# The prevalence of diabetes mellitus and associated risk factors in elderly coloured South Africans

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*Objective.* To determine the prevalence of diabetes and its associated risk factors in elderly coloured South Africans.

*Research design.* Cross-sectional analytical study.

*Methods.* A random sample of 200 non-institutionalised coloured (mixed ancestry) subjects aged ≥ 65 years of age, resident in urban Cape Town, was drawn by means of a two-stage cluster design. The survey procedure included an oral glucose tolerance test, anthropometric measurements, and physical activity and alcohol intake assessments.

*Results.* The prevalence of diabetes was 28.7% (95% CI 21.7 - 35.7%), 25.7% in men and 30.3% in women. The prevalence of impaired glucose tolerance was 15% (95% CI 9.2 - 20.8%). Upper-segment fat distribution ($P < 0.001$) and body mass ($P < 0.05$) were identified as significant risk factors for diabetes. A differential age and sex interaction was evident; in men the association between the identified risk factors and diabetes increased with age, while in women the association was strongest in those aged < 70 years. Body mass index, alcohol intake and physical activity were not significant risk factors.

*Conclusions.* The prevalence of diabetes in older coloured South Africans was found to be high. The predicted increase in the proportion of the coloured population aged 65 years and older during the next 4 decades has important implications for the allocation of health resources for management of chronic diseases associated with ageing; diabetes appears to constitute a major health problem in this regard.

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Currently, 1.7 million South Africans are aged 65 years and over, a figure predicted to rise to over 7 million by the year 2035.[1] The increasing size of the ageing population is of concern to policy-makers as the prevalence of chronic diseases, such as non-insulin-dependent diabetes (NIDDM), increases with age. Interestingly, the prevalence of NIDDM varies from country to country, as well as among ethnic groups within a country and within the same ethnic group, as members of the group migrate from their place of origin.[2] This variation in the prevalence of diabetes in South Africa was highlighted by the studies of Jackson and colleagues in 1969 - 1971, in which the prevalence of diabetes in subjects over 55 years of age was found to be 22.2% in Malays, 20.2% in Indians, 3.8% in blacks,[3] 11.8% in whites,[4] and 25% in coloureds.[5]

Knowledge of the prevalence of diabetes in a community is important to determine: (*i*) the magnitude of public health resources required to care for those with the disease; and (*ii*) the most important risk factors to facilitate the development of intervention programmes. In view of the lack of any current information on the prevalence of diabetes in the elderly coloured community, the present study was undertaken.

## Subjects and methods

A sample of 200 non-institutionalised coloured subjects (104 women, 96 men) aged 65 years and older, resident in Cape Town, was recruited for a cross-sectional analytical study conducted in 1993; a two-stage cluster sampling technique, based on 1991 Population Census data, was used.[1] The study formed part of the International Union of Nutritional Sciences' (Committee on Nutrition and Ageing) cross-cultural studies on food habits and health in later life.[6] Exclusion criteria included mental confusion, assessed on the basis of a subject's inability to answer three questions relating to their name, address and the current year. Written informed consent was obtained from all participants and the study was approved by the Ethics and Research Committee of the University of Cape Town and Allied Teaching Hospitals.

Anthropometric measurements were taken and interviews conducted in the subjects' homes. Physical activity levels were assessed by asking the subjects to estimate the length of time spent performing five common activities (walking, light housework, heavy housework, gardening and participation in a sport) during the week prior to the interview. As participation in most other activities was minimal, walking was taken as the indicator of physical activity and categorised into four levels: none; < 1 hour per week; 1 - 2 hours per week; and > 2 hours per week.

Height and weight were measured and body mass index (BMI) calculated as weight (kg)/height squared ($m^2$). Waist circumference was recorded at the level of the umbilicus and hip circumference was measured at the largest diameter below the umbilicus or maximum circumference over the buttocks. Triceps skinfold thickness was measured in triplicate with Harpenden calipers.

Fasting blood samples were drawn from all consenting subjects ($N$ = 191). All subjects who, according to self-report, did not have previously diagnosed diabetes treated with oral hypoglycaemic agents or insulin ($N$ = 153) ingested 75 g glucose monohydrate in 250 ml water and had blood drawn 2 hours thereafter. Plasma glucose levels were measured by means of the glucose oxidase reference

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method.[7] Diabetes and impaired glucose tolerance (IGT) were diagnosed according to WHO[8] criteria for epidemiological surveys (2-hour plasma glucose level ⩾ 11.1 mmol/l for diabetes; 2-hour plasma glucose levels ⩾ 7.8 and < 11.1 mmol/l for IGT). Subjects who did not comply with the request to fast prior to an oral glucose tolerance test (OGTT) were asked to re-attempt fasting.

Gender-related differences in diabetes prevalence between the age bands 65 - 74 years and 75+ years, were tested with the Wilcoxon 2-sample test. A stepwise logistic regression procedure was used to screen the risk factors (BMI, weight, height, waist/hip ratio (WHR), waist circumference, hip circumference, triceps skinfold thickness, physical activity and alcohol intake) for significance, with sex and age included in the models as possible confounders. All risk factors, except physical activity, were initially used in the regression analyses as continuous variables. For the next stage of the modelling, the risk factors or confounders were entered as discrete variables, according to two categories which were selected from exploratory non-parametric regression plots of diabetes against the significant variables. The final model was also tested after adjustment for sampling design but as the design effect was minimal, unadjusted estimates are reported. Gender-related differences in anthropometric variables between diabetics and non-diabetics were tested with the Wilcoxon 2-sample test.

## Results

One hundred and ninety-one of the sample of 200 subjects participated in the study (response rate of 95.5%); of these, 11 subjects (6%) did not adhere to the instruction to fast on two occasions and were excluded from the analyses. The mean age of the subjects was 73.7 years (SD = 5.9; range 65 - 92 years). For both sexes, the age distribution of the sample was similar to that of the national coloured population aged 65 years and older.[1] The mean proportion of lifetime spent in Cape Town was 86%. The main source of income of most (87%) subjects was the social pension of R340 per month. Sixteen per cent of the subjects had received no formal education.

The prevalence of diabetes was 28.3%, and 28.7% (95% CI 21.7 - 35.7%) after adjustment for the sampling design (Table I). Five of the 9 subjects with self-reported diabetes not on medication had normal glucose tolerance, 1 had IGT and the remainder were confirmed diabetic. Fig. 1 compares the prevalence of diabetes found in the present study with studies of other elderly populations.[9-20] There was no significant sex difference in the prevalence of diabetes (25.7% for men; 30.3% for women). The prevalence of IGT was 15% (95% CI 9.2 - 20.8%) and, although it appeared to be more common in men than in women (23.7% and 9.8%, respectively), the small number of cases of IGT did not allow an assessment of statistical significance. Neither diabetes nor IGT prevalence differed significantly between the age bands 65 - 74 years and 75+ years in both sexes.

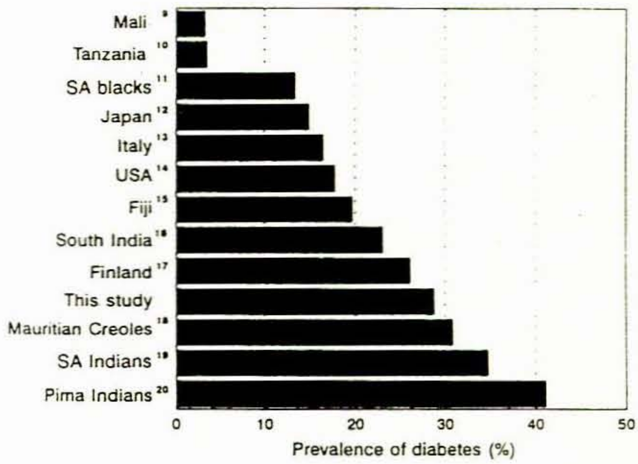


**Fig. 1. Prevalence of NIDDM in older populations aged ⩾ 65 years (Verrillo *et al.*[13] includes subjects aged ⩾ 60 years; Hiltunen *et al.*[17] includes subjects aged ⩾ 70 years).**

Twenty-five per cent of the diabetic subjects ($N$ = 13) were previously undiagnosed. Of those subjects who were known diabetics, 39% ($N$ = 15) had been diagnosed within the previous 2 years and 13% ($N$ = 5) between 2 and 5 years previously. Eighty-four per cent of the known diabetics ($N$ = 32) were currently being treated for the disease and, with the exception of 1 woman on insulin, all were taking oral hypoglycaemic agents. Thirty-one per cent of the known diabetics ($N$ = 12) reported that they had received dietary advice since diagnosis.

Of the anthropometric measurements taken, the only significant gender-related differences between diabetic and non-diabetic subjects was a higher mean BMI in male diabetics and a higher mean WHR in female diabetics (Table II). Mean fasting and 2-hour plasma glucose values for diabetic and non-diabetic subjects are shown in Table II.

**Table I. Prevalence of diabetes and IGT**

| | Diabetes | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Previously diagnosed* | | | Undiagnosed | | | Total | | | IGT† | | |
| | % | 95% CI | *N* | % | 95% CI | *N* | % | 95% CI | *N* | % | 95% CI | *N* |
| Men (*N* = 85) | | | | | | | | | | | | |
| Total | 16.2 | 8.3 - 24.1 | 14 | 9.4 | 3.1 - 15.6 | 8 | 25.7 | 16.4 - 35.0 | 22 | 23.7 | 13.7 - 33.7 | 17 |
| Women (*N* = 95) | | | | | | | | | | | | |
| Total | 25.0 | 19.0 - 31.0 | 24 | 5.3 | 2.3 - 8.3 | 5 | 30.3 | 20.9 - 39.7 | 29 | 9.8 | 2.9 - 16.7 | 7 |
| Population estimates adjusted for design | 22.0 | 15.6 - 28.4 | | 6.7 | 3.0 - 10.4 | | 28.7 | 21.7 - 35.7 | | 15.0 | 9.2 - 20.8 | |

* Self-reported diabetes treated with insulin/oral hypoglycaemic agents **or** self-reported diabetes, not on medication and validated by an OGTT.
† Subjects who were not diagnosed currently on drug therapy, and who underwent a glucose tolerance test (*N* = 142).

**Table II. Anthropometric characteristics and plasma glucose values of diabetic v. non-diabetic subjects (mean ± SD)**

| | Diabetic | *N* | Non-diabetic | *N* | Total | *N* |
|---|---|---|---|---|---|---|
| Age (yrs) | | | | | | |
| Men | 75.4 ± 5.4 | 22 | 73.3 ± 5.7 | 63 | 73.8 ± 5.6 | 85 |
| Women | 72.5 ± 5.2 | 29 | 74.4 ± 6.2 | 65 | 73.8 ± 5.9 | 94 |
| Weight (kg) | | | | | | |
| Men | 70.6 ± 11.4 | 22 | 63.9 ± 14.6 | 62 | 65.6 ± 13.9 | 84 |
| Women | 70.1 ± 11.5 | 29 | 64.5 ± 13.2 | 65 | 66.3 ± 12.7 | 94 |
| BMI (kg/m²) | | | | | | |
| Men | 26.9 ± 3.6 | 22 | 23.6 ± 5.2* | 62 | 24.5 ± 4.8 | 84 |
| Women | 30.0 ± 5.4 | 29 | 28.6 ± 5.9 | 65 | 29.0 ± 5.7 | 94 |
| Waist/hip ratio | | | | | | |
| Men | 0.97 ± 0.04 | 22 | 0.95 ± 0.07 | 63 | 0.96 ± 0.06 | 85 |
| Women | 0.98 ± 0.06 | 29 | 0.93 ± 0.07† | 66 | 0.95 ± 0.06 | 95 |
| Fasting plasma glucose (mmol/l) | | | | | | |
| Men | 9.9 ± 5.1 | 22 | 5.6 ± 0.7† | 62 | 6.7 ± 2.6 | 84 |
| Women | 9.1 ± 4.2 | 29 | 5.5 ± 0.8† | 65 | 6.6 ± 2.4 | 94 |
| 2-hour plasma glucose (mmol/l) | | | | | | |
| Men | 14.4 ± 3.6 | 10 | 6.5 ± 2.1† | 62 | 7.6 ± 2.4 | 72 |
| Women | 16.1 ± 5.5 | 8 | 6.3 ± 1.5† | 65 | 7.4 ± 2.2 | 73 |

* $P < 0.05$.
† $P < 0.005$; 2-sample *t*-test between diabetic and non-diabetic subjects.

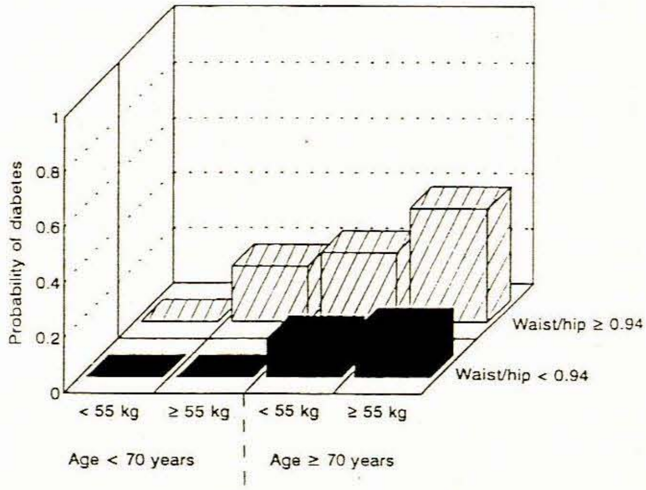


**Fig. 2. Probability of diabetes, according to risk factor profiles by age — men.**

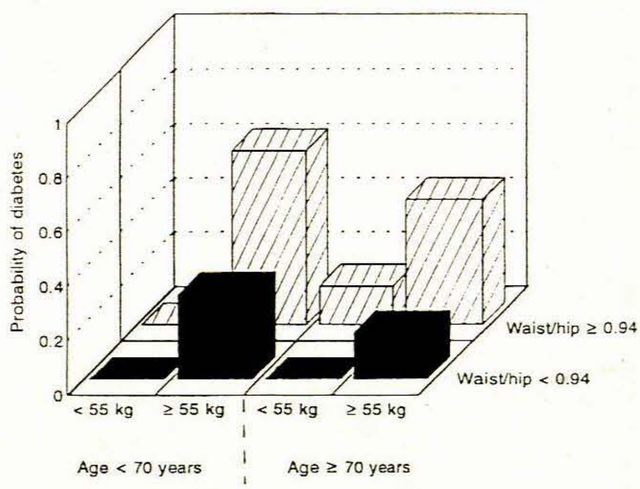


**Fig. 3. Probability of diabetes, according to risk factor profiles by age — women.**

Information obtained from the subjects on the family history of diabetes was unreliable and therefore excluded from the analyses. The stepwise regression modelling identified WHR and body mass as the only variables significantly associated with diabetes in the presence of the confounding variables of age and sex (Table III). In the next stage of the modelling, the following cut-off points were implemented for the three continuous variables: 70 years for age; 55 kg for body mass; and 0.94 for WHR. The risk factor was considered present if the value exceeded or equalled the cut-off points. Age and sex were kept in the model as confounders, together with a sex-age interaction term. The likelihood ratio test for the goodness of fit of the model, reported in Table III, is 4.4 with 10 degrees of freedom, which indicates a good fit. The observed and predicted probabilities for the different combinations were calculated; the observed probabilities, according to age, sex, waist/hip ratio and body mass, are shown in Figs 2 and 3. Based on a combination of the observed and predicted values, three risk groups could be identified: low (probability of diabetes < 0.1); moderate (probability 0.1 - 0.35); high (probability ⩾ 0.35). Women, irrespective of age, with a WHR ⩾ 0.94 and body mass ⩾ 55 kg fall within the high-risk group, as do men aged over 70 years with the same risk profile.

**Table III. Estimated logistic regression parameters of significant risk factors associated with diabetes**

| Variable | Parameter estimate | Standard error | *P*-value |
|---|---|---|---|
| Intercept | 1.819 | 0.377 | < 0.001 |
| Body mass | 0.744 | 0.326 | 0.022 |
| Waist/hip | 0.653 | 0.198 | 0.001 |
| Sex | 0.515 | 0.245 | 0.035 |
| Age | 0.180 | 0.241 | 0.455 |
| Sex * age | 0.487 | 0.242 | 0.044 |

# Discussion

The study population is thought to be representative of non-institutionalised coloured people aged 65 years and older in Cape Town; the study area is occupied by 45% of the older coloured population of Cape Town and 17% of the older coloured population of the country. The prevalence of diabetes found in this study is among the highest in elderly populations worldwide[9-20] and was similar to that found in older South African Indians[19] and Mauritian Creoles.[18] Given that the prevalence of undiagnosed diabetes is about equal to that of diagnosed diabetes in the large American NHANES II study,[14] the finding that only one-quarter of the diabetic subjects were previously undiagnosed in the present study indicates that the utilisation of health services was satisfactory (at least with regard to screening for the disease).

Midthjell *et al.*[21] have shown that the collection of information for epidemiological purposes by questionnaire method is reliable in the case of a well-defined disease such as diabetes. Despite this, two-thirds of the subjects who reported being diabetic but were not being treated for the condition would have been falsely classified as diabetic by self-report methods alone. This finding indicates the importance of validating self-reported methods in older subjects who are not taking anti-diabetic medication; this requires the administration of an OGTT if medical records are not available.

Available evidence suggests that the prevalence of diabetes in a population may be determined both by underlying genetic susceptibility and by the extent to which individuals are exposed to various environmental factors.[19] Data relating to the family history of diabetes in this sample of older adults were unreliable, but it is of interest that Jackson and colleagues found similar prevalences of diabetes in older coloureds, Malays and Indians in Cape Town,[3,5] which may suggest a similar genetic predisposition to the disease in these groups.

It is important to identify modifiable environmental risk factors associated with diabetes in order to develop preventive strategies. In this cross-sectional study, body mass and WHR were the only significant risk factors for diabetes. The lack of an association with BMI, but not body mass, suggests problems in the estimation of height in the elderly. The measurement of height in older people may be inaccurate because of the problems of kyphosis, vertebral collapse and loss of disc height. Further, BMI may not be a valid indicator of obesity in older adults, because of an internalisation and centralisation of body fat that occurs with ageing.[22] An additional confounder is that many subjects lose weight after the diagnosis of diabetes,[23] almost half of the known diabetics in the present study had been diagnosed within the previous 2 years.

Age modifies the effect of sex on the probability of diabetes in this sample. For men, the association between body mass, WHR and diabetes probability appears to be cumulative and increases with age; however, in the case of the women, subjects younger than 70 years in whom the risk factors are present have the highest probability of developing diabetes. It is tempting to speculate that coloured women present earlier with the disease than men. This is substantiated by the comparatively higher prevalence of IGT and correspondingly lower prevalence of diabetes in the men. The greater risk factor exposure in women may predispose them to earlier diabetes-related mortality than in men. The women in the sample had a high prevalence of android obesity, assessed by BMI indicators, percentage body fat and WHR, which may be attributed, at least partially, to their low levels of physical activity.[24]

Of the other risk factors investigated, neither physical activity nor alcohol intake were associated with diabetes in this study. The difficulty of measuring physical activity with any degree of accuracy in older people who are no longer employed, together with the small number of individuals who fell into the most active categories, may have resulted in the lack of an association in this sample. Similarly, the lack of an association between alcohol intake and diabetes may be due to an inaccurate assessment of alcohol consumption.

In view of the poor prognostic significance of diabetes in the elderly,[25,26] the high prevalence of diabetes identified in this study indicates a need for routine screening in older coloured people during visits to primary health care facilities. The potential increase in the number of diagnosed diabetics resulting from widespread screening will place a burden on the already stretched health care resources. The implementation of cost-effective strategies to manage the disease, particularly in the light of the more than threefold predicted increase in the proportion of people aged 65+ years in the coloured population over the next four decades,[27] is clearly important. In this context, it is of concern that the majority of known diabetics had not received dietary instruction, which comprises the first step in diabetes management. In addition, a number of subjects appeared confused or misinformed about their diagnosis.

In conclusion, the prevalence of NIDDM in this sample of apparently healthy older coloured South Africans in urban Cape Town was high. Strategies to identify diabetes and manage the disease effectively in this age group are strongly recommended.

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