Original Research Paper

Volume - 15 | Issue - 07 | July - 2025 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Nutritional Science

ASSESSMENT OF BODY COMPOSITION AND NUTRITIONAL STATUS AMONG COLLEGE STUDENTS USING BIOELECTRICAL IMPEDANCE ANALYSIS: A CROSS- SECTIONAL STUDY

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ABSTRACT Assessment of body composition is an important aspect of evaluating the nutritional status of individuals, particularly among young adults who are at a transitional stage in terms of diet, physical activity, and lifestyle. Conventional indicators such as Body Mass Index (BMI) are widely used for nutritional assessment but have limitations in distinguishing between lean mass and fat mass. Bioelectrical Impedance Analysis (BIA) offers a practical and non-invasive method for assessing detailed body composition parameters including body fat, visceral fat, and muscle mass. This cross-sectional observational study was conducted among 50 college students aged 18 to 25 years, to assess their body composition and nutritional status using a standardised Omron BIA device. Data were collected on a single day through voluntary participation. Parameters measured included height, weight, BMI, body fat, muscle mass, and visceral fat. The mean BMI was found to be 25.3 ± 2.9 kg/m_2, with a significant number of students falling in the overweight range. Several participants had elevated body fat percentages despite a normal BMI, indicating the presence of normal-weight obesity. Muscle mass percentages varied widely, and visceral fat levels were found to be higher in 30% of the students. These findings highlight the limitations of BMI as a standalone tool, and the utility of BIA in identifying hidden nutritional risks. The study emphasises the importance of incorporating body composition analysis in routine health assessments for college students to enable early intervention, nutritional counselling, and lifestyle modifications to prevent long-term health complications.

KEYWORDS : Body Composition; Bioelectrical Impedance Analysis; Normal-weight Obesity; Young Adults

INTRODUCTION

Body composition is a key determinant of an individual's health status and plays a crucial role in the early identification of nutrition-related risks such as obesity, sarcopenia, and metabolic disorders. Body composition is a critical indicator of health, as it reflects the distribution of fat mass, lean mass, visceral fat, and water content in the body which are linked to metabolic function, nutritional status, and disease risk. While Body Mass Index (BMI) is a commonly used for assessing nutritional status, it does not distinguish between muscle and fat mass and can misclassify individuals, particularly those with normal-weight obesity (Rajpal et al., 2022). Among young adults, particularly college students, lifestyle patterns characterised by irregular eating habits, physical inactivity, and increased screen time contribute to body composition imbalances, often without overt clinical symptoms (Mahajan et al., 2021).

Bioelectrical impedance analysis (BIA) has emerged as a widely accepted, non-invasive, and cost-effective tool for assessing body composition in both clinical and research settings. It provides detailed information on fat mass, muscle mass, visceral fat and water content, enabling a nuanced evaluation of nutritional status beyond simple anthropometric measures like BMI (Lukaski., 2013, Tiwari et al.,2020). Given its practicality and reliability, BIA is especially useful for large-scale health assessments in community and field settings such as schools and colleges due to its ease of use, speed, and affordability (Bosy-Westphal et al.,2021, Sultana et al.,2021).

In India, the nutrition transition among urban youth has brought a dual burden of undernutrition and rising overweight and obesity prevalence (Tiwari et al., 2020). Hidden adiposity, even among those with normal BMI, may predispose this population to long-term cardiometabolic risks (Rajpal et al., 2022). College students represent a unique group undergoing physiological, behavioural, and lifestyle changes, making them particularly vulnerable to poor nutritional outcomes. Monitoring their body composition can offer critical insights for early preventive interventions and health promotion strategies. Another study highlighted the role of lifestyle factors in shaping body composition patterns in Indian college students, particularly with regard to muscle-fat ratios (Romero et al., 2010). Recent trends in body composition among Indian youth also highlights the emerging concern of hidden obesity (Kumar et al., 2020). The nutrition transition seen in China mirrors similar shifts in other developing countries including India (Zhao et al., 2022).

Despite increasing awareness of fitness and wellness, and increasing availability of BIA devices, limited data is available on the actual body composition of young adults. The study aims to evaluate BMI, body fat percentage, and muscle mass, and visceral fat levels across a cross-section of healthy college goers using BIA device and to highlight trends for future interventions in campus-based nutrition and health promotion.

MATERIALS AND METHODS

This descriptive cross-sectional observational study was conducted to assess body composition among college students using Bioelectrical Impedance Analysis (BIA). A total of 50 college students between 18 - 25 years from Jammu were included in the study. Data was collected on a single day through voluntary participation and informed consent was obtained from all participants. Body composition parameters such as weight, BMI, body fat percentage, skeletal muscle mass, and visceral fat levels were measured using a calibrated Omron BIA device. Participants were advised to follow standard pre-assessment conditions for accurate results. The collected Data was compiled in Microsoft Excel and analysed using descriptive statistics. Gender-wise comparison and BMI categorisation were used to identify difference in body composition patterns.

RESULTS

The mean age of participants was 21.9 ± 2.2 years, with mean height and weight recorded at 168.6 ± 4.8 cm and 69.0 ± 9.8 kg, respectively. The mean BMI was 25.3 ± 2.9 kg/m^2, placing a significant number of the students in the overweight category. The body fat percentage ranged from 14.2% to 35.7% with a mean of 23.5 ± 4.3% while the skeletal mass mean was 70.0 ± 5.7%. Gender comparisons revealed that males had higher BMI (25.5 vs 25.0), higher body fat percentage (24.6% vs 22.4%), and muscle mass percentage (70.9% vs 69.2%) than females. Several participants showed elevated body fat percentages despite a normal BMI. Visceral fat analysis showed approximately 30% of participants with higher visceral fat levels.

Table1: Descriptive Statistics of Anthropometric and Body Composition Parameters (n=50)

Parameter	Mean ± SD
Age (years)	21.9 ± 2.2
Height (cm)	168.6 ± 4.8
Weight (kg)	69.0 ± 9.8
BMI (kg/m2)	25.3 ± 2.9
Body Fat Percentage (%)	23.5 ± 4.3
Skeletal Mass Percentage (%)	70. 0 ± 5.7
Visceral Fat Percentage (%)	7.6 ± 2.1

Table 1 shows the anthropometric and body composition of 50 participants which includes their mean age, height, weight, BMI, body fat, mean skeletal mass, visceral fat respectively.

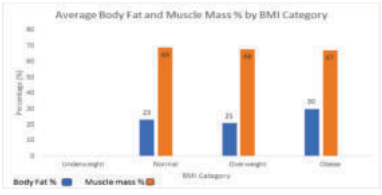

Figure 1: Average Body Fat and Muscle Mass Percentage by BMI Category

Figure 1 shows that as BMI increased, fat percentage increased but muscle mass did not increase proportionally. This indicates that higher BMI in many cases reflects fat, not muscle gain, and suggests normal-weight obesity in some students.

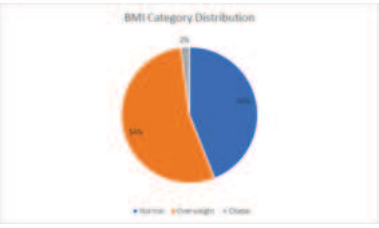

Figure 2: Distribution of BMI Categories

As per BMI category range, 44% of students had normal weight while 54% of students fell in overweight, and 2% in obese category as shown in Figure 2.

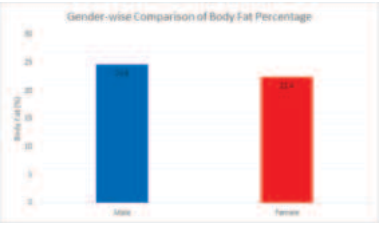

Figure 3: Gender-wise Comparison of Body Fat Percentage

Figure 3 illustrates that male students had higher body fat as compared to females. The comparison indicates biological and lifestyle differences influencing body compositions.

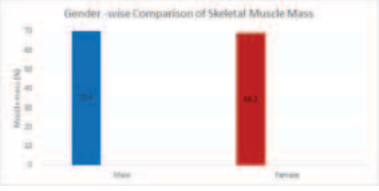

Figure 4: Gender-Wise Comparison of Skeletal Muscle Mass

Figure 4 shows the mean muscle mass percentage of male and female participants. This comparison again reiterates dietary and lifestyle differences influencing body composition.

Figure 5: Visceral Fat Levels

As shown in Figure 5, about 30% of the students had elevated visceral fat levels. This is a known risk factor for metabolic syndrome and cardiovascular diseases, especially when present in normal-BMI individuals.

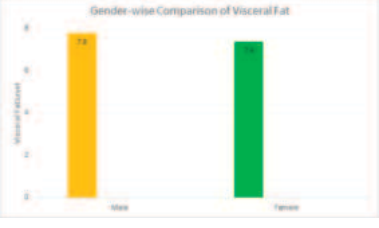

Figure 6: Gender-wise Comparison of Visceral Fat Levels

The average visceral fat level was found to be higher in males than the females as seen in Figure 6. This restates the importance of measuring visceral fat, as hidden fat around internal organs can increase health risks.

DISCUSSION

This study explored the body composition of college students using Bioelectrical Impedance Analysis (BIA). While the average BMI indicated a tendency towards overweight, the body fat and muscle mass values showed wide variation, suggesting that BMI alone is insufficient for assessing the health status of young adults. Similar observations were reported by various studies which also stated high variability in body composition among university students, with many individuals presenting high fat percentages despite normal BMI values (Sultana et al.,2021, Tripathy et al.,2019). This condition referred to as "normal-weight obesity" is associated with increased cardiometabolic risk factors, reinforcing the need for alternative assessment methods beyond BMI (Rajpal et al., 2022).

Skeletal muscle mass percentages varied among participants. Similar trends were reported in other studies that found muscle mass differences in young adults influenced by physical activity, dietary patterns, and sleep quality (Tiwari et al.,2020, Romero et al., 2010, Zhao et al., 2022). This further emphasises the role of lifestyle in shaping body composition. The gender-based comparison showed that male students had slightly higher BMI, fat percentage, and muscle mass. Males demonstrated a higher body fat percentage (24.6%) compared to females (22.4%), which may point out to lifestyle differences such as lower physical activity or poor dietary habits among male students. These differences align with the previous studies on gender-based variations in body composition influenced by hormonal and behavioural factors (Tiwari et al.,2020, Romero et al., 2010). Similar trends in body fat percentage among normal BMI individuals have been observed in young adults (Tripathy et al., 2019). Visceral fat, often an overlooked marker was found to be elevated in about 30% of the students. This observation reinforces the need to assess internal adiposity even in the absence of visible weight gain. Elevated visceral fat has been associated with increased risk of metabolic syndrome, insulin resistance, and cardiovascular complications.

The application of BIA in the context proved valuable due to its non-invasive nature and ease of use. The results of this study support earlier research advocating for the integration of BIA into routine health assessments in educational institutions (Bosy-Westphal et al.,2021, Sultana et al., 2021, Kumar et al., 2020). The early identification of individuals at risk can facilitate timely lifestyle interventions and health education programs.

However, this study has limitations. The cross-sectional design restricts the ability to draw causal inferences. Moreover, the sample was limited to a single institution and data were collected on a single day, which could be affected in hydration or physical activity levels. For future studies, variables such as dietary intake, physical activity levels, sleep patterns can also be assessed as these can impact body composition. Despite these limitations, the findings provide insights into body composition of college students and affirm BIA based assessments.

CONCLUSION

The present study concludes the importance of evaluating body composition using BIA among college students beyond conventional BMI alone. The study supports the integration of BIA assessments in educational institutions to promote early detection of at-risk individuals and encourage timely lifestyle interventions.

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