Diabetes and Impaired Fasting Glycemia in the Tribes of Khagrachari Hill Tracts of Bangladesh

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OBJECTIVE — To determine the prevalence of type 2 diabetes and impaired fasting glycemia (IFG) in a tribal population of Bangladesh.

RESEARCH DESIGN AND METHODS — A cluster sampling of 1,287 tribal subjects of age ≥20 years was investigated. They live in a hilly area of Khagrachari in the far northeast of Bangladesh. Fasting plasma glucose, blood pressure, height, weight, waist girth, and hip girth were measured. Lipid fractions were also estimated. We used the 1997 American Diabetes Association diagnostic criteria.

RESULTS — The crude prevalence of type 2 diabetes was 6.6% and IFG was 8.5%. The age-standardized (20–70 years) prevalence of type 2 diabetes (95% CI) was 6.4% (4.96–7.87) and of IFG was 8.4% (6.48–10.37). Both tribesmen and women had equal risk for diabetes and IFG. Compared with the lower-income group, the participants with higher income had a significantly higher prevalence of type 2 diabetes (18.8 vs. 3.1%, $P < 0.001$) and IFG (17.2 vs. 4.3%, $P < 0.001$). Using logistic regression, we found that increased age, high-income group, and increased central obesity were the important risk factors of diabetes.

CONCLUSIONS — The prevalence of diabetes in the tribal population was higher than that of the nontribal population of Bangladesh. Older age, higher central obesity, and higher income were proven significant risk factors of diabetes. High prevalence of diabetes among these tribes indicates that the prevalence of diabetes and its complications will continue to increase. Evidently, health professionals and planners should initiate diabetes care in these tribal communities.

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The increasing trend of type 2 diabetes is common in the developing nations and most common in Southeast Asian countries (1). Tribal or aboriginal populations show an accelerated increase of diabetes worldwide (2). Very high prevalence of diabetes has been found among the natives of America, Alaska, and Canada and the aborigines of Australia (3–6). These tribes and aborigines were also shown to have high prevalence of the metabolic syndrome (3,4,7). Similar findings were also reported among the tribal populations from northern Sudan (8), the United Arab Emirates (9), and Taiwan (10).

Very little information is available in the literature regarding the prevalence of diabetes among the different tribes living in Southeast Asian countries. According to a population census conducted in 1991, the indigenous population was an estimated 1.2 million, comprising >30 different ancestries. Among these, the major tribes are Chakma, Marma, and Tripura, with a population of 0.253, 0.154, and 0.08 million people, respectively (11). These three distinguished ancestries live in the hill tracts (forest reserves) of Chittagong, which is situated in the far northeastern corner of Bangladesh. Most of them still maintain their indigenous lifestyle. They collect fruits, vegetables, and wood available in the vicinity of their dwellings in the forest. They use their traditional "Zhum cultivation" method for farming. This method does not involve the use of plows; instead they scatter or bury seeds over the slopes of the hillsides. The crop is harvested when it matures. After several such harvestings, they burn the remains of the crops. They then leave that area and move to another new destination for cultivation.

Bangladesh is one of the most densely populated countries in the world, with a population density of 834 people per square kilometer. There is a scarcity of arable land for both the majority Bangladeshi population and the minority indigenous tribal populations (11). As a result of this, for the last two decades there has been continuing dispute between the Bangladeshis and the different tribes over ownership of the forest reserves. It may be noted that although 63% of Bangladeshis are employed in agricultural activities, the available arable land is only 0.1 hectare per person (11). Consequently, the indigenous people are being gradually dispossessed of their ancestral land. So, it has become very difficult for them to retain their traditional form of "Zhum cultivation." They have been forced to change their indigenous lifestyle. They have to plow the land for farming and adopt other nonagrarian professions, such as business, services, etc.

This study was conducted to assess the prevalence of diabetes and impaired

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Abbreviations: CHD, coronary heart disease; FPG, fasting plasma glucose; IFG, impaired fasting glycemia; TG, triglyceride; WHR, waist-to-hip ratio.

fasting glycemia (IFG) among three indigenous tribes, the Chakma, Marma, and Tripura living in the far northeastern, hilly forest reserve of Khagrachari in Bangladesh.

RESEARCH DESIGN AND METHODS

RESEARCH DESIGN AND METHODS — We conducted this study during the month of June 2002. We purposely selected a subdistrict of Khagrachari, which is one of the three districts of Chittagong hill tracts. Khagrachari is situated in the far northeastern part of Bangladesh. It is a part of the forest of the country. It is linked with other districts via a single, narrow tortuous road, which is often muddy in the rainy season, running through forested hills. It is a 14-h journey by bus from Dhaka.

With the help and cooperation of the district administrators of Khagrachari and the elected body, the Khagrachari Union Council, we received an introduction to the tribal leaders, schoolteachers, and village people and, after consulting them, we purposely selected 11 of 22 discrete tribal villages. These villages have sparsely scattered houses. The local schoolteachers helped us by acting as interpreters. We explained the objectives and procedural details to the people. We demonstrated each step of the investigation, e.g., interviewing through an interpreter, measuring height, weight, waist girth, hip girth, taking blood pressure, and collecting blood samples. Following the demonstration, the community people discussed among themselves and agreed to participate in the study. Volunteers were selected from among the young people and students of the respective villages where the study was conducted. They helped us by preparing a list of at least 100 eligible participants from each village. They were advised to approach all adjacent houses within one-half kilometer of the investigation site (a school or the house of a village leader) and include at least one member from each household. In cases where there was more than one participant from one household, they were all included if they fulfilled the selection criteria. We excluded those subjects who needed to walk a long distance to reach the investigation site, which would affect their fasting plasma glucose (FPG) levels.

Diabetes survey and data collection

A survey questionnaire was designed and finalized after a field trial. The variables included were age, sex, education, occupation, annual family income, family size, religion, and housing condition. Men and women ≥20 years of age were considered eligible except pregnant women, seriously ill subjects, and those who were on herbal medication or on drugs such as corticosteroids and oral pills. Subjects with known diabetes were asked to stop oral hypoglycemic agent regimens for 3 days and insulin for 24 h before participation. Informed consent was obtained from subjects who had agreed to participate in the study. Each subject was asked to report at a selected investigation site after an overnight fast of at least 12 h.

Each participant was interviewed for occupation, education, housing, sanitation, family income, and number of family members. Their status of physical activities, family history of diabetes, hypertension, and coronary heart disease (CHD) were also taken. All types of physical activities (plowing, digging, gardening, harvesting, crop carrying, manual irrigation, etc.) were graded according to the intensity and duration of the work (heavy, moderate, mild, and sedentary, based on an equivalent walk of >90, 60–90, 30–59, and <30 min/24 h, respectively). The other investigations included anthropometry, blood pressure, and FPG. Measurements of height, weight, and waist and hip girth were taken with light clothes and without shoes. The weighing tools were calibrated daily by known standard weight. For height, the subject stood in an erect posture vertically with the occiput, back, hip, and heels touching the wall behind while gazing horizontally in front and keeping the tragus and lateral orbital margin in the same horizontal plane. Waist girth was measured by placing a plastic tape horizontally midway between twelfth rib and iliac crest in the midaxillary line. Similarly, the hip was measured by taking the extreme end posteriorly and the symphysis pubis anteriorly. Blood pressure was taken after a 10-min rest with standard cuffs for adults fitted with a mercury sphygmomanometer.

Venous blood (5 ml) was taken for FPG, total cholesterol, HDL cholesterol, and triglyceride (TG) levels. We used our own generator for electricity in the remote area for the required laboratory investigation. We estimated plasma glucose by the glucose oxidase (enzymatic oxidation) method (GOD/PAP kit; Randox, Antrim, U.K.) using the autoanalyzer Screen Master-3000 (B.S. Biochemical Analyzer, Arezzo, Italy). We used the diagnostic criteria of the American Diabetes Association (12).

Statistical analysis

The prevalence rates of type 2 diabetes and IFG were determined by simple percentages. Age-specific and age-standardized (20–70 years) prevalence rates were estimated on the basis of 1991 census data adjusted in 2000 (11,13). All associations were tested by χ^2 and correlation coefficient (r). The odds ratio (OR) with 95% CI for risk factors was calculated assuming the least prevalence of diabetes as a reference in the lowest quartile of age, BMI, and waist-to-hip ratio (WHR). Binary logistic regression was used to quantify the individual risk related to diabetes in various models, with different combinations of independent risk factors. The risk factors quantified were sex (men and women) and income group (low, middle, and high). In addition, we tested the association of diabetes with tertiles of total cholesterol, TGs, and HDL cholesterol. All statistical tests were considered significant at a level of ≤5%. SPSS version 10.05 was used.

RESULTS — The young volunteers made a list of 1,480 participants from 11 selected villages. Of them, 1,119 (75.6%) responded. The participants from Chakma, Marma, and Tripura composed 37.6, 31.3, and 21.5% of the study group, respectively. The rest (9.6%) were of mixed origin or from some other minor tribes. In regard to the sociodemographic characteristics, each household consisted of about five family members. The family size was five at the 50th percentile and seven at the 80th percentile. About 48% of the adult population (≥20 years of age) were illiterate (unable to write his or her address), and only 4.6% had successfully obtained an academic degree. Among the male population, major occupations were farming (30%), service (25%), day laborer (19%), and business (10%), whereas among the female population there were housewives (57%), farmers (13%), day laborers (8%), and in service (7%).

The mean annual family income was USD 620.00. For quantification of associ-

Table 1 —*Prevalence of IFG and type 2 diabetes according to sex, income, physical activity, family history of diabetes, and hypertension*

Variables	*n*	IFG	χ^2	*P*	Diabetes	χ^2	*P*
Sex							
Men	469	6.7	—	—	8.0	—	—
Women	650	5.2	1.27	0.159	5.6	2.37	0.079
All	1,119	8.5	—	—	6.6	—	—
95% CI	—	6.87–10.13	—	—	5.15–8.05	—	—
Illiterate							
Yes	546	4.9	—	—	5.6	—	—
No	586	6.7	1.51	0.136	7.6	1.71	0.119
Income group*							
Low	494	4.3	—	—	3.1	—	—
Middle	509	5.5	23.85	<0.001	6.0	22.42	<0.001
High	93	17.2	—	—	18.8	—	—
Physical activity†							
≥60 min	264	8.6	—	—	3.8	—	—
<60 min	766	9.6	0.24	0.35	7.6	4.56	0.031

χ^2 test for men versus women, poor versus rich, etc. IFG is FPG 6.1–6.9 mmol/l; diabetes is FPG ≥7.0 mmol/l. *Categorized based on tertiles of annual expenditure; low versus high tertile, with middle tertile excluded; †equivalent to walking "X" min/24 h.

ation between diabetes and income, we classified the family income into quartiles. With regard to their living condition, 73% of the houses had roofs made of corrugated tin, whereas 24% had thatched roofs. Only 59% of these houses had sanitary latrines. Family history (first-degree relatives) was positive for hypertension in 3.5%, diabetes in 3.1%, stroke in 1.5%, and coronary heart disease (CHD) in 0.2% of the study population.

The survey detected 74 type 2 diabetic and 95 IFG subjects. Of the 74 type 2 diabetic subjects, 7 (9.5%) were previously diagnosed with type 2 diabetes and 3 of them were taking an oral hypoglycemic agent irregularly. Of the 95 IFG subjects, 4 (4.2%) participants were known to have diabetes, controlled by diet and exercise, and none of them were taking any drug. The overall prevalence of diabetes was 6.6% (95% CI 5.15–8.05) and IFG was 8.5% (6.87–10.13) (Table 1).

The male participants had a higher prevalence of diabetes than their female counterparts, although the difference was not significant (8.0 vs. 5.6%; χ^2 8.14, $P = 0.079$). For IFG subjects also, there was no sex difference (men versus women, 6.7 vs. 5.2%; P = NS). Compared with the lower-income group, the higher-income group had a significantly higher prevalence of both IFG and type 2 diabetes (both cases, $P < 0.001$). Less physical activities (equivalent to <60 min walking vs. ≥60 min/24 h) also showed a significantly higher prevalence of diabetes ($P < 0.031$). When the prevalence rates were compared between illiterate and literate participants, the latter showed a higher prevalence, although the differences were not significant (type 2 diabetes: 5.6 vs. 7.6%; IFG: 4.9 vs. 6.7%, respectively; both cases, P = NS).

The age-specific prevalence of both type 2 diabetes and IFG showed an increasing trend with increasing age (Table 2). The trends were significant for both type 2 diabetes ($P < 0.001$) and IFG ($P < 0.001$). The age-standardized (20–70 years) prevalence of type 2 diabetes (95% CI) was 6.4% (4.96–7.87) and IFG was 5.6% (4.31–6.92). Age-standardized prevalence did not differ significantly between men and women for both type 2 diabetes (7.4 vs. 5.5%) and IFG (6.1 vs. 5.1%).

The characteristics were compared between subjects with normal and abnormal fasting glucose (FPG <6.1 vs. ≥6.1 mmol/l, respectively) (Table 3). The subjects with abnormal fasting glucose had significantly higher age ($P < 0.001$), BMI ($P < 0.01$), WHR ($P < 0.001$), blood pressure (systolic blood pressure, $P < 0.05$, and diastolic blood pressure, $P < 0.01$), and plasma glucose ($P < 0.001$). Total cholesterol and TGs were also significantly higher among them. The comparisons of characteristics between normal fasting glucose and IFG and between normal fasting glucose and type 2

Table 2 —*Age-specific and age-standardized prevalence with 95% CIs of IFG and type 2 diabetes among 475 men and 660 women in the Khagrachari study, 2002*

	Prevalence (95% CI)					
	Age specific (years)					Age standardized (years)
	20–29	30–39	40–49	50–59	≥60	20–70
Diabetes						
Men	2.4 (0.28–5.00)	3.5 (0.39–7.37)	7.6 (2.19–13.03)	14.1 (5.55–22.58)	19.4 (9.93–28.87)	7.4 (5.04–9.67)
Women	3.0 (0.42–5.62)	5.4 (2.15–8.66)	6.7 (2.20–11.13)	11.1 (3.35–18.87)	5.5 (0.26–10.70)	5.5 (3.71–7.34)
All	2.8 (0.58–4.96)	4.6 (1.80–7.34)	7.0 (3.15–10.72)	15.1 (7.79–22.32)	13.4 (7.09–19.70)*	6.4 (4.96–7.87)
IFG						
Men	5.4 (0.54–3.42)	11.5 (0.77–4.94)	4.1 (1.39–10.98)	4.5 (5.10–20.99)	11.8 (8.90–26.24)	7.3 (4.08–8.08)
Women	9.6 (4.44–14.76)	9.5 (4.92–14.06)	9.0 (3.39–14.61)	10.2 (1.73–18.68)	8.2 (1.31–15.08)	9.4 (6.76–12.08)
All	7.8 (4.26–11.41)	10.0 (6.06–14.03)	6.9 (3.15–10.72)	7.5 (2.16–12.86)	9.8 (4.31–15.33)*	8.4 (6.48–10.37)

Age adjustment was based on the adjusted census of 1996. IFG is FPG 6.1–6.9 mmol/l. Diabetes is FPG ≥7.0 mmol/l. *χ^2 for trend, $P < 0.001$.

Table 3 —*Characteristics compared between subjects with normal fasting glucose and abnormal fasting glucose in the Khagrachari study, 2002*

	NFG	AFG	*P* (NFG vs. AFG)
n	1,054	65	—
Age (years)	39.15 ± 14.47	48.08 ± 15.87	0.000
Height (cm)	155.03 ± 8.52	155.15 ± 8.71	0.908
Weight (kg)	51.65 ± 10.84	55.42 ± 12.15	0.007
Waist (cm)	71.73 ± 10.30	77.65 ± 11.08	0.000
Hip (cm)	85.89 ± 7.97	87.18 ± 9.87	0.210
BMI (kg/m^2)	21.37 ± 3.64	22.92 ± 4.22	0.001
WHR	0.8364 ± 0.091	0.8937 ± 0.1014	0.000
WHTR	0.4634 ± 0.063	0.5016 ± 0.067	0.000
Systolic blood pressure (mmHg)	123.24 ± 18.05	128.18 ± 19.27	0.032
Diastolic blood pressure (mmHg)	80.42 ± 11.15	84.70 ± 11.86	0.003
FPG (mmol/l)	4.67 ± 0.97	11.78 ± 5.65	0.000
TG (mg/dl)	118.75 ± 58.68	145.76 ± 76.31	0.000
Total cholesterol (mg/dl)	126.52 ± 46.01	143.24 ± 57.16	0.005
HDL cholesterol (mg/dl)	36.32 ± 14.72	35.74 ± 15.10	0.759

Data are means ± SD. *P* values are from after *t* test. AFG, abnormal fasting glucose (IFG + diabetes: FPG ≥6.1 mmol/l); NFG, normal fasting glucose (FPG ≤6.0 mmol/l); WHTR, waist-to-height ratio.

diabetes separately yielded similar results (data not shown).

In partial correlation, controlling for age and sex, FPG showed a significant positive association with BMI, WHR, total cholesterol, and TGs (for all, $P < 0.001$), but not with HDL cholesterol (data not shown).

We used logistic regression to quantify the individual effect of outcome variables (sex, income group, age, WHR, and physical activities) with diabetes as a dependent variable in different models (Table 4). In model 1, sex and income group were entered. Compared with the lowest income (reference) class, the highest income group showed greater risk (OR 4.12, 95% CI 2.06–8.24). The income-related risk remained significant even after the entry of other confounding risk factors and was entered in the equation (models 2–4). The highest quartiles of age and WHR also proved to have a significant contribution for diabetes (models 2–4). BMI was included, but its effect was not significant and is not shown in Table 4. Lack of physical activity was found to be significant when entered as a single independent variable but other risk factors confounded its effect (model 4).

CONCLUSIONS — This study addressed the prevalence of diabetes and IFG among the indigenous population in Bangladesh. The response rate was satisfactory (75.6%), which indicates active cooperation of the tribes. The young volunteers sincerely helped us in preparing the list of participants. Our effort was to avoid bias in selection of a representative sample of the tribes. Considering our logistic support, communication, and language gap, we had no option other than to trust the list of participants made by the local volunteers. This may be the limitation of this study. However, this is the first study on diabetes prevalence in the indigenous population not only in Bangladesh but also among other Southeast Asian countries.

The prevalence of diabetes (6.6%) observed in this study is almost comparable

Table 4 —*Binary logistic regression: risk factors were selected stepwise in different models taking type 2 diabetes as a dependent variable*

Risk factors	Model 1	Model 2	Model 3	Model 4
Sex*	0.78 (0.46–1.27)	0.88 (0.52–1.48)	1.46 (0.81–2.66)	0.74 (0.40–1.35)
Income (tertile)				
Low	1	1	1	1
Middle	1.14 (0.65–2.02)	1.25 (0.70–2.22)	1.35 (0.73–2.47)	1.26 (0.67–2.34)
High	4.12 (2.06–8.24)	4.32 (2.13–8.77)	3.54 (1.65–7.59)	3.07 (1.39–6.80)
Age				
Quartile 1†	—	1	1	1
Quartile 2	—	1.72 (0.67–4.38)	1.48 (0.55–4.00)	1.51 (0.55–4.11)
Quartile 3	—	2.81 (1.22–6.43)	2.03 (0.82–5.02)	2.02 (0.82–5.02)
Quartile 4	—	4.40 (1.92–10.10)	3.08 (1.23–7.75)	3.04 (1.21–7.67)
WHR				
Quartile 1†	—	—	1	1
Quartile 2	—	—	1.83 (0.67–4.97)	1.83 (0.67–4.98)
Quartile 3	—	—	2.37 (0.92–6.11)	2.32 (0.90–5.99)
Quartile 4	—	—	4.28 (1.68–10.88)	3.94 (1.54–10.09)
Physical activities‡				
≥90 min	—	—	—	1
60–89 min	—	—	—	1.69 (0.74–3.85)
<60 min	—	—	—	1.83 (0.73–4.58)

Data are OR (95% CI). BMI quartile was entered into the equation and found to be not significant. *Male sex = 1 and female sex = 2; †quartile 1 is taken as the reference category; ‡physical activities are equivalent to walking "X" min/24 h (excluded from models 1 to 3).

with the prevalence found in Alaska Natives (5), in the Canadian Saskatchewan First Nations (6), in the Danagla community of Sudan (8), and in those of Bedouin origin in the Arab Emirates (9). If we had used the oral glucose tolerance test, then the prevalence rates of both type 2 diabetes and IGT might have increased substantially. In our previous estimates in a Bangladeshi rural population (14), we found that about 10–14% of impaired glucose tolerance and 2–5% of type 2 diabetes cases remained undetected when only fasting criteria were used.

In this study, it was revealed that the age-standardized prevalence of type 2 diabetes was significantly higher in the study (tribal) population (8.4%, 95% CI 6.48–10.37) compared with the rural (nontribal) population of Bangladesh (3.8%, 3.12–4.49) (15). In contrast, IFG prevalence was lower in the tribes (8.4%, 6.48–10.37) than in the rural population (13.0%, 11.76–14.16) (15). It is not clear why diabetes frequency was higher and IFG was lower in the study subjects. Possibly, the conversion of IFG to type 2 diabetes was predominant in the tribes because of, first, stressful living in a disowned territory and, second, significant lifestyle changes from ancestral indigenous lifestyle.

It may be noted that their ancestral indigenous lifestyle was maintained by hunting and gathering in the forested hills used together with Zhum cultivation. They have been forced to change from their indigenous lifestyle to other methods of cultivation and to careers in business, service, and other mixed occupations.

Among the investigated risk factors, increasing age, central obesity (WHR), and higher-income group were found to have a higher risk for developing diabetes. These findings are consistent with those of other tribal and nontribal populations (5–9,15,16). Most of these studies and other studies (17–20) indicate that regardless of ethnicity, this metabolic disease increased with higher income and affluent lifestyle. Disproportionate calorie intake and less physical activity resulted in obesity and insulin resistance. The study findings also suggest a similar association of diabetes with higher-income group. The indigenous participants who were fortunate enough to be rich (Q4, fourth quartile of income) had the highest prevalence of diabetes compared with their poorer counterparts (income Q4 vs. Q1: 12.2 vs. 3.9%, $P < 0.001$). In contrast, literacy showed no effect, which indicates that both the literate and illiterate individuals among the tribes had an equal susceptibility of developing diabetes.

Some interesting observations on obesity and lipid fractions may be noteworthy. In the nontribal Bangladeshis, using logistic regression, we observed that the highest quartile of BMI showed higher risk for diabetes (15), whereas in the tribal population, the BMI effect (not WHR) proved insignificant when other factors were entered into the equation.

Interestingly, the nontribal hyperglycemic subjects had significantly lower total cholesterol and higher HDL cholesterol (15). On the contrary, tribal hyperglycemic subjects showed significantly higher total cholesterol and TG levels. Logistic regression analysis showed that central obesity (high WHR) had significant association with diabetes. All of these findings (higher cholesterol, TGs, and central obesity) suggest that, unlike nontribal Bangladeshis (15), insulin resistance is possibly an important contributor to diabetes among the indigenous participants (21,22).

When physical exercise was taken as a single independent risk factor, it showed significant effect but could not retain its significance when other independent variables were included in the logistic model. It is possible that most people still walk under compulsion because of a lack of roads and changes in traditional life. More sophisticated methods are needed for grading the physical exercise in such hilly areas, and more studies should be undertaken to explore the risk factors related to higher prevalence of diabetes in the tribal population.

In conclusion, the present study revealed that the prevalence of diabetes among the tribes is very high. Advancing age, increased central obesity, and higher income were the independent risk factors. It may be predicted that prevalence of diabetes and its complications will continue to increase because there is lack of access to diabetes care and education among these communities. Based on the study results, we expect that health care planners and professionals may develop strategies to make diabetes care accessible to the tribal populations, who have such a high prevalence of diabetes.

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References

1. King H, Rewers M: Global estimates for prevalence of diabetes mellitus and impaired glucose tolerance in adults. *Diabetes Care* 16:157–177, 1993
2. Rock M: Sweet blood and social suffering: rethinking cause-effect relationships in diabetes, distress, and duress. *Med Anthropol* 22:131–174, 2003
3. Greenlund KJ, Valdez R, Casper ML, Rith-Najarian S, Croft JB: Prevalence and correlates of the insulin resistance syndrome among Native Americans: the Inter-Tribal Heart Project. *Diabetes Care* 22:441–447, 1999
4. Hoehner CM, Greenlund KJ, Rith-Najarian S, Casper ML, McClellan WM: Association of the insulin resistance syndrome and microalbuminuria among nondiabetic native Americans: the Inter-Tribal Heart Project. *J Am Soc Nephrol* 13:1626–1634, 2002
5. Burrows NR, Geiss LS, Engelgau MM, Acton KJ: Prevalence of diabetes among Native Americans and Alaska Natives, 1990–1997: an increasing burden. *Diabetes Care* 23:1786–1790, 2000
6. Pioro MP, Dyck RF, Gillis DC: Diabetes prevalence rates among First Nations adults on Saskatchewan reserves in 1990: comparison by tribal grouping, geography and with non-First Nations people. *Can J Public Health* 87:325–328, 1996
7. Rowley KG, Iser DM, Best JD, O'Dea K, Leonard D, McDermott R: Albuminuria in Australian Aboriginal people: prevalence and associations with components of the metabolic syndrome. *Diabetologia* 43:1397–1403, 2000
8. Elbagir MN, Eltom MA, Elmahadi EM, Kadam IM, Berne C: A high prevalence of diabetes mellitus and impaired glucose tolerance in the Danagla community in northern Sudan. *Diabet Med* 15:164–169, 1998
9. el Mugamer IT, Ali Zayat AS, Hossain MM, Pugh RN: Diabetes, obesity and hypertension in urban and rural people of

bedouin origin in the United Arab Emirates. *J Trop Med Hyg* 98:407–415, 1995

10. Chen HD, Shaw CK, Tseng WP, Chen HI, Lee ML: Prevalence of diabetes mellitus and impaired glucose tolerance in Aborigines and Chinese in eastern Taiwan. *Diabetes Res Clin Pract* 38:199–205, 1997
11. Bangladesh Bureau of Statistics: *Statistical Pocket Book of Bangladesh, 2000*. Singha AC, Ed. Dhaka, Bangladesh, Statistical Division, Ministry of Planning, Government of the People's Republic of Bangladesh, 2000
12. Expert Committee on the Diagnosis and Classification of Diabetes Mellitus: Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus (Position Statement). *Diabetes Care* 20: 1183–1197, 1997
13. Morris JA, Gardner MJ: Calculating confidence interval for relative risks (odds ratios) and standardized ratios and rates. *Br Med J* 296:1313–1316, 1988
14. Mahtab H, Sayeed MA, Khanam PA, Ahsan KA, Alam Khan AKMS, Azad Khan AK: Prevalence of diabetes using fasting blood glucose: an appraisal of fasting value (Abstract). *Diabetologia* 45 (Suppl. 2): A297, 2002
15. Sayeed MA, Mahtab H, Khanam PA, Latif ZA, Ali SM, Banu A, Ahren B, Azad Khan AK: Diabetes and impaired fasting glycemia in a rural population of Bangladesh. *Diabetes Care* 26:1034–1039, 2003
16. Sayeed MA, Ali L, Hussain MZ, Rumi MAK, Banu A, Azad Khan AK: Effect of socioeconomic risk factors on the difference in prevalence of diabetes between rural and urban populations of Bangladesh. *Diabetes Care* 20:551–555, 1997
17. Pan XR, Li GW, Hu YH, Wang JX, Yang WY, An ZX, Hu ZX, Lin J, Xiao JZ, Cao HB, Liu PA, Jiang XG, Jiang YY, Wang JP, Zheng H, Zhang H, Bennett PH, Howard BV: Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance: the Da Qing IGT and Diabetes Study. *Diabetes Care* 20:537–544, 1997
18. Astrand PO: Physical activity and fitness: physical activities and carbohydrate metabolism. *Am J Clin Nutr* 55:1231S–1265S, 1992
19. Lovejoy J, Di Girolamo M: Habitual dietary intake and insulin sensitivity in lean and obese adults. *Am J Clin Nutr* 55: 1174–1179, 1992
20. O'Dea K, Spargo RM, Nestel PJ: Impact of Westernization on carbohydrate and lipid metabolism in Australian aborigines. *Diabetologia* 22:148–153, 1982
21. McKeigue PM, Shah B, Marmot MG: Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians. *Lancet* 337:382–386, 1991
22. McKeigue PM, Pierpoint T, Ferrie JE, Marmot MG: Relationship of glucose intolerance and hyperinsulinemia to body fat pattern in South Asians and Europeans. *Diabetologia* 35:785–791, 1992