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Research Article
A Multinomial Logistic Regression Analysis of the Association Between Physical Activity and Body Weight Status of University Women in Riyadh, Saudi Arabia

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Abstract

Background and Objective: Physical inactivity, excessive body weight and obesity are key communal endemic which have raised considerable public health concern in many countries, including Saudi Arabia. This study examines the association between physical activity (PA) level and body weight status among university women in Riyadh, Saudi Arabia. **Materials and Methods:** A total of 573 university women with the mean age of 21.98±7.51 years volunteered to participate in the study. Anthropometric variables were measured according to the protocol of the International Society for the Advancement of Kinanthropometry (ISAK). A short version of the International physical activity questionnaire (IPAQ) was used to evaluate PA levels among the women. Multinomial regression analysis were performed to examine the association between PA level and body weight status. One-way ANOVA used to analyze the data. **Results:** The women's weight categories indicated the following: Underweight (11.7%), normal weight (65.1%), overweight (18.7%) and obese (4.5%). Regression analysis showed that low (OR = 0.893, 95% CI = 0.642, 1.243), moderate (OR = 0.723, 95% CI = 0.477, 1.096) and vigorous (OR = 0.975, 95% CI = 0.711, 1.339) PA were related to less likelihood of being overweight. Furthermore, having low (OR = 0.750, 95% CI = 0.389, 1.444), moderate (OR = 0.913, 95% CI = 0.448, 1.862) and vigorous (OR =0.942, 95% CI = 0.521, 1.704) PA was associated with a less likelihood of being obese. **Conclusion:** The study established that the lower the PA level, the higher the participants' risk of body weight faltering. Similarly, the higher the women's PA level, the lower their tendency to accumulate excessive body fatness.

Key words: Physical activity, cardiometabolic diseases, health promotion, disease prevention, active lifestyle, sedentary, overweight, obesity

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Physical inactivity and excessive body weight and or obesity are key communal health endemic[1]. The incidence of excessive body fat and heaviness is rising day-by-day in both technologically advanced and emerging nations[2]. As obesity was world widely rated as the fifth leading cause of death[2] and physical inactivity was rated fourth[3]. Similarly, risks factors of numerous chronic non-communicable diseases (NCDs) of lifestyle have been understood to be the root cause of such mortalities. The risk factors often cited as being connected with NCDs are obesity, overweight, hypertension, increase in blood sugar and blood lipids[3].

Research evidence has shown that habitual physical activity (PA) lowers CVD risk[4-6] and the outcome has been assumed to be facilitated by healthy body weight[4]. Among Saudi Arabians, the risk of physical inactivity was estimated to be approximately 45%, which was higher than the value seen in some parts of American and European countries[7]. It is also well known that excessive body weight above recommended normal values is associated with numerous risk factors of chronic non-communicable diseases (NCDs)[3].

Low physical activity (LPA) level and increase in body mass index (BMI) have been implicated in the prognosis of cardiac diseases and all cause mortality[1]. Furthermore, it has been reported that 31% of the global population do not meet the least quantity of PA recommended by the World Health Organisation (WHO)[8-9]. In view of the health risks associated with physical inactivity and excessive body weight, it has been advocated that adults should engage in moderate-to-vigorous intensity PA for a minimum of two and half hours/week, equalling 30 min/day of activity for at least 5 days/week. Despite this recommendation, physical inactivity, obesity and overweight have reportedly been on the increase in many countries, including Saudi Arabia[10].

Studies have consistently reported inverse association between physical inactivity and BMI[11,12]. However, the association between PA and BMI has been said to be stronger among those, who possess excessive body weight, specifically obese individuals, than those, who are not obese[12]. It should be noted that such findings cannot be generalised due to racial and ethnic differences across populations. Despite that recent studies have reported the growing incidence of cardiometabolic diseases among Saudi women[13,14], the association between the BMI norms (underweight, normal weight, overweight and obesity) and PA category (low, moderate and vigorous), among Saudi girls and women have hardly been examined. Similarly, studies involving use of multinomial logistic regression analysis to elucidate the model's nominal outcome variables, in which the log odds of the outcomes are modelled as a linear combination of the predictor variables, are limited. Therefore, this study primarily examined the association between BMI and PA levels among a cohort of university women in Riyadh, Saudi Arabia. A secondary objective of the study was to analyze the relationship between the women's body weight classifications and PA levels using a multinomial logistic regression model.

MATERIALS AND METHODS

Research design and sample: Using a cross-sectional survey design, this study evaluated the PA levels and BMI characteristics of 573 apparently healthy women (mean age: 21.98±7.51 years) at Prince Sultan University (PSU) Campus for Women in Riyadh, Saudi Arabia, who volunteered to participate in the study. From the initial total sample of 616 participants, 43 had incomplete data and were excluded from the analysis. Therefore, the data of 573 women were subsequently analyzed. The study was carried out from March-April, 2016.

Ethical considerations: Before data collection, the purpose and procedures of the study were explained to the women, who were also informed that they could decline participating in the project without any repercussion. Data were subsequently collected from the participants, who gave informed consent. Guidelines of Helsinki declaration for the use of human participants in research was observed[15].

Anthropometric measurements: Height and weight were measured according to the protocol of the International Society for the Advancement of Kinanthropometry (ISAK)[16]. Height was measured to the nearest 0.1 cm in bare feet with participants standing upright against a stadiometer. A digital weighing scale [(Omron body composition monitor (Model no. BF508)] calibrated regularly to the nearest 0.1 kg was used to measure body weight with participants lightly dressed. Body mass index (BMI) was subsequently derived from height and weight measurements using the BMI formula [weight (kg)/height (m)^2]. The BMI was used to classify the participants in the following weight categories: Underweight (less than 18.5), normal (18.5-24.9), overweight (25-29.9) or obese (30 and above)[17].

Physical activity measurement: A short version of the International physical activity questionnaire (IPAQ), which is widely used to obtain internationally comparable data on health related PA[18,19], was applied to evaluate PA level among

the women[20]. The questionnaire contains items which require participants to indicate the kinds of physical activities that they do as part of their daily lives. Questions were asked generally about the time spent being physically active in the last 7 days, based on work related activities, domestic chores and yard work, activities related to commuting from one place to another and those undertaken in sport, exercise or during pastime. The participants were also asked to think about all the vigorous and moderate activities that they did in the last 7 days. Vigorous physical activities were those that require hard physical effort and make participants to breathe much harder than normal. Moderate activities refer to those that demand moderate physical effort and make them breathe somewhat harder than usual, while low physical activities were those involving walking and being sedentary at least 7 times a week for a minimum of 10 min. The participants were requested to answer the questions even if they did not consider themselves to be active. In the IPAQ only sessions which lasted 10 min or more were analyzed. All types of PA related to occupation, transportation, household chores and leisure time were also included. Based on the IPAQ scores, their PA levels were categorised as follows: Low = METs scores of less than 500, Moderate = METs scores of between 500-1499 and Vigorous = METs>1500.

Pilot test: The questionnaire was administered by a group of students as part of their project, who has been trained to collect the data. A pilot test was also conducted in which the administrative procedures for the data collection were refined. This was undertaken to ensure that the students could reliably and validly collect the data. The IPAQ has been validated internationally as a reliable tool to assess PA[20].

Data analysis: Descriptive statistics, such as mean, standard deviation and percentages were used to examine the women's body weight characteristics and PA levels. One-way analysis of variance (ANOVA) was used to test for any substantial differences in the participants' dependent measures according to PA categories. Multinomial regression analyses were performed to determine the association between the participants' BMI and PA. The Saudi women were also clustered into various PA categories (low, moderate and vigorous) and data used to determine adjusted odd ratios (ORs) as well as the 95% class interval using normal weight as a reference category. Data analysis was carried out using the IBM statistical package for the social sciences (SPSS) statistics for Windows, version 24.0 Armonk, NY: IBM Corp. All statistical tests were two-tailed and $p \leq 0.05$ was considered statistically significant.

Table 1: Physical characteristics of the participants (N = 573)

Variables	N	Mean	SD	Range
Age (year)	573	21.98	7.51	48.0
Weight (kg)	573	60.17	10.61	57.1
Height (cm)	573	162.72	6.51	44.0
BMI (kg m^{-2})	573	22.71	3.78	26.46
VPA (Mets)	573	586.51	1367.86	10560
MPA (Mets)	573	485.92	1129.80	13440
LPA (Mets)	573	707.92	1135.40	6930
Total PA (Mets)	573	1805.74	2480.92	20330.0

SD: Standard deviation, n: Number, VPA: Vigorous physical activity, MPA: Moderate physical activity, LPA: Low physical activity, BMI: Body mass index and METs: Metabolic equivalents

RESULTS

This study examined the association between PA and BMI and investigated the extent to which PA categories are associated with the BMI classifications of 573 Saudi University Women. Presented in Table 1 are the participants' physical characteristics. The women were aged 21.98±7.51 years. Their mean body weight and height measurements were 60.17±10.61 kg and 162.72±6.51 cm, respectively. The standard relating to male or female IOTF (International Obesity Task Force) designated benchmarks were used to classify the participants' BMI characteristics. Overall, the participants' BMI (22.71 kg/m^{-2}) was within the normal range based on IOTF's classification. The results of the participants' PA indicated the following mean values: Low (707.92±1135.40 METs), moderate (485.92±1129.80 METs), vigorous (586.51±1367.86 METs) and total PA (1805.74±2480.92 METs). Analysis of the participants' BMI data yielded the following weight categories: Underweight (11.7%), normal weight (65.1%), overweight (18.7%) and obese (4.5%).

When the participants' anthropometric variables based on PA categories, i.e. low, moderate and vigorous were analyzed using one-way ANOVA, the main effects of age $F(2, 570) = 0.980$, body weight $F(2, 570) = 0.950$ and BMI $F(2, 570) = 0.398$, were not significant (Table 2). However, the women's height [$F(2, 570) = 0.009$] yielded a significant difference. Furthermore, the participants did not significantly differ on reported PA categories based on age, body weight and BMI, but significantly varied based on stature.

Multinomial logistic regression of PA associated with BMI category: Results of the multinomial regression model are presented in Table 3. The model revealed that a low PA was associated with a greater likelihood of being underweight. By contrast, moderate and vigorous PA were associated with less likelihood of being underweight. Furthermore, the greater amounts of low, moderate and vigorous PA were associated with the less likelihood of being overweight. In the study

Table 2: Anthropometric variables according to PA categories

	PA Categories				
	Total PA (METs) (n = 573)	Low PA (METs) (n = 217)	Moderate PA (METs) (n = 148)	Vigorous PA (METs) (n = 208)	
Variables	Mean±SD	Mean±SD	Mean±SD	Mean±SD	p-value
Age (year)	21.98±7.51	22.05±7.13	21.99±7.67	21.90±7.81	0.980
Weight (kg)	60.17±10.6	59.99±10.61	60.32±10.34	60.24±10.84	0.950
Height (cm)	162.72±6.51	161.80±5.56	162.66±6.59	163.74±7.21	0.009*
BMI (Kg m^{-2})	22.71±3.78	22.93±4.05	22.77±3.51	22.44±3.67	0.398

*Significant difference at 0.05 level. Differences between PA categories compared using one-way ANOVA

Table 3: Association between PA and BMI category of the participant

PA categories	Low PA(Mets)		Moderate PA (Mets)		Vigorous PA (Mets)	
	Adjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
BMI Categories:						
Underweight	1.313 (0.920, 1.872)	0.133	0.762 (0.473, 1.228)	0.265	0.855 (0.575, 1.272)	0.440
Overweight	0.893(0.642, 1.243)	0.502	0.723(0.477, 1.096)	0.126	0.975(0.711, 1.339)	0.877
Obese	0.750(0.389, 1.444)	0.389	0.913 (0.448, 1.862)	0.802	0.942(0.521, 1.704)	0.844
Normal weight	1		1		1	

PA: Physical activity, BMI: Body mass index, Mets: Metabolic equivalents, p<0.05

sample, having a greater amount of low, moderate and vigorous PA was respectively associated with the less likelihood of being obese.

DISCUSSION

This study examined the association between the PA level and BMI among university women in Riyadh, Saudi Arabia. The study showed that majority of the participants had normal weight using IOTF's BMI classification. Having a BMI higher than normal could lead to severe health problems. Understanding the factors affecting body composition could also facilitate clinical monitoring of an individual's health status. Physical activity has been generally understood as a major remedy for effectively reducing excessive accumulation of fat and body weight. Habitual PA and or exercise is valuable and could improve general health and cardiorespiratory fitness, thereby negating the risk factors of cardiovascular diseases (CVDs)[21].

However, greater than or equivalent to 150 min of moderate intensity of PA has been recommended 3-5 times a week to maintain overall health and improve quality of life. Despite the health benefits of PA, numerous research reports have indicated its declining trend in many countries, including Saudi Arabia[3,10,13]. Although, not statistically significant, the present results on the classification of BMI according to PA categories showed a tendency in which the increase in BMI was associated with low levels of PA, thus implying that the lower the Saudi women's PA level, the higher their BMI and consequently, cardiometabolic disease risk. Martin *et al.*[11] stated that any individual with a low level of PA is at risk of gaining excessive body weight. Therefore, achieving moderate-to-vigorous PA could be the key factor to preventing cardiovascular disease risk factors among this cohort of women.

Body mass index has been widely used to assess adiposity, although it might be a poor indicator to assess fatness in certain people such as racial and or ethnic subgroups, school aged athletes, non-athletes and body builders[21]. Martin *et al.*[11], assessed the association between exercise and BMI in 318 adults aged 17-62 years in Madrid, Spain and reported that additional PA and or exercise periods/week poorly correlates with BMI. The discrepancy between Martin *et al.*[11]study and the present investigation could be attributed to the wide age differences in the studies. Furthermore, Zanovec *et al.*[21], examined the association of self-reported PA with body composition in 290 college students aged 18-25 years and reported that participants with the highest self-reported level of PA had an increased appropriate body composition profile as assessed by DXA, free from sex and race, which was not revealed by the BMI data. Rosehill and Gotshalk[22] also found no relationship between PA and BMI categories of normal weight and overweight participants. As body fatness assessed by BMI is clinically widely accepted, it is also important to consider possible variations in gender, race and ethnicity during the measurement.

The findings of the multinomial regression model revealed that for a one unit increase in low PA value, the relative risk of being underweight compared to normal weight

is increased. Conversely, a unit increase in moderate PA score, lowers the relative risk of being underweight compared to normal weight. Similarly, for a unit increase in vigorous PA, the relative risk of being underweight compared to normal weight is decreased. Therefore, the lower the women's PA level, the higher the propensity of becoming overweight. Similarly, the higher the PA level, the lower the risk of obesity. Specifically, participants, who were underweight, overweight and obese would prefer low-to-moderate and vigorous PA so as to keep themselves within the recommended weight range. PA is well recognised as a tool for preventing obesity and promoting health[9]. This prompted, who to globally recommend PA for health promotion in which adults are advised to participate in moderate-intensity PA 5 days/week[23]. Therefore, participation in moderate-to-vigorous PA irrespective of an individual's body weight classification is beneficial to health.

Strengths and limitations of the study: Although previous research[7] has been conducted on PA and cardiometabolic disease risk among Saudi women, the association between PA level and BMI categories among the women, using multinomial logistic regression model has hardly been studied. The results further lend credence to the importance of body weight management and PA in health promotion. However, the present findings should be interpreted in the light of a number of constraints. First, as this study was carried out among a cohort of university women in Riyadh, the findings cannot be generalised across the country in view of its socioeconomic diversity. Second, although the IPAQ has been validated internationally, it still remains a self-report instrument which may be influenced by participants' subjective responses. Regardless of these limitations, the present study provides data that could be useful to address the growing tendency of obesity in this region.

CONCLUSION

The findings of this study indicated an association between BMI categories and PA among university women in Saudi Arabia. The study also established that the lower the PA level, the higher the participants' risk of body weight faltering. Similarly, the higher the women's PA level, the lower their tendency to accumulate excessive body fatness. Further studies involving larger sample are needed to elucidate the findings.

SIGNIFICANCE STATEMENTS

The results lend credence to the importance of body weight management and PA in health promotion. The results will be helpful in adopting a physically active lifestyle in the prevention and management of overweight and obesity.

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