Prevalence of physical activity and inactivity among Saudis aged 30-70 years

A population-based cross-sectional study

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ABSTRACT

Objectives: To assess physical activity levels among Saudi adults, and to examine the relationships of physical activity with body mass index (BMI), waist circumference (WC) and obesity prevalence.

Methods: Data taken from the Coronary Artery Disease in Saudis Study which is a National Epidemiological Health Survey carried out between 1995 and 2000. Participants included 17395 Saudi males and females aged 30-70 years, selected randomly using a multistage stratified cluster sampling technique. Leisure-type and sport-related physical activities including walking were assessed using an interviewed-administered questionnaire. The activities were classified into five intensity categories and assigned metabolic equivalents (MET) according to the compendium of physical activity. Based on the intensity, duration and frequency of physical activity, subjects were classified into active or inactive category.

Results: Inactivity prevalence (96.1%) was very high. There were significantly ($p<0.001$)) more inactive females (98.1%) than males (93.9%). Inactivity prevalence increases with increasing age category, especially in males, and decreases with increasing education levels. Inactivity was the highest in the central region (97.3%; 95% CI = 96.8-97.8%) and the lowest in the southern region of Saudi Arabia (94.0%; 95% CI = 93.2-94.8%). Further, active individuals exhibited lower values of BMI and WC.

Conclusion: These findings reveal the sedentary nature of Saudi population. The overwhelming majority of men and women did not reach the recommended physical activity levels necessary for promoting health and preventing diseases. The high prevalence of inactivity among Saudis represents a major public health concern.

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During the past 3 decades, Saudi Arabia has undergone enormous changes in lifestyle, including physical activity patterns and eating habits. These dramatic lifestyle changes have undoubtedly considerable negative impacts on societal health. Indeed, such lifestyle transformation was thought to have been responsible for the recent epidemic of non-communicable diseases along with their complication in the country.[1-3] A recent community-based national study,[2] involving adult Saudis between 30 and 70 years, showed that the overall prevalence of coronary heart disease (CHD) and diabetes mellitus[3] to be 5.5% and 23.7%, respectively. However, the expected increase in ischemic heart disease mortality in the Middle East region in 2020 compared to 1990 was estimated to be the greatest among all regions of the world (146% increase in women and 174% increase in men).[4] This is greatly attributed to the high presence of major CHD risk factors. Prevention of noncommunicable diseases depends on controlling the predisposing risk factors, including physical inactivity.

In fact, physical inactivity represents an independent risk factor for a number of chronic diseases, including coronary heart disease (CHD), diabetes mellitus, hypertension, obesity and osteoporosis.[5] Furthermore, data from the World Health Organization (WHO) risk factors indicated that physical inactivity is regarded as one of the 10 leading global causes of death and disability.[6] Worldwide, physical inactivity was estimated to cause 1.9 million deaths and 19 million disability-adjusted life years.[7] Global estimates also showed that physical inactivity causes about 22% of ischemic heart disease and about 10-16% of cases each of diabetes mellitus, breast, colon, and rectal cancer.[7] Regular physical activity, on the other hand, was shown to lower the risk of numerous diseases, including cardiovascular (CV) diseases, type 2 diabetes, osteoporosis and certain types of cancer, and enhances psychological well-being.[5,8] Moreover, the maintenance of a healthy body weight is a function of energy expenditure. Leisure-time physical activity was shown to be positively associated with the likelihood of being in the normal body mass index (BMI) and lower body fat range,[9,10] while obesity and higher body weight were associated with sedentary lifestyle in the adult population.[11] The published reports on physical activity profile of Saudi adults indicate that the majority of Saudi people are not physically active enough to achieve health benefits from physical activity.[12-16] Furthermore, the proportion of Saudis who are at risk due to physical inactivity is much higher than for any other CHD risk factors.[14,17] However, when examining the Saudi physical activity reports, one can not disregard the fact that all of these reports were limited to samples from certain geographical areas in Saudi Arabia. Indeed, the majority of these studies involved samples from Riyadh, the Capital city of Saudi Arabia.[12,14-16] Additionally, many of these studies did not include women. Thus, there is a need to have physical activity data representing the whole population of Saudi Arabia, including males and females as well as urban and rural areas. Therefore, the objectives of the present study were to present findings from national cross-sectional study on physical activity profile of Saudi adults, and to examine the association of physical activity levels with body mass index (BMI), waist circumference (WC) and the prevalence of obesity.

Methods. ***Participants and study design.*** The data of the present study were taken from the Coronary Artery Disease in Saudis Study (CADISS) which is a National Epidemiological Health Survey carried out over a 5-year period between 1995 and 2000. Detailed description of the project can be found elsewhere.[2,3] Briefly, the participants included 17395 Saudi males and females aged 30-70 years, selected randomly using a multistage stratified cluster sampling technique with proportional allocation. For practical and logistic reasons, the study sample was drawn from the catchments areas of the local primary health care centers (PCCs). The Kingdom of Saudi Arabia was subdivided into 14 administrative regions, and each region was stratified into urban and rural communities. The number of PCCs in each region is relative to the population density in that region. The catchments population of each PCC was taken as a cluster. The first stage of sampling included 1623 PCCs uniformly distributed in the country. Then, a simple random sample of PCCs was selected proportional to the total number of PCCs in each community. The final numbers of selected PCCs were 66 and 58 from urban and rural areas, respectively. Next, blocks were randomly chosen from the catchments areas of each PCC. Finally, we selected 100 urban and 50 rural households in each block, and all Saudis between the ages of 30 and 70 years in the selected households were included in the study population. Less than 2% of the selected households declined to participate in the study, and they were replaced with other households. Informed consent was obtained from each participant in the study. Anthropometric measurements included body weight, height, BMI and WC. Body weight was measured without shoes to the nearest 0.1 kg using ordinary portable scale. Standing height was measured barefooted to the nearest 0.1 cm using a calibrated measuring rod, mounted on the weighing scale. Body mass index was then calculated and obesity was diagnosed when the BMI is $\geq$30 kg/m^2.[18] Waist circumference was measured midway between the lower rib margin and iliac crest using a non-stretching measuring tape and values of 102 cm or higher for males and 88 cm or higher for females were considered as abnormal WC size and carries risks for cardiovascular and metabolic diseases.[19]

Assessment of physical activity. Physical activity level was assessed using a questionnaire administered through an interview by a trained primary care physician. The questionnaire included basic demographic and socio-economic data as well as medical history. The form mostly assessed leisure-type physical activity and sport-related activity including walking. It contains details on physical activity habits, including type, frequency and duration of physical activity participation. The types of physical activities were classified into 5 intensity categories and assigned metabolic equivalent (MET) values according to the compendium of physical activity.[20] One MET equals to the energy expenditure at rest, or roughly 3.5 ml of oxygen consumed per kilogram of body weight per minute.[5] The types of physical activity categories included in the questionnaire were the following: 1. vigorous-intensity aerobic activity such as running, vigorous swimming and bicycling (MET = 7.5), 2. vigorous-intensity intermittent sport activity such as basketball, tennis and racquet balls (MET = 7), 3. moderate-intensity aerobic activity such as moderate intensity bicycling and light jogging (MET = 6), 4. moderate-intensity activity such as brisk walking and recreational volleyball (MET = 3.5), and finally 5. light aerobic activity such as normal walking and golfing (MET = 2.5). Based on the intensity, duration and frequency of physical activity, participants were classified into 2 categories, active and inactive. The active category was based on 30 minutes or more of at least moderate-intensity activity for three or more times per week. The inactive category included those participants who did not meet criteria for active category. In addition, MET-minutes per week were calculated as MET value multiplied by the duration of activity in minutes multiplied by the frequency of activity per week. All types of activity including light aerobic activity were included in this calculation. Participants were also classified into two categories of activity, active and inactive. Active category was based on MET-minutes per week equaling or exceeding 600. Inactive category was based on MET-minutes per week less than 600. The value of 600 was chosen as representing 150 minutes of activity per week multiplied by a MET value of 4, which is equivalent to moderate-intensity physical activity. This level of intensity was previously recommended for health benefits.[5]

Statistical analysis. Data entry and statistical analysis were performed using the Statistical Package for the Social Science (SPSS) program, version 10 (Chicago, IL). Data are reported as means and standard deviations or as percentages and 95% confidence intervals (CI). Pearson and Spearman Rho correlations were used for correlation analysis. Comparisons were made between active and inactive groups relative to demographic characteristics and categories of BMI and waist circumference, using Chi-Square tests. In addition, a two-way ANOVA test (activity by age groups) was used to examine differences in each of BMI and waist circumference between active and inactive across age categories. Tukey's honestly significant difference was used as post hoc test. Furthermore, values of BMI and waist circumference were compared relative to physical activity levels based on MET-minutes per week cut scores (inactive as below 600 MET-minutes per week and active as 600 or more MET-minutes per week). T-test was used to determine differences in age, BMI and waist circumference between active and inactive participants. Data related to males and females were analyzed separately.

Results. The mean (± SD) values of age, weight and height for the whole sample in the present study were 46.3 ± 11.5 years, 72.7 ± 15.4 kg and 159.4 ± 9.0 cm, respectively. Compared to females, males were older (49.1 ± 11.8 versus 43.7 ± 10.6 years), heavier (75.2 ± 15.1 versus 70.3 ± 15.4 kg) and taller (165.3 ± 7.8 versus 154.1 ± 6.9 cm). Female participants had significantly larger BMI (29.6 ± 6.2 versus 27.5 ± 5.0 $kg.m^2$, $p<0.001$) and smaller waist circumference (90.2 ± 14.6 versus 93.9 ± 1.5 cm, $p<0.001$). Demographic characteristics of the entire sample based on activity levels are shown in **Table 1**. Only 6.1% (95% CI = 5.6-6.6%) of the males and 1.9% (95% CI = 1.6-2.2%) of the females were considered active (having 30 minutes or more of moderate-intensity physical activity for at least three times per week). Inactivity prevalence (96.1%) for the whole population was very high. There were significantly ($p<0.001$)) more inactive females (98.1%) than males (93.9%). Inactivity appears to increase with increasing age category, especially in males ($p<0.001$). Analysis of the regional variations indicated that the prevalence of inactivity was the highest among people in the central region (97.3%; 95% CI = 96.8-97.8%) and the lowest among those in the southern region of Saudi Arabia (94.0%; 95% CI = 93.2-94.8%). However, there was no significant difference in the proportions of inactivity between urban and rural residents (96.1% versus 96.0%; $p=0.472$). In addition, the findings of this study showed that inactivity prevalence decrease with increasing education levels. Those participants having college or university degrees had the lowest inactivity prevalence (91.7%, 95% CI = 90.2-93.2). Age did not seem to have a major effect on the prevalence of inactivity relative to educational levels. Inactivity prevalence was also shown to be affected by marital status. Single participants had the lowest prevalence of physical inactivity (93.5%, 95% CI = 91.1-95.9). Age, however, appeared to have a significant effect on the prevalence of inactivity relative to marital status.

The proportion of Saudis engaged in physical activity, including light-intensity activity, who accumulate 600 MET-minutes per week or more was 12.4% (male=15.2% and female=9.7%; $p<0.001$). The exact value of MET-minutes per week for the whole participants was 180.9 ± 344.5 (males = 232.1 ± 400.5, and females = 134.3 ± 272.8; $p< 0.001$). There were no significant ($p = 0.383$) differences in MET-minutes per week between urban (179.4 ± 347.2) and rural (184.3 ± 338.5) residents. However, there were significant differences in MET-minutes per week among different regions of the country. Subjects from the southern and eastern regions were significantly ($p<0.05$) different from the other three regions. Subjects from the western region were significantly ($p<0.05$) different from those in the central and northern regions. Subjects in the southern region have not only had the lowest inactivity

Table 1 - The proportion of Saudis who are active or inactive relative to some demographic characteristics.

Variable	N	Active		Inactive		*P*-value*
		(%)	(95% CI)	(%)	(95% CI)	
Gender/age (years)						
Male						<0.001
30-39	2159	(10.5)	(9.2-11.8)	(89.5)	(88.2-90.8)	
40-49	2192	(6.8)	(5.7-7.8)	(93.2)	(92.1-94.2)	
50-59	1981	(3.9)	(3-4.8)	(96.1)	(95.2-96.9)	
60-70	1965	(2.6)	(1.9-3.3)	(97.4)	(96.7-98.1)	
All	8297	(6.1)	(5.6-6.6)	(93.9)	(93.4-94.4)	
Female						0.056
30-39	3811	(2.1)	(1.6-2.6)	(97.9)	(97.4-98.4)	
40-49	2739	(2.0)	(1.5-2.5)	(98.0)	(97.5-98.5)	
50-59	1543	(1.9)	(1.2-2.6)	(98.1)	(97.4-98.8)	
60-70	1005	(0.8)	(0.3-1.3)	(99.2)	(98.6-99.8)	
All	9098	(1.9)	(1.6-2.2)	(98.1)	(97.8-98.4)	
Region						<0.001
Central	4131	(2.7)	(2.2-3.2)	(97.3)	(96.8-97.8)	
Northern	1551	(2.8)	(2-3.6)	(97.2)	(96.4-98.0)	
Eastern	2643	(3.4)	(2.7-4.1)	(96.6)	(95.9-97.3)	
Western	5472	(3.9)	(3.4-4.4)	(96.1)	(95.6-96.6)	
Southern	3598	(6.0)	(5.2-6.8)	(94.0)	(93.2-94.8)	
All	17395	(3.9)	(3.6-4.2)	(96.1)	(95.8-96.4)	
Residence						0.472
Urban	11868	(3.9)	(3.6-4.3)	(96.1)	(95.8-96.4)	
Rural	5527	(4.0)	(3.5-4.5)	(96.0)	(95.5-96.5)	
Educational level						<0.001
Illiterate	8951	(2.4)	(2.1-2.7)	(97.6)	(97.3-97.9)	
Read & write only	2016	(2.6)	(1.9-3.3)	(97.4)	(96.7-98.1)	
Primary	3247	(5.3)	(4.5-6.1)	(94.7)	(93.9-95.5)	
Secondary	1739	(6.8)	(5.6-8.0)	(93.2)	(92.0-94.4)	
College/University	1381	(8.3)	(6.8-9.8)	(91.7)	(90.2-93.2)	
Marital Status						<0.001
Single	403	(6.5)	(4.1-8.9)	(93.5)	(91.1-95.9)	
Married	15892	(4.0)	(3.7-4.3)	(96.0)	(95.7-96.3)	
Divorced/widowed	1100	(1.7)	(0.9-2.5)	(98.3)	(97.5-99.1)	

* Chi-square for the proportion differences

Table 2 - The proportion of Saudi males and females who are active or inactive relative to body mass index (BMI) and waist circumference (WC) categories.

Variable	N	Active		Inactive		*P*-value*
		(%)	(95% CI)	(%)	(95% CI)	
BMI (kg/m²)						
Males						0.468
<25	2557	(6.4)	(5.5-7.4)	(93.6)	(92.7-94.5)	
25-29.9	3486	(6.1)	(5.3-6.9)	(93.9)	(93.1-94.7)	
≥30	2172	(5.5)	(4.5-6.5)	(94.5)	(93.7-95.4)	
All	8215	(6.0)	(5.5-6.5)	(94)	(93.5-94.5)	
Mean ± SD			27.0 ± 4.6		27.5 ± 5.0	0.041
Females						0.176
<25	2176	(2.3)	(1.7-2.9)	(97.7)	(97.1-98.3)	
25-29.9	2865	(1.9)	(1.4-2.4)	(98.1)	(97.6-98.6)	
≥30	3967	(1.6)	(1.2-2.0)	(98.4)	(98-98.8)	
All	9008	(1.9)	(1.6-2.2)	(98.1)	(97.8-98.4)	
Mean ± SD			28.5 ± 5.5		29.7 ± 6.2	0.022
WC (cm)						
Males						<0.001
<102	5750	(6.6)	(5.9-7.2)	(93.4)	(92.8-94.0)	
≥102	2282	(4.3)	(3.5-5.1)	(95.7)	(94.9-96.5)	
All	8032	(5.9)	(5.4-6.4)	(94.1)	(93.6-94.6)	
Mean ± SD			92.2 ± 13.3		94.0 ± 15.1	0.006
Females						0.007
<88	3646	(2.4)	(1.9-2.9)	(97.6)	(97.1-98.1)	
≥88	5259	(1.6)	(1.3-1.9)	(98.4)	(98.1-98.7)	
All	8905	(1.9)	(1.6-2.2)	(98.1)	(97.8-98.4)	
Mean ± SD			88.8 ± 12.4		90.2 ± 14.7	0.112

*Chi square for the proportion differences and t-test for means differences prevalence, but had also the lowest prevalence of obesity. Correlation analyses revealed that MET-minutes per week was negatively associated with BMI (r = -0.060; *p*=0.000). The correlation coefficient did not change much when age was controlled (r = -0.062; *p*=0.000). MET-minutes per week had also a low correlation with waist circumference (r = -0.018; *p*=0.019). The correlation decreased slightly when controlling for the effect of age (r = -0.012; *p*=0.132). The relationship between MET-minutes per week and educational levels was 0.153 (*p*=0.000). A low but significant correlation was found between MET-minutes per week and the average household monthly income (r = -0.100; *p*=0.000). **Table 2** shows the proportions of Saudi males and females who were active or inactive relative to BMI and waist circumference categories. Inactivity prevalence was not significantly different across BMI categories in males (*p*=0.468) and in females (0.176). However, compared to the inactive group, means of BMI for the active group were significantly lower in both males (27.0 ± 4.6 versus 27.5 ± 5.0; *p*=0.041) and females (28.5 ± 5.5 versus 29.7 ± 6.2; *p*=0.022). Waist circumference, on the other hand, exhibited significant differences between active and inactive male participants (92.2 ± 13.3 cm versus 94.0 ± 15.1 cm; *p*<0.001). The difference in waist circumference between active and inactive females, however, did not reach statistical significant (88.8 ± 12.4 cm versus 90.2 ± 14.7 cm; *p*=0.112). In addition, the proportions of active males and females having waist circumference below the cut scores for abdominal obesity (<102 cm. for men and <88 cm. for women) were significantly greater than those having waist circumference above the cut scores (6.6% versus 4.3% for males, *p*<0.001, and 2.4% versus 1.6% for females, *p*=0.007). **Figure 1** displays the mean values of BMI across age groups for each of the active and inactive males (a) and females (b). A 2-way ANOVA test indicated a non-significant interaction effect for activity and age on BMI in males (**Figure 1a**). However, there were significant main effects on BMI for each of activity (*p*=0.01) and age (*p*=0.001). Further analysis revealed that the significant difference in BMI between active and inactive males was in age category 50-60 years. In females (**Figure 1b**), however, there was no significant difference detected for the activity effect (*p*=0.130) or the interaction effect (*p*=0.996). The effect of age was obviously significant (*p*=0.039). **Figure 2** displays results of waist circumference in active and inactive males and females, relative to age categories. In males, the interaction between activity and age was not statistically significant (*p*=0.416), whereas the main effects for activity (*p*=0.033) and age (*p*=0.002) were significant. In females> waist circumference, neither the main effect for activity (*p*=0.252) nor the interaction of activity with age (*p*=0.847) was statistically significant. The main effect of age on waist circumference, however, was statistically significant (*p*=0.005).

Table 3 presents the means and standard deviations for age, BMI and waist circumference in males and females, separately. The activity categories were based on a slightly different classification than the one used in data presented in **Tables 1 and 2**. Active group represents those participants engaged in physical activity that expend 600 or more of MET-min per week. Inactive group, on the other hand, represents those engaged in activity that expends less than 600 MET-min per week. As is clearly shown in **Table 3**, inactive men and women had significantly higher BMI and waist circumference than their active peers. Further, since there were age differences between the two groups, we analyzed the data while controlling for the effect of age. Such analysis revealed that the differences in BMI and waist circumference between active and inactive groups remained significant.

Discussion. This is the first study that presents national data on physical activity status of Saudi males and females between the age of 30 and 70 years. The importance of having such national physical activity prevalence can not be overemphasized. The major finding of this large population-based study is that high levels of inactivity were found in both Saudi males and females. The prevalence of physical inactivity among both sexes averaged 96.1%, based on 30 minutes or more of moderate-intensity physical activity for at least three times per week. It is clear that Saudis need to be more physically active than the current estimates, in

Table 3 - Means and standard deviations for age, body mass index (BMI) and waist circumference (WC) of Saudi males and females who were active (spending 600 MET-min per week or more in physical activity) or inactive (spending less than 600 MET-min per week in physical activity).

Variable	Active ≥600 MET-min/week	Inactive <600 MET-min/week	**P*-value
Males			
N	1264	7033	
Age	47.5 ± 11.9	49.4 ± 11.8	<0.001
BMI	27.0 ± 4.8	27.6 ± 5.0	<0.001
WC	92.2 ± 13.9	94.2 ± 15.2	<0.001
MET-min/week	1020.4 ± 464.6	90.4 ± 136.5	<0.001
Females			
N	885	8213	
Age	42.7 ± 9.7	43.8 ± 10.7	<0.001
BMI	28.7 ± 6.1	29.7 ± 6.2	<0.001
WC	88.9 ± 13.3	90.3 ± 14.7	0.007
MET-min/week	857 ± 316.9	56.4 ± 104.7	<0.001

*T- test for means differences, MET -metabolic equivalent order to control the increased prevalence of obesity and reduce CHD and its metabolic risk factors.[2,3] According to the World Health Organization (WHO) report, the global health burden of physical inactivity is increasingly growing.[7] In the United States, for instance, the leading causes of death in 2000 were tobacco smoking (18.1%) and poor diet and physical inactivity (16.6%).[21] In a recent position paper, the European Society of Cardiology has outlined the need for physical activity for the primary and secondary prevention of cardiovascular risks.[22] Previous surveys estimated inactivity prevalence in Saudi Arabia to range from 43.3% to as high as 99%.[15] The findings from the present study conform to the upper range of the previous estimates. Although activity energy expenditure and physical activity levels were found to be greatly influenced by genetic factors,[23] environmental determinants of physical activity can play a significant role in promoting active lifestyle.[24] In Saudi Arabia, with increased urbanization, crowding, traffic, and poor air quality in major cities, extreme weather, cultural barriers, and lack of sports and recreational facilities, all make physical activity a difficult choice for Saudis.[14] Given the low level of physical activity in the Saudi population, determinants of physical activity and inactivity need to be identified. The public health recommendations from the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) call for accumulating 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week.[25] In the present study, only 3.9% of males and 1.5% of females met the recommendations of CDC/ACSM for daily physical activity. Recently, the Institute of Medicine (IOM) recommended increasing this amount of moderate physical activity, previously advised, to 60 minutes per day.[26] In Australia, it was reported that 51.5-60.2% of the population were meeting the

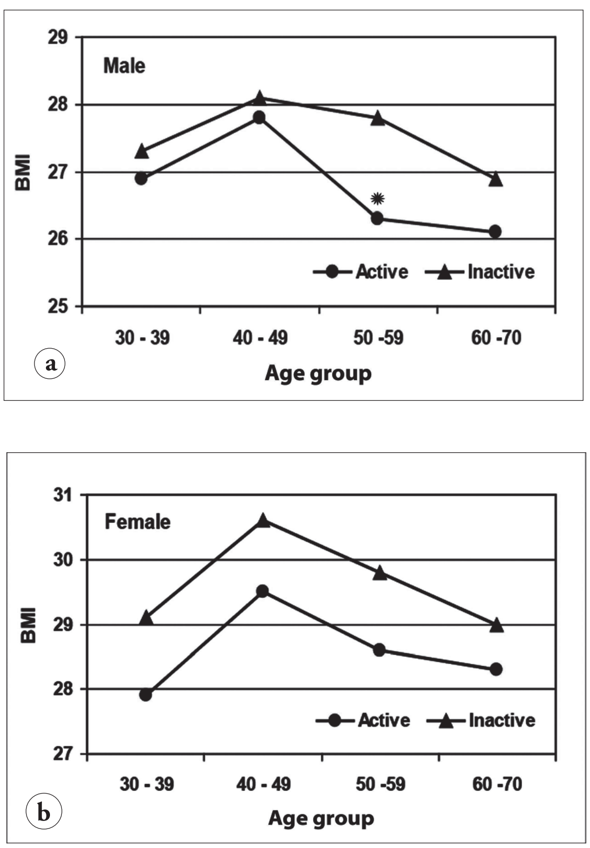

Figure 1 - Mean values of body mass index (BMI) across age groups for active and inactive Saudi **a)** males and **b)** females. *Significant differences between active and inactive groups; $p<0.05$.

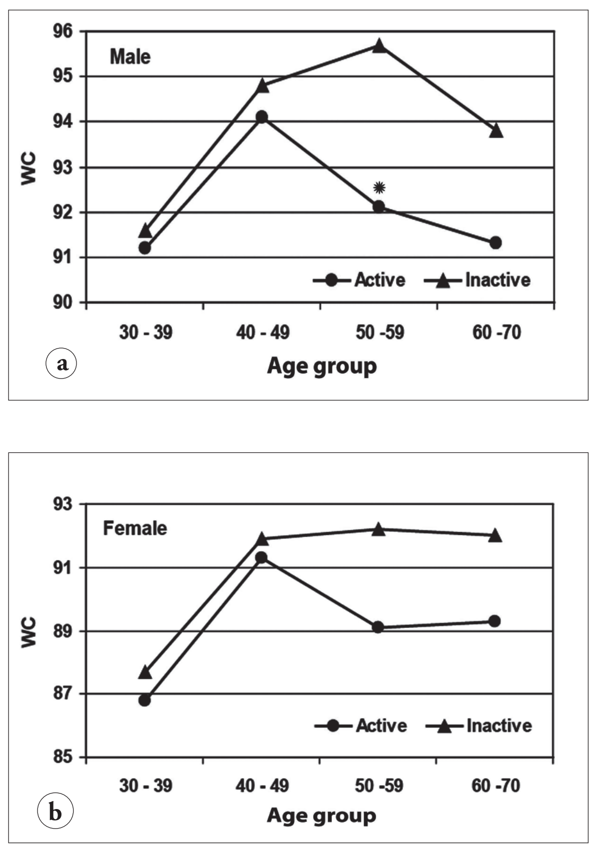

Figure 2 - Mean values of waist circumference (WC) across age groups for active and inactive Saudi **a)** males and **b)**females *Significant differences between active and inactive groups; $p<0.05$.

current CDC/ACSM recommendation.[27] Furthermore, recent estimate from WHO indicated that 60-80% of adults around the world are simply not active enough to achieve health benefits from physical activity.[6] Data for the year 2000 from the Behavioral Risk factors Surveillance System (BRFSS) in the United States indicated that the majority (73.8%) of the U.S. adults were not physically active enough to meet the current recommendations of at least 30 minutes of moderate-intensity activity on most days of the week.[28] In a later BRFSS survey that included physical activity from household chores and transportation, it was reported that 55% of the adults population in the United States were not active at the recommended levels of activity which are sufficient to promote health.[29] The national health objectives of the United States for 2010, though, call for reducing the prevalence of no leisure-time physical activity to 20%.[30] Current estimate of inactivity level found in the present study appeared much higher than levels of inactivity reported in previous researches using similar measures of physical activity. In the United States, the prevalence of leisure-time physical inactivity was 68%.[31] Sedentarism in Portuguese urban population was reported to be 83.7% in men and 84.4% in women.[32] The percentage of Greek men and women who were classified inactive in leisure time physical activity was reported as 47% and 52%, respectively.[33] In Singapore, only 20.9% of males and 15.1% of females were reported to be engaged in sport-related activities for 3 or more times per week.[34] This percentage for the level of physical activity, however, is much higher than that reported for Saudis in the present study (6.1% for men and 1.9% for women). Moreover, the average value for MET-min per week reported in the present investigation (180.9 ± 344.5) is considerably lower than the estimated average physical activity in Bavarian men and women from Germany (348 ± 79.7 and 330.0 ± 42.9 MET-min a week).[35] Males in the present study demonstrated higher levels of physical activity than females. Such finding is consistent with results from many previous reports, showing that males were more active than fem ales.[28,31,33,34,36,37] Contrary to the present findings, previous report on Saudis from Riyadh showed that women were more moderately active than men.[16] However, the previous report assessed all types of physical activities, including those performed at home such as carrying babies, scrubbing floor, sweeping, and vacuuming,[16] while the present survey included only sport and leisure-time physical activities. Furthermore, findings from the present study did not show any significant difference in activity levels between rural and urban participants. In contrast to this findings, however, it was reported that people living in rural area of Greece were more likely to be physically active as compared to those living in urban areas (55% versus 46%; p=0.02).[33] In another study, rural women were shown to be more sedentary than urban women. They also seem to face different barriers to leisure-time physical activity.[38] Our study showed that inactivity prevalence decreased with increasing education levels. In line with this finding, several previous reports have shown that leisure-time physical inactivity is inversely associated with socioeconomic status.[37,39] Inactivity was shown to be more prevalent among less educated American people.[40] In contrast to the previous findings, a study involving Greek population did not find a statistically significant association between physical activity levels and education levels or annual income.[33] It appears that the association between physical activity and education levels depends on the domain of physical activity assessed. It is very likely that such an inverse association would be present when levels of education were related to leisure-time physical activity.[32] However, the inclusion of work-related physical activity showed that less educated individuals who were involved in manual occupation were less sedentary.[32] The present study indicated that physical inactivity increased with advancing age group. Age-related decline in physical activity has been well described in the literature.[28,41] Data from the recent BRFSS study in the United States indicated that physical inactivity steadily increased with advancing age from 18-29 years to $\geq$70 years in both sexes.[28] In a large population-based cohort study of men aged 45-79 years in central Sweden, it was shown that total daily physical activity was systematically decreased between age 45 and 79 years.[42] Moreover, in Portuguese urban population, increased age was associated with higher odds of being sedentary in men and women.[32] However, a study conducted on Nigerian civil servants population found no significant physical activity trend across age between 20 and 64 years.[37] Previous report on physical activity levels of Saudi males between the ages of 19 and 68 years found a curvilinear relationship between inactivity prevalence and age.[14] As shown in **Tables 2 and 3**, inactive males and females in the present study exhibited higher values for BMI than their more active peers. In addition, compared to males and females with normal waist circumference, inactivity prevalence was higher in those participants with waist circumference above cut-off values for abdominal obesity. It is reasonable to assume that the low levels of physical activity displayed by Saudis in this study combined with excess energy intake are almost certainly responsible for the increase in overweight and obesity recently seen in Saudi Arabia.[43] The findings from our study regarding obesity and physical inactivity agree with the results from numerous studies conducted on Australians,[9] Americans,[10] Portuguese urban women,[32] Nigerians,[37] Swedish men,[42] and multi European population.[44] Our study also showed that inactive males and females had significantly higher waist circumference than active participants of both sexes. Although we did not assess body fat in the present study, waist circumference is considered a surrogate measure of abdominal obesity. Active individuals are likely to have less body fat than their peers. Using CT scan to assess abdominal obesity, it was shown that physical activity strongly associated with lower visceral adipose tissues in men from 30 to 71 years of age.[45] Moreover, Ross and Janssen demonstrated that abdominal fat was preferentially reduced in response to exercise-induced weight loss.[46] The maintenance of normal body weight is a function of balancing energy intake and expenditure. Exercise is beneficial in preventing weight gain and an important adjunct modality in treating obesity.[47] Based on WHO recommendation, a physical activity level (PAL) of 1.75 or more is necessary to avoid excessive weight gain.[18] However, our findings on Saudi males and females highlight the sedentary nature of this adult population. It is well acknowledged that physical inactivity and adiposity independently are important determinants of mortality risk.[45,48] Furthermore, lifestyle improvement, including weight reduction and increased physical activity, reduce the incidence of obesity and type 2 diabetes.[49] The major strength of the present study is that it is a population-based research involving a large number of both males and females from all regions of Saudi Arabia. However, there are some limitations of this study. First, physical activity was assessed using questionnaires. This form of assessment provides a crude measurement of physical activity and is subjected to recall bias. Second, the study did not assess all domains of physical activities. Indeed, the survey did not include the occupational and household related physical activities. Women in Saudi Arabia, particularly in rural areas, are more likely to engage in varieties of household physical activities. In addition, findings from a study conducted in the United States demonstrated that leisure-time physical activity contributes to a small proportion (5%) of the total energy expenditure.[50] Third, the cross-sectional design of the present study precludes the assumption of causality between inactivity and obesity indices. It remains unclear whether people in this study are obese due to reduced levels of physical activity or the inactivity is the result of being obese. However, our results are consistent with numerous other studies showing relationships between physical inactivity and each of BMI and abdominal obesity.

In summary, the findings of the present study revealed the sedentary nature of the Saudi population. The overwhelming majority of men and women did not reach the current physical activity recommendations that are necessary for promoting health and preventing diseases. In addition, active individuals exhibited lower values of BMI and waist circumference, something that is consistent with previous studies. The high prevalence of inactivity seen among Saudi population represents a major public health concern. Concerted public health efforts are needed to improve people participation in physical activities in Saudi Arabia. Public policies are necessary to encourage active living and discourage sedentary habits. Health care providers have to play an important role in promoting physical activity among the Saudi population.

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