Prevalence of Diabetes Mellitus and Impaired Glucose Tolerance in a Group of Urban Adults in Nigeria

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This survey was undertaken to determine the prevalence of diabetes mellitus and impaired glucose tolerance in a group of urban adults in Ibadan, Nigeria. A total of 998 subjects randomly selected from five main ministries and departments in the Government Secretariat participated in the survey. Each subject was asked to fast overnight and ingested 75 g of glucose dissolved in 250 mL of water after answering a questionnaire. Relevant anthropometric measurements such as weight, height, waist and hip diameters, and blood pressure also were taken. After 2 hours, of blood was drawn and plasma glucose concentration measured. Diagnosis of diabetes or impaired glucose tolerance was based on 1985 World Health Organization (WHO) cut-off values.

Blood glucose results were available in 875 subjects. Seven subjects were found to be diabetic for a prevalence of 0.8%, with the majority (5 subjects) being newly diagnosed. Nineteen were found to have impaired glucose tolerance for a prevalence of 2.2%. There were no sex differences between the two groups. All of the newly diagnosed diabetics were asymptomatic. Multivariate analysis revealed that subjects with a family history of diabetes, higher body mass index, and higher systolic blood pressure had higher blood glucose levels. The prevalence of diabetes in this survey is lower than rates reported in recent surveys in Nigeria that used less stringent criteria and different methodologies. The rate is comparable to that of a Tanzanian study that used WHO criteria. However, the rate of impaired glucose tolerance in this study, first to be reported in Nigeria, is lower than that obtained in the Bantu population. (*J Natl Med Assoc.* 1998;90:293-301.)

Key words: diabetes mellitus ◆ epidemiology ◆ impaired glucose tolerance

Prevalence of diabetes mellitus in Sub-Saharan Africa is believed to range between 1% and 2%.[1,2] However, there has been no epidemiologic study based on the World health Organization (WHO) recommended criteria and methodology of 1985[1] for the diagnosis of diabetes in Nigeria and most other countries in the subregion. Only one study[3] based on the WHO criteria for the diagnosis of diabetes and impaired glucose tolerance has been carried out in Africa. The survey, which involved rural Tanzanians, reported prevalence rates of 7.8% and 0.9% for impaired glucose tolerance and diabetes, respectively. Generalization with these data about abnormal glucose tolerance in the continent may be imprudent

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considering the heterogeneous nature of African populations.

Nigeria is Africa's most populous nation; there have been few studies on the prevalence of diabetes in Nigerian populations, and most of the early studies were hospital-based. In the 1960s, diabetes was considered to be rare among Nigerians; reported prevalence rates were <1%.[4-6] However, remarkable socioeconomic changes have been taking place. In 1985, Ohwovoriole et al[7] screened 1627 subjects in Lagos Metropolis using casual blood glucose or urine. The prevalence rates of undetected diabetes in men and women were 1.5% and 1.9%, respectively, with an overall prevalence of 1.7%.

Erasmus et al[8] in Ilorin measured fasting plasma glucose concentrations in 2800 subjects living in the city and suburbs. Diagnosis was based on 1980 WHO criteria,[9] and subjects with fasting glucose values between 6.5 and 7.7 mmol/L underwent oral glucose tolerance testing. The overall prevalence rate was 1.43%; no significant difference was observed between men and women. More recently, a survey of noncommunicable diseases[10] reported a national prevalence of 2.8% for diabetes. The WHO recommendations[1] were not followed, and there was marked variation in methodologies and criteria for diagnosis of diabetes among subjects studied even within the same community, including cut-off values based on random, fasting, and 2-hour postprandial (nonstandard home meal) blood glucose measurements.

There are no data on the prevalence of impaired glucose tolerance among Nigerians, and none of the previous studies on diabetes used the 1985 WHO criteria. Because subjects with impaired glucose tolerance have certain cardiovascular risk characteristics[11,12] and there could also be progression to diabetes,[12-17] it is reasonable for any general population diabetes survey to target these individuals as well. It has been suggested that the ratio of impaired glucose tolerance to diabetes or total glucose intolerance may be an index of epidemicity of glucose intolerance in a given population, ie, it may have some predictive value in determining the stage of an epidemic within a population.[2,18,19] Higher rates of impaired glucose tolerance compared with diabetes were seen among certain populations including the African Bantu; hence, the prevalence of noninsulin-dependent diabetes mellitus, although still low in Sub-Saharan Africa, may be rising to Western levels.[3,19] It was also postulated that given the high prevalence of diabetes reported in the US black population,[20,21] the potential for high rates to occur with time clearly exists in African populations with progressive modernization of lifestyle.[22]

A screening survey involving middle-aged male civil servants in Whitehall, London,[23] is of historical significance. The "borderline" or "chemical" diabetes of the Whitehall Survey[12,14,23,24] and other landmark studies from the United Kingdom[15,16,21] and the United States[25,26] was the forerunner of the impaired glucose tolerance category introduced by the National Diabetes Data Group[27] that was subsequently adopted by the WHO.[1,9] This article reports the results of a survey of diabetes and impaired glucose tolerance carried out in a group of civil servants in the Government Secretariat, Ibadan, Nigeria, that was fairly representative of the urban Nigerian population.

MATERIALS AND METHODS

Study Population

Ibadan, with a population of nearly 3.5 million according to the 1991 National Census[28] is located in southwestern Nigeria. The population is comprised predominantly of the Yoruba ethnic group, one of the major tribes occupying the area between Senegal River and the Cameroon; they constitute the West African black population. Oyo State Government Secretariat, located in Ibadan, the capital city, is in the vicinity of the University College Hospital. Nigeria has a young population, with a mean age of 31.6 ± 14.1 years.[28]

The Civil Service has the duty of initiating and implementing government policies and executing its projects for social, economic, and political development.[29] The civil servants in Oyo State Government Secretariat consist of men and women that include illiterate, unskilled workers, as well as workers from the middle echelon and upper class. They come from various parts of the state, and appointments are without regional, sex, or any form of social discrimination. These civil servants therefore are largely representative of the general urban population. A civil servant normally retires at the age of 60 years or after 35 years in service, whichever comes first.

There are 18 units (6 main ministries and 12 departments and parastatals) in the Secretariat Complex. The sample size for the survey was determined based on an estimated prevalence of 1%, and the sampling error was set at 1% with 95% confidence level. A multistage sampling was carried out, and

998 randomly selected subjects from five main ministries and departments were recruited into the survey. Specific number of days were assigned to each ministry/department according to the size vis-à-vis the number of subjects being expected.

Four months prior to the screening, permission to conduct the survey was sought from the Secretary to the state government and was granted. Intensive recruitment was initiated using posters, handbills, and personal contacts. The purpose of the screening, its confidential nature, and details of the test were described, and consent was obtained. These were necessary because community surveys involving blood sampling are often met with fear and suspicion.

Data Collection

Subjects attended the Secretariat Clinic in the morning where the survey procedures were carried out by two doctors assisted by nurses and technologists. To reduce observer bias and variation, a specific procedure according to standard regulations was assigned to each personnel. The medical personnel administered the questionnaire and measured subjects' blood pressure, while anthropometric measurements and supervision of the glucose drink were carried out by nurses and technologists, respectively. The technologists also assisted the doctors during venopuncture.

Each subject was asked to fast overnight, and smoking was not allowed on the morning of the screening. No other changes in lifestyle or diet during the days immediately preceding screening were requested. Compliance was checked prior to screening, and in cases where the instructions had not been followed or sudden illness had intervened, screening was deferred.

The subject's name, age, sex, and marital status were recorded. The socioeconomic status of each subject was determined by nature of job and income level (categorized as follows: salary grade level 1 to 8 = lower, 9 to 12 = middle, and 13 to 17 = upper). Information on level of physical activity (involvement in significant activity at least once a week), relevant medical and family history (diabetes in a first- or second-degree relative), and social habits (smoking and alcohol use) were obtained.

The subject was seated while a single blood pressure reading was taken on the left arm using a standard mercury sphygmomanometer. The first tapping sound (Korotkoff phase 1) was taken as the systolic blood pressure, and the diastolic pressure was recorded at the disappearance (phase 5) of Korotkoff sounds. Weight was recorded to the nearest 0.5 kg. Height was measured with the subject standing back to the measuring rod with the visual axis horizontal. Readings were recorded to the nearest centimeter. Waist circumference was measured using a flexible tape at the narrowest part of the torso as seen from the front in standing position and recorded to the nearest 0.5 cm. Hip circumference was measured with the same tape to the nearest 0.5 cm.

The subject then proceeded to drink a glucose preparation of 75 g of anhydrous dextrose dissolved in 250 mL of water at zero time. Exactly 120 minutes after the subject drank the glucose, 2 mL of blood was drawn from the antecubital vein

The blood sample was centrifuged to separate the plasma, which was stored frozen at −20°C for glucose analysis. Plasma glucose concentration was subsequently determined by a glucose oxidase method using 4-amino phenazone as described by Trinder.[30] A Grant Instruments incubator was used (Cambridge, England), and the optical density was measured with an SP6-200 Spectrophotometer (PYE UNICAM, Cambridge, England). Control sera were included in the analysis to monitor precision of measurements.

Diagnostic Criteria

Diabetes was defined according to 1985 WHO criteria,[1] ie, a 2-hour plasma glucose concentration ⩾200 mg/dL (11.1 mmol/L). Subjects were placed in the category of impaired glucose tolerance if the 2-hour value was ⩾140 mg/dL (7.8 mmol/L) but <200 mg/dL.

Statistical Analysis

Data were coded and entered into a dBase program on an IBM-PC compatible microcomputer and analyzed using SPSS (Statistical Package for the Social Sciences). Comparison for continuous variables was done using a *t*-test, and the chi-squared test for contingency tables was used for discrete variables (unless otherwise stated). Results are presented as mean±standard deviation or as count and percent of status or category. Comparisons among three groups (normal, impaired glucose tolerance, and diabetes) for continuous variables were done using analysis of variance (ANOVA), the least significant difference test for multiple comparisons, and also a preplanned contrast that compared the normal

Table 1. Characteristics of Subjects With Diabetes Mellitus and Impaired Glucose Tolerance

Characteristic	No. (%) Normal	No. (%) With Diabetes Mellitus	No. (%) With Impaired Glucose Tolerance
Total no.	849	7	19
Previously diagnosed		2 (28.6)	0 (0.0)
Newly diagnosed		5 (71.4)	19 (100)
Gender			
Male	487 (57.4)	4 (57.1)	11 (57.9)
Female	362 (42.6)	3 (42.9)	8 (42.1)
Salary grade level*			
I	709 (83.7)	5 (71.4)	16 (84.2)
II	86 (10.2)	1 (14.3)	3 (15.8)
III	52 (6.2)	1 (14.3)	0 (0.0)
Physical activity			
Yes	442 (52.1)	4 (57.1)	7 (36.8)
No	407 (47.9)	3 (42.9)	12 (63.2)
Smoking			
Yes	54 (6.4)	0 (0.0)	0 (0.0)
No	795 (93.6)	7 (100)	19 (100)
Alcohol			
Yes	156 (18.4)	2 (28.6)	2 (10.5)
No	693 (81.6)	5 (71.4)	17 (89.5)
Family history of diabetes mellitus			
Yes	22 (2.6)	1 (14.3)	0 (0.0)
No	792 (93.3)	6 (85.7)	16 (84.2)
Not sure	35 (4.1)	0 (0.0)	3 (15.8)

*Information for two subjects is missing.

group to the impaired glucose tolerance and diabetes mellitus groups combined was carried out. For discrete data, Fisher's exact test was used.

RESULTS

A total of 998 civil servants from the five main ministries and departments participated in the study.

Demographics

Of the 998 subjects, 579 (58%) were men and 419 (42%) were women. The women were relatively younger than the men (mean age: 36.63±6.86 versus 42.47±8.48 years, respectively) (*t*-test, t=12.0; $P<.001$). The mean age for the entire adult population was 40.02±8.35 years.

Blood Glucose Data

Blood glucose results were available in 875 subjects. One hundred twenty-three missing values were largely those of participants who did not return for venopuncture and those who breached fasting instructions and were unwilling to be rescheduled. An additional 7 subjects were found not to be among those selected for the survey.

Seven subjects were found to be diabetic for a prevalence of 0.8% (95% confidence intervals [CI], 0.21% to 1.39%); five of these were newly diagnosed. Nineteen subjects were found to have impaired glucose tolerance for a prevalence of 2.2% (CI=1.20% to 3.14%). There were no sex differences in both groups. Tables 1 and 2 show demographics for the subjects, and Table 3 presents examination/outcome variables.

The lowest body mass index among diabetic subjects was 19.9 kg/m^2. All of the newly diagnosed diabetics were asymptomatic. Two of the diabetic subjects (one newly diagnosed and one previously diagnosed) were found to be on thiazide diuretics.

Analysis of Outcome Variables

Height. Subjects with diabetes mellitus and impaired glucose tolerance were found to be shorter

Table 2. Age of Subjects With Diabetes Mellitus and Impaired Glucose Tolerance*

Age Group (Years)	No. (%) Normal	No. (%) With Diabetes Mellitus	No. (%) With Impaired Glucose Tolerance
15 to 24	19 (2.2)	0 (0.0)	0 (0.0)
25 to 34	207 (24.4)	1 (14.3)	4 (21.0)
35 to 44	352 (41.5)	4 (57.1)	5 (26.3)
45 to 54	235 (27.7)	2 (28.6)	9 (47.4)
≥55	36 (4.2)	0 (0.0)	1 (5.3)
Total	849 (100)	7 (100)	19 (100)
Mean age†	40.8 (8.2)	43.0 (4.9)	41.4 (8.7)

*Mean (standard deviation); age group analysis: normal versus impaired glucose tolerance, Fisher's exact test, $P=.354$; normal versus diabetes mellitus, Fisher's exact test, $P=.603$; and normal versus diabetes mellitus or impaired glucose tolerance, Fisher's exact test, $P=.628$.
†Mean age: ANOVA $F=0.6$, $P=.554$.

Table 3. Examination/Outcome Variables of Subjects With Diabetes Mellitus and Impaired Glucose Tolerance*

Variable	Normal	Diabetes Mellitus	Impaired Glucose Tolerance
Weight (kg)	62.0±12.7	68.8±19.6	62.5±12.7
Height (m)	1.64±0.08	1.60±0.07	1.60±0.00
Body mass index (kg/m^2)	23.0±4.6	27.3±9.3	24.5±5.8
Waist (cm)	81.2±10.4	87.2±17.3	84.6±12.2
Hip (cm)	95.2±10.8	99.1±19.7	96.7±12.6
Waist-hip ratio	0.85±0.06	0.88±0.06	0.85±0.06
Systolic blood pressure (mm Hg)	121±21	150±13	133±32
Diastolic blood pressure (mm Hg)	76±12	90±9	83±18
Blood glucose (mmol/L)	4.4±1.1	11.9±1.7	8.8±0.7

*Mean±standard deviation.

than those with normal glucose tolerance (ANOVA F=3.3; normal versus impaired glucose tolerance + diabetes mellitus, $P=.018$).

Body Mass Index. Subjects with diabetes mellitus and impaired glucose tolerance had higher body mass index than those with normal glucose tolerance (ANOVA F=3.6; normal versus impaired glucose tolerance + diabetes mellitus, $P=.028$; diabetes mellitus > normal, $P=.007$).

Blood Pressure. Subjects with diabetes and impaired glucose tolerance had higher blood pressures than subjects with normal glucose tolerance (systolic blood pressure: ANOVA F=9.4; normal versus impaired glucose tolerance + diabetes mellitus, $P<.001$; normal < impaired glucose tolerance = diabetes mellitus, $P<.001$; and diastolic blood pressure: ANOVA F=6.9, normal versus impaired glucose tolerance + diabetes mellitus, $P=.001$; normal < impaired glucose tolerance = diabetes mellitus, $P=.001$).

Waist-to-Hip Ratio. Waist-to-hip ratio was higher in diabetics and subjects with impaired glucose tolerance than those with normal glucose tolerance. This was not statistically significant (normal < impaired glucose tolerance < diabetes mellitus, ANOVA F=1.7; $P=.192$).

There were very few subjects with impaired glucose tolerance and diabetes mellitus, so some of the insignificant results might reflect this rather than a true lack of difference with abnormal glucose tolerance.

Multiple Regression Analysis

Blood Glucose Levels. Forward stepwise multiple

Table 4. Multiple Regression Analysis for Plasma Glucose Concentration*

Variable	Coefficient	*P* Value
Family history of diabetes mellitus	6.90	.040
Weight	−0.62	<.001
Body mass index	2.33	<.001
Systolic blood pressure	0.12	<.001
Intercept	57.01	

*The overall multiple correlation coefficient for the equation is 0.24 (R^2=0.06).

regression was used to determine the set of variables associated with blood glucose levels with all available variables entered into the equation. Significant findings are listed in Table 4.

Subjects with a family history of diabetes mellitus, higher body mass index, and higher systolic pressure had higher blood glucose values. The negative effect of weight was probably a statistical correction for the body mass index effect, which may be too strong.

Logistic Regression Analysis

Glucose Tolerance. Logistic regression was carried out to determine the set of variables associated with abnormal glucose tolerance. Forward stepwise logistic regression was used with all available variables entered into the equation. Significant results are listed in Table 5.

Subjects with a family history of diabetes mellitus, larger waist, and higher systolic pressure were more likely to have abnormal glucose tolerance. Taller subjects were less likely to have abnormal glucose tolerance.

DISCUSSION

This survey used WHO 1985 criteria in determining the prevalence of diabetes mellitus and impaired glucose tolerance in a group of adult Nigerians. The prevalence rate obtained for diabetes was lower than those reported in other surveys[7,8,10] carried out in Nigeria that used less stringent diagnostic criteria and methodologies. Comparison of the prevalence of diabetes obtained in the present study with rates observed in Nigeria in the 1960s[4-6] and early 1970s[31] is difficult because of differences in techniques and criteria, and also study populations.

Osuntokun et al[31] reported a prevalence of 0.4% in a hospital population. Diagnosis of diabetes in a community study by Akinkugbe and Ojo[5] was based on glycosuria; urinalysis was also the initial method of detection in the survey conducted by Johnson[6] in Lagos. Erasmus et al[8] reported a prevalence of 1.4%, but there was selection bias, and the diagnosis of diabetes was based on WHO 1980 criteria[9] using fasting plasma glucose estimation, and fasting can rarely be assured.[1] Ohwovoriole et al[7] measured random blood glucose levels in their Lagos subjects, who were respondents to an invitation for screening.

It is difficult to compare the rate (0.8%) observed in the present study with that (2.8%) from a national survey[10] because the latter did not use standard or uniform criteria. It is important to note that the rate of 7% reported for the Lagos Mainland in the survey–the highest ever reported in the country–was much higher than what would be predicted from that observed by Ohwovoriole et al[7] (1.7%) in the same population; a prevalence rate of 1.4% was reported for Ibadan Municipality. A concurrent report of a rate of 2.8%[32] in a sample of 247 adults in Ibadan who had fingerstick for measurement of capillary blood glucose was surprisingly twice that obtained from the national survey, which was based on fasting values.

The prevalence of diabetes from in the present study (0.8 %) is comparable to that found in a study in Tanzania (0.9 %),[3] which followed the WHO criteria. The authors[3] concluded that diabetes was less prevalent in rural Africa than in developed countries even when corrected for age. The Tanzanian study[3] involved villages with considerable geographical, dietary, and social differences, but no differences were observed in the rates of diabetes and impaired glucose tolerance. A comprehensive review[33] on diabetes in Africa asserted that no difference has been convincingly shown in the prevalence between rural and urban dwellers except in North Africa. If this assertion is true, the prevalence of diabetes among rural Nigerians may not differ much from what has been observed in the present survey. Teuscher et al[34] noted an extremely low prevalence in a West African rural population; using random blood glucose measurements, no case of diabetes was found among two Togolese villages. The high rate[35] previously reported in rural areas of West Africa was attributed to selection bias (older age group) and less strict criteria.

The 2.2% prevalence of impaired glucose toler-

ance obtained in the present study contrasts with the 7.8% found among rural Tanzanians.[3] This might imply an impending diabetes epidemic among the rural Bantu. However, McLarty et al[33] reported that 80% of the subjects who had impaired glucose tolerance reverted to normal glucose tolerance on repeating the test within 5 days; they attributed this partly to a phenomenon similar to "orienting reflex" in blood pressure measurements in a population unfamiliar with blood testing. There are no previous data for comparison of prevalence of impaired glucose tolerance among Nigerians.

It is difficult to compare the prevalence of diabetes in the civil servants in Ibadan with that obtained in the Whitehall survey.[23] Diagnostic criteria were different and the London subjects were much older.

Characteristics of the subjects found to have diabetes in this study did not differ significantly from what has been observed by previous workers in Nigeria[7,8] and elsewhere; there was no sex difference. As reported for most populations in Africa[33] and many parts of the world,[2] the newly detected diabetic subjects were asymptomatic. All of the 36 diabetic subjects in a study carried out in another Nigerian city[8] were symptom-free. Similarly, 74% of the 46 subjects with previously undiagnosed diabetes in the Tanzanian survey[3] were asymptomatic.

The clinical characteristics of the diabetic subjects were in keeping with noninsulin-dependent diabetes mellitus although insulin-dependent diabetes mellitus may occur at any age.[1,26] The prevalence of insulin-dependent diabetes mellitus in Africans is low.[31,36-38] None of the diabetics in this study could be categorized as malnutrition-related diabetes mellitus based on Ahuja's criteria,[39] the lowest body mass index among them being 19.9 kg/m^2. This appears to support the recent impression that malnutrition-related diabetes mellitus is actually rare[40] or unknown[34,41] in Sub-Saharan Africa in contrast with earlier reports[4,31] and that of the WHO in 1985.[1] There is the possibility of a marked decrease in the general population of exposure to some etiologic factor considering the high rates observed in earlier studies.

The subjects with impaired glucose tolerance in this study shared many characteristics with the diabetic subjects. There was no sex difference; this also was observed in the impaired glucose tolerance subjects in the Tanzanian survey.[3] A female preponderance was documented in most populations by the WHO Ad Hoc Diabetes Reporting Group.[2,19]

Table 5. Logistic Regression Analysis for Glucose Intolerance (Diabetes Mellitus + Impaired Glucose Tolerance)

Variable	Odds Ratio	*P* Value
Family history of diabetes mellitus	7.20	.003
Height	0.01	<.001
Waist	1.04	.026

Some of the factors shown or hypothesized to be risk factors for diabetes[20,21,42] were examined, but it would be difficult to establish any association because of the small number of subjects. Previous observation[38] from hospital data in Africa and simple correlation from the present study suggest that family history of diabetes, a surrogate of genetics, might be a less important epidemiological correlate for diabetes in blacks compared with whites. However, multivariate analyses showed that a family history of diabetes had a significant correlation with higher blood glucose level and also with abnormal glucose tolerance.

Height seemed to be a determinant of glucose intolerance among the civil servants when other factors were taken into consideration. A remarkable finding from a large prospective study of a group of adult men and women in Cambridgeshire, United Kingdom, was a continuous relationship between height and glucose tolerance; both male and female subjects with impaired glucose tolerance were significantly shorter than matched control subjects.[43]

Systolic and diastolic blood pressures were significantly higher in subjects with impaired glucose tolerance than in subjects with normal tolerance, and their mean weight and body mass index were intermediate between values obtained for normal subjects and those with diabetes. Establishing an association based on these findings is limited by the small number of subjects with glucose intolerance. However, it is interesting to note from the multivariate analysis that there was a positive correlation of blood glucose level with body mass index and systolic blood pressure in the population. Clustering of risk factors for coronary artery disease in diabetes and impaired glucose tolerance was observed only in females in the Tanzanian study.[44]

The relatively low prevalence of diabetes in African populations has been attributed to a high

level of physical activity, dietary factors, and age structure (ie, a relatively young population).[3,34,38] Recent studies[45-47] on the effects of diet and exercise in preventing noninsulin-dependent diabetes mellitus support these hypotheses. Physical activity also was suspected as a contributory factor to the symptomless nature of diabetes in Africans.[34] Dramatic improvement in carbohydrate and lipid metabolism was noted in diabetic Australian Aborigines after temporary reversal to traditional lifestyle.[48] The influence of lifestyle changes on the risk of noninsulin-dependent diabetes mellitus among populations of the African diaspora[49] has become a subject of interest; however, standardized data on the prevalence of diabetes among these groups, especially on the continent, are still scanty.[33]

CONCLUSION

A baseline standard survey, that is, employing the WHO 1985 criteria for diagnosis of diabetes and impaired glucose tolerance, has been carried out in Nigeria. The results confirmed Sub-Saharan Africa as a low-prevalence region for diabetes. Further cross-sectional studies and prospective data are needed to verify the findings of this survey. Large-scale surveys in the general population based on standard criteria should include both diabetes and impaired glucose tolerance and also their risk factors as they occur in African populations. The high percentage of previously undiagnosed diabetes mellitus in a supposedly enlightened population group and the asymptomatic nature of diabetes are indicators for the need to improve health services and health awareness in the general population.

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