

PHYSICAL ACTIVITY LEVELS AND BODY MASS INDEX AMONG MIDDLE SCHOOL STUDENTS: A CROSS-SECTIONAL STUDY

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Abstract

Adolescence is a critical period for establishing healthy lifestyle behaviors; yet physical inactivity and overweight are rising globally, posing significant public health challenges. This cross-sectional study aimed to assess physical activity (PA) levels and Body Mass Index (BMI) among middle school students in District Bajaur, Khyber Pakhtunkhwa, Pakistan and to examine the relationship between these variables. A total of 220 students aged 11–14 years were selected using multistage random sampling from government middle schools. Physical activity was measured using the Physical Activity Questionnaire for Adolescents (PAQ-A) and BMI was calculated from direct measurements of height and weight, classified according to WHO age and sex-specific cut-offs. Descriptive statistics indicated a mean PAQ-A score of 2.85 ± 0.65 , with 27.3% of students classified as low active, 54.5% as moderately active and 18.2% as highly active. The mean BMI was $19.8 \pm 2.9 \text{ kg/m}^2$, with 13.6% underweight, 63.6% normal weight, 15.9% overweight and 6.8% obese. Pearson correlation revealed a significant negative relationship between PAQ-A scores and BMI ($r = -0.42, p < .001$), indicating that higher physical activity is associated with lower BMI. Chi-square analysis further confirmed a significant association between PA categories and BMI classification ($\chi^2 = 18.67, df = 6, p = .005$). Age-wise comparisons showed no statistically significant differences in PA or BMI. The findings underscore that a considerable proportion of adolescents in District Bajaur are insufficiently active, with a notable prevalence of overweight and obesity. These results highlight the need for school-based interventions, structured physical activity programs and health promotion strategies to improve adolescent health and provide baseline data for regional policymakers.

INTRODUCTION

Physical activity is a fundamental component of healthy growth and development during adolescence. Regular engagement in moderate-to-

vigorous physical activity contributes to improved cardiovascular fitness, muscular strength, bone health and metabolic functioning, while also supporting psychological well-being and academic performance among school-aged children

(Janssen & LeBlanc, 2010; World Health Organization [WHO], 2020). Adolescence is considered a critical stage for establishing lifelong health behaviors, as physical activity habits formed during early and middle school years often continue into adulthood (Telama *et al.*, 2014). Therefore, promoting and monitoring physical activity in middle school populations is essential for preventing lifestyle-related health problems and for ensuring long-term health benefits. Despite these benefits, global evidence shows that physical activity levels among adolescents are declining, while sedentary behaviors are increasing. The WHO reports that more than 80% of adolescents worldwide do not meet the recommended guideline of at least 60 minutes of moderate-to-vigorous physical activity daily (WHO, 2007). Several factors contribute to this pattern, including increased screen time, academic pressure, reduced outdoor recreation and limited access to sports facilities (Guthold *et al.*, 2020). This growing inactivity is a major public health concern because insufficient physical activity is strongly associated with excess body weight, reduced fitness and higher risk of non-communicable diseases (Janssen & LeBlanc, 2010).

In parallel with declining physical activity, childhood and adolescent overweight and obesity have become serious global health challenges. Obesity in adolescence is linked to immediate health consequences such as reduced physical fitness, low self-esteem and metabolic disorders, as well as long-term consequences including adult obesity, cardiovascular disease and type 2 diabetes (Sahoo *et al.*, 2015). Body Mass Index (BMI) is widely used as a practical indicator for classifying weight status in population-based studies and for identifying adolescents at risk of overweight and obesity (Cole *et al.*, 2000). Previous research has frequently demonstrated an inverse relationship between physical activity and BMI, indicating that adolescents with lower physical activity levels tend to have higher BMI values and an increased likelihood of overweight or obesity (Nagata *et al.*, 2023).

In Pakistan, rapid lifestyle transitions, increasing sedentary routines and dietary changes have

contributed to emerging patterns of adolescent overweight and obesity. Recent evidence suggests that movement behaviors and physical inactivity are significantly associated with overweight and obesity among Pakistani school-aged children and adolescents (Tanveer *et al.*, 2025). However, available research is largely concentrated in major urban centers such as Karachi, Lahore and Islamabad, while evidence from rural, remote and underserved districts remains limited. This lack of regional data is problematic because physical activity behaviors and BMI patterns are strongly influenced by local socio-cultural norms, access to sports infrastructure, school environment and economic conditions. Consequently, findings from large cities may not accurately represent adolescents living in geographically and socio-economically distinct areas such as District Bajaur in Khyber Pakhtunkhwa.

District Bajaur is a mountainous and largely rural region where government schools represent the main educational institutions for middle school students. Students in this district may experience unique barriers to physical activity, including limited school-based sports facilities, fewer structured physical education programs, cultural constraints and restricted access to recreational spaces. Yet, no published study has specifically examined physical activity levels and BMI status among middle school students in District Bajaur. This represents an important research gap, as the absence of local evidence limits the ability of health authorities, school administrations and policymakers to develop effective school-based interventions and preventive strategies tailored to this population. Therefore, the present study aims to assess physical activity levels using the Physical Activity Questionnaire for Adolescents (PAQ-A) and to determine BMI categories among middle school students in District Bajaur. Additionally, this study examines the relationship between physical activity and BMI. By addressing the lack of evidence from this under-researched region, the findings of this study will provide baseline data for future research and support the development of targeted physical education programs and adolescent health policies in

government middle schools of Khyber Pakhtunkhwa.

METHODOLOGY

Study design

A cross-sectional quantitative research design was employed to evaluate physical activity levels and Body Mass Index (BMI) among middle school students and to determine the relationship between these variables. A cross-sectional approach was considered appropriate because it enables the measurement of exposure (physical activity) and outcome (BMI) at a single point in time within the target population, facilitating descriptive and inferential statistical analyses.

Study Area

The study was conducted in government middle schools located in District Bajaur, Khyber Pakhtunkhwa, Pakistan. It is of about 200 kilometers north of Peshawar. The total area of the District is 1,290 Km². The study area lies at altitude of 1126 meters above the sea level and exists geographically between 34°-30° and 34°-58° latitudes and 71°-11° and 71°-30° longitudes (Shah *et al.*, 2025, 2026). District Bajaur is a predominantly rural and mountainous region where government schools serve as the primary educational institutions for most adolescents. The selected schools represented the typical school environment of the district.

Study population and sampling

The study population consisted of middle school students aged 11-14 years enrolled in government schools of District Bajaur. A total of 220 students were selected as the study sample. The sample was chosen using a multistage random sampling technique. In the first stage, government middle schools were randomly selected from different areas of the district. In the second stage, students meeting the inclusion criteria were randomly selected from the chosen schools to participate in the study.

Eligibility Criteria

Inclusion Criteria

Students were included if they were:

- Enrolled in a government middle school in District Bajaur
- Aged between 11 and 14 years
- Provided assent and had parental/guardian consent

Exclusion Criteria

Students were excluded if they:

- Had medical conditions or physical disabilities affecting mobility or physical activity
- Were unwilling to participate

Data Collection Instruments and Measurements Physical Activity

Physical activity was measured using the Physical Activity Questionnaire for Adolescents (PAQ-A), a validated self-report instrument that assesses general physical activity over the previous seven days (Kowalski *et al.*, 2004). The PAQ-A provides a composite score ranging from 1 to 5, with higher scores indicating higher activity levels. For analysis, scores were categorized as:

- **Low physical activity:** 1.00-2.33
- **Moderate physical activity:** 2.34-3.66
- **High physical activity:** 3.67-5.00

Anthropometric Measurements and BMI Calculation

Height (in meters) and weight (in kilograms) were measured using standardized procedures. BMI was calculated using the formula:

$$BMI = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

BMI values were interpreted using age- and sex-specific WHO cut-offs to classify students as: underweight, normal weight, overweight and obese.

The BMI and PAQ-A scores were later analyzed using descriptive statistics (mean, standard deviation, frequency, and percentage) and inferential statistics (Pearson correlation, Chi-square tests) in SPSS version 25 to examine the relationship between physical activity levels and BMI categories.

Data collection procedure

Data collection was conducted following strict ethical and procedural guidelines to ensure the safety, privacy and reliability of the study data. Prior to data collection, ethical approval was obtained from the relevant institutional review board and formal permission was secured from the administration of each participating government middle school in District Bajaur.

Before participation, written informed consent was obtained from parents or guardians and assent was obtained from all students, ensuring voluntary participation. Students were informed about the study objectives, procedures, confidentiality and their right to withdraw at any time without consequences.

Physical activity levels were assessed using the Physical Activity Questionnaire for Adolescents (PAQ-A), and anthropometric measurements, including height and weight, were recorded using standardized techniques. All data were carefully documented and quality control measures, such as double-checking entries and calibrating measurement tools were implemented to minimize errors and ensure the accuracy of the dataset for subsequent statistical analysis.

Data Analysis

All data were entered and analyzed using SPSS version 25. Both descriptive and inferential statistical techniques were applied to summarize the data and examine the relationships between physical activity levels and BMI among middle school students.

Descriptive Analysis

Descriptive statistics were used to summarize participant characteristics, physical activity levels and BMI categories. Specifically; Frequencies and percentages were calculated for categorical variables, including physical activity levels (low, moderate, high) and BMI categories (underweight, normal, overweight, obese). Means and standard deviations (SD) were calculated for continuous variables, including PAQ-A scores and BMI values.

Inferential Analysis

Inferential analyses were performed to examine relationships and group differences:

Pearson Correlation

The association between continuous PAQ-A scores and BMI values was assessed using Pearson's correlation coefficient (r). This test evaluates the strength and direction of the linear relationship between physical activity and BMI.

Chi-Square Test

Associations between categorical PA levels (low, moderate, high) and BMI categories (underweight, normal, overweight, obese) were examined using the Chi-square test (χ^2). This test determines whether there is a statistically significant relationship between two categorical variables.

Independent t-tests / ANOVA

For group comparison by age, one-way ANOVA was applied for comparisons across more than two age groups. These tests assess whether mean PAQ-A scores or BMI differ significantly between groups.

Significance Level

For all inferential tests, a p-value $< .05$ was considered statistically significant. Effect sizes (e.g., Cohen's d for t-tests, Cramér's V for Chi-square) were also calculated where appropriate to quantify the magnitude of associations.

RESULTS

Participant Characteristics

Table 1 presents the demographic characteristics of the 220 middle school students included in the study, providing an overview of age distribution and grade-level representation.

Age Distribution

The participants ranged in age from 11 to 14 years, reflecting the typical age group of middle school students. Among the sample, the highest proportion of students was 13 years old (31.8%, $n = 70$), indicating that early adolescence was the most represented stage in the study. This was followed by 12 year old students (25.0%, $n = 55$),

while 14 year olds accounted for 22.7% (n = 50) and 11 year olds represented the smallest group (20.5%, n = 45).

The mean age of the participants was 12.8 ± 1.1 years, suggesting that the sample was centered around 13 years of age with relatively low variability. The small standard deviation indicates that the ages of participants were closely clustered around the mean, which enhances the homogeneity of the sample in terms of developmental stage. This is important because physical activity patterns and BMI may vary with age and a relatively narrow age range helps ensure more reliable comparisons.

Grade-Level Distribution

Participants were drawn from three grade levels (Grades 6-8), ensuring representation across the middle school stage. Grade 6 students constituted the largest group (35.0%, n = 77), followed closely by Grade 7 (33.2%, n = 73) and Grade 8 students (31.8%, n = 70).

The relatively even distribution across grades indicates that the sample was well balanced in terms of educational level. This is particularly important because both physical activity behaviors and BMI may vary with grade level due to differences in academic workload, physical development, and lifestyle patterns. A balanced sample across grades allows for more reliable comparisons and reduces the likelihood of bias toward a specific age or educational group.

Table 1. Participants' Demographics (N = 220)

	Category	N	%	Mean ± SD
Age (years)	11	45	20.5	-
	12	55	25.0	-
	13	70	31.8	-
	14	50	22.7	-
	Total / Overall	220	100	12.8 ± 1.1
Grade	6	77	35.0	-
	7	73	33.2	-
	8	70	31.8	-

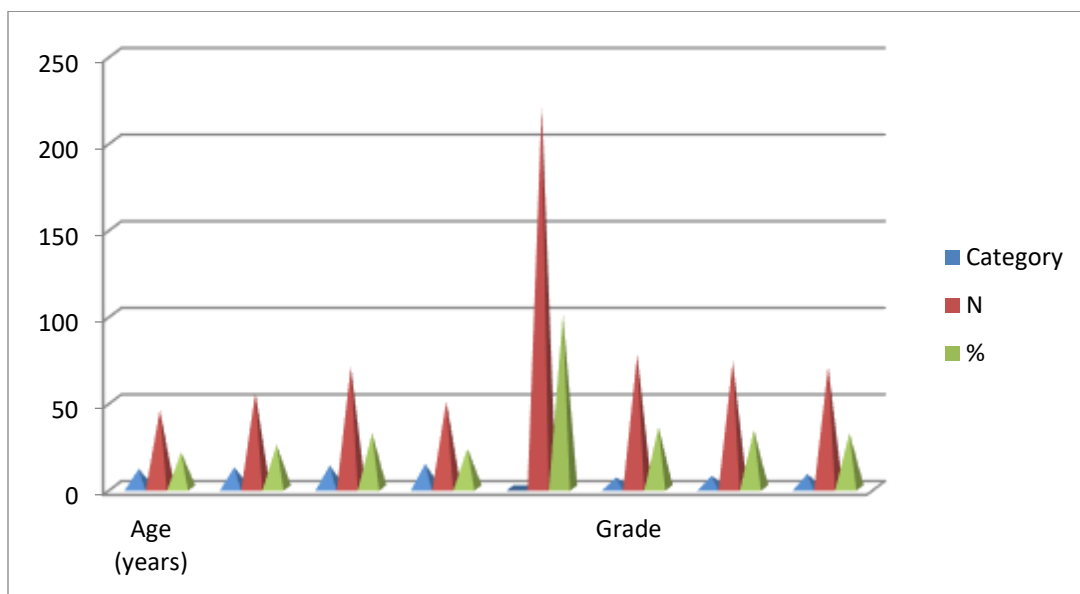


Fig.1. Participants' Demographics: Age and Grade

Overall, the demographic characteristics suggest that the study sample was diverse yet well balanced in terms of age and grade level. The relatively uniform distribution enhances the representativeness of the sample and supports the validity of subsequent analyses examining the relationship between physical activity and BMI among middle school students.

Physical Activity Levels

Physical activity among participants was assessed using the Physical Activity Questionnaire for Adolescents (PAQ-A), which provides a composite score ranging from 1 to 5, with higher scores indicating higher activity levels. The overall mean PAQ-A score for the 220 participants was 2.85 ± 0.65 , which corresponds to a moderate level of physical activity on average.

When physical activity was categorized:

- **Low physical activity:** 27.3% of students (n = 60)
- **Moderate physical activity:** 54.5% of students (n = 120)
- **High physical activity:** 18.2% of students (n = 40)

The distribution indicates that more than half of the participants engaged in moderate physical activity, while a smaller proportion were highly active, and slightly over a quarter were classified as low active. This pattern is consistent with previous research suggesting that moderate physical activity is the most common activity level among adolescents in school settings.

The mean PAQ-A scores within each category highlight the differences in activity levels:

Table 2. Physical Activity Levels of Participants.

PA Level	n	%	Mean PAQ-A \pm SD
Low	60	27.3	2.10 \pm 0.50
Moderate	120	54.5	3.00 \pm 0.35
High	40	18.2	4.10 \pm 0.40
Total	220	100	2.85 \pm 0.65

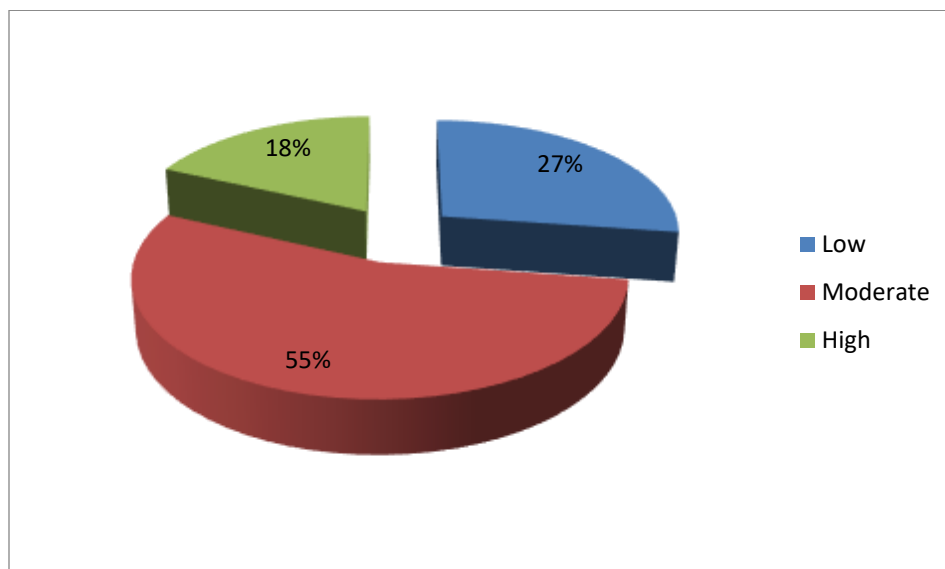


Fig.2. Percentage of Physical Activity Levels

These results suggest that while the majority of students meet at least moderate activity levels, a

significant proportion of students (27.3%) may be at risk of insufficient physical activity, which

could have implications for their overall health, fitness, and BMI status.

Body Mass Index (BMI) Categories

BMI was calculated using standardized measurements of height and weight, and the resulting values were classified according to WHO age- and sex-specific cut-offs for adolescents. The overall mean BMI was $19.8 \pm$

2.9 kg/m^2 , which falls within the normal weight range on average for this age group.

The distribution of BMI categories was as follows:

- **Underweight:** 13.6% (n = 30)
- **Normal weight:** 63.6% (n = 140)
- **Overweight:** 15.9% (n = 35)
- **Obese:** 6.8% (n = 15)

Table 3. The mean BMI for each category demonstrates clear distinctions between the groups

BMI Category	n	%	Mean BMI \pm SD
Underweight	30	13.6	16.8 ± 0.8
Normal	140	63.6	19.5 ± 1.2
Overweight	35	15.9	22.5 ± 1.1
Obese	15	6.8	25.8 ± 1.4
Total	220	100	19.8 ± 2.9

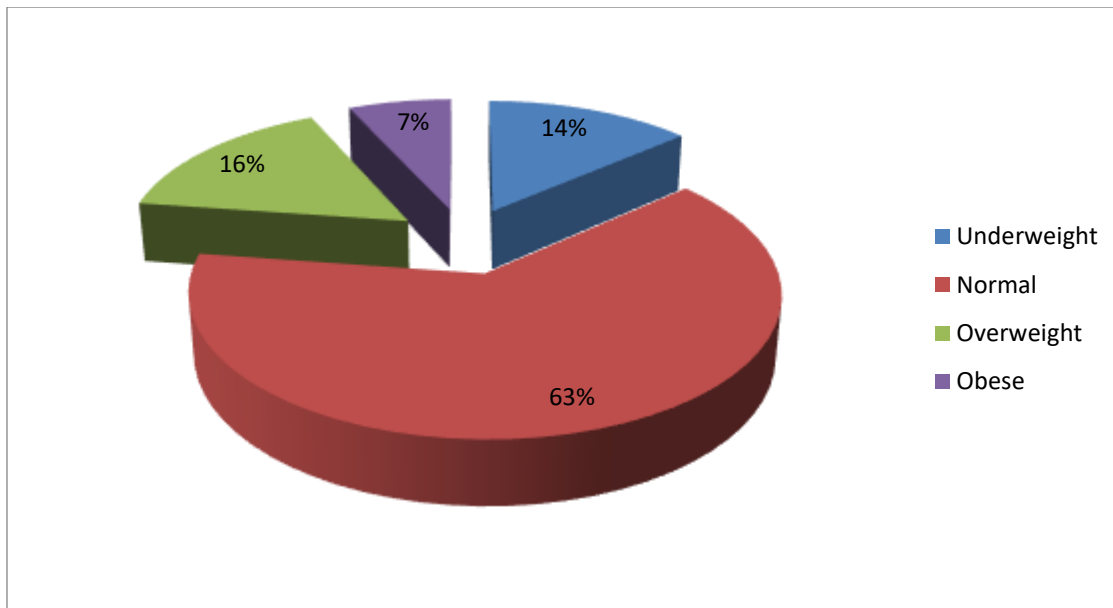


Fig.3. Percentage of BMI Categories of Participants

Most students (63.6%) fell within the normal BMI range, which is consistent with healthy growth patterns for middle school students. A smaller proportion (13.6%) were underweight, potentially reflecting nutritional deficiencies, socioeconomic factors, or health conditions that could impact growth and physical activity participation. About 22.7% of students were classified as overweight or obese, which is concerning as these conditions are associated

with increased risk for chronic health issues, including cardiovascular disease and type 2 diabetes, even during adolescence. Since BMI is influenced by energy balance, the distribution of BMI categories alongside physical activity levels provides insight into potential correlations. For example, low-active students may be more likely to fall into overweight or obese categories, whereas high-active students may be more likely to have normal BMI.

Example Table 4: Summary of Physical Activity and BMI Distribution

Variable	Category	n	%	Mean ± SD
Physical Activity (PAQ-A)	Low	60	27.3	2.10 ± 0.50
	Moderate	120	54.5	3.00 ± 0.35
	High	40	18.2	4.10 ± 0.40
BMI (kg/m ²)	Underweight	30	13.6	16.8 ± 0.8
	Normal	140	63.6	19.5 ± 1.2
	Overweight	35	15.9	22.5 ± 1.1
	Obese	15	6.8	25.8 ± 1.4

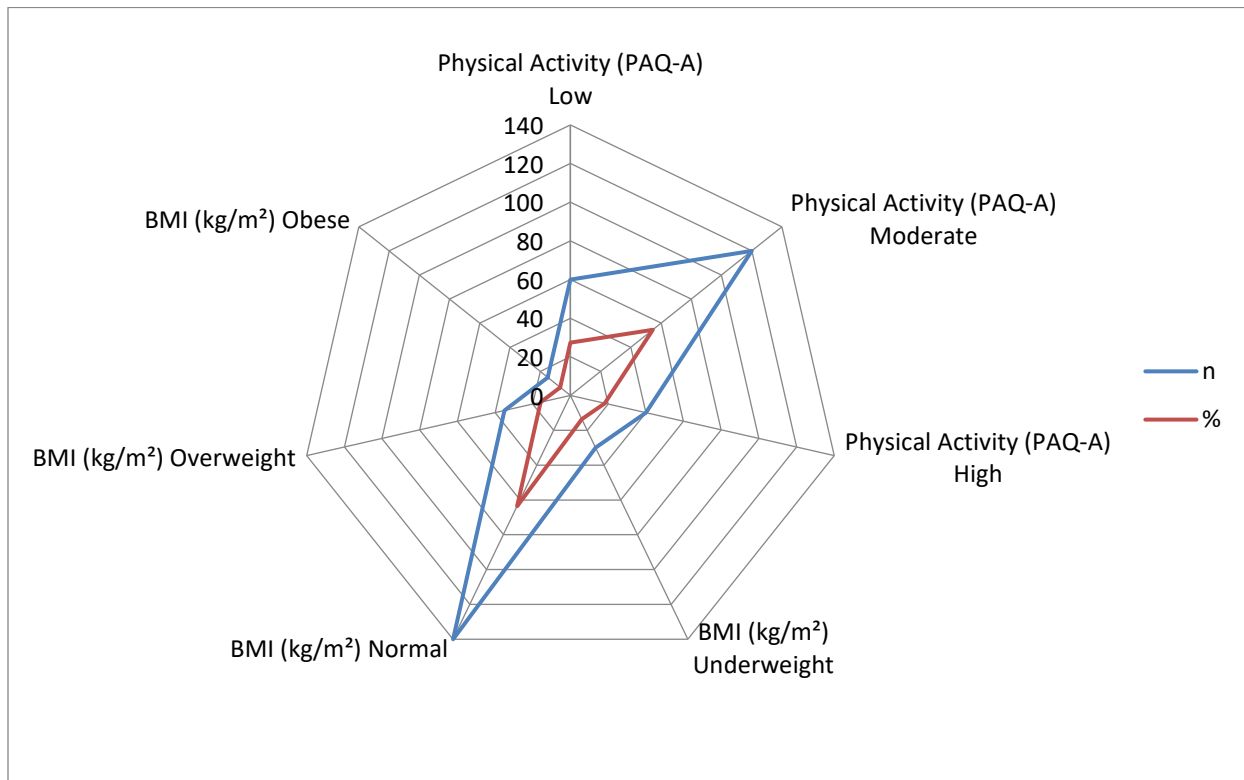


Fig.4. Physical Activity and BMI Distribution

The majority of students were moderately active and of normal weight, indicating overall acceptable health status in the sample. However, a notable proportion were either low-active or overweight/obese, highlighting the need for targeted interventions to increase physical activity and promote healthy weight management among middle school students. These results provide a foundation for subsequent analyses examining the relationship between physical activity levels and BMI, which can identify risk patterns and inform school-based health programs.

Relationship between Physical Activity and BMI

Pearson Correlation

A Pearson correlation analysis was conducted to examine the relationship between continuous PAQ-A scores and BMI. Results showed a significant negative correlation ($r = -0.42, p < .001$), indicating that students with higher physical activity levels tended to have lower BMI values.

This finding suggests an inverse relationship between activity and body mass students who are

more physically active are less likely to be overweight or obese. This is consistent with literature on energy balance, where increased physical activity contributes to lower adiposity and healthier BMI among adolescents.

Chi-Square Test

A Chi-square test was used to assess the association between categorical physical activity levels (low, moderate, high) and BMI categories (underweight, normal, overweight, obese). The association was statistically significant ($\chi^2 = 18.67$, $df = 6$, $p = .005$), indicating that physical activity level is meaningfully related to BMI classification.

Table 5. Cross-tabulation of PA Level and BMI Category

BMI Category	Low PA	Moderate PA	High PA	Total
Underweight	10	15	5	30
Normal	30	85	25	140
Overweight	15	20	0	35
Obese	5	0	10	15
Total	60	120	40	220

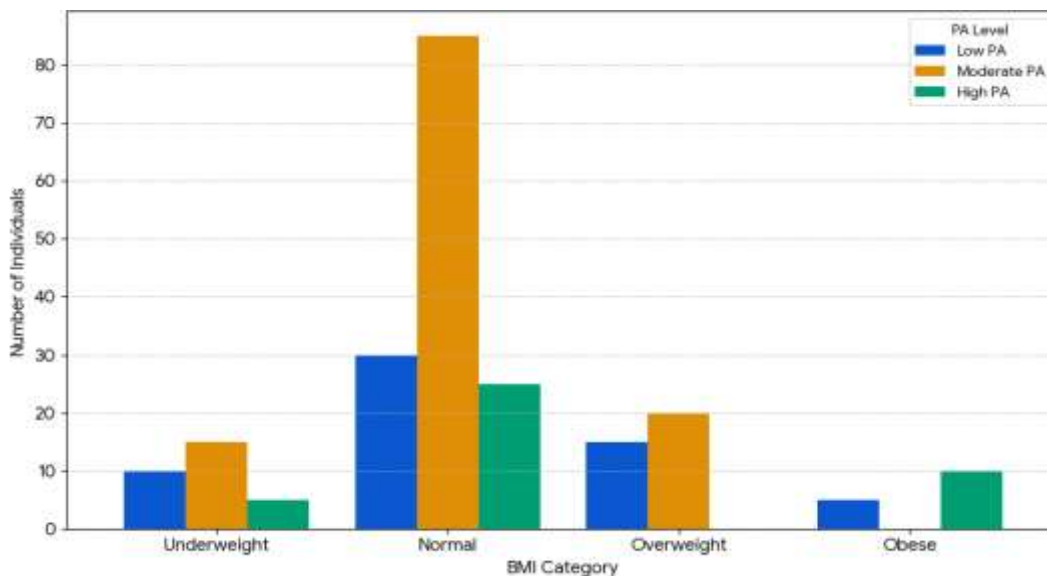


Fig.5. PA Level by BMI Category

Age and grade wise Comparisons

ANOVA results indicated no significant differences in PAQ-A scores across ages 11-14 years ($F = 1.87$, $p = .14$) or across grades 6-8 ($F = 2.01$, $p = .12$). Similarly, BMI did not differ significantly by age ($F = 0.92$, $p = .43$) or grade ($F = 1.05$, $p = .35$).

Age and grade did not appear to significantly influence physical activity or BMI, suggesting that activity levels and weight status were relatively consistent across early adolescence within this sample.

DISCUSSION

Interpretation of Main Results

The present study examined physical activity levels and BMI among 220 middle school students in District Bajaur. Findings indicate that over half of the students (54.5%) were moderately active, while 27.3% were low active and 18.2% highly active, suggesting suboptimal adherence to WHO physical activity guidelines. The mean BMI was 19.8 ± 2.9 kg/m², with 36.4% of students classified as overweight or obese, highlighting a concerning trend in adolescent

weight status. A significant negative correlation ($r = -0.42$, $p < .001$) between PAQ-A scores and BMI indicates that higher physical activity is associated with lower BMI, emphasizing the protective role of physical activity in weight management.

Comparison with Previous Research

These results align with global studies reporting insufficient physical activity and rising BMI among adolescents (Guthold *et al.*, 2020; Nagata *et al.*, 2023). In Pakistan, previous studies also indicate similar trends, with inactive school-aged children showing higher prevalence of overweight and obesity (Tanveer *et al.*, 2025). The negative association between PA and BMI in this study is consistent with the well-established role of physical activity in regulating body composition and preventing obesity (Janssen & LeBlanc, 2010; Sahoo *et al.*, 2015). Minor differences in PA and BMI levels compared to urban populations may reflect regional variations in school resources, lifestyle, and cultural practices in District Bajaur.

Public Health Implications

The findings highlight the need for school-based interventions to increase physical activity and reduce overweight/obesity among adolescents. Strategies may include structured physical education programs, active recess, extracurricular sports, and awareness campaigns for students and parents. Policymakers can utilize these findings to develop region-specific guidelines promoting regular physical activity and healthy weight management in government schools.

Strengths and Limitations

The study's strengths include a representative sample from government middle schools and the use of validated instruments (PAQ-A and WHO BMI standards). Limitations include the cross-sectional design, which does not allow causal inference, and reliance on self-reported physical activity, which may be prone to reporting bias. Nevertheless, the study provides valuable baseline data for an under-researched region, offering

insights that are locally applicable for planning adolescent health interventions.

CONCLUSION

This study examined physical activity levels and BMI among 220 middle school students in District Bajaur, Khyber Pakhtunkhwa. The results indicate that a substantial proportion of students were insufficiently active, and over one-third were classified as overweight or obese. A significant negative correlation between PAQ-A scores and BMI ($r = -0.42$, $p < .001$) confirms that higher physical activity is associated with lower BMI in this population.

These findings contribute to the limited regional literature on adolescent health in rural Pakistan, highlighting the critical role of physical activity in weight management and the need for targeted school-based interventions. By providing baseline data for an under-researched district, the study informs public health strategies aimed at improving adolescent health outcomes in similar rural contexts.

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