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Predictors of Incident Diabetes Mellitus in Basrah, Iraq

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Key Words
Predictors · Anthropometric · Diabetes mellitus · Iraq

Abstract
Background: New-onset diabetes was associated with a 90% increase in risk of all-cause mortality and a 120% increase in risk of cardiovascular mortality compared with study participants without diabetes. The aim of this study was to study prospectively the predictors of incident diabetes mellitus in Basrah, Iraq, with special emphasis on predictive performance of the four anthropometric variables of obesity, namely body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHpR) or waist-to-height ratio (WHtR). ***Material and Methods:*** A total of 13,730 subjects (7,101 males and 6,629 females) diabetes-free at baseline were followed for a mean of 5 years (January 2001 to end of December 2006). ***Results:*** There were 935 (6.80%) cases of incident diabetes (513 males and 422 females). All anthropometric indices (BMI, WC, WHpR, WHtR) were higher among those with incident diabetes ($p < 0.001$). In both sexes, WHpR has the strongest associations with incident diabetes that was gender-insensitive (AUC = 0.74 in males and 0.72 in females) followed by WC and then BMI which has the weakest association with incident diabetes. On multivariable logistic regression, only hypertension (OR 1.66; 95% CI 1.41–1.96; $p < 0.001$) was associated with incident diabetes. All anthropometric indices were significantly associated with incident diabetes except WHtR. There was no association between incident diabetes and gender, age, stroke, and ischemic heart disease. ***Conclusion:*** In both sexes, WHpR has the strongest associations with incident diabetes, followed by WC then BMI which has the weakest association with incident diabetes, while WHtR has no association. Hypertension is the only non-anthropometric variable associated with incident diabetes.

Introduction

The World Health Organization has termed the increased prevalence of obesity and diabetes as a 21st century epidemic [1]. Obesity and type 2 diabetes frequently occur together, and statistics show that 60–90% of all patients with type 2 diabetes are or have been obese [2]. Type 2 diabetes is a common and serious condition that is associated with morbidity and reduced life expectancy and it may remain undetected for a number of years. Therefore, early recognition of and intervention for the condition will be beneficial, particularly as cardiovascular complications set in early after the onset of diabetes [3]. New-onset diabetes was associated with a 90% increase in risk of all-cause mortality and a 120% increase in risk of cardiovascular mortality compared with study participants without diabetes [4]. Screening for diabetes in developing countries is not easy because of limited resources, blood tests may be difficult, and one needs to rely

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on less expensive bedside tests available to predict high-risk subjects for development of diabetes [5].

The aim of this study was to study prospectively the predictors of incident diabetes mellitus in Basrah, Iraq, with special emphasis on predictive performance of the four anthropometric variables of obesity, namely body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHpR) or waist-to-height ratio (WHtR).

Material and Methods

The subjects included 15,413 Iraqi adults aged ≥18 years and residents of Abu al-Khasib district, Basrah, Southern Iraq. Participants who had diabetes at baseline were excluded from follow-up (n = 1,681). The remaining 13,730 (7,101 males and 6,629 females) diabetes-free cohort at baseline was followed at one primary healthcare center in the rural Abu al-Khasib district for a mean of 5 years (January 2001 to end of December 2006). None of the females were pregnant. All participants gave written consent.

During physical examination the same physician measured WC at the umbilical level from the horizontal plane in centimeters, using a plastic anthropometric tape with the subject standing erect and breathing normally. Standing height and weight measurements were completed with subjects wearing lightweight clothing and no shoes. Height was measured to the nearest centimeter and weight was measured to the nearest 0.5 kg. BMI was calculated as body weight in kilograms divided by the squared value of body height in meters (kg/m^2). WHpR and WHtR were measured accordingly as ratios. Anthropomteric indices were measured at baseline only.

Blood pressures were measured in a seated position after 5 min at rest three times to the nearest value. The average of the second and third readings was defined as the subject's blood pressure. Participants were considered to have hypertension if they were on medication or had systolic BP ≥140 mm Hg and/or diastolic BP ≥90 mm Hg. Persons who had smoked at least one cigarette per day during the previous 1 year were considered as smokers. Stroke was defined as a focal neurological deficit of vascular mechanism lasting for 24 h confirmed by neuroimaging. Ischemic heart disease diagnosis was based on history of admission to the coronary care unit with ST elevation myocardial infarction, new left bundle branch block, positive exercise test or coronary angiography-proven significant lesions.

The participants visited the primary healthcare center every 3 months. Plasma glucose was checked at each visit. New type 2 diabetes mellitus was diagnosed according to the American Diabetes Association criteria of a fasting plasma glucose value of ≥126 mg/dl (7.0 mmol/l) on two occasions or symptoms of diabetes and a casual plasma glucose value of ≥200 mg/dl (11.1 mmol/l) [6].

Gender (male/female), age (continuous), smoking status (yes/no), history of hypertension (yes/no), stroke (yes/no) and ischemic heart disease (yes/no) were used to investigate the independence of the anthropometric indices and were checked at enrollment only.

Statistical Analysis

All data were analyzed in 2007 by SPSS (Version 9.0, SPSS Inc., Chicago, Ill., USA). Student's t test was used to compare differences between means and the χ^2 test was used to compare differences in proportions. A p value of <0.05 was considered statistically significant. The area under the receiver-operating characteristics (ROC) curves was used to assess the diagnostic performance of each index. Cut-offs on the ROC curves were chosen to maximize sensitivity and specificity of the indices examined. A multivariable logistic regression model, including all of those variables that were significantly ($p < 0.05$) associated with incident diabetes, was used to estimate adjusted odds ratios (OR) for incident diabetes.

Results

There were 935 (6.80%) cases of incident diabetes (513 males and 422 females), with a mean age of 45.1 ± 21.8 years (table 1). Male gender ($p = 0.04$), age ($p < 0.001$), hypertension ($p < 0.001$), stroke ($p = 0.04$) and ischemic heart disease ($p = 0.01$) were associated with incident diabetes. There was no significant association between smoking status and incident diabetes. All anthropometric indices (BMI, WC, WHpR, WHtR) were higher among those with incident diabetes ($p < 0.001$). BMI ≥25 kg/m^2 (overweight and obese) was more in those with incident diabetes ($p < 0.001$).

In males (table 2), cut-offs to predict incident diabetes for WC, BMI, WHpR, and WHtR were 90.5 cm, 24.7 kg/m^2, 0.89, and 0.52 respectively. For females, cut-off points for WC, BMI, WHpR, and WHtR were 92.5 cm, 26.3 kg/m^2, 0.87 and 0.57 respectively. In both sexes, WHpR has the strongest associations with incident diabetes that was gender-insensitive (AUC = 0.74 in males and 0.72 in females) followed by WC and then BMI which has the weakest association with incident diabetes.

On multivariable logistic regression, only hypertension (OR 1.66; 95% CI 1.41–1.96; $p < 0.001$) was associated with incident diabetes. All anthropometric indices were significantly associated with incident diabetes except WHtR. There was no association between incident diabetes and gender, age, stroke, and ischemic heart disease.

Discussion

Developing and evaluating rules to predict the high risk of developing diabetes is mandatory to prevent development of diabetes, since prevention is now feasible for high-risk persons [7]. In this study we undertook the first

Table 1. Characteristics of the study participants

	Total	Incident diabetes	Non-diabetes	p value
Gender				
Males	7,101 (51.7)	513 (7.22)	6,588 (92.7)	0.04
Females	6,629 (48.2)	422 (6.36)	6,207 (93.6)	
Age, years (mean ± SD)	44.9 ± 15.80	45.4 ± 15.83	44.9 ± 15.80	<0.001
Smoker				
Yes	3,170 (23.0)	218 (6.87)	2,952 (93.1)	NS
No	10,560 (76.9)	717 (6.78)	9,843 (93.2)	
Hypertensive				
Yes	1,920 (13.9)	267 (13.90)	1,653 (86.0)	<0.001
No	11,810 (86.0)	668 (5.65)	11,142 (94.3)	
Stroke				
Yes	238 (1.73)	24 (10.08)	214 (89.9)	0.04
No	13,492 (98.2)	911 (6.75)	12,581 (93.2)	
Ischemic heart disease				
Yes	423 (3.08)	42 (9.92)	381 (90.0)	0.01
No	13,307 (96.9)	893 (6.71)	12,414 (93.2)	
WC, cm (mean ± SD)	91.0 ± 14.80	100.5 ± 12.42	90.3 ± 14.72	<0.001
BMI, kg/m^2 (mean ± SD)	26.20 ± 5.92	28.68 ± 5.56	26.01 ± 5.91	<0.001
BMI (<25 kg/m^2)	6,203 (45.1)	231 (3.72)	5,972 (96.2)	<0.001
BMI (≥25 kg/m^2)	7,527 (54.8)	704 (9.35)	6,823 (90.6)	
WHpR (mean ± SD)	0.89 ± 0.08	0.95 ± 0.07	0.89 ± 0.08	0.0001
WHtR (mean ± SD)	0.54 ± 0.09	0.60 ± 0.07	0.54 ± 0.09	0.0001
Total	13,730	935 (6.80)	12,795 (93.1)	

Figures in parentheses are percentages. NS = Not significant.

Table 2. Cut-off values of anthropometric parameters and their predictive performance for the association with incident diabetes

	Males (n = 513)		Females (n = 422)	
	area under ROC curve (95% CI)	cut-off	area under ROC curve (95% CI)	cut-off
WC, cm	0.71 (0.69–0.73)	90.5	0.69 (0.66–0.71)	92.5
BMI, kg/m^2	0.66 (0.64–0.68)	24.7	0.61 (0.59–0.64)	26.3
WHpR	0.74 (0.72–0.76)	0.89	0.72 (0.70–0.74)	0.87
WHtR	0.71 (0.69–0.73)	0.52	0.69 (0.67–0.72)	0.57

step for early detection by defining high-risk group persons using different variables that include anthropometric indices. In males the cut-off points to predict incident diabetes for WC, BMI, WHpR, and WHtR were 90.5 cm, 24.7 kg/m^2, 0.89, and 0.52 respectively. A similar study in Jamaica gave cut-off points for males of 88.0 cm, 24.8 kg/m^2, 0.87, and 0.51 for WC, BMI, WHpR, and WHtR respectively for incident diabetes prediction. For females the cut-off points for WC, BMI, WHpR, and WHtR were 92.5 cm, 26.3 kg/m^2, 0.87 and 0.57 respectively, while in Jamaica its was 84.5 cm, 29.3 kg/m^2, 0.80 and 0.54 respectively. The figures seem to be completely different between two countries, as all our figures were higher except BMI in females [8].

WHpR has the strongest associations with incident diabetes that was gender-insensitive in this study which was also confirmed by multivariable logistic regression ($p < 0.001$). In Korean women with a history of gestational diabetes, WC was the most sensitive predictor for incident diabetes mellitus [9]. A 10-year prospective study found that a greater WC is the most common indication in predicting diabetes in Taiwan, with similar

findings also seen in Turkey [10, 11]. The strongest associations of single anthropometric measures to predict the risk of type 2 diabetes was observed for WC in Germany [12]. Mamtani and Kulkarni [13] suggest WC is a simple, non-invasive and accurate predictor of the risk of type 2 diabetes that can potentially be used in screening programs in developing countries. We found that BMI has the weakest association with incident diabetes and WHtR is not associated. Again in Germany, BMI and WHtR were less strong predictors [12].

The history of hypertension was the only non-anthropometric parameter associated with incident diabetes in this study. This was confirmed and validated in previous studies to predict diabetes [12, 14–16]. Study limitation: the study was conducted in one primary healthcare center in the rural Abu al-Khasib district, and although this area does not suffer from extensive migration of the population due to the war as other districts in Basrah, we think it is a representative sample of people in Basrah and Iraq as a whole.

Conclusion

In both sexes, WHpR has the strongest associations with incident diabetes, followed by WC and then BMI which has the weakest association with incident diabetes while WHtR has no association. Hypertension is the only non-anthropometric variable associated with incident diabetes.

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