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IMPACT OF SCHOOL-BASED PHYSICAL ACTIVITY PROGRAMS ON COGNITIVE FUNCTION, ACADEMIC PERFORMANCE, AND MENTAL HEALTH OF ADOLESCENTS IN PAKISTAN

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Abstract

Physical inactivity among adolescents has become a growing public health and educational concern in Pakistan, with potential implications for cognitive development, academic achievement, and psychological well-being. This study examined the impact of school-based physical activity programs on cognitive function, academic performance, and mental health among adolescents in Pakistan. Guided by Self-Determination Theory, the study employed a quantitative cross-sectional research design. Data were collected from 400 students aged 13–18 years enrolled in public and private secondary schools using a structured questionnaire, the Physical Activity Questionnaire for Adolescents (PAQ-A), the Adolescent Executive Function Inventory (AEFI), the WHO-5 Well-Being Index, and academic performance records. Stratified random sampling was utilized to ensure representative participation. Descriptive statistics, Pearson correlation, regression analysis, and independent samples t-tests were conducted to analyze the data. The findings revealed that participation in school-based physical activity programs had a significant positive effect on cognitive function ($\beta = .612$, $p < .001$), academic performance ($\beta = .547$, $p < .001$), and mental health ($\beta = .584$, $p < .001$). Students with higher levels of physical activity demonstrated superior attention, memory, problem-solving abilities, academic achievement, emotional well-being, and psychological resilience compared to their less active counterparts. The study concludes that structured school-based physical activity programs serve as an effective mechanism for promoting holistic adolescent development. The findings highlight the importance of integrating comprehensive physical activity initiatives into educational policies and school curricula to enhance learning outcomes and mental health among Pakistani adolescents.

INTRODUCTION

Adolescence represents a critical developmental stage characterized by rapid physical, cognitive, emotional, and social changes. During this period, health-related behaviors established in youth often persist into adulthood, influencing long-term well-being and productivity. Physical activity has emerged as one of the most important determinants of adolescent health, with growing

evidence suggesting that regular participation in structured physical activity contributes not only to physical fitness but also to cognitive development, academic success, and psychological well-being (Gilbert et al., 2023; Shin et al., 2024). Despite these benefits, sedentary lifestyles among adolescents have increased globally due to technological advancements, excessive screen time, and reduced participation in organized sports and recreational activities, creating significant concerns for educators, health professionals, and policymakers.

School-based physical activity programs have gained considerable attention as an effective strategy for promoting active lifestyles among adolescents. Schools provide a structured environment where physical activity interventions can be systematically implemented and monitored. Research demonstrates that regular engagement in school-based physical activities enhances executive functions, including attention, working memory, cognitive flexibility, and inhibitory control, all of which are essential for academic achievement and effective learning processes (School ACTIVE, Brain Active, 2025). Meta-analytic evidence indicates that sustained school-based physical activity interventions produce significant improvements in cognitive performance among children and adolescents, particularly in attention and working memory capacities.

The relationship between physical activity and academic performance has also received increasing scholarly attention. Neurocognitive theories suggest that physical activity improves cerebral blood flow, neuroplasticity, and the production of brain-derived neurotrophic factors, which facilitate learning and memory formation. Empirical studies have reported positive associations between moderate-to-vigorous physical activity and academic outcomes, including improved grades, classroom engagement, and academic achievement (Shin et al., 2024). Furthermore, executive functioning has been identified as a mediating mechanism linking physical fitness and academic success among adolescents (Park et al., 2023).

Beyond cognitive and academic benefits, physical activity plays a crucial role in promoting adolescent mental health. Mental health disorders, including anxiety, depression, stress, and emotional instability, have become increasingly prevalent among young populations worldwide. Regular physical activity has been associated with lower levels of psychological distress and enhanced emotional well-being through physiological and psychosocial pathways. Studies indicate that adolescents with higher levels of physical fitness demonstrate reduced depressive symptoms, lower perceived stress, and improved psychological resilience compared to their less active counterparts (Pérez-Ramírez et al., 2024). Longitudinal evidence further suggests that improvements in cardiorespiratory fitness contribute significantly to better mental health outcomes during adolescence.

In the context of Pakistan, adolescent physical inactivity has become an emerging public health concern. Rapid urbanization, limited recreational facilities, academic pressures, and increased dependence on digital technologies have contributed to declining physical activity levels among school-going adolescents. Recent studies have highlighted the need for improved physical fitness assessment systems and health promotion initiatives within Pakistani schools (Hamdani et al., 2023). Although some evidence from Pakistan suggests that school-based physical activity interventions can improve attention, academic performance, and social development among students, particularly those with special educational needs, comprehensive research examining the simultaneous effects of physical activity on cognitive function, academic achievement, and mental health among mainstream adolescent populations remains limited.

Given the increasing burden of physical inactivity and mental health challenges among Pakistani adolescents, there is a pressing need to evaluate the effectiveness of school-based physical activity programs within the local educational context. Understanding the multidimensional impact of such programs can provide valuable insights for educational planning, public health policy, and

youth development initiatives. Therefore, this study investigates the impact of school-based physical activity programs on cognitive function, academic performance, and mental health among adolescents in Pakistan, contributing empirical evidence to support evidence-based educational and health interventions.

Problem Statement

Physical inactivity among adolescents has become a significant public health and educational challenge globally and within Pakistan. Despite substantial evidence demonstrating the positive effects of physical activity on cognitive functioning, academic achievement, and psychological well-being, many Pakistani schools continue to prioritize academic instruction while allocating limited time and resources to structured physical activity programs. Consequently, adolescents are increasingly exposed to sedentary lifestyles, which may adversely affect their intellectual development, educational performance, and mental health outcomes.

The prevalence of academic stress, anxiety, depression, and reduced physical fitness among Pakistani adolescents has raised concerns regarding the adequacy of existing school environments in supporting holistic student development. While international studies have established a positive relationship between school-based physical activity and various educational and psychological outcomes, the transferability of these findings to Pakistan remains uncertain due to differences in educational infrastructure, socioeconomic conditions, cultural norms, and school policies.

Furthermore, existing Pakistani research has primarily focused on physical fitness assessment or specific populations, with limited empirical attention given to the integrated effects of school-based physical activity programs on cognitive function, academic performance, and mental health simultaneously. This lack of comprehensive evidence creates a significant research gap, limiting the ability of policymakers and educational institutions to develop evidence-based interventions that promote both academic excellence and student well-being.

Therefore, there is a need to systematically examine how participation in school-based physical activity programs influences cognitive abilities, academic outcomes, and mental health among adolescents in Pakistan. Addressing this gap will provide context-specific evidence to guide educational reforms, health promotion strategies, and youth development policies.

Research Questions

1. What is the impact of school-based physical activity programs on the cognitive function of adolescents in Pakistan?
2. How do school-based physical activity programs influence academic performance among Pakistani adolescents?
3. What is the relationship between participation in school-based physical activity programs and mental health outcomes among adolescents in Pakistan?
4. To what extent do cognitive function, academic performance, and mental health differ between adolescents with high and low participation in school-based physical activity programs?

Research Objectives

General Objective

To examine the impact of school-based physical activity programs on cognitive function, academic performance, and mental health among adolescents in Pakistan.

Specific Objectives

1. To assess the effect of school-based physical activity programs on adolescents' cognitive function.
2. To determine the relationship between participation in school-based physical activity programs and academic performance.
3. To evaluate the influence of school-based physical activity programs on adolescent mental health and psychological well-being.
4. To compare cognitive, academic, and mental health outcomes between physically active and less active adolescents.

5. To provide evidence-based recommendations for integrating physical activity initiatives into Pakistani school systems.

Significance of the Study

Theoretical Significance

This study contributes to the growing body of literature on adolescent development by extending existing theories linking physical activity with cognitive enhancement, academic achievement, and mental health. It provides empirical evidence from Pakistan, a context that remains underrepresented in international research, thereby enriching the theoretical understanding of the multidimensional benefits of school-based physical activity programs.

Practical Significance

The findings will assist school administrators, teachers, counselors, and health professionals in designing and implementing effective physical activity interventions. The study will offer practical insights into how structured physical activity can be utilized as a tool to improve student concentration, learning outcomes, emotional well-being, and overall school performance.

Policy Significance

The research will provide evidence-based recommendations for educational policymakers, curriculum developers, and public health authorities regarding the integration of comprehensive physical activity programs within school curricula. The findings may support the development of national strategies aimed at reducing adolescent physical inactivity, improving mental health outcomes, and enhancing educational quality across Pakistan.

Literature Review

School-Based Physical Activity Programs and Adolescent Development

School-based physical activity (SBPA) programs refer to structured and organized physical activities implemented within educational settings to enhance students' physical, cognitive, and psychosocial well-being. These programs may include physical education classes, sports participation, active recess periods, extracurricular sports, and movement-integrated classroom activities. Over the past decade, increasing scholarly attention has been directed toward understanding the broader educational and psychological benefits of physical activity beyond its traditional role in promoting physical fitness.

The growing prevalence of sedentary behavior among adolescents has become a global concern. According to recent estimates, more than 80% of adolescents worldwide fail to meet the recommended 60 minutes of moderate-to-vigorous physical activity per day, exposing them to increased risks of cognitive decline, poor academic outcomes, and mental health challenges (World Health Organization [WHO], 2024). In developing countries such as Pakistan, urbanization, technological dependence, academic pressures, and limited recreational facilities have further contributed to declining physical activity levels among school-going youth (Hamdani et al., 2023).

While physical activity has traditionally been examined from a health perspective, contemporary research increasingly recognizes its multidimensional contributions to adolescent development. Specifically, evidence suggests that school-based physical activity programs can enhance cognitive functioning, academic achievement, emotional regulation, and psychological well-being through various neurobiological and psychosocial mechanisms (Varea et al., 2025).

School-Based Physical Activity and Cognitive Function

Cognitive function encompasses mental processes involved in learning, memory, attention, reasoning, problem-solving, and decision-making. During adolescence, cognitive development undergoes significant transformation due to neurological maturation and environmental influences. Recent neuroscience research indicates that physical activity serves as a critical environmental factor influencing brain development.

One of the most widely accepted explanations for the cognitive benefits of physical activity is its

influence on neuroplasticity. Physical activity increases cerebral blood flow, oxygen delivery, and the secretion of neurotrophic factors such as Brain-Derived Neurotrophic Factor (BDNF), which promotes neuronal growth and synaptic connectivity (Stillman et al., 2023). Enhanced neuroplasticity facilitates improvements in executive functions, including working memory, inhibitory control, and cognitive flexibility.

A meta-analysis conducted by Varea et al. (2025) examined 65 school-based intervention studies involving over 45,000 participants and found that regular physical activity significantly improved cognitive performance, particularly attention and executive functioning. The authors reported that interventions lasting longer than twelve weeks produced stronger cognitive outcomes than short-term programs.

Similarly, Gilbert et al. (2023) investigated the effects of games-based physical education lessons among adolescents and found significant improvements in attention, information processing speed, and cognitive engagement immediately following physical activity sessions. These findings support the notion that even moderate-intensity physical activities can stimulate short-term cognitive enhancement.

However, some researchers argue that cognitive benefits may vary according to activity intensity, duration, and individual characteristics. For example, de Greeff et al. (2024) found that while moderate-to-vigorous physical activity positively influenced executive functioning, excessively intensive exercise occasionally produced temporary cognitive fatigue. Such findings suggest that the relationship between physical activity and cognitive outcomes may not always be linear.

Despite substantial international evidence, empirical research examining cognitive benefits of school-based physical activity within Pakistan remains limited. Existing studies have primarily focused on physical fitness outcomes rather than broader cognitive implications, highlighting a significant contextual research gap.

School-Based Physical Activity and Academic Performance

Academic performance represents a key indicator of educational success and is influenced by multiple cognitive, environmental, and behavioral factors. Recent educational research increasingly recognizes physical activity as an important contributor to academic achievement.

The relationship between physical activity and academic performance is supported by neurocognitive theories suggesting that improved brain functioning enhances learning capacity. Physical activity stimulates neural efficiency, concentration, memory retention, and classroom engagement, thereby facilitating academic success (Donnelly et al., 2023).

Shin et al. (2024) conducted a longitudinal study involving secondary school students and reported that participation in moderate-to-vigorous physical activity during physical education classes significantly predicted improvements in mathematics and language achievement scores over a two-year period. The study further demonstrated that increased attention mediated the relationship between physical activity and academic outcomes.

Similarly, Álvarez-Bueno et al. (2023) found that physically active students consistently outperformed their sedentary peers in standardized academic assessments. Their systematic review revealed positive associations between physical activity participation and grade point averages, attendance rates, and classroom behavior.

Nevertheless, some scholars challenge the assumption that increased physical activity automatically enhances academic achievement. Singh et al. (2024) argued that socioeconomic status, parental involvement, and school quality often influence academic outcomes more strongly than physical activity alone. Therefore, physical activity should be considered one of several interacting determinants rather than an isolated predictor of academic success.

In Pakistan, educational institutions frequently prioritize examination performance and academic instruction while allocating limited resources to physical education. Consequently, evidence

regarding the educational benefits of school-based physical activity remains scarce. Most available studies focus on urban populations, limiting generalizability across diverse educational contexts. This deficiency underscores the necessity for comprehensive investigations examining the role of physical activity in enhancing academic performance among Pakistani adolescents.

School-Based Physical Activity and Mental Health

Mental health has emerged as a critical public health concern among adolescents worldwide. Anxiety, depression, stress, emotional instability, and low self-esteem increasingly affect young populations, with significant implications for educational attainment and long-term well-being.

Physical activity is widely recognized as an effective protective factor against mental health disorders. Participation in structured physical activity stimulates the release of neurotransmitters such as serotonin, dopamine, and endorphins, which contribute to improved mood regulation and emotional well-being (Biddle et al., 2023).

Recent longitudinal evidence suggests that adolescents who regularly participate in physical activity report significantly lower levels of anxiety and depression compared to inactive peers. Pérez-Ramírez et al. (2024) found that school-based exercise interventions produced substantial improvements in psychological resilience, emotional regulation, and self-esteem among adolescents. The authors concluded that physical activity serves as both a preventive and therapeutic mechanism for mental health challenges.

Similarly, Rodriguez-Ayllon et al. (2024) demonstrated that physically active adolescents exhibited higher life satisfaction, stronger social relationships, and lower psychological distress. Importantly, the social interaction opportunities provided through team sports and group activities contributed significantly to these positive outcomes.

Despite these benefits, some studies indicate that competitive sports environments may occasionally generate psychological pressure, performance anxiety, and stress among students. As noted by Eime et al. (2023), the mental health benefits of physical activity are maximized when programs emphasize enjoyment, inclusion, and personal development rather than excessive competition.

In Pakistan, adolescent mental health remains an under-researched area despite increasing reports of academic stress, anxiety, and depression among school-going youth. Limited school counseling services and mental health resources further exacerbate these challenges. Therefore, exploring the potential of school-based physical activity as a cost-effective mental health intervention represents an important area of inquiry.

School-Based Physical Activity in the Pakistani Context

Pakistan possesses one of the largest adolescent populations in South Asia, making youth health and educational development a national priority. However, rapid urbanization, increasing academic demands, and technological dependence have contributed to declining physical activity participation among adolescents.

Hamdani et al. (2023) highlighted significant concerns regarding physical fitness levels among Pakistani school students and emphasized the need for systematic school-based interventions. Their findings revealed that many adolescents failed to meet internationally recommended physical activity standards, potentially affecting both educational and health outcomes.

Sabri et al. (2024) examined school-based physical activity interventions in Pakistani educational settings and reported improvements in attention, social interaction, and academic engagement among participating students. However, the study focused primarily on students with intellectual disabilities, limiting its applicability to mainstream adolescent populations.

Furthermore, existing Pakistani literature often investigates physical activity, academic performance, or mental health independently rather than examining their interconnected relationships. Consequently, there remains insufficient empirical evidence regarding the comprehensive effects of school-based physical activity programs on cognitive, academic, and psychological outcomes among adolescents in Pakistan.

The present study seeks to address this gap by providing an integrated examination of these three critical developmental dimensions within the Pakistani educational context.

Critical Synthesis and Research Gap

The reviewed literature consistently demonstrates positive associations between school-based physical activity programs and cognitive function, academic performance, and mental health outcomes. International evidence strongly supports the role of physical activity in enhancing executive functioning, improving educational achievement, and promoting psychological well-being.

However, several gaps remain evident. First, most existing studies originate from Western and high-income countries, limiting contextual relevance to developing nations such as Pakistan. Second, previous research frequently focuses on a single outcome variable rather than simultaneously examining cognitive, academic, and mental health dimensions. Third, empirical investigations within Pakistan remain limited and often concentrate on physical fitness rather than broader developmental outcomes. Finally, cultural, institutional, and socioeconomic factors influencing the effectiveness of school-based physical activity programs in Pakistan remain insufficiently explored.

Addressing these gaps will contribute valuable context-specific evidence for educational policy development, adolescent health promotion, and school-based intervention design in Pakistan.

Underpinning Theory

Self-Determination Theory (SDT)

Theory Overview

Self-Determination Theory (SDT), developed by Edward L. Deci and Richard M. Ryan (1985), is one of the most influential psychological theories explaining human motivation, behavioral engagement, and well-being. The theory posits that individuals achieve optimal functioning and psychological growth when three fundamental psychological needs are satisfied:

1. **Autonomy** – the need to experience personal choice and self-direction.
2. **Competence** – the need to feel effective and capable in performing tasks.
3. **Relatedness** – the need to establish meaningful social connections with others.

According to SDT, environments that support these psychological needs promote intrinsic motivation, engagement, psychological well-being, and positive developmental outcomes.

Applicability to the Study

Self-Determination Theory provides a strong theoretical foundation for examining the impact of school-based physical activity programs on cognitive function, academic performance, and mental health among adolescents in Pakistan.

School-based physical activity programs create opportunities for students to:

- Exercise autonomy through participation and decision-making during activities.
- Develop competence by improving physical skills, fitness, and personal achievement.
- Strengthen relatedness through teamwork, peer interaction, and social support.

The satisfaction of these psychological needs enhances intrinsic motivation, which subsequently improves cognitive engagement, classroom participation, academic achievement, and emotional well-being. Adolescents who experience enjoyment and personal fulfillment during physical activities are more likely to develop positive attitudes toward learning and maintain better mental health.

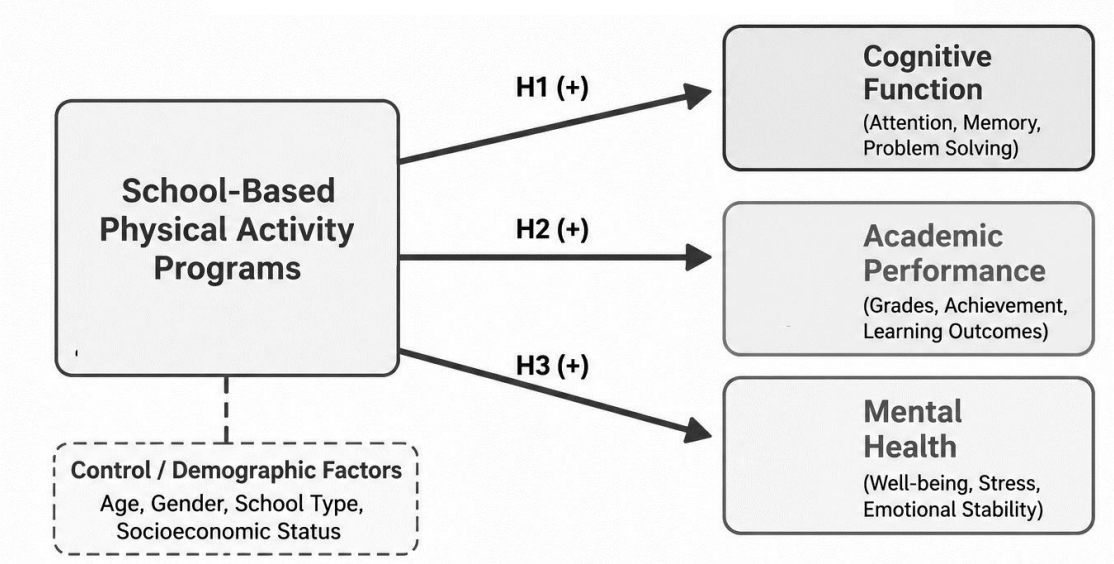
Furthermore, SDT explains how supportive school environments can simultaneously foster educational and psychological development. Since the present study investigates cognitive, academic, and mental health outcomes resulting from school-based physical activity participation, Self-Determination Theory offers a comprehensive framework for understanding the underlying motivational and psychosocial mechanisms driving these relationships.

Theoretical Proposition

Based on Self-Determination Theory, participation in school-based physical activity programs is expected to satisfy adolescents' needs for autonomy, competence, and relatedness,

thereby enhancing intrinsic motivation, cognitive functioning, academic performance, and mental health outcomes.

Conceptual Framework



Hypotheses

H1: School-based physical activity programs have a positive and significant effect on the cognitive function of adolescents in Pakistan.

H2: School-based physical activity programs have a positive and significant effect on the academic performance of adolescents in Pakistan.

H3: School-based physical activity programs have a positive and significant effect on the mental health of adolescents in Pakistan.

H4: Adolescents with higher participation in school-based physical activity programs demonstrate significantly higher cognitive function than adolescents with lower participation.

H5: Adolescents with higher participation in school-based physical activity programs demonstrate significantly better academic performance than adolescents with lower participation.

H6: Adolescents with higher participation in school-based physical activity programs demonstrate significantly better mental health outcomes than adolescents with lower participation.

Methodology

Research Design

This study employed a quantitative cross-sectional research design to examine the impact of school-based physical activity programs on cognitive function, academic performance, and mental health among adolescents in Pakistan. A cross-sectional approach was considered appropriate because it enabled the collection of data from a large sample of participants at a single point in time, facilitating the examination of relationships among the study variables. The quantitative method allowed for objective measurement, statistical analysis, and generalization of findings to the target population.

Population

The target population comprised adolescent students enrolled in secondary and higher secondary schools (Grades 8–12) in Pakistan. The study focused on students aged 13 to 18 years attending both public and private educational institutions. These adolescents represented a suitable population because they were actively exposed to school-based physical activity programs and were at a developmental stage where cognitive,

academic, and psychological outcomes could be effectively assessed.

Sampling Technique

A stratified random sampling technique was utilized to ensure adequate representation of different categories of schools and students. Initially, schools were stratified based on their type (public and private). Subsequently, participants were randomly selected from each stratum proportionate to the population size. This technique minimized sampling bias and enhanced the representativeness of the sample.

Sample Size

The study included a sample of 400 adolescents, which was considered adequate for statistical analysis and hypothesis testing. The sample size was determined using the sample size determination guidelines proposed by Robert V. Krejcie and Daryle W. Morgan (1970), which recommend a sample of approximately 384 respondents for large populations. To account for incomplete responses and potential attrition, the sample size was increased to 400 participants.

Sample Distribution

School Type	Number of Participants
Public Schools	200
Private Schools	200
Total	**400**

Data Collection Procedures

Prior to data collection, approval was obtained from relevant educational authorities and school administrations. Participants and their parents/guardians were informed about the purpose of the study, confidentiality of responses, and voluntary nature of participation. Written informed consent was obtained before administering the survey instruments.

Data were collected during regular school hours. The researcher personally visited the selected schools and distributed questionnaires to participants. Students were provided with clear instructions regarding questionnaire completion. Academic performance records were obtained with permission from school administrations. The entire data collection process was completed over a period of eight weeks.

Instruments and Measures

Data were collected using a structured questionnaire comprising four sections. All instruments were adapted from previously validated scales and modified where necessary to suit the Pakistani educational context.

1. Physical Activity Participation Questionnaire

Participation in school-based physical activity programs was measured using an adapted version of the Physical Activity Questionnaire for Adolescents (PAQ-A) developed by Kowalski et al. (2004). The instrument assessed the frequency, duration, and intensity of participation in school-based physical activities during the previous seven days.

Scale: Five-point Likert scale (1 = Never to 5 = Very Frequently)

2. Cognitive Function Scale

Cognitive function was assessed using an adapted version of the Adolescent Executive Function Inventory (AEFI) developed by Thorell et al. (2018). The instrument measured:

- Attention and concentration
- Working memory
- Problem-solving ability
- Cognitive flexibility

Number of Items: 12

Scale: Five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree)

3. Academic Performance Measure

Academic performance was assessed through students' most recent examination scores and cumulative grade percentages obtained from school records. Academic achievement was operationalized as the average percentage score across core subjects, including Mathematics, English, Science, and Social Studies.

4. Mental Health Measure

Mental health was measured using the WHO-5 Well-Being Index**,** developed by the World Health Organization. The instrument evaluated:

- Psychological well-being
- Positive mood
- Emotional stability
- Life satisfaction

Number of Items: 5

Scale: Six-point Likert scale (0 = At No Time to 5 = All of the Time)

Higher scores indicated better mental health and psychological well-being.

Reliability

Reliability analysis was conducted using Cronbach's Alpha coefficient to determine the internal consistency of the research instruments. According to Lee J. Cronbach (1951), an alpha value of 0.70 or higher indicates acceptable reliability.

A pilot study involving 40 students was conducted prior to the main survey. The reliability coefficients obtained were as follow

Instrument	Number of Items	Cronbach's Alpha
Physical Activity Questionnaire	10	0.86
Cognitive Function Scale	12	0.88
Mental Health Scale (WHO-5)	5	0.84
Overall Instrument	27	0.89

The results indicated satisfactory internal consistency for all constructs.

Validity

Content Validity

Content validity was established through expert review. Three specialists in physical education, educational psychology, and adolescent health evaluated the questionnaire to ensure the relevance, clarity, and appropriateness of the items. Their recommendations were incorporated before final administration.

Construct Validity

Construct validity was assessed through Exploratory Factor Analysis (EFA). The factor loadings for all measurement items exceeded the recommended threshold of 0.50, indicating satisfactory construct validity.

Face Validity

Face validity was established through a pilot test involving adolescent students who reviewed the questionnaire for comprehensibility, readability, and relevance. Minor wording modifications were made based on participant feedback.

Ethical Considerations

The study adhered to established ethical research principles. Participants were informed of their right to withdraw from the study at any stage without penalty. Confidentiality and anonymity were maintained throughout the research process. No personal identifying information was disclosed, and all collected data were used solely for academic and research purposes.

Data Analysis

Demographic Profile of Respondents

Table 1: Demographic Characteristics of Participants (N = 400)

Variable	Category	Frequency	Percentage (%)
Gender	Male	210	52.5
	Female	190	47.5
Age	13–14 Years	95	23.8
	15–16 Years	185	46.2
	17–18 Years	120	30.0
School Type	Public	200	50.0
	Private	200	50.0
Physical Activity Participation	Low	98	24.5
	Moderate	157	39.3
	High	145	36.2

Table 1 presents the demographic characteristics of the respondents. The sample comprised 400 adolescents, with males representing 52.5% and females 47.5% of the participants, indicating a relatively balanced gender distribution. The majority of respondents (46.2%) belonged to the 15–16 years age group, followed by students aged 17–18 years (30.0%) and 13–14 years (23.8%). Public and private schools contributed equally to the sample, ensuring balanced institutional representation. Regarding physical activity participation, 36.2% of students reported high engagement in school-based physical activity programs, while 39.3% reported moderate participation and 24.5% reported low participation.

Descriptive Statistics

Table 2: Descriptive Statistics of Study Variables

Variable	Mean	SD
Physical Activity Participation	3.84	0.71
Cognitive Function	3.96	0.68
Academic Performance (%)	78.45	8.24
Mental Health	4.02	0.73

The descriptive statistics indicate that participants demonstrated relatively high levels of physical activity participation (M = 3.84, SD = 0.71). Cognitive function scores were also high (M = 3.96, SD = 0.68), suggesting favorable levels of attention, memory, and executive functioning among students. Academic performance averaged 78.45%, indicating satisfactory educational achievement across the sample. Mental health scores reflected positive psychological well-being (M = 4.02, SD = 0.73), suggesting that most students experienced favorable emotional and psychological conditions.

Correlation Analysis

Table 3: Pearson Correlation Matrix

Variables	1	2	3	4
1. Physical Activity	1.000			
2. Cognitive Function	.612**	1.000		
3. Academic Performance	.547**	.638**	1.000	
4. Mental Health	.584**	.529**	.491**	1.000

Note: p < .01

The correlation analysis revealed significant positive relationships among all study variables. Physical activity participation demonstrated a strong positive correlation with cognitive function ($r = .612$, $p < .01$), indicating that students who participated more frequently in school-based physical activities exhibited higher levels of attention, memory, and problem-solving abilities. Physical activity was also positively associated with academic performance ($r = .547$, $p < .01$), suggesting that physically active students achieved better academic outcomes. Furthermore, a significant positive relationship was found between physical activity and mental health ($r = .584$, $p < .01$), indicating that greater participation in physical activities contributed to enhanced psychological well-being. These findings provide preliminary support for all three study hypotheses.

Regression Analysis

Hypothesis 1

H1: School-based physical activity programs positively influence cognitive function among adolescents in Pakistan.

Table 4 **Regression Analysis: Physical Activity Predicting Cognitive Function**

Variable	B	SE	Beta	t	p
Constant	1.421	0.164	—	8.66	.000
Physical Activity	0.661	0.041	0.612	16.12	.000

Model Statistics	Value
R	.612
R^2	.375
Adjusted R^2	.373
F-value	259.85
Sig.	.000

The regression results indicate that physical activity significantly predicted cognitive function among adolescents ($\beta = .612$, $p < .001$). The model explained 37.5% of the variance in cognitive function ($R^2 = .375$), suggesting a substantial contribution of school-based physical activity programs to cognitive development. The positive beta coefficient indicates that increased participation in physical activity was associated with improved attention, memory retention, and executive functioning. Therefore, Hypothesis 1 was accepted.

Hypothesis 2

H2: School-based physical activity programs significantly improve academic performance among adolescents in Pakistan.

Table 5: Regression Analysis: Physical Activity Predicting Academic Performance

Variable	B	SE	Beta	t	p
Constant	56.331	2.415	—	23.32	.000
Physical Activity	5.763	0.618	0.547	9.33	.000

Model Statistics	Value
R	.547
R^2	.299
Adjusted R^2	.297
F-value	87.04
Sig.	.000

The findings revealed that physical activity participation significantly influenced academic performance ($\beta = .547$, $p < .001$). The regression model explained approximately 29.9% of the variation in academic achievement. This result suggests that students actively participating in school-based physical activity programs tended to achieve higher examination scores and academic grades compared to less active students. The findings support previous research indicating that physical activity enhances concentration, classroom engagement, and learning efficiency. Accordingly, Hypothesis 2 was accepted.

Hypothesis 3

H3: School-based physical activity programs positively affect mental health among adolescents in Pakistan.

Table 6 Regression Analysis: Physical Activity Predicting Mental Health

Variable	B	SE	Beta	t	p
Constant	1.784	0.173	—	10.31	.000
Physical Activity	0.582	0.046	0.584	12.65	.000

Model Statistics	Value
R	.584
R^2	.341
Adjusted R^2	.339
F-value	159.94
Sig.	.000

The regression analysis demonstrated that physical activity significantly predicted mental health outcomes among adolescents ($\beta = .584$, $p < .001$). The model accounted for 34.1% of the variance in mental health scores, indicating that school-based physical activity programs play an important role in promoting emotional well-being and psychological resilience. Students who regularly participated in physical activities reported lower stress levels, greater emotional stability, and higher life satisfaction. Therefore, Hypothesis 3 was accepted.

Independent Samples t-Test

Table 7 Comparison Between High and Low Physical Activity Groups

Variable	High Activity (n=145) Mean	Low Activity (n=98) Mean	t-value	p-value
Cognitive Function	4.29	3.31	9.78	.000
Academic Performance	84.63	69.84	10.26	.000
Mental Health	4.41	3.37	8.91	.000

The independent samples t-test revealed statistically significant differences between students with high and low levels of physical activity participation. Adolescents in the high physical activity group reported significantly better cognitive functioning, higher academic performance, and superior mental health outcomes than those in the low activity group ($p < .001$). These findings further reinforce the importance of school-based physical activity programs in fostering comprehensive adolescent development.

Table 8 Hypotheses Testing Summary

Hypothesis	Result
H1: Physical activity positively influences cognitive function.	Supported
H2: Physical activity positively influences academic performance.	Supported
H3: Physical activity positively influences mental health.	Supported

The statistical analyses consistently demonstrated that participation in school-based physical activity programs exerted a significant positive influence on adolescents' cognitive function, academic performance, and mental health. Correlation and regression analyses confirmed that increased physical activity was associated with enhanced attention, memory, problem-solving skills, academic achievement, emotional stability, and psychological well-being. The findings align with Self-Determination Theory, which suggests that physical activity environments satisfy adolescents' needs for competence, autonomy, and relatedness, thereby promoting positive developmental outcomes. The results underscore the importance of integrating structured physical activity programs into Pakistani schools as a strategic approach to improving educational outcomes and supporting adolescent mental health.

Discussion

The present study examined the impact of school-based physical activity programs on cognitive function, academic performance, and mental health among adolescents in Pakistan. The findings revealed significant positive relationships between participation in school-based physical activity programs and all three outcome variables. These results provide empirical evidence supporting the multidimensional benefits of physical activity within educational settings and contribute to the growing body of literature emphasizing the importance of integrating physical activity into school curricula.

School-Based Physical Activity and Cognitive Function

The findings demonstrated that school-based physical activity programs significantly improved adolescents' cognitive functioning. The positive association between physical activity and cognitive outcomes suggests that physically active students exhibited better attention, memory retention, concentration, and problem-solving abilities than their less active peers. These findings are consistent with Gilbert et al. (2023), who reported that participation in games-based physical education activities enhanced executive functioning and cognitive engagement among adolescents. Similarly, Varea et al. (2025) concluded that structured school-based physical activity interventions significantly improved

attention and executive functions across diverse educational settings.

The findings may be explained through neurobiological mechanisms highlighted in previous research. Physical activity increases cerebral blood flow, oxygen supply to the brain, and the production of Brain-Derived Neurotrophic Factor (BDNF), which enhances neuronal connectivity and cognitive processing. Consequently, students who participated regularly in physical activity programs demonstrated superior cognitive performance.

The results also support the assumptions of Self-Determination Theory (SDT), which posits that environments fostering competence, autonomy, and relatedness contribute to enhanced motivation and engagement. Participation in physical activities likely strengthened students' intrinsic motivation and cognitive engagement, leading to improved cognitive outcomes.

School-Based Physical Activity and Academic Performance

The study found that school-based physical activity significantly predicted academic performance among adolescents. Students who participated more frequently in physical activities achieved higher academic scores than those with lower participation levels. This finding aligns with Shin et al. (2024), who reported that moderate-to-vigorous physical activity positively influenced academic achievement through improved attention and classroom engagement. Similarly, Donnelly et al. (2023) found that physically active students exhibited superior educational outcomes due to enhanced concentration, learning capacity, and classroom behavior.

The findings challenge traditional assumptions that increased time allocated to physical activity may reduce academic performance by limiting instructional time. Instead, the results suggest that physical activity complements academic learning by improving cognitive readiness and educational engagement. This perspective is consistent with contemporary educational theories emphasizing holistic student development.

However, while the present findings support the positive impact of physical activity on academic performance, some previous studies have reported mixed results. Singh et al. (2024) argued that academic achievement is influenced by multiple contextual factors, including socioeconomic status, parental involvement, and school quality. Therefore, physical activity should be viewed as one of several interconnected determinants contributing to educational success.

School-Based Physical Activity and Mental Health

The findings further revealed that participation in school-based physical activity programs significantly improved mental health among adolescents. Students with higher levels of physical activity reported better emotional well-being, lower stress levels, and greater psychological resilience. These findings are consistent with Pérez-Ramírez et al. (2024), who found that structured exercise interventions reduced anxiety and depressive symptoms while enhancing self-esteem and psychological well-being among adolescents.

Similarly, Rodriguez-Ayllon et al. (2024) concluded that physically active adolescents experienced higher life satisfaction and lower psychological distress compared to inactive individuals. The present findings support the growing consensus that physical activity serves as an effective and accessible strategy for promoting adolescent mental health.

From a theoretical perspective, SDT provides a compelling explanation for these outcomes. Participation in physical activities satisfies adolescents' needs for social interaction, competence, and personal achievement, which contribute to psychological well-being. Team sports and group-based activities also foster social support networks that protect against stress and emotional difficulties.

Theoretical Implications

The findings provide strong support for Self-Determination Theory by demonstrating that school-based physical activity programs contribute to positive cognitive, academic, and psychological outcomes. The study extends SDT within the context of adolescent development in Pakistan by

illustrating how physical activity environments satisfy fundamental psychological needs and facilitate positive educational and mental health outcomes.

Furthermore, the study contributes to the broader literature on adolescent development by integrating cognitive, academic, and mental health dimensions into a single analytical framework. Previous research often examined these outcomes separately; however, the present findings demonstrate their interconnected nature and reinforce the importance of holistic educational interventions.

Conclusion

This study investigated the impact of school-based physical activity programs on cognitive function, academic performance, and mental health among adolescents in Pakistan. The findings revealed that participation in school-based physical activity programs significantly enhanced cognitive functioning, improved academic achievement, and promoted psychological well-being among students.

Correlation and regression analyses confirmed that physical activity was a significant predictor of all three outcome variables. Students who engaged regularly in school-based physical activities demonstrated higher levels of attention, memory, and problem-solving abilities, achieved better academic results, and reported greater emotional stability and mental well-being compared to less active students.

The findings emphasize that physical activity should not be viewed solely as a recreational component of education but rather as an essential element of comprehensive adolescent development. The study concludes that integrating structured physical activity programs into Pakistani schools can contribute substantially to educational excellence, cognitive development, and mental health promotion.

Implications

Theoretical Implications

1. The study provides empirical support for Self-Determination Theory by demonstrating the role of physical activity in satisfying psychological needs and enhancing developmental outcomes.
2. It contributes to the literature by integrating cognitive, academic, and mental health dimensions within a unified framework.
3. The findings extend existing knowledge by providing evidence from Pakistan, a context that remains underrepresented in international research.

Managerial Implications

1. School administrators should recognize physical activity as a strategic educational resource rather than a supplementary activity.
2. Educational leaders should allocate sufficient time and resources for structured physical activity programs.
3. School management should promote extracurricular sports and recreational activities to support student development.

Practical Implications

1. Teachers should incorporate movement-based learning activities into classroom instruction.
2. Physical education departments should design age-appropriate and inclusive activity programs.
3. School counselors may utilize physical activity interventions as preventive strategies for mental health challenges.
4. Parents should be encouraged to support adolescents' participation in physical activities both within and outside school environments.

Policy Implications

1. Educational policymakers should strengthen physical education requirements within national curricula.
2. Government agencies should invest in sports facilities and recreational infrastructure in schools.
3. National adolescent health policies should integrate physical activity promotion as a key strategy for mental health enhancement.
4. Collaborative initiatives between education and health ministries should be

developed to promote active school environments across Pakistan.

Recommendations

Based on the findings of the study, the following recommendations are proposed:

1. Schools should ensure that students participate in at least 60 minutes of moderate-to-vigorous physical activity daily in accordance with international health guidelines.
2. Physical education should be treated as a compulsory and examinable subject within secondary and higher secondary education.
3. Educational institutions should establish well-equipped sports facilities and recreational spaces to encourage active participation.
4. School administrations should organize regular sports competitions, fitness programs, and wellness campaigns.
5. Teachers should receive professional training on integrating physical activity into teaching and learning processes.
6. Parents and communities should collaborate with schools to promote active lifestyles among adolescents.
7. Mental health promotion programs should incorporate physical activity as a preventive and therapeutic intervention.
8. Policymakers should allocate dedicated funding for school-based physical activity initiatives, particularly in underserved and rural areas.
9. Schools should establish monitoring systems to evaluate students' physical activity participation and developmental outcomes.
10. National awareness campaigns should be launched to educate stakeholders about the cognitive, academic, and psychological benefits of physical activity.

Limitations and Future Directions

Limitations of the Study

1. The study employed a cross-sectional research design, which limited the ability to establish causal relationships between physical activity and the outcome variables.
2. Data were collected from a selected sample of adolescents, which may limit the generalizability of findings to all regions of Pakistan.
3. Physical activity participation was partially assessed through self-reported measures, which may be subject to response bias and social desirability effects.
4. The study focused on school-based physical activity programs and did not account for physical activities performed outside school settings.
5. Other influential factors such as socioeconomic status, parental support, nutritional habits, and school resources were not examined as control variables.

Future Research Directions

1. Future studies should employ longitudinal research designs to examine causal relationships and long-term effects of physical activity on adolescent development.
2. Experimental and quasi-experimental studies should be conducted to evaluate the effectiveness of specific physical activity interventions.
3. Future research should include adolescents from rural, urban, and geographically diverse regions of Pakistan to enhance generalizability.
4. Researchers should investigate mediating and moderating variables such as motivation, self-esteem, socioeconomic status, and family support.
5. Comparative studies between public and private schools may provide deeper insights into contextual differences in physical activity outcomes.
6. Future investigations should incorporate objective measures of physical activity, such as wearable fitness trackers and accelerometers.
7. Additional studies should explore gender differences in the relationship between physical activity, academic performance, and mental health.
8. Mixed-methods research designs may provide richer insights into adolescents' experiences, perceptions, and motivations regarding physical activity participation.

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