Distribution and correlates of total impaired fasting glucose in Oman

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توزع وترابط مجمل حالات خلل سكر الدم على الريق في عُمان

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الخلاصة: لتقدير توزُّع مجمل حالات خلل السكر على الريق في عُمان، أجرينا مسحاً مستعرضاً شمل 1968 من السكان و7011 من المقيمين في عُمان عام 2000، وتضمن المسح إجراء مقابلات شخصية والحصول على معطيات ديمغرافية وقياس ضغط الدم وسكر الدم على الريق وكوليسترولِ المصل والوزن والطول ومحيط الخصر والحوض. وقد بلغ عدد الاختبارات المجراة لقياس سكر الدم على الريق 5788 (وتمثل نسبة استجابة 83%) كان معدل انتشار خلل سكر الدم فيها 17.3%، في حين كان معدل الانتشار المصحَّح وفقاً للعمر 20.3%. وكانت العوامل المتصاحبة في التحليل الثنائي العوامل هي التقدُّم في العمر، الذكورة، انخفاض مستوى التعليم، فرط كولسترول الدم، الزواج، البدانة، اختلال نسبة الخصر إلى الحوض، وارتفاع ضغط الدم. ويتبيَّن من الدراسة أن خلل سكر الدم على الريق يُعَدُّ أحد المشكلات الهامة في الصحة العمومية في عُمان؛ وأن رفع مستوى الوعي لدى المجتمع ولدى القائمين على إيتاء الرعاية الصحية بالتثقيف الصحي أمر هام.

ABSTRACT To determine the distribution and correlates of total impaired fasting glucose in Oman, we conducted a cross-sectional survey of 1968 households with 7011 eligible residents in 2000. During face-to-face interviews, demographic data, blood pressure, fasting blood glucose, serum cholesterol, weight, height and waist and hip measurements were obtained. Of 5788 subjects tested for total impaired fasting glucose (response rate: 83%), crude prevalence was 17.3% and age-adjusted prevalence was 20.3%. Associated factors in bivariate analysis were older age, male gender, lower education, hypercholesterolaemia, being married, obesity, abnormal waist to hip ratio and hypertension. Total impaired fasting glucose is a significant public health problem in Oman. Increasing the awareness of health care providers and community through health education is crucial.

Distribution et corrélats de l'intolérance au glucose et de la glycémie à jeun anormale à Oman

RESUME Pour déterminer la distribution et les corrélats de l'intolérance au glucose et de la glycémie à jeun anormale à Oman, nous avons réalisé une enquête transversale auprès de 1968 ménages composés de 7011 résidents éligibles en 2000. Au cours d'entretiens face à face, on a recueilli des données démographiques, effectué des mesures de la pression artérielle, de la glycémie à jeun, du cholestérol sérique, du poids, de la taille, du tour de taille et du tour de hanches. Chez les 5788 sujets testés pour l'intolérance au glucose et la glycémie à jeun anormale (taux de réponse : 83 %), la prévalence brute s'élevait à 17,3 % et la prévalence ajustée selon l'âge était de 20,3 %. Les facteurs associés dans l'analyse bivariée était l'âge plus élevé, le sexe masculin, le niveau d'instruction plus bas, l'hypercholestérolémie, le fait d'être marié, l'obésité, le rapport tour de taille/tour de hanches anormal et l'hypertension. L'intolérance au glucose et la glycémie à jeun anormale représentent un problème important de santé publique à Oman. La sensibilisation des prestataires de soins de santé et de la communauté par l'éducation sanitaire est cruciale.

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Introduction

Social advances in Oman since 1970 have been accompanied by cultural changes, a reduced incidence of communicable diseases, increased life expectancy, changes in nutritional habits and habitual physical activity, and an increased incidence of noncommunicable diseases such as hypertension and diabetes [*1*]. Development of diabetes mellitus, in particular, is associated with increased mortality and a high risk of developing vascular, renal, retinal and neuropathic complications leading to premature disability and death.

In a study from 1 January 1991 to 31 July 1991, adult diabetes in the general population of Oman was surveyed to estimate the prevalence of and associations between diabetes, impaired glucose tolerance, hyperlipidaemia, obesity and hypertension. Using the American Diabetic Association 1997 criteria, the prevalence of diabetes and impaired glucose tolerance for 4682 persons aged 20 years or older was 8.3% and 5.7% respectively, or a total prevalence of 14.0% [*2*].

McCarty and Zimmet [*3*] projected an increase of 189% in diabetes prevalence in Oman between 1994 and 2010. King et al. [*4*] projected a 30% increase in diabetes prevalence in the Middle East crescent and an approximate 14% increase in Oman between 1995 and 2025.

The aim of our study was to estimate the distribution and study the correlates of total impaired fasting glucose, i.e. diabetes mellitus and impaired fasting glycaemia, in a community-based survey as a part of the Oman National Health Survey, 2000.

Methods

Sample

The survey sample was selected to reflect as closely as possible the national situation. The survey adopted a multi-stage, stratified probability-sampling design. All 10 regions of the Sultanate were sampled proportionally, with one or more *wilayat*, or districts, depending on population chosen randomly from each region and resulting in the selection of 16 of 59 *wilayat* nationally. Each *wilayat* was classified as either urban (major population centres) or rural (villages or remote areas). The urban to rural ratio of 2:1 was similar to that of the 1993 national census.

In the second stage of study design, enumeration areas within each stratum were randomly selected. Enumeration areas were defined during the 1993 population census and each contains approximately 80 households. In the third stage, households were selected within each enumeration area. Maps of the selected enumeration areas were updated and a complete list of Omani households in each was made to obtain the sampling frame. Households were then randomly selected. All subjects aged 20 years or older in the selected households were invited to participate in the survey.

The total number of households selected was 1968 in which 7011 subjects met selection criteria. The response rate varied from 83% to 91% according to the type of measurement or laboratory investigation completed. Of 7011 eligible subjects, 5788 (83%) completed the questionnaire, had blood drawn for fasting blood glucose, completed most measurements and laboratory investigations and had their data analysed for total impaired fasting glucose.

Questionnaire and measurements

Our household health status questionnaire covered demographic data such as age, sex, marital, educational and employment status and self-reporting of diabetes mellitus, hypertension and smoking habits. World Health Organization (WHO) procedures [5] were used to measure blood pressure, weight, height and waist and hip circumference. The questionnaire also covered the results of laboratory investigations for fasting blood glucose and serum cholesterol levels.

Specimen collection and analysis

For specimen collection and analysis, 25 teams were assembled and trained in the methodology of the survey for 2 weeks. Each team consisted of a nurse to take measurements, a laboratory technician to draw samples, a health educator to interview subjects, a health inspector to transport laboratory samples and a field supervisor (statistician) to supervise and review the questionnaires in the field.

Eligible members in selected households were requested to commence fasting 1–2 hours before midnight the night before they were to be visited by the survey team. At 07:00 the following morning, household members were interviewed and measured and venous fasting blood glucose samples were collected. Fasting blood samples for glucose were collected in sodium fluoride potassium oxalate tubes, labelled and transferred immediately with laboratory forms to the laboratory at the *wilayat* hospital in cold boxes. Samples were immediately centrifuged, the plasma was separated and fasting plasma glucose was determined by a glucose oxidase method on the same day using a Hitachi 911 automated clinical chemistry analyser (Hitachi 911 analyser and reagents supplied by Boehringer Mannheim, Roche Diagnostics, Dubai, United Arab Emirates). Samples for estimation of cholesterol were collected in tubes containing lithium heparin anticoagulants and transferred to the laboratory. At the laboratory, investigations were performed with the enzymatic colorimetric method using the same Hitachi 911 automated clinical chemistry analyser.

Diagnostic criteria

WHO criteria were used for the diagnosis of hypertension, hypercholesterolaemia, anthropometric measurements and glucose intolerance [6].

Patients who self-reported hypertension were categorized as having diastolic hypertension even if their blood pressure reading at the time of screening was normal only if the interviewer either sighted their medication or verified that the subject had been diagnosed by a medical practitioner. Patients were also categorized as having diastolic hypertension if the mean of two blood pressure (BP) readings was ≥ 90 mmHg diastolic phase 5, regardless of systolic BP. Hypertensive subjects were further classified in the logistic regression models as having mild hypertension (diastolic BP 90-104 mmHg) or moderate/severe hypertension (diastolic BP ≥ 105 mmHg).

Patients were categorized as having hypercholesterolaemia if their total cholesterol reading was ≥ 5.2 mmol/L or ≥ 200 mg/dL.

Body mass index (BMI = weight (kg)/height^2 (m^2)) was classified according to accepted norms: underweight (BMI < 18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), obese (30.0–39.9 kg/m^2) and morbidly obese (≥ 40.0 kg/m^2).

Abnormal waist to hip ratio (WHR) measurements, or central obesity, were ≥ 0.85 for females and ≥ 0.95 for males.

Subjects were classified as having impaired fasting glycaemia with fasting blood glucose ≥ 6.1–6.9 mmol/L and diabetes mellitus if they self-reported diabetes mellitus or had fasting blood glucose ≥ 7.0 mmol/L. Total impaired fasting glucose was calculated by adding the two groups.

Data processing and analysis

Data were entered using *Epi-Info* version 6.04. The process of preparing the data file was completed by July 2000. Data were analysed using *SPSS* version 9.0. Data were given as counts, means and percentages. Variance among the group means were analysed (ANOVA) and the distribution of data using the likelihood ratio was examined with the chi-squared test. Step-wise logistic regression tested for factors most strongly associated with the studied dependent variables and to obtain the adjusted odds ratios (OR) for these factors. All independent variables used in the logistic models were dichotomous (after recoding some). *P*-value < 0.05 was significant.

Results

A crude prevalence of total impaired fasting glucose of 17.3% in the total sample of subjects aged 20-120 years was obtained by summing the percentage of diabetes mellitus cases (crude prevalence = 11.2%) and the impaired fasting glucose cases (crude prevalence = 6.1%). Using the Segi standard world population [7], the total impaired fasting glucose age-adjusted pre-

Table 1 **Demographic and social characteristics of subjects**

Characteristic	No.	%
Age group (years)		
20–39	4353	62.1
40–59	1753	25.0
≥ 60	905	12.9
Total	7011	100.0
Sex		
Male	3506	50.0
Female	3505	50.0
Total	7011	100.0
Residence		
Urban	5143	73.4
Rural	1868	26.4
Total	7011	100.0
Education		
Illiterate	2333	33.8
< Secondary	2824	40.9
≥ Secondary	1753	25.3
Total	6910	100.0
Employment status		
Working	2778	39.9
Not working	4191	60.1
Total	6969	100.0
Marital status		
Married	4668	66.7
Not married	2327	33.3
Total	6995	100.0
Family size		
≤ 10 members	3696	52.7
> 10 members	3315	47.3
Total	7011	100.0
Current smoking		
Yes	488	7.0
No	6515	93.0
Total	7003	100.0

Table 2 **Means, significance and proportions of health characteristics analysed by age and gender**

Characteristics	Overall sample	Age group (years) 20–39			40–59			60–120		
		Male	Female	*P*	Male	Female	*P*	Male	Female	*P*
Diabetes status (n = 5788)										
Fasting blood sugar mean (mmol/L)	5.51	5.21	5.01*	< 0.05	6.08	6.10	> 0.05	5.81	6.96*	< 0.05
Normal fasting glucose (%)	82.70	88.40	91.50		70.10	73.50		73.90	66.10	
Impaired fasting glucose (%)	6.20	6.20	3.70		10.00	7.40		6.20	8.10	
Diabetes mellites (%)	11.20	5.40	4.80		19.90	19.10		19.90	25.80	
Hypertension status[a] *(n = 6414)*										
Systolic BP mean (mmHg)	126.46	123.79	119.37*	< 0.05	131.65	132.28	> 0.05	138.03	141.63*	< 0.05
Diastolic BP mean (mmHg)	80.29	79.56	76.93*		83.40	83.14		83.93	85.43	
Normal BP (%)	66.90	76.10	83.20		53.50	49.30		39.10	31.90	
Systolic or diastolic hypertension (%)	33.10	23.90	16.80		46.50	50.70		60.90	68.10	
Cholesterol level (n = 5850)										
Cholesterol mean (mmol/L)	5.1	4.75	4.82	> 0.05	5.49	5.45	> 0.05	5.45	5.87*	< 0.05
Normal (%)	59.40	71.10	70.20		43.60	45.50		43.60	29.70	
High (%)	40.60	28.90	29.80		56.40	54.50		56.40	70.30	
Body mass index (n = 6430)										
BMI mean (kg/m^2)	25.52	24.79	25.38*	< 0.05	26.66	27.11	> 0.05	24.31	25.20*	> 0.05
Underweight/ normal (%)	52.10	58.00	54.00		40.40	40.50		60.00	54.10	
Overweight/obese (%)	47.90	42.00	46.00		59.60	59.50		40.00	45.90	
WHR (n = 6173)										
WHR mean	0.91	0.90	0.87*	< 0.05	0.95	0.94*	< 0.05	0.95	0.95	< 0.05
Normal WHR (%)	50.70	76.60	46.50		54.60	17.60		60.60	14.00	
Abnormal WHR (%)	49.30	23.40	53.50		45.40	82.20		39.40	86.00	

[a]*Hypertension status = sum of isolated systolic and diastolic hypertension cases.*
WHR = waist to hip ratio
n = *sample tested.*
**Statistically significant difference,* P < *0.05.*

Table 3 **Variables associated with total impaired fasting glucose**

Characteristic	Normal		Total impaired fasting glucose		Likelihood-ratio	*P*
	No.	%	No.	%		
Age group (years)						
20–39	3143	90.0	348	10.0	328.02	< 0.05
40–59	1092	71.9	427	28.1		
≥ 60	549	70.6	229	29.4		
Total	4784	82.7	1004	17.3		
Sex						
Male	2342	81.5	532	18.5	5.40	< 0.05
Female	2442	83.3	472	16.2		
Total	4784	82.7	1004	17.3		
Education						
Illiterate	1540	76.2	481	23.8	116.10	< 0.05
< Secondary	1946	84.1	369	15.9		
≥ Secondary	1239	90.0	138	10.0		
Total	4725	82.7	988	17.3		
Family size						
≤ 10 members	2504	82.0	549	18.0	1.83	0.18
> 10 members	2280	83.4	455	16.6		
Total	4784	82.7	1004	17.3		
Hypercholesterolaemia						
No	2994	87.6	424	12.4	133.31	< 0.05
Yes	1765	75.8	564	24.2		
Total	4759	82.8	988	17.2		
Employment status						
Working	1858	83.1	377	16.9	0.55	0.46
Not working	2907	82.4	622	17.6		
Total	4765	82.7	999	17.3		
Marital status						
Married	3117	80.6	751	19.4	37.98	< 0.05
Not married	1657	87.0	248	13.0		
Total	4774	82.7	999	17.3		
Obesity status						
Not obese	2617	86.9	394	13.1	83.68	< 0.05
Overweight and obese	2093	77.7	600	22.3		
Total	4710	82.6	994	17.4		

Table 3 **Variables associated with total impaired fasting glucose** (*concluded*)

Characteristic	Normal		Total impaired fasting glucose		Likelihood-ratio	P
	No.	%	No.	%		
Waist to hip ratio						
Normal	2427	87.1	358	12.9	76.60	< 0.05
Abnormal	2099	78.2	584	21.8		
Total	4526	82.8	942	17.2		
Hypertension						
No	3329	87.6	472	12.4	189.40	< 0.05
Yes	1387	72.6	524	27.4		
Total	4716	82.6	996	17.4		
Current smoking						
Yes	330	80.1	82	19.9	1.99	0.16
No	4451	82.9	920	17.1		
Total	4781	82.7	1002	17.3		
Residence						
Urban	3531	82.8	735	17.2	0.15	0.69
Rural	1253	82.3	269	17.7		
Total	4784	82.7	1004	17.3		

Significant at P < *0.05.*

valence for the overall sample within 5-year bands in the truncated age range of 20-89 years was 20.3% (21.3% for males and 19.3% for females).

Table 1 shows subjects' demographic and social characteristics. Males and females were equally represented, the majority (62.1%) were between 20 and 39 years of age, 73% lived in rural areas, approximately 34% were illiterate and 7% were smokers.

Table 2 shows the mean and proportion of selected characteristics of the sample according to age group and gender. Chi-squared test and ANOVA for comparison of means were used to determine the significance of the results. The significant gender difference in most of the parameters in the youngest group was markedly less apparent in the middle-aged group and re-emerged to a lesser extent in the age group 60–120 years.

Table 3 shows selected characteristics of subjects with total impaired fasting glucose. In bivariate analysis, older age, male gender, high cholesterol level, overweight or obesity, abnormal WHR and systolic or diastolic hypertension were significantly associated with higher rates of total impaired fasting glucose ($P < 0.05$). Being married (possibly because in Oman being unmarried is usually associated with being young, i.e. age is a confounder with marital status) and illiteracy (in Oman older subjects are more likely to be illiterate) were also significantly associated with higher rates of total impaired fasting glucose ($P < 0.05$). There was no significant association between family size, working status, current smoking, or urban or rural residence and total impaired fasting glucose rates ($P > 0.05$).

Table 4 shows the variables significantly associated with total impaired fasting glucose and with diabetes mellitus in the multiple logistic regression and OR in terms of the overall sample. (Marital status and education level were not included because of the age-related nature of these characteristics in Oman.) The OR for each variable was adjusted for the other variables in the model to account for confounding between them. Some of the significantly associated variables, such as gender, cholesterol level and abnormal WHR were binary. Age group, obesity and hypertension were categorical. For example, relative to the reference age group of 20–39 years, the odds of having total impaired fasting glucose increased significantly for the age group aged = 60 years (OR = 2.53) compared to the age group 40–59 years (OR = 2.39). In terms of total impaired fasting glucose, for the hypertension variable relative to the reference category (normotensive subjects), the significant increase in OR was more apparent between the moderately/severely hypertensive group (OR = 2.7) and the mildly hypertensive group (OR = 1.64). Female sex appeared to be a protective variable against total impaired fasting glucose after adjustment for age and other variables (OR = 0.76). All variables significantly associated with total impaired fasting glucose were also significant for diabetes mellitus, except for sex.

Discussion

Despite the efforts of the Ministry of Health to control the problem of increasing prevalence of noncommunicable diseases, diabetes and impaired fasting glucose rates continue to rise. Since 1991, a formal diabetes control programme has been in place. Specialist services for diabetics are now available at the regional level, although previously they had been available only in the major referral hospital in the capital, Muscat. In 1997, the Ministry initiated a pilot primary prevention project in Nizwa, the old capital, in the hope of curbing the rise in diabetes-associated mortality and morbidity.

Between 1991 and 2000, the crude prevalence of total impaired fasting glucose increased from 14.0% to 17.4%. This might be partially explained by the Neel 'thrifty genotype' hypothesis or by a failure to adapt to relatively rapid environmental changes. In 2000 (the year of our study), the percentage of new and old cases of diabetics registered and treated in Ministry of Health institutions was 3.04% among those aged = 20 years [*8*]. Thus, projections of the magnitude of the problem will be underestimated if planners rely solely on hospital-based statistics.

Identifying the distribution and correlates of total impaired fasting glucose in a community-based study provides more accurate data about the magnitude of the problem and its associated factors in regional settings. Primary health care doctors and their patients can benefit greatly from the dissemination of data about factors significantly associated with total impaired fasting glucose. Doctors would be able to

Table 4 **Variables significantly associated with total impaired fasting glucose according to multiple logistic regression for the overall sample**

Variable	Total impaired fasting glucose		Diabetes mellitus	
	Adjusted OR[a]	*P*	Adjusted OR	*P*
Age group (years)				
20–39*				
40–59	2.39		2.99	
60–120	2.53	< 0.05	3.72	< 0.05
Hypercholesterolaemia				
No = 0				
Yes = 1	1.47	< 0.05	1.43	< 0.05
Obesity				
Underweight or normal*				
Overweight	1.48		1.63	
Obese or morbidly obese	1.67	< 0.05	1.77	< 0.05
Gender				
Male = 0				
Female = 1	0.76	< 0.05	NS	
Hypertension				
Normotensive*				
Mildly hypertensive	1.64		1.7	
Moderately/severely hypertensive	2.71	< 0.05	2.25	< 0.05
Waist to height ratio				
Normal = 0				
Abnormal = 1	1.36	< 0.05	1.39	< 0.05

[a]OR, or odds ratio, of each variable is adjusted for the other variables in the model.
**Reference category.*
NS = not significant.

more accurately predict which patients are at greatest risk, thereby resulting in more prompt investigations of at-risk patients and improved management of patients with diabetes. Widely disseminated, such information has the potential to prevent and reduce morbidity and mortality of diabetes at the primary health care level.

In our study, obesity, central obesity, high cholesterol, older age and presence of hypertension were the common correlates of total impaired fasting glucose and diabetes mellitus in multivariate analysis in the logistic regression models. Female gender was significantly protective against total impaired fasting glucose, although not against diabetes mellitus. Romero et al. found that age was strongly associated with diabetes prevalence with a chi-squared risk of 39.1 ($P < 0.0001$) [*9*]. A significant proportion (5.9%) of younger individuals (35–44 years of age) was affected by the disease. Diabetes was associated with advanced age, was more common among the low-income group and had increased OR for hypertension, dyslipidaemia and myocardial infarction in both men and women and for obesity in women only.

In Jamaica, 12.6% of 669 females had diabetes compared with 7.8% of 649 males [*10*]. The same pattern was observed in the Libyan Arab Jamahiriya despite the low prevalence of diabetes among adults aged 20 years or older (3.8% for the overall sample, 4.7% in females and 2.9% in males, $P < 0.01$) [*11*]. In our study, female sex was protective for total impaired fasting glucose and was not significantly associated with diabetes mellitus.

These results differed from South African data in which prevalence of diabetes in male and female workers ($P = 0.31$) was similar and the highest incidence was observed in the age group 40–59 years. No subject under 40 years of age was diabetic and the prevalence of the disease increased with age. Impaired glucose tolerance was observed in 3.4% of male and 1.5% of female workers respectively ($P = 0.13$) with the peak prevalence occurring among the age group 30–49 years [*12*].

In South Africa, diabetes mellitus was more common in women (5.2% versus 2.3% for males), although the reverse was true of impaired glucose tolerance (5.5% vs. 11.5% for males). The mean age-adjusted BMIs of diabetic (31.3 ± 1.9 kg/m^2) and impaired glucose tolerant subjects (29.7 ± 1.9 kg/m^2) were significantly higher than those with normal glucose tolerance (28 ± 0.5 kg/m^2). Female subjects with all types of glucose tolerance had a significantly higher mean BMI than men. For women, there was a significant correlation between BMI and both fasting glucose ($r = 0.16$, $P = 0.0039$) and 2-hour plasma levels ($r = 0.15$, $P = 0.0065$), although for men only the fasting levels were similarly related ($r = 0.21$, $P = 0.01719$) [*13*].

In another study, subjects with diabetes mellitus were significantly older (mean age 50.7 years) than those with a normal glucose tolerance test result (mean age 30.9 years), but of similar age distribution compared with the impaired glucose tolerance group (mean age 46 years). Subjects with a normal glucose tolerance test had a significantly lower mean BMI (22.1 ± 2.8 kg/m^2) compared with diabetic subjects (26.1 ± 5.2 kg/m^2) or the impaired glucose tolerance group (25.8 ± 6.6 kg/m^2). Obesity was commonly associated with both diabetes mellitus and impaired glucose tolerance, particularly among women [*14*].

In Finland, the prevalence of impaired glucose tolerance and diabetes increased with age more steeply among women than men [*15*]. In the Sudan, family history of diabetes, obesity and advanced age were associated with higher rates of diabetes [*16*].

In Tanzania, the overall age-adjusted prevalence of impaired glucose tolerance was 21.5%, a little higher than the prevalence of total impaired fasting glucose in our study (20.3%), but with almost the same associated factors. Swai et al. reported a mean BMI of 24.3 kg/m^2 and 26.4 kg/m^2 for males and females respectively, but with similar age-adjusted diabetes rates (7.0% and 7.6% respectively). Diabetes and impaired glucose tolerance were more common in those with BMI > 25 kg/m^2 only in the older age groups. Diabetes and impaired glucose tolerance were more common in those with a family history of diabetes. Increasing parity was also associated with higher diabetes prevalence. Diabetes and impaired glucose tolerance were thus higher among Asians in Tanzania than among the indigenous community. Rates were higher than among most other immigrant Asian communities [*17*].

In India, the prevalence of known diabetes and abnormal glucose tolerance testing steadily increased with age with the highest prevalence in the age group = 70 years ($P < 0.001$). Obese subjects had significantly higher base and 2-hour blood glucose readings for males and females. Subjects with diabetes on glucose tolerance testing had higher waist to hip ratios.

We found no significant association between total impaired fasting glucose and place of residence (urban or rural). Zargar et al. reported similar results, although they did find that in bivariate analysis the prevalence of both diabetes and impaired glucose testing were significantly higher in urban populations. However, when the results were analysed by gender, the difference between urban and rural populations was statistically significant only among females. When the data were further analysed using multiple logistic regression even this difference was not significant [*18*]. Al-Nuaim found that the age-adjusted prevalence of diabetes mellitus but not impaired glucose tolerance was higher among urban populations [*19*].

The absence of any significant difference in the prevalence of either total impaired fasting glucose or diabetes mellitus between rural and urban populations in our study may be because the majority of our subjects who lived in urban areas were relatively recent arrivals from the countryside, having lived in an urban environment for only a few years, or were only temporary urban residents. Additionally, the difference in conditions in urban and rural environments in the Sultanate, with the exception of Muscat, is less distinct. Thus, the full impact of a sedentary lifestyle and stressful working conditions resulting from the increasing modernization of Oman have perhaps not had time to show up in the data collected among the urban dwellers in our survey.

Conclusions

Both diabetes mellitus and impaired fasting glucose are important public health problems in Oman. The crude and age-adjusted prevalence of total impaired fasting glucose are quite high. The participation rate in our survey was high and it is therefore unlikely that we missed many cases of diabetes mellitus or impaired fasting glucose as nonresponders. The crude prevalence of total impaired fasting glucose has increased by approximately 24% since the 1991 survey.

At the national government level there is an existing 5-year programme for control of chronic noncommunicable diseases. Controlling diabetes mellitus and its complication is an important component of the programme. To prevent or minimize morbidity and mortality arising from these diseases, heightening the level of surveillance among primary health care doctors and the level of community awareness are perhaps the best strategies to aid early diagnosis and management of total impaired fasting glucose. Primary health care and other medical professionals need to be vigilant because the onset of type 2 diabetes can occur up to 4 years before clinical diagnosis as evidenced by the presence of diabetic retinopathy or micro-angiopathy at the time of clinical diagnosis. Primary care doctors should always suspect total impaired fasting glucose or diabetes mellitus among males who are aged 40 years or older and who are obese, those with abnormal waist to hip ratios and hypertensive subjects with or without high cholesterol levels. Maintaining diabetes registration and improving community awareness for self-reporting of diabetes are also highly recommended. Improving awareness of the problem can be achieved through health education campaigns.

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Regional Consultation on Early Diabetes Prevention and Control

The World Health Organization (WHO) organized a Regional Consultation on Diabetes Prevention and Control in Teheran, Islamic Republic of Iran from 2 to 5 February 2003. The objectives of the Consultation were: to review the activities of diabetes control programmes in the Region; to develop strategies to integrate diabetes control programmes into primary health care services; and to prepare regional guidelines for prevention and control of diabetes. Experts from Egypt, Islamic Republic of Iran, Jordan, Lebanon, Libyan Arab Jamarhiriya, Oman, Pakistan, Saudi Arabia, Sudan, Syrian Arab Republic, Tunisia, United Kingdom, United States of America as well as WHO concerned staff participated in the consultation.