Original Article

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Body Composition of Medical Staff Working on Shift Duty and Day Duty: A Cross-sectional Study

Physiology Section

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ABSTRACT

Introduction: The necessity for 24-hour patient care in the medical field often requires staff to work in shifts, disrupting their circadian rhythms controlled by the hypothalamus's Suprachiasmatic Nuclei (SCN). This disruption can lead to sleep deprivation, which is linked to significant health issues such as obesity, type 2 diabetes, hypertension, and cardiovascular disease. Sleep deprivation affects body composition by altering fat distribution, muscle mass, and Body Mass Index (BMI), and changes meal preferences towards high-calorie, carbohydrate-rich foods. Irregular eating patterns due to hormonal and gut microbiome changes can lead to over-eating and weight gain. The sedentary nature of many shift-based jobs exacerbates the imbalance between energy intake and expenditure, promoting obesity.

Aim: To address the limited research on how shift work impacts the body composition of medical staff by comparing those on shift duty to those on day duty.

Materials and Methods: This study was a cross-sectional study that included medical staff between the age group of 25 to 40 years working in the Parent Institute. The subjects were divided into two equal groups consisting of 100 staff working on shift duty (study group) and 100 staff working on day duty (control group). Subjects were tested for body composition by using Karada Scan. Various parameters of body composition were compared using an unpaired t-test.

Results: The day duty group consisted of 36 females and 64 males (N=100) staff with a mean age of 33.0±4.6 years while the shift duty group consisted of 36 females and 64 males (N=100) staff with a mean age of 31.9±4.4 years. The study suggests a significant difference between the two groups for BMI, skeletal muscle mass, and subcutaneous fat with a p-value <0.05.

Conclusion: The study showed lower skeletal muscle mass and higher body weight, body fat percentage, visceral fat, BMI, and subcutaneous fat in medical staff working on shift duty.

Keywords: Circadian rhythm, Electric impedance, Sleep deprivation

INTRODUCTION

The nature of the medical field frequently necessitates atypical working hours in modern healthcare settings, with many medical staff working in shifts to guarantee 24-hour patient care [1-4]. The brain's internal circadian rhythm is controlled by the SCN located in the hypothalamus [4]. Shift work disrupts the circadian rhythm, leading to sleep deprivation, which has several detrimental effects on physical and mental health [5-8]. Many major health issues, such as obesity, type 2 diabetes, hypertension, and cardiovascular disease, can be brought on by sleep deprivation [8]. Modifications in an individual's physical health can bring changes in body composition, such as variations in fat distribution, muscle mass, and BMI, which can significantly impact overall health [9-13].

Sleep disruption alters meal preferences, favouring fast food and meals high in carbohydrates, thereby increasing daily caloric intake. Changes in the hormones and gut microbiome that control hunger might result in irregular eating patterns, which may encourage over-eating and weight gain [14,15]. Obesity can develop as a result of an imbalance between energy intake and expenditure, which is made worse by the sedentary nature of many shift-based professions [16].

Bioelectric Impedance Analysis (BIA) is a non-invasive technique that offers a quick and effective way to measure body composition. BIA measures impedance by passing a low-level electrical current through the body and taking advantage of the different resistances found in various body tissues. The BIA tool of choice, Karada Scan, measures the resistance that the electrical current faces precisely, making it possible to determine muscle mass, fat distribution, and BMI with accuracy [17]. With the assurance of a thorough assessment of body composition provided by this cutting-edge technology, the investigation is more reliable to look into the effects of shift work on the health parameters of medical staff.

There are concerns about how shift duty and day duty affect the body composition of medical staff because of the demanding nature of the healthcare system. There is limited research on how shift work affects the body composition of medical staff [18]. This study attempts to close this knowledge gap by comparing the body composition of medical staff working on shift duty with that of those on day duty through a cross-sectional analysis.

MATERIALS AND METHODS

The study was a cross-sectional study conducted on subjects selected from the parent Institute within the age group of 25 to 40 years from September 2023 to May 2024. Study approval was obtained from the Institutional Ethics Committee (EC/OA-132/2023) of Seth GS Medical College and KEM Hospital, Mumbai, India. The study was conducted in accordance with the ICMR's Ethical Guidelines for Biomedical Research on Healthy Participants, 2006, principles stated in the Declaration of Helsinki, 2013, and the ICH-GCP Guidelines.

Sample size calculation: Based on studies conducted by other authors with a confidence level of 95% and a power of 80%, the minimum sample size calculated was 34 [19]. The calculation of the sample size was done using Open Epi, version 2, an open-source calculator [20]. However, a total of 200 medical staff were included in the study and were divided into two equal groups. The day duty group and the shift duty group consisted of 100 medical staff working on day duty and in rotating shift duty, respectively.

Inclusion criteria: The medical staff (healthcare staff) working two morning shifts, two evening shifts, and two night shifts for atleast seven hours per day for six days a week at the parent institute; were included in the study.

Exclusion criteria: Subjects on any medications for sleep or any chronic diseases involving the cardiac and respiratory systems; Subjects who did not provide consent; Pregnant or lactating women; Subjects with sleep apnoea, obesity, insomnia, and claustrophobia; Subjects with any medical history like neuromuscular disorders, skeletal abnormalities, or surgical history were all excluded from the study.

Data collection: Subjects were chosen from the parent Institute through non-random sampling within the age group of 25 to 40 years. A total of 200 medical staff were included in the study and were divided into two equal groups. Informed consent was obtained after it was translated into the local language. The selected subjects were contacted in person, and a general history was recorded. They were instructed to dress comfortably and loosely and were asked to avoid consuming anything caffeinated for three hours before the test. All recordings were conducted in the Parent Institute between the hours of 9 am to 11 am and 4 pm to 6 pm in a quiet, well-ventilated room with ambient lighting. The Karada Scan was used to collect the data. Data on weight, Total Body Fat (TBF), visceral fat, BMI, skeletal muscle mass (whole body, trunk, arm, leg), and subcutaneous fat (whole body, trunk, arm, leg) were gathered. The instrument uses the BIA technique to measure various aspects of body composition. A total of 200 medical staff members participated in the study, and no subjects withdrew.

STATISTICAL ANALYSIS

The data were analysed using SPSS-16 software after entering the data in MS Excel-2021. Descriptive analysis for numerical data included the mean with Standard Deviation (SD), while categorical data was presented in frequency and percentage. An unpaired t-test was used to compare the means between the two groups. A p-value less than 0.05 was considered statistically significant.

RESULTS

The study participants included both males and females in the age group of 25 to 40 years. The shift duty group participants (N=100) had an age {Mean±SD (Range)} of 31.9±4.4 years, and the day duty group (N=100) had an average age of 33±4.6 years. The shift duty and day duty groups included 64 (64%) males and 36 (36%) females. There was no significant difference between the groups in terms of gender and age (p>0.05) [Table/Fig-1].

		Gender	
	Age (years)	Female	Male
Shift duty group (N=100)	31.9±4.4	36 (36%)	64 (64%)
Day duty group (N=100)	33.0±4.6	36 (36%)	64 (64%)
p-value	0.070		

[Table/Fig-1]: The socio-demographic information of the medical staff participating in the study.
(Unpaired t-test) (p<0.05=significant)

The mean weight in the shift duty group was 66.6±15.3 kg, while in the day duty group, it was 62.0±14.4 kg. The mean TBF in the shift duty group was 29.2±8.9%, while in the day duty group, it was 25.8±8.7%. The mean visceral fat in the shift duty group was 6.5±4.8, compared to 5.2±4.3 in the day duty group. The mean BMI in the shift duty group was 24.0±5.2 kg/m^2, while in the day duty group, it was 21.6±3.4 kg/m^2. The mean weight, TBF, visceral fat, and BMI were significantly higher in the shift duty group as compared to the day duty group (p<0.05) [Table/Fig-2].

The mean skeletal muscle mass (whole body) in the shift duty group was 30.0±3.7 kg, whereas in the day duty group, it was 36.3±5.0 kg. The mean skeletal muscle mass (trunk) in the shift duty group was 22.8±4.5 kg, while in the day duty group, it was

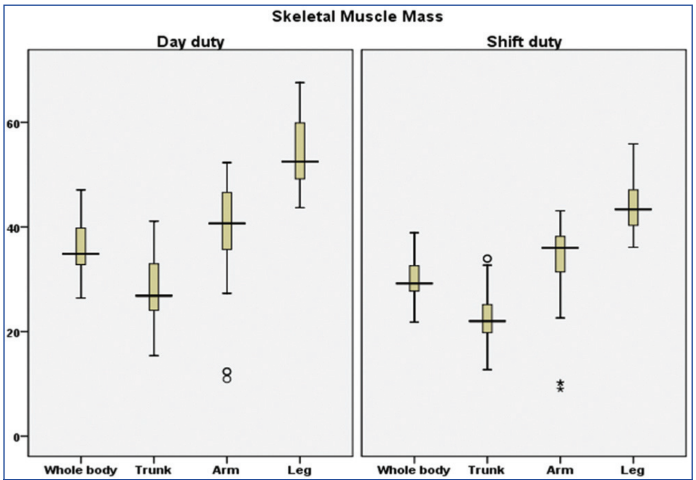
Parameters	Day duty (mean±SD)	Shift duty (mean±SD)	p-value
Weight	62±14.4	66.6±15.3	**0.029**
Total Body Fat (TBF)	25.8±8.7	29.2±8.9	**0.006**
Visceral Fat	5.2±4.3	6.5±4.8	**0.043**
BMI	21.6±3.4	24.0±5.2	**<0.001**

[Table/Fig-2]: Information about weight, TBF, visceral fat, and BMI of medical staff participating in the study.
(Unpaired t-test) (p<0.05=significant)

28.4±6.0 kg. The mean skeletal muscle mass (arm) in the shift duty group was 34.1±6.9 kg, compared to 40.9±8.6 kg in the day duty group. The mean skeletal muscle mass (leg) in the shift duty group was 44.2±5.3 kg, whereas in the day duty group, it was 54.4±6.9 kg. The mean skeletal muscle mass (whole body, trunk, arm, and leg) was significantly lower in the shift duty group as compared to the day duty group (p<0.05) [Table/Fig-3,4].

Skeletal muscle mass	Day duty (mean±SD)	Shift duty (mean±SD)	p-value
Whole body	36.3±5.0	30.0±3.7	**<0.001**
Trunk	28.4±6.0	22.8±4.5	**<0.001**
Arm	40.9±8.6	34.1±6.9	**<0.001**
Leg	54.4±6.9	44.2±5.3	**<0.001**

[Table/Fig-3]: Information about skeletal muscle mass in whole body, trunk, arms, and legs of medical staff participating in the study.
(Unpaired t-test) (p<0.05=significant)

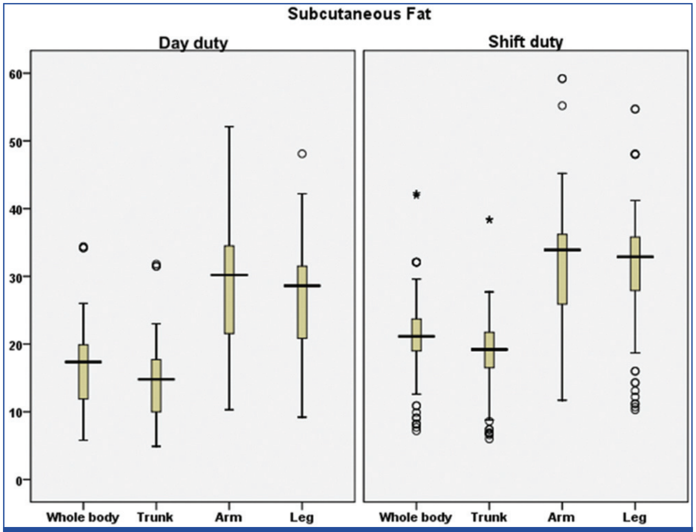


[Table/Fig-4]: Information about skeletal muscle mass in whole body, trunk, arms, and legs of medical staff participating in the study.

The mean subcutaneous fat (whole body) in the shift duty group was 21.1±6.8%, while in the day duty group, it was 16.7±6.1%. The mean subcutaneous fat (trunk) in the shift duty group was 18.5±6.4%, compared to 14.5±5.7% in the day duty group. The mean subcutaneous fat (arm) in the shift duty group was 32.3±9.7%, whereas in the day duty group, it was 28.2±9.5%. The mean subcutaneous fat (leg) in the shift duty group was 31.3±9.2%, while in the day duty group, it was 26.2±8.4%. The mean subcutaneous fat (whole body, trunk, arm, and leg) was significantly higher in the shift duty group as compared to the day duty group (p<0.05) [Table/Fig-5,6].

Subcutaneous fat	Day duty (mean±SD)	Shift duty (mean±SD)	p-value
Whole body	16.7±6.1	21.1±6.8	**<0.001**
Trunk	14.5±5.7	18.5±6.4	**<0.001**
Arm	28.2±9.5	32.3±9.7	**0.003**
Leg	26.2±8.4	31.3±9.2	**<0.001**

[Table/Fig-5]: Information about subcutaneous fat in whole body, trunk, arms, and legs of medical staff participating in the study.
(Unpaired t-test) (p<0.05=significant)



[Table/Fig-6]: Information about subcutaneous fat in whole body, trunk, arms, and legs of medical staff participating in the study.

DISCUSSION

The objective of this cross-sectional study was to compare the body composition of medical staff working on shift duty and day duty. The results provide several significant new insights. The major finding of the study was a significant increase in weight, TBF, visceral fat, BMI, and subcutaneous fat (whole body, trunk, arm, and leg), while there was a significant decrease in skeletal muscle mass (whole body, trunk, arm, and leg) in the shift duty group when compared to the day duty group. This suggests that shift work, with its irregular work hours and disrupted circadian rhythms, has a negative impact on body composition.

Although sleep disruption is highly prevalent among healthcare employees working in rotating shift duties, there has been little research on the negative consequences of sleep disruption on body composition [8,21]. The findings of the study are in line with earlier research that examined the connection between shift work and body composition in medical staff. A study by Handayani F et al., in year 2021, on healthcare workers showed an increase in BMI in healthcare workers working in shift duties [18]. These results are consistent with this study and highlight the challenges medical staff encounter in maintaining healthy sleep patterns. It also showed a positive correlation between lack of sleep and increased levels of cortisol, which is identified as a metabolic stressor, leading to an increase in BMI among medical staff working in shifts. Another study carried out by Kit LP et al., in year 2020, showed that primary healthcare workers have increased BMI and body fat percentage compared to the general population [22].

This could be because of an increase in stress levels among healthcare workers. The disruption of circadian rhythm not only causes sleep disturbances but also leads to altered body composition [18]. Another study by Meng R et al., in year 2021, conducted on women demonstrated that disruption of circadian rhythm leads to a decrease in muscle mass and raised levels of visceral fat and insulin resistance [9]. A meta-analysis study by Hemmer A et al., in year 2021, indicated an increased risk of overweight and obesity due to shift work [23]. Hence, not only in healthcare employees but also in other occupations, shift work results in altered body composition, leading to a negative impact on physical and mental health, thereby deteriorating the quality of life [8,24,25].

Research on body composition among medical staff working on shift duty, as opposed to day duty, offers several potential clinical benefits. This includes the development of health optimisation strategies for medical staff on shift duty and the creation of occupational health guidelines for scheduling and administration. With this data, institutions can create policies that consider the possible effects of shift work on body composition and implement initiatives to promote the well-being of their medical staff. Staff wellness programmes can be tailored to address the specific needs identified in the study, incorporating stress-reduction techniques, nutritional support designed for shift-work schedules, and fitness initiatives. Additionally, preventive healthcare measures can be considered since shift duty medical staff are found to have lower muscle mass and higher body fat percentages. Early interventions such as individualised exercise regimens or dietary counselling can address these health issues. The study also highlights the link between reducing the risk of chronic conditions and unfavourable body composition due to shift work. By implementing early interventions and routine health monitoring, the long-term health risks associated with altered body composition may be mitigated.

Limitation(s)

The cross-sectional design limits the ability to conclude causal linkages. Furthermore, variables that are not entirely controlled for, like dietary practices and physical activity, may affect body composition and cause variations in the findings.

CONCLUSION(S)

This research shows the complex connection between medical staff body composition and shift work. The study suggests lower skeletal muscle mass and higher body weight, body fat percentage, visceral fat, BMI, and subcutaneous fat in medical staff on shift duty. Longitudinal studies can be carried out to monitor changes in medical staff's body composition over time while they work shifts as opposed to day shifts to establish causality.

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