

Trends in overweight or obesity and other anthropometric indices in adults aged 18-60 years in western Saudi Arabia

Firas Sultan Azzeh,^a Hassan Mazzhar Bukhari,^a Eslam Ahmed Header,^{a,b} Mai Adil Ghabashi,^a Salma Saad Al-Mashi,^a Nafeesah Mohammed Noorwali^a

From the ^aDepartment of Clinical Nutrition, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, Saudi Arabia; ^bDepartment of Nutrition and Food Science, Faculty of Home Economics, Menufya University, Egypt

Correspondence: Prof. Firas Sultan Azzeh · Department of Clinical Nutrition, Umm Al-Qura University, Makkah 21955, Saudi Arabia T: +966-540833661 F: +966-25720000-4227 · fsazzeh@uqu.edu.sa · ORCID: <http://orcid.org/0000-0002-1400-5465>

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BACKGROUND: The prevalence of overweight and obesity has increased considerably in Saudi Arabia in the past two decades. We conducted this study because to examine trends in weight gain with age and related anthropometric measurements in Saudi Arabia such data are limited.

OBJECTIVE: To determine trends in overweight and obesity and examine anthropometric indices by age group.

DESIGN: Analytical cross-sectional study.

SETTING: Universities, malls, and hospitals in the cities of Mecca, Jeddah, and Al-Taif.

METHODS: Participants were selected by convenience sampling. Body weight, body fat percentage, visceral fat percentage, and skeletal muscle percentage were measured with the Omron body composition monitor device. Waist circumference, height, and body mass index (BMI) were also measured.

MAIN OUTCOME MEASURE(S): Changes in BMI, body fat percentage, visceral fat percentage, and skeletal muscle with age for both genders.

RESULTS: We selected 2548 Saudis, 1423 males and 1125 females, aged 18 to 60 years. A significant trend ($p_{\text{trend}} < .001$) for BMI and all anthropometric indices was observed with age for both genders. About 55.1% of the participants were overweight and obese (BMI > 25 kg/m²). Obesity and overweight were more prevalent in men than in women and was observed early in both genders, at the ages of 18–19 in men and 30–39 years for women. In the age range of 40–60 years, muscle mass dropped significantly ($P < .05$) for both genders. Mean waist circumference and visceral fat were significantly ($P < .001$) higher in men than in women, but the mean total body fat percentage was higher in females than in males ($P < .001$).

CONCLUSIONS: Significant trends were observed for BMI, WC, body fat, visceral fat, and muscle mass for both genders with age. National programs should be maintained to encourage physical activity and weight reduction as well as focusing on obesity-related lifestyle and behaviors at early ages to prevent weight gain and possibly muscle wasting with age.

LIMITATIONS: There was an unequal distribution in numbers of subjects between study groups. Convenience sampling was used to recruit the participants.

The term “globesity” signifies that the epidemic of obesity has become worldwide.¹ The prevalence of obesity was steady until the 1980s, but has since increased dramatically throughout the world.² According to the World Health Organization (WHO) in 2014, rough estimates of the number of obese adults worldwide were 600 million.³ Obesity is a serious prob-

lem because of the increasing possibility of a wide range of health consequences, including hypertension, insulin insensitivity, diabetes mellitus, cardiovascular disease, and distinct types of cancers.⁴ The burden of medical costs for obese individuals are 30% greater than for normal-weight peers.⁵ Each 5 kg/m² increase in body mass index (BMI) results in about a 30% higher

mortality rate.⁶ The risk of death increases by 20%–40% in overweight individuals, and it escalates to 200%–400% in obese individuals.⁷ Roughly, 3.4 million adults die annually due to overweight or obesity.⁸

Obesity in Saudi Arabia is a major public health concern; the country has one of the most rapidly increasing rates of obesity in the world.⁹ Western lifestyle behaviors and the consequent elevation in BMI in developing countries, including Saudi Arabia, can lead to an alarming epidemiological transition from communicable to noncommunicable diseases being the main causes of death.¹⁰ Studies in Saudi Arabia from the late 1980s through the mid-1990s reported a continual growth in the prevalence of obesity of about 20%.^{11–14} These studies showed that the prevalence of obesity in different regions of Saudi Arabia was estimated between 13% and 27%. In 2014, about 28.7%, or 3.6 million Saudis, were obese, ranging from 24.1% for men to 33.5% for women in different cities.⁹ Furthermore, a high frequency of overweight and obesity has been observed in younger Saudis,^{15,16} which may further increase the prevalence of obesity in the adult population over succeeding years. A recent study of 2382 young Saudis, aged 15 to 24 years old, showed that about 38.2% and 44% of men and women, respectively, are either overweight or obese.¹⁷ This proportion is expected to rise substantially by 2020, reaching 41% and 78% for men and women, respectively.¹⁸

To our knowledge, most studies are focused on the trend of overweight and obesity with over periods of time. However, no detailed studies describe trends in obesity and adiposity parameters by different age groups in Saudi Arabia. Therefore, this study aimed to describe trends in the prevalence of overweight and obesity by age groups and gender in the western region of Saudi Arabia and to determine the effect of this trend on some anthropometric measurements.

SUBJECTS AND METHODS

This cross-sectional observational study was conducted between March 2011 and February 2012 in major cities in western Saudi Arabia (Mecca, Al-Taif, and Jeddah). Saudis aged 18 to 60 years were selected by convenience sampling. Printed announcements were placed in universities, malls, and hospitals to inform individuals about this community-based study. Pregnant women and persons with disabilities were excluded. This study was accepted by the Ethics Committee of the University of Umm Al-Qura, and informed consent forms were signed by all participants before collecting the data.

All anthropometric measurements were taken during face-to-face interviews by well-trained profes-

sional interviewers. Measurements included height, weight, waist circumference (WC), and body composition while participants wore light clothing and were barefoot. Height was measured in centimeters using a Harpenden stadiometer (Holtain, Crymych, Wales, UK). WC was measured in centimeters at the midpoint between the last costal margin and the iliac crest, using a measuring tape. Weight and body composition analyses were obtained by using an Omron HBF-510 Body Composition Monitor device with scale (Kyoto, Japan). The apparatus, with footpad and handlebar electrodes, estimates various body composition variables such as body weight, body fat percentage, visceral fat percentage, and skeletal muscle percentage. Body mass index (BMI) was calculated as kg/m^2 , and then the following BMI groups were obtained: underweight ($<18.5 \text{ kg/m}^2$), normal weight (18.5 to $<25 \text{ kg/m}^2$), overweight (25.0 to $<30 \text{ kg/m}^2$), obese class-I (30.0 to $<35 \text{ kg/m}^2$), obese class-II (35.0 to $<40 \text{ kg/m}^2$), and obese class-III ($\geq 40 \text{ kg/m}^2$).¹⁹ The normal cutoff values for the anthropometric indices were for WC: men ≤ 89 cm and women ≤ 79 cm;²⁰ body fat percentage: men ≤ 24 and women ≤ 36 ;²¹ muscle percentage: men ≥ 33 and women ≥ 24 ;²² and visceral fat percentage <9 for both sexes.²³

Statistical analysis was done using IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp. A P value $<.05$ was considered statistically significant. Since the obtained data were not normally distributed, Mann-Whitney U and Kruskal-Wallis tests were used to determine the significance between two groups and more than two groups, respectively. Data were stratified into four groups based on age: late-adolescents (18–19 years), young adults (20–29 years), adults (30–39 years), and middle-aged adults (40–60 years). Trends in BMI and anthropometric variables by age were also analyzed. The P value for trend (p_{trend}) was obtained by the Jonckheere-Terpstra test. The odds ratio (OR) and 95% confidence interval (CI) were measured by multinomial logistic regression. Correlation between BMI and age was determined by the beta coefficient value in a linear regression for both genders.

RESULTS

Our sample consisted of 2548 Saudis, 1423 males and 1125 females, aged 18 to 60 years. Males were about 55.8% of the total participants. Age bracket frequencies were unequal: 12% ($n=306$) aged 18–19 years, 60.3% ($n=1536$) aged 20–29 years, 16.4% ($n=417$) aged 30–39 years, and 11.3% ($n=289$) aged 40–60 years. Overall, 29.2% ($n=743$, BMI ≤ 30) were overweight and 25.9% were obese ($n=660$, BMI ≥ 30). Almost 40% had a normal weight (39.4%, $n=1004$). The prevalence in obesity

Table 1. Baseline characteristics of study sample stratified by gender (n=2548).

Parameter	Total (n=2548)	Male (n=1423)	Female (n=1125)	P value
Age (year)	29.1 (8.5)	29.7 (8)	28.3 (9.1)	<.001
Height (cm)	164.8 (8.8)	170.2 (6.2)	157.9 (6.4)	<.001
Weight (kg)	72.4 (19.2)	79.4 (18.1)	63.5 (16.7)	<.001
BMI (kg/m ²)	26.8 (6.9)	27.6 (6.8)	25.7 (3.9)	<.001
WC (cm)	85.2 (14.3)	88.9 (14.1)	80.5 (13)	<.001
Body fat%	32.3 (11.2)	28 (9.6)	37.8 (10.8)	<.001
Muscle%	30.4 (7.6)	34.8 (6.1)	24.8 (5.3)	<.001
Visceral fat%	8.2 (5.3)	10.2 (5.4)	5.7 (3.9)	<.001

Results are expressed as mean (SD). P value was determined by Mann-Whitney U test (Although the median is appropriate to report with the Mann-Whitney U test, the means are more comparable to other studies.)

Table 2. Association and distribution of BMI categories by gender.

Parameter	Male n (%)	Female n (%)	OR (95% CI)
BMI (kg/m ²)			
Underweight (males vs. females)	41 (2.9%)	100 (8.9%)	0.43 (0.3-0.64) ^a
Normal weight	488 (34.3%)	516 (45.9%)	1
Overweight (males vs. females)	477 (33.5%)	266 (23.6%)	1.9 (1.56-2.3) ^a
Obese class-I (males vs. females)	259 (18.2%)	156 (13.9%)	1.76 (1.39-2.22) ^a
Obese class-II (males vs. females)	109 (7.7%)	56 (5%)	2.06 (1.46-2.91) ^a
Obese class-III (males vs. females)	49 (3.4%)	31 (2.8%)	1.67 (1.05-2.67) ^b
Obese (males vs. females)	417 (29.3%)	243 (21.7%)	1.82 (1.48-2.22) ^a

Percentages were determined within each gender. Binomial logistic regression. Pseudo R-square: Cox and Snell: .030; Nagelkerke: .031

OR: Odds ratio; 95% CI: 95% confidence interval. The reference category is the normal weight group.

^aSignificant at P<.001, ^bSignificant at P<.05, Significant at P<.01. Underweight: BMI <18, normal weight: BMI 18–24.9, overweight: BMI 25–29.9 kg/m², obese class-I: BMI 30–34.9 kg/m², obese class-II: BMI 35–39.9 kg/m², obese class-III: BMI >40 kg/m², obese: BMI >30 kg/m².

subgroups was 16.3% (n=415) for obese class-I, 6.5% (n=165) for obese class-II, and 3.1% (n=80) for obese class-III.

The mean (SD) age for the whole sample was 29.1 (8.5) years; 29.7 (8.0) years for males and 28.3 (9.1)

years for females. Mean values for BMI were overweight for males and females (27.6 [6.8] vs. 25.7 [3.9] kg/m²). The mean WC, muscle mass, and visceral fat were significantly higher (P<.001) in men than in women, but women's mean total body fat percentage (37.8 [10.8]) showed higher values (P<.001) than men's (28 [9.6]) (Table 1).

Table 2 shows the prevalence of BMI categories and the corresponding ORs by gender. The prevalence of overweight and obesity in males was higher than in females (62.8% vs. 45.3%). Males were about 1.9 times more likely to be overweight compared to females (OR=1.9, 95% CI=1.56–2.3). The study results presented that prevalence of obesity in males was higher compared to females (29.3% vs. 21.7%), and males had a 1.8-fold higher risk of being obese than females (OR=1.82, 95% CI=1.48–2.22). Approximately 18% of males had 1.76 times higher odds of being obese class-I than did females (95% CI=1.39–2.22). Furthermore, males were at higher risk to be class-II obese and class-III obese, approximately two times (95% CI=1.46–2.91) and 1.67 times (95% CI=1.05–2.67), respectively, more than females. However, females had noticeably higher prevalence of underweight (8.9% vs. 2.9%) and normal weight (45.9% vs. 34.3%) than males.

Table 3 presents the trends of BMI, muscle mass, and adiposity parameters by age. For both genders, BMI, WC, body fat percentage, and visceral fat percentage all increased significantly (p_{trend}<.001) with age, and a significantly diminishing trend in muscle mass (p_{trend}<.001) was detected. Average BMI results showed that males at all ages exhibited overweight values. Normal weight was revealed in females younger than 30 years, whereas average BMI for females 30–39 years and 40–60 years showed overweight and obese values, respectively. In addition, body fat and visceral fat percentages increased remarkably at ages 20–29 in males and females. Visceral fat percentage increased significantly (P<.05) with age, and WC and body fat percentage increased significantly (P<.05) until the age of 40; then an insignificant (P>.05) increase appeared at the middle-aged period. Regarding WC, higher than normal values for males (>90 cm) and females (>80 cm) were detected in the 30–39 age group for both genders. Men showed higher than the normal values of mean body fat percentage (>24) and visceral fat percentage (>9) at the young adult age, whereas females showed higher than normal values for body fat percentage (>36) at the young adult age and for visceral fat percentage (>9) at the middle-aged period. Muscle mass decreased significantly (P<.05) after 40 years in males and females, and at that age, both genders ex-

Table 3. Trends of average weight, BMI, WC, body fat percentage, muscle percentage, and visceral fat of both genders with age brackets.

Parameter	18–19 years (n=128, males) (n=178, females)	20–29 years (n=885, males) (n=651, females)	30–39 years (n=246, males) (n=171, females)	> 40 years (n=164, males) (n=125, females)	P value	P _{trend}
Weight (kg)						
Males	72.8 (18)	78.6 (18.1)	82.5 (17.8)	84.6 (16.3)	<.001	<.001
Females	56.8 (13.8)	60.7 (15.2)	71.8 (15.2)	76.1 (19.5)	<.001	<.001
BMI (kg/m ²)						
Males	25.1 (5.7)	27.4 (6.7)	28.4* (5.5)	29.8* (8.6)	<.001	<.001
Females	23.2 (6.6)	24.7 (6.7)	29* (6.1)	30.1* (5.9)	<.001	<.001
WC (cm)						
Males	83.5 (11.6)	88 (14.2)	91.3* (13.4)	94.4* (14.3)	<.001	<.001
Females	76.9 (11.6)	79 (12.4)	85.1* (12.6)	87.5* (14.8)	<.001	<.001
Body fat %						
Males	22.8 (10.5)	27.7 (9.9)	29.6* (7.9)	31.4* (6.8)	<.001	<.001
Females	33.7 (11.9)	36.3 (10.4)	42.9* (8.7)	44.3* (7.7)	<.001	<.001
Muscle %						
Males	38.3* (6.1)	35.2* (6)	33.2* (4.8)	32 (6.1)	<.001	<.001
Females	24.7* (5)	25.2* (5.2)	24.7* (6.7)	22.9 (3.8)	<.001	<.001
Visceral fat %						
Males	7.1 (5)	9.7 (5.3)	11.2 (4.8)	13.8 (5.2)	<.001	<.001
Females	3.9 (1.9)	5.1 (3.7)	7.8 (4.3)	9.1 (3.2)	<.001	<.001

Results are expressed as mean (SD). P value was determined by Kruskal-Wallis. P_{trend} was determined by Jonckheere-Terpstra test. Mean JT Statistic, males: 284477.0 (weight), 280497.0 (BMI calculated), 284477.0 (WC), 284477.0 (body fat%), 284477.0 (muscle%), 281680.5 (visceral fat); females: 191318.5 (weight), 187688.0 (BMI calculated), 191318.5 (WC), 191318.5 (body fat%), 191318.5 (muscle%), 188668.5 (visceral fat).

Table 4. Odds ratios and 95% confidence intervals of overweight and different obesity categories with age brackets in males and females.

Parameter	18–19 years	20–29 years OR (95% CI)	30–39 years OR (95% CI)	> 40 years OR (95% CI)
Overweight				
Males	1	1.95 (1.23-3.09) ^a	3.05 (1.79-5.21) ^b	5.03 (2.71-9.34) ^b
Females	1	1.21 (0.77-2)	3.06 (1.74-5.38) ^b	6 (3.09-11.64) ^b
Obese class-I				
Males	1	2.46 (1.29-4.68) ^a	4.43 (2.18-9.03) ^b	9.23 (4.3-20) ^b
Females	1	0.98 (0.55-1.75)	4.16 (2.13-8.1) ^b	9.9 (4.71-20.8) ^b
Obese class-II				
Males	1	1.64 (0.75-3.58)	2.71 (1.13-6.52) ^c	4.13 (1.56-10.93) ^a
Females	1	1.59 (0.46-5.5)	15.5 (4.46-53.88) ^b	14.76 (3.74-58.35) ^b
Obese class-III				
Males	1	1.82 (0.54-6.16)	2.96 (0.77-11.4)	7.86 (2.01-30.73) ^a
Females	1	1.72 (0.381-7.74)	3.72 (0.66-21.02)	26.57 (5.53-127.73) ^b
Obese				
Males	1	2.09 (1.26-3.45) ^a	3.64 (2.05-6.45) ^b	7.28 (3.82-13.87) ^b
Females	1	1.13 (0.67-1.89)	5.67 (3.14-10.24) ^b	12.08 (6.12-23.85) ^b

Dependent variable is BMI categories. The reference category is the normal weight group. OR: odds ratio; CI: confidence interval. Multinomial logistic regression. Pseudo R-squared: Cox and Snell: .083, Nagelkerke: .088

^aSignificant at P<.01, ^bSignificant at P<.001, ^cSignificant at P<.05; Overweight: BMI 25–29.9 kg/m², obese class-I: BMI 30–34.9 kg/m², obese class-II: BMI 35–39.9 kg/m², obese class-III: BMI >40 kg/m², obese: BMI >30 kg/m².

hibited lower muscle mass percentage than the normal value.

The magnitude of association between BMI and age brackets was determined by ORs for each gender (**Table 4**). Interestingly, overweight and obesity in females at 20–29 years showed no significant ORs compared to females younger than 20 years. At 30 years of age and higher, ORs increased significantly ($P < .05$) for overweight and all obesity categories in females. On the other hand, males had significant ($P < .05$) ORs in the 20–29 age bracket compared to males younger than 20 years, and a significant increase was observed with age. However, the magnitude of ORs increased remarkably for obesity for females during the middle-aged period compared to late-adolescent females. The corresponding increase in male ORs increased, but not as much as for the females. The beta coefficient by linear regression for age as a predictor for high BMI showed values of 0.14 and 0.25 for males and females, respectively. (Beta co-efficient males: 23.368 [95%CI 22.033–24.704]; females: 18.380 [95%CI 17.126–19.633]. Adjusted R-square males: .028, females: .113).

DISCUSSION

In 2014, WHO declared that the worldwide prevalence of overweight and obesity affected about 1.9 billion adults aged 18 years or older.³ Overweight and obesity have increased continuously with time in Saudi Arabia and other Gulf countries.²⁴ Our results showed that BMI and anthropometric indices were greatly influenced by age and gender. Significant trends ($p_{\text{trend}} < 0.001$) for all anthropometric parameters were observed with age. Key findings of the current study include an overall higher prevalence of overweight and obesity in males than in females. Overweight was observed in late adolescents in males and in adults in females. Study results showed that 29.2% and 25.9% of all the participants were overweight and obese, respectively. The rapid rise in obesity prevalence in Saudi Arabia can be attributed to distinct factors: Musaiger²⁴ and Memish et al⁹ summarized these factors as change to poor diet quality, physical inactivity, marital status (married men and women were more frequently obese than singles), low education, a shorter period of breastfeeding, skipping breakfast, snacking frequently, a high intake of carbonated soft beverages, an increase in the frequency of eating outside the home, long daily sitting time for television and other electronic devices, history of chronic diseases, hypertension, and stunting. Another important cause is that Saudi Arabia is one of the economically fastest-growing countries since the discovery of oil during the 1960s.²⁵ The increased incomes and urbanization in concomitance with the in-

vasion of present-day technology into food production have facilitated the production of large quantities of fat and sugar at very low prices.²⁶ This has improved fast-food manufacturers' abilities to introduce larger portion sizes at cheaper prices.²⁷ The "supersizing" of menu items has increased roughly by 2–5 times over the past two decades,^{28,29} and total energy consumption accordingly has increased up to 40% compared to the 1970s.³⁰ As a result, the risk of obesity among all age groups in Saudi Arabia has increased sharply.^{9,12,17,25,31} Rosenheck³² in his systematic review reported that six out of seven prospective cohort studies showed that fast-food consumption increased with increasing age, which was positively linked to increased caloric intake and BMI. Fast-food consumption in Saudi males was shown to be significantly higher than in Saudi females (days eating fast foods/week: 2.6 vs. 1.9, $P < .001$),¹⁷ a possible factor that could increase the BMI in males more than in females. In general, the prevalence of obesity is higher in females than in males;^{3,9,17} however, many BMI-related lifestyle and behaviors would increase the ratios of overweight and obesity in males over that in females, as shown by Moradi-Lakeh et al,¹⁷ such as higher overweight and obesity in former smokers (2.7% vs. 0.8%, $P < .001$), daily users of Shisha (5% vs. 1%, $P < .001$) and intake of other processed foods and processed meat as servings/day (1.6% vs. 1.4%, $P = .007$). In addition, the intake of red meat and poultry was noted to be higher in Saudi males than in Saudi females (>3 servings/day, 23.1% vs. 15.5%, $P < .001$),⁹ which could contribute to increased overweight and obesity because of the high fat content of these foods. A recent cohort study of smokers by Dare et al³³ on 499 504 middle-aged adults in Britain reported that current smokers were at lower risk of obesity (adjusted OR = 0.83 95% CI: 0.81–0.86), and former smokers were more likely to be obese than those who never smoked (adjusted OR = 1.14 95% CI: 1.12–1.15). Heavy smokers, as with daily users of shisha, tend to have higher weight gain than light smokers or nonsmokers by increasing insulin resistance and fat accumulation.³⁴ These bad habits could greatly increase the prevalence of obesity in males than in females at a young age. However, studies of comparative risks have demonstrated that the magnitudes of obesity and other obesity subgroups tremendously increased in middle-aged females. Moreover, linear regression results showed that increasing age in males and females can be expected to increase BMI by 0.14 kg/m² and 0.25 kg/m², respectively. These results confirm that BMI increased to a higher extent in females than in males over the years, mainly after the age of 40. At that age, the postmenopausal transition in females leads to in-

creased BMI by decreasing estrogen hormone and consequently increasing fat deposition.³⁵ Al-Quwaidhi and his colleagues¹⁸ predicted the possible trend of obesity in Saudi society in the 30 years from 1992 to 2020 for different age groups, and concluded that obesity prevalence will increase remarkably (>200%) in both sexes, and women will exhibit more obesity than men particularly in the ≥ 35 age group. Ng et al,³⁶ from their global estimation of overweight and obesity from 1980 to 2013, found that the peak age of obesity in developing countries was at about 45 years for men and 55 years for women. From the previous results, the prevalence of overweight and obesity would be affected by the age of the sample; female weight gain could be higher than male weight gain at older ages. Because the majority of the sample was under 30 years old ($n=1842$; 72.3%), the prevalence of obesity is expected to be higher in men than in women, which was confirmed by the results of this study.

The current study showed that WC and visceral fat were higher in males, but total body fat percentage was higher in females. This can be explained by the fact that fat distribution differs between males and females, the central obesity and apple-shape in men compared with the pear-shaped obesity in women. Many other studies are in line with this finding.^{9,12,17,37} Body fat percentages differ among countries depending on genetic factors, eating patterns, regular exercise, and other life-style habits.³⁷ A study in the United States (6544 men and 6362 women) showed that body fat percentages in males aged 18-29 years and 30-49 years were 26.6% and 30.6%, respectively; while the corresponding values in females were 24.5% and 31.5%, respectively.³⁸ These results showed that body fat percentages in Saudi females were higher than that of American females, whereas Saudi males showed percentages similar to American males. Another study in Kuwait showed that the average body fat percentages in males (mean age 39.1 years) and females (mean age 40.9 years) were 23.3% and 37.7%, respectively,³⁹ which were relatively comparable to our results in Saudi Arabia. Furthermore, our study noted higher muscle mass percentage in men than in women, which could be related to a lower level and duration of physical activity among women in comparison to men, which is in accordance with the findings of the Memish et al,⁹ Al-Nakeeb et al,⁴⁰ and Al-Dokhi⁴¹ studies. Indeed, the desert climate in Saudi Arabia presents a barrier for outdoor activity for both men and women.⁴² However, Moradi-Lakeh et al¹⁷ found that 42.8% of Saudi females were physically outdoor-inactive, whereas only 19.7% of males were physically inactive outdoors ($P<.001$). Therefore, it is recommended to

establish well-designed facilities tailored to the needs of the Saudi community, primarily for females, to promote physically active activities.

Anthropometric indices are interrelated with each other with age; muscle mass loss and increased body fat percentage, BMI, WC, and visceral fat. This result is consistent with the findings of other studies in other countries.⁴³⁻⁴⁵ However, fat mass increases with age and reaches a plateau at about 60 to 70 years, as concluded by Bosy-Westphal and Muller.⁴⁶ These changes in body composition would possibly increase the incidences of cardiovascular and other chronic diseases, principally as a result of high WC and visceral fat.^{23,47} Muscle mass in obese people is lower than in those with normal weight due to the fat infiltration within the skeletal muscle.⁴⁸ In our study, we found that the muscle mass percentage decreased significantly ($P<.05$) between the age of 40 and 60 for both genders. Romero-Corral⁴³ found that lean mass started to decline after 60 years of age for both genders. However, our study showed that mean (SD) muscle mass percentages for middle-aged males and females were 32% (6.1) and 22.9% (3.8), respectively, which were lower than those reported among Swedish adults aged 40-49 years, which were 39.8% [3.5] for males and 33.4% [4.3] for females.⁴⁴ This variation in muscle mass could be related to genetic variations, type and intensity of exercise, and quality of the diet between populations. The reduction in skeletal muscle mass with or without losses in body weight with age is known as sarcopenia, which is linked mainly to aging as well as to inactivity and increased protein degradation.⁴⁹ Sarcopenic obesity means having much fat and little muscle,⁵⁰ which could appear in our cohort as high percentages of obesity and muscle wasting in the middle-aged period. This is a matter that should be studied in depth in further investigations.

Our concerns in this work were with the selected sample, which was not heterogeneous, and had an unequal distribution between groups as a result of the cross-sectional design of this study. Other studies are recommended to determine the effect of possible confounders, such as income, education, dietary habits, marital status, smoking, and physical activity, on overweight and obesity prevalence in the western region of Saudi Arabia.

Significant trends were observed for increasing BMI, WC, body fat, visceral fat, and decreasing muscle mass for both genders with age. Men were more likely to be overweight and obese than women. High BMI, body fat, and visceral fat were detected in the age bracket of 20-29 years in males, whereas females showed a significant increase in the aforementioned variables at

an older age. Muscle mass deteriorated significantly in the middle-aged males and females. National programs should be maintained to encourage physical activity and weight reduction as well as focusing on obesity-related lifestyle and behaviors at early ages to prevent possible health-related consequences of weight gain and fat accumulation with age.

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Conflict of interest

The authors have declared that no competing interests exist.

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