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High prevalence of metabolic syndrome & its correlates in two tribal populations of India & the impact of urbanization

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***Background & objectives*: Metabolic syndrome is one of the major causes of morbidity and mortality in the world. The prevalence of this syndrome is high among Asians, including Indians, and is rising, particularly with the adoption of a modernized life style. Whether traditional societies in India have a low prevalence and the extent to which a transition to a modern life style contributes to the increase in prevalence are unknown. To examine the role of environmental and genetic factors in metabolic syndrome we conducted a study in two sub-Himalayan tribal populations with shared ancestry (Toto and Bhutia). The Toto live exclusively in a rural area, whereas a section of the Bhutia has adopted a modern life style.**

***Methods*: Fasting (12 h) blood samples of Toto (n=258); rural Bhutia (n=75) and urban Bhutia (n=230) were collected, with written informed consent. Lipid profile, blood pressures, body fat and other anthropometric parameters were assessed. Criteria suggested by National Cholesterol Education Programme (NCEP) Adult Treatment Panel III (2001) were used for assessment of metabolic syndrome.**

***Results*: The prevalence of metabolic syndrome was high (about 30-50%) among the Bhutia, with no significant rural-urban difference. Among the Toto, though the prevalence of metabolic syndrome was low (about 4-9%), their lipid levels were alarmingly adverse (about 37-67% had low HDL-cholesterol or high triglyceride levels). There was an additional adverse impact of adoption of urban life-styles (perhaps primarily mediated through dietary changes) on cardiovascular risk factors.**

***Interpretation & conclusion:* Our study suggested that metabolic syndrome and its correlates could be a major health problem even in traditional societies, indicating that this syndrome was not necessarily a result of modernization. Further, our study indicates that genetic factors that adversely affect the levels of such variables have long antiquities in Indian ethnic groups.**

Key words India - metabolic syndrome - tribal population - urbanization

Epidemiological studies have recorded a high prevalence of metabolic syndrome[1-3] and cardiovascular mortality[4-6] among Indians, including those settled outside of India. Adverse body fat distribution, especially abdominal adiposity, seems to be an important determinant. A recent review[7] has

concluded that lifestyle factors alone or modulated by inherited factors appear to play an important role, because obesity and dyslipidaemia become worse with urbanization and migration. Even though the prevalence of metabolic syndrome, obesity and dyslipidaemia are known to vary across defined ethnic groups[8], most epidemiological studies have been conducted in conglomerate populations without considering ethnicity of the sampled individuals[2,9]. With a view to assess the relative roles of environmental (modernization) vis-à-vis genetic factors in the determination of metabolic syndrome and other known risk factors of cardiovascular disease, we undertook a study of two tribal groups of India - Toto and Bhutia - who share a common ancestry and live in a similar ecological habitat (rural sub-Himalayan region). A large fraction of one tribe (Bhutia) has adopted a modern life style and lives in an urban area. The *a priori* expectation, if indeed environmental factors are of primary importance, is that the prevalence of dyslipidaemia, diabetes and metabolic syndrome will be low and of similar magnitude among the Toto and rural Bhutia (since these are traditional societies) and higher among the urban Bhutia. If genetic factors are important, then the Toto and rural Bhutia will have prevalence of a similar magnitude (because of shared ancestry).

Material & Methods

Two tribal groups - Toto and Bhutia - were chosen for this study as these are claimed to have descended from a common ancestral population[10]. Despite sharing a common ancestry, there are considerable demographic, economic and cultural dissimilarities between them. The Toto are a demographically small population and have passed through demographic bottlenecks, but are now an expanding population. As per 1901 census[10], their population size was 171, but currently the number (as counted in this study) is 1206 (637 males and 569 females). The Bhutia, on the other hand, are a large population and number several million. The Toto are geographically localized in a single village (Totopara) of Jalpaiguri district of West Bengal, bordering Bhutan. The Bhutia are geographically widely distributed - throughout Bhutan and Sikkim, as well as in the hill subdivisions of Darjeeling district of West Bengal. The Toto are exclusively rural, while the Bhutia live in both rural and urban habitats. As a result of urbanization, dietary habits and life styles of the Bhutia have changed in recent decades. Both the Toto and the rural Bhutia are predominantly engaged in agri-horticultural activities and also work as agricultural labourers, and therefore undergo a lot of physical exercise, especially because of the lack of flat agricultural terrain. However, it must be mentioned that many rural Bhutia do not themselves physically participate in agricultural activities, but engage hired Nepalese labourers. The urban Bhutia, on the other hand, are predominantly white-collar workers or are engaged in petty businesses of various types or work as drivers of vehicles, and therefore do not undergo much physical exercise. Both Toto and Bhutia possess Mongoloid morphological features and speak dialects that belong to the Tibeto-Burman linguistic family. While among the Toto first-cousin (cross-cousin, but not parallel-cousin) marriages are preferred, the Bhutia do not practice inbreeding. Both Bhutia and Toto consume large quantities of red meat. The Bhutia, but not the Toto, also consume large quantities of milk products.

After obtaining institutional ethical approval, data and blood samples were collected from all Totos above 12 yr of age, numbering 570 individuals. However, data and blood samples could be collected only from 430 individuals (213 males and 217 females). The period of data and sample collection was October 2002 to March 2003. The primary reasons were (*i*) illness (mainly fever and gastrointestinal ailments) prevailing during the period of blood collection, (*ii*) unwillingness to remain in a fasting condition for 12 h, and (*iii*) temporary migration to upper terraces of the hilly region for agriculture, making it impossible for us to collect and transport blood samples. Many sampled individuals were first-degree relatives, therefore only 283 individuals (133 males and 150 females) who were not first-degree relatives, were included in the study. Bhutia both urban and rural living in Sikkim were studied. Inclusion criterion for urban Bhutia was that the individual should have been living in Gangtok, the capital town of Sikkim located in the East district, or vicinity for at least 10 yr continuously. A total of 75 unrelated (not first-degree

relatives) individuals (29 males and 46 females) were included from the rural habitat (Ralong revenue block, located in the South district), and 230 individuals (102 males and 128 females) from the urban habitat. Self-reported ages of the individuals were cross-ascertained with reference to the major local events or with reference to the traditional Bhutia calendar, especially when date of birth records were unavailable.

From each individual, after obtaining written informed consent relevant demographic data and life style information were collected using a questionnaire. Demographic information included age, gender, education, marital status, nature and degree of consanguineous relationship between spouses, numbers of living and dead children, ages of children, *etc*. Life style information included occupation, food habits and tobacco and alcohol usage. Anthropometric data were collected from each individual using standard methodology[11]. These measurements included height (measured using an anthropometric rod manufactured by Siber Hegner & Co., Switzerland), weight (measured using a standard bathroom scale), waist circumference (WCIR) and hip circumference (HCIR) (measured by using nonelastic tape), skinfold thicknesses (measured using a Lange skinfold caliper, Beta Technology Inc., California, USA) at several sites that included biceps (BSF), triceps (TSF), abdomen (ASF), subscapular (SSSF), and suprailiac (SUSF). Blood pressure, systolic (SBP) and diastolic (DBP) was measured, using a mercury sphygmomanometer, in sitting position. Blood pressure was measured twice, with an interval of 5 min of resting between measurements and the average value was taken.

A 12 h fasting blood sample (10 ml, in two aliquots - one aliquot in EDTA and another without anti-coagulant) - was collected from each individual by venipuncture. Clinical biochemisty analyses were performed, and levels of the following parameters were determined: fasting blood glucose (FBG), total cholesterol (TC), high-density lipoprotein cholesterol (HDLC), low-density lipoprotein cholesterol (LDLC), very low-density lipoprotein cholesterol (VLDLC) and triglycerides (TG). FBG was measured using 'Accutrend Alfa' glucometer (Boehringer Mannheim, Germany). Lipid levels were measured using a Toshiba (Japan) autoanalyzer or a Reltech-Crony 640 (Italy) semi-autoanalyzer, using Roche (Switzerland) Kits (VLDLC value was obtained by subtraction of HLDC and LDLC values from TC).

To assess differences in mean values of biochemical variables between groups, Student's t-test was used. However, before using the t-test, the biochemical variables were adjusted for the effects

Table I. Percentages of sampled individuals belonging to various age groups, by gender among urban and rural Bhutia and Toto

Age group (yr)	Bhutia						Toto		
	Urban			Rural					
	Male (n=488)	Female (n=555)	Total (n=1043)	Male (n=174)	Female (n=149)	Total (n=323)	Male (n=637)	Female (n=569)	Total (n=1206)
0-4	2.78	2.30	5.08	0.62	0.31	0.93	6.96	7.21	14.17
5-9	3.55	2.39	5.94	1.86	0.62	2.48	8.79	7.63	16.42
10-14	3.36	5.08	8.44	1.24	1.55	2.79	6.73	6.05	12.78
15-19	4.51	7.09	11.60	1.24	0.93	2.17	5.89	4.98	10.87
20-24	4.22	6.90	11.12	9.29	9.29	18.58	5.56	4.64	10.20
25-29	6.33	8.24	14.57	8.67	6.19	14.86	2.98	3.48	6.46
30-34	4.99	4.02	9.01	5.57	3.10	8.67	4.64	4.15	8.79
35-39	3.55	3.07	6.62	2.79	2.78	5.57	3.18	2.90	6.06
40-44	3.07	3.16	6.23	4.02	4.34	8.36	3.07	1.82	4.89
45-49	2.01	2.11	4.12	2.79	2.47	5.26	1.41	1.41	2.82
50-54	1.92	2.11	4.03	4.64	3.72	8.36	1.24	0.99	2.23
55-59	2.40	2.20	4.60	4.64	4.03	8.67	1.33	0.99	2.24
≥ 60	4.12	4.51	8.63	6.50	6.81	13.31	1.08	0.99	2.07

Table II. Levels of blood pressure and clinical biochemistry parameters among the Toto and the Bhutia, by age group and gender

Variable	Age group (yr)	Toto (n=258) M (n=127)	Toto (n=258) F (n=131)	Bhutia Urban (n=230) M (n=102)	Bhutia Urban (n=230) F (n=128)	Bhutia Rural (n=75) M (n=29)	Bhutia Rural (n=75) F (n=46)
SBP (mm/Hg)	20-29	121.4±1.27 n=47	120.2±1.13 n=58	124.8±3.68 n=9	119.2±2.23 n=25	123.2±3.43 n=5	119.6±0.29 n=7
	30-39	121.8±1.24 n=40	120.9±0.97 n=50	132.2±3.03 n=23	124.6±2.30 n=37	128.3±4.33 n=4	121.0±4.32 n=6
	40-49	125.6±2.98 n=27	122.8±3.06 n=17	134.5±2.51 n=27	125.7±2.98 n=25	131.0±2.65 n=4	124.4±3.36 n=12
	≥ 50	121.0±2.18 n=13	124.0±3.13 n=6	143.8±2.93 n=43	142.9±2.63 n=41	133.6±2.50 n=16	142.5±3.40 n=21
DBP* (mm/Hg)	20-29	85.3±8.31	75.6±0.79	80.1±3.13	78.9±1.64	77.4±2.75	77.4±1.49
	30-39	77.4±0.86	77.5±0.70	88.7±1.92	80.9±1.44	79.0±4.64	75.3±2.52
	40-49	80.0±1.61	76.0±1.52	87.1±1.59	82.7±1.58	83.3±1.11	80.7±1.36
	≥ 50	76.6±1.64	75.3±2.30	89.0±1.52	87.7±1.54	82.3±1.58	86.1±1.32
TC* (mg/dl)	20-29	145.2±3.99	157.1±4.96	182.7±9.16	184.8±3.78	171.8±5.08	174.9±6.10
	30-39	159.4±4.19	153.2±4.82	198.3±5.48	185.7±3.86	186.0±8.80	178.8±5.93
	40-49	163.5±7.14	172.4±14.75	214.3±9.06	193.9±4.56	198.0±18.01	190.1±10.20
	≥ 50	149.1±10.87	183.3±10.10	198.8±3.89	193.9±5.60	180.0±5.56	193.5±7.38
HDLC* (mg/dl)	20-29	37.5±1.28	44.7±1.35	35.1±0.93	36.3±0.82	35.6±0.68	36.1±1.24
	30-39	43.3±1.85	46.9±1.96	36.2±0.85	35.5±0.67	37.3±1.03	36.6±1.02
	40-49	45.1±3.23	43.3±3.33	38.7±1.02	37.5±0.75	38.0±1.58	38.3±1.03
	≥ 50	45.7±4.46	49.2±3.75	37.3±0.60	37.1±0.73	36.1±0.75	37.7±0.75
LDLC* (mg/dl)	20-29	79.3±3.51	87.2±4.00	117.5±6.20	122.2±2.87	113.0±4.13	122.6±4.82
	30-39	86.5±3.07	75.4±3.56	119.4±3.00	121.8±2.85	123.0±5.45	97.7±17.45
	40-49	88.9±5.49	94.5±10.18	140.2±6.06	122.9±3.69	130.3±15.26	119.2±4.25
	≥ 50	71.6±6.58	103.2±7.79	125.9±3.19	128.8±4.42	116.6±4.95	126.9±6.50
VLDLC* (mg/dl)	20-29	28.4±1.36	25.3±1.29	30.0±4.81	26.3±1.78	22.6±2.29	16.1±1.71
	30-39	29.7±1.58	30.8±2.06	42.7±4.01	27.9±1.26	25.8±4.35	26.3±2.56
	40-49	29.6±3.16	34.5±5.12	37.3±3.37	32.2±2.56	29.8±5.41	32.7±7.34
	≥ 50	31.6±4.21	31.0±4.80	35.6±2.17	27.6±1.06	27.0±4.03	28.8±3.82
TG* (mg/dl)	20-29	144.1±7.12	134.2±7.78	150.0±24.05	131.6±8.90	113.0±11.47	80.7±8.55
	30-39	150.6±8.35	159.9±0.83	213.5±20.04	139.3±6.29	128.8±21.73	131.7±12.82
	40-49	156.6±22.21	158.2±23.66	187.8±16.69	162.8±12.49	148.8±27.03	163.3±36.72
	≥ 50	172.0±27.76	156.7±24.20	178.0±10.80	141.2±5.41	142.5±22.21	144.2±19.10
FBG* (mg/dl)	20-29	78.5±2.40	74.9±1.99	89.8±5.37	86.4±2.73	94.8±3.84	94.7±5.91
	30-39	79.7±1.79	79.8±1.90	90.2±3.13	92.8±4.06	94.7±6.97	109.3±6.33
	40-49	80.3±2.59	80.1±2.65	101.1±8.12	91.4±3.55	96.3±4.87	106.6±3.80
	≥ 50	82.2±3.96	85.7±3.66	113.1±8.76	92.8±2.54	106.3±2.26	107.2±2.88

Values are mean ± SE; *Sample sizes are the same as for SBP; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; HDLC, high density lipoprotein cholesterol; LDLC, low density lipoprotein cholesterol; VLDLC, very low density lipoprotein cholesterol; TG, triglycerides; FBG, fasting blood glucose

of various covariates. For this, the effects of age, $(age)^2$ and gender were regressed out. From the values of biochemical variables, adjusted for the linear and non-linear effects of age, the effects of significant body measurements were regressed out using a stepwise regression analysis. t-tests were then performed to compare the mean values, between groups, of the biochemical variables adjusted for age, gender and significant body measurements.

Results & Discussion

The age- and gender-distributions among the Toto and Bhutia (urban and rural) were markedly different in character. While the Totos had 43.37 per cent individuals in the younger (0-14 yr) age groups, the corresponding figures for rural and urban Bhutia were 6.20 and 19.46 per cent, respectively. Further, while Totos had only 6.54 per cent individuals in the older

Table III. Percentages of unrelated adults suffering from metabolic syndrome and above the thresholds of the variables that comprise the syndrome among Toto and Bhutia by gender

Metabolic syndrome criteria	Toto (n=283)		Bhutia rural (n=75)		Bhutia urban (n=230)	
	M (n=133)	F (n=150)	M (n=29)	F (n=46)	M (n=102)	F (n=128)
WC (M >102 cm; F >88 cm)	0.00	1.53	0.00	17.39	3.92	47.66
TG (≥ 150 mg/dl)	47.24	36.64	27.59	23.91	64.71	37.50
HDLC (M <40 mg/dl; F <50 mg/dl)	53.54	66.41	82.76	100.00	64.71	99.22
SBP (≥130 mm/Hg)	18.11	11.45	55.17	52.17	60.78	46.09
DBP (≥ 85 mm/Hg)	16.54	9.92	34.48	36.96	60.78	39.06
FBG (≥ 110 mg/dl)	3.15	0.76	20.70	41.30	19.61	7.03
BMI (≥ 28.8 kg/m^2)	0.00	0.00	13.79	6.52	12.74	17.97
Metabolic syndrome	8.70	3.80	27.60	52.20	34.30	48.40

WC, waist circumference; TG, triglycerides; HDLC, high density lipoprotein cholesterol; SBP & DBP, systolic & diastolic blood pressures; FBG, fasting blood glucose; BMI, body mass index

Table IV. Effects of age, age^2 and sex for all log-transformed values of blood pressures and clinical biochemistry parameters, separately for Toto and Bhutia

Variables	Toto						Bhutia					
	Age		Age^2		Sex		Age		Age^2		Sex	
	t+	*P* value	t+	*P* value	t+	*P* value	t+	*P* value	t+	*P* value	t+	*P* value
SBP	0.151	0.880	0.005	0.996	1.007	0.315	0.837	0.403	0.846	0.398	1.972	0.050*
DBP	0.545	0.586	-0.594	0.553	1.929	0.055	2.785	0.006*	-1.897	0.059	2.574	0.011*
TC	2.098	0.037*	-1.850	0.065	-1.053	0.293	2.783	0.006*	-2.573	0.011*	1.914	0.057
HDLC	1.824	0.069	-1.418	0.157	-3.021	.003*	1.785	0.075	-1.510	0.132	0.226	0.821
LDLC	0.866	0.387	-0.865	0.388	-0.086	0.932	1.041	0.299	-0.802	0.423	0.693	0.489
VLDLC	1.583	0.115	-1.402	0.162	0.659	0.511	3.773	0.000*	-3.735	0.000*	4.233	0.000*
TG	1.170	0.243	-1.054	0.293	0.664	0.507	3.950	0.000*	-3.879	0.000*	4.201	0.000*
FBG	1.329	0.185	-0.899	0.369	0.616	0.539	1.657	0.099	-1.071	0.285	1.375	0.170

+Value of t-test statistic for the significance of the corresponding regression coefficient
*statistically significant
Abbreviations as in Table II

(>50 yr) age group, the rural and urban Bhutia had 30.34 and 17.26 per cent individuals, respectively (Table I). However, there were no significant differences between the ethnic groups in the proportions of individuals belonging to reproductive age groups. These distributions indicated that the Toto are a demographically expanding population, while the Bhutia are an aging population.

The distributions of values of blood pressures, lipid levels and fasting blood glucose (Table II) and some relevant anthropometric variables were used to estimate the prevalence of metabolic syndrome (also called Syndrome X). For defining metabolic syndrome, we used the criteria suggested by the National Cholesterol Education Program (NCEP) Adult Treatment Panel-III (2001)[12]. An individual was said to be suffering from metabolic syndrome if the individual satisfied at least three of the following five criteria: (*i*) waist circumference >102 cm (for a male) or >88 cm (for a female); (*ii*) triglyceride level >150 mg/dl; (*iii*) HDL cholesterol level <40 mg/dl (for a male) or <50 mg/dl (for a female); (*iv*) blood pressure (SBP/DBP) >130/85 mm/Hg; and (*v*) fasting glucose >110 mg/dl. In Table III are presented the proportions of individuals who exceeded the cut-off values of the variables considered to define the metabolic syndrome, among the Toto and the Bhutia (urban and rural), and the percentages of individuals suffering from metabolic syndrome. It was seen that the presence of metabolic syndrome was alarmingly high (approximately 30-50%) among both the rural and the urban Bhutia. Further, the prevalence was higher among females (about 50%) than among males (about 30%). While the prevalence of metabolic syndrome was not so high among the Toto, their lipid levels were alarmingly adverse (Table III).

As the Toto and the Bhutia are thought to have descended from a common ancestral population, it was expected that the Toto and the section of the Bhutia who share a rural habitat will largely have similar health and lipid profiles, while the section of the Bhutia who has been living in an urban habitat will show significant differences because of the impact of urbanization. The prevalence of metabolic syndrome among the urban and the rural Bhutia was found to be similar, but different from that of the Toto (Table III). However, since the cut-off points used in defining metabolic syndrome are not age-specific (*i.e.*, uniform across adults), more rigorous statistical analyses were done. The effects (linear and

Table V. Anthropometric measurements (log-transformed) that are significant predictors of blood pressures and clinical biochemistry parameters (standardized for age and gender effects) separately for Toto and Bhutia

Variables	Toto			Bhutia		
	Significant predictor(s)	t*	*P* value (df=256)	Significant predictor(s)	t*	*P* value (df=303)
SBP	ASF	2.333	0.020	BMI	3.357	0.001
DBP	-	-	-	WCIR	4.440	0.000
TC	BSF	2.218	0.027	SUSF	2.867	0.004
HDLC	HCIR	-1.985	0.048	-	-	-
LDLC	HCIR	2.183	0.030	SUSF	4.223	0.000
				BMI	-2.926	0.004
VLDLC	WCIR	2.770	0.006	BMI	4.080	0.000
TG	WHR	3.250	0.001	BMI	3.904	0.000
FBG	-	-	-	BMI	3.447	0.001

*Value of t-test statistic for the significance of the corresponding regression coefficient
ASF, abdomen skinfold thickness; BSF, biceps skinfold thickness; HCIR & WCIR, hip & waist circumference; SUSF, suprailiac skinfold thickness; BMI, body mass index
Other abbreviations same as in Tables II & III

non-linear) of age and gender on the different variables were investigated and adjusted for the significant effects. Age and gender effects were more pronounced among the Bhutia than among the Toto (Table IV). The effects of various anthropometric variables on blood pressures and biochemical variables (log-transformed) indicated that while BMI was a significant predictor of systolic blood pressure and biochemical variables (LDLC, VLDLC, TG and FBG) in case of Bhutias, waist and hip circumferences or their ratio (WHR) were significant predictors of the majority of biochemical variables considered among the Totos (Table V). It appeared that among the Totos central obesity was a significant correlate of lipid and blood sugar levels, while among the Bhutias overall adiposity and obesity measures were the significant correlates.

The mean values of blood pressures and other clinical biochemistry parameters standardized for age, gender and significant anthropometric correlates were compared between Totos and rural Bhutias, and also between rural and urban Bhutias. Results showed that for some important clinical biochemistry variables both pairs of comparisons show significant differences (Table VI).

This study of two tribal populations, believed to have descended from a common ancestral population and resident in the same ecological region (sub-Himalayan region) of India, has been conducted to investigate the possible influence of genetic and environmental factors on parameters of cardiovascular risk (blood pressures, blood lipids, blood glucose and obesity). It is to be noted that even though the two populations share a common genetic ancestry, they have experienced markedly dissimilar socio-demographic histories. Bhutia showed a relatively more adverse cardiovascular risk profile compared to the Toto, as measured by blood pressure, blood lipids and blood glucose. Bhutia had higher mean values in majority of the traits considered, except HDLC, irrespective of age groups and gender. Urban Bhutia had generally higher values compared to rural Bhutia, irrespective of gender. The Bhutia - both males and females, and both rural and urban - had a much higher prevalence of metabolic syndrome compared to the Toto. The prevalence of metabolic syndrome was not significantly higher among urban Bhutia compared to their rural counterparts. When Toto and rural Bhutia were compared (Table VI), the rural Bhutia showed significantly higher values of all variables, except TG, that underlie the definition of metabolic syndrome. Statistically significant differences existed between the Toto and the rural Bhutia in respect of TG, VLDLC and FBG (Table VI). While mean TG and VLDLC values in younger as well as older age groups were higher among the Toto as compared with the Bhutia, the reverse was true in case of FBG. This indicates that triglyceridaemia poses a problem among the Toto. On the contrary, among the Bhutia hyperglycaemia was prevalent.

Table VI. Tests of differences in mean values of standardized variables between Totos and rural Bhutias, and between rural and urban Bhutias

Variables	Toto vs. Bhutia (rural)		Bhutia - Rural vs. Urban	
	t*	*P* value (df = 331)	t*	*P* value (df = 331)
SBP	0.919	0.359	-1.165	0.245
DBP	1.446	0.149	-1.815	0.070
TC	1.370	0.172	-1.789	0.075
HDLC	-0.464	0.643	0.576	0.565
LDLC	1.637	0.103	-2.413	0.016*
VLDLC	3.077	0.002*	-4.360	0.000*
TG	2.815	0.005*	-3.996	0 .000*
FBG	94.405	0.000*	3.854	0.000*

*Value of t-test statistic; *statistically significant. Abbreviations as in Tables II-IV

Urban Bhutia significantly differed from their rural counterparts in respect of LDLC, VLDC, TG and FBG. Urban Bhutia had higher mean values compared to rural Bhutia in respect of all these traits in both younger and older age groups, except in FBG.

Different definitions of the term metabolic syndrome have been proposed including different sets of variables by various organizations, such as National Cholesterol Education Program (NCEP), World Health Organization (WHO), International Diabetes Federation (IDF), American Association Clinical Endocrinology (AACE) and EGIR (European Group of Insulin Resistance). The IDF, in April 2005, has proposed a "consensus" definition[13] of metabolic syndrome in which cut-off thresholds have been made geography and ethnicity (race) specific. Our study also showed that uniform cut-off thresholds may not be applicable across various ethnic groups.

The present study revealed that metabolic syndrome (or its contributing variables) could be a major health problem even in traditional rural ethnic groups, indicating that this syndrome was not necessarily a result of modernization or urbanization. Further, our study indicated that genetic factors that adversely affect the levels of such variables have long antiquities in Indian ethnic groups. An additional adverse impact of adoption of urban life styles (perhaps primarily mediated through dietary changes) was also apparent on cardiovascular risk factors and metabolic syndrome.

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