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A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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Summary

Background: The purpose of this study was to investigate the distribution and association of selected risk factors for diabetes mellitus in a semi-rural Palestinian village.

Material/Methods: We performed a cross-sectional, population-based study of 500 adults aged 30 to 65 in a semi-rural Palestinian village. The study included two phases: a household survey and an individual assessment utilizing the oral glucose tolerance test OGTT to determine the diabetes status of the participants, anthropometric measurements for body mass index (BMI) and waist-hip ratio (WHR), blood biochemistry measurements for lipids, blood pressure measurement, and a standard questionnaire to assess demographic and other factors.

Results: The association between various risk factors and diabetes status was explored by comparing statistical means and proportions and crude and adjusted odds ratios (OR). A multivariate logistic regression using sex and seven factors initially found to be significantly associated with diabetes identified four factors that remained significantly associated with diabetes after adjustment for age and sex. The four main factors are age (OR = 1.08, 95%CI = 1.05–1.12), positive family history of diabetes (OR = 3.09, 95%CI = 1.53–6.24), triglycerides (OR = 1.006, 95%CI = 1.002–1.009), and WHR (OR = 2.13, 95%CI =1.31–3.45).

Conclusions: Two factors associated with diabetes are potentially modifiable in this Palestinian population: WHR and triglyceride levels. These should be addressed by preventive health activities, including health promotion. The association between diabetes and age supports the conclusion that the prevalence of diabetes is expected to increase with the aging of the population.

key words: **diabetes mellitus • associated factors • Palestine • rural**

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BACKGROUND

The emergence of chronic diseases in developing countries is an issue of increasing public health importance. Diabetes mellitus (DM) and impaired glucose tolerance (IGT) are considered a global health problem [1] and a cause of major public health concern in the Eastern Mediterranean Region [2]. The population in this region has doubled over the last two decades, and the percentage of people living in urban areas has increased from 39% to 44% in the period between 1985 and 1990. The urban population is expected to reach 50% by the end of the century [3]. The contributions and influence of urbanization and lifestyle changes to diabetes mellitus have been documented [2]. The association between obesity and Type 2 diabetes and its relationship with insulin resistance is established [4,5].

Several studies have been conducted in the Eastern Mediterranean region to determine the prevalence of diabetes and its associated risk factors [2,6–9]. However, not all of these studies utilized the World Health Organization (WHO) guidelines and diagnostic criteria. A study in Egypt, in which WHO guidelines were applied, revealed an estimated prevalence of 9.3% in the population aged 20 years and above [7]. This study also examined the association between diabetes and socio-economic status (SES), obesity measured by body mass index (BMI), and waist-hip ratio (WHR). In the West Bank, the prevalence has been estimated to be 9.8% [10] and 12.0% [11] in rural and urban areas respectively.

Risk factors associated with diabetes have not previously been described in any other Palestinian population study where the WHO guidelines and classification criteria have been applied [12,13].

The purpose of the present study was to identify factors associated with diabetes mellitus in the rural West Bank.

MATERIAL AND METHODS

The study was conducted in the village of Kobar, located 15 km to the northeast of Ramallah City in the central region of the West Bank. All the inhabitants are Muslim Arabs. The village is a semi-rural community typical of many semi-rural communities in the West Bank, especially those that are close to the main urban areas in terms of size, demographic characteristics, accessibility to health care, and socio-economic conditions.

The first phase of the study was composed of a household survey (census) completed during June 1996, which showed a total of 2, 360 inhabitants residing in 368 households. Of the males in the sample, only 9% identified agriculture as their main employment. Construction-related employment in nearby urban Ramallah accounted for the majority of male employment, while most of the females were housewives. The household survey in Kobar was conducted before the first Palestinian census (1997). At that time of our survey there was no information available about the village population size and demographics, or other data necessary to identify individuals eligible to participate in the study.

The second phase of the study was an individual assessment, which included an interview using a prepared questionnaire, anthropometric measurements, medical checkup, and blood measurements. All adults (N=585) in the age group 30 to 65 years who were deemed suitable to participate based on the inclusion criteria were invited to participate. Five hundred villagers participated, yielding a response rate of 85%. All participants had been residents of the village for at least six months before the beginning of the individual assessment, as well as being mentally and physically able to participate.

The study team was composed of epidemiologists, nurses, medical technologists, a physician, and trained field workers. Further description of the methods, including questionnaires, selection criteria, measurements, and quality control, has been detailed in a previous paper [10].

The participants were divided into three categories according to their diabetes (glycemic) status: 1) those with normal glucose tolerance (NGT), where 2-hour venous blood glucose was less than 140 mg dl^{-1}; 2) those with impaired glucose tolerance (IGT), where 2-hour venous blood glucose was between 140–200 mg dl^{-1}; and 3) those with diabetes mellitus (DM), who had either been previously diagnosed with diabetes or had a 2-hour venous blood glucose ≥200 mg dl^{-1}.
The independent (explanatory) variables included the following:
- age;
- sex;
- education (number of years of schooling);
- obesity, assessed by body mass index (BMI) and waist-hip ratio (WHR);
- hypertension, assessed by blood pressure (BP);
- lipids, including triglycerides, total cholesterol, LDL and HDL;
- fasting blood sugar (FBS);
- smoking;
- family history of diabetes.

Some of the measured variables, such as physical exercise and nutrition, were not used, being not valid or suitable for this analysis.

To identify factors associated with diabetes among various groups, calculations were based on means, 95% confidence intervals (CI), and proportions. The strength of association between the dependent and selected independent variables was assessed using odds ratio (OR) in logistic regression analyses.
The bivariate association between diabetes status (normal or diabetic) and each of the independent variables was examined [14–16]. In a final logistic regression analysis [17,18] of diabetes status (normal or diabetic), using the backward stepwise conditional method, the following independent variables were included:
- diastolic blood pressure (mmHg);
- total cholesterol (0=low, 1= medium; 2=high);

• LDL (mg/dl);
• HDL (mg/dl);
• triglycerides (mg/dl);
• sex (0 = male; 1 = female);
• family history of diabetes (0 = no relationship, 1= relationship);
• WHR (x 10);
• age.

These variables were chosen because they have been shown to have a statistically significant association with the dependent variable (normal or diabetic) in primary logistic regression adjusting for age and sex. The level of statistical significance was set at $p < 0.05$, and a 95% confidence interval for the OR was calculated.

Results

Of the 500 adults who participated in the study, 408 individuals (81.6%) had normal glucose tolerance (NGT), while 43 (8.6%) were diagnosed with impaired glucose tolerance (IGT). Thirty-five (7.0%) were previously diagnosed individuals with diabetes and an additional 14 (2.8%) were survey diagnosed. Thus, the total number of people with diabetes was 49 (9.8%). The proportion of persons with total glucose intolerance, which includes both DM and IGT, was 18.4%[10].

Both males and females with diabetes or IGT were older than those with normal glucose tolerance (Table 1). Obesity measured by BMI was not significantly different between normoglycemic males and females and those with DM. This was not the case with central adiposity measured by WHR, where males and females with DM had higher WHR than those with normal glucose tolerance. Although there was no significant difference between individuals with DM and those with IGT in systolic and diastolic blood pressure, among females, both were significantly higher than normoglycemics. Of the blood lipids, triglycerides were higher in people with diabetes than those with normal glucose tolerance. Normoglycemics had lower LDL and higher HDL than people with diabetes. A family history of diabetes was significantly more prevalent among persons with diabetes than normoglycemic individuals.

In a logistic regression analysis controlling for age and sex between individuals with diabetes and normoglycemics, diastolic blood pressure, total cholesterol, LDL, HDL, triglycerides, family history of diabetes, WHR, and age were significantly associated with diabetes (Table 2).

When we included the factors that were significantly associated with diabetes mellitus after controlling for age and sex in a final conditional logistic regression analysis, age, triglycerides, family history of diabetes, and WHR remained significant. As shown in Table 2, the subgroup of individuals with Type 2 diabetes were older, more centrally obese, had higher triglyceride levels, and were more likely to have a positive family history of diabetes than those with normal glucose tolerance.

Table 1. Selected factors associated with diabetic status of Palestinian adults.

Associated factors	Sex	NGT Mean (95%CI)		IGT Mean±(95%CI)		D.M Mean±(95%CI)	
Age (years)	Males	42.73	(41.26–44.20)	48.08	(43.12–53.04)	51.14	(47.38–54.90)
	Females	41.70	(40.37–43.03)	50.57	(47.39–53.75)	53.89	(50.34–57.44)
BMI	Males	26.22	(25.53–26.91)	29.08	(27.20–30.96)	26.99	(25.17–28.81)
	Females	28.09	(27.35–28.83)	30.50	(28.48–32.52)	30.28	(28.18–32.38)
WHR	Males	0.92	(0.90–0.94)	0.96	(0.92–1.00)	1.00	(0.98–1.02)
	Females	0.87	(0.85–0.89)	0.90	(0.88–0.92)	0.93	(0.91–0.95)
Systolic BP (mm Hg)	Males	124.56	(122.11–127.01)	140.23	(129.23–151.23)	132.43	(125.86–139.00)
	Females	118.55	(115.79–121.31)	136.23	(127.16–145.30)	131.25	(124.92–137.58)
Diastolic BP (mm Hg)	Males	78.68	(77.39–79.97)	85.08	(80.43–89.73)	83.14	(79.96–86.32)
	Females	71.68	(70.21–73.15)	78.67	(74.56–82.78)	78.57	(74.93–82.20)
Triglycerides (mmol/l)*	Males	1.38	(1.24–1.52)	1.92	(1.05–2.79)	2.51	(1.60–3.43)
	Females	1.21	(1.12–1.29)	1.38	(1.13–1.62)	1.79	(1.45–2.13)
T. cholesterol (mmol/l)*	Males	5.15	(5.01–5.29)	5.25	(4.69–5.80)	5.45	(4.94–5.96)
	Females	5.00	(4.87–5.13)	4.89	(4.57–5.21)	5.83	(5.35–6.31)
LDL (mmol/l)*	Males	3.37	(3.23–3.52)	3.49	(2.95–4.03)	3.68	(3.16–4.21)
	Females	3.11	(2.89–3.33)	2.85	(2.57–3.13)	3.81	(3.37–4.25)
HDL (mmol/l)*	Males	1.11	(1.05–1.18)	1.05	(0.90–1.19)	0.89	(0.80–0.97)
	Females	1.28	(1.23–1.33)	1.10	(1.02–1.19)	1.20	(1.07–1.33)
Education (years)	Males	9.67	(9.06–10.28)	8.85	(6.16–11.54)	8.24	(6.46–10.02)
	Females	5.55	(4.90–6.20)	3.15	(1.60–4.70)	1.57	(0.55–2.59)
Associated factors	**Sex**	**NGT %**		**IGT %**		**D.M %**	
Family history of diabetes (%)	Males	26.9		15.4		52.4	
	Females	29.6		20.0		53.6	
Smoking (%)	Males	50.0		23.1		42.9	
	Females	3.0		0.0		7.1	

* Blood lipid results were measured in conventional units and later converted to international units in this table

Table 2. Odds Ratio (OR) and 95% confidence intervals for selected independent variables adjusted for age and sex (Adjusted 1), and a final logistic regression model (Adjusted 2) including the variables significantly associated with DM in (Adjusted 1).

Variable	Adjusted 1 OR	95% CI	Adjusted 2 OR (LR)	95% CI
Background				
Age	1.09	1.06–1.13	1.08	1.05–1.12
Sex				
(Male)	ref			
Female	1.00	0.53–1.88	1.92	0.92–3.98
Family history				
(No)	ref			
(Yes)	3.41	1.78–6.54	3.09	1.53–6.24
Education (years)	1.00	0.90–1.10		
Smoking				
(Smoker)	ref			
(Non-smoker)	0.64	0.25–1.61		
Metabolic				
Triglycerides	1.007	1.004–1.011	1.006	1.002–1.009
Total cholesterol				
(Low)	ref			
(Medium)	1.49	0.57–3.87		
(High)	2.80	1.19–6.61		
HDL	0.97	0.94–1.00		
LDL	1.005	1.001–1.009		
Systolic BP	1.00	0.99–1.02		
Diastolic BP	1.04	1.01–1.07		
Anthropometric				
BMI	1.04	0.98–1.10		
WHR10	2.40	1.53–3.75	2.13	1.31–3.45

Reference category (OR = 1)

DISCUSSION

Understanding various factors associated with diabetes mellitus and determining their distribution is extremely important if any effective prevention efforts are to be undertaken. This is the first study in the Palestinian territories that examines the different factors associated with diabetes mellitus.

Kobar village was chosen as the site for this study because it represents a prototypic population [10,16] for many of the villages surrounding the city of Ramallah, and probably other villages close to urban areas in the West Bank. Proximity and previous experience with this village also allowed us to motivate the community, yielding a very high response rate which minimized sampling error.

The relationship and association between the factors identified by statistical methods (logistic regression analysis) was explored, yielding four factors significantly associated with diabetic status (NGT versus DM): age, triglycerides, family history of diabetes, and WHR.

Two of these factors, triglycerides and WHR, are modifiable. WHR is an indicator of central adiposity that seems to be a better predictor of diabetes than BMI or relative weight [4]. A review of available epidemiological data notes that 'increased WHR with obesity (abdominal obesity) seems to be associated with a cluster of metabolic risk factors, as well as hypertension' [17] In Palestine, increased WHR may also be associated with the urbanization of rural areas and the socioeconomic changes that go along with it. Only 9% of males in the present study reported agriculture as their main employment [10], and the estimated energy consumption based on a list of 25 food items included in the first phase of this study (household survey) was slightly higher than the normal energy requirements [18]. Compared to a previous study from Kobar, our results show that consumption of sugar-rich foods has increased in most households during the past ten years [18]. Therefore, central obesity measured by WHR may be an important risk factor for diabetes in rural Palestine. The level of triglycerides is another important modifiable factor that is associated with diabetes. The combination of hyperlipidemia and diabetes places the patient under a higher risk of cardiovascular diseases and complications.

Previous studies have been conducted to explore the risk factors for Type 2 diabetes in neighboring countries. In Jordan, age, sex, family history, hypertension, triglycerides and cholesterol were significantly associated with diabetes [19]. In Egypt, age, BMI, sex and WHR were identified as risk factors [20]. These results were similar to those obtained in this study.

Like other developing countries in the EMR, the Palestinian territories are in epidemiological transition. Indicators include a decline in infant mortality rate, increased life expectancy, increased urbanization and food availability, and increased prevalence of obesity [3,21]. Demographic, socio-economic, and nutritional trends that are associated with DM and cardiovascular diseases are apparent.

The expected increase in life expectancy in the Palestinian territories and the significant association between diabetes and age indicate that the prevalence of diabetes in the country is expected to increase. The modifiable risk factors identified in this study should be addressed by suitable prevention measures.

CONCLUSIONS

Of the four factors associated with diabetes identified in this rural Palestinian population, WHR and triglyceride levels are potentially modifiable, and should be addressed by preventive health activities, including health promotion. The association between diabetes and age supports the conclusion that the prevalence of diabetes is expected to increase with the aging of the population.

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