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Original Communication
Obesity and associated factors in a Palestinian West Bank village population

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Objective: To describe body mass index (BMI), waist circumference and waist-hip ratio in a Palestinian West Bank village population, and to assess the associations of these variables to blood pressure and serum lipids.
Design: Cross-sectional study.
Setting: Community-based study in a prototypic semi-rural Palestinian village in the central West Bank.
Subjects: All individuals aged 30–65 y in the study village were invited for the study and 500 (85%) participated.
Main outcome measures: BMI≥30 was used as the measure of obesity.
Results: The prevalence of obesity was 37.5% among women and 18.8% among men. The prevalence of abdominal obesity was 62.5% among women and 14.8% among men. BMI seemed to be the more important correlate of blood pressure whereas waist–hip ratio seemed to be the more important correlate of serum triglycerides, compared to the other obesity measures.
Conclusions: The prevalence of obesity in the study population was very high compared to most other countries in the world, particularly among women.
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Descriptors: anthropometry; body mass index; cross-sectional survey; developing country; obesity; waist–hip ratio; abdominal obesity
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Introduction

Obesity is an important public health problem. Both overall and abdominal obesity are associated with non-communicable chronic diseases such as type 2 diabetes mellitus and cardiovascular diseases (Björntorp, 1988; Lapidus *et al*, 1984; Manson *et al*, 1995; Modan *et al*, 1986). The prevalence of obesity is increasing in many developed countries (Kuczmarski *et al*, 1994; Kuskowska-Wolk & Bergström, 1993; Prentice & Jebb, 1995), as well as in many developing countries (Hodge *et al*, 1996; Monteiro *et al*, 1995; Popkin, 1994; Popkin *et al*, 1995). Although there is a general lack of data, there are indications that diet-related non-communicable chronic diseases have increased in several Middle Eastern countries (Musaiger & Miladi, 1996). Few nationally representative surveys of obesity exists from this region, with the exception of Saudi Arabia (al-Nuaim *et al*, 1996b). There are also very few studies of abdominal obesity from the Middle Eastern region (al-Rehaimi & Björntorp, 1992). Recently, a few studies of obesity in populations from Arab countries in the Middle Eastern region have been published, indicating that the prevalence of obesity is higher than in most other countries of the world (Ajlouni *et al*, 1998; al-Isa, 1995; al-Nuaim *et al*, 1996b; Musaiger, 1996; Pishdad, 1996). Our objective in this article is to provide the first descriptive data on obesity among adults in a Palestinian West Bank population. Furthermore, we have estimated the associations of body mass index (BMI), waist circumference and waist–hip ratio with blood pressure, serum triglycerides, serum total and high-density lipoprotein cholesterol.

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Contributors: RG and GH-O are the principal investigators. AH was responsible for the data collection. RG, GH-O, KRN and AH designed the study. LCMS designed the analysis strategy, carried out the data analyses, and wrote the paper. All contributors helped interpreting the data and gave comments on earlier drafts of the manuscript.
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Subjects and methods

Subjects

For the purpose of this study, a West Bank village, Kobar, was selected to serve as a prototypic village of the Ramallah district in the central region of the Palestinian West Bank. Kobar is a Muslim, semi-rural village located about 15 km from the nearest city, Ramallah. Most of the wage-workers from Kobar are employed in Ramallah in low-paid unskilled work or semi-skilled manual work such as building or painting. Less than 10% of men aged 30–65 state agriculture as their main occupation. Few women are formally employed.

The study was carried out in two phases, a household survey completed in June 1996 and a study of individuals aged between 30 and 65 y, which was carried out from December 1996 to January 1997. Field workers were hired from the village and trained at Birzeit University. Information meetings were held in the village before the initiation of the study, and the purpose of the study was explained. In the first phase, all the households in the study village were visited by field workers. A structured questionnaire was administered to the female head of the household. She provided information on age, sex, marital status, main occupation and educational attainment of each household member. In the second phase of the study, all individuals between 30 and 65 y of age residing in the village were invited to participate in a more detailed health study, which included drawing of blood samples, blood pressure and anthropometric measurements. Information on tests and procedures involved were explained, and informed consent was obtained from each participant.

Measurements

Respondents were given individual appointments to come for testing in the village hall in the morning after an overnight fast. Anthropometric measurements were taken with respondents in light clothing and with shoes removed. Body weight was measured to the nearest 0.1 kg, using a balance scale. Height was measured to the nearest cm with a vertical ruler. BMI was calculated as weight (kg) divided by height (m) squared. Obesity was defined as BMI≥30 (WHO, 1995). Waist and hip circumferences were measured with a measuring tape to the nearest 0.1 cm. Waist circumference was measured at the level midway between the lower rib and the iliac crest, and hip circumference was measured at the maximal circumference over the buttocks. The ratio between the two circumferences, the waist–hip ratio (WHR), was calculated. Waist circumferences of 102 cm or more for men and 88 cm or more for women were defined as abdominal obesity (Lean *et al*, 1995). Blood samples were drawn 2 h after a standard oral glucose tolerance test (75 g glucose in 250 ml water). Serum concentrations of total cholesterol, high-density lipoprotein (HDL) cholesterol and triglycerides were determined by standard enzymatic methods. Systolic and diastolic blood pressure were measured using a standard sphygmomanometer with the subject in the sitting position. The same female physician measured the blood pressure of all women, and the same male nurse measured the blood pressure of all men. A structured questionnaire on lifestyle and socio-demographic factors was administered by trained interviewers.

Data analysis

Data analysis was done using SPSS for Windows, version 8.0. Data on men and women were analysed separately. Twenty-one pregnant women were excluded from the analysis. The point prevalence of obesity was directly standardised to the world population age structure (WHO, 1996). Associations of BMI and waist circumference with systolic blood pressure and serum lipids were estimated using linear regression with BMI and waist circumference as continuous independent variables. Age was added to the regression models to adjust for potential confounding. Associations between BMI and other variables were also adjusted for waist circumference and vice versa by including both waist circumference and BMI in the same models. The linear regression coefficient was used as a measure of association. It is interpreted as the increase in the dependent variable corresponding to a one-unit increase in the independent variable (when the other variables in the model are kept fixed). Variables with skewed frequency distribution were log-transformed (to base 10) if this resulted in an improved model fit. When the dependent variable is log transformed, the regression coefficient exponentiated may be interpreted approximately as the proportionate increase in the dependent variable corresponding to a one unit increase in the independent variable (Altman, 1991). Model fit was assessed by inspecting residual plots. A two-sided *P*-value less than 0.05 or a 95% confidence interval (CI) excluding the value zero for the regression coefficient was regarded as statistically significant.

Results

All 368 households in the selected village participated in the study. The total population was 2360, with 44% below

Table 1 Summary descriptive statistics for selected variables in the study population consisting of women and men aged 30–65 y from a Palestinian West Bank village[a]

	Women	*Men*
	Mean (s.d.)	*Mean (s.d.)*
Age (y)	44.6 (11.0)	43.9 (10.1)
Weight (kg)	67.2 (14.5)	73.4 (14.1)
Height (cm)	153.2 (6.8)	166.3 (7.2)
Total serum cholesterol (mM)	4.98 (0.99)	5.18 (0.97)
HDL-cholesterol (mM)	1.23 (0.35)	1.08 (0.43)
Serum triglycerides (mM)[b]	1.22 (0.67)	1.53 (1.19)
Diastolic blood pressure (mmHg)	73.8 (11.4)	79.5 (8.8)
Systolic blood pressure (mmHg)	122.9 (22.5)	126.3 (17.2)

[a]There were 269 women (56.3%) and 209 men (43.7%) included in the analysis, after exclusion of 21 pregnant women.
[b]Frequency distribution skewed towards the right tail. s.d.: standard deviation. HDL: high-density lipoprotein.

the age of 15 y. Eighty-five percent of eligible individuals participated in the survey of men and women aged 30−65 y (95% for women and 75% for men). Summary descriptive statistics for the study factors in the study population are presented in Table 1.

Prevalence of obesity

The prevalence of obesity among women was 37.5%, and it increased markedly from the 30−39 age group to the 40−49 age group (Table 2). Among women aged 40−59, the prevalence of obesity was more than 50%. Among men, the total prevalence of obesity was 18.8%. There was a steady increase in the prevalence of obesity from the 30−39 age group to the 50−59 age group (Table 2). The linear relationship between age and BMI was highly significant ($P < 0.001$), although it was stronger among women that among men. The prevalence of obesity among women (pooled for all age groups) was about twice that of men. Since this population is relatively young, the total prevalence of obesity was slightly increased when directly standardised to the world population (WHO, 1996). For women, the total prevalence of obesity was 42.1% when standardised to the world population of 30−64 y. For men, the total age-standardised prevalence of obesity was 19.5%.

Table 2 Prevalence of overweight and obesity, and mean body mass index, by age group among women and men in a Palestinian village in the West Bank[a]

Gender	*Age group*	*BMI 25−29.9*	*BMI≥30*	*BMI Mean (s.d.)*	n
Women	30−39	36.0%	18.0%	26.1 (4.1)	111
	40−49	32.3%	52.3%	31.2 (7.6)	65
	50−59	27.3%	56.4%	30.8 (5.4)	55
	60−65	39.5%	42.1%	28.4 (4.3)	38
	30−65	33.8%	37.5%	28.6 (5.7)	269
Men	30−39	38.2%	14.6%	25.9 (5.0)	89
	40−49	45.9%	19.7%	27.0 (4.5)	61
	50−59	25.7%	25.7%	26.3 (3.9)	35
	60−65	52.2%	21.7%	27.4 (4.0)	23
	30−65	39.9%	18.8%	26.5 (4.6)	208

[a]Overweight and obesity defined by body mass index (BMI) according to cut-off values recommended by the WHO. Twenty-one pregnant women were excluded. s.d.: standard deviation.

Waist circumference, WHR and correlation to BMI

The prevalence of abdominal obesity increased strongly with age to more that 90% among the oldest women (Table 3). The overall prevalence of abdominal obesity was lower among men than among women, and increased with age to more than 30% among the oldest men. The overall mean WHR was 0.88 for women and 0.93 for men (Table 3). There was little increase in hip circumference with age, but there was a significant increase in both waist circumference and WHR with age ($P < 0.001$), most strongly from the 30−39 to the 40−49 age group. Pearson's correlation coefficient between waist circumference and BMI was 0.85 among women and 0.91 among men. The correlation coefficient between WHR and BMI was 0.26 for women and 0.54 for men.

Association of BMI with blood pressure and blood lipids

The results of regression analyses of associations of BMI with blood pressure and blood lipids are shown in Table 4. BMI was significantly associated with blood pressure. The strength of association was modestly reduced after adjustment for age, but it was hardly influenced by further adjustment for WHR. However, the association between BMI and blood pressure was weaker after adjustment for waist circumference, particularly among women. There was a borderline significant association between BMI and serum triglycerides. The estimates indicated an increase of about 2% for women and about 5% for men corresponding to a one unit increase in BMI, but this was weaker after adjustment for waist circumference. Adjustment for age

Table 3 Mean waist circumference, hip circumference and waist-hip ratio, and prevalence of abdominal obesity by age group among women and men in a Palestinian village in the West Bank[a]

Age group	*Waist circumference Mean (s.d.)*	*Hip circumference Mean (s.d.)*	*Waist−hip ratio Mean (s.d.)*	*Abdominal obesity*[b]	n
Women					
30−39	84.1 (10.5)	100.1 (9.2)	0.84 (0.08)	36.0%	111
40−49	96.1 (15.4)	108.5 (13.9)	0.89 (0.08)	72.3%	65
50−59	97.1 (10.2)	109.1 (10.6)	0.90 (0.07)	83.6%	55
60−65	97.1 (10.1)	104.5 (10.7)	0.93 (0.07)	92.1%	38
30−65	91.6 (13.3)	104.6 (11.6)	0.88 (0.08)	62.5%	269
Men					
30−39	86.5 (11.9)	95.8 (9.7)	0.90 (0.06)	6.7%	89
40−49	91.3 (11.5)	96.3 (8.5)	0.95 (0.06)	17.7%	62
50−59	90.3 (10.9)	95.5 (7.4)	0.94 (0.07)	17.1%	35
60−65	95.8 (11.0)	97.5 (7.3)	0.98 (0.07)	34.8%	23
30−65	89.6 (11.9)	96.1 (8.7)	0.93 (0.07)	14.8%	209

[a]Twenty-one pregnant women were excluded from the analysis.
[b]Defined as waist circumference ≥102 cm for men and ≥88 cm for women.

and WHR, however, had little influence on this result. BMI was negatively associated with HDL-cholesterol, but the association was weak and only borderline significant. There was no significant association between BMI and serum total cholesterol, except a weak unadjusted association among women, which disappeared upon adjustment for age and WHR.

Associations of waist circumference with blood pressure and blood lipids

The patterns of crude and age adjusted associations of waist circumference with blood pressure and blood lipids (Table 5) were generally very similar to that of BMI with blood pressure (Table 4). However, in models with both BMI and waist circumference, the association between waist circumference and blood pressure tended to diminish (Table 5), whereas the associations between BMI and blood pressure were still significant. The opposite pattern was seen for blood lipids, although the associations were generally relatively weak (Table 5).

Associations of WHR with blood pressure and blood lipids

The unadjusted association of between WHR and systolic blood pressure was relatively strong, but disappeared after adjustment for age and BMI (Table 6). There was a relatively strong association between WHR and serum triglycerides, which persisted even after adjustment for age and BMI. According to the regression models, a one-tenth unit increase in WHR predicted an approximately 20–40% increase in serum triglycerides, depending on gender and which factors were adjusted for. There was a negative association between WHR and HDL-cholesterol among men persisting after adjustment for BMI, but there was no signifi-

Table 4 Associations of body mass index with blood pressure and blood lipids among adults in a Palestinian West Bank village population

	Linear regression coefficient[a] *(95% CI), adjusted for*:			
	Unadjusted	*Age*	*Age and waist*	*Age and WHR*
Women				
Diastolic blood pressure (mmHg)	0.9 (0.7, 1.1)	0.8 (0.6, 1.0)	0.6 (0.2, 1.0)	0.8 (0.6, 1.0)
Systolic blood pressure (mmHg)	1.6 (1.2, 2.0)	1.2 (0.8, 1.6)	0.9 (0.1, 1.6)	1.2 (0.8, 1.6)
Serum total cholesterol (mM)	0.03 (0.01, 0.05)	0.02 (−0.01, 0.04)	0.004 (−0.03, 0.04)	0.02 (−0.01, 0.04)
Serum HDL-cholesterol (mM)	−0.01 (−0.02, 0.00)	−0.01 (−0.02, 0.00)	−0.001 (−0.02, 0.01)	−0.01 (−0.01, 0.00)
Log_{10} serum triglycerides (mM)	0.01 (0.01, 0.02)	0.01 (0.01, 0.02)	−0.002 (−0.01, 0.005)	0.01 (0.00, 0.01)
Men				
Diastolic blood pressure (mmHg)	0.8 (0.6, 1.0)	0.8 (0.5, 1.0)	0.09 (−0.5, 0.7)	0.7 (0.4, 1.0)
Systolic blood pressure (mmHg)	1.6 (1.1, 2.0)	1.4 (1.0, 1.9)	0.6 (−0.5, 1.6)	1.4 (0.8, 1.9)
Serum total cholesterol (mM)	0.02 (−0.01, 0.05)	0.02 (−0.01, 0.05)	0.008 (−0.06, 0.08)	0.01 (−0.02, 0.05)
Serum HDL-cholesterol (mM)[b]	−0.01 (−0.02, 0.00)	−0.01 (−0.02, 0.00)	−0.02 (−0.01, 0.05)	0.00 (−0.01, 0.2)
Log_{10} serum triglycerides (mM)	0.02 (0.01, 0.03)	0.02 (0.01, 0.03)	−0.001 (−0.02, 0.02)	0.01 (0.004, 0.02)

[a]The estimated increase in the dependent variable corresponding to an increase of one unit body mass index when the factors adjusted for are kept fixed.
[b]Three outliers were detected in these models. When the outliers were excluded, the age adjusted coefficient changed to −0.14 (−0.02, −0.005).
WHR: waist–hip ratio.

Table 5 Associations of waist circumference with blood pressure and blood lipids among adult men and women in a Palestinian West Bank village population

	Linear regression coefficient[a] *(95% CI), adjusted for*:		
	Unadjusted	*Age*	*Age and BMI*
Women			
Diastolic blood pressure (mmHg)	0.4 (0.3, 0.5)	0.4 (0.3, 0.5)	0.1 (−0.1, 0.3)
Systolic blood pressure (mmHg)	0.8 (0.6, 1.0)	0.5 (0.3, 0.7)	0.2 (−0.2, 0.5)
Serum total cholesterol (mM)	0.02 (0.01, 0.03)	0.01 (0.001, 0.02)	0.01 (−0.01, 0.03)
Serum HDL-cholesterol (mM)	−0.004 (−0.01, −0.001)	−0.004 (−0.01, −0.001)	−0.004 (−0.01, 0.003)
Log_{10} serum triglycerides (mM)	0.008 (0.006, 0.01)	0.006 (0.005, 0.01)	0.007 (0.004, 0.01)
Men			
Diastolic blood pressure (mmHg)	0.3 (0.3, 0.4)	0.3 (0.2, 0.4)	0.3 (0.1, 0.5)
Systolic blood pressure (mmHg)	0.7 (0.5, 0.9)	0.6 (0.4, 0.7)	0.4 (−0.05, 0.8)
Serum total cholesterol (mM)	0.01 (0.00, 0.02)	0.008 (0.00, 0.02)	0.005 (−0.02, 0.03)
Serum HDL-cholesterol (mM)	−0.005 (−0.01, 0.000)	−0.005 (−0.01, 0.000)	−0.1 (−0.02, 0.001)
Log_{10} serum triglycerides (mM)	0.009 (0.006, 0.01)	0.009 (0.006, 0.01)	0.009 (0.003, 0.02)

[a]The estimated increase in the dependent variable corresponding to an increase of cm in waist circumference when the factors adjusted for are kept fixed.
BMI: body mass index.

Table 6 Associations of waist-hip ratio with blood pressure and blood lipids among adult men and women in a Palestinian West Bank village population

	Linear regression coefficient[a] *(95% CI), adjusted for*:		
	Unadjusted	*Age*	*Age and BMI*
Women			
Diastolic blood pressure (mmHg)	3.2 (1.6, 4.9)	2.0 (0.2, 3.8)	1.0 (−0.7, 2.6)
Systolic blood pressure (mmHg)	7.9 (4.7, 11.1)	2.1 (−1.0, 5.2)	0.5 (−2.4, 3.5)
Serum total cholesterol (mM)	0.32 (0.02, 0.5)	0.17 (0.02, 0.3)	0.14 (−0.01, 0.3)
Serum HDL-cholesterol (mM)	−0.04 (−0.09, 0.02)	−0.03 (−0.09, 0.03)	−0.02 (−0.08, 0.04)
Log_{10} serum triglycerides (mM)	0.12 (0.09, 0.15)	0.09 (0.06, 0.12)	0.08 (0.05, 0.11)
Men			
Diastolic blood pressure (mmHg)	4.1 (2.5, 5.8)	3.6 (1.8, 5.3)	0.9 (−1.2, 2.9)
Systolic blood pressure (mmHg)	9.2 (6.0, 12.3)	6.2 (3.0, 9.5)	1.1 (−2.5, 4.7)
Serum total cholesterol (mM)	0.21 (0.02, 0.40)	0.14 (−0.06, 0.34)	0.09 (−0.15, 0.33)
Serum HDL-cholesterol (mM)	−0.1 (−0.2, −0.02)	−0.1 (−0.2, −0.03)	−0.1 (−0.2, −0.02)
Log_{10} serum triglycerides (mM)	0.14 (0.10, 0.19)	0.15 (0.10, 0.20)	0.11 (0.05, 0.16)

[a]The estimated increase in the dependent variable corresponding to an increase of one-tenth unit waist−hip ratio (for instance from 0.8 to 0.9) when the factors adjusted for are kept fixed.
BMI: body mass index.

cant association among women. There were indications of a weak positive association between WHR and serum total cholesterol, but this diminished upon adjustment for BMI.

Discussion

This study was part of a larger investigation of non-communicable chronic diseases in the West Bank. To our knowledge, it represents the first study of obesity, blood pressure and blood lipids in the adult Palestinian West Bank population. Standard, generally accepted methods were used. By focusing on one village, we managed to obtain a very high response rate. On the other hand, the descriptive results cannot readily be generalised beyond the study sample. However, since the study village was carefully selected to be prototypic for the area (Giacaman, 1988), the results may be representative for a large proportion of the semi-rural population of the Ramallah district of the West Bank and possibly other parts of the West Bank.

A prevalence of obesity of close to 40% among women and nearly 20% among men is remarkably high. Although the age groups are not directly comparable, this is higher than the prevalence in the USA, at least among women (Kuczmarski *et al*, 1994). On the other hand, perhaps paradoxically, prevalences of similar magnitude have been reported in some rapidly developing countries of the Middle East, especially Jordan where one study indicated that around 60% of women and around 30% of men had a BMI≥30 (Ajlouni *et al*, 1998).

It is commonly thought that the shifts in dietary structure and decrease in physical activity that occur with urbanisation are at least partly responsible for the increase in obesity in many rapidly developing countries (Popkin, 1994). It is difficult to make any inferences on this matter because of the lack of previous data from the Palestinian population. There are, however, some indications that changes in lifestyle have taken place in recent years, and results from our study population have shown that the consumption of energy and fat at household level is relatively high (Stene *et al*, 1999). Furthermore, it is socially acceptable to be overweight in this population, at least among women. The prevalence of diabetes is also very high in many countries in the Middle East (al-Nuaim *et al*, 1996a; Alwan & King, 1992; Herman *et al*, 1995), and indeed it was very high in our study population (Husseini *et al*, 2000). It may be speculated that a common mechanism is responsible for the high prevalence of both obesity and type 2 diabetes, and the foetal origins hypothesis offers a possible explanation (Barker, 1998).

The mean WHR among women in our study was higher than that for all populations in the WHO MONICA project (Molarius *et al*, 1999), but similar to that found in a study of Saudi women (al-Rehaimi & Björntorp, 1992). The Palestinian men had a mean WHR in the mid-range compared to the MONICA populations, which was mostly European (Molarius *et al*, 1999). Both the men and women in the present study had a higher mean WHR than that found in community-based studies in China (Folsom *et al*, 1994) and in USA (Keenan *et al*, 1992), but little data exist from Arab populations. Our results among women aged 30−49 y were comparable to that found in a study of Saudi Arabian women (al-Rehaimi & Björntorp, 1992). A high WHR is thought to reflect an abdominal body fat distribution, and although the linear association between BMI and WHR is highly significant, it is far from complete. The pooled data from the WHO MONICA project indicated an r^2 (proportion of variation in one variable explained by the other variable) of 0.30 for women and 0.49 for men (Molarius *et al*, 1999). In the present study, the association between WHR and BMI was even lower, with an r^2 of 0.07 for women and 0.29 for men. Waist circumference has been proposed as a simpler and better indicator of abdominal obesity than WHR (Lean *et al*, 1995). However the cut-off points suggested by Lean *et al* (1995) were based on correlation with BMI, and it is unclear whether waist circumference provides more information about cardiovascular risk factors than does BMI. The properties of different measures of abdominal obesity are still not clear, and the limitations imposed on inference regarding associations between anthropometric and other biologic variables by the cross-sectional design must be acknowledged (Molarius & Seidell, 1998).

BMI and WHR are known to be associated with a range of cardiovascular risk factors such as serum triglyceride concentration, blood pressure and type 2 diabetes mellitus. An association between WHR and type 2 diabetes has previously been reported from our study population (Husseini *et al*, 2000). In the present study, there were significant associations between BMI on one hand and systolic blood pressure and serum triglycerides on the other hand, even after adjustment for age and WHR, but the associations were relatively weak. For instance, in a Turkish study, the regression coefficient for BMI explaining systolic blood pressure was approximately 10-fold higher than in the present study (Onat & Sansoy, 1998). WHR was relatively strongly associated with systolic blood pressure and serum triglycerides, but the association with blood pressure disappeared after adjustment for age and BMI. Thus, it seemed that in this population, BMI was the more important correlate of blood pressure, whereas WHR was the more important correlate with serum triglycerides, compared to the other measures of obesity. This was also supported by the proportion of explained variance (r^2) in the simple models (data not shown).

We conclude that the prevalence of obesity in the study population is very high compared to most other countries in the world, and that it is considerably higher among women than among men. This suggests, together with the high prevalence of type 2 diabetes (Husseini *et al*, 2000), that a trend of increasing morbidity and mortality from cardiovascular diseases may emerge, even in the semi-rural Palestinian population.

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