JURNAL UPI

Journal of Physical Education for Secondary Schools

Journal homepage: https://ejournal.upi.edu/index.php/JPESS

JPESS

A Comparative Study of Body Fat Percentage in Urban and Rural Male Adolescents Aged 13–14 in Klang District, Malaysia

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ABSTRACT

Adolescent obesity continues to rise globally due to lifestyle changes, dietary patterns, and technological influences. This study aimed to compare body fat percentage among 13- and 14-year-old male adolescents in urban and rural secondary schools in the Klang District, Selangor, Malaysia. Using a comparative design, 150 students (80 urban and 70 rural) were assessed for body fat percentage through BMI-based calculations. Two-way ANOVA analysis indicated no significant differences between locations or age groups. The findings suggest that variations in body fat are more strongly associated with physiological development and pubertal stages than with chronological age or geographic setting. Similarities in school environments, nutritional habits, and technology access across both areas may also explain the results. The study recommends expanding the age range, applying longitudinal designs, and integrating qualitative approaches to better understand lifestyle factors. These implications highlight the need for public health programs that promote physical activity and health education to reduce sedentary behaviors among Malaysian adolescents.

ARTICLE INFO

Article History:
Submitted/Received 15 Aug 2025
First Revised 25 Aug 2025
Accepted 01 Oct Mar 2025
First Available online 29 Oct 2025
Publication Date 29 Oct 2025

Keyword:
Adolescent Obesity,
Body Fat Percentage,
Pubertal Development,
Body Mass Index,
Physical Activity.

DOI: http://dx.doi.org/10.xxxxx/ijost.v2i2
p- ISSN 2528-1410 e- ISSN 2527-8045

1. INTRODUCTION

Adolescent obesity represents a significant public health challenge on a worldwide level, with profound consequences for physical, psychological, and social well-being. The increasing prevalence among adolescents can be attributed to a multitude of factors, including changes in lifestyle, environmental influences, socioeconomic conditions, and genetic predispositions. Numerous consequences arise from obesity, including chronic diseases, mental health issues, and social challenges. The prevalence of adolescent obesity has risen from 8.4% in 1990 to 17.6% in 2021, with projections suggesting an increase to 20.9% by 2030, which would represent more than 227 million adolescents classified as having a high BMI (World Health Organization, 2025; Ge et al., 2025). Approximately 20% of children and adolescents are classified as overweight or obese, with a combined obesity prevalence of 8.5% (Zhang et al., 2024). Prevalence in Asia shows significant variation: 3.5% in rural Bangladesh, over 65% in the Maldives, 24.5% in Eastern Asia, and 11.9% in Western Asia (Mazidi et al., 2018). In Southeast Asia, the prevalence of obesity is increasing significantly, with 14 million boys (5%) and 8 million girls (3%) aged 5–19 categorized as obese in 2020. Factors contributing to this issue encompass urbanization, consumption of fast food and sugary beverages, increased sedentary screen time, and diminished physical activity (Annisa et al., 2025; Tee & Siok Hui Voon, 2024). In Malaysia, the prevalence of adolescent obesity has doubled in under ten years. Estimates indicate a prevalence of 11–15% among adolescents aged 15–17 years, associated with sedentary lifestyles and poor dietary habits. Conversely, protective factors encompass diets rich in antioxidants and increased physical activity (Zulfarina et al., 2022). The data indicated the importance of intervention to mitigate the increasing rate of obesity among adolescents globally.

The prevalence of obesity among adolescents varies significantly based on several factors such as gender, socioeconomic status, and geographic location. Bygdell et al. (2021) explained the variation in obesity prevalence by age, highlighting that boys have higher obesity rates than girls, particularly during adolescence (ages 15-18). However, during early childhood (ages 5-8), girls show marginally higher rates of overweight, whereas they demonstrate lower rates of obesity in adolescence. Chen et al. (2024) reported that the meta-analysis revealed a pooled obesity prevalence of approximately 13% in boys and 10% in girls aged 6-18 years, indicating a higher overall obesity rate in boys. Additionally, some countries exhibit a twofold higher obesity prevalence in boys compared to girls, particularly in high and upper-middle-income nations (Shah et al., 2020). Adolescent boys exhibit a higher prevalence of obesity than girls, attributable to a combination of behavioural, biological, and sociocultural factors, as indicated by recent global and regional data.

According to research conducted in Malaysia, obesity is more common in boys than in girls. A thorough analysis and synthesis of data revealed that boys exhibited a notably greater prevalence of obesity at 12.5%, in contrast to girls, who had a rate of 9.1% (Chua et al., 2024). In line with another study that found that in a particular cohort, boys had a greater prevalence of obesity (52.5%) (Putri et al., 2018). Furthermore, between 2006 and 2015, the incidence of overweight and obesity increased among both boys and girls, with a more significant increase observed in boys. The prevalence of overweight increased from 20% to 26% in males and from 19% to 24% in girls (Mohamad et al., 2021). The differences of obesity rate among gender may due to body weight perception, dietary intake and physical activity, socioeconomic and demographic factors, health and lifestyle factors. These disparities

DOI: https://doi.org/10.17509/jpess.v2i2.60950
p-ISSN: 2776-3307 e-ISSN: 2776-4648

underscore the necessity for gender-specific approaches in addressing obesity among Malaysian adolescents.

Platon-Desnacido et al. (2022) indicated that the prevalence of obesity among adolescents in urban regions is typically higher than in rural areas. A comparable trend is observed in the United States, where rural adolescents aged 10-17 exhibit a 37.6% rate of overweight or obesity, in contrast to 32.1% in urban areas. Rural residence is associated with 1.30 times higher odds after adjustments (Crouch, 2023). A systematic review by Zhang et al. (2024) clearly demonstrated adolescent overweight links to urban boys compared to rural area. Nevertheless, patterns demonstrate significant variation both globally and regionally; in Indonesia, urban adolescents demonstrated a higher prevalence of overweight/obesity at 17% compared to their rural counterparts at 13.5% (Nurwanti et al., 2019). A study conducted in Malaysia indicated differing obesity levels between rural and urban adolescents in specific areas such as Kuala Terengganu, coinciding with a national increase in childhood obesity in both environments (Zulaily et al., 2024).

The trend of adolescent obesity is at an alarming stage and has significant potential for serious consequences, both physiological and psychological, which can adversely affect the quality of life among adolescents. Surprisingly, there are clear differences between boy and girl. For example, boys are constantly more likely to be overweight than girls. This suggests that biological, cultural, and behavioural factors may interact differently between both genders. Even though these trends are known, the number of overweight and obese adolescents is still rising. This shows how important it is to quickly implement focused, evidence-based programs that address both lifestyle factors and gender-specific risks.

Even though there is growing evidence that Malaysian adolescents are becoming obese, little study has been done at the district level to compare the body fat percentage of male adolescents from cities and rural areas. The Klang District exhibits a range of socioeconomic and environmental factors that could influence differences in adolescent body composition. Current research indicates a greater prevalence of obesity among boys and adolescents residing in urban environments; however, the absence of localized, body-fat-based data complicates the ability of policymakers and educational institutions to formulate effective, targeted interventions. Consequently, it is imperative to investigate the potential disparities in body fat percentage that may be present between male adolescents in urban and rural secondary schools within the Klang District. Therefore, the current study aims to examined the difference in body fat percentage between urban and rural male students aged 13 and 14 in secondary schools in the Klang district, Selangor

2. METHODS

Study Design and Participant Selection

The study employed a comparative study design with clearly defined inclusion and exclusion criteria. Eligible participants were male adolescents aged 13 to 14 years, enrolled in either Seri Andalas Secondary School (urban) or Rantau Panjang Secondary School (rural) within the Klang District. The total number of participants is at 150, which includes 80 students from Seri Andalas Secondary School and 70 from Rantau Panjang Secondary School. Only Malaysian citizens who were present during the data collection period and who provided both parental consent and personal assent were included. Students outside the specified age range, females, and those with known chronic illnesses, metabolic disorders, or physical disabilities that could influence body composition were excluded. In addition, individuals undergoing special diets, weight management programs, or medication affecting body fat percentage, as well as those absent during data collection or unwilling to participate, were

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN 2776-608X e- ISSN 2776-5970

not considered. Participants with incomplete or invalid measurement data were also excluded to maintain the integrity of the dataset. Male adolescents aged 13 and 14 years were chosen for this study, as this period is crucial for physical development, characterized by rapid growth, significant increases in body fat, the achievement of minimal body fat levels in males, and the accumulation of visceral fat, in contrast to females, who generally accumulate more subcutaneous fat over their lifespan (Malina Robert M et al., 2004).

Instrument

Body Mass Index (BMI) was utilized as an instrument for data collection for the 150 participants in this study. Morrow et al. (2000) state that BMI serves as an appropriate alternative to measuring obesity in adolescents, with body fat percentage determined by the formula BF% = 1.51 x BMI - 0.70 x age - 3.6 x gender + 1.4 (where boy = 1, girl = 0), as formulated by Deurenberg et al. (1991), which offers accurate estimates of body fat across all age groups. Test administration was conducted by 2 experience Physical Education Teachers. All the assessors went through the standardized training session which included the study protocol, hands-on training for measuring height and weight using the study equipment for different participants.

All anthropometric measurements were performed in a specific room allocated by the school administration. A portable, calibrated stadiometer (Seca 213) was placed on a hard, level floor for height assessment. A digital floor scale (Tanita HD-351), positioned on a hard, flat surface, was utilized to measure body weight and was calibrated to zero before to each evaluation. Participants were assessed separately, barefoot and attired in lightweight clothes. For height measurement, each participant positioned himself with their back against the vertical board of the stadiometer, heels together, and head aligned in the Frankfort horizontal plane. Following a natural deep inhale and assuming an upright posture, the assessor carefully lowered the helmet to compress the hair. Height was measured to the closest 0.1 cm. Participants positioned themselves at the centre of the scale platform with arms at their sides and maintained stillness until the digital display stabilized. The weight was measured to the closest 0.1 kg. The BMI was subsequently computed using the formula: Weight (kg) / [Height (m)]^2 and converted to body fat % according to the formula of Deurenberg et al. (1991).

Statistical Analysis

All data were analysed with IBM SPSS Statistics, Version 29.0.1. Descriptive statistics were used to explain the attributes of the participants. A two-way ANOVA was performed to analyse differences between male participants aged 13 and 15 in both rural and urban settings. The use of Two-Way ANOVA is appropriate as this study encompasses two categorical factors (location and age) and one continuous dependent variable (body fat percentage). This analysis evaluates both the primary impacts of each element and their interactions, so fully achieving the study's purpose.

3. RESULT AND DISCUSSION

Table 1. Mean Body Mass Index (BMI) and Estimated Body Fat Percentage (BF%) by Age, and Residence Location

Gender	Age (Years)	Residence	Mean BMI (kg/m^2)	*SD*	*n*	Mean BF%
Boy	13	Urban	20.30	8.16	43	19.35
		Rural	17.95	5.67	36	14.80

DOI: https://doi.org/10.17509/jpess.v2i2.60950
p-ISSN: 2776-3307 e-ISSN: 2776-4648

14	Urban	20.39	6.92	37	18.79
	Rural	18.27	7.36	34	15.59

Note. BF% (Body Fat Percentage) was estimated using the formula: BF% = (1.51 × BMI) − (0.70 × Age) − (3.6 × Gender) + 1.4, where Boy = 1. BMI = Body Mass Index; SD = Standard Deviation.

Table 1 showed the results of descriptive statistics for all groups, including mean BMI, standard deviations, sample sizes, and computed mean BF%. The data revealed a continuous trend wherein urban male adolescents had greater average BMI and body fat percentage compared to their rural counterparts in both the 13-year-old and 14-year-old groups.

Table 2. Test of Equality of Error Variances(a)

F	df1	df2	Sig.
.920	3	58	.437

Tables 2 and 3 present the results of a two-way ANOVA analysing the variation in body fat percentage among boys aged 13 and 14 in rural and urban areas. The analysis in Table 2 shows that Levene's Test of Equality of Error Variances yielded F (3,58) = 0.920, p = 0.437, p > .05, which is not significant. Therefore, the assumption of homogeneity of variance for the two-way ANOVA was satisfied.

Table 3. Tests of Between-Subjects Effect

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	74.920[a]	3	24.973	.469	.705	.024
Intercept	21333.790	1	21333.790	400.697	.000	.874
Age	.624	1	.624	.012	.914	.000
Residential Area	71.994	1	71.994	1.352	.250	.023
Age * Residential Area	.192	1	.192	.004	.952	.000
Error	3088.020	58	53.242			
Total	26202.124	62				
Corrected Total	3162.940	61				

a. R Squared = .063 (Adjusted R Squared = .005)
b. Computed using alpha = .05
c. Dependent VariableBody Fat Percentage

Based on Table 3, the results of the two-way ANOVA indicate that there was no significant main effect of residential location (urban vs. rural) on body fat percentage among male students, F (1,58) = 1.352, p = 0.25, p > .05. The effect size for residential location was very small, with a partial eta squared value of 0.023. This finding suggests that residential location accounted for only 0.23% of the variance in body fat percentage. The two-way ANOVA also showed no significant main effect of age (13 vs. 14 years) on body fat percentage among male students, F (1,58) = 0.012, p = 0.914, p > .05. The effect size was negligible, with a partial eta squared value of .00. This finding indicates that age did not contribute any variance to body

DOI: http://dx.doi.org/10.17509/xxxx.xxx
p- ISSN 2776-608X e- ISSN 2776-5970

fat percentage. Furthermore, the two-way ANOVA revealed that the interaction effect between residential location and age on body fat percentage was not significant, $F(1,58) = 0.004$, $p = 0.952$, $p > .05$. The effect size was negligible, with a partial eta squared value of .00. This finding confirms that the combined influence of residential location and age did not explain any variance in body fat percentage.

4. DISCUSSION

This study seeks to investigate the variations in body fat percentage among individuals aged 13 and 14, considering the geographical context of urban and rural areas within the Klang District of Malaysia. The results show no significant difference between age and geographic area, consistent with previous studies conducted across various regions. The studies conducted in Kosovo, New Zealand, South Africa, Poland, and Turkey revealed no statistically significant differences in the prevalence of overweight, obesity, and body fat percentage among adolescents aged 13 to 17 (Tishukaj et al., 2017; Coppell et al., 2023; Sedibe et al., 2018; Hoffmann et al., 2012; Naci Öner et al., 2004). Most of the previous studies indicated that variations in body fat among adolescents are influenced by various factors, including physical fitness, socio-economic conditions, dietary habits, eating habits within their living context, and other factors that are not limited to age, gender, or residential area. However, a few studies have shown differing findings regarding geographical areas, with some indicating higher rates in urban settings due to lifestyle factors (Zawodniak-Szałapska et al., 2007), while others demonstrate elevated rates in rural areas attributed to socioeconomic factors (Thorisdóttir et al., 2012; Johnson & Johnson, 2015).

Oguz & Oguz, (2016) found that adolescents aged 13 and 14 are influenced by physiological growth and stages of puberty, which may not differ significantly within this particular age range. Therefore, significant differences in body fat attributable exclusively to age are not consistently evident within short periods. Meanwhile, several studies indicate that variations in adolescent body fat and obesity are more closely associated with stages of pubertal development and physiological growth processes than with age differences between 13 and 14 years. This explains the lack of significant changes in obesity status within this short age range.

A study by Clemente et al. (2021) examines the ways puberty entails hormonal changes, with estrogen facilitating fat accumulation in girls and androgens enhancing muscle growth in boys, thereby influencing body composition development during adolescence beyond age as the only factor. In addition, Adami et al. (2020) found that patterns of body fat accumulation vary by pubertal stage and sex, with early adolescents showing higher adiposity regardless of chronological age within the typical ranges of early adolescence. In another study by Chung et al. (2017) demonstrated that obesity-related hormonal changes, like leptin levels, accelerate growth and pubertal maturation, indicating a complex relationship between obesity patterns and puberty beyond simple age differences.

The findings indicate no significant difference in body fat among male adolescents in rural and urban areas in terms of geographic location. The geographical variations in Malaysia frequently relate to lifestyle differences, including eating habits, levels of physical activity, and school settings. Research conducted on Malaysian adolescents revealed no significant differences between body fat percentages and sociodemographic factors, such as residential area, likely due to the varying impacts of urbanization on body composition, which may be counterbalanced by increased health awareness or physical activity in urban settings. This indicates that in Klang District, the lifestyle and environmental factors between urban and rural areas may not vary enough to produce statistically significant changes in body fat

DOI: https://doi.org/10.17509/jpess.v2i2.60950
p-ISSN: 2776-3307 e-ISSN: 2776-4648

percentage among adolescents (Zainol et al., 2022; Mohamad et al., 2021). The use and access to digital devices and the internet is increasing in both rural and urban areas today. The Klang district, a developed region in Selangor neighbouring to Kuala Lumpur, demonstrates significant digital device usage among adolescents, indicating usage patterns similar to young adults in the Klang Valley. (Tengku Wook et al., 2015; Nge et al., 2012; Saat et al., 2023). The development of Klang District especially in term of penetration of internet, access to digital devices may reduces the involvement of physical activity among adolescents in rural and urban area and lead to sedentary lifestyle due to excess of screen time among this population. Studies indicates that sedentary behaviours such as internet usage, gaming, and screen time are common among both rural and urban adolescents, similarly affecting physical activity levels and body fat accumulation (Saat et al., 2023; Azmawati Mohammed Nawi & Ilyani, 2015). Furthermore, the school environments in both urban and rural areas of Klang District exhibit similarities. The Physical Education syllabus is generally consistent throughout Malaysia, featuring similar time allocations and physical activities for the subject. Therefore, the similar pattern may result in comparable behaviour regarding physical activity among adolescents in this age group. The dietary habits in both school and residential areas also affect the findings of the current study. The prevalence of fast food, processed snacks, and sugary beverages has become common in both rural and urban areas. A study conducted by Jeinie et al. (2021) in Malaysia indicated that there is no significant difference in dietary practices between urban and rural adolescents, showing high fast-food consumption and frequent snacking patterns. Furthermore, a recent study revealed a similar pattern indicating poor diet quality among both urban and rural adolescents, characterized by a high level of unhealthy choices such as sugary beverages (Tay et al., 2023).

5. CONCLUSION

The current study shows that there is no significant difference in body fat percentage among male adolescents aged 13 and 14 in urban and rural areas. The findings indicate that various factors may impact body fat percentage within this age group, including physical growth, physiological aspects, school environment, dietary habits, physical activity behaviors, and the availability of digital devices and internet access. Still, the results of this study requires careful consideration due to the small age range, limited sample size, the measurement instruments employed, and the use of conversion formulas for body fat percentage, which may not be as precise as more advanced laboratory methods, potentially limiting the applicability of the findings. Future research should expand the age range and utilize a longitudinal strategy to evaluate variations in body fat percentage during various periods of adolescence. Future studies may use qualitative methods to analyze lifestyle choices, food patterns, and technology utilization, thereby offering a more thorough comprehension of the determinants affecting adolescents' health. The results of this study have significant significance for the formulation of public health policies that prioritize physical activity and comprehensive health education. Moreover, community-oriented interventions and approaches are to be formulated to encourage active lives and advance sustainable health practices in various environments.

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p- ISSN 2776-608X e- ISSN 2776-5970