Abstract  Fasting glucose and oral glucose tolerance test (OGTT) criteria for glucose homeostasis were compared in a cross-sectional cluster, community study in Accra, Ghana. A total of 4636 subjects without prior diagnosis of diabetes had fasting plasma glucose, 2-hour OGTT and measurement of cardiovascular risk factors. Mean age of subjects was 44.2 years; 39.1% of subjects were males. The overall prevalence of undiagnosed diabetes ascertained with both criteria was 4.5% (n=209). The prevalence of undiagnosed diabetes by fasting (3.2%) and OGTT (3.1%) criteria were similar (p>0.05). The prevalence of impaired glucose tolerance (IGT) (15.8%) was higher than that of impaired fasting glucose (IFG) (10.7%). Only 56.5% (n=83) of subjects with diabetes by fasting criteria also had diabetes by OGTT criteria. Sixty-two subjects (42.8%) with diabetes by OGTT had normal or impaired fasting glucose. There was poor agreement between the two diagnostic criteria (kappa=0.31). The concordant normoglycaemic group was the youngest and had the lowest body-mass index (BMI), waist girth, waist-hip ratio (WHR), total cholesterol, and systolic and diastolic blood pressures. The concordant diabetic group, in contrast, had the highest BMI, waist girth, WHR, total cholesterol and triglyceride levels. Both systems gave similar undiagnosed diabetes rates but dissimilar IFG and IGT rates. There was poor agreement between the two diagnostic criteria. Diagnostic criteria influenced cardiovascular risk factors. A case may be made for using both criteria in order to ascertain all “diabetes” and all “at-risk” subjects.

Key words  Undiagnosed diabetes • Prevalence • Type 2 diabetes • Comparison • Impaired glucose tolerance • Impaired fasting glucose • ADA • WHO criteria

Introduction

Until recently, the most widely used system for diagnosis of diabetes and impaired glucose regulation in epidemiological studies was based on 1980–1985 recommended criteria of the World Health Organization (WHO) [1]. The diagnosis of diabetes was based on fasting plasma glucose ≥7.8 mmol/l or 2-hour plasma glucose level ≥11.1 mmol/l after a 75-g oral glucose tolerance test (OGTT) [1]. The OGTT, however, is at present rarely used for diagnosing diabetes in clinical practice on account of its inconvenience to patients and the perception by clinicians that it is unnecessary for diabetes diagnosis [2]. Furthermore, retinal abnormalities possibly related to diabetes have been observed in subjects with fasting plasma glucose of 7.0 mmol/l [3–5]. Also studies have shown that the 2-hour post-load glucose level did not contribute additional information to the predictive value of the fasting plasma glucose with respect to the prevalence of microvascular disease [5].

Recently, an expert committee of the American Diabetes Association (ADA) published new criteria for the clinical and epidemiological diagnosis of diabetes [3, 6]. In asymptomatic subjects, the committee recommends that diabetes be defined by a fasting plasma glucose ≥7.0 mmol/l for both clinical diagnosis and epidemiological studies. The 2-hour post-load plasma glucose ≥11.1 mmol/l, the basis of the 1985 WHO diagnostic criteria, is retained as a diagnostic...
category but is not recommended for routine screening for clinical diabetes or epidemiological studies. The recommenda-
tion was made in the interest of standardization and to fa-
tilize fieldwork particularly where the OGTT may be dif-
ficult to perform and where the cost and demands on par-
ticipant’s time may be excessive [3, 6]. Impaired fasting

glucose (IFG, 6.1–6.9 mmol/l), a new category of glucose
homeostasis, is proposed as an intermediate between dia-
betes and normal glucose level (<6.1 mmol/l) by both ADA
and WHO [3, 6, 7]. The WHO recommendations have re-
cently been reviewed in a recent report of a WHO consul-
tation [7].

The adoption in 1997 by the ADA of the fasting blood
glucose as the sole basis for diabetes diagnosis has brought
about the debate as to whether the OGTT be totally aban-
donated or not. Reports comparing the new fasting criteria
(ADA criteria) and the 2-hour post-OGTT criteria, main-
tained by WHO, have begun to emerge with diabetes preva-

cence being higher with ADA criteria [8, 9], similar with
both criteria [10] or lower with the ADA criteria [11, 12].
Other investigators have reported variable results in differ-
ent populations in the southern hemisphere island popula-
tions [13]. Little contribution to the scientific debate has
emerged from sub-Saharan Africa [14]. In this communica-
tion the fasting criteria and the 2-hour post-glucose criteria
[1, 3, 7] are compared in a community sample of adult
Ghanaian subjects without prior diagnosis of diabetes.

**Patients and methods**

One rural and two urban communities in the Greater Accra area of
Ghana were purposely selected for a comprehensive non-commu-
nicable disease survey. A stratified two-stage cluster sampling


technique was used. The first stage units were census enumeration
areas in the three survey areas. The second stage units were the
adults aged 25 years and over. The Statcalc function of EpInfo,
version 6 (Centres for Disease Control, Atlanta, Georgia, USA, and
World Health Organization, Geneva, Switzerland) was used to
determine the sample size. Assuming a diabetes prevalence of 2% in
the adult Ghanaian population, a 95% confidence level and
absolute precision of 1%, a sample size of 752 was obtained. On
account of the effect of clustering, the minimum sample size was
multiplied by the maximum design effect for clustering of 2 to give
a sample of 1504. To allow for a non-response rate of 20% and
non-participation of 10%, 1504 was multiplied by 100/(100–30) to
give a sample of 2149 (rounded to 2100).

**Sampling frame and sample allocation**

The Ghana Statistical Service randomly selected 14 census enum-
eration areas from each of the three survey areas. Each enum-
eration area was expected to have approximately 200 adults aged 25
years and over. From each of the selected enumeration areas, adults
aged 25 years and above were listed; of these, 150 adults were sub-
sequently selected per enumeration area to participate in the study
by systematic random sampling. A total of 6300 subjects (2100 per
survey area) was thus recruited into the study.

**Survey methods**

Subjects were requested to report to a central survey site (two sites
in the rural area) early in the morning, after an overnight fast of
10–14 hours. A fasting blood sample was withdrawn from a fore-
arm vein into fluoride-oxalate tubes and plain tubes. Subjects were
then given 300 ml glucose drink containing 82.7 gm dextrose
monohydrate (equivalent to 75 gm anhydrous glucose). After the
drink, subjects were not permitted to smoke or engage in strenuous
activity. A 2-hour post-glucose blood sample was withdrawn into
fluoride-oxalate tubes. The fluoridated blood samples were kept on
ice and centrifuged within 15 minutes of blood draw. The plasma
and serum were aliquoted into storage vials and transported on dry
ice to be stored at -80° until analyzed. Plasma glucose was deter-
mined in duplicate using glucose oxidase kits; fasting triglyceride,
total cholesterol and HDL cholesterol were determined by enzym-
atic methods with multisera controls (Randox Laboratories,
Crumlin, Antrim, UK) on chemistry analyzer (Erba Smartlab,
TransAsia, Mumbai, India) at the Diabetes Research Laboratory,
University of Ghana Medical School, Accra, Ghana.

Anthropometric measurements were performed on subjects in
light clothing and without shoes. Weight was measured with a
heavy duty Seca 770 floor digital scale (Seca, Hamburg, Germany)
to the nearest 0.1 kg. Height was measured with a stadiometer to the
nearest 0.1 cm. Waist and hip girth were measured in duplica-
tion with a non-elastic plastic measuring tape to the nearest 0.1 cm
at the mid-point between the lower rib margin and the iliac crest at
the end of gentle expiration and at the level of the greater trochanter,
respectively. The mean of the duplicate was used to determine the
waist-hip ratio (WHR). After at least 10 minutes rest, blood pressure
was measured in the right arm of seated subjects on two occasions
at an interval of one minute with the aid of a mercury sphygmno-
manometer. The mean of the two measurements was used.

**Data analysis**

Data for the three communities were pooled together for the pres-
ent report. Diabetes was defined in accordance with the new ADA
criteria [3, 6]. Diabetes was defined by a venous fasting plasma
glucose ≥7.0 mmol/l. Impaired fasting glucose (IFG) was defined
as venous plasma glucose ≥6.1 and <7.0 mmol/l. Additionally, dia-
betes was defined by a 2-hour venous plasma glucose ≥11.1
mmol/l [1, 3, 6, 7]. Impaired glucose tolerance (IGT) was defined
by a 2-hour venous plasma glucose ≥7.8 and <11.1 mmol/l [1, 3, 6,
7] following the abbreviated OGTT.

Data are expressed as mean ± (standard deviation) or percent
with 95% confidence interval (CI), unless otherwise stated. The
statistical package SPSS 10.0 for Windows (SPSS, Chicago, IL)
was used for analyses. Student’s unpaired, two-sided t tests were
used to compare means between two groups for variables with nor-
mal distribution. Cross-tabulation function of SPSS was used to
determine the chi-square derived p value and the measurement of
agreement, kappa statistic [15].