Body fat and cardiovascular risk factors in Indian men in three geographical locations

Himangi Govind Lubree, Sonali Suresh Rege, Dattatry Shivram Bhat, Kondiram Namdeo Raut, Anjali Panchnadikar, Charudatta Vaman Joglekar, Chittaranjan Sakarlal Yajnik, Prakash Shetty, and John Yudkin

Abstract

We studied cardiovascular risk factors in 149 rural, 142 slum dwellers, and 150 urban middle class Indian men (30 to 50 years, mean 40 years) in relation to their body fat. Mean body mass index (BMI) was 21.0, 22.3, and 24.3 kg/m² and mean body fat percent (bioimpedance) was 20.4, 22.5, and 30.4, respectively. A 75g oral glucose tolerance test showed no diabetes in rural subjects; 4% of urban slum dwellers and 10% of urban middle class men were diabetic. Hypertension (blood pressure ≥ 140/90 mm Hg) was present in 2% of the rural, 4% of the urban slum, and 10% of the urban middle class men. All cardiovascular risk factors were strongly related the percentage of body fat and waist to hip ratio. Two hour plasma glucose concentration and blood pressure were, in addition, independently related to geographical location (urban middle class were higher than slums who were higher than rural men). Our results suggest that urbanization increases the risk of hyperglycemia and hypertension independent of the percentage of body fat or its central distribution.

Key words: insulin resistance syndrome (IRS), coronary heart disease (CHD), body fat, oral glucose tolerance test, India

Introduction

India is experiencing an epidemic of type 2 diabetes, insulin resistance syndrome (IRS), and coronary heart disease (CHD) among its young adult and middle-aged population. It is projected that by the year 2020 India will have the highest number of diabetic patients anywhere in the world and that CHD will be the leading cause of premature death [1]. There is a striking excess in the prevalence of these conditions in urban compared to rural Indians. In a recent study of 38 year-old fathers of 8 year-old children in urban Pune, 8% were diabetic and 16% had impaired glucose tolerance (IGT) in the middle class men and 12% were diabetic and 18% IGT in slum dwellers. In another study in a nearby village (Pimpale Jagtap) only 4% of those over 40 years of age (mean 55 years) were diabetic and 4% had IGT [2, 3]. These findings suggest an increase in prevalence of insulin resistance syndrome in the near future with continuing rural to urban migration. The cause of this 'epidemic' is not clear but the major contributors to this are postulated to be the urban lifestyle as well as high genetic susceptibility of the population resulting in increased body fat percent and central adiposity, the main determinants of both diabetes and CHD.

Himangi Govind Lubree, Sonali Suresh Rege, Dattatry Shivram Bhat, Kondiram Namdeo Raut, Anjali Panchnadikar, Charudatta Vaman Joglekar, Chittaranjan and Sakarlal Yajnik are affiliated with the Diabetes Unit, King Edward Memorial Hospital Research Centre, Rasta Peth in Pune India. Prakash Shetty is affiliated with the London School of Hygiene and Tropical Medicine in London, UK. John Yudkin is affiliated with the International Health and Medical Education Centre, UCL, in London, UK.

Research design and methods

We studied 150 men each (30 to 50 years of age) from three different geographical locations: rural, urban slums, and urban middle class who were selected by multi-stage random sampling.

Population sampling

The King Edward Memorial (KEM) Hospital and Research Centre is a tertiary care hospital with a rural outreach program in surrounding villages. We selected one geographical area in the vicinity of the Vadu Rural Health Centre. Of the six villages where we had conducted a community-based study of maternal nutrition and fetal growth, we selected randomly two villages. The villages were comprised of hamlets, which were listed, and five hamlets each were selected randomly from the two villages. A house-to-house survey was

done in these five hamlets to create a list of all men between the ages of 30 and 50 years from which the proposed number was selected.

The city of Pune is divided into 124 administrative wards. Four wards were selected randomly. Two wards were selected for the study of subjects living in the slums and two for studying middle class subjects. More than 1,000 houses were surveyed. A list of eligible men who were willing to participate in the study was created from which subjects were randomly selected.

Anthropometry

Height was measured using a stadiometer (CMS Instruments, London, UK), and weight using portable sohnell scales. Biceps, triceps, subscapular, and suprailiac skinfold thicknesses were measured on the left side of the body using Harpenden skinfold callipers (CMS Instruments). Head, mid-upper-arm circumference (MUAC), waist, and hip circumference were measured using a standard measuring tape. Fat mass was calculated from the sum of four skinfold thicknesses using Durnin's formula ((4.95/density) − 4.5) × 100, where density = (1.1599 − (0.0717 × $\log_{10}$ sum of four skinfolds) [4]. The percentage of body fat was calculated using bioimpedance values and by the deuterated water method.

Laboratory methods

An 75 g oral glucose tolerance test (OGTT) [5] was done. Plasma glucose, cholesterol, triglycerides, and HDL-cholesterol were measured using standard enzymatic methods, and leptin concentrations using radioimmuno assay.

Statistical method

Data are represented by means and standard deviations unless or otherwise noted. Variables having skewed distributions have been log transformed to satisfy assumptions of normality. The comparisons across geographical locations have been made using ANOVA (analysis of variance).

Results and discussion

A study of the migration pattern across the geographical location revealed that 75% (table 1) of urban slum dwellers had migrated at least once in their lifetime as opposed to the rural and urban middle class who were more stable (40% and 31%, respectively).

Table 2 summarizes the lifestyles of the study population. Urban middle class men were more educated than their two counterparts while the percentage of those unemployed was similar in rural, urban slums, and urban middle class populations (3.1, 2.9, and 3.3, respectively). Alcohol consumption and smoking was higher in the urban slums (50.7 and 38.7, respectively).

The mean ages were 38 ± 5.9, 38 ± 5.9, and 41 ± 5.9 in rural, urban slum, and urban middle class men, respectively. The urban middle class men had the highest BMI (24.3 ± 3.9) followed by urban slum (22.3 ± 4.1) and rural (21.0 ± 2.8) men. The urban middle class men had greater subscapular and triceps skinfold thicknesses than the urban slum and rural populations (22.5 and 13.1, 15.9 and 9.0, 12.4, and 7.9, respectively)

Table 3 shows the anthropometric characteristics of the study groups. The urban middle class men had a higher percentage of body fat than those in the urban slums, while the rural men had the lowest percentage

TABLE 1. Migration history

	Rural (N = 149)	Urban Slums (N = 142)	Urban (N = 150)
Born and studied in the same geographical location (%)	75.8	42.2	76.0
Migrated at least once (%)	40.3	75.3	31.3
Years in the place of study	31	25	34

TABLE 2. Lifestyle

	Rural (N =149)	Urban Slums (N = 142)	Urban (N = 150)
Addicting habits (current)			
Smoking (%)	23.5	38.7	26.2
Tobacco chewing (%)	62.4	60.6	28.9
Mishri[a] (%)	55.7	26.1	12.1
Alcohol (%)	19.5	50.7	42.3
Education			
Mean years of education	7	7	14
No schooling (%)	23.1	18.9	0.6
Primary school (%)	34.7	34.5	2.7
Middle school (%)	12.6	23.7	17.3
Secondary school (%)	25.3	20.1	35.3
Intermediate (%)	—	0.7	4.7
Graduate (%)	3.2	0.7	26.7
Postgraduate (%)	1.1	1.4	12.7
Employment			
Unemployed (%)	3.1	2.9	3.3
Skilled (%)	9.5	12.9	28.0
Semi-skilled (%)	7.4	33.1	28.7
Unskilled (%)	80.0	51.1	40.0

a. Mishri is burned tobacco applied to teeth.

of fat. This holds true for the waist to hip ratio (WHR) as well as subscapular to triceps ratio (SSTR) (table 4). The total percentage of body fat was calculated by three different methods, and there was a good correlation between all of them (table 5).

Urban middle class men had higher glucose, cholesterol, triglyceride, and leptin concentrations than the other groups. There was no significant difference in the blood pressure between the three groups (table 6). Many of the insulin resistance syndrome outcome variables were higher in the urban middle class population and least in the rural population (table 7).

TABLE 3. Anthropometric characteristics

	Rural (N = 149)	Urban Slums (N = 142)	Urban (N = 150)
Age (yr)	38 (5.9)	38 (5.9)	41 (5.9)
Height (cm)	165.0 (5.6)	163.4 (6.5)	166.2 (6.8)
Weight (kg)	57.4 (8.4)	59.8 (12.5)	67.3 (12.1)
BMI (kg/m^2)	21.0 (2.8)	22.3 (4.1)	24.3 (3.9)
Head circumference (cm)	54.1 (2.2)	54.6 (1.7)	55.6 (1.6)
Mid arm circumference (cm)	26.3 (2.4)	27.4 (3.5)	28.9 (3.2)
Waist circumference (cm)	79.4 (9.1)	83.7 (14.1)	90.4 (10.2)
Hip circumference (cm)	88.1 (5.6)	90.9 (7.9)	96.0 (7.6)
Biceps (mm)[a]	4.1 (2.1–15.4)	5.1 (2.0–18.1)	6.9 (2.2–24.1)
Triceps (mm)[a]	7.9 (3.2-26.5)	9.0 (3.4-31.6)	13.1 (3.3-40.0)
Subscapular (mm)[a]	12.4 (5.1–40.0)	15.9 (4.8–48.6)	22.5 (8.0–46.4)
Suprailiac (mm)	15.8 (9.7)	18.7 (10.8)	26.6 (9.5)

Mean (SD).
a. Geometric mean, range.

TABLE 4. Body fat and its distribution

	Rural	Urban Slums	Urban
% Body fat			
Anthropometry	19.6 (5.8)	21.8 (6.6)	27.4 (5.3)
D2O	19.9 (6.2)	21.6 (6.9)	27.2 (7.1)
Bioimpedance	20.4 (10.2)	22.5 (10.9)	30.4 (8.1)
Weight:hip ratio	0.89 (0.06)	0.92 (0.09)	0.94 (0.09)
Subscapular:triceps ratio[a]	1.5 (0.6–3.7)	1.8 (0.9–3.2)	1.7 (0.6–4.2)
Leptin (ng/ml)[a]	1.8 (0.2–22.0)	3.9 (0.1–42.0)	7.6 (0.5–50.0)

Mean (SD).
a. Geometric mean, range.

TABLE 5. Spearman correlations for body fat and leptin

	% Body fat			
	Anthropometry	D_2O	Bioimpedance	Leptin
% Body fat				
Anthropometry	1	0.80**	0.84**	0.72**
D_2O	0.80**	1	0.81**	0.64**
Bioimpedance	0.84**	0.81**	1	0.70**
Leptin (ng/ml)*	0.72**	0.64**	0.70**	1

* $p < .05$, ** $p < .01$, *** $p < .001$.

TABLE 6. Insulin resistance syndrome

Outcome (%)	Rural (N = 149)	Urban slums (N = 142)	Urban (N = 150)
Impaired glucose tolerance	9	12	20
Diabetes mellitus	0	4	10
Hypertension (≥ 140/90 mmHg)	2	4	10
Cholesterol			
Total ≥ 200 mg	3.4	8.7	14.8
HDL ≤ 35 mg	44.6	48.4	52.1
Triglycerides ≥ 150 mg	6.1	19.8	26.8

Conclusion

The percentage of body fat and central adiposity significantly increased from rural to the urban middle class men through the urban slum dwellers. An increased percentage of body fat predicted an increased insulin resistance and other cardiovascular risk factors. Central adiposity (waist:hip ratio and subscapular:triceps ratio) made a significant but relatively smaller contribution to this risk compared to the percentage of body fat.

Our results suggest that urbanization increases the percentage of body fat and central adiposity. Together these factors make a major contribution to the rise in the prevalence of insulin resistance syndrome. Body fat and its distribution do not account for all the geographic differences. Other environmental factors may also contribute to the rising prevalence of insulin resistance syndrome in India.

TABLE 7. Insulin resistance syndrome variables

	Rural (N = 149)	Urban Slums (N = 142)	Urban (N = 150)
Glucose (mg%)			
Fasting	91 (10.7)	94 (14.4)	99 (25.8)
30 minutes	152 (29.1)	156 (34.3)	163 (43.7)
120 minutes	102 (25.3)	117 (40.5)	136 (58.7)
Cholesterol (mg%)			
Total	148 (25.6)	153 (31.1)	164 (34.0)
HDL	38 (9.6)	39 (12.1)	36 (10.1)
Triglycerides[a]	82 (31–319)	95 (38–680)	108 (26–940)
Blood Pressure (mmHg)			
Systolic	113 (9.6)	115 (11.3)	118 (14.3)
Diastolic	66 (7.9)	70 (8.5)	74 (10.0)
Leptin (ng/m	1.8 (0.2–22.0)	3.9 (0.1–42.0)	7.6 (0.5–50.0)

Mean (SD).
a. Geometric mea range.
All blood measurements were on plasma samples.

TABLE 8. ANOVA (independent variable = geographical location)

	2 hour glucose	Systolic blood pressure	Cholesterol	Triglycerides
Location	9.1**	3.86 ns	4.7 ns	5.1 ns
Age (yr)	1.2 ns	0.08*	0.3 ns	0.2 ns
Body fat (%)	6.4***	7.70***	11.5***	13.5 ***
R^2 (%)	16.7	12.64	16.5	19.6
Location	9.1**	3.86 ns	4.7 ns	5.1 ns
Age (yr)	1.2 ns	0.01*	0.4 ns	0.2*
Body fat (%)	6.4***	8.77***	11.4***	13.9***
WHR	1.3*	0.56 ns	0.3 ns	2.2**
R^2 (%)	18.0	13.2	16.8	21.4
Location	9.1*	3.86 ns	4.7 ns	5.1 ns
Age(yr)	1.2 ns	0.01*	0.4 ns	0.2 ns
Body fat (%)	6.4***	8.77***	11.4***	13.9***
SSTR	1.9**	0.06 ns	0.0 ns	1.3**
R^2 (%)	18.5	12.7	16.5	20.5

Figures in table indicate percent contribution to R^2 values.
* $p < .0$, ** $p < .01$, *** $p < .001$, ns, not significant, SSTR, subscapular: tricepts ratio

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