Diabetes and Other Disorders of Glycemia in a Rural South African Community

Prevalence and associated risk factors

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OBJECTIVE — The purpose of this study was to determine the prevalence of diabetes, impaired glucose tolerance (IGT), impaired fasting glycemia (IFG), and associated risk factors in a rural South African black community.

RESEARCH DESIGN AND METHODS — This was a cross-sectional survey conducted by random cluster sampling of adults aged >15 years. Participants had a 75-g oral glucose tolerance test using the 1998 World Health Organization criteria for disorders of glycemia.

RESULTS — Of 1,300 subjects selected, 1,025 subjects (815 women) participated (response rate 78.9%). The overall age-adjusted prevalence of diabetes was 3.9%, IGT 4.8%, and IFG 1.5%. The prevalence was similar in men and women for diabetes (men 3.5%; women 3.9%) and IGT (men 4.6%; women 4.7%) but higher in men for IFG (men 4.0%; women 0.8%). The prevalence of diabetes and IGT increased with age both in men and women, with peak prevalence in the 55- to 64-year age-group for diabetes and in the ≥65-year age-group for IGT. Of the cases of diabetes, 84.8% were discovered during the survey. In multivariate analysis, the significant independent risk factors associated with diabetes included family history (odds ratio 3.5), alcohol ingestion (2.8), waist circumference (1.1), systolic blood pressure (1.0), serum triglycerides (2.3), and total cholesterol (1.8); hip circumference was protective (0.9).

CONCLUSIONS — There is a moderate prevalence of diabetes and a high prevalence of total disorders of glycemia, which suggests that this community, unlike other rural communities in Africa, is well into an epidemic of glucose intolerance. There is a low proportion of known diabetes and a significant association with potentially modifiable risk factors.

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Over the past few decades, type 2 diabetes has emerged as an important medical problem in sub-Saharan Africa (SSA). Until the 1980s, the few reported studies indicated a low prevalence, i.e., between 0 and 1.0% (1,2).

From recent estimates of the International Diabetes Federation, the largest increases in prevalence of diabetes are expected to occur in developing regions of the world, including Africa. For Africa, the regional prevalence of diabetes is projected to increase from 3.1% in 2007 to 3.5% in 2025, with a corresponding increase in numbers: from 10.4 to 18.7 million. The report also highlighted the paucity of prevalence data for Africa (3).

Much of the available, albeit limited, data on the epidemiology of diabetes in Africa are those based on 1985 World Health Organization (WHO) criteria (4). These studies show a variable prevalence of diabetes, with low rates (<3%) in both urban and rural communities in West and East Africa, whereas moderate rates (3–10%) are reported in periurban and urban communities in South Africa, comparable with rates in developed countries. The moderate to high prevalence of IGT, especially in populations with low diabetes prevalence, is suggestive of the early stage of a diabetes epidemic (2,3,5).

Where examined, diabetes prevalence is higher in urban than in rural communities in the same country and lower in the indigenous African population than in migrant Asian or mixed-ancestry communities. There is evidence for significant association with age, family history of diabetes, adiposity, urbanization, and high rates of IGT with low diabetes prevalence and a low proportion of known diabetes (2,5).

The three reported studies from indigenous population groups in South Africa have shown moderate diabetes prevalence varying from 5.3 to 8.0% (6–8). The only reported studies from Africa using current revised American Diabetes Association (ADA) (9) and WHO (10) criteria are those from Tanzania (11) and Ghana (12). To date, there are no studies reported in rural communities in South Africa and none, either urban or rural, using the current criteria. This study was undertaken to determine the prevalence of diabetes and associated risk factors in a rural South African community of Zulu descent using 1998 WHO criteria for disorders of glycemia.

RESEARCH DESIGN AND METHODS

— This was a cross-sectional study of individuals aged >15 years, undertaken over a 3-month period in a rural African (black) community of Zulu descent in the Ubombo district of the province of KwaZulu-Natal in South Africa.

Background

With use of the 1996 population census for South Africa, Africans constitute 76.7% (31,127,631) of the total population of 40.5 million. KwaZulu-Natal is the most densely populated province, ac-

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counting for more than one-fifth of the total population (8,417,021). Of these, 81.7% are African, there is a female preponderance (53.1%), and 56.9% are nonurban.

The study was done in the Ubombo district of rural northern KwaZulu-Natal, which has an estimated population of 487,144 (241,639 aged >15 years). The study region is predominantly rural.

The estimated sample size based on population size, expected maximum prevalence (9.0%), precision (2.5%), and confidence (95%) was 1,003. When adjusted for a 30% nonresponse, the estimated sample size was 1,300.

Survey design

Using the geographic information system that was set up for a Malaria Control Programme in the region, a radius of 10 km with a regional hospital in Mkhuze as the center was chosen as the area to be studied and included the districts of Mamfene, Ntshange, and Orphansi. The approval of the local health authority and tribal leaders was obtained for the study.

The study was conducted by cluster sampling of households chosen at random from the geographic information system map by an independent individual. Before the test day, all chosen homesteads were visited by trained field workers who sought the permission of the head of the household to study all nonpregnant adult family members aged >15 years including subjects known to have diabetes.

The study was conducted either in the subjects' own homes or at a central site, usually a community center. A nonresponder was defined as one who had been contacted on at least three occasions. Informed consent was obtained from all participants, and the University of KwaZulu-Natal Ethics Committee approved the study.

Survey procedure

The survey methodology was based on the WHO field guide for diabetes and noncommunicable risk factor studies (13). On the test day, all consenting subjects provided information for a questionnaire and had an anthropometric examination and a 75-g oral glucose tolerance test (OGTT).

Questionnaire information was obtained by trained interviewers in the local language and included sociodemographic details, history and duration of urban living, family history of diabetes in first-degree relatives, personal medical history, obstetric history where applicable, and personal habits (smoking, current alcohol consumption, and physical activity). Occupational physical activity was defined as sedentary, light, moderate, or heavy and leisure physical activity as never, <1 time/week, 1–2 times/week, and ≥3 times/week.

Weight and height were measured, in subjects wearing light clothing and without shoes, for determination of BMI. Waist circumference and hip circumference were also measured. Blood pressure was measured twice, in the sitting position, using a mercury sphygmomanometer; the mean of two readings, at least 30 min apart, was used. BMI was used as a measure of total body obesity, and waist circumference and waist-to-hip ratio (WHR) were used as measures of upper body (abdominal) obesity (14). Hypertension was defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg.

For the OGTT (4), venous blood samples were drawn after an overnight fast and 2 h after ingestion of 75 g glucose monohydrate dissolved in 250 ml water for measurement of plasma glucose. In addition, fasting samples were obtained for serum lipids and uric acid. Blood samples were kept on ice and centrifuged within 6 h, separated, and stored at −30°C until determination.

Biochemical methods

Plasma glucose was measured by a glucose oxidase method; serum total cholesterol, HDL cholesterol, total triglycerides, and uric acid were measured by an enzymatic calorimetric method with kits (monotest cholesterol CHOD-PAP, peridochrome, and uric acid) from Boehringer Mannheim (Mannheim, Germany). LDL cholesterol was calculated by the Friedewald formula.

OGTT classification

On the basis of the 1998 WHO criteria for a 75-g OGTT (10), normoglycemia is defined by fasting plasma glucose (FPG) <6.1 mmol/l or 2-h postload plasma glucose (2-h plasma glucose) <7.8 mmol/l or both, impaired fasting glycemia (IFG) is defined by FPG ≥6.1–<7.0 mmol/l and (if measured) 2-h plasma glucose <7.8 mmol/l, impaired glucose tolerance (IGT) is defined by 2-h plasma glucose ≥7.8 to < 11.1 mmol/l and (if measured) FPG <7.0 mmol/l, and diabetes is diagnosed by FPG ≥7.0 mmol/l and/or 2-h plasma glucose ≥11.1 mmol/l. For comparison with other studies, the 1985 WHO (4), 1997 ADA (9), and 2003 ADA (15) criteria were also applied to the OGTT results.

Statistical analysis

Statistical analysis was performed with SAS (version 6.12; SAS Institute, Cary, NC) and SPSS (version 11.5; SPSS, Chicago, IL). Numerical variables are expressed as means ± SD. When more than two groups were being compared, ANOVA was used; Scheffe's multiple-range test was used to evaluate the difference between any two groups studied. When only two groups were compared, Student's *t* test was used. The χ^2 test was used for categorical variables. A test was considered significant if $P < 0.05$.

For prevalence estimates, the 1998 WHO criteria were applied to all subjects who had both FPG and 2-h plasma glucose data or only a classifiable FPG (≥6.1 mmol/l) result; all further intergroup analyses were undertaken on these subjects. The 1985 WHO criteria were applied to the results of subjects who had both FPG and 2-h plasma glucose data or only a classifiable FPG (≥7.8 mmol/l) result. The 1997 and 2003 ADA criteria were applied to all subjects who had FPG results available. The age-standardized prevalence rates were calculated with the direct method, using the world population as the standard (16).

To assess risk factors associated with diabetes, in bivariate analysis, clinical and biochemical variables were compared in the group with diabetes and the group without diabetes (normoglycemia plus IFG plus IGT) using Student's *t* test or a χ^2 test; in multivariate analysis, a binary logistic regression model was used with a backward elimination method based on likelihood ratios. Odds ratio (ORs) with 95% CI and *P* values of the final model are presented.

RESULTS

Response rate

Of 1,300 subjects selected, 1,025 subjects (210 men and 815 women) participated in the survey, with an overall response rate of 78.9%; of these, 4 subjects, all women, had only demographic and anthropometric information available. Of the 275 nonresponders, 193 (70%) were

Table 1—*Age- and sex-specific and age-adjusted prevalence based on 1998 WHO criteria for categories of glycemia*

		Category of glycemia			
	n	Normoglycemia	IFG	IGT	Diabetes
Age-group (men + women)					
15–24 years	154	149 (96.8)	4 (2.6)	1 (0.7)	0 (0.0)
25–34 years	146	138 (94.5)	0 (0.0)	4 (2.7)	4 (2.7)
35–44 years	173	156 (90.2)	2 (1.2)	9 (5.2)	6 (3.5)
45–54 years	144	122 (84.7)	3 (2.1)	8 (5.6)	11 (7.6)
55–64 years	159	129 (81.1)	2 (1.3)	14 (8.8)	14 (8.8)
≥65 years	221	178 (80.5)	4 (1.8)	28 (12.7)	11 (5.0)
Missing	2	1 (—)	1 (—)	—	—
Total crude	999	873 (87.4)	16 (1.6)	64 (6.4)	46 (4.6)
Age-adjusted		—	1.5	4.8	3.9
Men (*n* = 200)					
15–24 years	46	44 (95.7)	2 (4.4)	0 (0.0)	0 (0.0)
25–34 years	20	20 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
35–44 years	22	20 (90.9)	1 (4.6)	1 (4.6)	0 (0.0)
45–54 years	31	21 (67.7)	3 (9.7)	4 (12.9)	3 (9.7)
55–64 years	29	24 (82.8)	0 (0.0)	1 (3.5)	4 (13.8)
≥ 65 years	52	40 (76.9)	3 (5.8)	3 (13.5)	2 (3.9)
Total crude	200	169 (84.5)	9 (4.5)	13 (6.5)	9 (4.5)
Age-adjusted		—	4.0	4.6	3.5
Women (*n* = 799)					
15–24 years	108	105 (97.2)	2 (1.9)	1 (0.9)	0 (0.0)
25–34 years	126	118 (93.7)	0 (0.0)	4 (3.2)	4 (3.2)
35–44 years	151	136 (90.1)	1 (0.7)	8 (5.3)	6 (4.0)
45–54 years	113	101 (89.4)	0 (0.0)	4 (3.5)	8 (7.1)
55–64 years	130	105 (80.8)	2 (1.5)	13 (10.0)	10 (7.7)
≥ 65 years	169	138 (81.7)	1 (0.6)	21 (12.5)	9 (5.4)
Missing	2	1 (—)	1 (—)	—	—
Total crude	799	704 (88.1)	7 (0.9)	51 (6.4)	37 (4.6)
Age-adjusted		—	0.8	4.7	3.9

Data are *n* (%). Total *n* = 999.

men. The study group for prevalence analysis included 1,021 subjects (210 men and 811 women). The 1998 WHO criteria were applied to 999 subjects (799 women), the 1985 WHO criteria to 994 subjects (797 women), and the 1997/2003 ADA criteria to 1,021 subjects (811 women).

Prevalence

With use of 1998 WHO criteria (*n* = 999), the crude overall prevalence of diabetes was 4.6%, IGT 6.4%, IFG 1.6%, and total disorders of glycemia 12.6% (Table 1). The prevalence was similar in men and women for diabetes and IGT, whereas there was a male preponderance for IFG. Using age-specific rates, the prevalence of diabetes increased with age in both men and women; peak prevalence was in the 55- to 64-year age-group. The prevalence of IGT also increased with age with peak prevalence in the oldest age-group (≥65 years). Of the 46 subjects classed as having diabetes, in 39 (84.8%) diabetes was discovered during the survey. The age-adjusted prevalence was lower for diabetes (3.9%) and IGT (4.8%) but not for IFG (1.5%).

Using 1985 WHO criteria (*n* = 994), the crude overall prevalence of diabetes was 4.2% and IGT 6.7%. The prevalence was similar in men and women for diabetes (men 4.1%; women 4.3%), whereas there was a male preponderance for IGT (men 7.1%; women 6.5%). The age-adjusted prevalence was lower for diabetes (all 3.5%; men 3.0%; women 3.6%) and for IGT (all 4.9%; men 5.6%; women 4.5%).

Using 1997 and 2003 ADA criteria (*n* = 1,021), the overall prevalence (crude [adjusted]) of diabetes was 3.1% (2.53%). IFG prevalence was higher using 2003 ADA criteria (7.8% [7.0%]) than using 1997 criteria (2.8% [2.6%]).

Clinical and biochemical characteristics

Table 2 shows the characteristics of the total study group (*n* = 1,025) and the four glycemic categories using 1998 WHO criteria (*n* = 999). In the total study group, sex comparison (women versus men) showed that women had higher mean values than men for the following variables: BMI (25.9 ± 6.5 vs. 22.8 ± 6.8 kg/m^2, $P < 0.001$), waist circumference (86.0 ± 13.5 vs. 83.3 ± 12.2 cm, $P < 0.01$), and hip circumference (102.0 ± 13.6 vs. 95.7 ± 11.2 cm, $P < 0.001$). The prevalence of total body adiposity (47.1 vs. 22.1%, $P < 0.001$), increased waist circumference (62.8 vs. 19.3%, $P < 0.001$), and increased WHR (45.7 vs. 1.9%, $P < 0.001$) was also higher in women, whereas the prevalence of hypertension was higher in men (25.0 vs. 32.2%, $P < 0.05$). A history of urban living (21.0 vs. 39.6%, $P < 0.001$), smoking (10.0 vs. 22.5%, $P < 0.001$), and alcohol consumption (8.6 vs. 33.5%, $P < 0.001$) was more frequent in men, as was the mean WHR (0.87 ± 0.07 vs. 0.84 ± 0.07, $P < 0.001$).

Regarding the four glycemic categories (*n* = 999), when compared with the normoglycemia group, subjects with diabetes and IGT were significantly older and had a higher prevalence of hypertension, sedentary activity, and total body and abdominal adiposity. There was a high prevalence of adiposity, even in the normoglycemic group.

Risk factor analysis

Multivariate analysis showed that the significant independent variables (risk factors) for diabetes in the final model included family history of diabetes (P = 0.014, OR 3.48 [95% CI 1.29–9.43]), history of alcohol ingestion (P = 0.009, 2.79 [1.29–6.03]), waist circumference (P = 0.000, 1.1 [1.04–1.16]), systolic blood pressure (P = 0.013, 1.02 [1.00–1.04]), serum total cholesterol (P = 0.001, 76 [26–2.46]), and serum total triglycerides (P = 0.005, 1.58 [1.15–2.17]); hip circumference was a protective factor (P = 0.004, 0.92 [0.87–0.97]). Age, BMI, WHR, and diastolic blood pressure, although significant in bivariate analysis, failed to achieve significance in multiple logistic regression.

CONCLUSIONS — This study in a rural South African community of Zulu descent using current WHO criteria has highlighted a moderate prevalence of di-

Table 2—*Clinical and biochemical characteristics in the total study group and when based on 1998 WHO criteria for categories of glycemia*

		Category of glycemia				
	Total	Normoglycemia	IFG	IGT	Diabetes	*P* value*
n	1,025	873	16	64	46	
Sex (men/women)	210/815	169/704	9/7	13/51	9/37	0.04
Age (years)	46.9 ± 18.9	45.4 ± 18.7	48.6 ± 21.5	59.9 ± 16.6†	57.2 ± 15.9†	<0.001
BMI (kg/m^2)	25.2 ± 6.1	24.95 ± 5.9	24.98 ± 5.4	27.96 ± 7.3†	27.90 ± 8.3†	<0.001
Waist (cm)	85.6 ± 13.2	84.6 ± 12.6	87.2 ± 16.8	94.0 ± 15.2†	94.1 ± 14.2†	<0.001
Hip (cm)	100.7 ± 13.1	100.2 ± 12.9	99.4 ± 10.5	106.6 ± 14.7†	103.8 ± 12.8†	<0.001
Waist-to-hip ratio	0.85 ± 0.07	0.85 ± 0.07	0.87 ± 0.10	0.88 ± 0.07†	0.91 ± 0.07†	<0.001
Systolic blood pressure (mmHg)	126.3 ± 18.4	125.3 ± 17.9	133.8 ± 17.5	131.4 ± 18.9	137.7 ± 21.5†	<0.001
Diastolic blood pressure (mmHg)	80.0 ± 11.7	79.4 ± 11.5	82.3 ± 11.2	83.9 ± 12.4†	85.9 ± 12.9†	<0.001
Familial diabetes (%)	8.9	8.4	18.8	6.3	13.0	0.2
Urban living (%)	24.7	23.6	43.8	23.4	32.6	0.4
Sedentary activity (%):						
Occupational	19.8	18.1	18.8	39.1	30.4	0.004
Leisure	29.5	27.7	31.3	42.2	50.0	0.003
Tobacco smoking (%)	12.5	14.2	50.0	15.6	17.4	0.001
Alcohol (%)	13.7	15.2	37.5	22.2	30.4	0.003
BMI ≥25 kg/m^2 (%)	42.2	39.7	43.8	63.5	60.5	0.001
Waist ≥94 cm (men)/≥80 cm (women) (%)	53.9	52.0	50.0	71.4	75.0	<0.001
Waist-to-hip ratio >1.0 men/>0.85 women (%)	36.7	34.6	31.3	49.2	70.5	<0.001
Hypertension (%)	26.5	23.7	37.5	46.9	47.8	0.001
Plasma glucose (mmol/l)						
0 min	4.9 ± 1.6	4.6 ± 0.6	6.4 ± 0.3†	5.4 ± 0.6†	9.5 ± 4.9†	<0.001
120 min	6.2 ± 2.5	5.6 ± 0.9	6.8 ± 0.4†	8.7 ± 0.8†	15.4 ± 5.8†	<0.001
Serum lipids (mmol/l)						
Total cholesterol	4.1 ± 1.1	4.0 ± 1.0	4.5 ± 1.4	4.3 ± 1.1	5.0 ± 1.2†	<0.001
Total triglyceride	1.1 ± 1.1	0.98 ± 0.6	1.23 ± 0.8	1.26 ± 0.6†	1.96 ± 1.8†	<0.001
HDL cholesterol	1.23 ± 0.39	1.22 ± 0.4	1.30 ± 0.5	1.23 ± 0.4	1.33 ± 0.5	0.3
LDL cholesterol	2.4 ± 0.07	2.3 ± 0.8	2.6 ± 0.9	2.5 ± 0.9	2.8 ± 1.1†	0.003
Serum uric acid (μmol/l)	0.27 ± 0.07	0.27 ± 0.07	0.32 ± 0.09†	0.31 ± 0.08†	0.29 ± 0.07†	<0.001

Data are means ± SD unless otherwise indicated. Total study group n = 1,025; n = 999 for application of WHO criteria. *P values for comparison between normoglycemia versus IFG versus IGT versus diabetes (analysis of variance or χ^2 method). †Significant difference using Scheffe's multiple range test versus normoglycemia.

abetes and a high prevalence of total disorders of glycemia. There is a significant association with modifiable risk factors.

The reported African studies using current WHO criteria are confined to those in Tanzanians (11) and Ghanaians (12). The overall prevalence of diabetes in this study (3.9%) is higher than that in rural Tanzanians (men 1.7%; women 1.1%) but lower than that in urban Tanzanians (men 5.9%; women 5.7%) and compared with that in a combined group of urban and rural Ghanaians (6.4%). However, in the Tanzanian study, only fasting capillary blood glucose was sampled.

Using 1985 WHO criteria, the diabetes prevalence of 3.5% in this study is lower than that in previous studies in urban South Africans of Zulu (5.3%), Xhosa (8.0%), or Sesotho (6.0%) descent or in periurban Sesothos (4.8%) but higher than the rates reported for other rural communities in SSA, e.g., in Mali (0.9%), Togo (0.0%), Cameroon (0.8%), and Tanzania (1.1%) (2,5–8,17–19). Such findings highlight the heterogeneity among African communities. In this study, the prevalence of IGT (4.8%) is higher than that of diabetes and is similar to that for previous studies in South Africa and the rest of SSA.

Of interest is the fact that if FPG results alone are used, the prevalence of diabetes would be 36% lower (2.5%) and none of the subjects with IGT (4.8%) would be picked up (a group that is at increased risk for future diabetes). This fact supports previous reports that advocate retention of the OGTT for evaluation of prevalence estimates in African populations (5).

An interesting observation is the older peak age for diabetes prevalence. This is comparable to global estimates for developed countries but different from estimates for developing countries in which the peak is at a younger age and supports global predictions that the numbers of people with diabetes in the older age-groups will increase in developing countries, owing in part to the increase in the aging population across the world (3).

A surprising finding is that only 15.2% of the subjects with diabetes were known to have the disorder. This finding is in contrast to results of previous studies in urban South Africans in which >50% were known to have diabetes and comparable with findings in developed countries and was thought to reflect better access to health care facilities and opportunistic screening (2,6,7). These results suggest that there still exists a disparity in health care access and facilities between urban and rural areas in this country. From available reports, the only African studies that reported a lower proportion

of known diabetes are those in rural Tanzanians (13.2 and 8.3%) (11,19).

Multivariate analysis showed that a positive family history of diabetes, alcohol consumption, waist circumference, hip circumference, systolic blood pressure, and levels of serum total triglycerides and total cholesterol are associated with diabetes. This is the first study in Africans that has examined serum lipids, waist circumference, and hip measurements as risk factors. In the three other African studies in which family history was examined, this variable was a significant risk factor in two Sudanese studies (2) but not in urban Xhosas in South Africa (7).

The finding that waist circumference is an independent risk factor for diabetes confirms recent reports in other populations that measures of abdominal rather than of total body adiposity (BMI) may be a better indicator of the relationship between obesity and diabetes. Moreover, where examined, waist circumference and not WHR is a better correlate of visceral fat deposits (20). Previous studies in Africans have examined WHR as a measure of abdominal adiposity; WHR was a significant risk factor in Tanzanians (11) and in urban and peri-urban South Africans (7,8). To our knowledge, this is the first study in Africans in which waist circumference was examined as a risk factor; clearly there is a need for further studies in Africans to confirm this finding.

There are no previous reports of the association between hip circumference and diabetes in Africans. The negative association found in this study confirms the recent findings in Australians (21) and requires further evaluation in African populations.

The association between serum total triglycerides and diabetes confirms a recent report in a Spanish community (20) but is the first to be reported in Africans. Its significance needs to be established.

The positive association between alcohol consumption and diabetes confirms recent reports in Asians, but this finding is in contrast with several other reports in Western populations that showed a negative association or an inverse relationship (22). However, in this study, the association with grades of drinking was not examined.

This study confirms the fact that established risk factors such as family history, systolic blood pressure, and total cholesterol are associated with diabetes in South Africans and concurs with findings in Western and other populations (3,22).

A major limitation of this study is the overrepresentation of women, a problem that was also encountered in two previous studies in urban South Africans in which women constituted 70% of the survey population (6,7). In this study, there was a higher nonresponse rate in men, which might be accounted for by the fact that more men in the economically productive age-group move to urban areas, whereas women, children, and older individuals remain in the rural areas (migrant labor system). It is therefore possible that true estimates are higher than those reported in this study.

In summary, this study in a rural South African community shows a moderate prevalence of diabetes and a high prevalence of total disorders of glycemia. There is a low proportion of known diabetes and a significant association with potentially preventable and modifiable risk factors, which suggests that this community, unlike other rural communities in SSA, is well into an epidemic of glucose intolerance.

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