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Obesity in Jordan: Prevalence, Associated Factors, Comorbidities, and Change in Prevalence over Ten Years

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Abstract

Objectives: To determine the prevalence of obesity in northern Jordan, identify its associated factors, assess its association with selected comorbidities, and determine how the prevalence of obesity has changed in Jordan over 10 years.

Methods: A total of 1121 participants aged 25 years and above were randomly selected. Sociodemographic characteristics as well as information on selected metabolic disorders and their potential risk factors were obtained. Anthropometric and biochemical characteristics were measured. Obesity was defined based on body mass index (BMI), waist circumference, and waist-to-hip ratio.

Results: The age-standardized prevalence of obesity in northern Jordan was 28.1% (95% CI: 23.4, 32.8) for men and 53.1% (95% CI: 49.3, 57.0) for women. Irrespective of age or measure used, women always had a considerably higher prevalence of obesity than men. The prevalence of obesity varied greatly with age, generally increasing, irrespective of the measurement used. There has been a significant increase in the prevalence of obesity over a period of ten years for both men and women aged 60 years and above only. When important variables were taken into account in logistic regression analyses, obesity was significantly associated with increased odds of having all studied metabolic abnormalities. Female gender, increase in age, being married, former smoker or nonsmoker, and fewer than 12 years of education were significantly associated with increased odds of BMI-defined obesity and high waist circumference.

Conclusions: This study demonstrated alarming rates of obesity and of its associated comorbidities among Jordanians, especially among women.

Introduction

Obesity is a major public health problem in the Western world[1] as well as in developing countries.[2–7] It is a risk factor for coronary heart diseases[8,9] and it is strongly associated with diabetes and hypertension,[9] other health problems,[10–13] decreased life expectancy,[14] impaired quality of life,[15] and high costs.[16] Therefore, prevention and control of obesity can play an important role in reducing the risk for such problems.

The prevalence of overweight and obesity is rapidly increasing in developing as well as industrialized countries.[17] Studies in the Eastern Mediterranean region (EMR) showed an alarmingly high prevalence of obesity, especially in urban areas and among women.[2–7] In Jordan, a high overall prevalence of obesity of 49.7% (32.7% among males and 59.8% among females) was reported in 1998.[5] In-depth studies in the Arab countries that determine the factors associated with obesity have been few. In the EMR, economic development has precipitated profound social and demographic changes over the past two decades. Changes in lifestyle, dietary habits, physical activity, and the social and cultural environment are associated with the occurrence of obesity.[18] In general, obesity in this region was found to be more prevalent among young, better educated, currently married, female, and unemployed.[18–20]

In epidemiological studies the most commonly used measure to define overweight and obesity is the body mass index (BMI). On the other hand, central obesity is measured by increase in waist circumference (WC) or waist-to-hip ratio (WHR).[21] Some controversy exists over the accuracy of the BMI

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for setting obesity standards. Because the BMI uses a standard weight-against-height formula, it doesn't take into account frame size and whether the weight is fat or muscle. Determining waist circumference eliminates the inconsistencies of the BMI. Waist circumference measurement is an important part of determining obesity and morbid obesity. Waist-to-hip ratio is also used as a guideline for determining obesity. This measurement determines how weight is distributed on the body. Therefore, different anthropometric measurements were used in the present study to determine the prevalence of obesity in northern Jordan, identify its associated factors, and assess its association with selected comorbidities. Furthermore, this study determined how the prevalence of obesity has changed in Jordan over 10 years.

Materials and Methods

Study population and data collection

This survey was conducted in the town of Sarih in northern Jordan to estimate the prevalence of cardiovascular disease risk factors. This town with about 3328 households and 19227 residents was selected because of the presence of a large comprehensive health center in which to perform the study, because of its proximity to the study team, and because this town showed the highest response rate in the 2002 Behavioral Risk Factor Survey (BRFS).[22] The 2002 BRFS did not show evidence to conclude that this town is different from other towns in the country in the prevalence of obesity and self-reported chronic diseases. Because the purpose of this survey was to study the epidemiology of risk factors of cardiovascular diseases, the required sample was calculated based on the prevalence of diabetes to yield the largest sample size. Minimum sample size needed was calculated assuming a prevalence of diabetes. The calculated sample size with a precision of $\pm 2\%$ and confidence level of 95% was 1086 subjects. A systematic sample of households (every sixth house) was made after a random start was selected. One week before the survey, a 2-member team (a male and a female) visited the selected households, explained the purpose of the study, and invited all residents aged 25 years and above, who were present at the time of the study, to attend the health centre at a given day after an overnight fast. Subjects on regular medications were asked not to take their medications early that day and to bring all their medications with them to the survey site. To encourage participation, community and religious leaders, local clubs, schools, and the municipality were contacted to secure subjects' cooperation. The study team offered free transportation to and from the health center upon request and worked all week days and weekends to encourage employed people to participate.

Participants attended the health centre early in the morning (7:30 to 10:00 AM). A pilot-tested structured questionnaire was administered by trained interviewers to collect information on sociodemographic factors as well as information on diabetes mellitus, hypertension, hyperlipidaemia, smoking habits, and potential risk factors.

Measurements and laboratory analysis

Anthropometric measurements including weight, height, and hip and waist circumference were measured with the subjects wearing light clothing and no shoes. Waist circumference was measured to the nearest centimeter using nonstretchable tailor's measuring tape at the narrowest point between the umbilicus and the rib cage and hip circumference in centimeters was measured at the widest part of the body below the waist.[24] Waist-to-hip ratio was calculated as the ratio of waist circumference to hip circumference. Body mass index (BMI) was calculated as the ratio of weight (kilograms) to the square of height (meters). Two readings of systolic (SBP) and diastolic blood pressure (DBP) were taken from the left arm with the subject seated and the arm at heart level, after at least 5 minutes of rest, using a standardized mercury sphygmomanometer. The mean of the two readings was taken as the individual's blood pressure.

For laboratory analysis and all biochemical measurements, two sets of fasting blood samples were drawn, with a fasting time of 10 to 12 hours, from a cannula inserted into the antecubital vein into sodium fluoride/potassium oxalate tubes for glucose and lithium heparin vacuum tubes for lipids. Samples were centrifuged within 1 hour at the survey site, and plasma was transferred to separate labeled tubes and transferred immediately in cold boxes filled with ice to the central laboratory of the Jordan University Hospital. All biochemical measurements were carried out by the same team of laboratory technicians and the same method throughout the study period. Fasting plasma glucose (FPG), cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and triglyceride were measured using a Cobas Analyzer (Roche, Basel, Switzerland).

Definition of variables

According to WHO guidelines, obesity for men and women was defined as a BMI of at least 30 kg/m^2, while overweight was defined as a BMI between 25 and 29.9 kg/m^2.[25] Obesity, based on WC, was defined as waist circumference more than 102 cm (40 in) in men and more than 88 cm (35 in) in women. Obesity, based on WHR, was defined as a WHR more than 0.90 for men and more than 0.85 for women.[26] A subject was defined as affected by diabetes mellitus if this diagnosis was known to the patient or, according to the ADA definition (fasting serum glucose of 7 mmol/L (126 mg/dL) or more).[27] Impaired fasting glucose was defined as a fasting serum glucose level of more than 100 mg/dL but less than 126 mg/dL. Other metabolic abnormalities were defined according to Adult Treatment Panel (ATP) III criteria.[28] High blood pressure was defined as systolic blood pressure at least 130 and/or diastolic blood pressure at least 85 mm Hg or on treatment for hypertension. Hypertriglyceridemia was defined as serum triglycerides level at least 150 mg/dL (1.69 mmol/L). Low HDL cholesterol was defined as serum HDL cholesterol less than 40 mg/dL (1.04 mmol/L) in men and less than 50 mg/dL (1.29 mmol/L) in women.

Statistical analysis

Age-specific prevalence rates of obesity were obtained. To facilitate comparison with other populations, we further derived a directly adjusted rate using the world population as a standard population. Data were described using means, standard deviations, and percentages, and analyzed using *t* test or chi-square test wherever appropriate. Factors asso-

Table 1. Demographic Characteristics and Smoking Status of 1121 Northern Jordanians Aged 25 Years or Older

Variable	Male (n = 394) n *(%)*	Female (n = 727) n *(%)*	Total (N = 1121) n *(%)*	P-*value*
Age (years)				<0.0001
25 to 29	32 (8.1)	76 (105)	108 (9.6)	
30 to 39	94 (23.9)	192 (264)	286 (25.5)	
40 to 49	106 (26.9)	204 (28.1)	310 (27.7)	
50 to 59	59 (15.0)	141 (19.4)	200 (17.8)	
60 and older	103 (26.1)	114 (15.7)	217 (19.4)	
Education				<0.0001
Illiterate	12 (3.0)	177 (24.3)	189 (16.9)	
1-11 years	139 (35.3)	258 (35.5)	397 (35.4)	
12 years or more	243 (61.7)	292 (40.2)	535 (47.7)	
Marital status				<0.0001
Married	349 (89.3)	605 (83.2)	954 (85.3)	
Single	39 (10.0)	47 (6.5)	86 (7.7)	
Widow or divorced	3 (0.8)	75 (10.3)	78 (6.9)	
Smoking				<0.0001
Current	126 (32.0)	17 (2.3)	143 (12.8)	
Past	69 (17.5)	13 (1.8)	82 (7.3)	
None	199 (50.5)	695 (95.9)	894 (79.9)	

ciated with obesity were analyzed using binary logistic regression analysis. Associations between the three anthropometric indices as categorical independent variables and, taken one by one, diabetes, hypertension, and dyslipidaemia as dependent variables were assessed separately, after controlling for important variables, using logistic regression analyses. Data were analyzed using the Statistical Package for Social Sciences software (SPSS, Chicago, IL), version 11.5. A *P*-value of less than 0.05 was considered statistically significant.

Results

Participants' characteristics

A total of 1121 participants (394 men and 727 women) aged 25 years and above completed all information for the study variables. Their sociodemographic characteristics are shown in Table 1. Age of the subjects ranged from 25 to 85 years with a mean of 46.2 (±13.2). About 52% of the subjects had less than high school education. Fifty four percent (54%) were married and 43% were single.

Table 2. Anthropometric and Metabolic Characteristics of 1121 Northern Jordanians Aged 25 Years or Older

Variable	*Male (n = 394) Mean ± SD**	*Female (n = 727) Mean ± SD*	*Total (N = 1121) Mean ± SD*	P-*value*
Weight (Kg)	81.6 ± 14.3	77.4 ± 14.2	78.9 ± 14.4	<0.0001
Height (cm)	169.6 ± 7.4	156.4 ± 6.6	161.1 ± 9.3	<0.0001
Waist circumference (cm)	93.5 ± 14.4	98.2 ± 13.5	96.6 ± 14.0	<0.0001
Hip circumference (cm)	113.9 ± 13.0	117.5 ± 11.7	116.2 ± 12.3	<0.0001
Body mass index (Kg/m^2))	28.3 ± 4.7	31.6 ± 5.8	30.5 ± 5.6	<0.0001
Waist to hip ratio	0.82 ± 0.07	0.84 ± .07	0.83 ± .07	0.001
Systolic blood pressure (mm Hg)	125.1 ± 16.0	123.9 ± 19.7	124.3 ± 18.5	0.275
Diastolic blood pressure (mm Hg)	78.6 ± 10.2	80.9 ± 12.4	80.1 ± 11.7	0.001
Fasting plasma glucose (mg/dL)	109.4 ± 43.9	109.8 ± 50.5	109.7 ± 48.2	0.886
Cholesterol (mg/dL)	197.8 ± 42.2	205.0 ± 42.4	202.5 ± 42.4	0.007
Triglycerides (mg/dL)	185.7 ± 116.1	152.6 ± 95.5	164.3 ± 104.4	<0.0001
Low-density lipoprotein (LDL; mg/dL)	122.4 ± 34.7	126.5 ± 37.1	125.1 ± 36.3	0.074
High-density lipoprotein (HDL; mg/dL)	38.2 ± 8.0	47.1 ± 12.4	44.0 ± 11.8	<0.0001

[a]SD Standard deviation

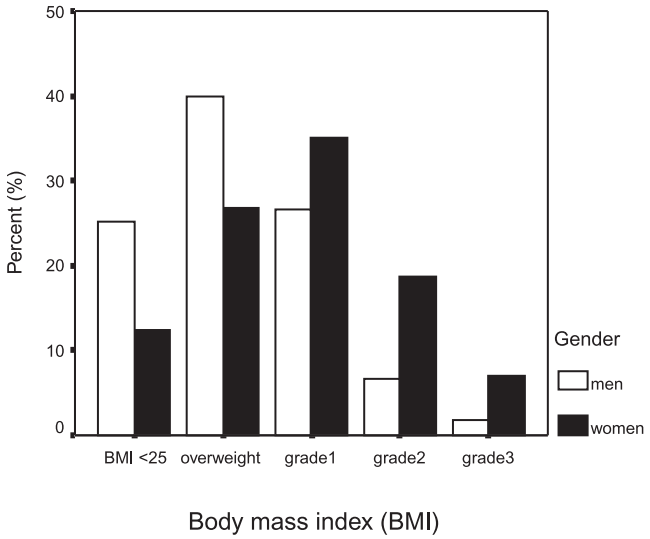

FIG. 1. The prevalence of overweight and obesity according to gender.

Anthropometric and clinical measurements

Table 2 shows anthropometric and metabolic characteristics of participants according to gender. The average waist circumferences, hip circumferences, BMI, WHR, HDL, total cholesterol, and DBP were significantly higher among women than men. Means of FPG, SBP, and LDL were not significantly different between men and women. Weight, height, and triglycerides level were significantly higher among men. Mean levels of BMI, WC, and WHR increased with increasing age, being higher among women than men in all age groups. Pair-wise partial correlation between BMI, WC, and WHR, after controlling for age, showed that BMI and WC were strongly correlated in both sexes. However, they were moderately correlated with WHR.

Prevalence of overweight and obesity

Based on BMI, the overall prevalence of overweight was 31.4 % (39.8% for men and 26.8% for women) and the prevalence of obesity was 51.7% (35.0% for men and 60.8% women) (Figure 1). The age-standardized prevalence of overweight was 36.2% (95% confidence interval [CI]: 30.4, 42.0) for men and 28.8% (95% CI: 24.8, 32.8) for women. The age-standardized prevalence of obesity was 28.1% (95% CI: 23.4, 32.8) for men and 53.1% (95% CI: 49.3, 57.0) for women. The prevalence of overweight (BMI 25-29.9 kg/m^2) and prevalence of obesity based on BMI, WC, and WHR according to gender and age are shown in Table 3. Irrespective of age or measure used, women always had a considerably higher prevalence of obesity than men. The prevalence of obesity varied greatly with age, generally increasing, irrespective of the measurement used (P-value for trend <0.001 for both genders). The difference in prevalence of obesity between men and women was particularly large in the older age groups. Based on age-standardized values, BMI provided the highest prevalence of obesity among men (28.1%) followed by WC (11.8%), while WC yielded the highest prevalence of obesity among women (59.4%) followed by BMI (53.1%). WHR yielded the lowest prevalence among both men (8.8%) and women (31.5%).

The prevalence of overweight (BMI 25-29.9 kg/m^2) demonstrated a very different pattern. While the prevalence was slightly higher for women than men in the age group 25 to 29 years, it was much higher among men compared to women in the older age groups. The prevalence of over-

TABLE 3. AGE AND SEX-SPECIFIC AVERAGE ANTHROPOMETRIC MEASUREMENTS AND PREVALENCE OF OBESITY DEFINED BY BODY MASS INDEX, WAIST CIRCUMFERENCE, AND WAIST-TO-HIP RATIO AMONG ADULTS AGED 25 YEARS OR OLDER IN JORDAN*

	Body mass index (BMI)			*Waist circumference (WC)*			*Waist-hip ratio (WHR)*	
Gender/age (year)	N	*Mean (SD)*	*Overweight* n *(%)*	*Obesity* n *(%)*	*Mean (SD)*	*High WC* n *(%)*	*Mean (SD)*	*High WHR* n *(%)*
Men								
25–29	32	24.5 (4.0)	8 (25.0)	3 (9.4)	80.5 (13.6)	1 (3.1)	0.74 (0.06)	0 (0.0)
30–39	94	27.3 (4.6)	38 (40.4)	26 (27.7)	89.3 (11.9)	6 (6.4)	0.78 (0.06)	4 (4.3)
40–49	106	29.2 (5.5)	42 (39.6)	43 (40.6)	94.7 (13.2)	19 (17.9)	0.83 (0.06)	17 (16.0)
50–59	59	28.9 (4.5)	25 (42.4)	22 (37.3)	94.5 (16.7)	10 (16.9)	0.84 (0.09)	8 (13.6)
≥60	103	29.6 (4.8)	44 (42.7)	44 (42.7)	99.8 (12.7)	29 (28.2)	0.86 (0.06)	23 (22.3)
Total	394	28.4 (5.1)	157 (39.8)	138 (35.0)	93.5 (14.3)	65 (16.5)	0.82 (0.07)	52 (13.2)
Age standardized			36.2	28.1		11.8		8.8
(95% CI)			(30.4, 42.0)	(23.4, 32.8)		(8.6, 15.0)		(6.4, 11.3)
Women								
25–29	76	26.8 (5.3)	24 (31.6)	20 (26.3)	84.1 (11.2)	21 (27.6)	0.78 (0.05)	7 (9.2)
30–39	192	29.8 (5.3)	67 (35.3)	90 (47.4)	92.2 (11.7)	100 (52.1)	0.81 (0.07)	44 (22.9)
40–49	204	32.7 (5.5)	46 (23.0)	141 (70.5)	99.9 (12.2)	149 (73.0)	0.84 (0.07)	79 (38.7)
50–59	141	34.0 (5.6)	29 (20.7)	105 (75.0)	104.6 (11.7)	125 (88.7)	0.86 (0.06)	72 (51.1)
≥60	114	33.2 (5.2)	27 (23.7)	82 (71.9)	106.7 (9.8)	107 (93.9)	0.89 (0.06)	81 (71.1)
Total	727	31.7 (5.8)	193 (26.8)	438 (60.8)	98.2 (13.5)	502 (69.1)	0.83 (0.07)	283 (38.9)
Age standardized			28.8	53.1		59.4		31.5
(95% CI)			(24.8, 32.8)	(49.3, 57.0)		(55.7, 63.2)		(28.3, 34.7)

*A BMI between 25 and 29.9 kg/m^2 was defined as overweight and a BMI 30 kg/m^2 or greater was defined as obesity. High WC was defined as greater than 102 cm in men and greater than 88 cm in women. High WHR was defined as 0.95 or more in men and 0.85 or more in women.

TABLE 4. PREVALENCE OF OVERWEIGHT AND PREVALENCE OF OBESITY AS DEFINED BY BODY MASS INDEX, WAIST CIRCUMFERENCE AND WAIST-HIP RATIO ACCORDING TO SOCIODEMOGRAPHIC AND IMPORTANT CHARACTERISTICS AMONG ADULTS AGED 25 YEARS AND OLDER IN JORDAN*

	Body mass index (BMI)			
	Overweight n *(%)*	*Obesity* n *(%)*	*High waist circumference (WC)* n *(%)*	*High waist-hip ratio (WHR)* n *(%)*
Gender				
Male	157 (39.8)	138 (35.0)	65 (16.5)	52 (13.2)
Female	193 (26.8)	438 (60.8)	502 (69.1)	283 (38.9)
Age (year)				
25–29	32 (29.6)	23 (21.3)	22 (20.4)	7 (6.5)
30–39	105 (37.0)	116 (40.8)	106 (37.1)	48 (16.8)
40–49	88 (28.8)	184 (60.1)	168 (54.2)	96 (31.0)
50–59	54 (27.1)	127 (63.8)	135 (67.5)	80 (40.0)
≥60	71 (32.7)	126 (58.1)	136 (62.7)	104 (47.9)
Years of education				
<12	156 (26.9)	364 (62.7)	399 (68.1)	261 (44.5)
≥12	194 (36.4)	212 (39.8)	168 (31.4)	74 (13.8)
Marital status				
Married	300 (31.6)	515 (54.2)	491 (51.5)	281 (29.5)
not married	50 (30.5)	61 (37.2)	76 (45.5)	54 (32.3)
Smoking status				
Current	68 (47.6)	32 (22.4)	23 (16.1)	20 (14.0)
Former	29 (35.4)	45 (54.9)	27 (32.9)	14 (17.1)
Never	252 (28.4)	498 (56.1)	516 (57.7)	301 (33.7)
Diabetes mellitus				
No	258 (33.7)	343 (44.8)	332 (43.0)	183 (23.7)
Impaired	37 (22.0)	118 (70.2)	111 (66.1)	60 (35.7)
Diabetes	55 (30.6)	114 (63.3)	123 (68.3)	91 (50.6)
Hypertension				
No	206 (36.5)	218 (38.7)	214 (37.7)	120 (21.1)
Yes	144 (26.2)	358 (65.1)	353 (63.8)	215 (38.9)
Low HDL				
No	126 (30.5)	180 (43.6)	175 (42.1)	100 (24.0)
Yes	224 (32)	396 (56.5)	392 (55.6)	235 (33.3)
Hypertriglyceridemia				
No	196 (31.2)	278 (44.3)	284 (44.9)	155 (24.5)
Yes	154 (31.7)	298 (61.3)	283 (57.9)	180 (36.8)

* A BMI between 25 and 29.9 kg/m^2 was defined as overweight and a BMI 30 kg/m^2 or higher was defined as obesity. High WC was defined as WC over 102 cm in men and over 88 cm in women. High WHR was defined as a WHR 0.95 or greater in men and 0.85 or more in women.

weight and prevalence of obesity as defined by BMI, WC, and WHR according to sociodemographic and relevant characteristics among adults aged 25 years and older in Jordan are shown in Table 4.

The change in the prevalence of obesity over 10 years

Table 5 shows the change in the prevalence of obesity (BMI ≥30 kg/m^2) between the two surveys that were conducted 10 years apart in the same population (1994 and 2004). In both

TABLE 5. THE CHANGE IN THE PREVALENCE OF OBESITY (BODY MASS INDEX ≥30 KG/M^2) FOR ADULTS AGED 25 YEARS OR OLDER IN JORDAN BETWEEN 1994 AND 2004 ACCORDING TO AGE AND GENDER

	1994		*2004*		
	N	n *(%)*	N	N *(%)*	*Change (95% CI)*
Gender					
Men	226	57 (25.1)	394	138 (35.0)	9.9 (2.6, 17.3)
Women	472	244 (51.7)	720	438 (60.8)	9.1 (3.4, 14.9)
Age (year)					
25–29	113	19 (16.6)	108	23 (21.3)	4.7 (−5.6, 15.0)
30–39	161	61 (37.7)	284	116 (40.8)	3.1 (−6.3, 12.6)
40–49	155	86 (55.3)	306	184 (60.1)	4.8 (−4.7, 14.4)
50–59	138	77 (55.9)	199	127 (63.8)	7.9 (−2.7, 18.6)
≥60	131	58 (44.5)	217	126 (58.1)	13.6 (2.8, 24.3)
Total	698	301 (43.1)	1114	576 (51.7)	8.6 (3.9, 13.3)

Table 6. Adjusted Odds Ratios (95% Confidence Interval) of Metabolic Abnormalities Associated with Overweight, Obesity (Body Mass Index (BMI) ≥ 30 Kg/M^2), High Waist Circumference (WC), wnd High Waist-to-Hip Ratio (WHR)*

	Dependent variables				
Independent variable	*Impaired fasting glycemia*	*Diabetes mellitus*	*Hypertension*	*Low HDL cholesterol*	*Hypertriglyceridemia*
BMI (kg/m^2)					
<25					
≥25–29.9	1.90 (0.97, 3.76)	1.97 (0.94, 4.14)	1.54 (1.00, 2.38)	2.24 (1.54, 3.26)	3.52 (2.24, 5.53)
≥30	4.81 (2.56, 9.04)	2.25 (1.09, 4.65)	3.23 (2.11, 4.93)	2.79 (1.93, 4.06)	5.23 (3.33, 8.20)
High WC vs normal WC	4.57 (2.86, 7.32)	2.04 (1.24, 3.38)	2.22 (1.60, 3.07)	1.95 (1.43, 2.66)	2.52 (1.81, 3.51)
High WHR vs normal WHR	1.81 (1.22, 2.70)	1.41 (0.87, 2.31)	1.40 (1.03, 1.90)	1.53 (1.14, 2.07)	1.86 (1.39, 2.50)

*Associations between the three anthropometric indices as categorical independent variables and, taken one by one, metabolic abnormalities as dependent variables were assessed separately, after controlling for important variables, using logistic regression analyses. Impaired fasting glycemia model included sex, years of education, and family history of diabetes. Diabetes mellitus model included sex, age, years of education, and family history of diabetes. Hypertension model included sex, age, and smoking. Low HDL cholesterol model included sex and age. Hypertriglyceridema model included sex and age.

surveys, the study population, data collection, measurements, and laboratory analysis were identical. Compared to the 1994 survey, there were changes in the distributions of age, education, BMI, and smoking status. The tendency in the recent survey (2004) was toward a lower proportion of younger people (25-29 years), a smaller proportion of illiterates (16.9% vs. 36.5%), and a smaller proportion of smokers.

There has been a significant increase in the prevalence of obesity between the two surveys for both men and women. However, the increase was statistically significant for people aged 60 years and above only.

Obesity comorbidities

The prevalence of metabolic abnormalities increased with increasing BMI. When important variables were taken into account in logistic regression analyses for each metabolic abnormality, obesity as measured by BMI and WC (separate models) were significantly associated with increased odds of having all studied metabolic abnormalities (Table 6). Overweight was significantly associated with increased odds of having hypertension, low HDL-cholesterol, and hypertriglyceridaemia only. High WHR was significantly associ-

Table 7. Multivariate Analysis of Factors Associated with Obesity (BMI ≥ 30 Kg/M^2), High Waist Circumference (WC), wnd High Waist-to-Hip Ratio (WHR) among Adults aged 25 Years or Older in Jordan*

	Obesity (BMI ≥ 30 kg/m^2)		*High WC*		*High WHR*	
	OR (95% CI)	P-*value*	*OR (95% CI)*	P-*value*	*OR (95% CI)*	P-*value*
Gender						
Men	1		1		1	
Women	3.3 (2.0, 5.5)	<0.0005	13.2 (8.2, 21.3)	<0.0005	3.1 (2.0, 4.6)	<0.0005
Marital status						
unmarried	1		1			
Married	2.7 (1.4, 5.2)	0.0024	2.1 (1.2, 3.7)	0.0132		
Smoking						
Current	1		1			
Former	4.4 (1.7, 11.4)	0.0024	2.4 (1.1, 5.5)	0.0315		
Never	2.5 (1.3, 4.8)	0.0053	2.3 (1.2, 4.4)	0.0164		
Age (year)						
25–29	1		1		1	
30–39	3.7 (1.9, 7.2)	<0.0005	2.3 (1.3, 4.2)	0.0057	3.1 (1.4, 7.3)	0.0078
40–49	10.2 (5.0, 20.7)	<0.0005	5.7 (3.1, 10.4)	<0.0005	6.1 (2.7, 14.0)	<0.0005
50–59	10.1 (4.3, 23.6)	<0.0005	8.8 (4.3,18.1)	<0.0005	5.0 (2.1, 11.9)	<0.0005
≥60	9.5 (3.8, 24.0)	<0.0005	9.2 (4.1, 20.4)	<0.0005	6.8 (2.6, 17.7)	<0.0005
Years of education						
≥12	1		1		1	
<12	1.7 (1.1, 2.6)	0.0236	2.4 (1.7, 3.4)	<0.0005	2.5 (1.8, 3.6)	<0.0005

ated with increased odds of all metabolic abnormalities except diabetes mellitus.

Factors associated with obesity

Table 7 shows the multivariate analysis of factors associated with overall obesity, high WHR, and high WC among adults aged 25 years and older in Jordan. Female gender, increase in age, being married, former smoker or nonsmoker, and fewer than 12 years of education were significantly associated with increased odds of BMI-defined obesity and high WC. On the other hand, the same variables except marital status and smoking status were significantly associated with increased odds of high WHR.

Discussion

Once considered as the main public health problem worldwide, the present study assessed obesity in the adult population in northern Jordan using different anthropometric measurements. This study highlighted the high prevalence of overweight measured by BMI and obesity whether measured by BMI, WC, or WHR in Jordan. Compared to studies that reported age-standardized estimates, the age-adjusted prevalence of obesity (BMI $\geq$30 kg/m^2) among Jordanian women (53.1%) was higher than that reported among Saudi women (44%), Iranian women (34.9%), and American women (33.2%),[29,30] and close to that among Turkey women (51.0%).[31] For men, the age-adjusted prevalence of obesity (BMI $\geq$30 kg/m^2) among Jordanians (28.1%) was higher than that among Turkish (15.1%) and Iranian men (16.2%), and close to that among Saudi (26.4%) and Americans (27.5%). Although direct comparisons of crude rates are difficult because of differences in the study populations' age groups, the estimated overall prevalence of BMI-defined obesity in Jordan is higher than that in the US, the Netherlands, and Italy,[32–34] and higher than that reported in Middle East countries.[29,35–40]

A remarkable variation in the prevalence of both overweight and obesity between the sexes was observed in this study as well as other studies conducted in the Middle East.[30,35,37] Obesity is clearly more prevalent in women. These differences are probably biologically based and relate to men's ability to deposit more lean (muscle) than fat tissue when energy imbalance occurs with weight gain.[41] Furthermore, differences in physical activity or calorie intake may explain the gender differences.

The prevalence of obesity varied greatly with age in this study, generally increasing, irrespective of the measurement used. The mean BMI was reported by many studies[42–44] to be gradually increasing in both sexes by age until it reaches peak at fifth decade, after which it tends to decrease. This decrease after the age of 60 years old may be explained by survival bias because obese persons have higher mortality rates at younger ages,[45] but this was not observed in this study.

The increasing prevalence of obesity is not limited to this country. In the last decade alone the prevalence of obesity in the US has increased from 12.0% in 1991 to 17.9% in 1998,[46] and has reached 21.9% during the year 2002 with a prevalence over 20% in more than 39 US states.[47] Increased modernization and a westernized diet and lifestyle are associated with an increased prevalence of obesity in Jordan as well as in many developing countries.

BMI and WC were strongly correlated in both sexes. The correlation of indices of overall and central obesity is highly suggestive of an association between increased overall obesity with increased visceral fat.

Female gender, increase in age, being married, former smoker or nonsmoker, and fewer than 12 years of education were significantly associated with increased odds of BMI-defined obesity. Studies in developed countries have shown that the lower the education or the social class, the higher the prevalence of obesity. However, in developing countries, a strong positive relationship often exists between socioeconomic status and obesity.[26] This study showed that the lower the level of education, the higher the prevalence of obesity whether measured by BMI, WC, or WHR. Number of years of education can be used as a proxy for socioeconomic status.

Smoking was shown to be associated with lower odds of obesity. It has been claimed that decreasing rates of smoking in the US is one of the important contributing factors to the rising prevalence of obesity in the US.[32]

Another important result of our study was the significant association with obesity of all studied metabolic abnormalities, including impaired fasting glycemia, diabetes mellitus, hypertension, low HDL cholesterol, and hypertriglyceridemia.

In conclusion, our study has demonstrated alarming rates of obesity and its associated comorbidities among Jordanians, especially among women.

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