

# Prevalence of Abnormal Glucose Tolerance and Risk Factors in Urban and Rural Malaysia

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**OBJECTIVE**—To determine the prevalence of prediabetes and diabetes among rural and urban Malaysians.

**RESEARCH DESIGN AND METHODS**—This cross-sectional survey was conducted among 3,879 Malaysian adults (1,335 men and 2,544 women). All subjects underwent the 75-g oral glucose tolerance test (OGTT).

**RESULTS**—The overall prevalence of prediabetes was 22.1% (30.2% in men and 69.8% in women). Isolated impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) were found in 3.4 and 16.1% of the study population, respectively, whereas 2.6% of the subjects had both IFG and IGT. Based on an OGTT, the prevalence of newly diagnosed type 2 diabetes was 12.6% (31.0% in men and 69.0% in women). The prediabetic subjects also had an increased prevalence of cardiovascular disease risk factors.

**CONCLUSIONS**—The large proportion of undiagnosed cases of prediabetes and diabetes reflects the lack of public awareness of the disease.

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The prevalence of type 2 diabetes has increased globally over the past two decades. In Malaysia, the National Health and Morbidity Survey (NHMS) 2006 (Z. Hussein, W.M.W.B., W.N.w.M., G.R. Letchuman, J. Hasan, F. Ismail, N. Mohd Nor, G.H. Tee, and M.R. Ishak; NHMS III Diabetes Study Group, unpublished data) recorded a diabetes prevalence of 14.9% among adults aged >30 years. This is an astounding increase from a similar survey conducted in 1996. Despite this rising prevalence and increasing awareness, diabetes is often left undetected (1). Early recognition and prevention is therefore important because diabetes is associated with

unhealthy contemporary lifestyle (2). Impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) identify individuals at increased risk for developing diabetes and cardiovascular disease (CVD) (3,4). Because of increased awareness, IGT is being diagnosed and reported more frequently, resulting in the higher prevalence of IGT compared with a few decades ago. Using the 75-g oral glucose tolerance test (OGTT) would identify those individuals with IGT and diabetes based on 2-h postprandial blood glucose values. The aim of this study was therefore to determine the prevalence of prediabetes and diabetes using a 75-g OGTT

in both rural and urban areas in Malaysia and to identify the metabolic abnormalities and risk factors associated with these conditions.

## RESEARCH DESIGN AND METHODS

This nationwide, cross-sectional study was conducted from April until August of 2008 among Malaysians aged  $\geq 18$  years. The subjects were randomly selected with the aid of the kirschtals and the topographical charts of the district. Written consents were obtained. Ethical approval for the study was obtained from the medical research and ethics committee of the Ministry of Health, Malaysia.

An OGTT and other biochemical tests, as well as anthropometric measurements, were performed. Blood samples were processed on the same day and transported to a central laboratory in the Institute for Medical Research, Kuala Lumpur, and stored at  $-20^{\circ}\text{C}$  prior to additional analysis. Fasting plasma glucose; triglycerides; and HDL, LDL, and total cholesterol were analyzed using a Selectra XL chemistry analyzer. The interassay coefficients of variation for glucose at 6.27 and 15.6 mmol/L were 4.7 and 6.3%, respectively, and for lipids ranged from 3.5 to 6.4%.

EpiData version 3.1 was used for data entry, and data were then analyzed using SPSS version 17. Data were expressed as means  $\pm$  SD. Significant results were determined according to the two-tailed alternative hypothesis and deemed significant when the  $P$  value was  $< 0.05$ .

**RESULTS**—The prevalence of prediabetes among adults was 22.1%, affecting almost half (47.0%) of the adults aged between 30 and 49 years. The prevalence of isolated IGT was higher (16.1%) compared with isolated IFG (3.4%) and the combination of both IFG and IGT (2.6%). Subjects with both IFG and IGT had higher waist circumference and BMI compared with those with isolated IFG or IGT (Table 1). Among overweight adults (BMI  $\geq 23$  kg/m<sup>2</sup>) with prediabetes, 17.3% had isolated IGT, 3.8% had isolated IFG, and 3.1% had both IFG and IGT. For those

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Table 1—Demographic characteristics and biochemical parameters of the prediabetic and diabetic subjects

	Isolated IFG	Isolated IGT	IFG/IGT	New diabetes
n (%)	131 (3.4)	625 (16.1)	102 (2.6)	487 (12.6)
Age (years)	50.41 ± 13.43	49.75 ± 13.98†	50.44 ± 11.48	52.70 ± 12.78*
Sex (%)				
Male	66 (50.4)	164 (26.2)	29 (28.4)	151 (31.0)
Female	65 (49.6)	461 (73.8)	73 (71.6)	336 (69.0)
Waist circumference (cm)				
Male	90.92 ± 10.47	90.98 ± 12.30	92.32 ± 10.11	93.47 ± 12.86
Female	85.04 ± 11.88†	85.88 ± 12.76†	90.73 ± 12.99#	90.00 ± 12.41*
BMI (kg/m <sup>2</sup> )	26.31 ± 4.50†	26.84 ± 5.42†	28.32 ± 5.64#	28.02 ± 5.62*
Systolic blood pressure (mmHg)	137.24 ± 22.43	134.62 ± 23.60†	140.98 ± 23.46	140.54 ± 23.43*
Diastolic blood pressure (mmHg)	79.79 ± 12.30	80.63 ± 11.32	82.02 ± 11.15	83.45 ± 12.35*
Fasting plasma glucose (mmol/L)	6.41 ± 0.24	5.04 ± 0.70†	6.43 ± 0.24	8.22 ± 3.26*
2-HPP (mmol/L)	6.31 ± 1.05†	8.97 ± 0.86†	9.09 ± 0.83	13.87 ± 5.49*
A1C (%)	5.48 ± 0.81	5.45 ± 0.49†	5.57 ± 0.41	6.72 ± 1.95*
Total cholesterol (mmol/L)	6.15 ± 1.30	5.82 ± 1.26†	6.04 ± 1.22	6.19 ± 1.33
HDL (mmol/L)	1.36 ± 0.32	1.38 ± 0.39	1.33 ± 0.37	1.34 ± 0.37
LDL (mmol/L)	3.76 ± 1.04	3.70 ± 1.14†	3.75 ± 1.02	3.86 ± 1.22
Triglycerides (mmol/L)	1.72 ± 1.18	1.60 ± 1.04†	1.60 ± 1.01	2.01 ± 1.52*
Uric acid (mmol/L)	380.20 ± 124.55†	325.27 ± 101.46	349.83 ± 86.51	334.21 ± 97.66

Data are means ± SD or n (%). \**P* < 0.05 between IFG and new diabetes. †*P* < 0.05 between IFG and IFG/IGT. ‡*P* < 0.05 between IGT and new diabetes. #*P* < 0.05 between IGT and IFG/IGT. 2-HPP, 2-h postprandial.

with both IFG and IGT, the prevalence of CVD risk factors was high (65.7% had dyslipidaemia, 52.0% had hypertension, 76.5% had abdominal obesity [ $>90$  cm for men and  $>80$  cm for women], 82.4% had BMI  $\geq 23$  kg/m<sup>2</sup>, and 10.8% were current smokers). Using multiple logistic regression analysis, prediabetes was found to be associated with a history of smoking, age, and the low-income group.

The prevalence of newly diagnosed type 2 diabetes was 12.6% (31.0% in men and 69.0% in women) and increased with age from 3.8% among adults aged  $<30$  years to 11.6% among adults aged 40–49 years and was still higher (16.5%) in the older age-group ( $\geq 60$  years). Without relying on the OGTT, we would have missed ~5% of type 2 diabetes cases.

**CONCLUSIONS**—Glucose intolerance in this study is defined according to the World Health Organization diagnostic criteria (5). The prevalence of prediabetes in our study is comparable to other similar studies (6,7), and the percentage rose to 24.4% in those aged  $\geq 60$  years. Interestingly, the prevalence of IFG was lower than IGT in studied populations. Similarly, IGT was found to be more prevalent compared with IFG in Mauritius (8), in the U.S. (9), and in Pima Indians (10).

In our study, ~16.1% of adults had isolated IGT, a condition that increases

the risk for diabetes and other cardiovascular risk factors (11). In fact, many subjects with IGT will develop CVD before progressing to diabetes, as shown in one Japanese study (12). Changes in lifestyle and dietary habits in our population, in both rural and in urban areas, have resulted in the increased prevalence of risk factors for CVD, such as obesity, hypertension, and diabetes. Our prediabetic subjects had a high risk for CVD. This is not to be unexpected because prediabetes is a prelude to type 2 diabetes and is also associated with various comorbidities, which has been termed metabolic syndrome.

The prevalence of newly diagnosed type 2 diabetes in our study was 12.6% and is increasing with age. This high prevalence of undiagnosed diabetes, together with its earlier age of onset ( $<30$  years), poses a serious public health problem, especially if there is no serious concerted effort taken to improve it. By performing the OGTT, we were able to diagnose more subjects with type 2 diabetes because it captured both fasting and elevated 2-h plasma glucose levels.

In summary, the high prevalence of glucose intolerance among adults aged  $>18$  years has raised public health concerns. Because individuals with prediabetes usually have no apparent clinical symptoms, great efforts may be needed to identify them early and to intervene

against the root causes of insulin resistance, such as overweight, physical inactivity, and unhealthy diet in pediatric primary care and through public health services.

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