Prevalence of Undiagnosed Diabetes in Three American Indian Populations

A comparison of the 1997 American Diabetes Association diagnostic criteria and the 1985 World Health Organization diagnostic criteria: The Strong Heart Study

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OBJECTIVE — In 1997, the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus of the American Diabetes Association (ADA) recommended three new sets of criteria for the diagnosis of diabetes that were different from those established by the World Health Organization (WHO) in 1985. One of these three methods was based on a fasting plasma glucose value only. This article compares ADA criteria with WHO criteria by applying them to three subgroups of American Indians in the Strong Heart Study who had no known diabetes.

RESEARCH DESIGN AND METHODS — The Strong Heart Study is a prospective epidemiological study of vascular disease in three American Indian populations aged 45–74 years. During the baseline examination from 1988 to 1991, participants without diagnosed diabetes underwent a fasting glucose test and a 2-h oral glucose tolerance test. These values were used to compare the ADA and WHO diagnostic criteria.

RESULTS — By using fasting and 2-h glucose values, prevalence rates of undiagnosed diabetes were 15.9% according to WHO criteria and 14.4% according to ADA criteria. The overall agreement rate was 65%, and the weighted κ statistic was 0.474, which indicates moderate agreement. The age-specific analysis showed that, among participants between 45 and 54 years of age, the prevalence rates of undiagnosed diabetes were 13.4% according to WHO criteria and 12.7% according to ADA criteria. Among those aged 55–74 years, the rates were 18.7% according to WHO criteria and 16.3% according to ADA criteria. Thus, the difference in the prevalence rates when using WHO and ADA criteria, although generally small in this population, was three times higher in the older group (2.4%) than the difference in the younger group (0.7%).

CONCLUSIONS — The Strong Heart Study found that prevalence rates of undiagnosed diabetes determined by ADA criteria and WHO criteria were similar in its American Indian population. The data suggest that the difference between the two criteria may increase as age increases. Longitudinal data will be needed to evaluate further the utility of the two criteria.

Diabetes Care 23:181–186, 2000

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Received for publication 5 March 1999 and accepted in revised form 3 November 1999.

Abbreviations: ADA, American Diabetes Association; CHS, Cardiovascular Health Study; FPG, fasting plasma glucose; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; NDDG, National Diabetes Data Group; NFG, normal fasting glucose; NGT, normal glucose tolerance; NHANES III, Third National Health and Nutrition Examination Survey; OGTT, oral glucose tolerance test; UA/C, urinary albumin/creatinine; WHO, World Health Organization.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

The first systematic classification of diabetes was published by the National Diabetes Data Group (NDDG) in 1979 in an attempt to eliminate confusion stemming from the use of many often quite different criteria for the diagnosis of diabetes (1). The World Health Organization (WHO) endorsed the substantive recommendation of the NDDG and published its diagnostic criteria in 1985 (2). The 1985 WHO diagnostic criteria for diabetes have been used in most epidemiological and clinical studies since then. These criteria were based on clinical manifestations or treatment and pathogenesis and required measures of fasting plasma glucose (FPG) and plasma glucose 2 h after an oral glucose tolerance test (OGTT). WHO criteria involve three broad diagnostic classifications: diabetes, impaired glucose tolerance (IGT), and normal glucose tolerance (NGT).

In 1997, the American Diabetes Association (ADA) Expert Committee on the Diagnosis and Classification of Diabetes Mellitus recommended a set of revised diagnostic criteria on the basis of the 1979 accepted standards and new research findings since that time (3). The revised criteria suggest three possible ways to diagnose diabetes. One of the new criteria allows the diagnosis of diabetes to be made by using only an FPG measurement without requiring a 2-h OGTT. The Expert Committee also recommended that, for epidemiological studies, diabetes prevalence and incidence should be estimated on the basis of FPG. Instead of using IGT, which requires a 2-h OGTT, 1997 ADA criteria introduced a new category based only on FPG called "impaired fasting glucose" (IFG).

In a comparison of the FPG-based ADA criteria with WHO criteria by using the data from the 1988–1994 Third National Health and Nutrition Examination Survey (NHANES III), Harris et al. (4) found that the prevalence of undiagnosed diabetes in the 40- to 74-year age-group was 6.4% according to WHO criteria and

4.4% according to ADA criteria. The prevalence of IGT was 15.6% according to WHO criteria and that of IFG was 10.1% according to ADA criteria. A study of 647 Japanese-Brazilians, aged 40–79 years, found very similar prevalence rates of diabetes (20.3% according to WHO criteria and 19.2% according to ADA criteria), but the prevalence of IGT according to WHO criteria (14.7%) was twice as high as that of IFG according to ADA criteria (7.4%) (5).

A report from the Cardiovascular Health Study (CHS) (6), however, showed that, in its cohort (n = 4,515) of older adults (aged 65–100 years, 95% Caucasian), the prevalence of undiagnosed diabetes when using ADA criteria was 7.7%, which is significantly lower than the 14.8% obtained with WHO criteria. In a smaller subset of African-Americans (n = 262), prevalence rates were 2.7% according to ADA criteria and 11.8% according to WHO criteria. A lack of concordance between the WHO and ADA criteria was also found in a study of 1,706 adults from Mexico City, Mexico (7). ADA criteria failed to detect 69% of the patients who had diabetes according to WHO criteria, and the κ statistic was only 0.36. A recent study (8) of 2,290 northwestern Italians showed that the prevalence rates of diabetes were 25.5 and 23.6% according to the WHO and ADA criteria, respectively, and the concordance between IFG and IGT was low. Another report (9) showed that the concordance rates for diabetes diagnosed by ADA criteria and WHO criteria varied considerably across seven populations in the southern hemisphere.

This article examines the level of agreement between the ADA and WHO criteria in a large cohort of American Indians aged 45–74 years in the Strong Heart Study at their baseline examination and compares our results with those obtained from the other studies (4–9).

RESEARCH DESIGN AND METHODS

— The baseline examination of the Strong Heart Study was conducted between 1988 and 1991. The study design and methods have been described elsewhere (10). Briefly, the study involved American Indians in 13 tribes or Indian communities in Arizona, Oklahoma, South Dakota, and North Dakota. The participating tribes were the Pima/Maricopa/Papago of the Gila River in Arizona; the Salt River and Ak-Chin Indian communities near Phoenix, AZ; the Apache, Caddo, Comanche, Delaware, Fort Sill Apache, Kiowa, and Wichita tribes in southwestern Oklahoma; the Oglala Sioux and Cheyenne River Sioux in South Dakota; and the Spirit Lake tribe of North Dakota. The study had three components: a community mortality survey, a morbidity survey of hospitalized myocardial infarction and stroke, and a clinical examination of tribal members aged 45–74 years who resided in the study communities. The clinical examination included a personal interview and a physical examination. Family history, personal health habit information (e.g., smoking and drinking), degree of Indian blood, and socioeconomic information were collected at the personal interview. The physical examination included measurements of height, weight, body fat, and blood pressure; a 12-lead electrocardiogram; an examination of the heart and lungs; and an evaluation of peripheral vascular disease.

Laboratory tests included FPG and glucose 2 h after ingestion of a 75-g glucose load (Glutol; Paddock, Minneapolis, MN). The 2-h OGTT was performed on all participants except for diabetic patients who were treated with insulin or who were taking oral hypoglycemic agents and participants whose fasting glucose level was ≥225 mg/dl as determined by Accu-Chek II (Baxter Healthcare, Grand Prairie, TX). We believed that this population included many individuals with undiagnosed diabetes and that a cut point of 225 mg/dl would allow us to detect most, if not all, of those cases. In additional, we considered individuals with a fasting glucose level of ≤224 mg/dl according to Accu-Chek II to be safe to undergo the OGTT. Other laboratory measurements included lipids, apolipoproteins, fasting insulin, plasma creatinine, HbA_{1c}, and urinary albumin/creatinine (UA/C). Fasting and 2-h glucose values were determined at the Penn Laboratory (core laboratory) in Washington, DC, by using the glucose oxidase method. The glycated hemoglobin assay was performed at the laboratory of the Epidemiology and Clinical Research Branch of the National Institute of Diabetes and Digestive and Kidney Diseases in Phoenix, AZ, using a high-pressure lipid chromatography assay (11).

WHO criteria for diabetes, IGT, and NGT are as follows:

- Diabetes: FPG ≥140 mg/dl or 2-h glucose ≥200 mg/dl,
- IGT: FPG <140 mg/dl and 2-h glucose 140–199 mg/dl,
- NGT: FPG <140 mg/dl and 2-h glucose <140 mg/dl.

The 1997 ADA criteria on the basis of FPG for diabetes, IFG, and normal fasting glucose (NFG) are as follows:

- Diabetes: FPG ≥126 mg/dl,
- IFG: FPG 110–125 mg/dl,
- NFG: FPG <110 mg/dl.

In the Strong Heart Study, a total of 4,549 participants were examined in Phase I. In our analysis, we excluded 1,682 participants who had known diabetes and thus did not undergo an OGTT (those who were taking insulin or oral hypoglycemic agents and those who had a medical history of diabetes and an abnormal glucose level) and 246 participants whose glucose tolerance status could not be determined because of factors including refusal to take the OGTT and blood samples being damaged during shipping. Thus, the total number of participants included in this comparison study was 2,621.

Statistical methods included the weighted κ statistic (12) and a χ^2 test for the degree of agreement between WHO criteria and ADA criteria. An analysis of the sensitivity and specificity (13) of ADA criteria by using WHO criteria as the "gold standard" was also performed.

RESULTS

— Table 1 gives the diagnostic results according to WHO criteria and ADA criteria. Of the 2,621 participants, 15.9% (416) were diagnosed as having diabetes according to WHO criteria, and 14.4% (377) were diagnosed as having diabetes according to ADA criteria. Similarly, the prevalence of IGT when using WHO criteria (26.4%) was higher than that of IFG (21.2%) when using ADA criteria. The overall agreement rate was 65% (1,713/2,621), and the weighted κ statistic was 0.474 (95% CI 0.44–0.51), which indicates moderate agreement. Among the 416 participants who were classified as having diabetes according to WHO criteria, 63 (15.1%) were classified as having NGT, and 91 (21.9%) were classified as having IFG according to ADA criteria. Among the 377 participants who were diagnosed as having diabetes according to ADA criteria, 41 (10.9%) and 74 (19.6%) were classified as having NFG and IFG, respectively, according to WHO criteria.

Of the 1,512 participants who were diagnosed as having NGT according to

Table 1—*Comparison of WHO and ADA diagnostic categories for undiagnosed diabetes*

	ADA criteria				Prevalence by WHO criteria
	NFG	IFG	Diabetes	Total	
WHO criteria					
NGT	1,229	242	41	1,512	57.7
IGT	397	222	74	693	26.4
Diabetes	63	91	262	416	15.9
Total	1,689	555	377	2,621	—
Prevalence by ADA criteria	64.4	21.2	14.4	—	—

WHO criteria, most (81.3%) were diagnosed as having NFG according to ADA criteria. However, among the 693 subjects with IGT, 10.7% were classified as having diabetes and 32% were classified as having IFG according to ADA criteria. Almost 4% (3.7%) of the 1,689 subjects with NFG according to ADA criteria were classified as having diabetes according to WHO criteria. Among the 555 subjects with IFG, 40% were diagnosed as having IGT and 16% were diagnosed as having diabetes according to WHO criteria.

A detailed description of the diagnostic categories is given in Table 2 with the corresponding mean values of HbA_{1c}, fasting insulin, UA/C ratio, total cholesterol, HDL cholesterol, and LDL cholesterol. Compared with WHO criteria, the lower cutoff value (126 mg/dl) for diabetes in ADA criteria identified 115 more undiagnosed diabetes cases, but ignoring the 2-h glucose data missed 154 diabetes cases according to WHO criteria (91 were considered to have IFG, and 63 were considered to have NFG). Participants who had a fasting glucose level ≥140 mg/dl and a 2-h glucose level ≥200 mg/dl had the highest mean HbA_{1c} (7.94%). This mean value was followed by that of those with an FPG level ≥140 mg/dl and a 2-h glucose level between 140 and 200 mg/dl (mean HbA_{1c} 6.13%). A total of 619 (23.6%) participants who were diagnosed with IGT according to WHO criteria had an FPG level <126 mg/dl, and 397 (15%) of these had an FPG level <110 mg/dl. Mean HbA_{1c} values for the patients with undiagnosed diabetes when using the WHO and ADA criteria were 6.61 and 6.70%, respectively. Similarly, the next HbA_{1c} category includes the subjects with IGT according to WHO criteria and the subjects with IFG according to ADA criteria. Participants who had NGT or NFG had the lowest HbA_{1c} (~5%). Patients classified with diabetes according to WHO criteria but with IFG according to ADA criteria had a mean HbA_{1c} value (5.65%) similar to those classified with diabetes according to ADA criteria but classified with IGT according to WHO criteria (5.55%). Patients who were classified with diabetes according to WHO criteria but classified with NFG according to ADA criteria had a much higher mean HbA_{1c} (5.45%) than those classified with diabetes according to ADA criteria but classified with NGT according to WHO criteria (5.18%). The difference was statistically significant at $P = 0.054$.

The mean fasting insulin value of patients who were diagnosed as having diabetes according to ADA criteria was only slightly higher (29.7 μU/ml) than that of those diagnosed with diabetes according to WHO criteria (28.2 μU/ml). The differences in mean fasting insulin levels between the subjects with IFG (20.7 μU/ml) and those with IGT (20.2 μU/ml) and between the subjects with NFG (13.9 μU/ml) and those with NGT (13.5 μU/ml) were negligible. However, larger differences were observed in mean UA/C ratios (83.9 in subjects with diabetes classified according to WHO criteria vs. 79.7 in subjects with diabetes classified according to ADA criteria). Similarly, patients who were diagnosed with IGT according to WHO criteria had a higher mean UA/C ratio (59.4) than those who

Table 2—*Prevalence of diabetes diagnostic categories, with 1997 ADA criteria and 1985 WHO criteria, mean HbA_{1c}, fasting insulin, UA/C ratio, total cholesterol, HDL cholesterol, and LDL cholesterol*

						Mean					
				Prevalence							
FPG	2-h glucose	1997 ADA category	1985 WHO category	*n*	%	HbA_{1c} (%)	Fasting insulin (μU/ml)	UA/C	Total cholesterol (mg/dl)	HDL cholesterol (mg/dl)	LDL cholesterol (mg/dl)
≥140	≥200	Undiagnosed DM	Undiagnosed DM	121	2.81	7.94	30.20	162.31	194.16	40.90	113.92
≥140	140 t o <200	Undiagnosed DM	Undiagnosed DM	20	0.46	6.13	36.40	38.91	179.15	41.40	107.36
≥140	<140	Undiagnosed DM	Undiagnosed DM	10	0.23	5.22*	70.59	12.72	198.70	43.50	128.70
≥140	Missing	Undiagnosed DM	Undiagnosed DM	35	0.81	9.23*	20.65	134.21	206.54	42.23	119.13
126 to <140	≥200	Undiagnosed DM	Undiagnosed DM	76	1.77	5.88*	28.91	27.41	191.47	43.01	116.85
126 to <140	140 to <200	Undiagnosed DM	IGT	74	1.72	5.55	30.51	26.71	189.01	47.16	115.35
126 to <140	<140	Undiagnosed DM	NGT	41	0.95	5.18*	22.73	19.84	192.63	44.98	120.56
110 to <126	≥200	IFG	Undiagnosed DM	91	2.11	5.65	24.76	61.58	186.89	46.19	111.32
110 to <126	140 to <200	IFG	IGT	222	5.16	5.34	22.30	78.24	192.18	45.35	115.72
110 to <126	<140	IFG	NGT	242	5.62	5.28	17.79	22.95	195.17	46.53	119.04
<110	≥200	NFG	Undiagnosed DM	63	1.46	5.45	23.41	32.45	188.06	46.89	111.13
<110	140 to <200	NFG	IGT	397	9.23	5.18	17.11	55.05	191.60	48.98	114.30
<110	<140	NFG	NGT	1,229	28.56	4.98	12.34	31.32	193.41	48.72	118.75
Diagnosed DM	—	—	—	1,682	39.09	9.00	27.37	748.63	189.74	42.87	108.77
Total	—	—	—	4,303	100.00	—	—	—	—	—	—

DM, diabetes. *Between 10 and 20% of the sample have missing HbA_{1c} values.

Table 3—*Comparison of WHO and ADA diagnostic categories by age*

	ADA criteria				
	NFG	IFG	Undiagnosed diabetes	Total	Prevalence (%)
WHO criteria					
Aged 45–54 years					
Normal	704	126	25	855	61.2
IGT	207	113	35	355	25.4
Undiagnosed diabetes	38	32	117	187	13.4
Total	949	271	177	1,397	—
Prevalence (%)	67.9	19.4	12.7	—	—
Aged 55–74 years					
Normal	525	116	16	657	53.7
IGT	190	109	39	338	27.6
Undiagnosed diabetes	25	59	145	229	18.7
Total	740	284	200	1,224	—
Prevalence (%)	60.5	23.2	16.3	—	—

were classified with IFG (51.5) according to ADA criteria. In participants who were diagnosed as NGT by WHO criteria, the mean UA/C ratio was 29.7, 8% had microalbuminuria, and 1% had macroalbuminuria. On the other hand, participants who were considered to have NFG according to ADA criteria had a mean UA/C ratio of 36.9, 8% had microalbuminuria, and 2% had macroalbuminuria. In addition, we examined family history of diabetes, total cholesterol, HDL cholesterol, and LDL cholesterol between patients diagnosed as having diabetes or IFG/IGT according to the two criteria. No substantial differences were found. In comparing patients diagnosed as having diabetes according to ADA criteria (NGT according to WHO criteria) with those diagnosed as having diabetes according to WHO criteria (NFG according to ADA criteria), we noted that the former had only slightly higher total and LDL cholesterol levels than the latter.

Table 3 compares the two diagnostic criteria by age. Only 424 participants were in the 65- to 74-year age-group; these participants were combined with those aged between 55 and 64 years. In the 45- to 54-year age-group, the overall agreement rate between the two criteria was 67%, which was slightly higher than that in the 55- to 74-year age-group (64%). However, of participants who were classified with IFG according to ADA criteria, 20.8% of those in the 55- to 74-year age-group were classified as having diabetes according to WHO criteria, but only 11.9% in the 45- to 54-year age-group were so classified. In the 45- to 54-year age-group, prevalence of diabetes was 13.4% according to WHO criteria and 12.7% according to ADA criteria, a difference of 0.7%. In the 55- to 74-year age-group, the difference in the prevalence of diabetes according to the two criteria was 2.4% (18.7% according to WHO criteria and 16.3% according to ADA criteria), which is more than three times higher than the prevalence in the 45- to 54-year age-group. When examining the 65- to 74-year age-group separately, we found that the difference in diabetes prevalence between the two diagnostic criteria was also 2.4%. When using WHO criteria among female participants who were aged between 65 and 74 years, only 10% were diagnosed as having diabetes because of their high fasting glucose level only, and 68% were diagnosed because of their high 2-h glucose values only (56 and 57%, respectively, in the 45- to 54-year and 55- to 64-year age-groups). Among the men in this age-group, 48% were diagnosed as having diabetes because of their high 2-h glucose values only. Age did not affect the results in men as greatly as it affected the results in women.

The IGT rates produced by WHO criteria were higher than the IFG rates produced by ADA criteria in both age-groups. However, the difference was lower in the 55- to 74-year age-group (4.4%) than the 45- to 54-year age-group (6.0%). In the 55- to 74-year age-group, 20.8% of participants who were classified as having IFG according to ADA criteria were classified as having diabetes according to WHO criteria. This rate was much higher than the 11.8% found in the 45- to 54-year age-group.

By using WHO criteria as the "gold standard," ADA criteria for diabetes had a sensitivity of 63%, a specificity of 95%, a false-positive rate of 5.2%, and a false-negative rate of 37%. The predictive value of a positive diagnosis according to ADA criteria was 69.5%, and the predictive value of a negative diagnosis was 93.1%. However, the sensitivity of ADA criteria for detecting IGT according to WHO criteria was only 32%.

CONCLUSIONS — Diabetes and its complications are very common among the American Indian people. Therefore, a simple diagnostic procedure would greatly facilitate early diagnosis of the disease and consequently early detection of complications. New ADA criteria, which allow the use of only FPG values, provide a simpler diagnostic method than WHO criteria, which require a 2-h OGTT. In the Strong Heart Study, a population study of more than 4,500 American Indians aged 45–74 years from 13 tribes and communities, we found that the two criteria for diabetes are comparable when previously known diabetic individuals are excluded. The κ statistic indicated a reasonably good agreement between the two criteria. The overall rates of undiagnosed diabetes were 15.9% according to WHO criteria and 14.4% according to ADA criteria. Compared with results from previous studies (4–8), our findings were similar in that ADA criteria produced a lower prevalence rate than WHO criteria. The difference in prevalence of undiagnosed diabetes when using the two criteria found in our study (1.5%) was comparable with the 2% found in NHANES III (4) (which included a large probability sample of the U.S. population aged 40–74 years), the 1.1% reported in the study from Brazil (5) (which was conducted in a representative sample of Japanese-Brazilians aged 40–79 years), and the 1.6% found in the study of northwestern Italians (8) whose age range was unknown. The difference found in our study was much lower than the 7.1 and 9.1% found in the CHS (6) in its 1989 cohort and its African-American cohort, respectively, and the 8.44% reported in the study of adult patients in Mexico City (7). The exact age range of participants in the Mexico City study was unknown. The CHS participants were between 65 and 100 years of age and represented a much older population than the Strong Heart Study. In our age-specific analysis, we did find that the difference in

the prevalence rates of undiagnosed diabetes was more than three times higher in subjects aged ≥55 years (2.4%) than in subjects between 45 and 54 years of age (0.7%), which suggests that the WHO and ADA criteria become more divergent among older groups.

A report from seven populations in the southern hemisphere (Nauru, Western Samoa, Rodrigues, Fiji, Karibati, Mauritius, and Papua New Guinea) showed that prevalence rates of diabetes when using WHO criteria ranged from 0 (females of urban West Samoa) to 3.67 times (females in rural Kiribati) higher than those determined by ADA criteria (9). Subjects included in this report were aged 19–99 years from surveys conducted between 1980 and 1994. Our findings in the American Indian population are similar to some of these populations (e.g., those from Rodrigues and Nauru).

Similar to results reported previously (4–7,9), we found that the undiagnosed IFG rate (21.2%) when using ADA criteria was lower than the undiagnosed IGT rate (26.4%) when using WHO criteria. Both were higher than those found in NHANES III (4) (10.1 and 15.6%, respectively) and the Japanese-Brazilian study (5) (7.4 and 14.7%, respectively). This is partially because both of these studies included a group of individuals younger (aged 40–45 years) than the Strong Heart Study participants. However, the Strong Heart Study had a net difference between the two diagnostic criteria (4.2%) comparable with the NHANES III (5.5%) but much lower than the Japanese-Brazilian study (7.3%). This may be because the Japanese-Brazilian study included individuals older (aged 75–79 years) than the Strong Heart Study participants. The Mexico City study showed an IFG rate (10.96%) similar to that in NHANES III (10.1%) and an IGT rate (23.86%) close to that in the Strong Heart Study (26.4%). The exact reason for this is unclear.

The CHS (6) reported much higher IGT rates (32.1% in its 1989 cohort and 29.8% in its African-American cohort) but lower IFG rates (14.6% in the 1989 cohort and 6.1% in the African-American cohort). The differences between the two diagnostic criteria for IGT and IFG were much higher in the CHS than in the Strong Heart Study. Again, among the seven populations in the southern hemisphere (8), the differences in the prevalence rates of IFG varied considerably compared with those of IGT. The prevalence of IGT was lower than that of IFG in some of the populations (e.g., almost 70% lower in males in rural Western Samoa) and much higher in others (e.g., 4.8 times higher in female urban Fijian Indians). The differences we found in our American Indian populations were similar to some of these populations (e.g., Chinese and Muslim individuals in Mauritius). We also observed that the difference between the IFG and IGT rates was ~50% higher in the 45- to 54-year age-group than in the 55- to 74-year age-group, which suggests that the age effect was not the same between participants with diabetes and those with IFG or IGT.

The difference between the two diagnostic criteria for IGT and IFG (5.2%) was greater than that for diabetes (1.5%) in the Strong Heart Study. Similar results were found in NHANES III (5.5 vs. 2%), the CHS (17.5% in the 1989 cohort and 23.7% in the African-American cohort vs. 7.1 and 9.1% in the two respective cohorts), the Japanese-Brazilian study (7.3 vs. 1.1%), and the Mexico City study (12.9 vs. 8.44%). Therefore, determining whether individuals with IGT or those with IFG are at greater risk for developing diabetes will be especially important.

When comparing mean values of HbA_{1c}, fasting insulin, UA/C ratio, total cholesterol, HDL cholesterol, and LDL cholesterol between participants who were classified as having diabetes or IGT according to WHO criteria and those who were classified as having diabetes or IFG according to ADA criteria, no substantial differences were found except in UA/C ratio. Those who were diagnosed according to WHO criteria had higher mean UA/C ratios than those diagnosed according to ADA criteria. Among the subjects classified with NGT according to WHO criteria, the average UA/C ratio was lower than those classified with NFG according to ADA criteria. This indicated that WHO criteria are more sensitive in finding individuals with abnormal kidney function.

Another possibility for the discordance between the WHO and ADA criteria could be the variations in laboratory accuracy because no internationally recognized standards exist for glucose assays, and laboratory precision tends to be lower for glucose values <150 mg/dl. The likelihood exists that variations in glucose values produced by different laboratories may affect the diagnosis of diabetes, IFG, and IGT. For example, a laboratory may underestimate glucose values in the lower range; therefore, individuals with lower glucose values may not be diagnosed as having diabetes according to ADA criteria but may be diagnosed according to WHO criteria, which include a requirement of 2-h glucose values ≥200 mg/dl.

In summary, the Strong Heart Study found that undiagnosed diabetes rates determined by ADA criteria and WHO criteria were similar in its American Indian population. The new criteria may be useful in identifying individuals with diabetes without the need for an OGTT in epidemiological studies. Our data suggest that the difference between the two criteria may increase as age increases. ADA criteria were developed with consideration given to the degree of hyperglycemia and its relationship to the development of micro- and macrovascular complications. Ultimately, the value of a diagnostic algorithm is its ability to predict clinically adverse events (e.g., symptomatic diabetes, diabetic microvascular or macrovascular complications). We did find that patients diagnosed according to WHO criteria had higher mean UA/C ratios. Only longitudinal observations will enable us to evaluate further the utility of the new ADA criteria and the older WHO criteria. In the interim, given that the age-associated differences between the criteria and the importance of further confirmation by OGTT and symptoms of diabetes are recognized, the use of fasting glucose levels should facilitate screening for diabetes.

Acknowledgments— This research was supported by grants U01-HL-41642, U01-HL-41652, and U01-HL-41654 from the National Heart, Lung and Blood Institute.

The authors thank the Strong Heart Study participants of the 13 American Indian tribes and communities for their cooperation, the Strong Heart Study staff members for their assistance, and the Indian Health Service for its support. We also appreciate the statistical assistance of Dr. Wenyu Wang.

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