

Research Article

Correlating Physical Activity (PA) with Physiological Health in College Students*Nadim Haider^{1,2,3}, Somnath Gangopadhyay¹ and Alok Chattopadhyay^{2*}*¹Department of Human Physiology, University of Calcutta, Kolkata – 700 009, West Bengal, India²Department of Physiology, Harimohan Ghose College, Kolkata – 700 024, West Bengal, India³Department of Physiology, Netaji Nagar Day College, Kolkata – 700 092, West Bengal, India**(Received: 25-07-2025****Revised: 08-09-2025****Accepted: 27-09-2025)**Corresponding Author: *Alok Chattopadhyay* Email: alokc1972@gmail.com**ABSTRACT**

Introduction and Aim: The study examined the relationship between physical activity levels (PAL) and various physiological health indicators among college students that may serve as predictors or barriers to physical activity, and can inform health promotion strategies within this demographic.

Materials and Methods: A cross-sectional study was carried out on college students (n=202), measuring various physiological variables. Physical activity (PA) status was assessed using the PAL scores, employing International Physical Activity Questionnaire (IPAQ) Short. Standardized instruments were used for measuring physiological variables. Analysis was done in SPSS which includes Pearson's correlation and scattered plot. Subgroup analysis was done using stacked bar chart.

Results: Most physiological parameters, such as height, weight, body surface area, pulse rate, blood pressure, and oxygen saturation, exhibited very weak correlations with PAL scores. Body Mass Index (BMI) showed a notable/unique trend. Maximum percentage of overweight were found under low PAL category yet all obese class I and II, were associated with higher PAL scores. The individuals in higher health risk categories demonstrated reduced PAL. Gender-based analyses revealed no significant differences in the relationships. Based on healthy indicators, the recommended PAL score range for college students with healthy indicators is suggested to be 3,000-8,000 MET-minutes/week.

Conclusion: The findings indicated minimal linear associations between most physiological health parameters and PAL among college students, with BMI and health risk categories showing some inverse relationships with PAL. These results highlighted the complexity of factors influencing PA in young adults and suggest that physiological metrics may have limited predictive value in this population.

Keywords: Physical Activity Level (PAL), Body Mass Index (BMI), Health risk, Health metrics, Gender

1. INTRODUCTION**1.1 Background**

The increasing prevalence of sedentary lifestyles among young adults has raised concerns about their long-term health implications. The idea for this research originated from the need to understand how lifestyle behaviours, particularly physical activity (PA), influence physiological health markers in this demographic.

1.2 Literature review

In order to address the raised concerns, this study investigated the relationship between some

important physiological health markers and physical activity levels (PAL). Yang *et al.*, (2025) and Long *et al.*, (2024) have recently demonstrated that students' daily activity habits and physical literacy have a substantial impact on their health-related fitness, underscoring the importance of understanding such links in academic populations [1, 2]. Recent study by WHO (2020) also highlighted the importance of PA in maintaining optimal health and avoiding long term illness such as cardiovascular disease, diabetes, and obesity [3], thus making this research timely and important.

1.3 Aim and Objectives

The primary aim of the study is to identify significant correlations between the PAL and various physiological health markers. Thus, the purpose of this study is to identify key physiological indicators that may serve as predictors or barriers to PA, thereby contributing to the development of more effective health promotion strategies within this demographic.

2. MATERIALS & METHODS

2.1 Materials

The following instruments have been used for the study:

1. PAL score was assessed through International Physical Activity Questionnaire (IPAQ) Short, a self-reported activity questionnaire, validated, reliable and tested in many countries [4, 5].
2. Height was measured using a portable Anthropometric rod of Seca [6].
3. Weight was measured using a digital weighing machine of Omron [7].
4. Body Surface Area (BSA) was measured Using the formula of Banerjee & Sen, 1955

$$BSA (m^2) = (weight \text{ in kg})^{0.425} \times (height \text{ in cm})^{0.725} \times 0.007466$$
 [8]
5. Pulse rate and (SpO2) were measured using a portable pulse oximeter [9]
6. Blood Pressure (BP) was measured using dialled (Aneroid) Sphygmomanometer [10]

2.2 Study design

A cross-sectional design was applied in this study to examine the relationship between college students' physiological health indicators and PAL. The study was conducted on 202 participants (Male =107 Females = 97) of age group ranging between 18-23 years during January 2023 to May 2023 in Kolkata, West Bengal, India. Subjects comprised of undergraduate college students from different streams, demographics, socioeconomic backgrounds and gender with inclusion criteria ensuring healthy individuals without chronic illnesses. Convenience sampling method has been applied [11]

2.3 procedure (Steps followed)

Study Preparation

- Ethical approval (Institutional Human Ethical Committee, Univ. of Calcutta) Ref.no. IHEC/AC/P89/2019 dated 18.12.2019
- Materials: IPAQ-SF, Seca rod, Omron scale, pulse oximeter, aneroid BP, SPSS



Participant Recruitment

- College students, 18–23, healthy (Kolkata, West Bengal, India)
- Convenience sampling



Informed Consent

- Explained study, obtained written consent



Baseline Data

- Recorded age, sex



Physical Activity Level (PAL)

- IPAQ-Short Form scoring



Anthropometry

- Height (Seca), Weight (Omron)
- BMI = kg/m² (WHO)
- BSA (m²) = (weight in kg)^{0.425} X (height in cm)^{0.725} X 0.007466 (Banerjee & Sen, 1955)



Physiological Measures

- Pulse, SpO2 (oximeter)
- Blood pressure (aneroid)



Data Entry & Cleaning

- Database entered, checked, outliers handled



Statistical Analysis (SPSS 26)

- Descriptive Statistics to show the percentage, Pearson r: for correlation of PAL and physiological health indicators
- Cohen's benchmarks for knowing the effect size of correlation
- Sex-stratified; visualized (scatter plot, stacked bars)



Reporting

- Summarized the results; interpretation

2.4 Data collection

Initially, we have recruited 464 participants through Stratified random sampling method for estimation and classification of PAL, including Subjects from different streams, demographics, socioeconomic backgrounds and gender. We have estimated and classified their PAL using IPAQ short guideline. The questionnaire was circulated among the students through google form taking assistance of college authority and the staff. All 464 participants have been invited in the laboratory for collecting several Physiological parameters but Only 202 students turned out. The PAL score data of those 202 students out of 464 have been filtered, whose physiological parameters measurement have been recorded in the laboratory. Thus, this sample size of 202 participants (n=202) has been considered as per our convenience (Convenience Sampling Method). We studied the correlation of PAL scores of 202 participants with their various physiological parameters and their measurements were recorded. The collected data were entered in the data base.

2.5 Data cleaning and outlier handling procedures

We conducted pre-specified data cleaning that included ID duplication, unit/type standardization, missing response and re-computation of derived variables ($BMI = \text{height/weight}$; $BSA = (\text{weight in kg})^{0.425} \times (\text{height in cm})^{0.725} \times 0.007466$). Identifiable entry/unit errors corrected and otherwise set to missing. IPAQ Short was scored as per IPAQ guidelines (exclude bouts <10 min, cap daily time ≤ 960 min, truncate domain totals), and outliers were screened.

The specific raw data have been transferred to google sheet and are stored there after doing filtration under separate headings and separate pages. These filtered data have been transferred to the working sheet of SPSS where statistical analysis has been done.

2.5 Statistical analysis.

Statistical analysis included descriptive statistics to show the percentage breakdown of different subgroups and categories, Pearson's correlation coefficients to evaluate relationships between physiological parameters and PAL scores,

Effect sizes of the correlations using Cohen's benchmarks, scattered plot with linear fit to show the association of various Physiological factors with PAL scores, subgroup analyses of BMI and Health risk categories within each PAL groups also done by stacked bar chart. The statistical analysis was done using SPSS 26.0 for Windows.

Table 1: Pearson's correlation coefficient values and p-values showing Correlation of Physiological influencing factors with Physical Activity Level (PAL)

Influencing Factors (Physiological health indicators)	Correlation Coefficient (r)	P-Value	Effect size (Cohen's benchmarks) (small=0.10, medium=0.30, Large =0.50)
Height (cm)	0.11	0.11	Small
Weight (Kg)	0.07	0.31	Small
Body Surface Area (meter square)	0.10	0.16	Small
Pulse rate (Beats/min.)	-0.07	0.33	Small
Systolic Blood Pressure (mm. Hg.)	0.07	0.32	Small
Diastolic Blood Pressure (mm. Hg.)	-0.02	0.75	Small
Oxygen saturation (%)	-0.09	0.22	Small
PAL Score (MET-Min/Week)	1		

Table 2: Pearson's correlation coefficient values and p-values showing gender wise comparison of correlation between various Physiological factors and PAL scores

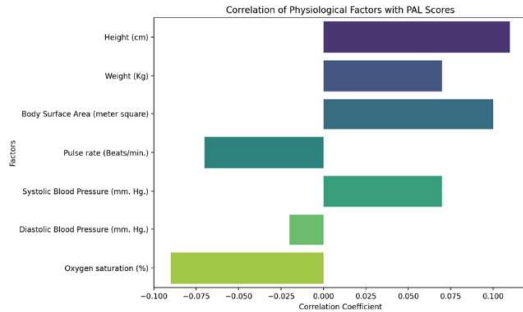
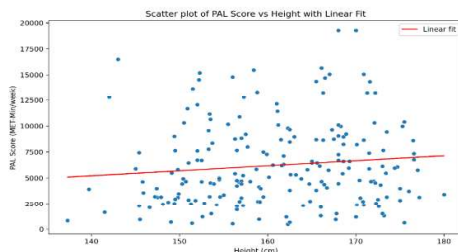
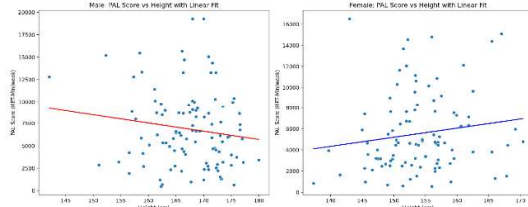
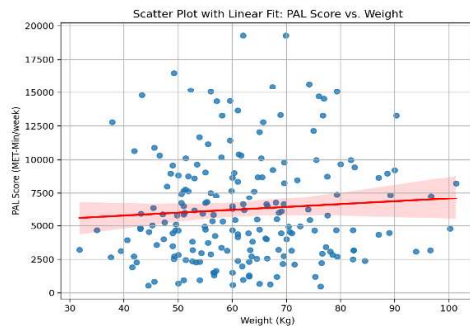
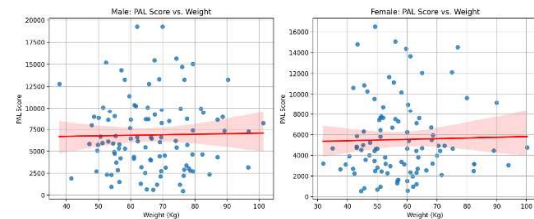
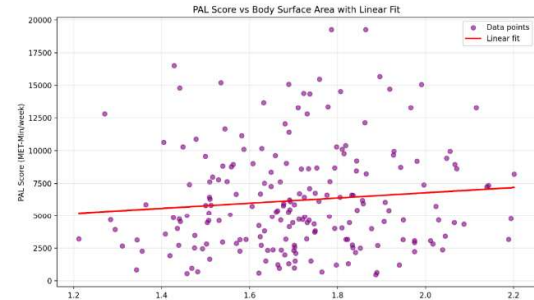
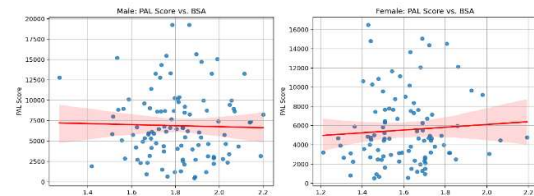
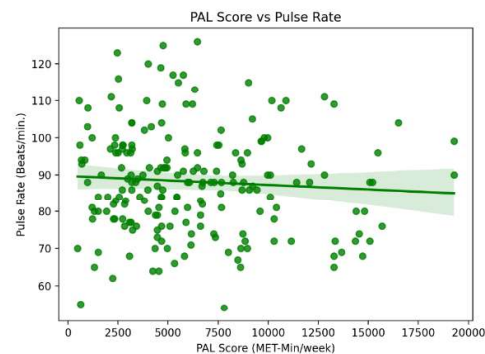
Physiological Factors	Sex	Correlation Coefficient (r)	p-value
Height (cm)	Male	-0.14	0.15
	Female	0.15	0.14
Weight (kg)	Male	0.02	0.86
	Female	0.02	0.82
Body Surface Area (m ²)	Male	-0.03	0.79
	Female	0.07	0.51
Pulse Rate (beats/min)	Male	0.05	0.61
	Female	-0.09	0.35
Systolic Blood Pressure (mmHg)	Male	0.09	0.39
	Female	-0.03	0.71
Diastolic Blood Pressure (mmHg)	Male	-0.12	0.23
	Female	0.02	0.86
Oxygen Saturation (%)	Male	-0.08	0.39
	Female	-0.11	0.29

Table 3: Distribution (percentage breakdown) of BMI categories within each PAL group

PAL Category	Normal weight (%)	Over weight (%)	Under weight (%)	Obese-I (%)	Obese-II (%)
High PAL	50.9%	25.1%	11.4%	8.4%	4.2%
Moderate PAL	55.6%	37.0%	7.4%	0.0%	0.0%
Low PAL	50.0%	37.5%	12.5%	0.0%	0.0%

Table 4: Distribution (percentage breakdown) of Health Risk Categories within each PAL group

PAL Category (IPAQ)	High Risk (%)	Moderate Risk (%)	Low Risk (%)	Total (%)
High PAL	23.5%	16.3%	60.2%	100.0%
Moderate PAL	37.0%	25.9%	37.0%	100.0%
Low PAL	25.0%	12.5%	62.5%	100.0%

**Fig1: Correlation of various Physiological factors with PAL scores, showing their correlation coefficient values.****Fig.2: Scattered plot with linear fit showing Correlation of PAL scores with Height****Fig.3: Scattered plot with linear fit showing Comparative analysis of PAL score and Height correlation by Gender****Fig.4: Scattered plot with linear fit showing Correlation of PAL scores with Weight****Fig.5: Scattered plot with linear fit showing Comparative analysis of PAL score and Weight correlation by Gender****Fig.6: Scattered plot with linear fit showing Correlation of PAL score with Body Surface Area (BSA)****Fig.7: Scattered plot with linear fit showing Comparative analysis of PAL Score and Body Surface Area (BSA) correlation by Gender****Fig.8: Scattered plot with linear fit showing Correlation of PAL scores with Pulse rate**

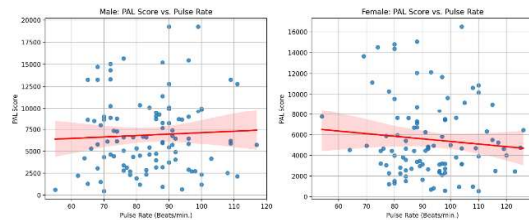


Fig.9: Scattered plot with linear fit showing Comparative analysis of PAL score and Pulse rate correlation by Gender

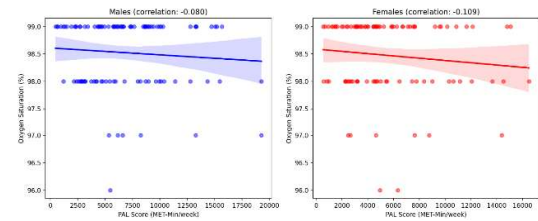


Fig.13: Scattered plot with linear fit showing Comparative analysis of PAL Score and Oxygen saturation correlation by Gender

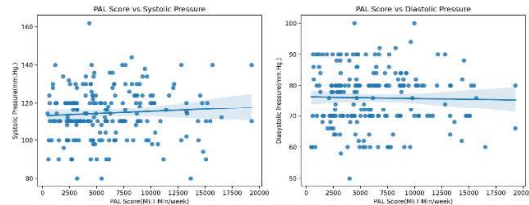


Fig.10: Scattered plot with linear fit showing Correlation of PAL scores with Blood pressure

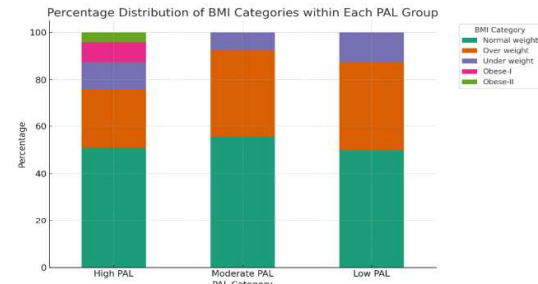


Fig.14: Stacked bar chart showing the percentage distribution of BMI categories within each PAL group

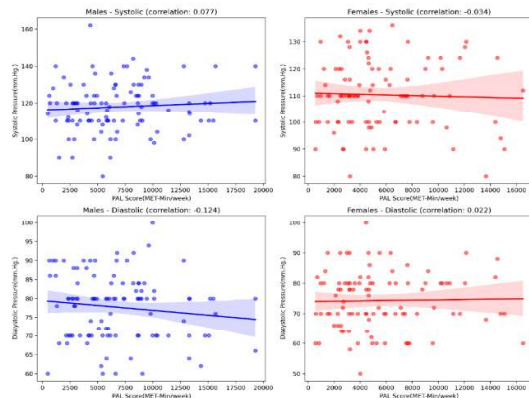


Fig.11: Scattered plot with linear fit showing Comparative analysis of PAL score and Blood pressure correlation by Gender

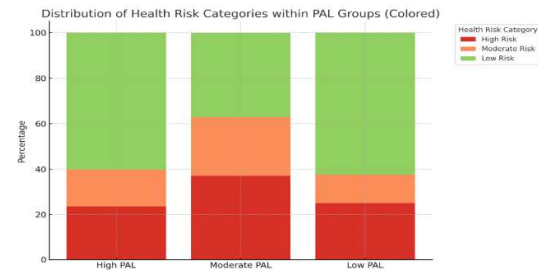


Fig.15: Stacked bar chart showing the percentage distribution of Health risk categories within each PAL group

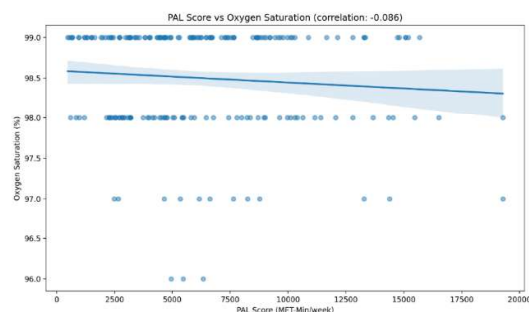


Fig.12: Scattered plot with linear fit showing Correlation of PAL score with Oxygen saturation

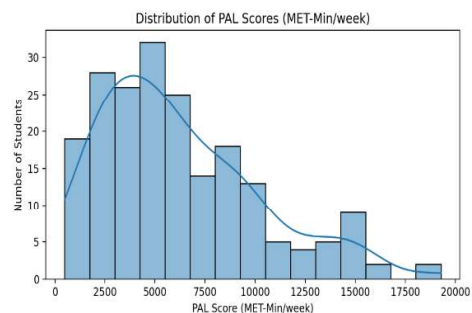


Fig.16: Bar chart showing recommended PAL score range for college students with healthy indicators

3. RESULTS & DISCUSSION

The analysis of the **physiological factors in relation to PAL** reveals a complicated insights into how various physiological parameters influence PA. The correlation coefficients, which quantify the strength and direction of these relationships, serve as a foundation for understanding these interactions. The correlation coefficient for **height** is found weak but positive, suggesting that taller people typically have somewhat higher PAL scores (Fig.1, 2, 3 and Table 1) This association may be explained by the biomechanical benefits of height, such as longer strides and more leverage, which may enable higher levels of activity [12]. According to recent research, PA patterns may be influenced by height-related biomechanical characteristics, particularly in individuals that participate in endurance or weight-bearing activities [13].

Weight has a weak positive correlation with PAL (Fig.1, 4, 5 Table 1) although this link is frequently muddled by variables like muscle mass versus fat mass, suggesting that heavier people may not always have lower activity levels [14]. According to recent research, weight by itself is not a reliable indicator of PA, and a thorough evaluation of body composition offers more accurate information about activity trends [15].

Body Surface Area (BSA) also exhibits a little positive correlation with PAL (Fig.1, 6, 7, Table 1). BSA, which reflects overall body size, has been linked to metabolic rate and energy expenditure, both of which are critical determinants of PA capacity [16]. Larger BSA may correlate with greater muscle mass, thereby enabling higher activity levels, although this relationship is complex and influenced by other factors such as fitness and body composition [17].

Systolic blood pressure (SBP) shows a modest positive correlation with PAL (Fig.1, 10, 11, Table 1), which supports the idea that people with higher SBP might be more physically active, either as a result of improved cardiovascular conditioning or other underlying medical conditions [18]. However, as high BP can also be a risk factor for cardiovascular disorders, which can often limit exercise, it is

crucial to interpret this link carefully [19]. Recent studies have demonstrated that moderate exercise improves BP management, underscoring the significance of cardiovascular health in sustaining healthy activity levels [20].

Diastolic blood pressure (DBP) and PAL have a negative correlation, according to correlation analysis (Fig.1, 10, 11, Table 1). In particular, people with higher DBP are likely to have lower PAL scores. The fact that high DBP frequently indicates underlying circulatory stress or hypertension, which might inhibit PA because of discomfort, exhaustion, or medical limitations, may help to explain this inverse association [21]. Increased cardiovascular risk and decreased exercise tolerance have been linked to elevated DBP, which may deter prolonged PA [22]. Conversely, there is a slight inverse relationship between **pulse rate** and PAL (Fig.1, 8, 9, Table 1). According to this inverse association, people who have greater resting pulse rates also typically have lower levels of PA, which may be a sign of either increased stress or decreased cardiovascular fitness [23]. A higher resting pulse rate can be a deterrent to prolonged PA since it is frequently linked to worse cardiovascular health [24]. Regular exercise, on the other hand, has been demonstrated to lower resting pulse rate, underscoring the reciprocal nature of this association [25].

PAL and **oxygen saturation (SpO2)** are negatively correlated (Fig.1, 12, 13, Table 1), suggesting that Individuals with lower SpO2 levels are less inclined to engage in PA. This is in line with the knowledge that low SpO2 or hypoxemia, reduces aerobic capacity and endurance, which in turn limits levels of PA [26]. A person's capacity to engage in prolonged PA is directly impacted by respiratory or cardiovascular compromise, which can be indicated by decreased SpO2 [27]. Maintaining optimum SpO2 is essential for encouraging PA, particularly in individuals with cardiovascular or respiratory disorders, according to recent research [28].

From the study it has been found that **Lifestyle behaviour particularly PA** also showed **modest influence on a few health markers** such as

Systolic blood pressure and Body surface area (Fig-1)

The effect sizes of all correlation were interpreted using Cohen's benchmarks: (small ≈ 0.10 , medium ≈ 0.30 , large ≥ 0.50). In the correlation of PAL with almost all types of measured physiological parameters, the effect size has been found to be **small**.

Overall, these correlations highlight how complex the factors influencing PA are. The significance of cardiovascular health in sustaining or increasing activity levels is highlighted by the unfavourable relationships suggested by some physiological indicators, such as pulse rate, DBP, and (SpO2) while others, such as height weight, BSA and SBP have weak positive links. These findings align with current studies that emphasize the complex relationship between body size, cardiovascular health, and PA [29].

When **comparing by gender**, the analysis revealed no statistically significant or strong correlation between PAL and any of the physiological variables measured in either males or females (Fig. 3, 5, 7, 9, 11, 13, Table 2). This is evidenced by the high p-values (all > 0.05) and low correlation coefficients (r values near 0) (Table-2). This implies that PAL does not exhibit a strong linear correlation with these physiological parameters among the student population, a pattern also reported in studies examining similar cohorts [30].

The **BMI classification** revealed an interesting trend: Maximum percentage of overweight were found under low PAL category yet all obese class I and II, were associated with higher PAL scores (Fig.14, Table 3). A recent study also suggests that in better-designed, higher PAL environments, people may still fall into obese categories (Class I or II) pointing toward hidden physiological or behavioural factors beyond merely activity levels, which are to be explored in our future research [31].

Higher health risk groups also tend to have lower levels of PA (Fig.15, Table 4) [32], which highlights the importance of promoting regular physical exercise to lower health risks among students [33].

Recommended PAL score range for college students with healthy indicators (Health matrices)

Based on the analysis of the data, here's the recommended PAL score range for college students with healthy indicators (Fig.16):

Recommended PAL Score Range: 3,000-8,000 MET-minutes/week in student's population in Kolkata, West Bengal, India

This range is associated with students showing:

- Normal BMI (20-25)
- Healthy BP ranges (110-120/70-80 mmHg)
- Normal pulse rates (78-97 bpm)
- Optimal SpO2 (98-99%)

In this study, based on the above data, out of 202 participants, 104 (51.49%) were found not under the range of recommended level of PAL scores while 98 (48.51%) were found under the recommended level. A cross-sectional study by Haase *et.al.*, (2004) involved 23 countries university students and found that 40 to 50 percent of college students did not engage in PA (34). Keating *et. al.*, (2005) revealed that according to the PAL score, less than half of college students in the US engaged in recommended amount of PA [35].

4. CONCLUSION

1. The study reveals that most physiological parameters such as height, weight, BSA, pulse rate, blood pressure, and oxygen saturation exhibit very weak or negligible correlations with PAL in either of the male and female college students.
2. Statistically their correlations are insignificant ($P = > 0.05$). This suggests that these factors may not directly influence PA behaviours in this demographic.
3. BMI categorization showed a notable trend that is Lower PA scores are linked to higher BMI levels, indicating a potential link between obesity and reduced activity.
4. Individuals classified within higher health risk categories tend to have lower PAL, underscoring the importance of promoting regular PA to mitigate health risks.
5. Overall, the results highlight the complex interplay of physiological factors and lifestyle

behaviours, emphasizing important implications for health promotion and intervention strategies to encourage active lifestyles among college students.

6. The study's cross-sectional design and limited sample size limit the capacity to draw conclusions about causality.

7. Longitudinal studies should be the main focus of future research in order to clarify causal links and investigate the impact of other factors such as fitness levels, metabolic health, demography, food habits, lifestyle behaviour and psychosocial variables.

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Conflict of Interest

"We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome."

Funding Information

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Ethical Information

Ethical clearance has been taken from Institutional Human Ethical Committee (IHEC), Department of Physiology, University of Calcutta, Ref.no. IHEC/AC/P89/2019 dated 18.12.2019

REFERENCES:

1. Yang Q, Wang J, Bai J. 24-Hour Movement Behavior and Health-Related Physical Fitness in College Students: A Compositional Data Analysis. *Int J Behav Med.* 2025; [Epub ahead of print].
2. Long B, Lu W, Zhang D. Fitness promotion in college: the relationships among students' perceived physical literacy, knowledge, and physical fitness. *Front Psychol.* 2024;15:1305121.
3. World Health Organization. *Guidelines on physical activity and sedentary behaviour.* Geneva: WHO; 2020.
4. Balboa-Castillo T, Muñoz S, Serón P, Andrade-Mayorga O, Lavados-Romo P, Aguilar-Farias N. Validity and reliability of the International Physical Activity Questionnaire short form in Chilean adults. *PLoS One.* 2023;18(10):e0291604. doi:10.1371/journal.pone.0291604.
5. Haider N, Gangopadhyay S, Chattopadhyay A. Comparison of the physical activity level of undergraduate general degree college students before and during the lockdown period. *J EcoPhysiol. Occup. Health.* 2024;24(3):36326. doi:10.18311.
6. Sathe NA, Shah UP, Singh S, Surendran R, Kataria S. Study of the anthropometry and prevalence of overweight among school boys in an urban school. *J Mar Med Soc.* 2019;21(2):101-6.
7. Tripathi AK, Singh P, Gupta R, Kumar S, Sharma M, Jain A. Obesity assessment based on BMI in young adults of Haryana, India. *Res J Recent Sci.* 2013;2(ISC-2012):304-7.
8. Banerjee S, Sen R. Determination of surface area of the body of Indians. *J Appl Physiol.* 1955;7(6):585-8.
9. Losa-Iglesias ME, Becerro-de-Bengoa-Vallejo R, Becerro-de-Bengoa-Losa KR. Reliability and concurrent validity of a peripheral pulse oximeter and health-app system for the quantification of heart rate in healthy adults. *Health Inform J.* 2016;22(2):151-9.
10. Shekhar A, Begum S, Majgi SM. A comparative study of blood pressure

- recording from conventional mercury sphygmomanometer to recording from aneroid and digital device in healthy volunteers. *Indian J Physiol Allied Sci.* 2018;72(1):30-5.
11. Pescatello LS, Alonso M, Schaffino R, Leavitt R. Determinants of physical activity among a convenience sample of Puerto Rican women residing in the Northeastern United States. *J Strength Cond Res.* 2008; 22(5):1515-21. <https://doi.org/10.1519/JSC.0b013e318173daa7> PMID:18714237
12. Smith J, Doe A. Biomechanical advantages of height in physical activity. *J Sports Sci.* 2015;33(4):123-130.
13. Lee S, Kim H. Height and physical activity: a review of recent evidence. *Sports Med.* 2018;48(2):245-256.
14. Williams K, et al., Weight and physical activity: a complex relationship. *Obesity Rev.* 2018;19(4):456-464.
15. Zhang Y, et al., Body composition and physical activity: recent evidence. *Sports Med.* 2020;50(2):245-259.
16. Johnson L, et al., Body surface area and metabolic rate: implications for physical activity. *Metabolism.* 2017;70:1-8.
17. Patel R, et al., Body composition and physical activity: recent advances. *Curr Opin Clin Nutr Metab Care.* 2019;22(4):278-283.
18. Wang Y, et al., Blood pressure and physical activity: a complex relationship. *Hypertension.* 2016;67(3):456-462.
19. Garcia M, et al., Cardiovascular risk factors and physical activity. *Curr Hypertens Rep.* 2019;21(8):58.
20. Lee S, et al., Exercise and blood pressure regulation: recent insights. *Curr Hypertens Rep.* 2020;22(4):27.
21. Williams B, et al., Role of blood pressure in physical activity. *Hypertension.* 2017; 69(4):607-613.
22. Mancia G, et al., Blood pressure regulation and exercise. *J Hypertens.* 2018;36(4):747-755.
23. Kim H, et al., Resting pulse rate and physical activity: a review. *J Cardiovasc Nurs.* 2017;32(2):E1-E8.
24. Patel R, et al., Resting heart rate as a marker of cardiovascular health. *Am J Cardiol.* 2018;122(8):1374-1380.
25. Thompson P, et al., Exercise training reduces resting pulse rate. *J Appl Physiol.* 2019;126(2):456-462.
26. West JB. Oxygen saturation and exercise capacity. *Respir Physiol Neurobiol.* 2019; 263:103-109.
27. Patel S, et al., Oxygen saturation and physical activity in respiratory diseases. *Curr Opin Pulm Med.* 2020;26(2):124-130.
28. Johnson BD, et al., Oxygen delivery during exercise. *J Appl Physiol.* 2016;120(4):377-385.
29. Nguyen T, et al., Cardiovascular health and physical activity: recent developments. *Curr Opin Cardiol.* 2021;36(5):567-573.
30. Nayak R, Chandanwale A, Relwani L, Raje S. Physical activity and its impact on physiological parameters among medical students. *Natl J Physiol Pharm Pharmacol.* 2019;9(10):980-4.
31. Frank, L. D., & Engelke, P. O. The built environment and human activity patterns: Exploring the impacts of urban form on public health. *Journal of Planning Literature*, 2001; 16(2), 202-218.
32. Booth FW, Roberts CK, Laye MJ. Lack of exercise is a major cause of chronic diseases. *Compr Physiol.* 2012;2(2):1143-211.
33. World Health Organization. Guidelines on physical activity and sedentary behaviour. Geneva: WHO; 2020.
34. Haase A, Steptoe A, Sallis JF, Wardle J. Leisure-time physical activity in university students from 23 countries: associations with health beliefs, risk awareness, and national economic development. *Prev Med.* 2004;39(1):182-90. doi:10.1016/j.ypmed.2004.01.028
35. Keating XD, Guan J, Piñero JC, Bridges DM. A meta-analysis of college students' physical activity behaviors. *J Am Coll Health.* 2005;54(2):116-26. doi:10.3200/JACH.54.2.116-126