Prevalence of Impaired Glucose Regulation in Asymptomatic Kuwaiti Young Adults

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Key Words

Impaired glucose regulation • Kuwait • Young adults • Diabetes • Obesity • Waist circumference • Oral glucose tolerance test

Abstract

Objective: The objective of this study was to determine the prevalence of impaired glucose regulation in a young, asymptomatic Kuwaiti population. **Subjects and Methods:** A cross-sectional study of 484 Kuwaitis (females: 311, and males: 173, aged 17–24 years), students at a public college for basic education, was conducted. Each participant underwent a 75-gram oral glucose tolerance test, and biochemical testing for hemoglobin A_{1c} (HbA_{1c}), total cholesterol and triglyceride levels. Physical examinations were performed to measure body mass index (BMI), waist circumference and blood pressure. **Results:** The prevalence of impaired glucose regulation (impaired fasting glucose, impaired glucose tolerance, and elevated HbA_{1c} levels) was 32%, including 4% with newly diagnosed diabetes. Of the 484 participants, 47 (10%) of the population had hypertension and 52 (11%) had dyslipidemia. A total of 244 (50%) were classified as overweight/obese (BMI >25 kg/m²) and 201 (42%) had an elevated waist circumference (≥88 cm in females; ≥102 cm in males). Im-

paired glucose regulation was significantly related to increased waist circumference ($p = 0.021$) but not to increased BMI ($p = 0.181$). Those with impaired glucose regulation also had a higher prevalence of hypertension ($p = 0.05$), particularly systolic hypertension ($p = 0.023$). **Conclusion:** Kuwaiti youth have a high prevalence of impaired glucose regulation and overweight/obesity. Waist circumference, rather than BMI, may be a more appropriate screening tool to predict impaired glucose regulation in Kuwaiti youth.

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Introduction

In adults, type 2 diabetes develops over a long period of time. Most, if not all, patients initially have impaired glucose tolerance, which is an intermediate stage in the natural history of type 2 diabetes and predicts the risk of the development of diabetes and cardiovascular disease [1, 2]. The epidemic of obesity in Kuwait has been accompanied by a marked increase in the frequency of type 2 diabetes [3, 4]. With appropriate lifestyle modification, progression from impaired glucose tolerance to overt diabetes can be delayed or prevented, and thus, great emphasis has recently been placed on the early detection of

impaired glucose regulation [5, 6]. We conducted this study to investigate the prevalence of impaired glucose regulation as a primary aim, and obesity as a secondary aim, in Kuwaiti youth, as there is no published data in this population. We chose this age group where lifestyle modification (if applied appropriately) might be of benefit in modifying the prevalence of diabetes in older age groups in the coming years [5–7].

Subjects and Methods

A total of 484 students who attended a college of basic education at the Public Authority for Applied Education and Training, Kuwait, between March 2009 and January 2010 were included in the study. We distributed flyers among the students over 4 weeks prior to the study, describing the project and inviting volunteers to participate in the study, followed by 2 lectures to describe and to answer any enquiries concerning the project. A total of 173 men and 311 women accepted to be included in the study. Participants were college students aged 17–24 years. Exclusion criteria were: neither clinical history (past or present) suggestive of diabetes nor being on treatment known to increase insulin resistance or induce diabetes, e.g. steroids, and (if female) participant not currently pregnant because plasma glucose levels and body mass index (BMI) values are influenced by both physiology and stage of pregnancy; no current acute infection. The exclusion criteria were assessed by direct interview with the participants by a specially trained nurse.

The study was approved by the Ethics Committee of the Ministry of Health, Kuwait. Informed consent was obtained from all the participants.

Measures

All measurements were taken by trained nurses in a specially designated clinic on the faculty campus. Individuals attended the clinic after an 8- to 14-hour fast. Participants underwent a 75-gram oral glucose tolerance test using liquid glucose (Trutol™ 75, glucose tolerance beverage, Thermo Fisher Scientific Inc.). Blood samples via finger prick were obtained for measurement of fasting blood glucose (as well as hemoglobin A_{1c}, HbA_{1c}, total cholesterol and triglycerides); additional blood samples were drawn after 120 min for postprandial blood glucose measurement. Body weight was measured with a Detecto weight/height scale to the nearest 0.5 kg, and height was measured in centimeters using the same scale. BMI was calculated as weight in kilograms divided by the square of the height in meters. Blood glucose levels were tested using HemoCue Glucose 201+ with plasma converter (HemoCue Inc.). HbA_{1c} levels were measured using a DCA 2000+ analyzer. Total cholesterol and triglycerides were tested using Afinion™ AS100 analyzer.

Definitions

Type 2 diabetes was defined according to the American Diabetes Association criteria, i.e. fasting blood glucose ≥ 7 mmol/l, and/or 2-hour postprandial glucose ≥ 11.1 mmol/l, and/or HbA_{1c} $\geq 6.5\%$. Impaired glucose tolerance was defined as the presence of one or more of the following: fasting plasma

Table 1. Clinical characteristics of 484 Kuwaiti individuals aged 17–24 years

Gender	
Male	173 (35.7%)
Female	311 (64.3%)
Age, years	20.3 $\pm$ 1.3
Family history of hypertension	181 (41.7%)
Family history of diabetes	245 (50.6%)
Current smoker	50 (10.3%)
BMI, kg/m ²	26.3 $\pm$ 6.7
Waist circumference, cm	
Male	92.9 $\pm$ 9
Female	80.7 $\pm$ 10.1
Systolic blood pressure, mm Hg	113.5 $\pm$ 14.4
Diastolic blood pressure, mm Hg	74.2 $\pm$ 9.4
Fasting blood glucose, mmol/l	4.9 $\pm$ 0.7
2-hour postprandial blood glucose, mmol/l	6.4 $\pm$ 1.4
HbA _{1c} , %	5.2 $\pm$ 0.3
Total cholesterol, mmol/l	3.6 $\pm$ 0.8
Triglycerides, mmol/l	1.3 $\pm$ 0.7

Values are expressed as means $\pm$ SD unless otherwise indicated.

glucose of $>5.6/<7$ mmol/l, 2-hour postprandial glucose level of $>7.8/<11.1$ mmol/l and HbA_{1c} $>5.6/<6.5\%$ [8]. Dyslipidemia was defined as triglyceride level ≥ 2.2 mmol/l and/or total cholesterol ≥ 5.6 mmol/l [9]. Hypertension was defined as systolic blood pressure ≥ 140 mm Hg and/or diastolic blood pressure ≥ 90 mm Hg [10]. Overweight was defined as BMI $>25/\leq 30$ kg/m² and obesity as BMI >30 kg/m². Elevated waist circumference was defined as ≥ 88 cm in females and ≥ 102 cm in males [9].

Data Analysis

Clinical characteristics were described using means and standard deviations for continuous variables and numbers and percentages for categorical data. All analyses were completed using SPSS version 17 for Windows (SPSS Inc., Chicago, Ill., USA). A 5% level was chosen as a level of significance.

Results

The clinical characteristics of the 484 study participants are shown in table 1. The female:male ratio was 2:1, representing the female:male ratio of the registered students in the collage at the time of the study. Family history of diabetes and hypertension was 50.6 and 41.7%, respectively (reflecting the high prevalence of these conditions among Kuwaitis). On average, participants were overweight, with a mean BMI of 26.3 ± 6.7 kg/m², with 244 (50.4%) of the cohort being overweight and 96 (19.8%)

Table 2. Abnormalities detected in 484 Kuwaiti individuals aged 17–24 years

Impaired glucose regulation ^a	155 (32%)
Hypertension (SBP ≥140 mm Hg and/or DBP ≥90 mm Hg)	47 (9.7%)
Dyslipidemia ^b	52 (10.7%)
Overweight (high BMI)	244 (50.4%)
Overweight (high waist circumference) ^c	201 (41.5%)

SBP = Systolic blood pressure; DBP = diastolic blood pressure.

^a Includes impaired fasting glucose, impaired postprandial glucose, high levels of HbA_{1c} and participants diagnosed to have diabetes.

^b Hypertriglyceridemia and/or hypercholesterolemia.

^c Waist circumference ≥88 cm in females and ≥102 cm in males.

Table 3. Characteristics of 155 individuals with impaired glucose regulation out of the 484 study participants

Characteristics	Impaired glucose regulation	Diabetes
Elevated fasting BG	67 (13.8%)	6 (1.2%)
Elevated 2-h postprandial BG	62 (12.8%)	9 (1.9%)
Elevated HbA _{1c}	45 (9.3%)	4 (0.8%)

BG = Blood glucose. There is an overlap in the fasting, postprandial and level of HbA_{1c} in a number of participants.

obese. Mean waist circumference was within the normal range for females (80.7 ± 10.1 cm) and males (92.9 ± 9 cm), but 201 (41.5%) of the study population were considered to have an elevated waist circumference. Hypertension was found in 47 (9.7%) of the study group, and dyslipidemia in 52 (10.7%) (table 2).

A total of 155 (32%) of the participants had impaired glucose regulation. Of these, 138 (28.5%) had prediabetes, which included impaired fasting plasma glucose in 67 (13.8%), impaired 2-hour postload glucose in 62 (12.8%), and HbA_{1c} ≥6.5% in 45 (9.3%). Newly diagnosed diabetes was found in 17 (3.9%) subjects (table 3).

Those with glucose intolerance had significantly higher waist circumference than those with normal glucose tolerance (49 vs. 38%; $p = 0.021$), but BMI did not differ significantly between the groups (54.8 vs. 48.3%; $p = 0.181$). Although hypertension was marginally higher in glucose-intolerant subjects than in those with normal glucose tolerance (13.5 vs. 7.9%; $p = 0.05$), systolic

Table 4. Clinical characteristics of patients with impaired glucose regulation

Variable	Glucose regulation		p value
	impaired (n = 155)	normal (n = 329)	
Female	96 (30.9)	215 (69.1)	0.465
Male	59 (34.4)	114 (65.9)	
Mean age ± SD, years	20.2 ± 1.3	20.4 ± 1.3	0.240
Family history of diabetes	79 (51)	166 (50.5)	0.916
Family history of hypertension	74 (47.7)	128 (38.9)	0.066
Current smoker	15 (9.7)	35 (10.6)	0.746
Diagnosis with hypertension	21 (13.5)	26 (7.9)	0.05
Overweight by BMI	85 (54.8)	159 (48.3)	0.162
Overweight by waist circumference	79 (49)	125 (38)	0.021
Hypertriglyceridemia	17 (11)	25 (7.6)	0.219
Hypercholesterolemia	3 (1.9)	8 (2.4)	0.733

Values are expressed as number of patients with percentage in parentheses unless otherwise indicated.

rather than diastolic hypertension was significantly related to impaired glucose regulation (9 vs. 4%; $p = 0.023$) (table 4).

Discussion

The high prevalence of 32% of impaired glucose regulation in our study population of Kuwaiti individuals aged 17–24 years is similar to the 37% level found in a cohort of 491 European children and young adolescents aged 7–18 years [11]. However, it is higher than the 16% found in a survey of 2,689 US adolescents aged 12–19 years [12] and 27.5% in 169 Turkish children (100 prepubertal, aged 7–11 years and 69 pubertal, aged 12–18) [13]. A possible explanation for the high prevalence of impaired glucose regulation in our population is the high prevalence of overweight and obesity: 73% of the general Kuwaiti population is overweight (BMI >25 kg/m²), and 40.6% is obese (BMI >30 kg/m²) [14]. In this study, the prevalence of 50.4% overweight, 19.8% obesity and 42% elevated waist circumference is higher than the 32% overweight/obesity rate reported by al-Isa [15] in 842 Kuwaiti University students, also higher than the 26.5% obesity rate found by Moussa et al. [16] in 2,400 Kuwaiti schoolchildren aged 6–13 years. The discrepancy between the BMI and waist circumference may be explained by an in-

creased BMI in a number of nonobese male individuals due to increased muscle bulk. We found that waist circumference was significantly associated with impaired glucose regulation, while BMI was not. While elevated BMI is clearly a risk factor for many diseases and conditions, the excess deposition of fat in the abdominal region is more strongly associated with the metabolic disturbances thought to underlie many of the obesity-related conditions. Several indicators of abdominal obesity are available, but recent reports suggest that waist circumference is the most practical and accurate measure of abdominal obesity for use in public health research [17, 18].

There was no significant association between family history of diabetes and the prevalence of impaired glucose regulation in our population, though this is probably due to the very high prevalence of type 2 diabetes in the general Kuwaiti community [19], a similar phenomenon noted by other investigators when they studied a group of 167 Turkish children and adolescents for the prevalence of impaired glucose tolerance [13].

The prevalence of 10% hypertension in our study is within the range of 6.5–16% of previous studies [20, 21]. However, the prevalence was higher in individuals with impaired glucose regulation. This association reflects the fact that cardiovascular risk factors tend to cluster, a finding confirmed by others [19, 22].

Our study is limited by the fact that our cohort does not represent the 17–24 age group of the general Kuwaiti population in terms of sex distribution. The female:male distribution of the Kuwaiti population of the study age group in December 2009 was 1.02:1 [23] while in our study it is 2:1, yet this may not affect the overall estima-

tion of prevalence of impaired glucose regulation, as there was no significant difference in the prevalence of impaired glucose regulation between both genders. Our selection criteria implied that only relatively highly educated young adults were included, which might have reflected lifestyle behaviors that are different from the general population, accordingly we would expect a higher prevalence of impaired glucose regulation if the sample studied was a random sample of the Kuwaiti population of the same age group.

Conclusion

Impaired glucose regulation is highly prevalent in young Kuwaiti adults aged 17–24; this condition is associated with a high prevalence of overweight/obesity. Our finding might be a warning of a future public health burden of diabetes and cardiovascular disease, which warrants preventive action. Further studies are needed in Kuwait to confirm our results and to inform preventive action.

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