Pakistan National Diabetes Survey: Prevalence of Glucose Intolerance and Associated Factors in Shikarpur, Sindh Province

A.S. Shera[a], G. Rafique[a], I.A. Khwaja[a], J. Ara[a], S. Baqai[a], H. King[b]

[a]Diabetic Association of Pakistan and WHO Collaborating Centre for Diabetes, Karachi, Pakistan, and [b]Division of Noncommunicable Diseases, World Health Organization, Geneva, Switzerland

The prevalence of diabetes mellitus and impaired glucose tolerance (IGT) and their relationship to age and obesity was estimated in the rural town of Shikarpur in Sindh Province, Pakistan by a population-based survey in 1994. Oral glucose tolerance tests were performed in a stratified random sample of 967 adults (387 men, 580 women) aged 25 years and above. The diagnoses of diabetes and IGT were made on the basis of WHO criteria. The response rate was 71 % for men and 80 % for women. The prevalence of diabetes was 16.2 % (9.0 % known, 7.2 % newly diagnosed) in men, and 11.7 % (6.3 % known, 5.3 % newly diagnosed) in women. The prevalence rose with age to a peak of 30 % and 21 % in 65–74 year-old men and women respectively. IGT was detected in 8.2 % of men and 14.3 % of women. Thus, total glucose intolerance (diabetes and IGT combined) was present in 25 % of subjects examined. These results indicate that glucose intolerance in South Asians can no longer be regarded as a problem confined to migrant communities. Of the 72 subjects previously known to have diabetes, none was using insulin treatment, but 57 (79 %) took oral hypoglycaemic agents. Central obesity and positive family history were strongly associated with diabetes, as was prevalence of hypertension. The association with central obesity was greater for women than for men, and suggests important, modifiable risk factor(s) related to lifestyle.

KEY WORDS **Diabetes mellitus Impaired glucose tolerance Obesity Prevalence Asians**

Introduction

Epidemiological studies in different populations around the world have shown marked variation in the prevalence of non-insulin-dependent (Type 2) diabetes mellitus (NIDDM) between different ethnic groups.[1,2] Among those groups with high prevalence are migrants from the Indian subcontinent.[3] Several studies in migrant Asian Indian populations in Fiji,[4] South Africa,[5] Tanzania,[6] Mauritius[7] and the United Kingdom[8,9] have shown a much higher prevalence of NIDDM in these communities than has been observed in the Indian subcontinent.[10] Although a number of studies have been done on the indigenous population in the Indian subcontinent,[11] very few have used diagnostic criteria recommended by the World Health Organization,[12] hindering comparison. This report documents the first phase of a national survey of diabetes and its risk factors in Pakistan, which was conducted in a rural area of Sindh Province.

Correspondence to: Professor A. Samad Shera, Diabetic Association of Pakistan, 5-E/3 Nazimabad, Karachi 74600, Pakistan

Methods

Background

Shikarpur is a town in the north of Sindh Province, Pakistan, with a population of 80 000 persons of low–medium socio-economic status. Most of the inhabitants are Sindhis and are long-established residents of the area. A small proportion of the population (about 2 %) are Mohajirs, who migrated to Pakistan at the time of partition of the Indian sub-continent in 1947. Thus, Shikarpur represents a relatively stable, rural community with a traditional lifestyle, in which almost all people have been resident for more than 15 years. Ninety percent of the population is of the Muslim religious faith.

Study Population Selection Criteria

The survey was carried out in two phases, in February and March 1994. Prior to the first phase of the survey, a team of survey officers marked households for inclusion in the survey. A stratified random sample of households from 11 blocks was selected (every seventh house was included). Names of all inhabitants aged 25 years and above were noted for each household. A second survey

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team consisting of the survey officers and local teachers revisited every household, providing the members with detailed information about the survey and encouraging them to take part. Printed leaflets which emphasized the significance and value of the exercise were distributed.

Screening Procedure

All subjects were asked to attend the survey site on a specified day in the morning, after a 10–14 h overnight fast. After registration, a fasting blood sample was drawn and each subject, with the exception of those with previously diagnosed diabetes, received 82.5 g of glucose monohydrate (equivalent to 75 g anhydrous glucose) dissolved in 250 ml water, which was drunk within a period of 5 min.

Height, weight and waist-hip ratio (WHR) were then recorded. Standing height and weight were measured with subjects in light clothing and without shoes. Height was recorded to the nearest cm and weight to the nearest 0.1 kg. Weighing scales were standardized daily using standard weights of 20 kg and 70 kg. Waist circumference was measured to the nearest cm, at the mid-point between the iliac crest and the lower margin of the ribs, with the subject standing and breathing normally. In subjects with a very pendulous abdomen, the waist circumference was measured at the midpoint between the iliac crest and the lower margins of the ribs laterally, with slight slanting of the measuring tape to the umbilicus in front. Hip circumference was measured to the nearest cm at the level of the maximum circumference around the buttocks posteriorly, and at the symphysis pubis anteriorly.

The subjects were interviewed by a physician, who completed a standard questionnaire. Family history of diabetes was regarded as positive if NIDDM was present in a first degree relative. Subjects not known to be diabetic remained at the examination centre until the second sample of blood glucose was taken, exactly 2 h after commencing the glucose drink. Every day, the non-responders for that particular day were contacted by the survey team in the evening and given a new appointment.

Blood Samples

All blood samples were collected in fluoride tubes, centrifuged immediately and refrigerated. After the sample collection was completed the plasma was transferred to separate tubes, frozen at −20°C until analysis later on the same day. Plasma glucose was determined by the glucose oxidase method using a Hitachi 705 analyser in a laboratory which takes its quality assurance through CAP (College of American Pathologists) survey programme. Every 20th sample was tested a second time to assess the coefficient of correlation between duplicate readings which was found to be 0.993. The coefficient of variation for measurements was 1.0 %.

Classification of Abnormal Glucose Tolerance

Diabetes was diagnosed according to the recommendations of a WHO Study Group,[12] that is, a 2-h plasma glucose concentration of 11.1 mmol l^{-1} or greater. Impaired glucose tolerance (IGT) was classified as 2-h plasma glucose concentration 7.8 mmol l^{-1} or greater, but less than 11.1 mmol l^{-1}. Diabetes was considered to be already present if the diagnosis of diabetes had been made previously by a physician.

Statistical Methods

Data analysis was conducted with the statistical package 'Stat Graphic version 3'. Body mass index (BMI) was calculated as weight/height^2 (kg m^{-2}) and WHR as the waist girth in cm/hip girth in cm. Obesity was defined as BMI $\geq$27 kg m^{-2} for men and $\geq$25 kg m^{-2} for women. Central obesity was defined as WHR $\geq$0.95 in men and $\geq$0.85 in women. The chi-squared test was used to measure the association among the different variables. The results for continuous variables are given in the form of averages, standard deviations, and their 95 % confidence intervals. The significance between two group means was assessed by Z test. The relative risk was obtained by comparing BMI, WHR, and positive family history of diabetes, in both sexes separately.

Results

A total of 967 subjects were examined during the two phases of the survey representing a response of 71 % for males and 80 % for females. The lower response rate in males was due to their inability to attend on working days. The lower total number of males in the survey sample was due to many men in the community working regularly in larger cities, and thus being away from their homes most of the time. The most common reasons given by the non-responders for not participating in survey was that they were healthy and did not require a medical examination, or that they did not want to give blood samples. The age distribution of males and females is shown in Figure 1. Females can be seen to be relatively over-represented in the younger age groups.

Prevalence of Abnormal Glucose Tolerance

The prevalence of diabetes and IGT by gender is shown in Table 1. Prevalence of previously diagnosed NIDDM was 6.3 % in women and 9.0 % in men. Newly diagnosed NIDDM was detected in 5.3 % of women and 7.2 % of men. Thus, 12 % of women and 16 % of men were diabetic. In addition, 14.2 % of women and 8.2 % of men displayed IGT. Thus, one-quarter of all subjects examined were glucose intolerant.

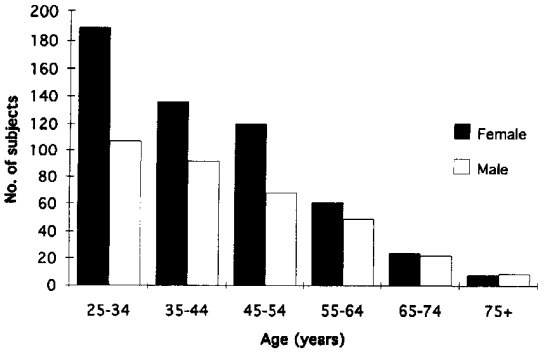

Figure 1. Age structure of the survey population

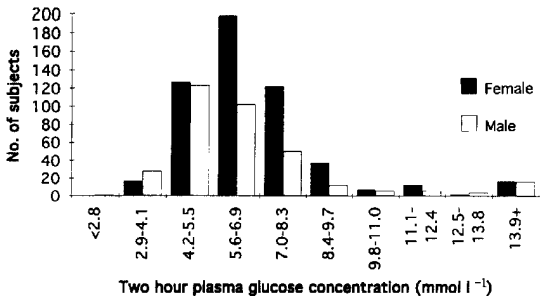

Figure 2. Distribution of 2 h plasma glucose concentration (mmol l^{-1}). Note that 72 subjects with previously known diabetes are excluded

Table 1. Number of subjects, and prevalence of diabetes and impaired glucose intolerance (IGT), by age and sex in Shikarpur, Pakistan, 1994

Age (yr)	*n*	Total number (%) with diabetes	Number of new cases of diabetes	Number with IGT (%)
Women				
25–34	191	3 (1.5)	1	17 (8.9)
35–44	144	20 (13.8)	13	22 (15.2)
45–54	134	25 (18.6)	11	19 (14.1)
55–64	73	14 (19.1)	5	13 (17.8)
65–74	29	6 (20.6)	1	9 (31.0)
75+	9	0	0	3 (33.3)
All ages	580	68 (11.6)	31	83 (14.3)
Men				
25–34	108	5 (4.6)	4	1 (0.9)
35–44	98	13 (13.2)	8	6 (6.1)
45–54	84	20 (23.8)	5	12 (14.2)
55–64	56	15 (26.7)	8	5 (8.9)
65–74	30	9 (30.0)	3	7 (23.3)
75+	11	1 (9.0)	0	1 (9.0)
All ages	387	63 (16.2)	28	32 (8.2)

Prevalence of glucose intolerance increased with advancing age in both sexes, reaching a peak in the 65–74 yr age group: for diabetes, 30 % in men and 21 % in women; for IGT, 31 % in women and 23 % in men. Age-specific prevalence of IGT was higher, and of diabetes was lower for women than for men at almost all ages.

Distribution of 2-h Blood Glucose

The distribution of the 2-h BG concentration (excluding subjects with known diabetes) is shown in Figure 2. The mean (±95 % confidence interval) for 2-h BG was 5.6 ± 0.1 mmol l^{-1} and 5.4 ± 0.1 mmol l^{-1} for women and men, respectively. A significantly higher mode was seen in women (6.9 mmol l^{-1}) compared to men (4.5 mmol l^{-1}, $p < 0.001$). In women, a cluster of subjects occurred at plasma glucose values just greater than 11.1 mmol l^{-1}, which is the diagnostic cut-point between IGT and diabetes. In both sexes, the distribution was skewed to the right.

Pattern of Treatment

Of the persons with previously known diabetes, only 1 % claimed to be taking no treatment, 19 % were treated with diet alone, and 79 % were taking oral hypoglycaemic drugs. None of the subjects was using insulin.

Factors Associated with Glucose Tolerance

Subjects with abnormal glucose tolerance (both IGT and diabetes) were older than those with normal tolerance in both sexes (Table 2). Obesity and high WHRs were notably more prevalent in individuals with IGT and NIDDM than those with normal glucose tolerance. In both sexes high WHR was more closely associated with

Table 2. Means and proportions for selected factors in men and women with normal glucose tolerance, impaired glucose tolerance, and diabetes mellitus. Shikarpur, Pakistan, 1994

Variable	Normal glucose tolerance	Impaired glucose tolerance	Diabetes mellitus
Women			
Number examined	429	83	68
Age (yr)	39 ± 1.2	46 ± 3.2	48 ± 2.4
BMI (kg m^{-2})	24.2 ± 0.5	27.0 ± 1.2[b]	28.5 ± 1.1[c]
WHR	0.90 ± 0.01	1.29 ± 0.36[c]	1.00 ± 0.02[c]
BMI > 25.0 (%)	40.7	63.7[c]	79.4[c]
WHR > 0.85 (%)	72.9	93.7[c]	95.5[c]
F/H of DM (%)	13.5	14.4	41.1[c]
Hypertensive (%)[a]	19	36	53
Men			
Number examined	292	32	63
Age (yr)	42 ± 1.6	53 ± 4.2	51 ± 3.0
BMI (kg m^{-2})	23.7 ± 0.5	25.0 ± 1.4[b]	25.9 ± 1.1[c]
WHR	0.94 ± 0.01	1.00 ± 0.03[c]	1.00 ± 0.02[c]
BMI > 27.0 (%)	19.8	28.1	36.5
WHR > 0.95 (%)	53.7	84.3[c]	79.3[c]
F/H of DM (%)	16.2	28.1[c]	46.0[c]
Hypertensive (%)	15	28	44

Values shown are means or proportions ±95% confidence interval.
BMI, body mass index; WHR, waist-hip ratio; F/H, family history; DM, diabetes mellitus.
[a]Systolic blood pressure ≤140 and/or diastolic blood pressure ≤90 or on antihypertensive therapy.
[b]$p < 0.05$, [c]$p < 0.01$.

diabetes than was high BMI. The relative risk for presence of diabetes in men with BMI ≥ 27 was 1.9 whereas in men with WHR ≥ 0.95 this increased to 2.7. For women, over 90 % of those with IGT or diabetes had WHR > 0.85.

In both sexes, there was a higher prevalence of positive family history of diabetes in subjects with NIDDM than in subjects with normal glucose tolerance (men, 46.0 % vs 16 % and women, 41.1 % vs 14 %). An intermediate proportion of men with IGT had a positive history (28.1 %) whereas in women with IGT it was not different from that seen in the subjects with normal glucose tolerance. The relative risk of being diabetic for subjects with a positive family history of diabetes was increased three fold in both sexes, but the association between positive family history of diabetes and presence of IGT was not significant.

The prevalence of hypertension was closely associated with glucose tolerance status. Approximately one-half of persons with diabetes were also classified as hypertensive, as compared with less than 20 % of subjects with normoglycaemia. An intermediate association was observed for subjects with IGT.

Associations between glucose tolerance ($\log_{10}$ 2-h BG concentration) and the factors of interest were also examined by means of multiple regression analysis. For both men and women, age, central obesity and diastolic blood pressure were significantly and independently associated with glucose tolerance, accounting for some 10 % of the total variation in $\log_{10}$ 2-h BG.

Discussion

This is the first published report of glucose intolerance in Pakistan that uses the field survey methods and diagnostic criteria published by WHO.[13] The overall prevalence of glucose intolerance (IGT and NIDDM) in this study was found to be 25 % in both sexes. This figure was higher than expected, given the rural location of Shikarpur. Non-response by healthy subjects in the workforce may have led to a degree of overestimation, especially in men. However, the prevalence of diabetes was also notably high in women, and the prevalence of total glucose intolerance was the same for both sexes.

Early reports from the Indian subcontinent suggested that diabetes was not a common disorder. Gupta *et al.*[10] found an overall prevalence rate of 2.1 % in India. In the population aged over 15 years of age Ahuja found the prevalence of diabetes (both known and new cases) to be 2.1 % in urban areas and 1.8 % in rural areas.[14] On the other hand, more recent studies by Verma *et al.*[15] and Ramachandran *et al.*[16] have reported higher prevalence rates (3 % known diabetes, and 5 % known and newly diagnosed diabetes, respectively) from India. The most recent information, from Madras, indicates a prevalence of diabetes of 12 % in men and 11 % in women in the age range 30–64 years.[3] These later reports, and the findings from the present study, indicate that either the prevalence was underestimated in India in the past (most earlier studies did not use the standard

glucose tolerance test and some only assessed prevalence of diagnosed diabetes), or that prevalence is rising, or both.

Epidemiological studies of diabetes in migrant South Asian populations have consistently shown a much higher prevalence than in the indigenous population of the host country. In Fiji[4] the prevalence of diabetes in the rural and urban Indian populations was similar (12 % vs 13 % for men, and 11 % in both cases for women) and these were much higher than in the indigenous Melanesian population (1 % vs 4 % for men and 1 % vs 7 % for women). In South Africa[5] the prevalence of diabetes was 11 % in Indians as compared to 4 % in both whites and Africans. In Tanzania[6] the prevalence of diabetes was 7 % (4 % known and 3 % newly diagnosed) in Muslim Indians. In Mauritius[7] Indian Muslims had a prevalence of diabetes of 13 %.

Studies in the United Kingdom have also reported a high prevalence in migrant Asian communities, compared to Europeans. Mather and Keen demonstrated a prevalence of known diabetes in Asians that was 3.8 times higher than that in Europeans in Southall.[8] Simmons *et al.*,[9] in the Coventry diabetes study, noted diabetes in 11 % of Asian men and 8 % of Asian women, compared to 3 % in white men and 4 % in white women. In Leicester[17] the prevalence in Asians was 5 %, which was twice that of white Caucasians. In the most recently reported study[18] prevalence of diabetes in South Asians in London was 19 %, as against 4 % in the Europeans.

In the population of Shikarpur, NIDDM presented at a relatively young age. Prevalence in the range 35–44 years was 14 % in women and 13 % in men. Similar findings have been reported in studies of migrant South Asian communities.[8,9,18] The importance of diabetes in pregnancy should not be overlooked in such communities. Also consistent with many other studies was the strong relationship between increasing age and prevalence of both NIDDM and IGT. In the age group 65–74 years, over one-half of all subjects were glucose intolerant. This may be compared with the 41 % prevalence of diabetes recently reported for subjects aged 55–64 in South India[16] from a study which used a similar protocol to our own.

The treatment pattern of diabetes in this population is of some interest. Of 72 persons previously known to have diabetes, none was taking insulin. This may suggest that the drug is relatively unaffordable or unavailable in this community. However, it is also a popular misconception among Pakistanis that insulin is a dangerous and addictive drug, which should only be used as a last resort. Hence, many patients are unwilling to accept insulin treatment. The high proportion of subjects (79 %) using oral hypoglycaemic agents indicates the potential for cost reduction by improved education and effective dietary and lifestyle modification.

A family history of diabetes, obesity and abdominal fat distribution have been described as major risk factors for glucose intolerance.[19–21] A positive family history was strongly related to diabetes in our study. In subjects with NIDDM, 44 % had a positive family history of diabetes as compared to 15 % in normoglycaemic subjects. Positive family history was also noted in 45 % of migrant Indians in South Africa,[5] and was particularly frequent (55 %) in Muslims. In Tanzania[6] a family history of diabetes was present in 17 % of Indian Muslims above the age of 34 years, and those with positive family history had twice the prevalence of diabetes compared with those with a negative history. A family history was also noted in 47 % of those with diabetes and in 60 % of those with IGT in the South Indian study.[16] In the present study, the association between positive family history and IGT was not significant.

The finding of a stronger association of glucose intolerance with WHR than with BMI in both sexes is consistent with earlier studies reporting that individuals with central obesity have a greater risk of developing diabetes as compared to those with peripheral obesity, irrespective of the body mass index.[20,22,23] Central obesity is also more strongly associated with diabetes in women than men.[18,20] In this study, over 90 % of glucose intolerant women had a high WHR, suggesting an important, modifiable risk factor(s) related to lifestyle in this population.

In this study, there was a marked association between glucose intolerance and hypertension, with evidence of a gradient from normoglycaemia, through IGT, to diabetes. This may recommend a common approach to the prevention and control of these two conditions.

The higher prevalence of IGT in women than in men at almost all ages, together with the higher prevalence of IGT than of diabetes in women, suggests that diabetes may not yet be manifest to its full extent for women, indicating a potential for primary prevention. However, it is evident from this study that diabetes has already emerged as a major threat in the indigenous population in Pakistan.

Taken in the context of the most recent data from India, the findings indicate that glucose intolerance in South Asians can no longer be regarded as a problem confined to migrant populations. If the prevalence estimates for Shikarpur were to apply to the whole of Pakistan, the present number of diabetic subjects in in the country would be 6.4 million, almost one-half of whom are undiagnosed. A further 5 million persons could be expected to exhibit IGT. This indicates the high cost and burden that glucose intolerance now represents to the health care services in Pakistan, and the urgent need for intensified prevention and treatment programmes for diabetes and its severe complications.

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