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BODY MASS INDEX VERSUS BODY FAT PERCENTAGE: IMPLICATIONS FOR ACCURATE ASSESSMENT OF WEIGHT STATUS

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Abstract

Body Mass Index (BMI) is widely used to classify weight status, yet it does not distinguish between fat mass and lean mass. Therefore, BMI may misclassify individuals when adiposity is assessed directly. This study aimed to examine the relationship and discrepancies between BMI and body fat percentage (Fat %) in the evaluation of weight status. Twenty-three females were assessed for body composition using a Tanita bioelectrical impedance analyzer. BMI was calculated from height and body mass, and body fat percentage was obtained via bioelectrical impedance analysis. BMI and Fat % were further categorized using standard cut-off values. Associations between categorical variables were examined using Crosstabs with Chi-square and Fisher’s Exact Test. Pearson correlations were computed among age, BMI, and Fat %. A multiple linear regression analysis was conducted to determine whether BMI and age predict Fat %. Crosstabulation showed a significant association between BMI categories and Fat % categories (p = .003), indicating general agreement between classification methods. However, Pearson correlation between BMI and Fat % was moderate and not statistically significant (r = .37, p = .08). The regression model including BMI and age explained 14.8% of the variance in Fat % and was not significant, F(2, 20) = 1.73, p = .202. BMI showed a positive but non-significant contribution (B = 0.67, p = .114), while age had no meaningful effect (B = 0.20, p = .656). Although BMI categories correspond broadly with body fat classification, BMI does not accurately predict individual body fat percentage. These findings support the limitation of BMI as a standalone indicator of adiposity and highlight the importance of direct body composition assessment for evaluating weight status.

Introduction

Body Mass Index (BMI) is widely used as a simple anthropometric measure for assessing weight status and classifying individuals into categories such as underweight, normal weight, overweight, and obesity. However, BMI is based solely on height and weight and does not distinguish between fat mass and lean mass. As a result, it may misclassify individuals with high muscle mass as overweight or obese, and fail to identify individuals with normal BMI but high body fat. This limitation has raised concerns about its accuracy for individual-level body composition assessment, particularly in clinical and research settings where precision is crucial [12]. Despite its simplicity, BMI does correlate with several adiposity-related biomarkers and cardiometabolic risk factors, though the strength of these correlations can vary. Some research has reported that BMI is effective as an indicator of adiposity for epidemiological purposes, particularly among younger age groups and specific populations, but may perform less well when compared with direct measures of fat mass in predicting metabolic risk at the individual level [6]. Given the limitations of BMI and the observed variability in body fat distribution, many experts recommend complementing BMI with direct body composition assessments, such as body fat percentage or waist circumference, to improve the evaluation of weight status and health risk. These integrated approaches help identify individuals with "normal-weight obesity" or those with high adiposity despite normal BMI, conditions that may be associated with increased cardiometabolic risk and poorer health outcomes [14]. Body mass index (BMI) is commonly employed as a practical and low-cost method to estimate body fatness. Nevertheless, BMI cannot distinguish between adipose tissue and lean tissue [5]. In general, BMI is moderately to strongly associated with body fat percentage, with reported correlation coefficients ranging from approximately 0.72 to 0.86, though these associations fluctuate based on factors such as age, gender, and ethnicity [1], [9]. Research involving 23,627 adults in the United Kingdom demonstrated that age independently influences body fat percentage [8]. As individuals age, fat accumulation tends to increase at a constant BMI, while lean tissue slightly declines, resulting in higher fat percentages over time. Body composition has been linked to the likelihood of developing conditions such as cancer, cardiometabolic disorders including type 2 diabetes, cardiovascular disease, and overall mortality. Due to these well-established associations, evaluating body composition has become a routine part of clinical practice for stratifying patient risk, commonly using classifications such as overweight and obesity [10], [13]. Two widely employed indicators for assessing body composition and associated health risks are Body Mass Index (BMI) and body fat percentage (BF%) [2].

Material-method

The sample consisted of 23 females who volunteered to participate in the study. Participants varied in age, height, and body mass index (BMI). All participants were measured under the same conditions. Inclusion criteria required participants to be apparently healthy and able to undergo body composition assessment using bioelectrical impedance analysis. Body mass and height were used to calculate Body

Mass Index (BMI) as weight in kilograms divided by height in meters squared (kg/m^2). Body fat percentage (Fat %) was assessed using a Tanita bioelectrical impedance analyzer, which estimates body composition based on the resistance of body tissues to a small electrical current. In addition to BMI and Fat %, age was recorded for each participant. BMI values were further classified into standard categories according to World Health Organization criteria: underweight (<18.5), normal weight (18.5–24.9), overweight (25–29.9), and obese (≥30). Body fat percentage was also categorized using sex-specific cut-off values to allow comparison between BMI classification and adiposity-based classification. Participants were measured individually. Body height and weight were recorded and entered into the Tanita analyzer to obtain body fat percentage values. All measurements were conducted following standard procedures recommended for bioelectrical impedance assessment. Data were anonymized and entered into IBM SPSS Statistics for analysis. All statistical analyses were performed using IBM SPSS Statistics. Descriptive statistics were computed for age, BMI, and body fat percentage. To examine the relationship between BMI classification and body fat percentage classification, variables were recoded into categorical forms and analyzed using cross-tabulation (Crosstabs). The association between categories was tested using the Chi-square test of independence, and because of small expected cell counts, Fisher’s Exact Test was also applied. Pearson correlation coefficients were calculated to assess linear relationships between age, BMI, and Fat %. Finally, a multiple linear regression analysis was conducted with body fat percentage as the dependent variable and BMI and age as predictors, in order to examine the extent to which BMI and age predict adiposity. Statistical significance was set at $p < .05$.

Results and discussions

Descriptive analyses were conducted to examine the distribution of Body Mass Index (BMI) categories and body fat percentage (Fat %) categories among the 23 participants. The sample was categorized into three BMI groups: Normal (n = 4, 17.4%), Overweight (n = 6, 26.1%), and Obese (n = 13, 56.5%). Fat percentage was classified into Low (n = 2, 8.7%), Normal (n = 4, 17.4%), and High (n = 17, 73.9%). A crosstabulation of BMI categories and Fat percentage categories is presented in Table 1. Among participants with Normal BMI (n = 4), 75% (n = 3) had Fat percentage within the normal range, while 25% (n = 1) had low Fat percentage. All participants classified as Overweight (n = 6) were in the High Fat percentage category. Among those with Obese BMI (n = 13), 84.6% (n = 11) had High Fat percentage, but two participants (15.4%) had either Low or Normal Fat percentage, indicating a discrepancy between BMI classification and body fat content.

Table 1. Crosstabulation of BMI Categories and Fat percentage Categories

BMI category	Fat % Low (1)	Fat % Normal (2)	Fat % High (3)	Total
Normal	1	3	0	4
Overweight	0	0	6	6
Obese	1	1	11	13
Total	2	4	17	23

The row percentages within BMI categories indicate that most participants classified as Overweight or Obese by BMI were also classified as High Fat percentage, suggesting general agreement between BMI and body fat percentage at higher BMI levels. However, the presence of participants with Normal BMI who have Low Fat percentage and participants with Obese BMI with lower Fat percentage indicates that BMI alone may not fully capture individual variations in body composition. To test the association between BMI categories and Fat percentage categories, a Pearson Chi-square test was performed. The results indicated a significant association, (χ^2 = 14.85, p = 0.005. The Likelihood Ratio test confirmed this association (χ^2 = 15.607, p = 0.004). Because many cells had expected counts less than 5 (8 cells, 88.9%), Fisher's Exact Test was also calculated. The Fisher's Exact Test yielded a significant result, p = 0.003, confirming that the association between BMI and Fat percentage is statistically significant even with the small sample size and low expected frequencies. Additionally, the Linear-by-Linear Association test showed a standardized statistic of 2.159, $\chi^2(1) = 4.661$, p = 0.031, indicating a significant linear trend: as BMI category increased, the probability of being classified in a higher Fat percentage category also increased. The results indicate a statistically significant relationship between BMI and Fat percentage, suggesting that, overall, higher BMI is associated with higher body fat percentage. However, discrepancies were observed: some participants with Normal BMI had Fat percentage that was Low or Normal, highlighting that BMI may not detect low body fat or subtle differences in body composition at lower BMI ranges; a small proportion of participants with Obese BMI had Normal or Low Fat percentage, suggesting that BMI may overestimate adiposity in individuals with higher body mass that is not exclusively fat (e.g., increased lean mass). These findings align with previous literature indicating that BMI is an imperfect measure of body composition, as it does not differentiate between fat mass and lean mass (Deurenberg et al., 2002). In contrast, body fat percentage provides a more direct assessment of adiposity. The combination of BMI and Fat percentage allows a more accurate evaluation of weight status, particularly in individuals at the extremes of BMI (Normal or Obese). Pearson correlation coefficients were computed to examine the relationships among age, Body Mass Index (BMI), and body fat percentage (Fat percentage). Descriptive correlations, significance levels, and 95% bootstrap confidence intervals were reported. The correlation between age and BMI was positive but weak, $r(21) = .23$, $p = .289$. This result indicates that although BMI tended to increase slightly with age, the relationship was not statistically significant. The 95% bootstrap confidence interval ranged from −.17 to .57. Age alone does not appear to meaningfully influence BMI in this group. Any observed trend may be due to random variation rather than a true population effect. The association between age and fat percentage was also weak and positive, $r(21) = .18$, $p = .419$. The bootstrap 95% confidence interval ranged from −.20 to .47. This indicates that the relationship between age and body fat percentage was not statistically significant. Older participants did not systematically present higher body fat percentages compared to younger participants. In this sample, age does not appear to be a strong determinant of adiposity. The correlation between BMI and fat percentage was moderate and positive, $r(21) = .37$, $p = .080$. Although this correlation suggests that higher BMI values tend to be associated with higher fat percentage, the association did not reach conventional statistical significance ($p < .05$). The bootstrap 95% confidence interval ranged from −.17 to .90. There is a moderate tendency for individuals with higher BMI to also present higher body fat percentages, but the relationship is not strong enough to be considered statistically reliable. This finding supports the idea that BMI reflects adiposity only partially and may fail to capture individual differences in body composition. Overall, none of the correlations between age, BMI, and fat percentage reached statistical significance. The strongest association was observed between BMI and fat percentage, indicating a moderate positive trend, but insufficient evidence to confirm it statistically.

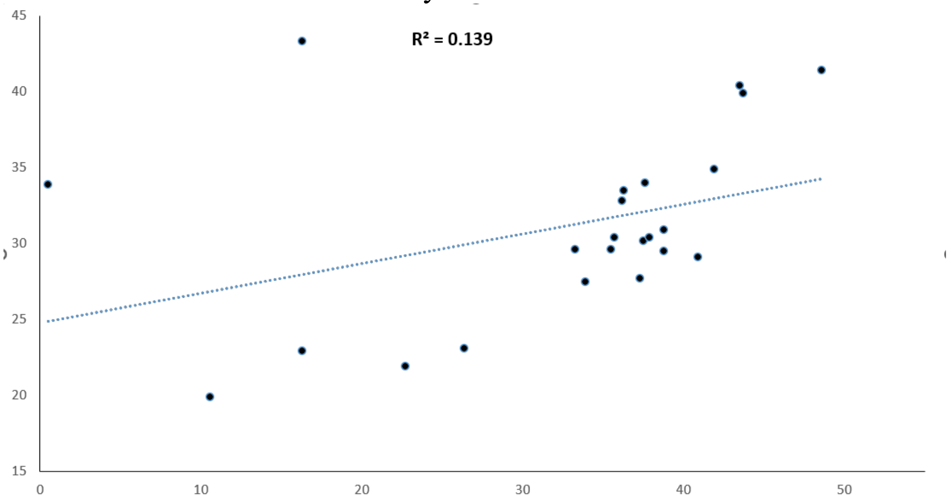

Figure 1. Scatterplot illustrating the association between Body Mass Index (BMI) and body fat percentage (Fat %)

This pattern suggests that age is not a major determinant of either BMI or Fat percentage in this sample, BMI and fat percentage are related, but imperfectly, reinforcing the notion that BMI alone does not fully reflect body fat accumulation and individual variability in lean mass and fat mass may explain why participants with similar BMI values can present different body fat percentages. A multiple linear regression was conducted to predict body fat percentage from BMI and age. The model was not significant, $F(2, 20) = 1.73$, $p = .202$, explaining 14.8% of the variance ($R^2 = .148$). BMI showed a moderate but non-significant effect, $B = .67$, $SE = .41$, $\beta = .35$, $p = .114$, indicating that for each one-unit increase in BMI, body fat percentage increased on average by approximately 0.67 percentage points, holding age constant, while age was not a significant predictor, $B = .20$, $SE = .44$, $\beta = .10$, $p = .656$, suggesting that each additional year of age was associated with an average increase of about 0.20 percentage points in body fat percentage, although this effect was not statistically significant. These findings indicate that BMI and age do not reliably predict body fat percentage in this sample.

Several studies have investigated the relationship between BMI and directly measured body fat percentage (BF% or Fat %). In general populations, BMI is correlated with BF%, but the strength and pattern of this relationship can vary by age, sex, ethnicity, and body composition. Large-scale studies have demonstrated that the association between BMI and % body fat is not strictly linear and may be influenced by factors such as aging and gender, highlighting that BMI may not capture individual variability in adiposity, especially at lower or higher BMI ranges [8]. Body fat percentage has been shown to be a stronger predictor of health outcomes than BMI in several epidemiological studies. For example, increased BF% is significantly associated with all-cause mortality and cardiovascular mortality over extended follow-up periods, whereas BMI may not demonstrate the same predictive power after adjusting for confounders. These findings suggest that direct measures of adiposity could more accurately reflect health risk than BMI alone [7]. In a 15-year prospective analysis of young adults from the National Health and Nutrition Examination Survey, body fat percentage and waist circumference were both significantly associated with all-cause and cardiovascular mortality, whereas BMI showed no significant independent relationship with overall mortality when adjusted for confounders. This evidence suggests that percentage body fat may be a stronger indicator of health risk than BMI alone in population studies. In a large, nationally representative cohort of US adults drawn from the National Health and Nutrition Examination Survey, researchers examined the predictive value of body composition measures for long-term mortality risk over a 15-year period. Participants were classified according to conventional BMI categories, with a healthy range defined as 18.5–24.9 kg/m² and overweight or obese as ≥25 kg/m². In addition, thresholds for unhealthy body fat percentage (BF%) and waist circumference (WC) were established, with ≥27% for men and ≥44% for men's WC, and ≥40% and ≥35 inches for women, respectively. Using Cox proportional hazard regression, the study estimated 15-year mortality risk associated with each metric, both before and after adjustment for potential confounders. The findings indicated that BF% and WC were robust predictors of both all-cause and heart disease-specific mortality. Specifically, higher BF% was associated with significantly increased risk of dying from any cause, with an adjusted hazard ratio of 1.78 (95% CI, 1.28–2.47; P < .001), and similarly elevated risk for heart disease mortality (adjusted HR 3.62; CI, 1.55–8.45; P = .003). WC showed comparable predictive strength. In contrast, BMI demonstrated no significant association with all-cause mortality after adjustment, and while it was linked to heart disease mortality in unadjusted models, this relationship did not persist after accounting for confounding variables [7]. The association between BMI and body fat varies markedly between populations. A population-based study of Singaporean adults demonstrated that, when matched for age and sex, Singaporean individuals had a higher body fat percentage at lower BMI levels compared to white populations in Europe and the United States, leading to large discrepancies in obesity prevalence depending on the metric used. Notably, prevalence of obesity defined by fat percentage was substantially higher than obesity defined by BMI, highlighting the risk of underestimating adiposity when relying solely on BMI in certain ethnic populations [3]. Research conducted in South Asian adults revealed a strong positive correlation between BMI and body fat percentage overall, but also demonstrated that this relationship is influenced by both age and gender. In that study, BMI–fat percentage correlations were significant for both men and women, with evidence of a curvilinear rather than strictly linear association, and age and sex contributing significantly to variability. These findings emphasize that both biological factors and demographic characteristics must be considered when interpreting BMI as a proxy for body composition [11]. The use of BMI as a screening tool can lead to misclassification in clinical populations as well. In patients with coronary heart disease, BMI and body fat percentage were significantly correlated, but they classified individuals differently in a substantial proportion of cases. In that cohort, BMI underestimated adiposity in about one-quarter of patients and overestimated it in a smaller percentage, indicating that BMI may not reliably detect true adiposity status in clinical subgroups [4].

Conclusion

The present study examined the differences between Body Mass Index and body fat percentage in the assessment of weight status. Although BMI categories showed a significant association with fat percentage categories, indicating a general agreement in broad classification, the numerical relationship between BMI and adiposity was weak. Correlation and regression analyses demonstrated that BMI explained only a small proportion of the variance in body fat percentage and did not significantly predict individual adiposity levels. These findings suggest that BMI is useful for population-level screening but limited for accurately evaluating body composition at the individual level. Individuals with similar BMI values may present substantially different fat percentages, reflecting variations in lean mass and fat distribution that

BMI cannot capture. Therefore, reliance on BMI alone may lead to misclassification of weight status, particularly in contexts where precise assessment of adiposity is required. The inclusion of direct body composition measures, such as bioelectrical impedance analysis, can improve the accuracy of weight status evaluation and provide more meaningful insight into metabolic and health-related risk. Future studies with larger samples and additional predictors are needed to further clarify the relationship between BMI and body fat percentage.

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