

# Impact of the new American Diabetes Association and World Health Organisation diagnostic criteria for diabetes on subjects from three ethnic groups living in the UK

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## Abstract

**Background and Aim:** *The American Diabetes Association (ADA) recommends basing diabetes diagnosis on a fasting plasma glucose (FPG) of  $\geq 7.0$  mmol/L and impaired fasting glucose (IFG) on  $6.1 \leq \text{FPG} < 7.0$  mmol/L. The new World Health Organisation (WHO) recommendations also adopt this FPG cut-off, but retain the oral glucose tolerance test (OGTT) where possible and the intermediate group of impaired glucose tolerance (IGT) in addition to IFG. We compare the effect of the new ADA and WHO diagnostic criteria in three ethnic groups.*

**Methods and Results:** *Three hundred and eighty whites, 340 South Asians and 347 subjects of African descent, aged 40–59 years and not known to have diabetes, were identified through South London general practices. Inevitably, the prevalence of new diabetes was lower under ADA than under WHO criteria (including post-load levels) for all three groups, falling from 5.7% overall to 3.3% (fall 2.4% 95% CI 1.6% to 3.6%).*

*The largest fall was for South Asians from 9.1% to 5.0% (fall 4.1% 95% CI 2.2% to 6.8%). The prevalence of impaired glucose homeostasis under ADA criteria (IFG) was substantially less than under WHO criteria (IFG+IGT). Under WHO criteria, including a glucose tolerance test,*

*there was marked variation by ethnic group in diabetes prevalence ( $p < 0.001$ ) and IGT ( $p < 0.0001$ ), both were most prevalent amongst South Asians. Under ADA criteria, (or new WHO criteria without OGTT) diabetes prevalence still differed significantly between groups ( $p < 0.01$ ), but there was no difference in IFG prevalence ( $p = 0.43$ ).*

**Conclusions:** *Subjects with IGT but normal FPG are at greater risk of coronary heart disease. The new ADA definition fails to identify substantial numbers of such subjects, particularly among South Asians. Our study supports the retention of the OGTT in the new WHO criteria, particularly for South Asians.*

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## Introduction

The diagnostic criteria for diabetes have recently been revised. The American Diabetes Association (ADA) recommends basing diabetes diagnosis on a fasting plasma glucose (FPG) of  $\geq 7.0$  mmol/L (compared with the previous fasting cut-off level of 7.8 mmol/L) and impaired fasting glucose (IFG) on  $6.1 \leq \text{FPG} < 7.0$  mmol/L (1). The World Health Organisation (WHO) has also revised its criteria and suggests adopting the same lower fasting cut-off for diabetes, but favours retaining the use of the oral glucose tolerance test (OGTT) and thus the intermediate group of impaired glucose tolerance (IGT) (2). The WHO also recognises a group with impaired fasting gly-

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TABLE 1

Comparison of fasting plasma glucose levels and 2 h post glucose load levels for subjects from three ethnic groups in South London.

2h post glucose load levels			Fasting plasma glucose levels		
Caucasian		n=377	(<6.1 mmol/L)	(6.1-6.9 mmol/L)	(≥7.0 mmol/L)
			Normal	IFG	New diabetes
			96.3%	2.9%	0.8%
(<7.8 mmol/L)	Normal	89.7%	333	5	0
(7.8-11.0 mmol/L)	IGT	8.0%	27	3	0
(≥11.1 mmol/L)	New diabetes	2.4%	3	3	3
African descent		n=342	92.7%	4.4%	2.9%
(<7.8 mmol/L)	Normal	85.7%	285	6	2
(7.8-11.0 mmol/L)	IGT	10.8%	27	8	2
(≥11.1 mmol/L)	New diabetes	3.5%	5	1	6
South Asian		n=331	92.7%	4.4%	2.7%
(<7.8 mmol/L)	Normal	74.6%	240	6	1
(7.8-11.0 mmol/L)	IGT	19.3%	57	5	2
(≥11.1 mmol/L)	New diabetes	6.0%	10	4	6

For this analysis, 126 subjects with known diabetes were excluded: 11 whites, 53 of African descent and 62 of South Asian origin. Only the 1050 subjects with both fasting plasma glucose and 2-h post glucose load levels were included.

caemia (IFG) with FPG  $\geq 6.1$  and  $< 7.0$  mmol/L and 2-h post glucose load, if measured,  $< 7.8$  mmol/L. Thus, for the new WHO criteria there are two groups of impaired glucose homeostasis, IGT and IFG. When it is not possible to perform the OGTT, the WHO allows FPG alone to be used for epidemiological purposes (*ie* using identical criteria to the ADA), but recognises that some individuals, particularly the elderly and South Asian subjects, may not be identified by the new fasting values. For clinical practice both the ADA and the WHO recommend repeat testing before diagnosis is confirmed. Whilst the new WHO diagnostic criteria were still under discussion, re-analysis of European (3), American (4) and UK (5) data were performed by comparing the new ADA criteria to the old WHO criteria. These studies showed considerable variation in the prevalence of diabetes and of the intermediate categories as well as considerable reclassification of individuals. This variation may depend on age, weight, overall prevalence of diabetes and ethnic background. We have previously reported large differences in diabetes prevalence between ethnic groups, with age and sex standardised prevalence ratios of 2.7 (95% CI 1.8 to 4.0) in people of African descent and 3.8 (2.6 to 5.6) in South Asians compared to whites (6). Here we examine the effect of the new ADA compared to the new WHO criteria on the prevalence of diabetes and on the intermediate category between normals and diabetics across three ethnic groups.

### Methods

A population-based survey was carried out in Wandsworth, South London, UK, where roughly 12% of residents are from the Caribbean or West Africa (that is, of African descent) and 6% are of Indian, Pakistani, or Bangladeshi origin (that is, South Asian). These ethnic groups are not evenly distributed across general practices and areas of the district. Nine practices were selected to give a balanced geographical and ethnic mix. Men and women aged 40-59 were invited from the practices as part of a cardiovascular screening study. In order to obtain an approximately equal number of participants in each sex and ethnic-specific stratum, all names suggestive of a South Asian origin and of West African origin were selected. In addition, patients of Afro-Caribbean origin were identified by a combination of name searching and contact with the general practitioners and the receptionist or practice nurse at the surgery. A proportional random sample of white patients was also drawn to yield a number of participants approximately equal to the other ethnic groups. The response rate to the survey was 64% (1695/2654). Ethnic group was recorded at interview, based on the answers to a combination of questions, including place and country of birth, language, religion, history of migration and parental country of birth (7).

There were 1577 subjects aged 40-59 in the three ethnic groups: 524 white, 549 of African descent, and 505 of South

Asian origin. Among the group of African descent, 62% were born in the Caribbean and 36% in West Africa. Among the group of South Asian origin, about two-thirds were born in South Asia (India, Pakistan, Bangladesh or Sri Lanka), and just over a quarter in East Africa. Full study details including practice and subject selection and blood testing methods have been reported elsewhere (6, 8). For this analysis, 126 subjects known to have diabetes were excluded: 11 whites, 53 of African descent and 62 of South Asian origin.

Seventeen subjects with glycosuria did not have an OGTT for safety reasons, but had an FPG. They are excluded from Table 1 for this reason, but are included in the comparison of prevalence of diabetes and impaired fasting glucose between ethnic groups (Table 2), being labelled as diabetic if their FPG was  $\geq 7.0$  mmol/L and IFG if it was  $\geq 6.1$ - $<7.0$  mmol/L. They were included in this comparison as they are part of the screened population and because 15/17 were picked up as abnormal by the fasting criteria.

Prevalence rates between ethnic groups were compared using  $\chi^2$  tests. Confidence limits for the difference in prevalence of diabetes and impaired glucose homeostasis are based on a test of a binomial proportion (9) since differences are simply a percentage of the population who are positive under WHO but not ADA criteria.

## Results

FPG levels were directly compared with 2-h post OGTT levels for the 1050 subjects from the groups with both measurements and also compared by ethnic group (Table 1). This table shows those who would be classified as normal by FPG levels alone, but classified as having IGT or diabetes after a glucose load. For IGT, there are 27 (7.2%) Caucasians, 27 (7.9%) subjects of African descent and 57 (17.2%) subjects of South Asian origin. For diabetes, there are 3 (0.8%) Caucasians, 5 (1.5%) subjects of African descent and 10 (3.0%) subjects of South Asian origin.

The prevalences of diabetes, IGT and IFG under the new full WHO criteria (based on fasting and 2-h load levels) were compared with the prevalence of diabetes and IFG using the new ADA criteria (based on FPG alone) for the three ethnic groups (Table 2). As stated before, partial WHO criteria, based only on FPG, are identical to the ADA criteria.

Overall 61/1067 (5.7%) qualified for a new diagnosis of diabetes using the new full WHO criteria (including post load measurements) (FPG  $\geq 7.0$  mmol/L and/or 2 h post glucose tolerance test  $\geq 11.1$  mmol/L). Thirty-five out of 1067 (3.3%) qualified for a diagnosis of diabetes under the new ADA criteria (FPG  $\geq 7.0$  mmol/L). This would also be

**TABLE 2**

Comparison of prevalence of new diabetes, IGT and IFG under the new full WHO criteria (including postload samples) and the ADA or new partial WHO criteria (using fasting glucose alone) for subjects from three ethnic groups in South London

	New full WHO criteria <sup>a</sup> (based on fasting and post load glucose samples)			ADA criteria <sup>b</sup> and new partial WHO criteria (based on fasting plasma glucose alone)	
	Diabetes prevalence	IGT prevalence	IFG prevalence	Diabetes prevalence	IFG prevalence
	n (%)	n (%)	n (%)	n (%)	n (%)
Caucasian n=380	10 (2.6)	30 (7.9)	6 (1.6)	4 (1.1)	11 (2.9)
African descent n=347	20 (5.8)	35 (10.1)	6 (1.7)	14 (4.0)	15 (4.3)
South Asian n=340	31 (9.1)	62 (18.2)	7 (2.1)	17 (5.0)	15 (4.4)
Total n=1067 <sup>c</sup>	61 (5.7)	127 (11.9)	19 (1.8)	35 (3.3)	41 (3.8)

<sup>a</sup>WHO criteria (2): diabetes = fasting plasma glucose  $\geq 7.0$  mmol/L or 2-h post glucose load  $\geq 11.1$  mmol/L;

IGT= 2-h post glucose tolerance test  $\geq 7.8$  mmol/L -  $<11.1$  mmol/L (and fasting, if measured  $<7.0$  mmol/L)

IFG= fasting plasma glucose  $\geq 6.1$ - $<7.0$  mmol/L (and 2-h post glucose load, if measured,  $<7.8$  mmol/L).

<sup>b</sup>ADA criteria (1): diabetes= fasting plasma glucose  $\geq 7.0$  mmol/L; IFG = fasting plasma glucose  $\geq 6.1$ -  $<7.0$  mmol/L.

<sup>c</sup>Total includes all subjects with fasting and 2-h post glucose load levels (n=1050), and subjects with glycosuria and fasting glucose levels (n=17).

Of the 17 subjects with glycosuria, 13 were diabetic on the basis of the FPG (1 Caucasian, 4 African descent, 8 South Asian), 2 had IFG (1 Caucasian, 1 South Asian) and 2 had normal FPG.

the prevalence using the new partial WHO criteria if only FPG were used. Overall there is a difference in prevalence of 2.4% (95% CI 1.6% to 3.6%) between the two criteria.

Diabetes prevalence shows differences between ethnic groups on using both the new full WHO criteria ( $\chi^2$  for heterogeneity =14.0,  $p<0.001$ ) and the new ADA or partial WHO criteria ( $\chi^2$  for heterogeneity =9.7,  $p<0.01$ ). The prevalence is highest amongst South Asians, intermediate in those of African descent and lowest in whites. The differences would have been greater if known diabetics had been included. We have too little power to model the fall in prevalence of diabetes by ethnic group, though South Asians exhibit the greatest fall, from 9.1% to 5.0% (fall 4.1%, 95% CI 2.2% to 6.8%).

The change in definition from IGT to IFG results in a marked change in the identification of those judged as having borderline abnormalities. The prevalence of IFG is significantly lower than that of IGT within each ethnic group ( $p<0.001$  for each group). Moreover, while IGT exhibits significant variation by ethnic group ( $\chi^2=23.4$ ,  $p<0.0001$ ) with South Asians having a much greater prevalence than the other two groups, there is no evidence of variation by ethnic group in prevalence of IFG ( $\chi^2=1.7$ ,  $p=0.43$ ).

In clinical terms, the number of individuals who will be identified as having impaired glucose homeostasis by the two criteria is important. For the full WHO criteria, this will be the sum of those with IGT and IFG, *ie* overall 13.7%, compared with 3.8% with IFG under ADA criteria (fall 9.9%, 95% CI 8.1% to 11.8%). This difference is greatest for South Asians, 20.3% with impaired glucose homeostasis under the full WHO criteria compared with 4.4% under the ADA criteria (fall 15.9% 95% CI 12.0% to 19.8%).

## Discussion

We have shown that the new fasting ADA criteria give a markedly lower prevalence of diabetes than the new full WHO criteria, including post glucose load levels. Wahl *et al* (4) and the ADA (1) compared the new ADA criteria with the old WHO criteria and also showed a fall in diabetes prevalence.

Analyses of our own data comparing the new ADA with the old WHO criteria (not shown) support this conclusion. Other researchers reported a rise in prevalence, but have defined the old WHO criteria on the basis of only the 2-h post load glucose level (3, 5). All previous reports comparing the new ADA with the old WHO criteria have shown

substantial reclassification of individuals (1, 3-5). We now demonstrate that this is also the case when comparing the new ADA criteria with the new full WHO criteria, including post load levels. In absolute terms, the lower diabetes prevalence under the ADA criteria was greater for South Asians. Importantly, subjects not detected under the new criteria are those with isolated 2-h hyperglycaemia, who have been shown to have raised mortality (10). This group is far larger in South Asians.

The DECODE study (3) showed the importance of age and BMI as determinants of disagreement of classification between the ADA and the old WHO definitions of diabetes. Individuals below age 65 years and with BMI  $\geq 25$  Kg/m<sup>2</sup> were more likely to be diagnosed on the basis of the ADA criteria than on the basis of the old WHO criteria. We do not have large enough numbers in our study to break down this analysis by age and BMI. However, all our subjects are under 60, and the between-group mean age differences are small: Caucasian 49.8, African descent 51.1, South Asian 49.4. In terms of BMI, there are no big differences between the groups, except for subjects of African descent, where there are significantly more women with obesity (8). However, this is not the group where the post load differences in diabetes and IGT have been demonstrated, so confounding of our results by between-group differences in BMI would not explain our findings.

The marked change between the two criteria for the intermediate category IGT/IFG reflects the biological difference between these measures of impaired glucose homeostasis. The prevalence of IGT was significantly greater in South Asians compared to whites or subjects of African descent. In contrast, the much lower prevalence of IFG was very similar across the three groups.

The failure to identify subjects with IGT under the ADA (or WHO fasting only) criteria is important. There is evidence that subjects with impaired glucose tolerance but normal fasting glucose are at greater risk of coronary heart disease (11) and death (10) and form a group for which preventive measures would be useful. Our results suggest that, particularly among South Asians, abandoning the OGTT could lead to fewer subjects being classified in the intermediate group with consequent implications for prevention and treatment. We believe that these findings lend further support to those who advocate retaining the OGTT for the diagnosis of glucose tolerance (10, 12). The full WHO criteria including 2-h post load levels should particularly be advised for those of South Asian origin, as the new WHO document suggests (2).

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