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The likelihood of diabetes based on the proposed definitions for impaired fasting glucose

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ABSTRACT

The current study aimed to evaluate whether individuals with fasting plasma glucose (FPG) of 5.6–6.0 mmol/l has a similar risk profiles for diabetes or impaired glucose tolerance (IGT) to those with FPG of 6.1–6.9 mmol/l. A community-based cross-sectional survey in Chinese adults (20–74 years) was conducted during April–July in 2002. Participants without a prior history of diabetes underwent a standardized 2-h 75 g oral glucose tolerance test. Positive likelihood ratios were calculated to estimate the odds of having diabetes or IGT for subjects with different FPG levels. Among 1856 participants, prevalence of IFG increased from 12.4 to 28.2% with the cut-off value of FPG lowered from 6.1 to 5.6 mmol/l. Individuals with FPG of 6.1–6.9 mmol/l were more obese and insulin resistant than those with FPG of 5.6–6.0 mmol/l. The positive likelihood ratio for diabetes and IGT were 1.83 (1.28–2.61) and 2.60 (1.96–3.44) in subjects with FPG of 6.1–6.9 mmol/l, and 0.54 (0.30–0.95) and 1.47 (1.11–1.95) for those with FPG of 5.6–6.0 mmol/l, respectively. In conclusion, the likelihood of diabetes and IGT was lower in subjects with FPG of 5.6–6.0 mmol/l than in those with FPG of 6.1–6.9 mmol/l. The clinical and social implication of labelling more individuals with impaired fasting glucose needs to be further studied.

1. Introduction

In 1997, the Expert Committee on the Classification and Diagnosis of Diabetes Mellitus of the American Diabetes Association (ADA) approved a new diagnostic criterion for diabetes and impaired glucose metabolism [1]. Impaired fasting glucose (IFG) based on the fasting plasma glucose (FPG) level of 6.1–6.9 mmol/l was introduced to define the intermediate stage of disordered glucose metabolism between diabetes and normal, which was also considered as the analogous to impaired glucose tolerance (IGT).

Since the introduction of the IFG, a number of studies have compared it with IGT in regard to predicting the risk of diabetes [2–7]. Most of these studies reported that specificity in subjects with IFG was similar to, but sensitivity and positive predictive value lower than IGT with regard to the prediction of diabetes [5,8–13]. It was speculated that no natural difference exists between FPG and 2-h post-challenge plasma glucose (2h-PG) in respect of the risk of future diabetes [13]. Given the same sensitivity as that for IGT, the FPG cut-off value should be lowered from 6.1 mmol/l to around 5.5–5.8 mmol/l [5,13,14]. Based on these findings, the ADA Expert Committee

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re-considered the cut-off value for IFG, and recommended lowering FPG from 6.1 to 5.6 mmol/l in 2003 [15].

Since the definition of IFG aimed at identifying individuals with IGT and with an increased risk of future diabetes, as well as cardiovascular events, one of the pertinent questions related to the new criteria is ''Do subjects with FPG of 5.6–6.0 mmol/l have the similar probability of having IGT and diabetes as those with FPG of 6.1–6.9 mmol/l?'' In the current study, we try to answer the question by analysing the data from a survey in an urban Chinese population.

2. Materials and methods

A cross-sectional survey was conducted in an urban community of Qingdao city, China, during April–July in 2002. Stratified random cluster sampling method was employed to recruit the study population. The community, named Zhanshan, is divided into eight street blocks according to the resident committee, with an adult population (aged 20 years or older) of about 10,000. From every block, 300 or 400 individuals aged 20–74 years were randomly selected and 2600 of these were invited. A total of 2156 people took part in the survey, with a response rate of 82.9%.

Information on demographic characteristics, parental and personal history of diabetes, was collected with a standard questionnaire. Every participant was asked whether or not he/she had previously been diagnosed with diabetes. If the answer was yes, the subject's medical records on the diagnosis and treatment of diabetes were reviewed by a doctor. Height and weight was measured with participants in light clothes and without shoes. Body mass index (BMI) was calculated by dividing the weight (kg) by the height (m) squared. Waist circumference at the minimal abdominal girth between the rib cage and iliac crest, and hip circumference at the maximal horizontal girth between the waist and thigh was measured. Waist to hip ratio (WHR) was calculated by waist circumference divided by hip circumference. Three consecutive blood pressure readings, apart for at least 30 s, were taken from the right arm of seated subjects and the average of the three readings was used in subsequent data analyses.

Individuals without a prior history of diabetes were invited to undergo a standard 2-h 75 g oral glucose tolerance test (OGTT) in the survey site between 7:00 and 9:30 after an overnight fast. Venous blood samples were collected from the antecubital vein into a vacuum tube containing sodium fluoride before and 120 min after the ingestion of 75 g glucose. Plasma glucose was determined with glucose oxidase method. Fasting plasma lipid profile, including triglycerides, total and high-density lipoprotein cholesterol (HDL-c) was determined with enzymatic method. Fasting and 2-h serum insulin was measured in a sub-sample with radioimmunoassay (kit purchased from North Biotechics Institute, Beijing). Homeostasis model assessment insulin resistance (HOMA IR) index was calculated as: fasting insulin (μIU/l) multiplied by fasting glucose (mmol/l), divided by 22.5.

The Healthy Administrative Bureau of Qingdao approved the study protocol. Verbal or written consents were obtained from all participants prior to data collection.

3. Statistical analysis

Participants were divided into four groups according FPG level with the ADA 1997 [1] and 2003 criteria [15]: <5.6 mmol/l, 5.6–6.0 mmol/l, 6.1–6.9 mmol/l, and ≥7.0 mmol/l. Plasma glucose, triglyceride, total and HDL cholesterol, fasting and 2-h serum insulin, and HOMA IR index was logarithmically transformed

Table 1 – Characteristics of subjects without a prior history of diabetes according to their fasting plasma glucose levels

Fasting plasma glucose (mmol/l)	<5.60 (group 1)	5.60–6.09 (group 2)	6.10–6.99 (group 3)	≥7.00 (group 4)	*p* Value for trend test
No (%)	1206 (65.0)	293 (15.8)	230 (12.4)	127 (6.8)	–
Gender (M%)	36.7	33.5	38.7	43.3	0.25
Age (years)	51 (50.0–51.5)‡	54 (53.2–55.6)	57 (55.3–57.9)¶	57 (54.7–58.5)	<0.01
BMI (kg/m^2)	25.8 (25.6–26.0)‡	26.6 (26.2–27.0)	27.7 (27.3–28.2)¶	27.2 (26.6–27.9)	<0.01
Waist (cm)					
Men	88.4 (87.6–89.3)‡	91.6 (89.8–93.5)	94.3 (92.4–96.2)	94.0 (91.5–96.4)	<0.01
Women	82.2 (81.6–82.8)‡	84.6 (83.4–85.8)	86.1 (84.7–87.6)	86.4 (84.4–88.4)	<0.01
Systolic blood pressure (mmHg)	127 (125.7–127.8)‡	131 (129.3–133.5)	135 (133.0–137.8)	133 (129.4–135.8)	<0.01
Diastolic blood pressure (mmHg)	82 (81.2–82.5)‡	84 (83.0–85.6)	86 (84.6–87.4)	84 (82.2–86.0)	<0.01
2-h plasma glucose (mmol/l)	5.3 (5.2–5.4)‡	6.2 (5.9–6.4)	6.9 (6.6–7.2)¶	12.7 (12.0–13.4)	<0.01
Triglycerides (mmol/l)	1.2 (1.2–1.3)‡	1.4 (1.3–1.5)	1.5 (1.4–1.6)	1.7 (1.5–1.8)	<0.01
Total cholesterol (mmol/l)	5.5 (5.4–5.5)	5.6 (5.5–5.7)	5.6 (5.4–5.7)	5.8 (5.6–6.0)	0.02
HDL_c (mmol/l)	1.47 (1.46–1.79)	1.50 (1.47–1.54)	1.50 (1.47–1.54)	1.51 (1.46–1.56)	0.12
Fasting insulin (μIU/ml)[a]	10.6 (9.9–11.4)	9.5 (8.3–11.0)	12.1 (10.5–14.0)	11.8 (9.6–14.5)	0.10
HOMA$_{-IR}$ index[a]	2.3 (2.1–2.5)	2.5 (2.1–2.8)	3.5 (3.0–4.1)¶	4.7 (3.8–5.8)	<0.01
2-h serum insulin (μIU/ml)[b]	50.1 (45.4–55.2)	43.6 (36.5–52.1)	51.6 (42.7–62.4)	45.0 (34.2–59.1)	0.48

Values are means (95% CI) with age- and sex-adjusted except for noted.

[a] The number of subjects was 344, 95, 88, and 44 in groups 1, 2, 3, and 4, respectively.

[b] The number of subjects was 326, 96, 85, and 41 in groups 1, 2, 3, and 4, respectively.

‡ $p < 0.05$, for the difference between groups 1 and 2.

¶ $p < 0.05$, for the difference between groups 3 and 2.