Prevalence of NIDDM and impaired glucose tolerance in a rural and an urban population in Cameroon

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Summary The adoption of Western lifestyles is known to lead to increasing prevalence of non-insulin-dependent diabetes mellitus in Africa, yet epidemiological studies using standardised methods are rare. The prevalence of diabetes and impaired glucose tolerance was determined in a rural and an urban community in Cameroon using the 75-g oral glucose tolerance test and the World Health Organization diagnostic criteria in 719 rural (292 men, 427 women) and 1048 urban (458 men, 590 women) subjects aged 24–74 years. The response rate was 95 and 91 % for the rural and urban population, respectively. The age-standardized prevalence of diabetes in the rural and urban population was respectively 0.9 % (95 % confidence interval (0.2–2.7)) and 0.8 % (0.2–1.8) for men and 0.5 % (0.1–1.6) and 1.6 % (0.7–3.1) for women, and that of impaired glucose tolerance was 5.8 % (3.3–9.4) and 1.8 % (0.9–3.2) for men, and for women, 2.2 % (1.0–4.0) and 2.0 % (0.6–4.5).

Although for both men and women the body mass index was higher at all ages in the urban than in the rural area, the 2-h plasma glucose, even after adjustment for age and body mass index, was significantly higher in the rural than in the urban area ($p < 0.005$, $p < 0.002$ for men and women, respectively). There was a female excess of diabetes in the urban area and an equal sex distribution in the rural area. In the rural area 67 % (4 of 6) of diabetic subjects were unknown before the survey, compared with 57 % (8 of 14) in the urban area. These data indicate a low prevalence of diabetes in Cameroon; however, the prevalence of impaired glucose tolerance suggests an early stage of a diabetes epidemic. [Diabetologia (1997) 40: 824–829]

Keywords Diabetes mellitus, impaired glucose tolerance, prevalence, 75-g oral glucose tolerance test, Cameroon, Africans, rural, urban.

Many countries at the early stages of modernization are undergoing a demographic transition with both the affluent and poor urban dwellers rapidly adopting Western lifestyles with an increase in consumption of fat, sugar and salt [1]. In Africa, these lifestyle changes have evolved along with an increasing prevalence of diabetes mellitus, obesity and hypertension in both rural and urban communities [2–6]. Yet epidemiological studies of these and other chronic diseases are rare in Africa. Clearly, there is a need for more information on the prevalence and health burden of these diseases in this region of the world.

The prevalence of non-insulin-dependent diabetes mellitus (NIDDM) is high in African Americans, Afro-Caribbeans and African migrants in Europe [7–10], all of whom share genetic ancestry with black Africans. This is the first report of the prevalence of NIDDM in Cameroon, using the same standardised methods as other epidemiological studies in different populations around the world.

Subjects, materials and methods

Cameroonian men and women of African origin, aged 24–74 years were studied in an urban area, Cité Verte Housing District, Yaoundé and in a rural area, three villages in Evodoula, Cameroon. The study was approved by the Ministry of Health's National Ethical Committee.

The Cité Verte Housing District is located in the City of Yaoundé, the capital of the Republic of Cameroon. A preliminary house census of the inhabitants of the housing estate, aged 24–74 years was conducted before the study. In all, there were 1493 households with an eligible population of 1160, of whom 533 were men and 627 women, who were all invited to participate in the study; 1058 (91 %) consented. Of the 102 subjects who refused to participate, only 8 (3 men, 5 women) subjects were over 55 years of age. The main reason for non-participation was in order of priority, not at home after several visits, lack of free time due to work schedule, fear of the quantity of blood drawn for the study and fear of blood being used to test for AIDS. The adult population of this housing estate is mostly middle grade civil servants and middle income earners for those in the private sector.

Three of the seven villages; Minwoho, Nkolassa and Nloudou, of the rural area of Evodoula situated about 60 km from Yaoundé were randomly selected as the rural sites. As neither a census nor a map of the villages was available, a household census and a descriptive map of each village were established by trained villagers at the onset of the study. The eligible population of the three villages was 786 with 362 inhabitants in Minwoho, 207 in Nkolassa and 217 in Nloudou; 746 (95 %) consented to participate in the study. The principal reason for non participation was lack of free time due to farm work. The occupation of the people of Evodoula is mainly farming and hunting.

All field workers and laboratory technicians were trained to administer the lifestyle questionnaire, to take anthropometric measurements and to draw blood. Those who were certified were selected and they were re-certified every two weeks.

The initial screening of the consenting subjects included questions about established diabetes, symptoms of diabetes as well as past and current medications for diabetes. The subjects were then given an appointment for an oral glucose tolerance test (OGTT) at the local health centre or the village chief's home. The OGTT was performed according to the World Health Organization (WHO) protocol [11] with the subjects ingesting glucose in 300 ml of chilled water corresponding to 75-g of anhydrate glucose (Plantecam/Medicam, Mutengene, Cameroon) between 07.00 and 10.00 hours after an overnight fast of at least 12 h. In every subject, 2.5 ml of whole blood was drawn from an antecubital vein into fluoride oxalate tubes before and 120 min after the ingestion of the glucose for the determination of plasma glucose. The blood specimens were transported immediately in ice-cooled containers to the Biochemistry Laboratory of the University Teaching Hospital Yaoundé where the tubes were centrifuged and plasma separated and analysed. Plasma glucose was determined by the glucose-oxidase method using a spectrophotometer with external quality control on every 4th sample by a Cobas Bio hexokinase fluorometric method (Paris, France). The linear correlation between the two methods was 0.96, with a mean difference of 0.17 mmol/l which did not increase with increasing glucose levels and the laboratory coefficient of variation was 1.74 %.

Measures of weight and height were taken, with subjects dressed in light clothing, and the body mass index (BMI) was calculated, weight/height^2 in kg/m^2.

Subjects were defined as having treated diabetes if they had previous hyperglycaemia and were currently being treated by oral hypoglycaemic agents, insulin and/or diet. The 2-h 75-g OGTT was used to identify newly diagnosed diabetes (2-h plasma glucose $\leq$ 11.1 mmol/l) and impaired glucose tolerance (2-h plasma glucose $\leq$ 7.8 mmol/l) [11].

Statistical analysis. The Kruskal Wallis test was used to compare the age, BMI and glucose distributions between urban and rural participants. The age-standardized prevalence of diabetes was calculated using the age distribution from the 1993 Cameroon census [12], which gave the age and sex distribution of the urban and rural areas. For comparison between urban and rural areas and with other studies, a truncated Segi, "old world standard" age distribution was also used for age standardization [13]; 95 % confidence intervals were determined using an approximation to Poisson distribution [14].

In order to compare glucose distributions between rural and urban areas, both the fasting and 2-h plasma glucose concentrations were adjusted for age and BMI, using regression analysis with linear, quadratic and interaction terms based on the non-diabetic population. The curves shown are for all subjects not treated for diabetes and are the estimated glucose distributions for age 40 years, and a BMI of 23 kg/m^2. The resulting distributions were compared using a Kolmogorov-Smirnov test.

Results

A total of 1804 subjects was included in the survey. However, only 1767 (1048 urban and 719 rural) have been included in the analysis as 1 woman from the urban area was of unknown age and 36 subjects who were not treated for diabetes had missing 2-h plasma glucose measurements. The sample was not representative of the age, sex and urban and rural distribution of the country as a whole (in the rural area, males and females between 55 and 64 years were over sampled while in the urban area, males and females 35 to 44 years were over sampled). There was therefore a need for age standardization in calculating the overall prevalence.

Sixteen participants indicated that they had been informed by a doctor that they had diabetes; of these, 8 (5 women and 3 men) were on treatment (1 woman on diet alone and 7 on oral hypoglycaemic agents). Of the 8 subjects who were not treated for diabetes, only 1 was classified as impaired glucose tolerant, and all others had fasting plasma glucose concentrations between 5 and 8 mmol/l.

Twenty women reported having glycosuria or diabetes during their pregnancy. Two of these subjects were currently being treated for diabetes and the others were normal glucose tolerant.

The subjects in the urban area were on average 6 or 7 years younger ($p = 0.0001$) and more obese, by 3.0 kg/m^2 in men and 4.6 % kg/m^2 in women ($p = 0.0001$) than those in the rural area (Table 1). The men in the urban area had higher fasting plasma glucose concentrations ($p = 0.009$) than those in the rural area while both men and women in the rural area had higher 2-h plasma glucose concentrations than those in the urban area (Table 1).

Table 1. Characteristics median (quartiles) of the 1767 subjects studied according to sex and rural/urban location: the Cameroon survey

	Men			Women		
	Rural ($n = 292$)	Urban ($n = 458$)	p value	Rural ($n = 427$)	Urban ($n = 590$)	p value
Age (years)	43 (34–57)	37 (30–43)	0.0001	47 (34–56)	36 (31–42)	0.0001
BMI (kg/m^2)	21.5 (20.2–23.4)	24.5 (22.2–27.4)	0.0001	21.8 (20.1–24.0)	26.4 (23.5–29.8)	0.0001
Fasting plasma glucose (mmol/l)	4.0 (3.6–4.4)	4.2 (3.7–4.6)	0.009	4.1 (3.7–4.4)	4.1 (3.7–4.5)	0.2
2 h plasma glucose (mmol/l)	5.0 (4.3–5.9)	4.8 (4.1–5.6)	0.005	4.9 (4.3–5.6)	4.7 (4.1–5.3)	0.0002

Table 2. Plasma glucose concentrations (mmol/l) 2 h after a 75 g oral glucose tolerance test: the Cameroon survey

Age (years)	Men										Women									
	n	Mean	SD	5	10	25	Percentiles median	75	90	95	n	Mean	SD	5	10	25	Percentiles median	75	90	95
Rural																				
24–34	81	4.8	1.2	3.0	3.4	4.0	4.8	5.6	6.3	7.1	108	4.9	1.0	3.4	3.7	4.1	4.9	5.4	6.2	6.8
35–44	69	5.1	1.1	3.2	3.3	4.3	4.9	6.0	6.6	6.8	85	5.0	1.1	3.7	3.9	4.3	4.8	5.5	6.3	7.3
45–54	52	5.5	1.7	3.5	4.0	4.3	4.9	5.8	8.4	9.3	102	5.4	3.3	3.7	3.8	4.3	4.9	5.6	6.6	7.3
55–64	61	5.8	3.4	3.7	4.0	4.5	5.0	6.5	8.0	8.5	95	5.6	3.6	3.6	3.9	4.3	5.0	5.9	7.0	8.1
65–74	29	5.7	1.2	4.1	4.4	5.0	5.5	6.3	7.7	8.1	37	5.2	1.0	3.9	4.0	4.4	4.9	5.9	6.4	7.3
Urban																				
24–34	180	4.6	0.9	3.2	3.5	4.0	4.5	5.1	5.9	6.3	225	4.6	1,1	3.3	3.5	3.9	4.5	5.2	5.8	6.3
35–44	177	5.4	2.8	3.3	3.8	4.3	5.0	5.8	6.9	7.9	250	4.8	1.0	3.4	3.6	4.2	4.7	5.3	6.0	6.5
45–54	82	5.3	1.6	3.6	3.8	4.4	5.1	5.6	7.4	8.9	74	5.2	1.8	3.5	3.7	4.2	4.9	5.5	6.3	8.9
55–64	14	5.2	0.7	4.0	4.4	4.5	5.3	5.7	6.2	6.4	31	5.9	3.1	4.2	4.3	4.7	5.2	6.0	6.9	7.8
65–74	4	5.8	1.1	4.6	4.6	5.0	5.7	6.6	7.2	7.2	7	5.7	1.7	3.8	3.8	4.1	5.1	7.9	8.2	8.2

Table 3. Numbers of subjects with treated diabetes, diabetes diagnosed by the survey, impaired glucose tolerant

Age (years)	Men				Women			
	n	IGT	Diabetes screened	Diabetes treated	n	IGT	Diabetes screened	Diabetes treated
Rural								
24–34	81	2	0	0	108	1	0	0
35–44	69	0	0	0	85	0	0	0
45–54	52	7	0	1	102	2	2	0
55–64	61	6	1	1	95	5	1	0
65–74	29	2	0	0	37	1	0	0
	292	17	1	2	427	11	3	0
Urban								
24–34	180	0	0	0	226	0	1	1
35–44	178	6	3	1	251	3	1	2
45–54	82	5	1	0	75	3	2	1
55–64	14	0	0	0	31	0	0	1
65–74	4	0	0	0	7	2	0	0
	458	11	4	1	590	8	4	5

Characteristics of the distributions of the 2-h plasma glucose concentrations are shown by age group, sex and location (urban and rural) in Table 2. For both men and women, the BMI was higher at all ages in the urban area (Fig. 1), with the median values of both fasting and 2-h plasma glucose concentrations being slightly but not always higher in the rural than in the urban area. There were few subjects in the older age groups particularly in the urban area, thus, the percentiles are poorly determined.

Even after adjustment for age and BMI, the fasting plasma glucose concentrations in the urban subjects tended to be higher than in the rural areas (Fig. 2), but this difference was not statistically significant ($p = 0.13$ and $p = 0.20$, in men and women, respectively). In contrast, the 2-h plasma glucose concentration distributions were significantly higher in the rural area ($p = 0.008$ and $p = 0.0001$, in men and women, respectively). The 2-h plasma glucose distributions were unimodal (Fig. 2).
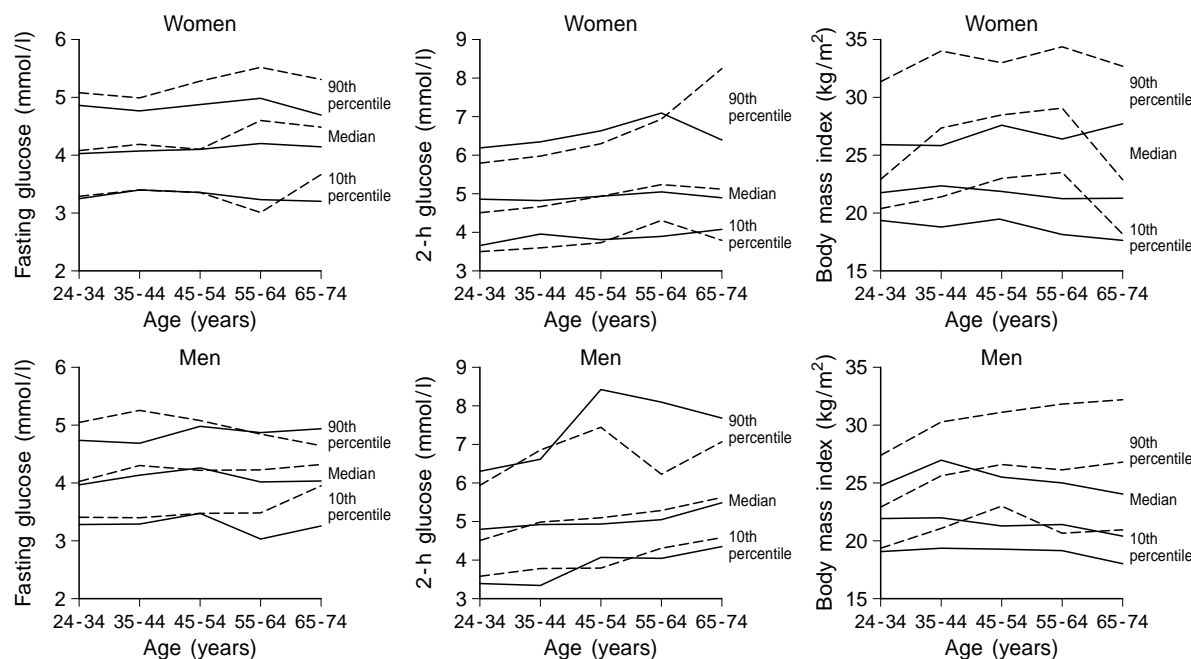
Fig. 1. Distribution of percentiles of fasting and 2-h plasma glucose and body mass index by location (— rural – – urban) and by sex: the Cameroon survey

The number of subjects with treated diabetes, screened diabetes and impaired glucose tolerance is shown in Table 3. In the rural area 67 % (4 of 6) of diabetic subjects were unknown before the survey, compared with 57 % (8 of 14) in the urban area (Table 3). Table 4 shows the prevalence of diabetes and impaired glucose tolerance in the two communities. For the men, there was little difference in the prevalence of diabetes between the urban and rural areas, both being close to 1 %. Impaired glucose tolerance was three times more frequent in the rural area. For the women, diabetes was three times more common in the urban than in the rural area, but the frequency of impaired glucose tolerance was similar in both areas; the high age standardized prevalence of 4.0 %

in the urban women is due to 2 out of 7 of the 65–74 year old women being impaired glucose tolerant.

Discussion

This study confirms the report that the prevalence of glucose intolerance (NIDDM and impaired glucose tolerance) is rising in populations in which diabetes was hitherto thought to be rare [15]. Urbanization has been strongly associated with diabetes prevalence in many developing countries [15]. In the present study, the urban population is heterogeneous, while the rural population is more homogeneous with more than 95 % of the population being from one Bantu tribe. We expected the prevalence of NIDDM to be higher in the urban than in the rural area in view of the accelerated social change with an increase in caloric intake, a decline in physical activity and a marked increase in obesity taking place in the urban communities of developing countries [1, 2]. Indeed,

Table 4. Prevalence (95 % confidence interval) of diabetes (treated and screened combined) and of impaired glucose tolerance in subjects 25–74 years: the Cameroon survey

	Men		Women	
	Rural	Urban	Rural	Urban
Unadjusted prevalences (%)				
Diabetes	1.0 (0.2–3.0)	1.1 (0.4–2.6)	0.7 (0.2–2.1)	1.5 (0.7–2.9)
Impaired glucose tolerance	5.9 (3.4–9.5)	2.4 (1.2–4.4)	2.6 (1.3–4.7)	1.4 (0.6–2.7)
Prevalences (%) standardized for the Cameroon rural/urban age distribution				
Diabetes	0.9 (0.2–2.7	0.8 (0.2–1.8)	0.5 (0.1–1.6)	1.6 (0.7–3.1)
Impaired glucose tolerance	5.8 (3.3–9.4)	1.8 (0.9–3.2)	2.2 (1.0–4.0)	2.0 (0.6–4.5)
Prevalences (%) standardized to the 'old world' population [14] for the age group 30–64 years				
Diabetes	1.6 (0.3–4.8)	1.1 (0.3–2.7)	0.7 (0.1–2.0)	2.4 (0.7–5.3)
Impaired glucose tolerance	5.9 (3.0–10.3)	2.8 (1.3–5.2)	3.0 (1.5–5.7)	2.2 (0.5–5.3)
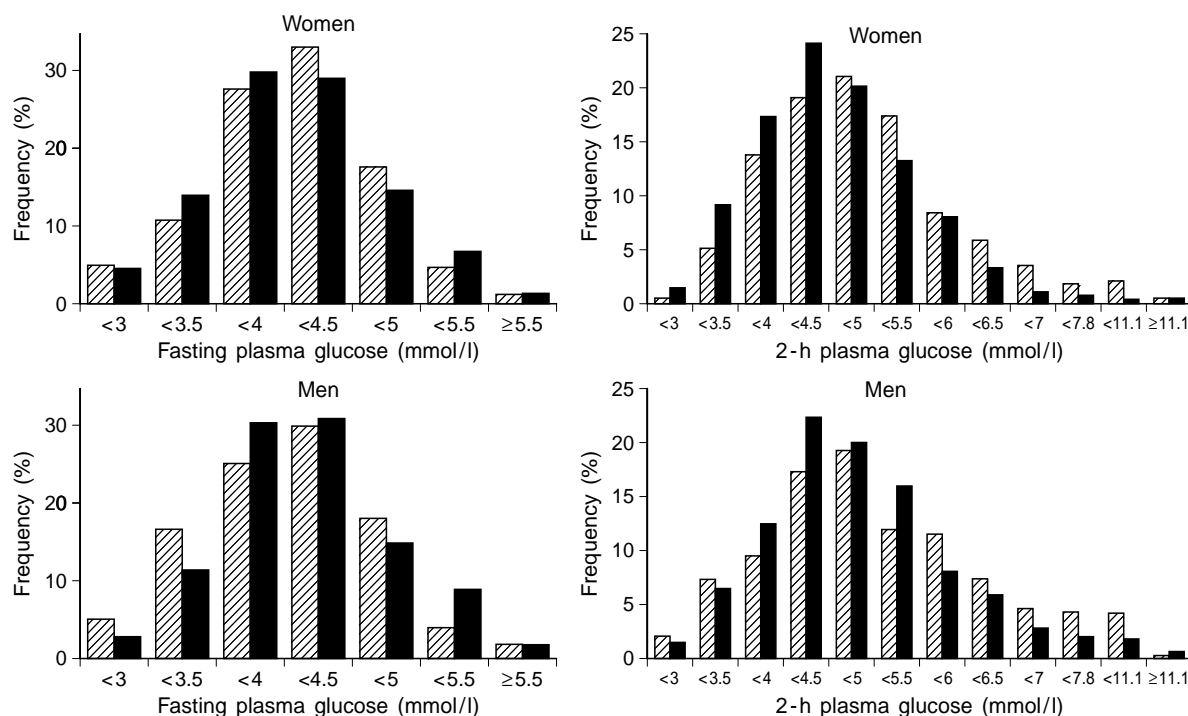
Fig. 2. Distribution of fasting and 2-h plasma glucose, age and body mass index adjusted by location and by sex: the Cameroon survey. ■ Urban; ▨ Rural

the urban population studied was significantly more obese than the rural population.

The age distribution differs in Cameroon [12], between the urban and the rural area, and this is reflected in the sample studied. In consequence, the prevalences in the age classes with few subjects will be poorly estimated; the age-standardized prevalences and their associated confidence intervals, take into account this lack of precision.

A few population-based studies of NIDDM using the WHO criteria [11] exist from East and South Africa [16–18], nevertheless, population-based reports of diabetes in Africa are uncommon. A low age standardized diabetes prevalence was observed in the rural and urban Bantu communities of Tanzania [15, 16] in 1987–1988. The age-standardized prevalence of diabetes in urban Cameroon women is higher than in those reported in rural and urban Tanzania (2.4 vs 0.4 to 0.9 %). Diabetes prevalence in urban Cameroonian men was much lower than in the urban Tanzanian Bantu men (1.1 vs 3.3 %) [16]. When compared with data from Indian migrants of Durban, South Africa [17] and Muslim and Hindu migrants of Dar es Salaam, Tanzania [18], prevalence in both rural and urban Cameroon was about ten times lower than in any of these populations. The prevalence of diabetes in the Cameroon survey was lower than that observed for United States blacks in the

NHANES II study close to 20 years ago (9 and 12 % for men and women, respectively) and for United States whites (5 vs 7 % for men and women, respectively) [19].

The prevalence of impaired glucose tolerance in the Cameroon population was lower than those observed by McLarty et al. [16] in rural and urban Tanzania (2.2 to 5.9 vs 7.4 to 16.3 %) and much lower than in migrant Indian populations of Tanzania and South Africa [17, 18]. There was an excess of impaired glucose tolerance in rural men which could be due to excessive alcohol consumption which has been described in the same population [20]. Indeed, it has been suggested that diabetes diagnosed by OGTT in a working man population may partially be a consequence of excessive alcohol consumption [21]. Moreover, the age-standardized prevalence of glucose intolerance (diabetes and impaired glucose tolerance) was more than two times higher in the rural than in the urban men (7.0 vs 3.0 %, respectively). Follow-up studies in young and in middle-aged populations indicate that about 50 % of subjects with impaired glucose tolerance revert to normal glucose tolerance, 25 % remain permanently glucose intolerant and 25 % progress to diabetes [22–25]. Middle-aged subjects with impaired glucose tolerance have an approximately fourfold risk of developing diabetes compared with normoglycaemic subjects [22, 24, 25].

The urban population though younger, was more obese than the rural population. Obesity is an established risk factor of diabetes and impaired glucose tolerance. The 2-h plasma glucose, even after adjustment for age and BMI, was significantly higher in the rural area. This may be due to nutritional factors.

The rural population tends to eat mostly complex carbohydrates whereas the urban population eats mostly simple carbohydrates [20] and this could have an effect on glucose tolerance.

A higher percentage of the diabetes was unknown before the survey in the rural than in the urban area (67 vs 57%). By contrast, the proportion of unknown cases was over 80% in Tanzania subjects [16, 18] and less than 50% in Durban, South Africa [17]. Figures of 50% and up to 100% have been found respectively in European and American and in Pacific populations [7, 26, 27]. The urban-rural differences may be due to the fact that the subjects in the urban area are more aware of the symptoms of diabetes because of their education level and therefore seek medical advice at an earlier stage of the disease than those living in the rural areas. Also, access to medical facilities is easier in the urban than in the rural area.

These data show that diabetes is still rare in both urban and rural communities in Cameroon. The rates of impaired glucose tolerance suggest an increase in the public health impact of diabetes in Cameroon in the future and an early stage of a diabetes epidemic.

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