Prevalence of Glucose Intolerance in Asian Indians

Urban-rural difference and significance of upper body adiposity

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OBJECTIVE — To evaluate the prevalence of NIDDM and IGT in the urban and rural areas in southern India.

RESEARCH DESIGN AND METHODS — Two populations of the same ethnic background, but different socioeconomic background were chosen for this study. Nine-hundred urban people and 1038 rural subjects were studied. Fasting and 2-h post-glucose capillary blood samples after a 75 g oral glucose load (WHO criteria) were obtained in these randomly selected adults (≥20 yr of age).

RESULTS — Using the WHO criteria, the prevalence of NIDDM, adjusted to the age of the respective general population, was 8.2% in the urban and 2.4% in the rural populations. The prevalence was 8.4 and 7.9%, respectively, in urban men and women, and 2.6 and 1.6% in rural men and women. The age-adjusted prevalence of IGT was 8.7 and 7.8% in the urban and rural areas, respectively. The prevalence of IGT was 8.8% in urban men and 8.3% in women; the corresponding values for rural men and women were 8.7 and 6.4%. The prevalence of NIDDM increased with age, markedly so in the urban people. The urban-rural difference was significant for NIDDM ($\chi^2 = 29.4, P < 0.001$) but not for IGT. In the urban population, 65% of the NIDDM patients were known cases, whereas in the rural area, the known cases accounted for only 24%. Bivariate analysis showed an association of BMI, STR, and WHR with prevalence of NIDDM plus IGT. In the multiple logistic regression analysis, age, BMI, STR, and WHR were associated significantly with glucose intolerance in the urban population, whereas only age was significant in the rural population. The best predictors of NIDDM were age, BMI, WHR, and urbanization.

CONCLUSIONS — The study showed a high prevalence of NIDDM in the urban southern Indian population. The prevalence of NIDDM in the same ethnic group in rural areas was significantly lower. The prevalence of IGT was similar in both populations. Upper body adiposity was a significant predictor of NIDDM in this population with low rates of obesity.

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NIDDM, NON-INSULIN-DEPENDENT DIABETES MELLITUS; IGT, IMPAIRED GLUCOSE TOLERANCE; WHO, WORLD HEALTH ORGANIZATION; BMI, BODY MASS INDEX; STR, SUBSCAPULAR-TRICEPS RATIO; WHR, WAIST-TO-HIP-RATIO; GTT, GLUCOSE TOLERANCE TEST; CI, CONFIDENCE INTERVAL; NS, NO SIGNIFICANCE; FI, FAMILY INCOME; PA, PHYSICAL ACTIVITY; OR, ODDS RATIO.

Migrant Indians in different parts of the world have a high risk of NIDDM (1–4), which may be attributable to environmental factors or inherent genetic susceptibility to NIDDM. Previously, it was shown that the prevalence of NIDDM is high in urban areas, even within the Indian subcontinent, by two studies; a study where the subjects were tested with oral glucose load (5), and the other where an analysis of known NIDDM was made (6). The prevalence reported in these two studies was higher compared with that published 15 yr ago from India (7). This increase may be related to the changing life-style in this country, especially in urban areas. These factors may become apparent when rural and urban populations of the same ethnic background are screened for diabetes. In this study, we report on the prevalence of glucose intolerance in urban and rural populations in Tamil Nadu state in southern India.

RESEARCH DESIGN AND METHODS

Description of populations and sample selection

Two populations with considerable socioeconomic differences but belonging to the same ethnic background (southern Indian, Dravidian) were chosen for the survey. The urban population was located in Madras. The majority were Hindus (92%), Christians formed the next largest group (5%), and Muslims formed a small minority (2%). The literacy rate was high. The staple food of the people was rice. The population studied consisted mostly of businessmen, traders, professionals, clerical workers, manual laborers, and their families.

Details of the population were obtained from the Directorate of Census, Madras. From a total of 86 census divisions, 5 were selected at random. From each of these areas, every third parallel street was selected for survey. A total of 20 streets was included. We conducted a preliminary door-to-door survey along these streets with details of name, sex, age, and door numbers. All persons ≥20 yr of age were eligible for the survey. During this operation, informed consent was obtained for participation in the survey. Tests were done on Sundays in a community hall or a volunteer's house. We sought the help of the local general medical practitioners and local public leaders to ensure good cooperation.

The rural population was chosen from a group of villages in Sriperumbudur, 40 miles from Madras. The villagers were agricultural laborers and represented the low-income group of rural India. Their staple food was ragi (a cheap cereal); and their consumption of vegetables and protein was inadequate. Their literacy rate was extremely low. A private international voluntary organization has adopted this population for implementing several welfare measures, including health care. Accurate basic demographic data of this rural population thus was readily available from the peripheral medical units of the organization, data that otherwise would have been difficult to ascertain in rural India. We obtained a good response because of the good rapport between this organization and the villagers. From the total of 20 serially numbered villages, every 4th village was selected. Every 5th member of the population ≥20 yr of age from a continuous roll was included in the study. Fifteen auxillary nurses and a medical officer from the voluntary organization worked with the survey team. They informed the selected subjects of the date and time of the study by house visit. A six-member survey team from the diabetes centre in Madras, consisting of nutritionists, doctors, and laboratory technicians, visited the field on the days of the survey.

Survey procedure

Similar procedures were followed in both populations, based on the WHO recommendations (8). All the tested persons were fasted overnight (minimum 10 h), and the period of fasting was ascertained by questioning the study subjects prior to registration. After registration, fasting capillary blood glucose (finger prick) was measured by Reflolux II (Boehringer Mannheim, Germany), using glucose oxidase test strips. A 75 g anhydrous glucose load then was given orally in 250 ml of water. A capillary glucose sample was taken again 2 h later. Capillary blood sampling was done by one person throughout the study to avoid interpersonal error. All glucose measurements were made by only one technician on a single Reflolux II. Known NIDDM patients were instructed not to take their drugs 2 days before the test, and they also underwent a GTT. In a subsample (every 10th person), blood samples were drawn in fluoride tubes for estimations of plasma glucose in the laboratory at the Diabetes Research Centre. The samples were kept in ice boxes soon after collection, transported to the centre within 6 h, and estimations were carried out the same day. Plasma glucose was estimated in the laboratory by glucose oxidase method (GOD-PAP Kit, Boehringer). Correlation (r value) between capillary blood glucose measurements at the survey sites and venous plasma glucose oxidase estimations done at the diabetes center were: urban fasting, $r = 0.92$, post glucose, $r = 0.94$; and rural fasting, $r = 0.84$, post glucose, $r = 0.90$. The corresponding regression equations were $y = 0.45 + 0.93x$, $y = 1.9 + 0.76x$, $y = 1.3 + 0.91x$, and $y = 1.3 + 0.82x$, taking the capillary glucose values on y axis. Diagnosis of diabetes was made if the post-glucose value was ≥11.1 mM, and a diagnosis of IGT was made if the postglucose value was ≥7.8 mM but <11.1 mM.

During the survey, a detailed case history was recorded that included family income and educational status. Physical activity was assessed based on the type of occupation and the information regarding the time spent on other activities. In the questionnaire, details of occupation, periods spent on desk work, and manual labor were ascertained. Similarly, time spent on house work and outdoor activity, especially for nonemployed individuals, was assessed. All subjects finally were divided into four categories of physical activity, namely, sedentary (executives and elderly), light (housewives and clerks), moderate (skilled workers), and heavy (manual laborers and agricultural workers). Clinical examination included measurements of height, weight, skinfold thickness, and hip and waist measurements. Skinfold thickness was measured in the right subscapular and right triceps sites using Holtain skinfold calipers (Holtain Ltd, Crymmych U.K.). Waist and hip girths were measured with the subject standing wearing thin clothes. Waist was defined as the smallest girth between the costal margin and iliac crests and hip as the circumference at the level of the greater trochanters. The mean of two readings was taken in every case for calculating the STR and WHR. All readings were taken by two trained nutritionists throughout the survey.

Some 60–70 individuals were tested each survey day. This was carried out in 1988–1989 and took 1 yr 3 mo to complete. Information on each subject was recorded on a computerized data sheet. The data were stored, processed, and analyzed with a BPL Sanyo PC/XT computer.

Statistical methods

Comparison between the group means was done with Student's t test. χ^2 and CIs were done wherever relevant. The prevalence adjusted to the age distribution of the Tamil Nadu population (1981 census) was calculated by the direct standardization method (9). The prevalence of diabetes in various migrant Indians was adjusted to the age of our standard population using the data available from the tables in the respective papers. Stratification was done by 10 yr age-groups.

For analyzing the association of BMI, STR, and WHR with the prevalence of diabetes plus IGT, the age-adjustment was done as follows: the mean values for

Table 1—*Comparison of the urban and rural population*

	Urban			Rural		
	Total	Men	Women	Total	Men	Women
N	900	457	443	1038	520	518
Age (yr)	38 ± 12	40 ± 11	37 ± 12	41 ± 15	41 ± 15	41 ± 15
Ht (cm)	161 ± 9	168 ± 6.5	154 ± 5.8	157 ± 9	163 ± 7	150 ± 6
Wt (kg)	59.5 ± 11	63.4 ± 10	55.4 ± 10.5	44.8 ± 8*	47.3 ± 7*	42.3 ± 8*
BMI (kg/m^2)	23 ± 4	22.5 ± 3.5	23.4 ± 4	18.3 ± 2.7*	17.6 ± 2.2*	18.7 ± 3*
Obese (*n*) (≥25 for women) (≥27 for men)	194; 22%	46; 10%	148; 33%	20; 2%	0	20; 4%
STR	1.6 ± 0.5	1.7 ± 0.5	1.4 ± 0.4	1.3 ± 0.3†	1.4 ± 0.3†	1.2 ± 0.2†
WHR	0.86 ± 0.1	0.9 ± 0.1	0.8 ± 0.07	0.85 ± 0.07	0.88 ± 0.05	0.82 ± 0.07
Family income (rupees)	3136 ± 1622	3151 ± 1624	3121 ± 1621	254 ± 100†	274 ± 104†	234 ± 91*
Blood glucose (mM)						
Fasting	5.5 ± 1.7	5.6 ± 1.9	5.4 ± 1.6	4.9 ± 1.7	5.1 ± 1.8	4.7 ± 1.6
2-h post glucose	6.8 ± 3.5	7.0 ± 3.9	6.6 ± 3.2	5.8 ± 2.2*	5.8 ± 2.3†	5.7 ± 2.0*

Values are means ± SE.
*P < 0.001, compared with urban.
†P < 0.01, compared with urban.

the above parameters for the nondiabetic, normal group were calculated for urban and rural men and women separately. Using the mean values as the cut-off points, the prevalence of abnormal glucose tolerance in the two categories (<mean and ≥mean) was calculated for the respective parameters in each age-group. Age-adjusted prevalence of abnormal glucose tolerance in relation to the presence of family history of NIDDM also was calculated in urban men and women separately. Prevalence of NIDDM and IGT was taken together because of the small numbers of NIDDM alone in several age-groups, especially in the rural population. In the rural population, no data on the family history of diabetes was available.

Multiple logistic regression analysis was conducted to look for the association of various parameters with glucose intolerance using SPSS package. Separate regression analysis was done including either STR or WHR as the adiposity index to avoid the confounding effect of colinearity. Regression analyses for rural and urban populations were done separately, abnormal glucose tolerance (NIDDM plus IGT) as dependent variable, and for the total population using diabetes as dependent variable. All parameters were categorical for the regression analysis. Details are provided in the tables. Because family income was uniformly low in the rural group, it was not used as a variable in the analysis. Unless otherwise stated, a statistical significance indicates $P < 0.05$.

RESULTS— A total of 900 urban and 1038 rural subjects were tested. The response rate was 91% in the urban population and 88% in the rural population.

Table 1 shows a comparison of the urban and rural populations tested. Among the urban population, 64% had completed high school, 33% had higher education, and the remaining had not gone to school. Among the rural, 95% had only elementary school education, 5% had not gone to school, and none had higher education.

The age-specific prevalence of NIDDM and IGT in both populations are presented in Table 2. The prevalence of both increased with age.

Men and women with glucose intolerance (NIDDM plus IGT) had a significantly higher ($P < 0.001$) mean age in both populations (urban-normal vs. glucose intolerance; men 38 ± 11 vs. 46 ± 10 yr; women, 36 ± 11 vs. 46 ± 15 yr; rural-men, 39 ± 15 vs. 52 ± 15 yr; women, 40 ± 15 vs. 51 ± 14 yr).

Age-adjusted prevalence of NIDDM and IGT in the urban and rural populations are shown in Table 3. The prevalence of diabetes was higher in the urban men and women compared with the rural population (men 8.4% vs. 2.6%, $\chi^2 = 14.2$, $P < 0.001$; women 7.9% vs. 1.6%, $\chi^2 = 21.1$, $P < 0.001$).

The prevalence of diabetes in various migrant Indians, age-adjusted to our standard population, is shown in Table 4 for comparison.

In the urban subjects, 65% of the NIDDM patients were already known cases, whereas only 24% of the rural subjects had been detected earlier. The ratio of new to known NIDDM in the

Table 2—*Age-specific prevalence of diabetes and IGT*

	Urban					Rural				
		NIDDM (%)		IGT (%)			NIDDM (%)		IGT (%)	
	M:W tested (n)	M	W	M	W	M:W tested (n)	M	W	M	W
Age-group (yr)										
20–24	40:49	—	2.0	—	2.0	83:79	—	—	1.2	2.5
25–34	88:165	1.1	0.6	6.8	7.9	107:104	1.9	—	5.6	1.9
35–44	190:141	10.5	5.7	6.8	6.4	106:112	3.8	0.9	5.6	1.2
45–54	108:41	18.5	12.2	17.6	14.6	122:108	1.6	3.7	9.8	10.0
55–64	17:28	11.8	25.0	11.8	3.6	56:60	3.6	1.7	17.9	6.7
>64	14:19	28.6	26.3	21.4	26.3	46:55	8.9	0.9	26.0	14.5
Total	457:443	10.3	6.1	9.4	7.9	520:518	2.7	2.1	9.0	6.6
CI		7.5–13.1	3.9–8.3	6.7–12.1	4.7–11.1	—	1.3–4.1	0.9–3.3	6.6–11.4	4.5–7.7

20–34 yr, 35–54 yr, and ≥55 yr age-groups were 2:1, 0.6:1, and 0.3:1, respectively, in the urban population. The corresponding numbers in the rural population were 2:0, 1.2:1, and 11:1. Of the 48 known NIDDM patients in the urban population, 6 were on diet therapy, 40 were taking oral hypoglycemic agents, and 2 were taking insulin. In the rural population of the 6 known cases, 2 were on diet therapy, one was taking oral drugs, and 3 were receiving insulin therapy.

Table 3—*Age-adjusted prevalence of NIDDM and IGT in the two populations*

		Prevalence (%)	
	n	NIDDM	IGT
Urban			
Total	900	8.2	8.7
Men	457	8.4	8.8
Women	443	7.9	8.3
Rural			
Total	1038	2.4	7.8
Men	520	2.6	8.7
Women	518	1.6	6.4

NIDDM, urban vs. rural, $\chi^2 = 29.4$, $P < 0.001$; IGT, urban vs. rural, NS; NIDDM, urban vs. rural men, $\chi^2 = 14.2$, $P < 0.001$; IGT, urban vs. rural men, NS; NIDDM, urban vs. rural women, $\chi^2 = 21.1$, $P < 0.001$; IGT, urban vs. rural women, NS.

Family history of diabetes, ascertained by a questionnaire, was present in 226 urban subjects (25%), of whom 53 persons had glucose intolerance (33 with NIDDM and 20 with IGT). Age-adjusted prevalence of glucose intolerance was significantly higher among men with family history of diabetes compared with those without family history, whereas the difference was not significant in women (men $\chi^2 = 6.93$, $P = 0.008$; women $\chi^2 = 0.009$, NS). It was not possible to ascertain any data regarding the family history in the rural population because of their poor educational status and lack of awareness regarding the disorder.

Figures 1 and 2 show the distribution of the fasting and postglucose blood glucose, respectively, in the urban and rural populations tested. Among the normoglycemic subjects, the mean fasting and postglucose blood glucose values were lower in the rural population (fasting, 5.5 ± 1.7 vs. 4.9 ± 1.7 mM, $P < 0.001$; 2-h post-glucose, 6.8 ± 3.5 vs. 5.8 ± 2.2 mM, $P < 0.001$, in the urban and rural, respectively).

Table 5 shows the association of BMI, STR, and WHR with age-adjusted prevalence of abnormal glucose tolerance (NIDDM plus IGT) in urban and rural men and women separately. A significant association was noted between the prevalence of abnormal glucose tolerance and increasing BMI and WHR in urban men and women. In urban women, STR also showed a significant association. In rural men, none of the three parameters were

Table 4—*Age-adjusted prevalence (%) of NIDDM in various migrant Indian populations compared with results of this study*

	Urban		Rural	
	M	W	M	W
Madras (this study)	8.4	7.9	2.6	1.6
Mauritian Hindus	11.9	9.0	—	—
Fiji Indians	14.4	12.6	13.7	13.2
Tanzanians	7.3	7.7	1.0	0.8
Southall Asians	8.9 (total)	—	—	—

Standard population is the Tamil Nadu Census 1981. For information on Mauritian Hindus see ref. 18, on Fiji Indians see ref. 2, on Tanzanians see ref. 15, on Southall Asians see ref. 1.

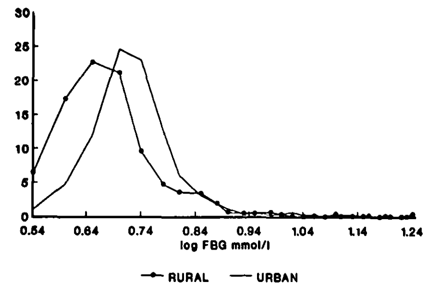

Figure 1—*Distribution of fasting blood glucose in the urban and rural populations studied. X axis shows log distribution of the fasting glucose (FBG mM) values. The distribution of persons in percentages is shown on the y axis.*

associated with the prevalence rate; but in rural women, the association with increasing BMI and WHR was significant.

Multiple logistic regression analysis showing the association of various parameters with glucose intolerance (NIDDM plus IGT) is presented in Table 6. Age was associated significantly with glucose intolerance in both populations. In the urban group, BMI, STR, and WHR were associated significantly with glucose intolerance. In the rural population, only age showed a significant association to glucose intolerance. In the logistic analysis using NIDDM alone as the dependent variable (Table 7), urbanization and age showed a significant association. When WHR was included in the analysis, WHR and BMI were associated significantly with diabetes, whereas when STR and BMI were included, only BMI showed a positive association.

CONCLUSIONS— We have tested two groups of a population, homogeneous with respect to ethnic background, but differing in their socioeconomic status. The urban population was fairly affluent, educated, and most had sedentary living habits. On the other hand, the rural population was poor, many were illiterate, and many were hard-working laborers. The prevalence (age-adjusted) of NIDDM was strikingly different in the two socioeconomic groups (8.2% in the urban and 2.4% in the rural populations).

Table 5—*Association of BMI, WHR, and STR to the age-adjusted prevalence of abnormal glucose tolerance (NIDDM plus IGT)*

		% Prevalence (95% CI)			
	Mean	<Mean	≥Mean	x^2	*P*
Urban men					
BMI (kg/m²)	22.3	11.0 (7–15)	25.7 (21.7–29.7)	16.1	0.0002*
STR	1.7	20.4 (16.4–24.4)	18.9 (15.1–22.7)	0.07	0.078
WHR	0.90	11.0 (8–14)	22.9 (19.3–26.5)	10.4	0.002*
Urban women					
BMI (kg/m²)	22.3	9.7 (4.7–14.7)	17.4 (13.4–20.4)	5.9	0.015*
STR	1.32	10.4 (6.4–14.4)	17.9 (12.9–22.9)	4.83	0.026*
WHR	0.8	7.8 (4.2–11.4)	18.2 (14.0–22.4)	8.9	0.003*
Rural men					
BMI (kg/m²)	17.9	16.0 (12–20)	13.1 (10.5–15.7)	1.92	0.163
STR	1.42	13.0 (10–16)	16.4 (13.4–19.4)	0.89	0.34
WHR	0.88	16.2 (13.2–19.2)	14.0 (11.2–16.8)	0.85	0.35
Rural women					
BMI (kg/m²)	18.5	6.2 (3.1–9.3)	14.2 (11.2–17.2)	11.07	0.0009*
STR	1.2	9.4 (6.2–11.6)	11.6 (8.6–14.6)	0.88	0.35
WHR	0.82	7.4 (4.4–10.4)	12.8 (10.0–15.6)	6.41	0.001*

*Significant.

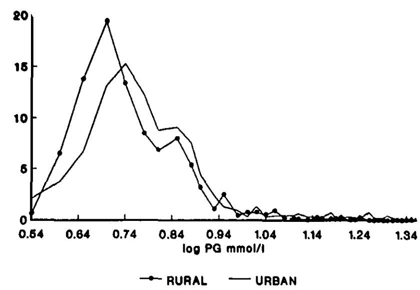

Figure 2—*Distribution of 2-h postglucose blood glucose in the urban and rural populations. (PG), 2-h post glucose value.*

Recent studies have confirmed that the prevalence of NIDDM among migrant Indians in different parts of the world was significantly higher than the host populations (1–4). This might be explained by a high genetic susceptibility to the development of NIDDM among Asian Indians. However, a common environmental factor cannot be ruled out. If urbanization contributes to the development of NIDDM, a high prevalence of the disease would be expected in urban Indians in India itself. So far little data has been published on this. This study illustrates that the prevalence of NIDDM in urban areas in India is comparable with that of migrant Indians of the same age-group (Table 3). This also is supported by our earlier report of 5% diabetes prevalence in a township in southern India representing a semiurban population (5).

This is the first study in India to show the ratio of newly detected to known NIDDM in urban and rural areas. In the urban population, the ratio of new to known was 1:2, and in the rural population it was reversed 3:1. The ratio thus seems to be related to the socioeconomic status of the population. In the rural areas, the awareness of diseases and health consciousness is poor. Medical help will be sought only for acute disability or painful chronic diseases. In the villages under the care of the voluntary organization, deaths from diseases such

Table 6—*Multiple logistic regression in urban and rural populations; dependent variable: NIDDM plus IGT*

	Urban							Rural					
	Independent variables							Independent variables					
	Age	Sex	FI	PA	BMI	STR	WHR	Age	Sex	PA	BMI	STR	WHR
B	0.564	−0.179	0.039	−0.039	0.324	0.220	—	0.465	−0.470	−1.23	0.202	0.106	—
Z	6.67*	−0.80	0.47	−0.28	3.77*	2.94*	—	5.19*	−1.83	−0.98	1.70	0.92	—
OR	1.757	0.836	1.04	0.962	1.382	1.246	—	1.592	0.625	0.884	1.224	1.112	—
CI	1.489	0.538	0.884	0.736	1.168	1.076	—	1.335	0.378	0.692	0.969	0.887	—
OR	2.074	1.298	1.225	1.258	1.636	1.442	—	1.90	1.033	1.130	1.545	1.394	—
	Likelihood ratio, 92.3							Likelihood ratio, 60.6					
B	0.503	0.225	0.033	−0.019	0.237	—	0.583	0.460	−0.492	−0.120	0.181	—	0.081
Z	5.77*	0.86	0.39	−0.14	2.64*	—	3.92*	5.09*	−1.84	−0.96	1.48	—	0.44
OR	1.653	1.252	1.034	0.981	1.268	—	1.792	1.584	0.611	0.887	1.199	—	1.084
CI	1.394	0.748	0.877	0.748	1.063	—	1.339	1.327	0.362	0.694	0.943	—	0.759
OR	1.961	2.094	1.218	1.285	1.512	—	2.40	1.892	1.031	1.132	1.524	—	1.548
	Likelihood ratio, 99.3							Likelihood ratio, 59.9					

*Significant; all are categorical variables.

Categories of variables: Rural 1; Urban 2. Sex, M 1, F 2. Age, groups of 10 yr. BMI, groups - 3 U. STR, 0.3 U. WHR, 0.1 U. FI, 1000 rupees. PA: (1), sedentary; (2), light; (3), moderate; (4), heavy.

B, coefficient; Z, standard normal variate.

as NIDDM were recorded and could not contribute to the lower prevalence rate noted in the study. It illustrates the high number of undetected cases of NIDDM in the rural population, and indeed, this may be true of populations in other developing countries. As we obtained slightly lower 2-h blood glucose values at the survey sites, even after using the regression equation for the correction, it likely caused an underestimation of abnormal glucose tolerance.

Although the prevalence of NIDDM was nearly fourfold higher in the urban population, the prevalence of IGT was not significantly different from the rural population (8.7 and 7.8% in the urban and rural areas, respectively). The high prevalence of IGT in the urban and rural populations in India assumes great importance in that it represents a large

Table 7—*Multiple logistic regression analysis: dependent variable - NIDDM*

	Independent variables						
	Rural-urban	Age	Sex	PA	BMI	STR	WHR
B	0.825	0.699	−0.440	−0.061	0.346	0.168	—
Z	1.9*	7.34*	−1.71	−0.44	3.34*	1.83	—
OR	2.282	2.011	0.644	0.941	1.414	1.183	—
CI OR	0.975–5.341	1.669–2.424	0.389–1.066	0.721–1.229	1.153–1.732	0.987–1.416	—
				Likelihood ratio, 134.7			
B	0.930	0.643	−0.094	−0.053	0.262	—	0.555
Z	2.21*	6.59*	−0.33	−0.39	2.45*	—	3.28*
OR	2.534	1.903	0.911	0.948	1.30	—	1.742
CI OR	1.112–5.773	1.572–2.304	0.522–1.588	0.724–1.241	1.054–1.603	—	1.251–2.428
				Likelihood ratio, 142.2			

*Significant; all are categorical variables.

Categories of variables: Rural 1; Urban 2. Sex M 1, F 2. Age, groups of 10 yr. BMI, groups - 3 U. STR, 0.3 U. WHR, 0.1 U. PA: (1), sedentary; (2), light; (3), moderate; (4), heavy.

B, coefficient; Z, standard normal variate.

group of subjects at high risk of developing NIDDM (10–14). No other study to date from India compares the prevalence of IGT in urban and rural populations. Zimmet et al. (2) noted a high prevalence of abnormal glucose tolerance (NIDDM plus IGT) in Fiji Indians, and the lack of urban-rural difference in this group was attributed partly to their strong genetic background for the disease. Swai et al. (15) found a very high prevalence of IGT (21.5%) among the expatriate Indian Muslim community in Tanzania. The study from Mauritius also described a high prevalence of IGT and NIDDM in three major ethnic groups living there, including Indians, and this was believed to be a reflection of a recent NIDDM epidemic (16). The similar prevalence of IGT in the urban and rural areas in this study are consistent with the hypothesis that both populations have a high genetic susceptibility to develop carbohydrate intolerance, and it is the environmental factors associated with urbanization that lead to diabetes.

Many epidemiological studies have shown an association between WHR and NIDDM (17–19). Haffner et al. (17) found that both STR and WHR were associated with risk of NIDDM in Mexican Americans, and that WHR was more predictive than STR. Ohlson et al. (18) demonstrated in a prospective study that a high WHR is a predictor of NIDDM independent of the degree of obesity. In this study, the mean BMI of the urban population was only 22.3 kg/m^2, which was much lower than that of the western populations (20); and in the rural population, it was lower still (18.0 kg/m^2). In the urban population, the BMI and the indexes of upper body adiposity, STR, and WHR, were associated with glucose intolerance, thereby showing the association between the above parameters with glucose intolerance even in a population with relatively low rates of obesity. However, the association is absent when the mean BMI decreases further, as in the rural population. Family income and physical activity failed to show significant association.

While identifying a high prevalence of NIDDM in the urban population and a low prevalence in the rural population, this study found a similar high prevalence of IGT in both. It is possible that with increasing urbanization and life expectancy, the prevalence of NIDDM in India could increase further.

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