomic factors further complicate this issue. Students from economically disadvantaged backgrounds are often unable to access sports facilities or extracurricular PA programs due to financial constraints. For these adolescents, the pressures of balancing academic work and household responsibilities leave little time for physical activity. In contrast, wealthier students are more likely to attend schools with better sports infrastructure, enabling them to benefit from regular physical activity and its associated cognitive benefits ^[10].

In recent years, there has been growing recognition of the importance of physical education in Indian schools. The National Education Policy (NEP) 2020, for instance, emphasizes the integration of sports and physical activity into the school curriculum, advocating for a more holistic approach to education that incorporates both academic and physical learning ^[11]. While the policy represents a step in the right direction, its implementation has been slow and uneven, particularly in rural areas and government-run schools where resources are limited.

To bridge this gap, experts argue for more comprehensive policies that not only increase time dedicated to physical education in schools but also focus on improving the quality of PE programs. This would include training physical education teachers, providing schools with adequate sports infrastructure, and encouraging parental and community involvement in promoting PA ^[12].

Experts in the field of adolescent health and education have increasingly called for a greater focus on physical education as a means to enhance academic performance. A report by the Indian Council of Medical Research (ICMR) emphasized the need for schools to incorporate PA into daily routines, noting that physical education is essential not just for physical well-being but for cognitive and emotional development as well ^[13].

Furthermore, educationists suggest that integrating PA with academic curricula could lead to more engaged, motivated, and mentally resilient students. According to Kumar, "When children engage in regular physical activity, they become more active participants in their learning, demonstrating better concentration, reduced anxiety, and increased academic motivation" ^[14]. This highlights the need for a paradigm shift in how education systems view physical activity-not as a secondary or optional activity but as an integral part of the learning process.

Integrative Analysis

The relationship between physical activity (PA) and academic performance (AP) in adolescents, both globally and in India, shows a clear, albeit modest, positive link. While many

studies consistently report that PA supports cognitive function and academic outcomes, the strength of this relationship depends on several factors, including the intensity and frequency of the physical activity, the educational setting, and the methodologies used to measure both PA and AP.

Consistency of Findings

Globally, the evidence supporting the PA-AP relationship is strong, with several meta-analyses and systematic reviews indicating that PA is beneficial for cognitive function and academic achievement. Studies in the United States and Europe have consistently shown that students who participate in regular physical activity outperform their sedentary peers in academic settings, particularly in areas such as mathematics, reading, and attention control (1, 2). Similar findings have emerged from studies in countries like Canada and Australia, where regular PA has been linked to higher grades, improved behavior in class, and greater cognitive functioning ^[3]. These results are supported by neurobiological research that suggests exercise promotes brain health by enhancing neuroplasticity, increasing BDNF, and improving blood circulation in the brain ^[4].

In India, although the body of research is still developing, existing studies align with global findings. For example, a study from Karnataka indicated that adolescents who were more physically fit scored better on academic assessments, especially in subjects requiring memory and problem-solving skills like mathematics and science ^[5]. In urban and rural settings alike, research suggests that physical activity boosts cognitive function and academic performance, though access to PA opportunities remains unequal, particularly in economically disadvantaged areas.

Variability in Results

While the overall trends are positive, there are instances where PA has a minimal or neutral effect on academic outcomes. These discrepancies may stem from several variables, such as the level of engagement with PA, the quality of the educational setting, and the academic demands placed on students. In some studies, particularly those that measure PA through self-report or focus on short-term interventions, the relationship between PA and AP is weaker or not significant ^[6]. This suggests that simply increasing PA in schools, without considering factors like exercise intensity, duration, and the quality of PE programs, may not lead to meaningful academic improvements.

Furthermore, gender, socioeconomic status, and cultural factors may influence how PA affects academic performance. In India, for example, cultural norms that restrict girls' participation in physical activity can lead to gender disparities in both PA and academic outcomes ^[7]. Additionally, socioeconomic barriers, such as a lack of sports infrastructure in lower-income schools, further compound the issue. This highlights the need for a nuanced understanding of how different factors, such as gender, school resources, and parental support, mediate the effects of PA on AP.

The Role of School Systems and Policy

One of the most critical factors that influence the relationship between PA and AP is the school system. Schools with well-structured physical education programs, adequate sports infrastructure, and trained educators tend to report stronger links between PA and academic success. The National Education Policy (NEP) 2020 in India advocates for holistic education, which includes physical activity as an integral part

of the school curriculum [8]. However, the implementation of such policies has been inconsistent, with many schools still neglecting PA due to academic pressure and lack of resources. This inconsistency in policy enforcement is a significant barrier to fully realizing the potential of PA to enhance academic outcomes in Indian adolescents.

Pathways for Improvement

While the global evidence consistently supports the positive effects of PA on AP, the Indian context calls for targeted interventions to ensure that PA programs are equitable and accessible. Increasing access to physical education, improving infrastructure, and addressing gender disparities in PA participation could yield significant improvements in both physical and academic outcomes for Indian adolescents. More longitudinal studies and rigorous interventions are needed to understand the causal pathways between PA and AP in the Indian educational landscape.

Policy Implications

The evidence presented in the previous sections underscores the importance of physical activity (PA) in enhancing academic performance (AP) among adolescents. However, to fully leverage the cognitive, psychological, and social benefits of PA, there is a critical need for comprehensive policy changes and systematic implementation within Indian schools. Effective integration of physical education (PE) into the academic curriculum will require not only policy reform but also infrastructural investments, teacher training, and community engagement.

One of the most important policy shifts needed in India is the mandatory integration of physical activity into the school curriculum. The National Education Policy (NEP) 2020 advocates for a more holistic approach to education, which includes the integration of sports, physical education, and mental well-being programs alongside academic subjects [1]. While the policy highlights the need for PA, its actual implementation has been inconsistent, with many schools still relegating physical education to the margins. As a result, adolescents continue to miss out on the cognitive and emotional benefits that physical activity offers.

In this context, Indian policymakers must ensure that PA becomes a structured, non-negotiable part of daily school routines. Schools should aim to offer at least 30 to 45 minutes of moderate-to-vigorous physical activity (MVPA) each day, as recommended by the World Health Organization [2]. Such an initiative would not only help improve physical health but also enhance academic performance by boosting cognitive function, reducing stress, and improving classroom behavior. For this policy to be effective, it will need to be supported by appropriate guidelines, infrastructure, and resources to ensure that every school has the capacity to implement it.

A significant barrier to physical activity in many Indian schools, especially in rural areas, is inadequate infrastructure. Many schools lack proper playgrounds, sports equipment, and facilities for physical education. Furthermore, the lack of qualified physical education (PE) teachers often results in poorly structured PA programs or the complete absence of physical education in the curriculum.

To address these challenges, the government must prioritize investment in school infrastructure. Funding should be directed towards the construction of safe sports facilities, the provision of adequate sports equipment, and the recruitment and training of qualified PE teachers. Additionally, there should be an emphasis on making extracurricular activities,

including sports and physical fitness programs, accessible to all students, regardless of their socio-economic background. This is particularly important for students from disadvantaged backgrounds, who may not have access to such opportunities outside of school [3].

The success of any physical education program depends largely on the quality of instruction. However, studies show that many PE teachers in India are not adequately trained in delivering engaging and effective physical activity programs. There is a pressing need for teacher training programs that equip educators with the skills to design and implement evidence-based PA interventions that are aligned with the cognitive and academic benefits of physical exercise.

Training should not only focus on physical fitness but also on the integration of PA with academic content. For example, teachers could be trained to incorporate movement breaks into academic lessons or integrate physical activity into subject-specific learning modules. Such strategies have been shown to enhance both engagement and academic performance [4]. Furthermore, teacher training programs should also emphasize the importance of inclusive practices, ensuring that PA opportunities are available to all students, including those with disabilities or special educational needs [5].

In addition to infrastructural and educational reforms, gender equity in physical activity must be a key priority. In many parts of India, cultural norms and societal expectations discourage girls from participating in physical activities, especially sports. This gender disparity not only limits girls' opportunities for physical development but also reduces their access to the cognitive and psychological benefits of PA.

Policymakers must address this issue by promoting equal opportunities for boys and girls in sports and physical education. Initiatives to encourage girls' participation in PA should be part of a broader strategy to challenge existing gender norms and create an inclusive, supportive environment for all students. Gender-sensitive programs, community outreach, and campaigns that highlight the benefits of PA for girls can play a key role in overcoming cultural barriers [6]. Schools should also ensure that female students have access to safe spaces for physical activity, free from societal judgment or safety concerns.

Finally, successful implementation of PA policies requires strong parental and community involvement. Parents play a crucial role in fostering a culture of physical activity within the home and the community. Schools should engage parents through workshops, awareness programs, and events that promote the benefits of physical activity for both health and academic success. Community-based initiatives can also help reinforce the importance of PA, especially in areas where access to physical education facilities is limited.

Moreover, local communities can collaborate with schools to create shared sports spaces and support youth-led sports initiatives. By integrating PA into the community fabric, schools and families can collectively promote a more active lifestyle for adolescents, leading to improved health outcomes and better academic performance.

Conclusion

The growing body of evidence underscores the undeniable relationship between physical activity (PA) and academic performance (AP) in adolescents. While the effects may be modest, they are consistent across diverse populations and academic contexts, demonstrating that PA is not just beneficial for physical health but also for cognitive function and learning outcomes. From a neurobiological perspective,

regular physical activity stimulates key areas of the brain associated with memory, attention, and executive function, enhancing the cognitive capacities necessary for academic success. Furthermore, physical activity plays a crucial psychological role, helping to alleviate stress, improve mood, and increase self-regulation, all of which foster a positive learning environment.

In the Indian context, however, the integration of physical activity into the educational system faces significant challenges. Adolescents in India are often subject to intense academic pressure, which leaves little room for physical activity. A combination of cultural norms, gender biases, inadequate infrastructure, and a lack of trained physical education teachers contributes to the exclusion of PA from the school curriculum, particularly in underprivileged areas. Despite the recognition of the importance of physical education in India's National Education Policy (NEP) 2020, practical implementation remains inconsistent, especially in rural schools where resources are limited.

Nevertheless, the findings of this review strongly suggest that integrating physical activity into the school routine could lead to improved academic performance among Indian adolescents. Schools play a pivotal role in shaping both the physical and academic lives of students, and it is essential that PA be recognized as an integral part of education, not a mere extracurricular activity. The adoption of policies that mandate daily physical activity, combined with investment in infrastructure and teacher training, could significantly improve both physical health and academic outcomes.

Moreover, future research must focus on identifying optimal PA interventions for Indian adolescents. Longitudinal studies and randomized controlled trials are needed to establish causality and determine the most effective types of physical activity, frequency, and duration for improving cognitive function and academic achievement in this demographic. Studies should also explore the impact of cultural factors, gender, and socioeconomic status on the PA-AP relationship to identify and address the barriers specific to different groups within Indian society.

In conclusion, physical activity is a crucial determinant of adolescent development, with profound implications for cognitive performance and academic success. While the barriers to integrating PA into Indian schools are significant, the potential benefits for both physical health and academic outcomes make it a worthwhile endeavor. By adopting a holistic approach to education-one that balances academics with physical health-India can better equip its adolescents to succeed in both school and life. The path forward will require coordinated efforts from policymakers, educators, parents, and communities to create an environment where physical activity is an essential and accessible part of every adolescent's educational experience.

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