Prevalence of diabetes mellitus in the rural southern Free State

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Abstract

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Background: A worldwide increase in the prevalence of diabetes mellitus (DM) has been reported and an even further increase is expected as a result of lifestyle changes. The objectives of this study were to determine the prevalence of DM in the rural southern Free State and to investigate the contribution of risk factors such as age, physical activity, body mass index (BMI), waist-to-hip ratio and waist circumference to the development of impaired fasting glucose (IFG) or DM.

Methods: Fasting venous plasma glucose (FVPG) levels were obtained from a total of 552 participants from Springfontein (n = 195), Trompsburg (n = 162) and Philippolis (n = 180). Participants were between 25 and 64 years of age, with 28.1% male (mean age 47.3 years) and 71.9% female (mean age 46 years). Anthropometric status was determined using standardised techniques. Levels of physical activity were determined using a 24-hour recall of physical activity as well as frequency of performing certain activities. Relative risks (RR) as well as 95% confidence intervals (95% CI) were used to distinguish significant risk factors for having IFG or DM.

Results: In the study population the prevalence of DM was 7.6% (5.2% in men and 8.6% in women) and that of IFG was 6.3% (4.5% in men and 7.1% in women). The majority of nondiabetic (34%), IFG (55%) and DM (61%) participants were between the ages of 51 and 60 years. Age was found to be a statistically significant risk factor for having IFG or DM in participants older than 40 years of age (RR 2.3; 95% CI [1.22; 4.34]). Crude measurements (not age- and gender-adjusted) of waist circumference (RR 3.23; 95% CI [1.82; 5.74]), BMI (RR 2.32; 95% CI [1.43; 3.78]) and waist-to-hip ratio (RR 2.51; 95% CI [1.55; 4.07]) were statistically significant risk factors for having IFG or DM. Physical inactivity in men ≥ 40 years was also a statistically significant risk factor (RR 3.23; 95% CI [1.15; 9.05]) for having IFG or DM.

Conclusions: In this study, 37.5% of diabetics were newly discovered. A high waist circumference, BMI and waist-to-hip-ratio were associated with an increased risk for developing IFG or DM, with a high waist circumference being the most significant general risk factor. Physically inactive men (≥ 40 years) were also at a higher risk of having IFG or DM. Follow-up FVPG and glucose tolerance tests should be performed on participants in the IFG group. A need for intervention regarding the identification and treatment of DM in these rural areas has been identified.

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Introduction

The rising prevalence of diabetes mellitus (DM) makes it an ever-increasing contributor to morbidity, premature mortality and health care costs.[1] In 2000, the prevalence of DM among all age groups worldwide was estimated at 2.8% and projected to be 4.4% by 2030.[2] In 2003, the International Diabetes Federation (IDF) reported the prevalence of DM to be 3.4% of 24 million South Africans between the ages of 20 and 79 years, with an expected increase to 3.9% by 2025.[3]

Data from South Africa show estimates of type 2 DM varying between 3% and 28.7%.[4] The highest prevalence was found among the Indian community of Durban (13%)[5] and the elderly coloured community of Cape Town (28.7%).[6]

Risk factors for developing DM include increasing age, acculturation, urbanisation, obesity, upper segment fat distribution and physical inactivity.[1] Waist circumference and body mass index (BMI) were significantly higher and physical activity significantly lower in type 2 DM individuals compared to nondiabetics in a Cape Town settlement.[7] Figures from the South African Demographics and Health Survey published in 2002 showed that 29.2% of men were overweight or obese (BMI ≥ 25) compared to 56.6% of women.[8]

Impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) are both intermediate categories of glycaemia that fall short of the diagnosis of DM but indicate an increased risk for developing DM. These patients are in an advanced stage of developing DM (type 2 DM) and their pancreatic secretion can no longer fully compensate for their insulin resistance.[9] A comparison drawn between the prevalence of DM and IGT[10] in urban areas (Cape Town, Durban and Mangaung)[7,11,12] and a semi-rural area (Qwaqwa) in the Free State[12,13] showed a higher prevalence of IGT relative to DM in Mangaung and Qwaqwa, compared to Durban and Cape Town. This could indicate that the prevalence of DM was likely to increase in the Mangaung and Qwaqwa areas.[10]

To date, the prevalence of DM in the rural southern Free State has not been investigated. This study seeks to determine the prevalence of DM, and to investigate the contribution of risk factors such as age, physical activity, BMI, waist-to-hip ratio and waist circumference, to the development of IFG or DM in this area.

Methods

In a cross-sectional study conducted in March 2007, 499 black and coloured households (n = 658) from Springfontein (36.3%), Trompsburg (30.1%) and Philippolis (33.5%) (all more than 100 km from urban Bloemfontein) participated in the study. Permission to undertake the study was obtained from the Ethics Committee of the Faculty of Health Sciences at the University of the Free State, the Department of Health and local municipalities. Before data collection, all households were visited by trained fieldworkers and informed written consent to participate was obtained in the language of choice. Participants were reminded to fast before intervention. All volunteers between the ages of 25 and 64 years were eligible to participate.

Socio-demographic and household food security questionnaires were completed for each household. Individual questionnaires included reported health status, dietary intake and physical activity. All participants underwent a medical examination, anthropometric evaluation and blood sampling. All questionnaires were completed in an interview with trained students from the Department of Nutrition and Dietetics at the University of the Free State under the supervision of lecturers. Where necessary, Sotho, Tswana and Xhosa interpreters assisted. Blood samples were drawn and medical examinations performed by medical doctors from the departments of Chemical Pathology and Basic Medical Sciences. Blood samples were only obtained if participants confirmed fasting and a meal was supplied to each participant after blood had been drawn. Reliability of responses to questionnaires was determined in a separate reliability study in which questionnaires were repeated in 10% of participants. If answers to questions differed by 20% or more, the question was considered unreliable and the data not reported.

Blood specimens for the measurement of fasting venous plasma glucose (FVPG) were drawn into fluoride tubes. Samples were centrifuged within four hours and FVPG was measured immediately using the glucose oxidase method on a Beckman LX20® auto-analyser. DM and IGT were defined according to the revised 2006 World Health Organization (WHO) classification and diagnostic criteria.[14] Glucose values could therefore be divided into three groups, namely a nondiabetic group (≤ 6 mmol/L), an IFG group (6.1–6.9 mmol/L) and a DM group (≥ 7.0 mmol/L).

Physical activity levels (PAL) were classified into four different categories, namely sedentary (PAL value 1.00–1.39), low active (PAL value 1.40–1.59), active (PAL value 1.60–1.89) and very active (PAL value 1.90–2.50).[15]

The height and weight of participants were measured in an examination gown without shoes. A Seca® (Germany) digital electronic foot scale was used for weight reading. BMI was calculated by dividing weight (kg) by height squared (m^2). Weight was defined as underweight (BMI < 18.5 kg/m^2), normal (BMI 18.5–24.9 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2) and obese (BMI > 30.0 kg/m^2).[16] Waist-to-hip ratio is the circumference of the waist (cm) divided by the circumference of the hip (cm). Cut-off point values for men were > 0.90 and for women > 0.85.[16] Waist circumference was measured to the nearest one millimeter using a measuring tape, with the individual standing relaxed in a single layer of clothing, at the smallest diameter between the xiphisternum and the umbilicus on normal expiration.[1] Cut-off point values (Europids) for men at ≥ 94 cm and for women ≥ 80 cm were used.[17]

Descriptive statistics were used to analyse the data, which are represented in the form of histograms and tables. Relative risks (RR) as well as 95% confidence intervals (95% CI) were calculated.[18]

Results

Of 658 participants, blood was drawn from 572 of whom 552 were fasting. These participants were aged between 25 and 64 years and fit for analysis. Of the participants, 28.1% were male (mean age 47.3 years) and 71.9% female (mean age 46 years). The overall prevalence of DM was 7.6%, 5.2% in men and 8.6% in women. Of all DM participants, 62.5% were known to be diabetic; therefore, 37.5% were newly discovered. The prevalence of IFG was 6.3% (4.5% in men and 7.1% in women). The majority of nondiabetic (34%), IFG (55%) and DM (61%) participants were between the ages of 51 and 60 years.

The women and men in this study had a mean PAL of 1.91 (SD 0.34) and 1.86 (SD 0.54), respectively. The sedentary PAL recorded was 5.3% in women and 18.6% in men. A higher percentage of men fell in the very active category (44.2%) than women (36.5%). Results are shown in Table I. Women and men in this study had a mean BMI of 28.9 kg/m^2 (SD 8.6) and 21.5 kg/m^2 (SD 5.3), respectively. Twenty-three per cent of women were overweight and 41.6% were obese, compared to 14.6% and 7.5% of men respectively. In contrast, 34% of men and 9.5% of women were underweight (see Table I). The distribution of BMI with age was equal in all weight groups. The prevalence of overweight and obesity was the highest (39.6% and 37.2%, respectively) in participants in the age group 51 to 60 years.

Table I: Physical activity levels and body mass indices of male and female participants

	Percentage of participants	
	Male (n = 155)	**Female (n = 397)**
PAL		
Sedentary	18.6	5.3
Low active	17.3	18.4
Active	19.9	39.7
Very active	44.2	36.5
BMI (kg/m^2)		
Underweight (< 18.5)	34.0	9.5
Normal (18.5–24.9)	43.8	25.9
Overweight (25.0–29.9)	14.6	23.1
Obese (> 30)	7.6	41.6

The analysis of the risk factors (relative risk and 95% CI) for the development of IFG or DM is shown in Table II. Participants ≥ 40 years had a statistically significantly higher risk of developing IFG or DM, while no significant gender differences for the development of IFG or DM were found. In general (crude sample, not age- and gender-adjusted), a statistically significant risk of having IFG or DM was found in participants with waist circumferences and waist-to-hip ratios above the cut-off point values, as well as in obese participants. The risk of having IFG or DM was also significantly higher in men and women ≥ 40 years with

Figure 1: Waist-to-hip ratio and waist circumference of male and female participants as distributed below and above the cut-off point values. Waist-to-hip ratio cut-off point value for men = 0.90 and women = 0.85. Waist circumference cut-off point value for men = 94 cm and women = 80 cm.

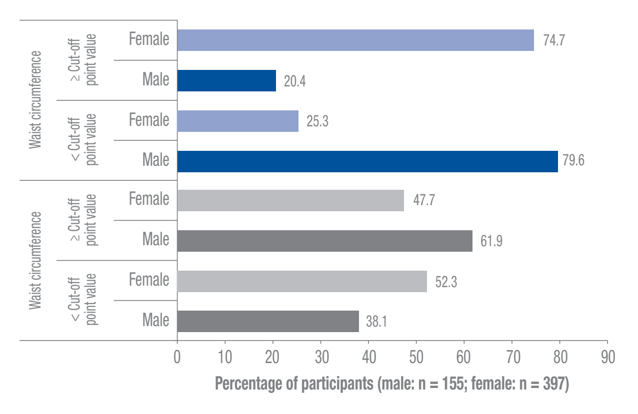

Table II: Analysis of risk factors for IFG or DM

Risk factor	RR	95% CI
Age*	2.30	[1.22; 4.34]†
Gender		
Male versus female	0.63	[0.37; 1.06]
Waist circumference		
Male* ≥ 94 cm	4.13	[1.65; 10.33]†
Female* ≥ 80 cm	2.91	[1.09; 7.73]†
Crude‡	3.23	[1.82; 5.74]†
BMI (kg/m²)		
Obese male*	5.00	[1.87; 13.39]†
Obese female*	1.66	[0.92; 2.97]
Crude‡	2.32	[1.43; 3.78]†
Waist-to-hip ratio		
Male* ≥ 0.9	3.17	[0.75; 13.36]
Female* ≥ 0.85	2.30	[1.30; 4.07]†
Crude‡	2.51	[1.55; 4.07]†
PAL (inactivity)		
Male* ≤ 1.59	3.23	[1.15; 9.05]†
Female* ≤ 1.59	1.23	[0.70; 2.15]
Crude‡	1.42	[0.91; 2.22]

* Participants ≥ 40 years of age
† Statistically significant
‡ Crude = not age- and gender-adjusted

waist circumferences above the cut-off point values. The same tendency was observed in obese men, men with a PAL ≤ 1.59 (low activity) and women with a waist-to-hip ratio ≥ 0.85.

Discussion

More women than men participated in this study, most probably because more men are employed as labourers in the vicinity.

The prevalence of DM tends to increase with the percentage of life spent in a city, as reported by a previous study.[19] In an investigation focussing on migrant labour and the movement of family members between the city and rural areas,[10] multivariate analysis indicated that age, urbanisation, upper segment fat distribution and obesity were all independent risk factors for type 2 DM. Gender, alcohol intake, family history and physical activity were not associated with type 2 DM.[10]

In previous studies undertaken in Qwaqwa and Mangaung (semi-urban and urban areas, respectively), the age-standardised prevalence of IGT was higher (10.7% and 12.2%, respectively) relative to the age-standardised prevalence of DM (4.8% and 6.0%, respectively).[10] As was pointed out above, this could indicate that the prevalence of DM was likely to increase in these two areas. In our (rural) study, the crude prevalence of DM or IFG was 7.6% and 6.3%, respectively. The smaller differences between the prevalence of DM and IFG could indicate that the prevalence of DM would probably not increase to the same extent in this area as in the Qwaqwa and Mangaung areas.

The majority of nondiabetic (34%), IFG (55%) and DM (61%) participants were between 51 and 60 years of age. It is generally known that type 2 DM usually develops at an age ≥ 40 years. For this reason it was decided to measure the RR as well as the statistical significance (95% CI) for risk factors for having IGF or DM in crude (not age- and gender-adjusted) measurements as well as participants ≥ 40 years. We concluded that age is a statistically significant risk factor for having IFG or DM in participants ≥ 40 years (RR 2.3; 95% CI [1.22; 4.34]).

In 100 metropolitan areas in the United States of America the prevalence of obesity ranged from 13.1 to 30.0% and that of type 2 DM from 3.3 to 9.2%. Significant differences in the prevalence of obesity and type 2 DM were observed with weight management.[21,22]

Low energy expenditure has been found to be a risk factor for the development of type 2 DM in a peri-urban community in South Africa.[1] In our study, the mean PAL of men (PAL 1.86) was very similar to that of women (PAL 1.91). More men than women were categorised as sedentary, while there were also more men than women in the highly active category (see Table I). Physical inactivity levels below cut-off point values for men ≥ 40 years were a statistically significant risk factor for having IFG or DM (Table I).

The mean BMI for women was 28.9 kg/m² and for men 21.5 kg/m². The same tendency had been reported previously,[1] but the difference between the mean BMI for men and women in our study was more than double the difference previously described. Although more women than men were overweight and obese (see Figure 1), the BMI for crude values as well as for men ≥ 40 years was found to be a statistically significant risk factor for having IFG or DM (see Table II).

The mean waist-to-hip ratios of male and female participants (0.88 and 0.85, respectively) were similar to recommended cut-off point values (0.90 and 0.85 respectively).[16] The mean waist-to-hip ratios for crude values as well as above cut-off point values for women ≥ 40 years were statistically significant risk factors for having IFG or DM (Table II).

Relevant cut-off point values for waist circumference in different ethnic groups in South Africans have not been determined. In South African studies, the cut-off point values for male and female Europids (≥ 94 cm and ≥ 80 cm, respectively) are used, which differ from studies involving USA populations in which cut-point values for men and women are even higher (≥ 102 cm and ≥ 88 cm, respectively).[17] In a previous South African study, the mean waist circumference of men and women were found to be similar (82.7 cm and 82.8 cm, respectively).[1] The male and female participants in our study had a mean waist circumference of 81.6 cm and 91.8 cm, respectively. Above cut-off point values give an indication of pronounced visceral fat distribution in female participants (see Figure 1). Waist circumference for crude (not age- and gender-adjusted) measurements (RR 3.23; 95% CI [1.82; 5.74]) as well as above cut-off point values for men and women ≥ 40 years (RR 4.13; 95% CI [1.65; 10.22] and RR 2.91; 95% CI [1.09; 7.73], respectively) were found to be statistically significant risk factors for having IFG or DM (see Table II). Waist circumference as an indicator of visceral fat distribution is therefore the most significant general risk factor for having IFG or DM.

BMI was significantly higher and physical activity significantly lower in type 2 DM individuals compared to nondiabetics in a Cape Town settlement.[7] In comparison to the South African Demographic and Health Survey published in 2002, which showed that 29.2% of men and 56.6% of women were overweight or obese (BMI ≥ 25),[8] the results of this study showed that crude (not age- and gender-adjusted) measurements of BMI (RR 2.32; 95% CI [1.43; 3.78]) and waist-to-hip ratio (RR 2.51; 95% CI [1.55; 4.07]) were significant risk factors for having IFG or DM. The same observation was also made in the BMI (RR 5.00; 95% CI [1.87; 13.39]) of obese men and the PAL (RR 3.23; 95% CI [1.15; 9.05]) of inactive men, as well as the waist-to-hip ratio (RR 2.3; 95% CI [1.30; 4.07]) of women ≥ 40 years.

As previously described, it was observed that more women than men tend to be obese,[8] but the risk for men to have IFG or DM is higher than for women. The underlying mechanisms are unknown, but oestrogen could act directly (via islet steroid receptors) or indirectly (via oestrogen-induced changes in other hormones) on the pancreas. This might consequently affect the pancreas directly or favourably modify glucose homeostasis to reduce the risk for DM in women.[20] More men than women were categorised as sedentary, and this may also contribute to the increased risk for IFG or DM in men.

An urgent need for interventions to address the low identification and inadequate treatment of DM in rural areas has been identified. In this study, 37.5% of diabetics were newly discovered. Waist circumference, BMI and waist-to-hip ratio were significant risk factors for developing IGT or DM with waist circumference being the most significant general risk factor. Physically inactive men ≥ 40 years were also at a higher risk of having IFG or DM. Cut-off point values for waist circumference in South African populations need to be developed. Follow-up FVPG and glucose tolerance tests should be performed on participants in the IFG group and the population should be screened for having IFG or DM. The influence of alcohol intake, family history and diet as nonmodifiable risk factors for having IFG or DM will be investigated in due course. The results of this study will be compared to those of an urban study planned for 2009 to determine the influence of urbanisation on the prevalence of IGT and DM.

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