PREVALENCE OF DIABETES MELLITUS AND IMPAIRED GLUCOSE TOLERANCE IN FACTORY WORKERS FROM TRANSKEI, SOUTH AFRICA

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Objective. To determine the prevalence of diabetes mellitus and impaired glucose tolerance (IGT) in a group of peri-urban black South Africans.

Design. Cross-sectional study in which an oral glucose tolerance test (OGTT) was performed on each subject.

Setting. Two of the largest factories in the surroundings of Umtata, the capital of the former homeland of Transkei, South Africa.

Subjects. A total of 374 Xhosa-speaking factory workers.

Main outcome measures. Frequency of diabetes mellitus and IGT according to age group and gender using the current World Health Organisation (WHO) criteria for the diagnosis of abnormal glucose tolerance and its relationship to obesity.

Results. The crude prevalences for diabetes mellitus and IGT were 2.45% and 2.7% respectively. The age-adjusted prevalences using a standard world population were 4.5% (confidence interval (CI) 1.54 - 7.42) and 5.1% (CI 2.45 - 5.51) for diabetes and IGT respectively. The prevalence of diabetes was similar in male and female workers ($P = 0.31$), with the highest incidence observed in the age group from 40 to 59 years. No subject below the age of 40 years was found to be diabetic, and the prevalence of the disease was found to increase with age. Obesity was present in 22.2% of all subjects. Prevalence of obesity was similar in subjects with diabetes and in those with impaired and normal glucose tolerance ($P = 0.71$). However, overweight, identified in 26.8% of subjects, was more frequently observed in the IGT group than in the other two groups ($P = 0.01$). IGT was observed in 3.4% of male and 1.5% of female workers respectively ($P = 0.13$), with peak prevalences occurring between the ages of 30 and 49 years.

Conclusion. In conclusion, this study found a prevalence of diabetes and IGT comparable to prevalence results reported in other black South African communities. The implications with regard to this community merit further study.

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Diabetes mellitus has become a major problem in both developed and developing countries. The prevalence of type 2 diabetes varies considerably between different populations. Recent reports demonstrate that diabetes is highly prevalent in developing countries, with the prevalence sometimes exceeding that in developed nations.[1] Reports from Africa have shown wide variation, with prevalences ranging from 0 to 19.3%.[2-12] Some of this variation has been attributed to the use of non-standardised methods in the diagnosis of diabetes. There is evidence that the prevalence of diabetes among South African blacks is much higher than previously reported.[9,10] For example, a recent study found that the prevalence of diabetes among urban blacks, predominantly of Xhosa origin, residing in Cape Town was almost twice the figure reported two decades earlier.[9] Similarly, Omar *et al.*[10] reported a high prevalence of diabetes in a group of urban South Africans of Zulu descent. However, several studies from different parts of the world have not only reported urban-rural differences in the same ethnic group, but also in those undergoing internal and external migration.[1]

The traditional home of the Xhosa is the former homeland of Transkei, South Africa — an area that is largely rural, with pockets of peri-urban areas. Knowledge of the prevalence of diabetes in a community is important in order to determine the magnitude of public health resources required to care for the disease. In this study we report on the prevalence of diabetes mellitus in a group of factory workers residing in Umtata, South Africa.

METHODS

Setting

Umtata was the capital of the former homeland of Transkei. Most of its population (99.5%) is of Xhosa origin. The population of Umtata is estimated at about 200 000. Our unpublished observations suggest that the eating pattern of this community can be described as urban, and that it is different from the dietary pattern of rural Transkeians. The majority of the adult male population (> 20 years of age) work in the mines and therefore are not normally resident in Umtata.

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However, as part of its development programme the former government of Transkei established a number of industries in and around Umtata as a source of employment for those who would otherwise have gone to look for employment in the mines or other industrialised areas, e.g. Cape Town. As part of the university's community outreach programme, two of the largest factories (workforce of more than 200) were selected in order to study the prevalence of diabetes in young black adults. The two factories were a soft drinks factory (200 employees) and a timber factory (500 employees). The study was approved by the Research and Ethical Committee of the Medical Faculty of the University of Transkei. Before commencing the study both verbal and written consent were obtained from the management as well as the individual participants. Caucasians and subjects of mixed origin were excluded from the study. The diagnosis of diabetes was made using the modified oral glucose tolerance test (OGTT). Details of the procedure were explained to all participants. Subjects who were known to be diabetic were not subjected to the glucose tolerance test. Before the blood collection subjects were interviewed by trained staff who were fluent in Xhosa regarding: (*i*) family history of diabetes; (*ii*) signs and symptoms of diabetes; (*iii*) presence or absence of diabetes; (*iv*) residential and socio-economic status; (*v*) exercise profile; and (*vi*) educational status.

Blood collection

Fasting blood samples were collected from each subject, following which a 75 g anhydrous glucose load dissolved in 300 ml of cold water was administered. A second sample was collected at 120 minutes. Samples were transported on ice to the laboratory for glucose analysis. Weight and height were measured, with subjects wearing light clothing and no shoes. Waist and hip measurements were taken to calculate the waist-to-hip ratio (WHR).

Diagnosis of diabetes

Diagnosis of diabetes was made according to the World Health Organisation (WHO) criteria,[13] i.e. a 120-minute plasma glucose value of more than or equal to 11.1 mmol/l.

Obesity

Body mass index (BMI) was calculated as weight/(height)^2. Subjects were considered overweight or obese if the BMI was equal to or more than 25 or 30 respectively.

Statistical analysis

Data were entered into a database file using the dBase III program, and were later imported into Epi-Info-6, which was used in the final analysis of comparison of means and frequencies. Frequencies were expressed as percentages and means as value (standard error of mean (SEM)); chi-square tests and analysis of variance (ANOVA) were used to compare them between sexes and age groups. *P*-values < 0.05 were taken as being significant. The prevalences of diabetes and IGT were age adjusted to the standard world population using a direct method,[14] and 95% confidence intervals (CIs) were calculated.

Results

Out of a total of 510 workers, 498 consented to an OGTT. However, 124 workers did not return for the 120-minute sample, leaving 374 participants in the study. Ninety per cent of these were semi-skilled manual workers. Their ages ranged from 20 to 69 years. The educational level of the majority of workers (90%) was between Standards 4 and 8. The overall response rate was 73%. The crude prevalence of diabetes was 2.4% and that of IGT 2.7%. When age-adjusted to the world population, the prevalence was 4.5% (CI 1.54 - 7.42) for diabetes and 5.1% (CI 2.45 - 5.51) for IGT. Of the 9 diabetic workers, only 1 had been diagnosed previously. The crude prevalence of diabetes was similar in males and females (2.9% versus 2.1%, $P = 0.31$).

Table I shows the anthropometric characteristics and plasma glucose values for diabetics and subjects with impaired and normal glucose tolerance. Diabetics were significantly older than non-diabetic subjects ($P = 0.006$). Within the diabetic and IGT groups there were no significant sex differences with regard to age, weight, BMI, WHR, fasting plasma glucose (FPG) and 120-minute plasma glucose levels.

Significant differences were found in age ($P = 0.02$), BMI ($P = 0.00001$) and weight ($P = 0.0002$) between males and females with normal glucose tolerance.

The highest prevalence of diabetes (8.1%) was observed in subjects between the ages of 50 and 59 years. The prevalence of diabetes was found to increase with age in female subjects (Table II). No subject with diabetes was detected below 40 years of age. None of the newly diagnosed diabetics ($N = 8$, 89%) was symptomatic or knew that she or he had the disease. Although the mean age of diabetics was significantly higher ($P = 0.04$) than that of non-diabetics, their respective BMIs and WHRs were similar. Among the diabetic subjects no differences were observed in BMI, WHR, FPG or 120-minute glucose values in either of the sexes. IGT was observed in 10 subjects (2.7%), and no difference was observed between their sex-specific prevalences (male 3.4%, female 1.5%, $P = 0.13$). The overall age-adjusted prevalence of IGT was 5.1%. Peak prevalence was observed between the ages of 30 and 49 years for males, and 30 and 39 years for females.

Obesity was present in 22.2% of all subjects. Its prevalence was similar in diabetics and subjects with impaired and normal glucose tolerance ($P = 0.71$). However, overweight, identified in 26.8% of subjects, was more frequently observed in the IGT group than the other two groups ($P = 0.01$).

Table I. Anthropometric characteristics and plasma glucose values of subjects with diabetes, impaired and normal glucose tolerance (mean (SEM))

		Diabetes	*N*	IGT	*N*	Normal	*N*	Total	*N*
Age (yrs)	Total	46.1 (1.7)	9	40.3 (3.0)	10	37.6 (0.48)*	355	37.9 (0.47)	374
	Males	45.4 (2.1)	5	42.3 (3.4)	8	36.8 (0.66)	224	37.2 (0.64)	237
	Females	47.0 (2.9)	4	32.5 (2.5)	2	39.1 (0.64)†	131	39.2 (0.63)	137
Weight (kg)	Total	75.2 (3.6)	9	72.7 (6.03)	10	68.9 (0.78)	355	69.2 (0.8)	374
	Males	77.0 (4.8)	5	81.0 (6.60)	8	66.5 (0.95)	224	67.2 (0.9)	237
	Females	73.0 (6.0)	4	62.0 (12.0)	2	72.9 (1.30)†	131	72.7 (1.3)	137
BMI	Total	27.8 (1.6)	9	28.0 (1.67)	10	26.2 (0.32)	355	26.2 (0.31)	374
	Males	27.2 (1.9)	5	28.1 (1.70)	8	23.6 (0.28)	224	23.9 (0.28)	237
	Females	28.5 (2.9)	4	27.7 (6.60)	2	30.5 (0.53)†	131	30.4 (0.52)	137
WHR	Total	0.94 (0.02)	9	0.88 (0.02)	10	0.89 (0.03)	355	0.89 (0.02)	374
	Males	0.95 (0.03)	5	0.90 (0.02)	8	0.82 (0.04)	224	0.92 (0.04)	237
	Females	0.93 (0.03)	4	0.83 (0.03)	2	0.84 (0.01)	131	0.84 (0.01)	137
FPG (mmol/l)	Total	11.4 (1.8)	9	5.6 (0.30)	10	4.5 (0.04)	355	4.7 (0.11)	374
	Males	10.0 (2.1)	5	5.7 (0.31)	8	4.4 (0.05)	224	4.6 (0.10)	237
	Females	13.2 (3.2)	4	5.3 (1.15)	2	4.6 (0.05)	131	4.8 (0.20)	137
120-min PG (mmol/l)	Total	19.1 (2.1)	9	8.4 (0.27)	10	4.6 (0.06)	355	5.1 (0.15)	374
	Males	19.4 (2.9)	5	8.3 (0.33)	8	4.4 (0.07)	224	4.8 (0.17)	237
	Females	20.6 (3.6)	4	8.9 (0.05)	2	5.0 (0.08)	131	5.5 (0.26)	137
Obesity	Total	3 (33.3%)	9	2 (20.0%)	10	78 (21.9%)	355	83 (22.2%)	374
	Males	1	5	1	8	16	224	18	237
	Females	2	4	1	2	62	131	65	137
Over-weight	Total	4 (44.4%)	9	6 (60.0%)	10	95 (26.8%)	355	105 (28.1%)	374
	Males	3	5	6	8	46	224	55	237
	Females	1	4	-	2	49	137	50	137

*$P < 0.05$ when compared with diabetic group.
† $P < 0.05$ when compared with males.
IGT = impaired glucose tolerance; BMI = body mass index; WHR = waist-to-hip ratio; FPG = fasting plasma glucose.

Table II. Age and sex distribution of subjects with diabetes and impaired glucose tolerance

Age group (yrs)	Total			Diabetes			IGT		
	All	Male	Female	All (%)	Male	Female	All (%)	Male	Female
20 - 29	78	63	15	–	–	–	–	–	–
30 - 39	129	77	52	–	–	–	4 (3.1)	2	2
40 - 49	125	66	59	6 (4.8)	4 (6.1)	2 (3.4)	5 (4)	5	0
50 - 59	37	26	11	3 (8.1)	1 (3.8)	2 (18.2)	–	–	–
> 60	5	5	–	–	–	–	1 (20)	1	–
Total	374	237	137	9 (2.4)	5	4	10 (2.7)	8	2

IGT = impaired glucose tolerance.

No significant correlations were observed between age and BMI with fasting and 120-minute plasma glucose values.

DISCUSSION

Most authorities regard diabetes as a disease of urbanisation and modernisation. Indeed it was not long ago that the existence of diabetes among sub-Saharan Africans was questioned. The increasing number of diabetics now seen in major African cities suggests that this is no longer the case.

The former homeland of Transkei is predominantly rural. Some areas such as Umtata can be considered peri-urban. This study was prompted by recent reports of a high prevalence of diabetes among urban Xhosas residing in Cape Town,[9] a distance of nearly 1 300 km from Umtata, as well as the observation that an increasing number of newly diagnosed diabetics are reporting to the local hospital. We found the age-adjusted prevalence of diabetics to be 4.5% (CI 1.54 - 7.42), a

figure that is lower than that reported for Xhosas residing in Cape Town.[9] The differences can probably be attributed to the degree of urbanisation of our study population. In the Cape Town study[9] urbanisation was identified as an independent risk factor for diabetes, with a substantial rise in the prevalence of diabetes after 20 years of urban residence. This is similar to observations made by Campbell,[15] who also reported a peak incubation period of 18 - 22 years of urban residence for a group of Zulus residing in Durban. On the basis of Neel's 'thrifty genotype' hypothesis (see Zimmet[16]) it is attractive to speculate that our results may be part of an intermediate phase whereafter a higher prevalence may occur once the population is sufficiently urbanised and affluent. However, age differences between these two population groups may also have contributed to the observed differences. The subjects in the Cape Town[9] survey were much older, and increased sensitivity of the 120-minute glucose values to ageing has been reported.[17,18] The results of our study are similar to those observed in other ethnic groups in South Africa. Mollentze *et al.*[11] found an age-adjusted prevalence of 4.8% in Sesothos residing in the rural area of QwaQwa, while Omar *et al.*[10] reported an age-adjusted prevalence of 5% in urban Zulus living in Durban.

Obesity in our subjects was similar to that reported in the recent South African Demographic and Health Survey of 1998,[19] but lower than that reported for urban Xhosas from Cape Town.[9] This may in part be attributed to the majority of our subjects being manual workers and comparatively less urbanised than their Cape Town counterparts. Obesity did not appear to be a risk factor for the development of diabetes mellitus in our study, with similar prevalence ratios observed among diabetics, normal subjects and those with IGT. However, overweight subjects appeared to be at risk of developing IGT. There is mounting evidence that a rising BMI and obesity constitute important risk factors in the emergence of diabetes in black females.[9,19] However, this was not observed in our subjects.[9,20]

We found that all of the subjects identified as having diabetes were unaware of their diabetic state. This finding is in contrast to the study by Levitt *et al.*[9] in Cape Town which reported a ratio of 1:1 of unknown to known cases, but it is similar to some studies reported from rural communities in other parts of Africa.[6,7] These data suggest that this community may not have sufficient access to health services.

IGT was observed more frequently among young males, which is similar to the trend noted among South African Zulus.[10] Its implication is not clear and further studies are needed to confirm whether a significant number of these subjects revert back to normal or progress to frank diabetes. In rural Tanzania, 80% of subjects with IGT reverted to normal on a repeat OGTT within 5 days of the initial investigation.[21]

In conclusion, this study found a prevalence of diabetes and IGT comparable to results reported in other black South African communities.[9-11] Our results indicate that the prevalence observed in this peri-urban population may be approaching figures seen in some developed countries. The implication with regard to this community merits further study.

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