ASSESSMENT OF GENDER DIFFERENCES IN BODY COMPOSITION AND PHYSICAL FITNESS SCORING IN SAUDI ADULTS BY BIOELECTRICAL IMPEDANCE ANALYSIS

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SUMMARY – Obesity is a global problem that is reaching epidemic proportions. Body composition is an important parameter for humans because previous studies indicate high values of body fat as a predictor of mortality. The aim of the study was to assess gender differences in body composition and physical fitness in Saudi adult population. This epidemiological cross-sectional study included 411 healthy adult Saudi subjects aged 18-72 years (mean ± SD, 36.91±15.22). All participants underwent body composition analysis. Body composition was assessed by bioelectrical impedance analysis, with a commercially available body analyzer (InBody 3.0, Biospace, Seoul, Korea). Measurements included body weight, body mass index (BMI), percent body fat, target weight, fat control, muscle control and fitness scoring based on target values. The mean BMI of the whole study population was 27.22±5.65 (median=26.80, range=15.6-55.4). The mean fitness score was 69.3±8.48 (median=71.0, range=29-99). Significant gender differences were observed in BMI, fitness score, percent body fat, and other parameters of body composition. In conclusion, the prevalence of obesity, percent body fat (%BF) and poor fitness is high in Saudi population with significant gender differences. In this regard, public awareness programs including exercise and diet teaching are required at large scale to cope up with the growing burden of obesity.

Key words: *Body composition; Body mass index; Fitness score; Lean body mass; Obesity; Percent body fat*

Introduction

Obesity, understood as a condition of excessive fat accumulation, is a global problem now reaching epidemic proportions. It is a major, yet largely preventable risk factor for a number of chronic diseases including coronary artery disease and type 2 diabetes mellitus. Body mass index (BMI), because of its simplicity and hence general applicability, is a widely used surrogate measure of obesity[1]. However, there are limitations of BMI as indicator of cardiovascular risk complications. Body weight is not a suitable measure for assessing ideal body composition related fitness because an increase in weight due to an increase in fat-free mass (FFM) can be misinterpreted as an increase in body fatness. BMI measure cannot be valid for all people; hence, we should be cautious when this index is applied to the extremes of physical types such as elite athletes, the physical frail, pregnant women, and children[2,3]. There are reports that say that ethnic-specific muscularity, fat distribution, bone mass and leg length are characteristics that may contribute to ethnic differences in the relationships between BMI and body fat[4]. Also, BMI and percentage of body fat (%BF) are generally well correlated, while there is increasing evidence of wide ethnic variations in the relationship between these two frequently tested vari-

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ables[5]. Therefore, it is appropriate to study it in different ethnic groups. For example, in a study by Rush *et al.* in both men and women, the percentage of total fat as abdominal fat was significantly higher in Maori, Pacific and Asian Indians than Europeans[6]. There are scanty data on gender differences in body composition analysis and physical fitness and no such report in Saudi population. Therefore, we aimed to see gender differences in body composition and physical fitness in Saudi adult population.

Subjects and Methods

This cross-sectional study included 411 healthy adult Saudi subjects (300 males and 111 females) aged 18-72 years (mean±SD, 36.91±15.22). The study was approved by the ethics review board of the College of Medicine, King Saud University. All participants underwent body composition analysis. Body composition was assessed by bioelectrical impedance analysis (BIA), with a commercially available body composition analyzer (InBody3.0, Biospace, Seoul, Korea). The parameters recorded included height, body weight, body surface area, body mass index (BMI), obesity degree, protein mass, muscle mass, fat mass, percent body fat, fat control, muscle control and fitness scoring based on target values for ideal body fitness. Body fitness depends on specific criteria for body composition based on age and sex. Biospace InBody has specific standardized criteria for fitness scoring, which is automatically calculated by the machine. Considering age, gender, fat mass, muscle mass, body fat percentage, BMI and obesity degree, the machine is programmed to calculate physical fitness scores by prediction equations for ideal body composition. The more the values are near to ideal values, the higher is the fitness score[7,8]. Obesity degree was taken as excessive tendency of obesity in percentage above standard value of 100%.

The body composition analyzer works on the principle of bioelectrical impedance[9,10]. Different tissues of the body have varying degrees of electrical resistance. The machine calculates the amount of each tissue with the difference in electrical impedance. The InBody 320 Body Composition Analyzer (BioSpace, Seoul, Korea) is a segmental impedance device measuring the voltage drop in the upper and lower body. The participant stands on the device while it measures body weight, and age, height and sex are entered on the touch screen. The InBody uses eight points of tactile electrodes (contact at the hands and feet). This detects the amount of segmental body water. The technique uses multiple frequencies to measure intracellular and extracellular water separately. The frequency of 50 kHz measures extracellular water, while the frequencies above 200 kHz measure intracellular water. Segmental analysis can calculate slight differences by sex, age and race without using empirical estimation.

The subject is asked to first wipe the sole of the feet by a wet tissue. Then he stands over the electrodes of the machine. Demographic data are entered into the machine and then the subject holds the palm electrodes in hands and machine is started. Within 3-5 minutes, results are given by the machine.

The standard BMI values were used to define obesity. On the basis of BMI, subjects were categorized into 6 groups (kg/m^2): underweight (BMI <18.5), normal (BMI 18.5-24.9), overweight (BMI 25.0-29.9), obesity class I (BMI 30.0-34.9), obesity class II (BMI 35.0-39.9) and extreme obesity class III (BMI 40.0+).

Statistical analysis

Data were analyzed by the Statistical Package for Social Sciences (SPSS Version 10) software. Descriptive characteristics of the study subjects were calculated as mean ± standard deviation (SD) for continuous variables and as percentages for categorical variables. The tests applied for statistical analysis were Student's t-test and regression analysis. A p value ≤0.05 was taken as statistically significant.

Results

Table 1 shows gender differences in demographic data, body composition parameters and physical fitness scores. The mean BMI of the whole study population was 27.22±5.65 (median=26.80, range=15.6-55.4). Significant gender differences were observed in BMI, fitness score, percent body fat and other parameters of body composition. Males had a significantly higher prevalence of overweight class compared to females (p=0.004). The difference in the prevalence of obesity in class I category was nonsignificant. However, females had a higher prevalence in obesity class II

Table 1. Gender differences in demographic data, body composition parameters and physical fitness scores

	Males	Females	p value
Age (yrs)	39.14±16.07	30.63±9.91	0.0001
Height (cm)	170.82±7.32	159.35±5.56	0.0001
Body surface area (m^2)	2.91±0.30	2.54±0.18	0.0001
Weight (kg)	80.29±16.80	66.22±15.05	0.0001
Obesity degree (%)	127.91±25.48	126.75±30.59	0.7047
Body mass index (kg/m^2)	27.58±5.44	26.15±6.15	0.0249
Protein mass (kg)	11.54±1.72	8.38±1.33	0.0001
Muscle mass (kg)	53.77±9.11	40.91±5.74	0.0001
Body fat mass (kg)	25.29±33.32	23.89±11.23	0.6765
Body fat %	27.28±8.07	34.61±9.01	0.0001
Fitness score	70.94±7.03	68.13±8.51	0.0010

Data are expressed as mean ± SD; differences were studied by Student's t-test
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(p=0.014) and III (p=0.0001) compared to males (Fig. 1). The prevalence of very poor physical fitness of <50 was significantly higher in females compared to males (p=0.0001), whereas males had a significantly higher prevalence of physical fitness between 70 and 89.9 (p=0.001) (Fig. 2).

Discussion

We observed a very high prevalence of obesity and poor fitness scoring in Saudi adult population. Moreover, significant gender differences were observed in BMI, fitness score, %BF and other parameters of body composition. Body anthropometric data are frequently collected in clinics, sports medicine, nutrition and other health-related fields, but the routine parameters of body fitness like BMI and waist-to-hip ratio do not give a true picture of physical fitness. Using the parameters of body fat analysis, lean body mass and muscle fat ratio would encourage people to initiate an active lifestyle early in their lives, thus preventing the occurrence of non-communicable diseases. The significant increase in overweight among male compared to female subjects, recorded in the present study, was in accordance with the previous studies performed by Al Nuaim *et al.* in 1996 and 1997 in Saudi Arabia, which found the prevalence of overweight among

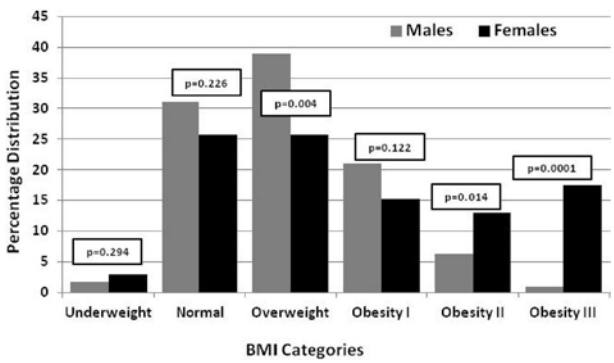

Fig. 1. Gender differences in the prevalence of WHO recommended body mass index (BMI) category distribution in Saudi adults.

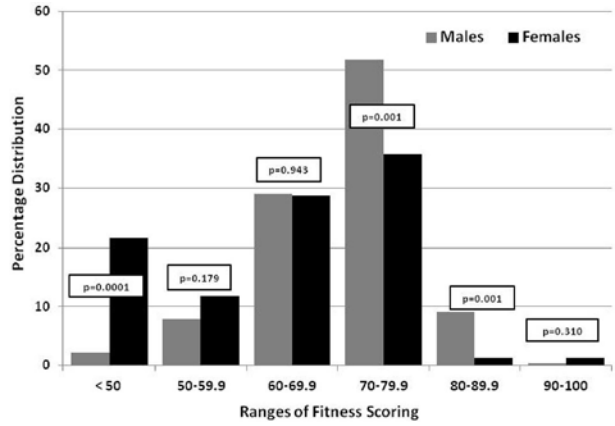

Fig. 2. Gender differences in different ranges of physical fitness score distribution in Saudi adults.

male to be significantly higher than in female subjects (29% *vs*. 27%)[11,12]. Also, our findings were similar to those reported by Al Othaimeen *et al*. in 2007[13], who found that the prevalence of overweight was by 30.7% higher in males compared with females (28.4%). In addition, our findings were similar to a previous study in the Netherlands[14], where the prevalence of overweight in the Dutch adult population was 34% in men and 24% in women. Overweight subjects of either sex showed abdominal obesity predisposing them to some diseases, e.g., diabetes, hypertension, cardiovascular disease and many other diseases.

On the other hand, obesity showed different distribution among the study population; for example, class I obesity was significantly higher in males than females (20.55% *vs*. 15.66%), while class II obesity was more common in females (13.25%) compared with males (6.16%), and class III or extreme obesity was significantly higher in females (15.06%) compared with males (1.7%). These findings were proved in a previous study by Al Nuaim *et al*.[12], who found that the prevalence of obesity was significantly higher among female subjects than in male subjects (24% *vs*. 16%) throughout the Saudi Arabia regions and was more prevalent among illiterate and high-income subjects who were residing in urban communities, and lower in subjects living in rural areas with traditional lifestyles than in those in more urbanized environments. Also, these findings were related to increasing age, which is consistent with Al Nuaim *et al*.[11] and Al Othaimeen *et al*.[13], who found the prevalence of obesity to be higher in women (23.6%) than in men (14.2%) and concluded that age, gender, income, educational level and residential area all affected obesity and could therefore be used as predictors of obesity. Our findings were similar to a previous study conducted by Zhang *et al*. in China, who stated that the prevalence of obesity was higher in women than in men, negatively related to social class, and increased with age[15]. Furthermore, Ismail *et al*. found the prevalence of obesity to be clearly greater in women than in men, obesity rates were higher in Indian and Malay women than in Chinese women, while in men the highest prevalence of obesity was recorded in the Chinese, followed by the Malay and Indians and was more related to dietary intake and physical activities[16]. Studies from different ethnicities like Malaysia, European and Indians reveal that obesity is related to age, gender and social class, but not to ethnicity. In addition, our findings were similar to those described by Hajian-Tilaki and Heidari from Iran, who report that the rate of obesity in women was significantly higher than in men. The increased rate of obesity in women could be related to parity, low level of activity and education, and family history of obesity[17]. In a published report from India, investigators related regional body composition to anthropometric indices and reproductive events in low income population. Their women had a high fat and poor muscle phenotype[18]. In our study, females had significantly lower physical fitness compared to males, however, Saudi community has no income problems, therefore poor muscle phenotype was not observed in our female population. Some studies show a higher prevalence of overweight and obesity in males compared to females. In a Spanish study, there were gender differences in lifestyle factors associated with overweight and obesity, which necessitated identification of areas for gender specific behavioral interventions in such cases[19]. Although reference methods such as dual-energy x-ray absorptiometry (DEXA) can provide accurate results, this method is costly and often inaccessible to the general public[20], and is not practicable for use with a large sample size. Moreover, in most situations, BIA and other field methods (e.g., waist circumference) are the only techniques available for body composition measurements. BMI is widely used as a measure of overweight and obesity, but it underestimates the prevalence of both conditions, defined as an excess of body fat[21]. Given the elevated concentrations of cardiometabolic risk factors reported herein in non-obese individuals according to BMI but obese based on body fat, the inclusion of body composition measurements together with morbidity evaluation in the routine medical practice both for the diagnosis and decision-making for introduction of the most appropriate treatment of obesity is desirable[22]. Comparison of changes in BMI and %BF in men and women after 5.5-year follow up has been reported by Wang *et al*. There were significant gender differences for BMI and %BF in their cases[23]. The validity and reliability of the BioSpace InBody 320, Omron and Bod-eComm body composition devices were compared between men and women and between boys and girls. Correlation analysis showed that the Bod-

eComm and Omron had significant mean differences compared with the reference criterion, therefore, the body composition analysis by these two devices should be interpreted with caution[24]. Large-scale studies to explore the true factors and causes of higher obesity and poor physical fitness in Saudi women are required. Collectively, we can relate the increased obesity in female compared with male in Riyadh to parity, lifestyle (sedentary life, reduced exercise, junk food and eating in restaurants), low level of education and genetic factors in some families.

Conclusions

The prevalence of obesity, percent body fat and poor physical fitness is very high in Saudi population with significant gender differences. In this regard, public awareness programs including exercise and diet teaching are required at large scale to cope up with the growing burden of obesity.

Recommendations

Using data from this study, weight reduction can be achieved through structured and community tailored training programs that would optimize body composition and physical fitness levels.

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Sažetak

PROCJENA SPOLNIH RAZLIKA U TJELESNOM SASTAVU I KONDICIJSKOM BODOVANJU U ODRASLOJ POPULACIJI SAUDIJSKE ARABIJE POMOĆU ANALIZE BIOELEKTRIČNE IMPEDANCIJE

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Pretilost je globalni problem koji poprima epidemijske razmjere. Tjelesni sastav je važan parametar kod ljudi, jer prijašnja ispitivanja pokazuju da su visoke vrijednosti tjelesne masti predkazatelji smrtnosti. Cilj ove studije bio je procijeniti spolne razlike u tjelesnom sastavu i kondiciji u odrasloj saudijskoj populaciji. Ova epidemiološka poprečna studija obuhvatila je 411 odraslih osoba u dobi od 18 do 72 godine (srednja dob ± SD, 36,91±15,22). Procjena tjelesnog sastava provedena je u svih ispitanika analizom bioelektrične impedancije pomoću tjelesnog analizatora dostupnog na tržištu (InBody 3.0, Biospace, Seoul, Koreja). Mjerila se tjelesna težina, indeks tjelesne mase, postotak tjelesne masti, ciljna težina, regulacija masti, regulacija mišića i bodovanje kondicije na osnovi ciljnih vrijednosti. Srednja vrijednost indeksa tjelesne mase za cijelu populaciju ispitanika bila je 27,22±5,65 (medijan=26,80, raspon=15,6-55,4), a srednja vrijednost kondicijskih bodova 69,3±8,48 (medijan=71,0, raspon=29-99). Značajne razlike prema spolu zabilježene su za indeks tjelesne mase, kondicijske bodove, postotak tjelesne masti i ostale parametre tjelesnog sastava. Ovi rezultati upućuju na visoku učestalost pretilosti, visokog postotka tjelesne masti i loše kondicije u saudijskoj populaciji, uza značajne razlike prema spolu. Zato su potrebni sveobuhvatni programi osvješćivanja populacije u tom smislu, uključujući izobrazbu u tjelovježbi i primjerenoj prehrani kako bismo se mogli nositi s rastućim teretom pretilosti.

Ključne riječi: *Tjelesni sastav; Indeks tjelesne mase; Bodovanje kondicije; Nemasna tjelesna masa; Pretilost; Postotak tjelesne masti*