ORIGINAL RESEARCH

Body Composition Assessment using Impedance Analysis among Employees of a Tertiary Healthcare Institute in Nashik district in India: A Descriptive Cross-sectional Study

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Abstract

Background: Body composition is a critical indicator of metabolic health and disease risk. Modern tools such as bioelectrical impedance analysis (BIA) offer convenient, non-invasive assessment in clinical and community settings.

Objective: To assess the body composition of employees at a tertiary healthcare institution in Nashik using BIA and to evaluate the influence of demographic, lifestyle, and occupational factors on body composition parameters.

Methods: A cross-sectional study was conducted among 53 employees aged ≥18-years. Participants included doctors, residents, interns, and Class 3/4 staffs. Sociodemographic data, anthropometric measurements, random blood sugar (RBS), and blood pressure (BP) were recorded. Body composition was assessed using the Tanita Body Composition Analyzer. Data analysis involved descriptive statistics, *t*-tests, and chi-square tests, with $p < 0.05$ considered significant.

Results: Participants were predominantly male (62.3%) and aged 18–30 years (41.5%). Statistically significant sex-based differences were observed in basal metabolic rate (BMR), waist circumference, total body fat percentage, and skeletal muscle mass ($p < 0.05$). Regular exercisers had significantly lower BMI (23.4 ± 3.6) and higher BMR (1490 ± 140 kcal/day) compared to non-exercisers (BMI: 26.1 ± 4.2; BMR: 1370 ± 150 kcal/day). Most participants (66%) consumed a mixed diet, with rice being the staple for 56.6%.

Conclusion: BIA effectively identified body composition disparities across gender and lifestyle habits. Regular physical activity was associated with favorable BMR and BMI outcomes. These findings support workplace wellness programs that encourage physical activity and balanced diets.

Keywords: Basal Metabolic Rate, Bioelectrical Impedance Analysis, Body Composition, BMI, Healthcare Workers.

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Introduction

Body composition, which includes body water, lean mass, bone mass, and fat mass, has become a key indicator of general health and a predictor of long-term conditions like metabolic syndrome, diabetes, and cardiovascular disease. While BMI remains the most widely used anthropometric indicator for assessing obesity and undernutrition, it does not differentiate between fat mass and lean mass, potentially limiting its utility in personalized health assessments.[1,2]

In the occupational setting, particularly in healthcare environments, employee health directly impacts productivity, absenteeism, and the quality of care provided. Healthcare workers, including doctors, nurses, and ancillary staff, often experience irregular work hours, stress, poor dietary habits, and sedentary lifestyles. These occupational stressors can lead to significant variations in body composition, thereby increasing the risk of non-communicable diseases (NCDs) among this population.[3,4]

A method that is becoming more and more popular for determining body composition in both clinical and research contexts is bioelectrical impedance analysis, or BIA. It uses the resistance provided by bodily tissues to a little electrical current to estimate a number of factors, including body fat percentage, skeletal muscle mass, and basal metabolic rate. BIA is appropriate for field and hospital-based evaluations since it is portable, non-invasive, and yields data quickly.[5,6] The precision and dependability of the Tanita Body Composition Analyzer, which is being employed in this investigation, have been confirmed in other Indian and international studies.[7,8] There is a growing need to evaluate health metrics in workplace settings, especially within tertiary

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care institutes, where stress levels are high and lifestyle management is often neglected. Limited Indian data are available on the body composition profiles of healthcare workers. Most studies focus on general populations, children, or athletes, with insufficient attention to occupational groups facing unique physiological and psychological challenges.[9,10]

This study aims to assess body composition using BIA among employees of a tertiary healthcare institute in Nashik. It examines differences by sex, occupation, exercise habits, and diet—parameters often linked to NCD risk. The findings will help generate evidence to support targeted wellness interventions, occupational health strategies, and health education tailored to the healthcare workforce.

Materials and Methods

Study Design, Participants, and Data Collection Tools

This cross-sectional study was conducted among employees of a tertiary healthcare institute in Nashik, Maharashtra. A total of 53 employees participated, including doctors, residents, interns, and Class III/IV workers (clerks, cleaners, attendants). Inclusion criteria were employees aged ≥18-years who provided informed consent; exclusion criteria were pregnant women and employees with pacemakers or severe deformities affecting measurements. Sociodemographic data were collected using a questionnaire that included age, gender, socioeconomic classification (modified BG Prasad Scale 2023), occupation, and income source. Body composition was assessed using a standardized BIA machine (Tanita Body Composition Analyzer).

Data Collection Procedures

Anthropometric measurements included height, weight, BMI, waist circumference, and waist-hip ratio (WHR). Height was measured using a stadiometer to the nearest 0.1 cm, with participants standing erect without shoes. Weight was measured using a calibrated digital weighing scale to the nearest 0.1 kg, with participants wearing light clothing and no shoes. BMI was calculated using the formula: BMI = weight (kg) ÷ height (m^2). Waist circumference was measured using a flexible, non-elastic measuring tape at the narrowest point between the lowest rib and the iliac crest, with the participant standing and breathing normally. Hip circumference was measured at the widest portion of the buttocks, and WHR was calculated by dividing waist circumference by hip circumference. Random blood sugar levels were assessed using a portable glucometer (Accu-Chek Active) from a finger-prick blood sample, without requiring participants to fast. Blood pressure was measured using a digital sphygmomanometer (Omron HEM-7120) on the left arm after the participant had been seated for at least 5-minutes; two readings were taken five minutes apart, and the average was noted.

Bioelectrical Impedance Analysis (BIA) Description

Bioelectrical Impedance Analysis (BIA) is a technique for determining body composition, including fat content and fat-free mass. It entails passing a small, safe electrical current through the body and calculating the impedance, or resistance, to the current's flow. BIA devices can estimate the relative amounts of fat and fat-free mass because fat tissue has a higher impedance (resistance to the current) than fat-free mass, which is primarily composed of water and electrolytes and conducts electricity well. One popular kind of BIA tool is the Tanita Body Composition Analyzer, which was employed in this investigation. The apparatus sends a signal via the participant's body while they stand on electrodes. The analyzer then uses equations that incorporate the impedance measurement along with other factors like height, weight, age, and gender to predict body composition parameters.

Variables Assessed

Anthropometric: BMI, Waist Circumference, Waist-Hip Ratio (WHR); Body Composition: Total Body Fat Percentage, Total Skeletal Muscle Mass Percentage, BMR; Exercise Patterns: Regular (>150 minutes/week) vs. Irregular/None.

Statistical Analysis ($p < 0.05$ considered significant). Descriptive statistics were used for sociodemographic data. Independent t-tests were used for comparing means across genders. Chi-square tests were used for associations between exercise pattern, BMI, and BMR. A *p-value* <0.05 was considered significant.

Results

The table presents the demographic characteristics of 53 study participants. A majority were in the 18–30 age group (41.5%) and predominantly male (62.3%). Most participants belonged to the lower middle socioeconomic class (39.6%) and worked as Class 3 and 4 employees (84.9%). In terms of income, 37.7% fell in the lower middle-income group, with an equal proportion (26.4%) in both the upper middle and lower classes. Only a small percentage (9.4%) reported monthly earnings above ₹50,000.

The body composition metrics of the male ($n = 33$) and female ($n = 20$) participants are contrasted in Table 2. The BMR, BMI, waist circumference, total body fat percentage, and total skeletal muscle mass mean and standard deviation are displayed, along with the accompanying *p-values* that signify statistical significance. BMR ($p < 0.001$), Waist Circumference ($p = 0.001$), Total Body Fat Percentage ($p = 0.02$), and Total Skeletal Muscle Mass ($p = 0.001$) all showed significant differences, indicating that these metrics vary by gender. There was no discernible gender difference in BMI ($p = 0.26$).

Table 3 examines the relationship between exercise patterns (Regular Exercise, Irregular/No Regular Exercise) and their impact on BMI and BMR. The table presents mean and standard deviations for BMI and BMR within each exercise group, along with *p-values* assessing the statistical significance of the differences. Participants engaging in regular exercise exhibited significantly lower BMI ($p = 0.03$) and higher BMR ($p = 0.04$) compared to those with no regular

Table 1: Sociodemographic Profile of Participants Demographic Profile of the Study Participants ($n = 53$).

Variable	Category	Frequency (*n*)	Percentage (%)
Age Group (Years)	18–30	22	41.5%
	31–45	18	34.0%
	>45	13	24.5%
Gender	Male	33	62.3%
	Female	20	37.7%
Socioeconomic Class	Upper	4	7.5%
	Upper Middle	15	28.3%
	Lower Middle	21	39.6%
	Upper Lower	13	24.5%
Occupation	Doctors/Residents/ Interns	8	15.1%
	Class 3 and 4 Workers	45	84.9%
Income (Monthly)	Upper Class (> ₹50,000)	5	9.4%
	Upper Middle (₹25,000–50,000)	14	26.4%
	Lower Middle (₹10,000–25,000)	20	37.7%
	Lower Class (< ₹10,000)	14	26.4%

Table 2: Sex-wise Distribution of Body Composition and Health Parameters.

Parameter	Male ($n = 33$) Mean ± SD	Female ($n = 20$) Mean ± SD	*p*-value
BMR (kcal/day)	1550 ± 160	1300 ± 120	<0.001*
BMI (kg/m^2)	25.2 ± 4.0	24.1 ± 3.7	0.26
Waist Circumference (cm)	89.2 ± 8.5	81.5 ± 9.1	0.001*
Total Body Fat Percentage (%)	26.5 ± 6.8	30.7 ± 7.9	0.02*
Total Skeletal Muscle Mass (%)	34.1 ± 4.7	30.1 ± 5.2	0.001*
Random Blood Sugar (mg/dL)	98 ± 20	92 ± 18	0.15
Systolic Blood Pressure (mmHg)	125 ± 15	120 ± 14	0.08
Diastolic Blood Pressure (mmHg)	80 ± 10	78 ± 9	0.32

**Statistically significant ($p < 0.05$)*

Table 3: Association between exercise pattern, BMI, and BMR.

Exercise Pattern	BMI (Mean ± SD)	BMR (Mean ± SD)	*p*-value (BMI)	*p*-value (BMR)
Regular Exercise	23.4 ± 3.6	1490 ± 140	0.03*	0.04*
No Regular Exercise	26.1 ± 4.2	1370 ± 150		

**Statistically significant ($p < 0.05$)*

Table 4: Dietary Patterns of Participants.

Dietary Parameter	Frequency ($n = 53$)	Percentage (%)
Type of Diet		
Vegetarian	18	34.0
Mixed (Veg & Non-Veg)	35	66.0
Main Staple Food		
Rice	30	56.6
Wheat	12	22.6
Millets (Bajra & Jowar)	11	20.8

exercise, highlighting the positive influence of exercise on these parameters.

Table 4 presents, the dietary patterns of the study participants, focusing on the type of diet consumed and the main staple foods. It includes the frequency and percentage distribution of participants who follow a vegetarian or mixed diet, with a majority consuming a mixed diet. The table also shows the frequency and percentage of those who primarily consume rice, wheat, or millets (Bajra and Jowar) as their main staple food, with rice being the most common staple. This table provides insights into the dietary habits of the study population, which is crucial for understanding the context of body composition and related health parameters.

Discussion

The present study revealed significant differences in body composition parameters by gender and exercise habits among healthcare employees. Male participants demonstrated higher basal metabolic rates and skeletal muscle percentages, while females had higher body fat percentages—consistent with known physiological norms.[14,15] The association of regular exercise with improved BMI and BMR aligns with global and Indian literature, which indicates that physical activity enhances metabolic efficiency and lean body mass while reducing fat mass.[16,17] Despite demanding work schedules, promoting exercise among healthcare workers is essential to reduce long-term health risks.

Dietary patterns, notably the dominance of a mixed diet and preference for rice, reflect regional dietary habits. However, excessive reliance on high-glycemic staples like rice may contribute to increased body fat and reduced muscle retention, especially in sedentary workers. This highlights the need for dietary counseling within workplace wellness programs.[18] BIA proved to be a reliable and convenient tool for body composition measurement in a hospital setting. Unlike BMI, it provides insights into fat and muscle distribution, which are critical for evaluating metabolic health, particularly among those with normal BMI but high fat percentage—commonly referred to as normal-weight obesity.[19]

Previous Indian studies in urban settings reported similar findings among hospital staff and administrative workers, underscoring the need for periodic health assessments using advanced tools like BIA.[10,20] While the study's limited sample size restricts generalizability, it effectively demonstrates trends that warrant larger longitudinal studies.

Conclusion

This study underscores the importance of detailed body composition analysis among healthcare workers. It demonstrates that bioelectrical impedance analysis is a practical and effective tool for identifying health risks related to high body fat and low muscle mass. Significant differences were observed based on gender and physical activity patterns, highlighting the need for personalized wellness strategies in healthcare institutions.

Recommendations

Workplace wellness initiatives should include regular health screenings using BIA, structured physical activity sessions, and tailored dietary guidance. Awareness programs focusing on diet and exercise should be integrated into occupational health services, especially for support staff.

Limitations

The study was carried out in a single tertiary institution and had a small sample size, which would limit how broadly the results can be applied. Recall bias might have been induced by using self-reported data on nutrition and exercise. It is advised to conduct more multicentric research with bigger sample sizes and longitudinal monitoring.

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