Access this Article online
Quick Response Code:

Website:
jecajournal.com
Doi:
doi.org/10.4314/jeca.v21i2.7

Original Article

Anthropometric evaluation of percentage body fat using skinfold parameters among students of Ebonyi State University

[1]Njoku, C.O.; [1]Nkanu, I.I.; [1]Anwara, C.E.; [1]Ngwuta M.C.; [2]Egbudu, O.E.

Abstract

AIM: This study investigates the anthropometric evaluation of percentage body fat using skinfold thickness among students at Ebonyi State University.
MATHODOLOGY: A total of 498 participants (243 males and 255 females) aged between 18 to 32 years were recruited for this cross-sectional study. The data were analyzed using the IBM Statistical Package for Social Sciences (SPSS) version 26.0, with descriptive statistics expressed as mean ± standard deviation and correlation coefficients determined for various age groups at two-tailed significance levels of <0.001 and <0.05. The percentage body fat was calculated using the Jackson and Pollock equations and the Siri method.
RESULTS: The results reveal significant differences in skinfold thickness and body composition between genders across various age groups. Males exhibited higher mean values in height (169.57 cm to 172.03 cm) and weight (59.06 kg to 62.59 kg) compared to females (165.19 cm to 167.16 cm and 55.15 kg to 56.97 kg). Notably, females showed higher skinfold measurements at most sites, with significant variations observed particularly in the triceps and anterior thigh skinfolds. The correlation analyses indicated that the relationships between various anthropometric parameters were generally weak, with all p-values exceeding 0.05, thus suggesting no significant correlation. The analysis of percentage body fat across different age groups highlighted a trend of decreasing body fat for both males and females after the age of 24, with males averaging between 21.29% to 24.31% and females ranging from 22.41% to 24.73%.
CONCLUSION: These findings underscore the need for targeted health interventions in university populations to promote healthy body composition, particularly among younger adults, and suggest that lifestyle factors may contribute significantly to the observed differences in body fat distribution between genders as they age.

Submitted: 3rd August, 2024
Revised: 26th November, 2024
Accepted: 3rd December, 2024
Published: 31st December, 2024

Keywords:
Anthropometry; Body Mass Index; Height; Percentage Body Fat; Skinfold thickness

[1]*Department of Human Anatomy, Ebonyi State University, Nigeria;*
[2]*Department of Human Anatomy, University of Cross River State, Nigeria.*

INTRODUCTION

Anthropometric measurements provides a valuable assessment of nutritional status among individual (Gavriilidou *et al*., 2015; Fryar *et al*., 2016). Thus, anthropometric measurements are quantitative methods that provides an insight to nutritional assessments of an individual which is an important tools for health professionals in formulating nutritional management and observing therapeutic nutritional intervention (kuriyan, 2018; Andreoli *et al*., 2016).

However, skinfold thickness is an important anthropometric measurements methods that is noninvasive less expensive, reliable and easy to measure among individuals (Rodríguez *et al*., 2005; Hillier *et al*., 2014). This measurements is achieved using skinfold calipers which is usually calibrated in millimeters (Bini *et al*., 2018). Skinfold parameters is use in determining percentage body fat by using various types standardized skinfold equation, this equations differs among children and adult (Ojo and Adetola, 2017), males and females (Chambers *et al*., 2014; Bacchi *et al*., 2017).

Although, body composition analysis is crucial for assessing the overall health of individuals, especially students who are in a critical stage of physical and mental development. One of the most reliable methods of estimating body fat is through skinfold thickness measurements, which have been widely used in clinical and research settings. Skinfold measurement is a simple, non-invasive method that estimates subcutaneous fat and provides a reliable estimate of total body fat percentage when performed accurately (Jackson & Pollock, 1978; Fosbøl and Zerahn, 2015; Lemos and Gallagher, 2017). The relationship between body fat and health outcomes such as obesity, cardiovascular disease, and metabolic disorders has been extensively studied, highlighting the

Address for Correspondence:
Nkanu, I.I.
Department of Human Anatomy, Ebonyi State University, Nigeria.
deannkanu@gmail.com

How to cite this article: Njoku, C.O.; Nkanu, I.I.; Anwara, C.E.; Ngwuta M.C.; Egbudu, O.E. Anthropometric evaluation of percentage body fat using skinfold parameters among students of Ebonyi State University. J Exp Clin Anat 2024; 21(2): 188-194.
https://dx.doi.org/10.4314/jeca.v21i2.7

importance of monitoring body composition in young populations (Deurenberg *et al*., 1991).

In developing countries such as Nigeria, where obesity and its associated complications are on the rise, it is essential to understand the body composition of students. As students in Ebonyi State continue to adopt more sedentary lifestyles and poor dietary habits, the need to evaluate their body fat percentage becomes pertinent. This study will focus on using skinfold measurements to estimate body fat among students in Ebonyi State, providing data that can be utilized to promote healthy lifestyle interventions and public health policy in Nigeria.

MATERIALS AND METHODS

Study population

A total of 243 males and 255 females were randomly selected among students of various departments and Faculties of Ebonyi State University, Abakaliki. The participants were between ages of 18 and 32yrs and were enlightened on the purpose of this study. The participants were indigenes of Ebonyi State, Nigeria. The following anthropometric parameters were measured; height, weight, bicep skinfold thickness, triceps skinfold thickness, anterior thigh skinfold thickness, and medial calf skinfold thickness were measured.

Height Measurement and Weight Measurements

Height and weight were measured using standardized method adopted by World Health Organization (1995). Participant were asked to stand upright on the base of a stadiometer and each participant height was measured from the skull of the head down to the floor of the foot and data were recorded in centimeter. After height measurements, each participants were asked to stand upright with both foot placed on the weighing scale placed on the floor and data were recorded in kilogram.

During measurements, participants were asked to remove their shoes, scarf, bags, belt, keys and any object that will altered the measurements.

Skinfold Thickness Measurement

Method adopted by Manuela, (2022) was used in measuring all the various skinfold sites. Participants were asked to sit on a stool and their skinfold were measured using skinfold caliper (CESCORF Equipamentos (51) 3395.3102) which is calibrated and recorded in millimeters.

Each participant were asked relaxed their arms and the bicep skinfold was picked vertically halfway between the acromion and radius at the anterior part of the arm. Triceps skinfold was picked vertically halfway between the acromion and radius at the posterior part of the arm. Anterior thigh skinfold was measured parallel to the long axis of the thigh. Participants were asked to relax, feet were apart and the bodyweight equally distributed between both feet and measurements and their medial calf was measured posteriorly at the mid-point of the calf.

During measurement of skinfold participants were selected based on their clothing, participant with long sleeves, trousers and any other wears that will altered skinfold measurements were excluded from the research exercise.

Calculation of Body Mass Index

The body mass index of was calculated using standardized method generated by World Health Organization, (1995).

BMI = weight (kg)/height $(m)^2$.

Statistical analysis

Data were analyzed using IBM Statistical Package for Social Sciences Software (SPSS) version 26.0. The descriptive statistics of anthropometric and skinfold thickness parameters were expressed in mean ± standard deviation and Correlation coefficients among various age groups at level of two tailed significant (<0.001 and <0.05). Percentage body fat using Jackson and Pollock equations and Siri method.

Evaluation of Percentage Body Fat

In calculating percentage body fat of each subject, the body density was first calculated using a standardized method generated by Jackson and Pollock equations (Jackson and Pollock, 1985) and then percentage body fat was calculated using Siri method, (Siri,1956).

Men: D=1.1125025-0.0013125(x) + 0.0000055(x2) – 0.000244(y)

Women: D=1.089733-0.0009245(x) + 0.0000025(x2) – 0.0000979(y)

Where D is density, x is sum of skinfolds parameters (in mm) and y is age.

Percentage body fat (%) = (495/body density)-450

RESULTS

Table 1 illustrates the descriptive statistic of males and females participants between the ages of 18 and 20years. The mean ages for both males (18.78 years) and females (18.82 years) are very similar, with both groups being in the same developmental stage. Males have a higher mean height (169.57 cm) and weight (59.06 kg) compared to females (165.19 cm and 55.15 kg). The BMI values are similar between males (20.47 kg/m^2) and females (20.20 kg/m^2), suggesting similar body composition despite differences in height and weight. The skinfold measurements indicate that females have higher mean values in most skinfold sites compared to males. The correlation coefficient is significant as P value is greater than 0.001 and 0.05.

Table 2 illustrates the descriptive statistic mean± standard deviation and correlation coefficient of some anthropometric variables and skinfold thickness at various sites were compared between males and females participants between 21 and 23years of age. The males generally is significantly taller (170.78 cm) than

females (167.16cm). The male weight (60.73 kg) are heavier than females (56.97 kg). The BMI values slightly increase for males (20.76 kg/m²) but decrease slightly for females (19.99 kg/m²). Males again show higher values in bicep (7.09mm) and medial calf skinfolds (13.40mm) compared to females (7.08mm, 13.29mm), while females have higher triceps (11.73mm) and anterior thigh skinfolds (16.72mm) than males (11.54mm, 15.33mm). The correlation coefficients reflect relationships between variables in both genders, with males showing stronger correlations overall as P value is greater than 0.001 and 0.05.

Table 3 result provide descriptive statistics and correlation coefficients for various parameters measured in males and females aged 24 and 26 years. The mean ages for both males (24.95 years) and females (25.16 years) are very similar, with both groups being in the same developmental stage. Males have a higher mean height (172.03 cm), weight (62.59 kg) and body mass index (21.04) compared to females (166.03 cm, 56.73 kg, and 20.43). Males show higher values in bicep (7.46mm) and triceps skinfolds (11.84mm) compared to females (7.11mm, 11.84mm), while females have higher anterior thigh (16.97mm) and medial calf skinfolds (13.19mm) than males (15.82mm, 13.09mm). The correlation coefficients reflect relationships between variables in both genders as P value is greater than 0.001 and 0.05.

Table 4 presents descriptive mean and correlation statistics for males and females aged 27 and 29 years, with a total sample size of 63 participants (32 males and 31 females). The mean height of females (162.49 cm) is shorter compared to males (169.20 cm) in this group. The result also indicated that females generally show lower body weight (55.81kg) and higher BMI (21.01kg/m^2) than males (59.13kg, 20.55 kg/m^2). Males skinfold (bicep; 7.06 mm, triceps skinfold; 10.85 mm, anterior thigh skinfold; 16.93 mm, and medial calf skinfold; 12.97 mm) are significantly lower compare to females skinfold parameters (bicep skinfold; 7.26 mm, triceps skinfold; 11.71 mm, anterior thigh skinfold; 18.35 mm), and medial calf skinfold (14.23 mm) which indicate body fat distribution among participants. All correlation coefficients for both males and females did not achieve statistical significance (p-values > 0.05).

Table 5 provides descriptive statistics and correlation analyses for males and females aged 30-32 years, comprising a total of 66 participants (34 males and 32 females). The males mean height (170.58 cm), weight (60.04 kg) are higher, and lower body mass index (20.50 kg/m²) than females (165.70 cm, 58.33 kg, and 21.02 kg/m²). Higher skinfold parameter were observed in females (7.68 mm, 12.55 mm, 16.17 mm, and 12.94 mm) than males (7.21 mm, 10.69 mm, 14.92 mm, and 11.74 mm). Correlation coefficients were not significant indicating P-value greater than 0.001 and 0.05 at 2 tailed.

Table 6 summarizes the percentage body fat for males and females across different age groups. Age Group 18-20: Males have a body fat percentage of 21.29%, while females have a higher percentage at 22.41%.Age Group 21-23: Males show an increase to 23.46%, and females rise to 24.73%. Age Group 24-26: Males decrease slightly to 24.31%, while females decrease to 23.58%.Age Group 27-29: Males further decrease to 22.24%, while females drop to 20.31%, suggesting a trend of decreasing body fat for both sexes. Age Group 30-32: Males increase to 22.78%, and females have a higher percentage of 24.32%.

Table 1; Descriptive Mean and Correlation Statistics of age group 18 and 20years of Males and Females Parameters (n=151).

parameters	Males (64)			Females (87)		
	Mean ± standard deviation	Correlation coefficient (r)	P-value	Mean ± standard deviation	Correlation coefficient (r)	P-value
Age	18.78 ± 0.81	0.15	0.44	18.82 ± 0.82	0.12	0.46
Height (cm)	169.57 ± 6.90	0.10	0.15	165.19 ± 6.67	0.23	0.31
Weight (kg)	59.06 ± 9.60	0.32	0.34	55.15 ± 7.31	0.09	0.38
BMI(kg/m^2)	20.47 ± 2.61	0.35	0.53	20.20 ± 2.33	0.26	0.44
bicep skinfold (mm)	6.61 ± 1.85	0.27	0.01	7.15 ± 1.85	0.11	0.20
Triceps skinfold (mm)	10.60 ± 4.07	0.33	0.08	10.93 ± 3.41	0.36	0.20
anterior thigh skinfold(mm)	14.66 ± 4.69	0.54	0.21	17.30 ± 5.34	0.45	0.23
Medial calf skinfold(mm)	12.40 ± 3.92	0.27	0.25	12.55 ± 3.37	0.30	0.24

*Correlation is not significant at level of 0.001 and 0.05 (2tailed)

Table 2; Descriptive Mean and Correlation Statistics of age group 21 and 23years of Males and Females Parameters (n=140).

parameters	Males (71)			Females (69)		
	Mean ± standard deviation	Correlation coefficient (r)	P-value	Mean ± standard deviation	Correlation coefficient (r)	P-value
Age	21.99 ± 0.98	0.23	0.32	21.97 ± 0.89	0.14	0.42
Height (cm)	170.78 ± 8.55	0.22	0.42	167.16 ± 7.08	0.21	0.31
Weight (kg)	60.73 ± 9.60	0.32	0.42	56.97 ± 7.69	0.40	0.12
BMI(kg/m^2)	20.76 ± 1.96	0.25	0.30	19.99 ± 2.01	0.26	0.16
bicep skinfold (mm)	7.09 ± 1.98	0.36	0.19	7.08 ± 1.85	0.37	0.15
Triceps skinfold (mm)	11.54 ± 4.07	0.39	0.22	11.73 ± 4.09	0.34	0.18
anterior thigh skinfold(mm)	15.33 ± 4.89	0.28	0.21	16.72 ± 5.00	0.37	0.23
Medial calf skinfold(mm)	13.40 ± 3.68	0.25	0.32	13.29 ± 3.37	0.30	0.16

*Correlation is not significant at level of 0.001 and 0.05 (2tailed)

Table 3; Descriptive Mean and Correlation Statistics of age group 27 and 29years of Males and Females Parameters (n=78).

parameters	Males (42)			Females (36)		
	Mean ± standard deviation	Correlation coefficient (r)	P-value	Mean ± standard deviation	Correlation coefficient (r)	P-value
Age	24.95 ± 0.84	0.14	0.50	25.16 ± 0.85	0.03	0.42
Height (cm)	172.03 ± 8.55	0.23	0.37	166.03 ± 7.54	0.30	0.34
Weight (kg)	62.59 ± 11.09	0.38	0.37	56.73 ± 8.76	0.31	0.50
BMI(kg/m^2)	21.04 ± 2.48	0.39	0.24	20.43 ± 2.44	0.26	0.14
bicep skinfold (mm)	7.46 ± 2.02	0.42	0.12	7.11 ± 1.62	0.28	0.22
Triceps skinfold (mm)	11.84 ± 3.98	0.42	0.22	11.54 ± 4.09	0.31	0.42
anterior thigh skinfold(mm)	15.82 ± 4.13	0.29	0.35	16.97 ± 4.32	0.29	0.28
Medial calf skinfold(mm)	13.09 ± 3.68	0.38	0.24	13.19 ± 3.01	0.14	0.46

*Correlation is not significant at level of 0.001 and 0.05 (2tailed)

Table 4; Descriptive Mean and Correlation Statistics of age group 27-29years of Males and Females Parameters (n=63).

parameters	Males (32)			Females (31)		
	Mean ± standard deviation	Correlation coefficient (r)	P-value	Mean ± standard deviation	Correlation coefficient (r)	P-value
Age	27.97 ± 0.82	0.12	0.59	27.90 ± 0.83	0.08	0.26
Height (cm)	169.20 ± 7.14	0.15	0.26	162.49 ± 7.61	0.18	0.36
Weight (kg)	59.13 ± 8.13	0.28	0.34	55.81 ± 6.65	0.29	0.27
BMI(kg/m^2)	20.55 ± 2.06	0.28	0.36	21.01 ± 2.44	0.19	0.37
bicep skinfold (mm)	7.06 ± 1.51	0.32	0.27	7.26 ± 1.55	0.36	0.28
Triceps skinfold (mm)	10.85 ± 2.47	0.29	0.36	11.71 ± 2.22	0.39	0.22
Anterior thigh skinfold (mm)	16.93 ± 4.57	0.24	0.23	18.35 ± 4.54	0.38	0.30
Medial calf skinfold (mm)	12.97 ± 3.43	0.31	0.23	14.23 ± 2.17	0.42	0.41

Correlation is not significant at level of 0.001 and 0.05 (2tailed)

Table 5; Descriptive Mean and Correlation Statistics of age group 30 and 32years of Males and Females Parameters (n=66).

parameters	Males (34) Mean ± standard deviation	Correlation coefficient (r)	P-value	Females (32) Mean ± standard deviation	Correlation coefficient (r)	P-value
Age	30.68 ± 0.81	0.01	0.34	30.57 ± 4.49	0.02	0.46
Height (cm)	170.58 ± 10.19	0.34	0.36	165.70 ± 7.84	0.26	0.36
Weight (kg)	60.04 ± 10.85	0.39	0.41	58.33 ± 9.46	0.49	0.16
BMI(kg/m^2)	20.50 ± 1.95	0.16	0.42	21.02 ± 2.88	0.35	0.19
bicep skinfold (mm)	7.21± 1.75	0.25	0.27	7.68 ± 2.06	0.46	0.05
Triceps skinfold (mm)	10.69 ± 2.77	0.32	0.07	12.55 ± 5.11	0.42	0.18
Anterior thigh skinfold (mm)	14.92 ± 3.18	0.10	0.25	16.17 ± 3.56	0.37	0.24
Medial calf skinfold (mm)	11.74 ± 2.73	0.29	0.14	12.94 ± 2.45	0.41	0.08

*Correlation is not significant at level of 0.001 and 0.05 (2tailed)

Table 6 Percentage body fat among sexes of various age distribution using

Age groups	Males	Females
18-20	21.29	22.41
21-23	23.46	24.73
24-26	24.31	23.58
27-29	22.24	20.31
30-32	22.78	24.32

*increase and decrease in body fat percentage across various age group

DISCUSSION

Anthropometric evaluations, particularly skinfold thickness measurements, play a crucial role in understanding body composition and estimating percentage body fat among populations. This can significantly impact health and physical performance. Among the various methods available for estimating body fat, skinfold thickness measurement remains a popular and non-invasive approach. This analysis focuses on students of Ebonyi State University, providing insights into the variations of body fat focusing on the differences between male and female participants across various age groups. The findings are contextualized within relevant literature.

For the youngest cohort (ages 18-20), the mean age, height, and weight showed expected trends, with males being taller (169.57 cm) and heavier (59.06 kg) than females (165.19 cm and 55.15 kg). Interestingly, despite these differences, the BMI values were similar (males: 20.47 kg/m²; females: 20.20 kg/m²), indicating comparable body composition at this developmental stage. The bicep, triceps, and thigh skinfold measurements were generally higher in females, suggesting a different fat distribution pattern (Myrtaj *et al.*, 2018). However, no significant correlations were observed between age and other parameters for either sex ($p > 0.05$). The study reviews that males had a body fat percentage of 21.29%, while females had a higher mean of 22.41%. This trend of higher body fat in females is consistent with existing literature that indicates females typically have a greater body fat percentage due to physiological differences, including hormonal influences and fat distribution patterns (Frank *et al.*, 2019). The study found that females exhibited higher skinfold measurements across most sites, supporting the idea that females retain more subcutaneous fat during this developmental stage (Thant *et al.*, 2014; Lumish *et al.*, 2020).

In the 21-23 age group, males continued to exhibit higher values in height (170.78 cm) and weight (60.73 kg) compared to females (167.16 cm and 56.97 kg). This trend emphasizes the importance of considering these variables in body composition assessments. The skinfold measurements indicated that females had greater triceps and anterior thigh skinfolds, which align with findings from other studies showing that females typically have higher subcutaneous fat deposits compared to males (Mohajan and Haradhan, 2023). Correlations among the measured parameters remained statistically insignificant. As students moved into the 21-23 age group, males showed an increase in body fat percentage to 23.46%, while females increased to 24.73%. This increasing trend can be attributed to lifestyle changes, such as reduced physical activity and increased caloric intake typical in young adulthood (Su-Min Jeong *et al.*, 2023). Notably, the correlation coefficients in both genders indicate weak associations between anthropometric measurements, suggesting that body composition may not be directly influenced by age or height within this age bracket.

At ages 24-26, males' average height and weight increased slightly to 172.03 cm and 62.59 kg, respectively, whereas females had a height of 166.03 cm and weight of 56.73 kg. Here again, males demonstrated higher skinfold thickness in bicep and triceps measurements, while females had higher values in the anterior thigh skinfold, reinforcing previous observations about sex differences in body fat distribution. The results were consistent with previous findings that indicate males tend to have higher muscle mass and lower body fat percentage than females and the lack of significant correlations further emphasizes the complexity of body composition, as hormonal and lifestyle factors may play a

role in influencing body fat distribution (Štefan *et al*., 2017; Yuyan *et al*., 2018). In this age group, there was a slight decline in body fat for both sexes, with males at 24.31% and females at 23.58%. The trend suggests an adaptation to lifestyle changes and possible increases in physical activity (Štefan *et al*., 2017; Wadden *et al*., 2020; Ben *et al*., 2021). Interestingly, while males generally have higher skinfold measurements, the changes in body fat percentage indicate a more complex interaction between age, sex, and body composition.

In this age group, both males (27.97 years) and females (27.90 years) presented similar mean ages. Males continued to have higher heights (169.20 cm) and weights (59.13 kg) than females (162.49 cm and 55.81 kg), with BMI values again similar across genders. The skinfold measurements revealed lower values for males compared to females across all sites, indicating a potential trend that women often accumulate subcutaneous fat in these regions (Ojo and Adetola, 2017; Ryan-Stewart *et al*., 2021). As in previous tables 4, correlation coefficients did not reach significance. The subsequent age group (27-29 years) showed a more significant drop in body fat percentages, with males at 22.24% and females at 20.31%. This decline may reflect life stage transitions, such as entering the workforce and changes in health consciousness (Mohajan and Haradhan, 2023). These findings resonate with previous studies that document a decrease in body fat in early adulthood due to increased physical demands and dietary awareness (Carpenter *et al*., 2013; Ryan-Stewart *et al*., 2021).

The final age group showed males averaging 30.68 years in age with corresponding mean height and weight values of 170.58 cm and 60.04 kg. Females in this cohort had slightly lower measurements (165.70 cm and 58.33 kg). Skinfold thickness was notably higher in females across all measured sites, corroborating the pattern observed in younger cohorts. Once again, the lack of significant correlations suggests that factors influencing body composition may be multifactorial and not solely dependent on age. These results highlight the ongoing trends in body composition changes as individual's age, particularly regarding fat distribution and retention (Lumish, *et al*., 2020). The final age group presented a reversal, with males increasing to 22.78% and females to 24.32%. This increase may indicate a return to sedentary lifestyles and dietary changes that often accompany increased responsibilities and life stressors, thus, his pattern aligns with studies that suggest body fat percentages often rise in middle adulthood due to hormonal changes and lifestyle adjustments (Štefan *et al*., 2017; Wadden *et al*., 2020).

Finally, the statistical results of this study indicate significant sex differences in anthropometric measures across all age groups. Males consistently exhibited higher mean heights and weights, while females showed greater skinfold measurements, reflecting established sex differences in body composition. Correlation coefficients tended to be low, with p-values exceeding 0.05, indicating a lack of significant relationships between variables in most cases. This lack of correlation might suggest that while sex differences in body fat distribution exist, other factors such as lifestyle and dietary habits may play a more significant role in body composition changes. Thus, these findings are consistent with current research on body composition among university students. Studies have shown that males generally maintain lower body fat percentages compared to females, especially during younger adulthood, aligning with the findings of this research (Su-Min Jeong *et al*., 2023). Moreover, the fluctuation of body fat percentages across age groups echoes existing literature that emphasizes the importance of life stage and lifestyle factors on body composition (Štefan *et al*., 2017; Yuyan *et al*., 2018; Ryan-Stewart *et al*., 2021; Su-Min Jeong *et al*., 2023).

Conclusion

The study highlights significant differences in body composition between male and female students at Ebonyi State University, as determined by skinfold thickness measurements. The correlation analysis indicates that while some relationships exist, they do not achieve statistical significance across most parameters. Future research could explore lifestyle factors, dietary habits, and physical activity levels that may contribute to these variations in body fat percentages among different age groups. Overall, understanding these dynamics is essential for developing targeted health and fitness interventions for university students.

Conflict of interest

None declared

REFERENCES

Andrreoli, A., Garaci F, Cafarelli, F.P., Guglielmi, G. (2016). Body composition in clinical practice. *European Journal of Radiology*, **85**(8):1461-8.

Bacchi, E., Cavedon, V., Zancanaro, C., Moghetti, P., Milanese, C. (2017). Comparison between dual-energy X-ray absorptiometry and skinfold thickness in assessing body fat in overweigh/obese adult patients with type-2 diabetes. *Scientic Reports Nature Publishing Group*, **7**:17424

Ben, Mansou Ghassen, Asma Kacem, Mohamed Ishak, Laurent Grélot and Foued Ftait ,(2021). The effect of body composition on strength and power in male and female students. *BMC Sports Science, Medicine and Rehabilitation*, 13:150.

Bini, Alessandro, Amaral, Teresa F., Olvera, Bruno M.P.M., Pedro Carvalho, and Vitor Hugo Teixeira, (2018). Skinfolds compressibility and calliper's time response in male athletes. *Progress in Nutrition*, **20**(2): 273-278.

Carpenter CL, et al., (2013). Body fat and body-mass index among a multiethnic sample of college-age men and women. *Journal of Obesity*, 2013:790654.

Chambers, A.J., Parise, E., Mccrory, J.L., and Cham R. (2014). A comparison of prediction equations for the estimation of body fat

percentage in non-obese and obese older Caucasian adults in the United States. *Journal of Nutrition, Health and Aging*, **18**:586–90.

Deurenberg, P., Weststrate, J.A., Seidell, J.C. (1991). "Body mass index as a measure of body fatness: age- and sex-specific prediction formulas". *The British Journal of Nutrition*. **65** (2): 105–114.

Fosbøl, M.Ø. and Zerahn, B., (2015). Contemporary methods of body composition measurement. *Clinical Physiology and Functional Imaging*, *35*, 81–97.

Frank, Aaron P., Roberta de Souza Santos, Biff F. Palmer, and Deborah J. Clegg, (2019). Determinants of body fat distribution in humans may provide insight about obesity-related health risks. *Journal of Lipid research*, 60:1710–1719.

Fryar CD, Gu Q, Ogden CL, Flegal KM, (2016). Anthropometric Reference Data for Children and Adults: United States, 2011-2014. Vital Health Stat 3 Anal Stud. (**39**):1-46.

Gavriilidou NN, Pihlsgård M, Elmståhl S, (2015). Anthropometric reference data for elderly Swedes and its disease-related pattern. *The European Journal of Clinical Nutrition*. 69(**9**):1066-75.

Jackson, A.S., and Pollock, M.L. (1985). Practical assessment of body composition. *Physician and Sports Medicine Journal*. **13**:76-90.

Kuriyan, R. (2018). Body composition techniques. *Indian Journal of Medical Research*, **148**(5):648-658.

Lemos, T. and Gallagher, D., (2017). Current body composition measurement techniques. *Current Opinion in Endocrinology, Diabetes and Obesity*, *24*, 310.

Lumish, Heidi S., Marcella O'Reilly, Muredach P. Reilly, (2020).Sex Differences in Genomic Drivers of Adipose Distribution and Related Cardiometabolic Disorders. *Arteriosclerosis, Thrombosis, and Vascular Biology*, 40:45–60.

Manuela Abreu, (2022). Measuring skinfolds for fat mass assessment: the ultimate guide. Accessed on 26th May, 2024.

Mohajan, Devajit and Mohajan, Haradhan, (2023). A Study on Body Fat Percentage for Physical Fitness and Prevention of Obesity: A Two Compartment Model. MPRA, Paper No. 117158, accessed on 12-07, 2023.

Myrtaj, N.; Maliqi, A.; Gontarev, S.; Kalac, R.; Georgiev, G. & Stojanoska, B. B., (2018) Anthropometry and body composition of adolescents in Macedonia. *International Journal of Morphology*, 36(4):1398-1406.

Ojo, G., and Adetola, O. (2017). The Relationship between Skinfold Thickness and Body Mass Index in Estimating Body Fat Percentage on Bowen University Students. *International Biol. Biomedical Journal*, l 3:3.

Ryan-Stewart H, O'Leary A, Paine E, Faulkner J, Jobson S., (2021). The Relationship between Skinfold and Ultrasound Measures of Subcutaneous Fat in Untrained Healthy Males. Applied Sciences, 11(22):10561.

Siri, W.E. (1956). The gross composition of the body. *Advances in Biology and Medical Physics*, **4**:239-80.

Štefan, Lovro, Marko Cule, Ivan Milinovi´c, Dora Juranko and Goran Sporiš, (2017). The Relationship between Lifestyle Factors and Body Compositionin Young Adults. *International Journal of Experimental Research and Environmental Health*, 14, 893.

Su-Min Jeong, Dong Hoon Lee, Leandro F. M. Rezende & Edward L.Giovannucci (2023). Diferent correlation of body mass index with body fatness and obesity-related biomarker according to age, sex and race-ethnicity. *Scientific Reports*, 13:3472.

Thant Zin, Aza Sherin Mohamad Yusuff, Than Myint, Daw K. S. Naing, Kyaw Htay, Aye Aye Wynn, (2014). Body fat percentage, BMI and skinfold thickness among medical students in Sabah. Malaysia. *South East Asia Journal of Public Health*, 4 (1):35-40.

Wadden, Thomas A., Tronieri, Jena S., and Butryn, Meghan L., (2020). Lifestyle Modification Approaches for the Treatment of Obesity in Adults. *American Psychologist*, 75(2): 235–251.

World Health Organization, (1995). Physical status: the use and interpretation of Anthropometry. *World Health Organization Technical Report Series*, **854**: 1-452.

Yuyan Liu, Yongfang Li, Jing He, Ping Ma, Luyang Yu, Quanmei Zheng and Guifan Sun (2018). Gender Stratified Analyses of the Association of Skinfold Thickness with Hypertension: A Cross-Sectional Study in General Northeastern Chinese Residents. *International Journal of Environmental Research and Public Health*, 15, 2748.