Association of Obesity with Coronary Risk Factors in the North Indian Bhatia Community: Jaipur Heart Watch-3

Rajeev Gupta, Mukesh Sarna, Priyanka Rastogi, Vijay Kaul and V.P. Gupta

INTRODUCTION

Obesity is a major cardiovascular risk factor. In developed countries it has been identified by multiple studies that increasing body weight and obesity are associated with increase in many proximate coronary risk factors such as high blood pressure, diabetes and insulin resistance, high total and low-density lipoprotein (LDL) cholesterol, low high density lipoprotein (HDL) cholesterol and triglycerides (WHO, 2000). All these risk factors translate into greater incidence of coronary heart disease (CHD) in the obese subjects (Abbasi et el., 2002; Grundy, 2002). In developing countries too we have hypothesized that rural to urban migration and consequent increase in CHD is basically due to increase in obesity (generalized or visceral) secondary to decreased physical activity and increase in consumption of calories in urban subjects (Deedwania and Gupta, 2004). Generalised and/ or visceral obesity results in increase in various major coronary risk factors and CHD (Fig. 1).

In Jaipur Heart Watch-1 (JHW-1) we studied prevalence of CHD and coronary risk factors in urban and rural populations of Rajasthan in early 1990's using cross-sectional survey design and stratified random sampling (Gupta et al., 1994; Gupta et al., 1995). Comparison of urban-rural differences identified that risk factors more prevalent in urban subjects (obesity, truncal obesity, hypertension, LDL cholesterol, diabetes, and low HDL cholesterol) could be important to explain greater CHD in urban Indians (Gupta and Gupta, 1997b). To evaluate serial changes in the major coronary risk factors in the same urban population, though not the same subjects, we performed a repeat cross-sectional survey the Jaipur Heart Watch-2 (JHW-2) using similar methodology in late 1990's (Gupta et al., 2002). This study reported a significant increase in prevalence of obesity, hypertension, diabetes and lipid abnormalities in the Jaipur population.

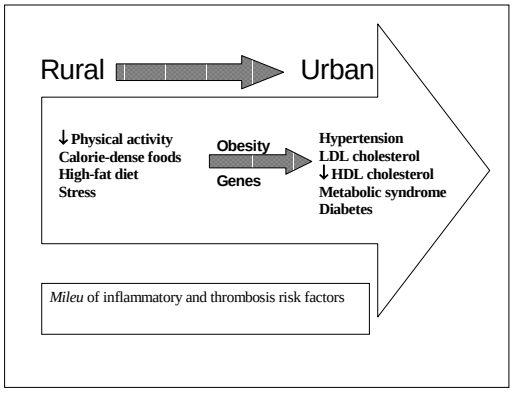

Fig. 1. Urbanization is a major coronary risk factor among developing countries of Asia and Africa. As populations move from rural to urban lifestyles, there is change in dietary habits and physical activity, resulting in population-wide increases in important coronary risk factors. These factors act conjointly with multiple thrombosis and inflammatory risk factors in precipitating various manifestations of atherosclerosis.

Studies have reported that there is difference in prevalence of coronary risk factors and CHD among emigrant Indian sub-communities. Ramaiya et al. (1991, 1995) reported that coronary risk factors were more prevalent in Patel (Gujarati) and Bhatia (Punjabi) communities living in Tanzania. Bhopal et al (1999) reported a greater prevalence of risk factors among Bangladeshi emigrants as compared to Pakistani and Indian subjects in UK. In India it has been reported that Gujaratis living in Delhi have a greater coronary risk factor profile as compared to local communities and there was no difference in risk factors among Hindu and Muslim communities (Chadha et al., 1992; Gopinath et al., 1995). Gupta et al. (2000) did not report any significant differences in coronary risk factors in Hindu and Muslim communities in Jaipur. A higher prevalence of hypertension in Parsi community in Bombay has been reported (Bharucha and Kuruvilla, 2003). Migrant studies reported a greater prevalence of coronary risk factors among the North Indian Bhatia community in Tanzania and Britain (Ramaiya et al., 1995). The city of Jaipur has a large numbers of subjects of this community. Therefore to evaluate the prevalence of various coronary risk factors in randomly selected sample of Bhatia community in Jaipur and using the methodology of JHW-2 we preformed an

epidemiological study-Jaipur Heart Watch-3 (JHW-3).

METHODS

The study was approved by the institution ethics committee. A proforma was prepared that incorporated information regarding demographic, anthropometric and clinical data (Gupta et al., 1995; Gupta et al., 1997a). This included the family history of hypertension and CHD, various life-style factors such as education and type of job. Details of major cardiovascular risk factors such as smoking, alcohol intake, amount of physical activity, diabetes and hypertension were inquired. The physical examination emphasized measurement of height, weight, waist-hip ratio (WHR) and blood pressure. Height was measured in centimetres and weight in kilograms using calibrated spring-balance. Supine waist girth was measured at the level of umbilicus with person breathing silently and standing hip girth was measured at inter-trochanteric level according to the World Health Organisation (WHO, 1995) guidelines. The blood pressure was measured using standard mercury manometer. At least two readings at 5 minutes intervals as per WHO guidelines were recorded (Rose et al., 1982). If a high blood pressure (≥140/90) was noted a third reading was taken after 30 minutes. The lowest of the three readings was taken as blood pressure. A 12-lead routine electrocardiogram was performed on all persons using proper standardization. Fasting blood sample was obtained from all the individuals for estimation of glucose, total, HDL and LDL cholesterol and triglycerides using the previously standardised techniques (Gupta et al., 1997a).

Unlike the JHW-1 and JHW-2 studies (Gupta et al., 1995; Gupta et al., 1997a; Gupta et al., 2002) which were population based, this study was designed to investigate people of a single community in Jaipur (JHW-3). We studied Bhatia populations in colonies of Jawahar Nagar, Janta Colony, and Adarsh Nagar. Details of the Bhatia subjects in these locations were available from the Bhatia community register maintained at Bhatia Bhawan, Jaipur. Community register lists 800 families living in the area. The target subjects were adults ≥20 years as used in earlier studies and from the lists 1600 subjects were identified. In this pilot phase, we randomly selected 600 subjects (300 men, 300 women) employing the random number technique on the member's lists. This sample size was considered adequate for identification of major coronary risk factors. The formulae for calculation of the sample size have been reported earlier. The study was preceded by meetings with local leaders who cooperated in identifying and ensuring participation of selected subjects.

Diagnostic Criteria: Smokers in India consume tobacco in various forms- rolled tobacco leaves (bidi), Indian pipe (chillum, hookah), cigarettes and tobacco-chewing -and more than one form is used by many making it difficult to accurately measure the amount of tobacco consumed. Therefore, users of all types of tobacco products and present and past smokers have been included in smoker category. The diagnostic criteria for tobacco use as well as other coronary

Table 1: Prevalence of major coronary risk factors

Risk factors	*Men (n=226)*	*Women (n=232)*	*Total (n=458)*
CHD in 1° relatives	45 (19.9)	50 (21.6)	95 (20.7)
Diabetes family history	96 (42.5)	77 (33.2)	173(37.8)
Known CHD	7 (3.1)	11 (4.7)	18 (3.9)
Sedentary habits (work or leisure)	82(36.3)	73 (31.5)	155 (33.8)
Smoking/tobacco use	59(26.1)	4 (1.7)	63 (13.7)
Regular alcohol use	35(15.5)	2 (0.9)	37 (8.1)
Obesity. BMI ≥25 kg/m^2	123(54.0)	161(69.4)	284(62.0)
Obesity. BMI ≥30 kg/m^2	47(20.8)	75(32.3)	122 (26.6)
Truncal obesity (waist: hip, men >0.9, women >0.8)	175(77.4)	186(80.2)	361 (78.8)
Abdominal obesity (men >102, women >88 cm)	78 (34.5)	129(55.6)	207 (45.2)
Hypertension (known or BP ≥140/90)	116(51.3)	120(51.7)	236 (51.5)
Diabetes (known or FPG ≥126 mg/dl)	40(17.7)	33(14.2)	77 (16.8)
High total cholesterol ≥200 mg/dl	75(33.2)	67(28.9)	142 (31.0)
LDL cholesterol ≥130 mg/dl	86(38.1)	81(34.9)	167 (36.5)
Triglycerides ≥150 mg/dl	55(24.3)	34(14.7)	89 (19.4)
Low HDL cholesterol <40 mg/dl	169(74.8)	155(66.8)	324 (70.7)
Metabolic syndrome	84(36.2)	111(47.8)	195 (42.6)

CHD - coronary heart disease, BMI - body mass index; BP - blood pressure; FBG - fasting blood glucose, LDL - low density lipoprotein, HDL - high density lipoprotein. N.B. - Numbers in parentheses are percent.

risk factors have been advised by the American College of Cardiology clinical data standards (Cannon et al., 2001). Physical activity was measured by asking about both work-related and leisure-time activities as used in the previous study (Gupta et al., 1995). Hypertension was diagnosed when systolic blood pressure was ≥ 140 mm Hg and diastolic blood pressure ≥ 90 mm Hg or a person was a known hypertensive.

Body mass index (BMI) (weight in kg)/ (height in metres)^2 was calculated and overweight and obesity defined as BMI ≥25 kg/m^2 (WHO, 2000). Truncal obesity was diagnosed when WHR was >0.9 in males and >0.8 in females while abdominal obesity was diagnosed when waist size was >102 cm in men and >88 cm in women as per the US National Cholesterol Education Program (NCEP, 2002) guidelines. Dyslipidaemia was defined by the presence of high total cholesterol (≥200 mg/dl), high LDL cholesterol (≥130 mg/dl), low HDL cholesterol (<40 mg/dl) or high triglycerides (≥150 mg/dl) according to NCEP (2002) guidelines. Metabolic syndrome was also diagnosed according to NCEP (2002) guidelines when any three of the five identifying risk factors (abdominal obesity, fasting glucose >110 mg/dl or diabetes, blood pressure ≥130/≥90 mm Hg, low HDL cholesterol (men <40 mg/dl, women <50 mg/dl) or high triglycerides ≥150 mg/dl) were present.

Statistical Analysis: The data were pooled and computerised. Continuous variables are reported as mean ± 1 SD. The prevalence rates are given in percent. Age-related trends have been examined by Mantel-Haenzel χ^2 for trend. Continuous variables have been compared using t-test and categorical variables by χ^2 test. BMI levels were divided into different groups with BMI <20, 20.0 to 22.9, 23.0 to 24.9, 25.0 to 29.9 and ≥30

Table 2: Age-specific prevalence of coronary risk factors

Risk factor	*Age 20-29*	*Age 30-39*	*Age 40-49*	*Age 50-59*	*Age 60±*	*Total*
	Men (n=226)					
Number	*42*	*45*	*58*	*34*	*47*	*226*
Smoking/ tobacco	8 (19.0)	15 (33.3)	17 (29.3)	10 (29.4)	9 (19.1)	59 (26.1)
Physical Inactivity	20 (47.6)	18 (40.0)	22 (37.9)	10 (29.4)	12 (25.5)	82 (36.3)
Hypertension	9 (21.4)	19 (42.2)	28 (48.3)	27 (79.4)	33 (70.2)	116 (51.3)
Obesity (BMI ≥25 kg/m2)	14 (33.3)	24 (53.3)	38 (65.5)	28 (82.3)	19 (40.4)	123 (54.0)
Obesity (BMI ≥30 kg/m2)	5 (11.9)	11 (24.4)	18 (31.0)	11 (32.4)	3 (6.4)	47 (20.8)
Truncal Obesity (WHR >0.9)	24 (57.1)	34 (75.5)	49 (84.5)	29 (85.3)	39 (82.9)	175 (77.4)
Waist obesity >102 cm	4 (9.5)	13 (28.9)	25 (48.1)	21 (61.8)	15 (31.9)	78 (34.5)
Diabetes (history or FBG ≥126 mg/dl)	1 (2.3)	1 (2.2)	9 (15.5)	12 (35.3)	17 (36.2)	40 (17.7)
High cholesterol (≥200 mg/dl)	6 (14.3)	15 (33.3)	24 (41.4)	16 (47.1)	14 (29.8)	75 (33.2)
High LDL (≥130 mg/dl)	8 (19.0)	20 (44.4)	24 (41.4)	18 (52.9)	16 (34.0)	86 (38.1)
ow HDL (<40 mg/dl)	28 (66.7)	35 (77.7)	45 (77.6)	27 (79.4)	34 (72.0)	169 (74.8)
High TG (≥150 mg/dl)	7 (16.7)	11 (24.4)	14 (24.1)	15 (55.1)	8 (17.0)	55 (24.3)
Metabolic syndrome	7 (16.7)	12 (26.7)	21 (36.2)	23 (67.6)	21 (44.7)	84 (37.2)
	Women (n= 232)					
Number	*40*	*62*	*49*	*44*	*37*	*232*
Smoking/ tobacco	-	2 (3.2)	1 (2.0)	1 (2.3)	-	4 (1.7)
Physical Inactivity	16 (40.0)	20 (32.2)	14 (28.6)	12 (27.3)	11 (29.7)	73 (31.5)
Hypertension	3 (7.5)	18 (29.0)	33 (67.3)	32 (72.7)	34 (91.9)	120 (51.3)
Obesity (BMI ≥25 kg/m2)	14 (35.0)	46 (74.2)	39 (79.6)	34 (77.3)	29 (78.4)	161 (69.4)
Obesity (BMI ≥30 kg/m2)	5 (12.5)	18 (29.0)	16 (32.7)	18 (40.9)	19 (51.4)	75 (32.3)
Truncal Obesity (WHR >0.8)	28 (70.0)	52 (83.9)	42 (85.7)	37 (84.1)	27 (72.9)	186 (80.2)
Waist obesity >88 cm	11 (27.5)	33 (53.2)	29 (59.2)	32 (72.7)	24 (64.9)	129 (55.6)
Diabetes (History or FBG ≥126 mg/dl)	-	1 (1.6)	6 (12.2)	12 (27.3)	14 (37.8)	33 (14.2)
High cholesterol (≥200 mg/dl)	5 (12.5)	14 (22.6)	17 (34.7)	15 (34.1)	16 (42.2)	67 (28.9)
High LDL (≥130 mg/dl)	6 (15.0)	20 (32.2)	18 (36.7)	18 (40.9)	19 (51.4)	81 (34.9)
Low HDL (<40 mg/dl)	18 (45.0)	42 (67.7)	35 (71.4)	30 (68.2)	30 (81.1)	155 (66.8)
High TG (≥150 mg/dl)	4 (10.0)	6 (9.7)	9 (18.4)	7 (15.9)	8 (21.6)	34 (14.7)
Metabolic syndrome	4 (10.0)	19 (42.2)	29 (50.0)	30 (88.2)	29 (61.7)	111 (47.8)

BMI - body mass index; BP - blood pressure; FBG - fasting blood glucose, LDL - low density lipoprotein, HDL - high density lipoprotein; TG - triglycerides. N.B. - Numbers in parentheses are percent.

Table 3: Body-mass index quintiles and coronary risk factors (mean±SD)

BMI groups	*No.*	*Risk factors*						
		Waist (cm)	*Systolic BP (mmHg)*	*Diastolic BP (mmHg)*	*Glucose Fasting; mg/dl*	*Cholesterol HDL mg/dl*	*cholesterol mg/dl*	*Triglycerides mg/dl*
		Men(n=226)						
≤ 20.0	27	77.6 ± 7.1	119.7 ± 20.6	72.7 ± 8.6	79.8 ± 33.2	169.9 ± 32.0	36.8 ± 5.9	107.5 ± 20.8
20.0-22.9	25	86.9 ± 7.9	109.5 ± 25.6	73.4 ± 17.5	95.5 ± 33.4	179.2 ± 68.0	34.2 ±12.0	113.4 ± 42.7
23.0-24.9	51	93.8 ± 5.6	122.5 ± 16.0	79.1 ± 9.2	84.6 ± 28.9	192.6 ± 46.2	35.9 ± 5.1	143.2 ± 68.8
25.0-29.9	75	102.9 ± 15.2	131.5 ± 27.5	83.9 ± 16.8	99.6 ± 41.6	190.3 ± 43.6	36.8 ± 6.8	152.6 ± 98.1
≥ 30.0	48	112.6 ± 16.2	139.9 ± 48.2	116.7 ± 13.5	92.3 ± 20.7	189.9 ± 31.0	36.4 ± 5.1	129.7 ± 38.6
ANOVA F, p value		44.5, <0.0001	5.26, 0.0005	3.49, 0.0087	2.45, 0.0474	0.18, 0.1290	0.79, 0.5331	0.017, 0.1354
		Women (n=232)						
≤ 20.0	16	72.2 ± 5.5	108.2 ± 11.5	66.9± 7.2	79.3 ± 8.0	158.5 ± 13.0	39.1 ± 5.4	104.8± 23.1
20.0-22.9	31	75.9 ± 11.6	106.6 ± 36.7	68.1± 21.6	83.5 ± 34.6	166.8 ± 38.2	45.1± 25.5	112.8± 43.3
23.0-24.9	23	90.2 ± 8.3	143.6 ± 87.5	76.8± 13.1	89.4 ± 16.7	174.8 ± 50.3	36.8 ± 9.2	115.4± 44.3
25.0-29.9	86	90.0 ± 10.7	127.3 ± 21.2	80.9± 12.7	89.6 ± 32.3	186.9 ± 45.6	36.9± 8.9	120.5± 35.6
≥ 30.0	76	102.7 ± 14.4	139.8 ± 29.6	96.6± 83.0	94.7 ± 29.6	194.6 ± 38.4	40.6± 18.9	128.0± 55.9
ANOVA F, p value		2.97, 0.0204	6.59, <0.0001	2.63, 0.0354	1.35, 0.2538	4.47, 0.0017	0.73, 0.5710	1.35, 0.2534

kg/m^2 according to WHO guidelines. Prevalence of coronary risk factors in different BMI quintiles was determined and trends examined using Mantel-Haenzel χ^2 for trend. P values <0.05 were considered significant. Direct method of age-adjustment was used to compare prevalence rates of various risk factors in the present with the previous Jaipur Heart Watch studies.

RESULTS

We evaluated 458 subjects (response rate 76.7%), 226 men and 232 women. The mean age in men was 43.2±14.6 years and women was 44.7±15.3 years (p= n.s.). Prevalence of risk factors in the study group is reported in Table 1. There was a high prevalence of family history of CHD and diabetes in the study subjects. A high prevalence of obesity, abdominal obesity, hypertension, diabetes, lipid abnormalities, and multiple metabolic abnormalities (the metabolic syndrome) was also seen in both men and women.

Age-specific prevalence of risk factors is shown in Table 2. In men, increasing age was associated with a significantly increasing trend in prevalence of severe obesity (BMI ≥30 kg/m^2), truncal obesity, waist obesity, hypertension, diabetes, metabolic syndrome and high cholesterol levels. In women, with age there was a significant increase of obesity, severe obesity, waist obesity, hypertension, diabetes, metabolic syndrome, and lipid abnormalities (Manel-Haenzel χ^2 for trend, p <0.05).

In men the BMI in age groups 20-29, 30-39, 40-49, 50-59 and 60± years was 25.6±11.1, 26.6±5.6, 27.2±4.3, 27.8±4.5 and 24.1±4.6 kg/m^2 (ANOVA F= 2.29, r^2= 0.03, eta^2= 0.04, p= 0.061). In women it was 23.5±4.7, 26.9±4.9, 28.7±4.9, 29.9±6.2 and 30.1±6.1 kg/m^2 respectively (ANOVA F= 10.46, r^2= 0.14, eta^2= 0.18, p<0.00001). BMI correlated (r value- men, women) significantly with waist diameter (0.67, 0.14), systolic BP (0.26, 0.26), diastolic BP (0.20, 0.19), fasting glucose (0.12, 0.15), total cholesterol (0.13, 0.27), and triglycerides (0.14, 0.15) (p <0.05). Numerical

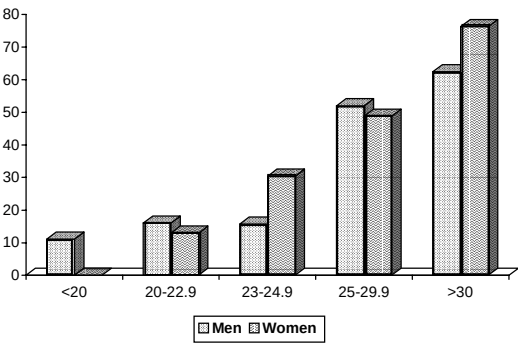

Fig. 2. Increasing BMI is associated with an increasing prevalence of metabolic syndrome indicating multiple metabolic abnormalities in Bhatia men and women

Table 4: Body-mass index quintiles and prevalence of various risk factors

BMI groups	*No.*	*Risk factors*									
		Hyper-tension		*Diabetes*		*High total cholesterol ≥200 mg/dl*		*High triglycerides ≥150 mg/dl*		*Low HDL cholestroel <40 mg/dl*		*Metabolic syndrome*	
						Men (n=226)							
≤ 20.0	27	8	(29.6)	3	(11.1)	3	(11.1)	1	(3.7)	21	(77.8)	3	(11.1)
20.0-22.9	25	4	(16.0)	8	(32.0)	9	(36.0)	2	(8.0)	17	(68.0)	4	(16.0)
23.0-24.9	51	23	(45.1)	5	(9.8)	17	(33.3)	12	(23.5)	41	(80.4)	8	(15.7)
25.0-29.9	75	50	(66.7)	18	(24.0)	28	(37.3)	29	(38.7)	55	(73.3)	39	(52.0)
≥ 30.0	48	17	(35.4)	6	(12.5)	18	(37.5)	11	(22.9)	35	72.9)	30	(62.5)
÷2 trend			22.04,		0.01,		4.22,		9.03,		0.11,		35.32,
(p value)			<0.0001		0.969		0.039		0.003		0.736		<0.0001
						Women (n=232)							
< 20.0	16	1	(6.3)	-	-	1	(6.3)	9	(56.3)	-			
20.0-22.9	31	9	(29.3)	3	(9.7)	5	(16.1)	6	(19.4)	13	(41.9)	4	(12.9)
23.0-24.9	23	9	(39.1)	3	(13.0)	7	(30.4)	3	(13.0)	16	(69.6)	7	(30.4)
25.0-29.9	86	44	(51.2)	8	(9.3)	26	(30.2)	12	(13.9)	62	(72.1)	42	(48.8)
≥ 30.0	76	57	(75.0)	19	(25.0)	29	(38.2)	12	(30.3)	55	(72.4)	58	(76.3)
÷2 trend			36.04,		7.58,		11.12,		0.13,		7.38,		53.82,
(p value)	<0.0001		0.006		0.001		0.724		0.007				<0.0001

N.B. Numbers in parentheses are percent.

Table 5: Age-adjusted coronary risk factor prevalence in Jaipur Heart Watch-1 (JHW-1, 1995), Jaipur Heart Watch-2 (JHW-2, 2002) and Jaipur Heart Watch-3 (JHW-3)

	Men			*Women*		
	JHW-1 (n=1415)	*JHW-2 (n=550)*	*JHW-3 (n=226)*	*JHW-1 (n=797)*	*JHW-2 (n=573)*	*JHW-3 (n=232)*
Smoking/tobacco	548/1415 (38.7)	196/550 (35.6)	58/226 (25.7)*	149/797 (18.7)	69/573 (12.1)	4/232 (1.6)***
Leisure-time physical inactivity	1003/1415 (70.9)	338/550 (61.5)	90/226 (39.8)***	577/797 (72.4)	362/573 (63.2)	72/232 (31.2)***
Diabetes (History)	15/1415 (1.1)	42/550 (7.6)	26/226 (11.5)***	8/797 (1.0)	49/573 (8.6)	32/232 (13.8)***
Obesity (BMI ≥27 kg/m2)	158/1415 (11.2)	123/550 (22.3)	87/226 (38.5)**8	105/797 (13.2)	170/573 (29.7)	123/232 (53.0)**8
Truncal obesity Males >0.9, Females >0.8	128/250 (51.2)	280/550 (50.9)	163/226 (72.2)*	131193 (67.9)	388/573 (67.8)	186/232 (80.1)
Hypertension (≥140/≥90)	417/1415 (29.5)	165/550 (30.0)	98/226 (43.4)*	267/797 (33.5)	174/573 (30.3)	127/232 (54.9)***
Diabetes (History or fasting glucose ≥125 mg/dl)	-	72/550 (13.1)	27/226 (11.9)	-	65/573 (11.3)	36/232 (15.4)**8
High cholesterol ≥200 mg/dl	49/199 (24.6)	183/532 (34.4)	66/226 (29.1)	22/98 (22.5)	243/559 (43.5)	69/232 (29.7)**
High LDL cholesterol ≥130 mg/dl	44/199 (22.1)	182/532 (34.2)	79/226 (35.0)*	28/98 (28.6)	254/559 (45.4)	89/232 (38.4)
Low HDL cholesterol >40mg/dl	86/199 (43.2)	284/532 (53.4)	166/226 (73.6)**	45/98 (45.9)	303/559 (54.2)	156/232 (67.3)
High triglycerides ≥ 150 mg/dl	53/199 (26.6)	163/532 (30.6)	54/226 (23.9)*	28/98 (28.6)	160/559 (28.7)	36/232 (15.4)**
Metabolic syndrome	- (18.4)	98/532 (31.8)**	72/226 -	- (30.9)	173/559	118/232 (50.9)***

BMI - body mass index; LDL - low density lipoprotein; HDL - high density lipoprotein.
* p<0.05, ** p<0.01, *** p<0.001 N.B. - Numbers in parentheses are percent.

value of various coronary risk factors at different BMI quintiles is shown in Table 3. In men there was a significant relationship of BMI with waist size, systolic BP, diastolic BP and fasting glucose levels ($p<0.05$). In women this relationship was observed with waist size, systolic BP, diastolic BP and total cholesterol levels ($p<0.02$).

Trend analysis (χ^2 for trend, Table 4) demonstrated that there was a significant linear relationship of BMI with the prevalence of hypertension ($p<0.0001$, hyper-cholesterolemia ($p=0.039$), hypertriglyceridemia ($p=0.003$) and the metabolic syndrome ($p<0.0001$) in men. In women a significant correlation was observed with hypertension ($p<0.0001$), diabetes ($p=0.006$), hypercholesterolemia ($p=0.01$), low HDL cholesterol ($p=0.07$) and the metabolic syndrome ($p<0.0001$). The lowest prevalence of these risk factor is observed at BMI <20 kg/m^2 and a marked increase is seen at BMI ≥25 kg/m^2 (Fig. 2).

We compared age adjusted prevalence of major coronary risk factors in the present study with previous studies performed by the same group of investigators using the same methodology (Table 5). As compared to JHW-1 study performed in 1993-1994 and JHW-2 study performed in 1999-2001, the present study performed in 2002-2003 shows that many risk factors are greater in the Bhatia community. Prevalence of obesity (BMI ≥27 kg/m^2), truncal obesity, hypertension, high LDL cholesterol, low HDL cholesterol, hypertriglyceridemia and the metabolic syndrome is significantly greater as compared to previous studies. The prevalence of smoking is significantly lower and that of self-reported leisure-time physical activity significantly greater in the present study group.

DISCUSSION

The present study shows that there is a high prevalence of obesity, abdominal obesity, hypertension, diabetes, lipid abnormalities and the metabolic syndrome in the North Indian Bhatia community. The prevalence of these risk factors is significantly greater than reported in studies from Jaipur and urban population elsewhere in India. Body-mass index and obesity correlate strongly with multiple coronary risk factors and are major determinants of these risk factors.

Bhatias are a North Indian business community who in the past 50 years have become a wealthy merchant class worldwide (Ramaiya et al., 1991). Their ancestor was a Rajput prince of Lahore (West Punjab, Pakistan) who when besieged in the sixth century engineered an escape of children and older subjects to other parts of the Punjab and Gujarat. Within a few generations the community had reconsolidated and started expanding. Members are settled in Sindh, Rajasthan, Madhya Pradesh and Gujarat. In each of these areas they expanded business and adopted local language but remained distinct. The community subjects migrated from Bombay and Gujarat to other countries and were among the first businessmen from India to settle down in Africa.

Ramaiya et al (1991) studied emigrant Indian populations in Tanzania for prevalence of cardiovascular risk factors. It was reported that obesity, hypertension, glucose intolerance and diabetes and lipid abnormalities were significantly greater in Bhatia and Patel Hindu communities. Age-adjusted prevalence of impaired glucose tolerance (27.2%), diabetes (14.3%), stage II hypertension (19.4%), overweight 22.7% and mild hypercholesterolemia (26.8%) were the highest in Bhatia community as compared to six other groups. In a study comparing cardiovascular risk factors and diabetes in Bhatia community living in Tanzania and in the UK (Ramaiya et al., 1995) it was reported that prevalence of known diabetes, hypertriglyceridemia, hypertension, and obesity were not different in Tanzanian and UK Bhatias but the prevalence of impaired glucose tolerance, diabetes, hypercholesterolemia, and smoking was significantly higher and sedentary lifestyle more common in subjects in Africa. Greater prevalence of coronary risk factors in Bhatia community in Jaipur when compared to the previous studies is in agreement with these observations.

In a multiethnic study in Singapore it has been reported that coronary risk factors are greater among South Asian migrants as compared to Chinese and local subjects (Deurenberg-Yap, 2001). In Mauritius, Vos et al. (1998) reported that the Hindus had the highest ischemic heart disease mortality as compared to Muslims, Creoles and Chinese populations (Toumelhito et al., 1993). Williams et al. (1994) reported on non-biochemical cardiovascular risk factors in different South Asian groups in Glasgow, UK. South Asians had a lower prevalence of smoking but there was a greater prevalence of sedentary habits, higher diastolic blood pressure, higher BMI, insulin resistance, stress, and socioeconomic deprivation. Cappuccio et al. (1997) reported prevalence of cardiovascular risk factors in different ethnic groups in South London. As compared to subjects of Caucasian and African descent, South Asians had a two-to threefold excess of hypertension and diabetes and an inferior control of

hypertension. The excess of coronary heart disease mortality among South Asians may be due to the higher prevalence of non-metabolic as well as metabolic risk factors. Anand et al. (2000) reported that South Asians settled in Canada had greater prevalence of truncal obesity, impaired glucose tolerance, diabetes, and lipid abnormalities as compared to Chinese and Caucasians settled there. Bhopal et al (1999) reported that South Asians are not a homogenous group and the cardiovascular risk factors are the greatest among Bangladeshi emigrants living in the UK as compared to Pakistani subjects and were the lowest in Indians. Bhopal (2000) has concluded that there are substantial variations in CHD mortality in South Asians and the estimates of excess risk of CHD are imprecise and may be too high if there are data errors or too low because comparisons with the general populations blunts ethnic variations. Our study that shows a greater prevalence of cardiovascular risks in Bhatia community is a step in identifying the high risk group among the ethnically diverse South Asian populations.

In India there have been only a few community specific studies of risk factors. Chopra and Chopra (1942) studied prevalence of high blood pressure among different groups in Indian in mid-1940's. They reported higher mean systolic blood pressure in North Indians as compared to the South Indian subjects. Malhotra (1971) studied railway workers for cardiovascular risk factors in mid 1960's and reported that there was a difference in prevalence of CHD as well as risk factors in different parts of India. He reported a higher prevalence of risk factors in North Indian workers as compared to the South Indians. Some epidemiological studies have reported a greater prevalence of CHD and coronary risk factors in Kerala (Kutty et al., 1993). Chadha et al. (1992) reported prevalence of risk factors in Gujaratis settled in Delhi and reported a higher prevalence of risk factors in this community as compared to the Delhi general population. Gopinath et al. (1995) reported prevalence of risk factors in multiple ethnic groups in Delhi. The prevalence rates of CHD were the highest in Sikhs, lowest in Muslims and identical in Hindus and Christians. Sikhs also had the highest prevalence of obesity, hypertension and diabetes. The present study also shows that the Punjabi Bhatia community has a very high prevalence of obesity and multiple coronary risk factors as compared to Jaipur general population and is similar to the Delhi study. Bharucha et al. (2003) determined prevalence of hypertension in Parsi community in Mumbai and reported a higher prevalence than other studies in India. Gupta et al. (2000) reported on differences in coronary risk factors among Hindu and Muslim communities in Jaipur. There was no significant difference in the risk factors in the two groups. All these studies have been performed using different tools by different persons and the role of methodological differences in producing biased results can not be excluded. The present study using a similar methodo-logy to JHW-1 and JHW-2 shows that the prevalence of coronary risk factors is significantly greater in the Bhatia community as compared to previous studies in Jaipur (Table 5).

Studies among obesity in Asian subjects has shown that generalized obesity is the major determinant of cardiovascular risk in the Chinese and East Asian subjects while central obesity is associated with greater cardiovascular risk in South Asians (Deurenberg et al., 2002). Deurenberg-Yap et al. (2002) determined body fat percentages (BF%) in Singaporean Chinese, Malays and Indians and conclu-ded that when the BF% prediction equation based on BMI in Caucasian populations was applied to these three ethnic groups in Singapore there was a gross underestimation of actual BF%. The mean bias in prediction ranged from 2.7 to 5.6% body fat. They concluded for the same BMI values Chinese have the lowest BF% while Indians have the highest. The present study shows that majority of cardiovascular risk factors in Bhatia men and women increase at BMI of $\geq$25 kg/m^2 and therefore, this cutoff should be used to determine obesity in South Asians. Similar reco-mmendations have been made by other Indian investi-gators (Dudeja et al., 2001; Reddy et al., 2002) as well as investigators from China and other Asian countries (Deurenberg et al., 2002; Jia et al., 2002).

The present study also shows that BMI levels accurately predict hypertension, diabetes and meta-bolic syndrome in this community. BMI was not an accurate predictor of lipid abnormalities. In the previous JHW-2 study, we reported that BMI accurately predicts non-biochemical coronary risk factors more accurately than WHR while the latter is more reliable in predicting the biochemical risk factors such as diabetes and lipid abnormalities (Gupta et al., 2004). A composite equation that combines BMI and WHR could be more reliable in predicting overall cardiovascular risk.

The high prevalence of obesity in the Bhatia community requires further studies among this community for elucidating genetic and environmental causes of obesity. The greater

prevalence of obesity and other coronary risk factors could be due to multiple factors. The major determinants of obesity are genetic factors, physical activity patterns (work related and leisure time) and diet (WHO, 2000; Clement and Ferre, 2003). It has been reported that obesity is influenced about 40% by genes and 60% by environment (Clement and Ferre, 2003; Cummings and Schwartz, 2003). We have not studied genetic factors although large genetic differences are unlikely in the Indian populations (Kashyap et al., 2003). Nor have we studied the diet of this community subjects in greater detail or the physical activity using recent validated tools and hence cannot comment on these aspects. This is a study limitation. Gene-environment interaction in influencing obesity is the likely cause (Perusse and Bouchard, 1999; Schousboe et al., 2004).

In conclusion, the present study shows that this North Indian Bhatia community has a high prevalence of obesity which is an important determinant of cardiovascular risk factors. Although a lower BMI cut-off to diagnose obesity (≥ 25 kg/m^2) appears important this finding needs to be confirmed by larger prospective epidemiological studies. Community wide preventive measures that focus on obesity reduction are important.

REFERENCES

Abbasi, F., Brown, B.W., Lamendola, C., McLaughlin, T. and Reaven, G.M.: Relationship between obesity, insulin resistance, and coronary heart disease risk. *J. Am. Coll. Cardiol.*, **40**: 937-943 (2002).

Anand, S.S., Yusuf, S., Vuksan, V., Devanesen, S., Teo, K. K., Montague, P. A., et al.: Differences in risk factors, atherosclerosis and cardiovascular disease between ethnic groups in Canada: The Study of Health Assessment and Risk in Ethnic Groups (SHARE). *Lancet*, **356**: 279-284 (2000).

Bharucha, N.E. and Kuruvilla, T.: Hypertension in the Parsi community of Bombay: a study on prevalence, awareness and compliance to treatment. *BMC Public Health*, **3**: 1-7 (2003).

Bhopal, R.: What is the risk of coronary heart disease in South Asians? A review of UK research. *J.Publ. Health Med.*, **B 22**: 375-385 (2000).

Bhopal, R,, Unwin, N., White, M., Yallop, J., Walker, L.and Alberti, K.G.M.M.: Heterogeneity of coronary heart disease risk factors in Indian, Pakistani, Bangladeshi and European origin populations: cross sectional study. *BMJ*, **319**: 215-220 (1999).

Cannon, C.P., Battler, A., Brindis, R.G., Cox, J.L., Ellis, S.G., Every, N.R., et al.: Key elements and data definitions for measuring the clinical management and outcomes of patients with acute coronary syndromes: a report of the American College of Cardiology Task Force on Clinical Data Standards. *J. Am. Coll. Cardiol.*, **38**: 2114-2130 (2001).

Cappuccio, F.P., Cook, D.G., Atkinson, R.W. and Strazzullo, P.: Prevalence, detection and management of coronary risk factors in different ethnic groups in South London. *Heart*, **78**: 555-563 (1997).

Chadha, S.L., Gopinath, N. and Ramachandran, K.: Epidemiological study o coronary heart disease in Gujaratis in Delhi (India). *Indian J. Med. Res.*, **96**: 115-121 (1992).

Chopra, R.N. and Chopra, G.S.: A study of normal blood pressure in Indians. *Ind. Med. Gazette*, **77**: 21-24 (1942).

Clement, K. and Ferre, P.: Genetics and the pathophysiology of obesity. *Pediatr. Res.*, **53**: 721-725 (2003).

Cummings, D.E. and Schwartz, M.W.: Genetics and pathophysiology of human obesity. *Annu. Rev. Med.*, **54**: 453-471 (2003).

Deedwania, P.C. and Gupta, R.: South Asians, East Asians, Koreans, and Asian and Pacific Islanders. In: N. D. Wong, H. R. Black and J. M. Gardin (Eds.): *Preventive Cardiology*. 2nd Edn. McGraw Hill, New York (2004).

Deurenberg, P., Deurenberg-Yap, M. and Guricci, S.: Asians are different from Caucasians and from each other in their body mass index/body fat percent relationship. *Obesity Rev.*, **3**: 141-146 (2002).

Deurenberg-Yap, M., Chew, S.K., Lin, V., Tan, B.Y., van Staveren, W.A. and Deurenberg P.: Relationships between indices of obesity and its co-morbidities in multi-ethnic Singapore. *Int. J. Obesity*, **25**: 1554-1556 (2001).

Deurenberg-Yap, M., Chew, S.K. and Deurenberg, P.: Elevated body fat percentage and cardiovascular risks at low body mass index levels among Singaporean Chinese, Malays and Indians. *Obesity Rev.*, **3**: 209-216 (2002).

Dudeja, V., Misra, A., Pandey, R.M., Devina, G., Kumar, G. and Vikram, N.K.: BMI does not accurately predict overweight in Asian Indians in northern India. *Br. J. Nutr.*, **86**: 105-112 (2001).

Gopinath, N., Chadha, S.L., Jain, P., Shekhawat, S. and Tandon, R.: An epidemiological study of coronary heart disease in different ethnic groups in Delhi urban population. *J. Assoc. Physicians India*, **43**: 30-33 (1995).

Grundy, S.M.: Obesity, metabolic syndrome and coronary atherosclerosis. *Circulation*, **105:** 2696-2698 (2002).

Gupta, R., Gupta, V.P. and Ahluwalia, N.S.: Educational status, coronary heart disease, and coronary risk factor prevalence in a rural population of India. *BMJ*, **309**: 1332-1336 (1994).

Gupta, R., Prakash, H., Majumdar, S., Sharma, S.C. and Gupta, V.P.: Prevalence of coronary heart disease and coronary risk factors in an urban population of Rajasthan. *Indian Heart J.*, **47**: 331-338 (1995).

Gupta, R., Prakash, H. and Kaul, V.: Cholesterol lipoproteins, triglycerides, rural-urban difference and prevalence of dyslipidaemias among males in Rajasthan. *J. Assoc. Physicians India*, **45**: 275-279 (1997a).

Gupta, R. and Gupta, V.P. Urban-rural differences in coronary risk factors do not fully explain greater urban coronary heart disease prevalence. *J. Association Physicians India*, **45**: 683-686 (1997b).

Gupta, R., Gupta, V.P., Prakash, H., Sarna, M, and Sharma,

A.K.: Hindu-muslim differences in the prevalence of coronary heart disease and risk factors. *J. Ind. Med. Assoc.,* **100:** 227-230 (2000).

Gupta, R., Gupta, V.P., Sarna, M., Bhatnagar, S., Thanvi, J., Sharma, V., et al.: Prevalence of coronary heart disease and risk factors in an urban Indian population: Jaipur Heart Watch-2. *Indian Heart J.*, **54**: 59-66 (2002).

Gupta, R., Rastogi, P., Sarna, M., Sharma, S.K., Gupta, V.P. and Kothari, K.: Body-mass index, waist-size, waist-hip ratio and cardiovascular risk factors in urban subjects. *J. Association Physicians India,* In Press (2004).

Jia, W.P., Xiang, K.S., Chen, L., Lu, J.X. and u, Y.M.: Epidemiological study on obesity and its comorbidities in urban Chinese older than 20 years of age in Shanghai, China. *Obesity Rev.,* **3**: 157-165 (2002).

Kashyap, V.K., Sarkar, N., Sahoo, S., Sarkar, B.N. and Trivedi, R.: Genetic variation at fifteen microsatellite loci in human populations of India. *Curr. Sci.,* **85**: 464-473 (2003).

Kutty, V.R., Balakrishnan, K.G., Jayasree, A.K. and Soman, A.: Prevalence of coronary heart disease in the rural population of Thiruvananthapuram district, Kerala, India. *Int. J. Cardiol.,* **39**: 59-70 (1993).

Malhotra, S.L.: Studies in arterial blood pressure n the north and south India with reference to dietary factors in its causation. *J. Assoc. Physicians India,* **19**: 211-224 (1971).

National Cholesterol Education Program. Detection, evaluation and treatment of high blood cholesterol in adults (Adult Treatment Panel III). *Circulation,* **106**: 3143-3421 (2002).

Perusse, L and Bouchard C.: Genotype-environment interaction in human obesity. *Nutr. Rev.,* **57**: S31-38 (1999).

Ramaiya, K.L., Swai, A.B., McLarty, D.G., Bhopal, R.S. and Alberti, K.G.: Prevalence of diabetes and cardiovascular disease risk factors in Hindu Indian sub-communities in Tanzania. *BMJ,* **303**: 271-276 (1991).

Ramaiya, K.L., Denver, E. and Yudkin, J.S.: Diabetes, impaired glucose tolerance and cardiovascular disease risk factors in the Asian Indian Bhatia community living in Tanzania and in the United Kingdom. *Diabet. Med.,* **12**: 904-910 (1995).

Reddy, K.S., Prabhakaran, D., Shah, P. and Shah, B.: Differences in body mass index and waist: hip ratios in north Indian rural and urban populations. *Obesity Rev.,* **3**: 197-202 (2002).

Rose, G.A., Blackburn, H., Gillum, R.F. and Prineas, R.J.: *Cardiovascular Survey Methods*. 2nd Edn. WHO Monograph Series No. 56. World Health Organisation, Geneva (1982).

Schousboe, K., Visscher, P.M., Erbas, B., Kyvik, K.O., Hopper, J.L., Henriksen, J.E., et al. Twin study of genetic and environmental influences on adult body size, shape, and composition. *Int. J. Obesity,* **28**: 39-48 (2004).

Toumelhito, J., Li, N., Dowse, G., Gareeboo, H., Chitson, P., Fareed, D., et al.: The prevalence of coronary heart disease in the multiethnic and high diabetes prevalence population of Mauritius. *J. Intern. Med.,* **233**: 187-194 (1993).

Vos, T., Gareeboo, H. and Russely, F.: Ethnic differences is ischaemic heart disease and stroke mortality in Mauritius. *Ethn. Health*, **3**: 45-54 (1998).

Williams, R., Bhopal, R. and Hunt, K.: Coronary risk in a British Punjabi population: comparative profile of non-biochemical factors. *Int. J. Epidemiol.,* **23**: 28-37 (1994).

WHO Expert Committee. Physical Status: the use and interpretation of anthropometry. *WHO Technical Report Series,* **854**: 424-438 (1995).

WHO Expert Group. Obesity: Preventing and managing the global epidemic. *WHO Technical Report Series,* **894**; 1-172 (2000).

KEYWORDS Coronary Heart Disease. Atherosclerosis. Risk Factors. Metabolic Syndrome. Hypertension

ABSTRACT Studies among emigrant Indian populations have shown a high prevalence of obesity and many coronary risk factors in Bhatia community. To determine the prevalence of risk factors in this community within India we performed an epidemiological study. Total community survey for prevalence of cardiovascular risk factors was performed using community registers for enrollment. Methodology used was similar to Jaipur Heart Watch studies performed in 1992 and 1999. Community registers listed 800 Bhatia families in Jaipur with 1604 eligible subjects aged ≥20 years. We invited 600 randomly selected subjects and examined 458 (76.7%, men 226, women 232). Evaluation for coronary risk factors, anthropometric measurements, blood pressure (BP), ECG, and fasting blood glucose and lipids was performed using standard definitions. Mean age of the subjects was 43.2±14.6 years in men and 44.7±15.3 in women. In both men and women respectively there was a high prevalence of family history of CHD in 45 (19.9%) and 50 (21.6%), diabetes in 96 (42.5%) and 77 (33.2%), sedentary habits in 82 (36.3%) and 73 (31.5%), smoking or tobacco use in 59 (26.1%) and 4 (1.7%), overweight or obesity (body mass index, BMI ≥25 kg/m^2) in 123 (54.0%) and 161 (69.4%), severe obesity (BMI >30 kg/m^2) in 47 (20.8%) and 75 (32.3%), truncal obesity in 175 (77.4%) and 186 (80.2%), waist obesity in 78 (34.5%) and 129 (55.6%), hypertension in 116 (51.3%) and 120 (51.3%), diabetes in 40 (17.7%) and 33 (14.2%), hypercholesterolemia in 75 (33.2%) and 67 (28.9%), high triglycerides in 55 (24.3%) and 34 (14.7%), low HDL cholesterol in 169 (74.8%) and 155 (66.8%), and the metabolic syndrome in 84 (36.2%) and 111 (47.8%) respectively. BMI correlated (r value- men, women) significantly with waist diameter (0.67, 0.14), systolic BP (0.26, 0.26), diastolic BP (0.20, 0.19), fasting glucose (0.12, 0.15), total cholesterol (0.13, 0.27), and triglycerides (0.14, 0.15) ($p < 0.05$). There was a significant linear relationship of BMI with the prevalence of hypertension, hypercholesterolemia, diabetes (women), and the metabolic syndrome (χ^2 for trend $p<0.05$). Prevalence of these risk factors was the least in subjects with BMI <20 kg/m^2. This study shows that there is high prevalence of

obesity, abdominal obesity, hypertension, diabetes and lipid abnormalities in this community. This is significantly greater than reported studies in Jaipur and urban populations elsewhere in India. Obesity correlates strongly with multiple coronary risk factors and is an important determinant.

Authors' Address: **Dr. Rajeev Gupta, Mukesh Sarna, Priyanka Rastogi, Vijay Kaul and V.P. Gupta**
Department of Medicine, Monilek Hospital and Research Centre, Jawahar Nagar, Jaipur 302 004, Rajasthan, India
E-mail: rajeevg@satyam.net.in

Human Ecology Special Issue No., **13:** 101-110 (2005)
Human Obesity: A Major Health Burden
Kaushik Bose, *Guest Editor*