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Examining the Relationship Between Physical Education and Academic Performance: Cross-Sectional Analysis (A Review Article)

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Abstract: ***Physical fitness education represents one of the most important components of overall educational development of an individual. Even after having recognized significance, the detailed and precise relationship between physical activity programs and academic performance continues to create sufficient amount of interest among the educational researchers and academic institutions. This brief study tries to examine the relationship between physical education participation and academic performance among the undergraduate students at J. V. Jain College, Saharanpur, (Uttar Pradesh). The quantitative statistical methods were used to determine any significant relation between these variables. In this study a cross-sectional research design was used in which 100 students were selected from various academic programs such as Arts, Science, Commerce and Computer Science at J. V. Jain College, Saharanpur. The data was collected using standardized survey instruments designed to store the related data. The chi-square statistical test was used to determine the relationship between student participation in physical education activities and their corresponding academic performance. The statistical examination showed a statistically significant relationship between participation in physical education programs and academic achievements/performance ($\chi^2 = 23.92$, $p < 0.05$), with analysis showing that students maintaining continuous participation in physical education activities results in better academic results when compared to students with less participation in such programs. The findings of the study shows that physical education plays a important role in supporting and improving the academic achievements among the students of the college. Based on these results, the study strongly supports for more focus and investment in physical education curricula within higher education institutions. The study also suggests that educational institutions should prioritize the development and maintenance of comprehensive physical activity programs as a strategy for maximizing the student's academic performance.***

Keywords: Academic Performance, Physical Education (PE), Chi-square Test, Student's Health, Educational Research

1. Introduction

Physical education is often considered as the fundamental aspect of education that provides opportunities for students to involve in physical activities, sports, and games. However, its significance goes far beyond just promoting physical fitness. Presently in a rapidly changing world where sedentary lifestyles, poor nutrition, and mental health issues are increasingly prevalent, the importance of physical education in fostering overall development has never been more critical. Physical education not only helps in physical well-being but also enhances cognitive abilities, emotional stability, and social skills, thereby influencing an individual's overall quality of life or we can say the holistic development of an individual. Physical education is essential for the overall development and well-being of individuals, especially in children and young adults' physical education has been an integral component of the educational system for centuries. The ancient Greek civilizations understood the important relation between bodily strength and intellectual growth, establishing the principle *"mens sana in corpore sano,"* meaning a healthy mind flourishes within a healthy body. In modern educational contexts, physical education continues to be valued not only for its health benefits but also for its potential influence on academic achievement. The relationship between physical activity and cognitive function has been extensively studied in recent decades. Various studies suggests that regular physical activity can improve brain functioning, enhance memory, and increase concentration levels. These cognitive benefits may directly translate into improved academic performance among students. At J. V. Jain College, Saharanpur, physical education is offered as both a compulsory and optional subject across various courses. However, the institution seeks to understand whether participation in physical education activities correlates with better academic results among its students [1-13].

2. Background / Literature Review

Literature review is a systematic identification and analysis of documents containing data related to the study. The relationship between physical education (PE) and the academic performance has been the subject of growing interest in educational research field. Several studies have suggested that there is a positive link between physical activity and cognitive function, academic achievement, and overall well-being. This literature review examines key studies that explore the impact or we say the influence of physical education on academic performance, exploring various factors such as physical activity, cognitive development & brain function.

(i) Historical Perspective about PE

This crucial concept of Physical Education contributing to physical and intellectual development dates back to ancient civilizations of the world. Plato emphasized the importance of physical training alongside the intellectual development. In the modern era, educational reformers like John Dewey also advocated for experiential learning that included physical activities. Research by Shephard (1997) states that students who spent more time in physical education showed no decline in academic performance even after having

reduced classroom time. This foundational study challenged the traditional belief that academic subjects should receive exclusive attention.

(ii) Neurological Basis of Physical Activity and Cognitive Function:

The modern neuroscience has provided insights into how physical activity affects the brain functioning. Cotman and Berchtold (2002) found that exercise increases the production of brain-derived neurotrophic factor, which promotes the growth of new neural connections which results in enhancement of learning capacity. Ratey and Hagerman (2008) in their seminal work *"Spark: The Revolutionary New Science of Exercise and the Brain"* showed that aerobic exercise increases the production of neurochemicals that improves the mood, attention, and learning. Their research showed that students who participated in physical education activities before Mathematics and reading classes performed significantly better than those who did not.

(iii) Cognitive Benefits of Physical Education

Multiple studies have identified specific cognitive benefits related with the physical education participation like Hillman et al. (2009) conducted a randomized controlled trial showing that children who participated in a physical activity program demonstrated improved attention and cognitive control compared to a control group. Winter et al. (2007) found that high-intensity exercise immediately after learning enhanced memory consolidation. This suggests that physical education sessions scheduled after academic classes could improve retention. Best (2010) conducted a meta-analysis showing that physical activity interventions significantly improved executive function in children, including working memory, cognitive flexibility, and inhibitory control.

(iv) Academic Performance Outcomes

The study specifically examining academic performance outcomes has shown consistent positive relationship as Castelli et al. (2007) analysed data from 259 third and fifth-grade students and found that aerobic fitness was positively related to academic achievement in both mathematics and reading. Tremblay et al. (2000) conducted a comprehensive review of 850 studies and concluded that increased time in physical education was related with improved academic performance across various subjects. Mahar et al. (2006) found that classroom-based physical activities improved on task behaviour and decreased the disruptive behaviour among elementary school students.

(v) PE and Academic Achievement in Specific Subjects

The study has also shown that physical education influences performance in specific subjects for example, Sallis et al. (1999) found that students who participated in physical education programs had better scores in Mathematics due to improvements in focus, problem-solving, and mental alertness. Additionally, O'Donovan et al. (2005) showed that students who involve in physical activity show improvements in reading comprehension and verbal fluency, likely due to better overall brain functioning and executive control. The Cooper Institute (2007) conducted a study that showed students who received consistent physical education scored higher on cognitive assessments, particularly in attention and memory tasks. These improvements were especially evident in children from low-income backgrounds, suggesting that PE can play a very important role in promoting equity in academic results of an individual.

(vi) Mechanisms of Influence

Researchers have identified several mechanisms through which physical education influences academic performance. Physical activity increases blood flow to the brain, delivering oxygen and nutrients essential for optimal cognitive function. Exercise also promotes the release of endorphins, which improves the mood and decreases the stress. Regular physical activity enhances self-esteem and reduces the anxiety. These psychological benefits create a more conducive and better learning environment. Physical education often involves team activities that develop social skills, cooperation, and leadership abilities, which can transfer to academic settings which in results helps in holistic development of a student.

(vi) Studies in Indian Educational Context

In the Indian educational context research has been limited but growing with the advancement in technology. Singh et al. (2012) studied 200 students from Delhi schools and found that students participating in regular physical education activities scored 15% higher on average in academic tests compared to the nonparticipants. Reddy and Kumar (2015) conducted a study in Karnataka and reported that schools with robust physical education programs had better overall academic performance and lower dropout rates of students.

(vii) Contradictory Findings Related to Study

Not all studies have found positive relationships between Physical education and the academic performance for example Ahamed et al. (2007) conducted a cluster randomized trial and found no significant difference in academic performance between students who received additional physical education and those who received standard curriculum. Some of the researchers argue that the relationship may be affected by socioeconomic factors since the students from higher socioeconomic backgrounds having better access to both physical education and academic resources which may results in following relationship.

3. Gaps in Literature

The researchers have explored this field extensively but many important knowledge gaps still need to be noticed and covered. Very few studies have been conducted in Indian colleges and universities, which means we do not fully perceive how this research findings apply to Indian students and educational settings. We also have insufficient longitudinal studies i.e. observing same variables for long period of time for tracking long term effects. Another challenge is that researchers have not spent enough time figuring out what makes a physical education program truly effective – we still do not know the best ways to structure these programs to maximize student benefits. Finally, there's

been limited research into whether physical education helps students perform better in specific subjects like Mathematics, Science, or Literature, which would help educators understand exactly where these programs make the biggest difference in student learning. The literature suggests a positive relationship between physical education and academic performance. However, the need for context-specific research, particularly in Indian higher education institutions, remains evident. This study aims to contribute to this knowledge gap by determining the relationship between the ca variables at J. V. Jain College, Saharanpur.

4. Statement of the problem

Despite the prevalent thought that physical education participation results in overall student development, empirical evidence supporting its direct influence on academic performance of an individual remains limited, mainly in the context of Indian higher education institutions. Many students and mentors question whether time spent on physical activities could be better utilized for academic results. This study targets the following research problem: Does participation in physical education significantly influence academic performance among students at J. V. Jain College, Saharanpur?

5. Methodology

This study uses a cross-sectional descriptive research design with a quantitative approach. The cross-sectional design allows the determination of the relationship between physical education participation and the academic performance at a specific point of time. This quantitative approach helps in statistical analysis to determine meaningful relationships between the variables.

(i)- Population and Sample

Population: The target population for this study consists of all the undergraduate students enrolled at J. V. Jain College, Saharanpur, during the academic year 2024-25. This educational institute have thousands of students across various courses including Arts, Science, Commerce, and Computer Science and others.

Sample Size: A sample size of 100 students was selected for this study. This sample size is appropriate for conducting chi-square analysis and provides sufficient amount of statistical power to detect meaningful and valid relationships between the variables.

Sampling Technique: The Stratified random sampling was used to ensure representation across different courses and academic levels. The stratification was based on course type such as (Arts, Science, Commerce, Computer Science), academic year (1st, 2nd, 3rd year) and gender (Male, Female).

(ii) Variables

Independent Variable: The Categorization of physical education participation was done into three levels such as regular participation (attending PE classes ≥ 80% of the time) , Irregular participation (attending PE classes 40-79% of the time) & non-participation (attending PE classes < 40% of the time).

Dependent Variable: The Categorization of academic performance was done into three levels based on overall percentages averages such as High performance (equivalent percentage ≥70%), Average performance (equivalent percentage 50-69%) and Low performance (equivalent percentage <50%).

(iii) Data Collection Methods

Primary Data Collection: A structured questionnaire was prepared to collect information about student demographics and physical education participation patterns, attitudes toward physical education and self-reported academic performance and factors influencing participation.

Secondary Data Collection: Academic records were obtained from the college administration to verify the official percentage averages & course enrolment details.

(iv) Research Instruments

A survey-based approach was used with 100 students, using a structured questionnaire to examine the relationship between physical education participation and academic performance.

Validity and Reliability: The questionnaire was validated through expert review by physical education faculty and with the help of Cronbach's alpha coefficient calculation (α = 0.82).

(v) Statistical Analysis

Data analysis is basically a systematic process that involves working with data, organizing them into manageable units, synthesizing them, such for patterns, discovering what is important and what to tell others.

Chi-square Test: The Chi-square test of independence was used to examine the relationship between physical education participation and academic performance. The test determines whether there is a significant relation between the two categorical variables.

Chi-square Formula: $\chi^2 = \Sigma[(\text{Observed}–\text{Expected})^2 / \text{Expected}]$

Assumptions of Chi-square Test: 1)-Data are categorical, 2)-Observations are independent,

3)- Expected frequency in each cell ≥ 5, 4)- Random sampling.

Level of Significance: The level of significance was set at α = 0.05 (95% confidence level).

6. Research Questions

1. Is there a significant relationship between physical education participation and academic performance?

2. What is the level of student participation in physical education activities at J.V. Jain College?
3. How does regular physical education participation affect different aspects of academic performance?

7. Hypotheses

Null Hypothesis (H_0): There is no significant relationship between physical education participation and academic performance among students at J.V. Jain College, Saharanpur.

Alternative Hypothesis (H_1): There is a significant relationship between physical education participation and academic performance among students at J.V. Jain College, Saharanpur.

8. Data Analysis & Interpretations

Here we present the analysis and interpretation of data collected from 100 students at J.V. Jain College, Saharanpur. The analysis includes descriptive statistics, chi-square test results, and detailed interpretation of findings related to the relationship between physical education participation and academic performance.

(i)-Descriptive Statistics:

(a). Demographic Characteristics:

Characteristic	Category	Frequency	Percentage
Gender	Male	58	58.0%
	Female	42	42.0%
Course	Arts	28	28.0%
	Science	32	32.0%
	Commerce	25	25.0%
	Computer Science	15	15.0%
Academic Year	1st Year	35	35.0%
	2nd Year	38	38.0%
	3rd Year	27	27.0%
Age Group	18-20 Years	62	62.0%
	21-23 Years	38	38.0%

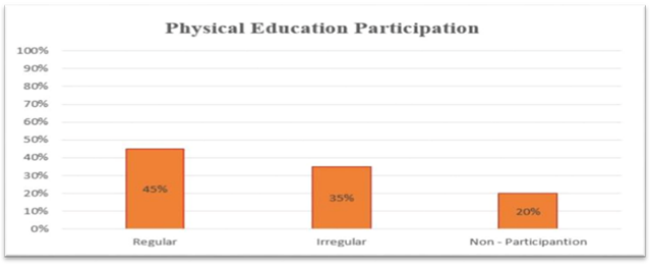
Table: Demographic Distribution of Participants (N=100)

Analysis: The sample shows a fairly balanced distribution across different demographic categories, with slightly more male participants (58%) than the female participants (42%). Science students form the largest group (32%), followed by Arts (28%) and Commerce (25%).

(b). Physical Education Participation:

Table: Physical Education Participation Levels (N=100)

Participation Level	Frequency	Percentage
Regular (≥80% attendance)	45	45.0%
Irregular (40-79% attendance)	35	35.0%
Non-participation (<40% attendance)	20	20.0%



Analysis: The majority of students (45%) participate regularly in physical education activities, while 35% have irregular participation, and 20% rarely participate. This shows that there is generally a positive attitude toward physical education among the students.

(c). Academic Performance Distribution

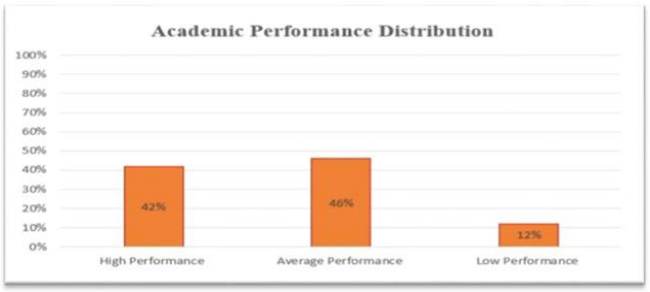


Table: Academic Performance Levels (N=100)

Performance Level	Percentage	Frequency	Percentage
High Performance	(≥70%)	42	42.0%
Average Performance	(50-69%)	46	46.0%
Low Performance	(<50%)	12	12.0%

Analysis: The majority of the students (46%) shows average academic performance, while 42% show high performance and only 12% show low performance. This distribution shows generally good academic standing among the sample.

(d). Cross-tabulation Analysis Physical Education Participation vs. Academic Performance

Table: Contingency Table – PE Participation vs. Academic Performance

PE Participation	High Performance	Average Performance	Low Performance	Total
Regular	28(62.2%)	15(33.3%)	2(4.4%)	45
Irregular	12(34.3%)	20(57.1)	3(8.6%)	35
Non-participation	2(10.0%)	11(55.0%)	7(35.0%)	20
Total	**42**	**46**	**12**	**100**

(e). Key Observations:

- From the data we can observe that students with regular or we can say consistent Physical Education participation show the highest proportion of high academic performance (62.2%).
- The non-participating students show the highest proportion of low academic performance (35.0%).

By observing the data there appears to be a clear trend suggesting and inclining towards the observation that there is better academic performance among students with regular PE participation.

(f). Chi-square Test Analysis

Table: Observed Frequencies

PE Participation	High Performance	Average Performance	Low Performance	Total
Regular	28(62.2%)	15(33.3%)	2(4.4%)	45
Irregular	12(34.3%)	20(57.1)	3(8.6%)	35
Non-participation	2(10.0%)	11(55.0%)	7(35.0%)	20
Total	**42**	**46**	**12**	**100**

Table: Expected Frequencies

PE Participation	High Performance	Average Performance	Low Performance	Total
Regular	18.9	20.7	5.4	45
Irregular	14.7	16.1	4.2	35
Non-participation	8.4	9.2	2.4	20
Total	**42**	**46**	**12**	**100**

(g). Chi Square Calculation:

Table: Chi-square Calculation

Category	Observed	Expected	O-E	$(O-E)^2$	$(O-E)^2/E$
Regular-High	28	18.9	9.1	82.81	4.38
Regular-Average	15	20.7	-5.7	32.49	1.57
Regular-Low	2	5.4	-3.4	11.56	2.14
Irregular-High	12	14.7	-2.7	7.29	0.50
Irregular-Average	20	16.1	3.9	15.21	0.94
Irregular-Low	3	4.2	-1.2	1.44	034
Non-part-High	2	8.4	-6.4	40.96	4.88
Non-part-Average	11	9.2	1.8	3.24	0.35
Non-part-Low	7	2.4	4.6	21.16	8.82

Chi-square value (χ^2) = 23.92

(h). Degrees of Freedom and Critical Value:

Degrees of Freedom (df) = (Rows – 1) × (Columns – 1) = (3 – 1) × (3 – 1) = 4
Critical Value at $\alpha = 0.05$: $\chi^2(4, 0.05) = 9.488$
Calculated Chi-square: $\chi^2 = 23.92$

(i). Decision and Interpretation: Here in this study since we get the calculated chi-square value (23.92) which is greater than the critical value (9.488), the null hypothesis got rejected at the 0.05 significance level. There is a statistically significant relationship between physical education participation and academic performance among the students at J.V. Jain College, Saharanpur.

(j). Effect Size Analysis – To determine the practical significance of the relationship, Cramer's V was calculated. This enables us to show the strength of association between the variables.

Cramer's V = $(\sqrt{(\chi^2/N \times \min(r-1, c-1))}$
Cramer's V = $\sqrt{(23.92/100 \times 2)} = \sqrt{0.1196} = 0.346$

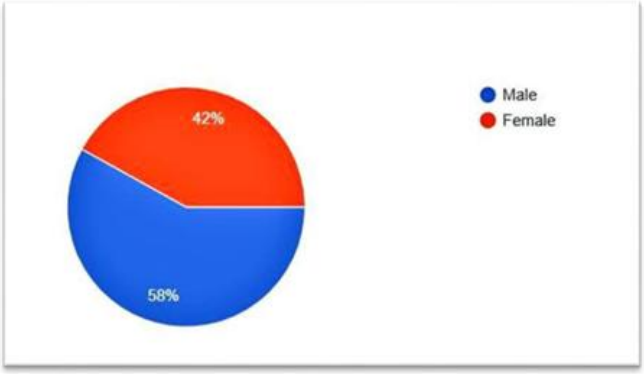
(k). Interpretation: The effect size is moderate (0.346), indicating a meaningful practical relationship between physical education participation and the academic performance.

(ii). Additional Analyses

(a). Gender-based Analysis

Table: PE Participation by Gender

Gender	Regular	Irregular	Non-participation	Total
Male	28	20	10	58
Female	17	15	10	42



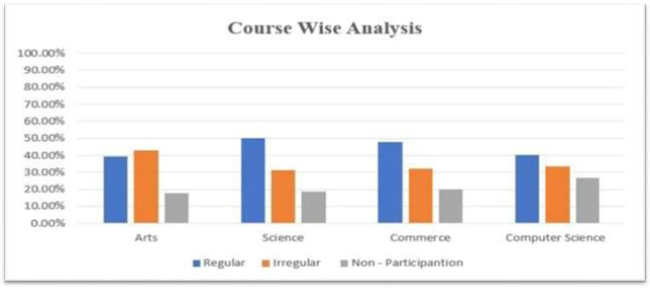
Analysis: The regular participation rates is slightly higher in the male students, but the difference is not much substantial.

(b). Course-wise Analysis

Table: PE Participation by Course

Course	Regular	Irregular	Non-participation	Total
Arts	11(39.3%)	12(42.9%)	5(17.9%)	28
Science	16(50.0%)	10(31.3%)	6(18.8%)	32
Commerce	12(48.0%)	8(32.0%)	5(20.0%)	25
Computer Science	6(40.0%)	5(33.3%)	4(26.7%)	15

Analysis: Science students show the highest rate of regular participation (50.0%), while the Computer Science students show the highest rate of non-participation (26.7%).



(iii). Qualitative Insights

Based on open-ended responses, the main obstacles in Physical Education participation identified were as follows:

1. Due to time constraints (45% of responses)
2. Because of lack of interest (25% of responses)
3. Due to the facility limitations (20% of responses)
4. Due to academic pressure (10% of responses)

(iv). Perceived Benefits of Physical Education:

Students who participated regularly reported:

1. Improvement in concentration (78% of regular participants)
2. Better stress management (65% of regular participants)
3. Enhanced mood (72% of regular participants)
4. Increased energy levels (68% of regular participants)

(v). Results and Discussion

The study successfully addressed the primary research question: "Is there a significant relationship between physical education participation and academic performance among the students at J.V. Jain College, Saharanpur?"

Answer: Yes, there is a statistically significant relationship ($\chi^2 = 23.92$, $p < 0.05$) between physical education participation and the academic performance.

(vi). The Key Statistical Findings

The chi-square test revealed a significant relationship between PE participation and the academic performance. Cramer's V = 0.346 indicates a moderate to strong practical effect. The Regular participants showed 62.2% high performance vs. 10.0% among the non-participants. Non-participants showed 35.0% low performance vs. 4.4% among the regular participants.

(vii). Participation Patterns

1. 45% of students participate regularly in physical education.
2. 35% of students participate irregularly.
3. 20% of students rarely or never participate.
4. Science students show highest regular participation (50%).
5. Computer Science students show highest non-participation (26.7%).

(vii). Hypothesis Testing

Null Hypothesis (H_0): We rejected it since there is sufficient evidence to reject the null hypothesis that there is no significant relationship between physical education participation and academic performance.

Alternative Hypothesis (H_1): The alternative hypothesis got accepted that there is a significant relationship between physical education participation and academic performance which is supported by the data.

9. Study Objectives Achievement: Primary Objective

Successfully achieved through statistical analysis showing significant relationship between PE participation and the academic performance.

Secondary Objectives: Assessed participation levels: 45% regular, 35% irregular, 20% non-participation.

Evaluated academic performance: 42% high, 46% average, 12% low performance.

Identified relationship using chi-square analysis: $\chi^2 = 23.92$, $p < 0.05$

10. Recommendations

By strengthening and supporting the physical education programs requires a multidimensional approach which includes coordinated efforts from the educational institutions, students, faculty members, and policymakers. The educational institutions may start prioritizing mandatory overall fitness requirements, modernizing athletic facilities, hiring qualified instructors, and developing flexible scheduling systems while at the same time creating interdisciplinary curricula that relates physical education with academic subjects and implementing comprehensive fitness assessment protocols. Students must commit to consistent physical activity participation, develop effective time management skills to balance academic and athletic responsibilities, explore multiple exercise options, and uses physical activity as a stress management tool during the study time. Faculty members and administrative staff should try to collaborate across departments to promote overall development of student, allocate sufficient number of resources for athletic programs, integrate research findings about exercise benefits into academic counselling, and establish institutional policies that support overall physical education initiatives. Policymakers must develop minimum physical education standards for higher education, provide dedicated funding for infrastructure improvements, support professional development opportunities for the instructors, and create quality assurance mechanisms that evaluates program effectiveness. This comprehensive planning emphasizes the critical relation between physical education and academic performance, requiring sustained commitment from all stakeholders to establish research centres, build community partnerships, implement technology-driven evaluation systems, and maintain continuous program

evaluation to ensure optimal student results in both intellectual and physical development domains.

11. Future Scope

We can track students over multiple years to establish causation and long-term effects and expand our study to multiple institutions for greater generalizability of the study. The comparative studies across different types of educational institutions can be done for more in-depth analysis regarding the association between the variables. The investigation of specific mechanisms linking PE to academic performance through neurological, psychological, and physiological assessments can be done.

12. Limitation of the study

The cross-sectional nature of the study limits our ability to talk about causation in other words due to the nature of our study we may show the significant association of physical education with academic performance but it might not be able to tell the cause of it. The small sample size for study results in reduced statistical Some data relied on self-reported information, which may introduce bias. However, the verification of academic records through official sources helps in mitigating this limitation. Since the study focuses on one institution may limit generalizability to other educational contexts. However, the findings provide valuable insights for similar institutions.

13. Conclusions

This study has successfully demonstrated a significant relationship between physical education participation and the academic performance among the students at J.V. Jain College, Saharanpur. The findings of this study shows that regular participation in physical education programs or activities is associated with better academic outcomes, supporting the integration of physical activity into the comprehensive educational strategies. This study contributes valuable insights to the limited body of knowledge on physical education and academic performance in Indian higher education contexts. The recommendations share the actionable suggestions and strategies for educational institutions, students, faculty, and policy makers to enhance student development through physical education. The study findings align with international research while providing context-specific insights relevant to Indian educational institutions. The moderate effect size and statistical significance indicate that the relationship is both statistically meaningful and practically important. Moving forward, educational institutions should prioritize physical education as an integral component of holistic student development. The investment in physical education programs is likely to produce significant returns in terms of improved academic performance, student well-being, and overall educational results. This study opens avenues for future investigations. The success of this study at J.V. Jain College, Saharanpur, can serve as a model for similar educational institutions which are seeking to enhance students' academic performance through comprehensive physical education programs.

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