Original Article :

Relationship between Physical Activity and Variables of Body Composition among Saudi Female Medical Students Taking into Account the Body Mass Index.

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Abstract

Background and Aims:
Physical inactivity and the prevalence of overweight/obesity are considered high among Saudi youth. Studying the factors that might be related to physical activity (PA) and finding strategies to promote it are necessary. This study aimed to assess the (PA) levels among medical students with different body mass index (BMI) and determine the relationship between PA and body composition.

Methods:
Eighty female students with a mean (SD) age of 20.18 (1.14) years were recruited to this comparative study. The body composition and PA levels of the participants were determined using bioelectrical impedance analysis and the International Physical Activity Questionnaire – Short Form (IPAQ-SF), respectively.

Results:
The study finds a significant but weak negative correlation between total PA score and fat % in the whole sample (P = .05, r = -.21). A Spearman's rho test detected a moderate negative correlation between total metabolic equivalent (MET)-min/week and fat mass, as well as fat % in both the underweight and normal weight groups. Moderate positive correlations were found between total PA score and BMI, fat-free mass, and total body water in the obese group.

Conclusions:
There is a significant but weak correlation between the fat % and PA level of the female medical students who participated in this study. Variation among groups in terms of PA confirms that BMI is not an accurate predictor of a person's PA level.

Keywords:
sedentary lifestyle, physical inactivity, exercise, fat mass, fat %.

Introduction

Regular physical activity (PA) is one of the most important ways in which people can improve their physical and mental health[1]. The minimum level of PA recommended by the World Health Organization (WHO) per week is 150 min moderate- and/or 75 min vigorous-intensity physical activity, but that was not met by 27.5% of adults aged 18 years worldwide in 2022[2]. A systematic review by Ferreira et al.,[3] reported that the prevalence of physical inactivity had increased among university students, which might refer to physical and mental changes and university being a very competitive environment[3, 4]. In Saudi Arabia, a recent cross-sectional study found that approximately three in ten undergraduate students were physically inactive[5]. Another study on a sample of 375 Saudi female university students found that 62% did not meet the WHO recommendation for vigorous activity and 70% of the participants did not meet that for moderate activity[6].

Insufficient levels of PA can be associated with the appearance of non-communicable diseases[7]. In addition, a recent systematic review reported that a low level of PA is a major contributing factor to the high prevalence of obesity[8]. Obesity is often a progressive, chronic disorder that affects health negatively and leads to stigma[9]. There are several complications related to obesity. For example, people who are overweight or obese often face social prejudice. They are also at higher risk of various life-threatening diseases, including cardiovascular disease, and an increased mortality rate[10]. The 2019 Global Burden of Disease analysis found that obesity-related disability-adjusted life years (DALYs) rose 0.48% annually from 2000 to 2019 and were predicted to increase by 39.8% from 2020 to 2030[11]. In Saudi Arabia specifically, the prevalence of obesity (35%) is higher than the global average (13%)[8]. Unfortunately, with such a global increase in the prevalence of obesity, and the well-known consequences of this for population health and well-being, there is no clear solution, despite numerous reports and recommendations[9].

Body mass index (BMI) is, due to its simplicity, routinely utilized as a robust measure to determine obesity. It is used to classify body mass into underweight, normal weight, overweight, and obese and has a modest correlation with adiposity[12]. Obesity is associated with excessive body fat mass and the BMI reflects the relationship between height and weight and should serve as an indicator for pre-estimating abnormal weight[13]. However, healthy individuals with high muscle mass can be

misclassified as overweight or even obese, which makes BMI an inaccurate measure of body fat mass[14-17]. Despite a strong correlation between BMI and body fat % found in a large sample of the US adult population, BMI has limited diagnostic accuracy for diagnosing obesity, especially in individuals in the intermediate BMI ranges[18].

Body composition assessment is used to describe body fat %, fat mass, and muscle mass. Numerous approaches can be taken to assess human body composition, which include analyzing bioelectrical impedance and body density, dual-energy X-ray absorptiometry, and total body water estimates[19]. Moreover, the risk of many chronic conditions associated with high body fat can be reduced by increasing PA[20].

This study was undertaken in response to the high prevalence of both obesity and physical inactivity among young Saudi females and the need to promote PA among this population. The study assessed the variation among the participants' BMI groups in terms of their PA levels and determined the relationship between PA and body composition, taking BMI classification into account.

Materials and methods

Study Design, Participants, and Sample Size

This was an observational comparative study conducted for 3 months at the College of Applied Medical Sciences (Female campus), King Saud University (KSU). It was designed and reported in line with the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines[21]. Eighty female medical students aged 18¬–25 were recruited. Participants were divided into four sub-groups according to their BMI, with n = 20 participants in each group: BMI < 18.5 = underweight; BMI 18.5–24.9 = normal weight; 25–30 = overweight; and BMI > 30 kg/m² = obese. Students were excluded from the study if they reported any of the following: if they suffered from a cardiovascular, metabolic, rheumatic, or vestibular disease[22]; if they had problems with their lower limbs, such as injuries, in the 6 months prior to the study or had previous surgery on the legs, clinical instability in the knee or ankle, any amputation, contracture or deformity of the knee, hip replacements, or arthritis[22, 23], a history of chronic conditions (such as musculoskeletal disorders and type II diabetes mellitus); any kind of visual impairments[24], if they were smokers or recent ex-smokers (abstinent for less

than 6 months); or pregnant[23,24]. A convenience sampling method was used. The sample size was calculated based on previous studies[24, 25]. It was found that 80 students needed to be included in the study, with a confidence interval of 95% and a margin of error of 5%. Eighty students were recruited and then divided into four groups: 20 students in each group: underweight, normal weight, overweight and obese group.

Outcome Measures

Body Composition

Measurements of selected body mass and body composition variables were performed for all participants. The participants were measured in the morning, at least 3 hours after waking up and eating or drinking. Bioelectrical impedance, using the Tanita Body Composition Analyzer BC- 418 (Tanita, Tokyo, Japan), was employed to assess body mass and body composition. The Tanita BC 418-MA is a reliable system with good test–retest reliability and excellent limits of agreement (< 1%). It is equivalent to skinfold thickness assessment and provides a non-invasive alternative that does not require operator training[26].

All the guidelines/recommendations for the analysis of bioelectrical impedance were considered. The device was calibrated to account for clothing weight (0.2 kg). Then, data regarding the age, sex, and height of each participant were entered. A Seca weight and height scale (Seca GmbH & Co., Hamburg, Germany) was used to measure weight and height. Afterwards, each participant was asked to stand on the scale with bare feet and to place her hands on the places marked. The body composition analyzed by the device was based on differences in the ability of the body tissues (varying resistances) to conduct an electrical current due to the different water content. The variables measured included body weight (kg), body mass index (BMI, kg/m2), fat mass (FM, kg and %), fat-free mass (FFM, kg and %), and total body water (TBW, kg and %).

Physical Activity

The PA level was measured using the International Physical Activity Questionnaire – Short Form (IPAQ-SF). The IPAQ is a self-reported questionnaire that asks participants about the time they spend on various intensities of PA (vigorous, moderate, walking) for a minimum of 10 min at a time in the last 7 days[27]. The IPAQ demonstrates moderate to good validity, as evidenced by correlation coefficients typically ranging from 0.50 to 0.80 when compared to objective measures of PA across 12 countries. Moreover, the IPAQ exhibits satisfactory reliability, with intraclass

correlation coefficients (ICC) generally falling within the same range, supporting its consistent performance in assessing PA levels among diverse populations[27]. The total PA score is calculated using a metabolic equivalent (MET) task scored in minutes/week (MET-min/week)[27, 28]. PA was reported in this study as a continuous score (https://sites.google.com/site/theipaq/) and as a categorical score: < 600 = inactive; > 600 and < 3000 = sufficiently active; and > 3000 MET-min/week = very active.

Data Collection/Data Source

After receiving ethical approval for this study, an advertising banner with the researcher's contact information (telephone number and email) was distributed in the corridors and in the main hall of the college. Students contacted the researcher by phone and/or email to ascertain their eligibility to be included in the study based on the inclusion criteria. Following this stage, the researcher booked an appropriate appointment for one session with each student separately. The researcher then explained the study procedure to each participant and asked her to sign a consent form and complete the IPAQ-SF. After that, height and weight were measured to calculate the BMI and body composition was assessed to identify the body mass, FM, and fat % of each participant.

Ethical approval

The study was approved by the Institutional Review Board, College of Medicine, KSU (Reference no. 21/0924/IRB). A written consent form was taken from each participant.

Statistical Analysis

All statistical analysis was performed using the SAS statistical software package version 9.4 (SAS Institute Inc., Cary, NC, USA). Anthropometric and body composition measures were assumed a priori to follow a normal distribution and were summarized by providing means and standard deviations (SDs). The PA measures were summarized using median, minimum, and maximum values as they were not normally distributed. One-way analysis of variance (one-way ANOVA) was used to assess the differences among the four groups (underweight, normal body weight, overweight, and obese) in terms of anthropometric and body composition using an F-test. For PA measures, non-parametric one-way ANOVA was used to assess the differences between the corresponding Wilcoxon scores of the PA measures among the four groups using the Kruskal–Wallis test.

The correlation between body composition measures and PA was determined using the Spearman's rho correlation test.

In this study, the level of significance was accepted as $P \leq .05$.

Results

Characteristics of the Participants

A total of 80 participants were included in this study. The demographics of the participants, classified by their BMI, are presented in Table 1. The mean (SD) age of all participants was 20.2 (1.15) years. All the participants (100%) were female.

Anthropometric and Body Composition Measures

There was a statistically significant difference among the groups in terms of anthropometric measures (weight and BMI) and all body composition measures of $P < .0001$. No statistically significant differences were seen among the groups for age and height (Table 1).

Table 1 Participants' Anthropometric and Body Composition Measures

Group Variable	Total (N = 80) Mean (SD)	Underweight (n = 20) Mean (SD)	Normal weight (n = 20) Mean (SD)	Overweight (n = 20) Mean (SD)	Obese (n = 20) Mean (SD)	P[1]
Age (years)	20.2 (1.15)	20.3 (1.13)	20.3 (0.92)	19.9 (0.99)	20.3 (1.49)	.52
Anthropometric measures						
Height (cm)	158.8 (5.28)	157.7 (6.18)	160.6 (5.22)	158.2 (4.71)	158.6 (4.79)	.32
Weight (kg)	63.9 (18.78)	43 (3.88)	55.8 (6.88)	67.5 (5.34)	89.3 (12.36)	< .0001
BMI (kg/m²)	25.3 (7.35)	17.4 (0.98)	21.5 (1.76)	27 (1.38)	35.4 (5.27)	< .0001
Body composition measures						
Fat %	32.5 (11.44)	18.4 (4.43)	27.9 (5.42)	36.9 (3.68)	46.8 (3.63)	< .0001
FM (kg)	22.8 (13.97)	8.1 (2.49)	15.9 (4.65)	25.1 (4.13)	42.3 (9.13)	< .0001
FFM (kg)	41.1 (5.28)	35 (2.2)	39.9 (3.17)	42.4 (2.49)	47.2 (3.8)	< .0001
TBW (kg)	30.1 (3.85)	25.7 (1.61)	29.2 (2.32)	31.1 (1.62)	34.5 (2.78)	< .0001

BMI, body mass index; FM, fat mass; FFM, fat-free mass; SD, standard deviation; TBW, total body water.
[1]*P*-value obtained from an *F*-test in one-way ANOVA.

For the PA analysis, the Kruskal–Wallis test showed a significant difference among groups for vigorous PA and total PA score of $P < .05$. However, there was no significant difference among groups in respect of moderate PA, walking, and sitting time (Table 2).

Analysis of the IPAQ showed that ap-

Table 2 Analysis of the Physical Activity of the Participants

Variable	Characteristic	Total (N = 80)	Underweight group (n = 20)	Normal weight group (n = 20)	Overweight group (n = 20)	Obese group (n = 20)	P[1]
Vigorous PA MET-min/week	Median (minimum, maximum)	0 (0, 5760)	0 (0, 2880)	0 (0, 0)	0 (0, 5760)	0 (0, 0)	.03*
Moderate PA MET-min/week		0 (0, 4320)	0 (0, 240)	0 (0, 360)	0 (0, 4320)	0 (0, 600)	.90

Variable	Characteristic	Total (N = 80)	Underweight group (n = 20)	Normal weight group (n = 20)	Overweight group (n = 20)	Obese group (n = 20)	P[1]
Walking MET-min/ week	Median (minimum, maximum)	957 (0, 5544)	1386 (0, 5544)	726 (0, 3465)	1155 (49.5, 5544)	792 (0, 4158)	.22
Sitting time		420 (30, 960)	360 (60, 720)	420 (180, 600)	420 (120, 720)	480 (30, 960)	.48
Total PA		924 (0, 12456)	1699.5 (0, 5772)	494 (0, 3465)	1386 (49.5, 12456)	701.25 (0, 4158)	.03*

MET, metabolic equivalent; PA, physical activity; *, significant at $P \leq .05$.
[1]*P*-value obtained from the Kruskal–Wallis test in non-parametric one-way ANOVA.

proximately 46% of the participants were determined as being inactive. There was also a lack of a high level of PA among the participants in the normal weight and obese groups (0%). Only 10% of those in the underweight group and 15% of the overweight group were very active. Sixty percent of participants in the underweight group were sufficiently active, and 70% of those in the normal weight group were inactive (Figure 1).

The Spearman's rho test detected a

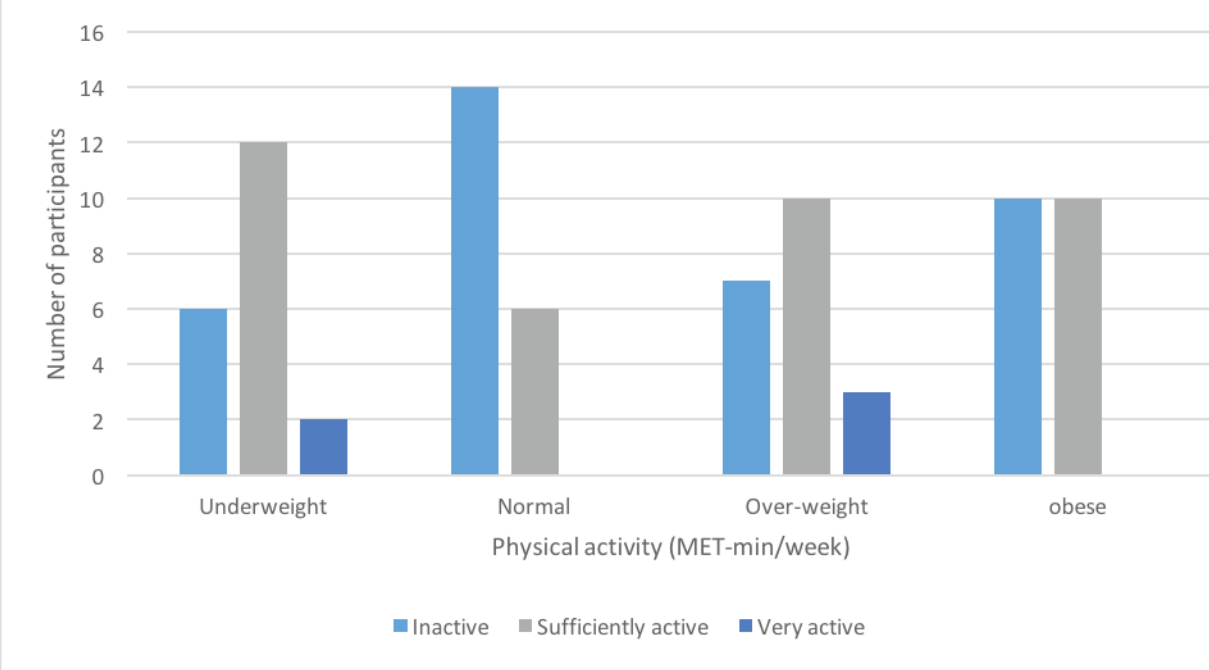


Figure 1 Physical Activity Level of Participants.

moderate negative correlation between total MET-min/week and FM as well as fat % in both the underweight and normal weight groups. Moderate positive correlations were found between total MET-min/week and BMI, FFM, and TBW in the obese group. P-values for these results ranged from .09 to .11 (Table 3).

Table 3 Correlation Analysis between Total PA and Variables of Body Composition

Body composition variable	Characteristic	Under-weight (n = 20)	Normal weight (n = 20)	Over-weight (n = 20)	Obese (n = 20)	Total (N = 80)
BMI	n	20	19	20	20	79
	Correlation	.06	-.25	-.23	.39	-.14
	P	.78	.30	.31	.09	.23
FM (kg)	n	20	19	20	20	79
	Correlation	-.37	-.38	-.21	.26	-.20
	P	.10	.10	.36	.27	.07
Fat (%)	n	20	19	20	20	79
	Correlation	-.39	-.41	-.19	.23	-.21
	P	.08	.07	.41	.32	.05*
FFM	n	20	19	20	20	79
	Correlation	-.03	-.29	-.22	.36	-.16
	P	.88	.22	.35	.11	.17
TBW	n	20	19	20	20	79
	Correlation	-.03	-.29	-.23	.36	-.14
	P	.90	.23	.33	.11	.20

BMI, body mass index; FM, fat mass; FFM, fat-free mass; PA, physical activity; TBW, total body water. *, significant at $P \leq .05$.

Discussion

This study aimed to assess the PA levels among Saudi female medical students with varying BMI and determine the relationship between PA and body composition, taking into account BMI classification. About 46% of the participants were determined as being physically inactive. This result supports the findings of Alzamil et al.,[29] who found that 46% of females in Saudi health sciences colleges were inactive, and Al-Drees et al.,[30] who reported that 55% of the Saudi female medical students in their study were inactive. All these findings confirm the earlier results of a systematic review that reported a high prevalence of physical inactivity in Saudi youth[31]. In contrast, Aljehani et al.,[6] showed that almost one third (29%) of a large sample (N = 375) of female students were inactive. All these studies were conducted at KSU. However, Aljehani et al.,[6] included students from different specialties, whereas the others recruited students from medical/health sciences colleges. In practice, students from different specialties may have more time to participate in PA, whereas female medical students may suffer from lack of time due to academic load. However, the most commonly reported barrier by medical students to engaging in PA is lack of time [29,30,32,33].

However, the prevalence of physical inactivity in this study exceeds that of phys-

ical inactivity among medical students worldwide. For example, in Brazil, the prevalence of physical inactivity among N = 294 medical students was 34.4%[34]. Another study, in Bangalore, India, showed that only 15.4% of N = 259 medical students were inactive[35]. The lower level of physical inactivity among medical students could be explained by the trend in the students' awareness of the importance of a healthy lifestyle[36]. The lower PA level among Saudi medical students found in this study might relate to several factors, such as environmental barriers, cultural differences, and lifestyle habits. For example, the climate in Saudi Arabia was reported as a barrier factor to PA[6],[31,37]. Furthermore, incongruous urban designs, lack of footpaths, cycle ways, and safety issues force most students to use cars instead of walking to and from the the university[6, 31].

The current study found variation among groups in terms of their PA levels, as participants with a low BMI had higher levels of PA. The findings showed a significant statistical difference in total PA score among the groups, those in the overweight group having the highest score with a median of 1386 (49.5, 12456). Those in the normal weight and obese groups did not participate in a vigorous level of PA at all. It was determined that more than half of those in the underweight group (60%) and half (50%) of those in both the overweight and obese groups participated in a level of moderate PA. In addition, about two thirds of those in the normal weight group (70%) and just under half (42.5%) of the overweight and obese participants were inactive. This finding is in contrast to that in Shahadan et al.,[38] who found only 18.6% of the participants were inactive in a study that included N = 102 overweight and obese female Malaysian students[38]. Again, this variation could relate to environmental and cultural factors[6,31,27].

There was no significant statistical difference detected in this study among groups in relation to moderate PA, walking, and sitting time. A significant difference was only determined among groups in respect of vigorous PA. However, walking was detected as the most common form of PA, especially for those in the underweight and overweight groups, with a maximum MET-min/ week of 5544, and this finding is consistent with the literature[6,39,40]. This can be justified by students walking between colleges to meet their friends, as well as walking in shopping malls. However, students might be walking out of necessity and not due to a preference for walking as a form of PA[6].

The findings show a significant but weak negative correlation between fat % and PA for the whole sample regardless of their

BMI. This result is in line with the literature[41-44]. With regard to BMI classification, a moderate negative but not significant correlation was detected between PA, FM, and fat % in the underweight and normal weight groups only. This supports findings of a study in China that reported that the inverse association between PA and total body fat % was found only in a particular sub-population who had normal BMI but a high body fat content in a sample of middle-aged Chinese adults[42]. The findings of the current study also show a moderate positive but not significant correlation between PA and BMI, FFM, and TBW in the obese group. This finding is in contrast to the hypothesis that when PA increases, the BMI value decreases. It is also in contrast to the literature[41,43]. For example, in a large sample of the middle-aged British general population, PA was inversely associated with BMI and body fat %. More PA was associated with a lower BMI and a lower body fat %, although even men and women who engaged in high-level PA were, on average, overweight[43].

Although some studies suggested that PA had an impact on the participants' BMI[41,43], others reported that PA had an impact on body FM and fat %[42,45]. Bradbury et al.,[43] found that people who more active had a lower body fat % even they have the same BMI. This might be because BMI is not a consistent measure of body fatness[45].

As BMI does not consider the percentage of fat and non-fat body mass distribution in the total body weight, it does not always have explanatory power for assessing body weight. The current study only included female students and it is known that women have higher visceral fat % and genetically predisposed to higher body fat storage[7]. This may contribute to the limited accuracy of BMI as an index of body fatness[7,44,45] and general health status, since bodybuilders, for example, have a high BMI, close to overweight, even if they have the lowest percentage of fat[45].

Further, a moderate positive correlation between muscle mass and PA was detected only in members of the obese group in this study, 50% of whom were active at a moderate level. Therefore, it can be claimed that this increase in muscle mass might be a physical adaptation in response to moderate PA, as the body responds to a high volume of weekly PA by reducing fat %[45]. However, the current study only included female students and it is known that females are less physically active, on average, than males[30,31].

Possible limiting factors for this study are that only female students were included and assessing PA (weekly training hours and types of activity) was based solely on

a self-reported questionnaire. Participants were not given any specific instructions prior to using the bioimpedance device. As body fat values may be affected by some variables, including hydration status, exercise, and food consumption, controlling these factors might show slightly stronger associations between body fat % and PA[45,46]. Therefore, conducting a larger study that includes both male and female students using an objective outcome measure for assessing PA and considering standardized factors of using bioimpedance is recommended.

Conclusion

The study found a significant weak negative correlation between PA and fat % among female students regardless of their BMI. There was variation among the groups. For the underweight and normal weight groups in relation to PA, there was a moderate negative correlation between total MET and FM as well as fat %. Moderate positive correlations were found between total MET-min/week and BMI, FFM, and TBW in the obese group. Variation among groups in terms of their PA levels confirms that BMI is not an accurate predictor of a person's PA level. However, the findings of this study confirmed the need to find strategies to promote PA among female university students, regardless of their BMI.

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Conflicts of Interest

The author declares no conflict of interest.

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