Association of Anthropometric and Metabolic Variables with Cardiovascular Disease among Urban and Rural Origin

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Abstract: Problem statement: We have examined the prevalence and association of cardiovascular diseases with respect to obesity and metabolic risk factors clustering among urban and rural Punjabi males aged 20-55 years. Obesity has been defined by increased Waist Circumference (WC), Body Mass Index (BMI) and Waist Hip Ratio (WHR). Metabolic traits such as increased total cholesterol, triglycerides and lipoproteins have also detrimental effect on the development of cardiovascular disease. **Approach:** This cross-sectional study was carried out on a total of 400 urban and rural origin Punjabi males (200 each from urban and rural). The anthropometric, physiometric and metabolic assessments were through standard procedures. Statistical analysis includes descriptive statistics, correlation, multivariate regression analysis and odds ratios. **Results:** It observed that males of rural population were at a higher risk to develop cardiovascular diseases compared to their urban counterparts. Rural males had significantly ($p<0.001$) higher mean values of cardiovascular risk factors with respect to BMI, weight, waist circumference, WHR, fasting glucose, total cholesterol, triglyceride, HDL and CHO-HDL ratio. SBP and DBP have positive association with waist-to-hip ratio, body mass index; waist circumference, skinfolds, pulse pressure, alcohol consumptions, food habit, HDL and triglyceride. **Conclusion:** Cardiovascular disease risk is found more in rural male Punjabi population due to consumption of more dietary products and leading of more sedentary lifestyle due to the overuse of mechanized substances for agriculture and personal use.

Key words: Punjabi males, blood pressure, anthropometric and metabolic phenotypes, Waist Circumference (WC), Waist Hip Ratio (WHR), Body Mass Index (BMI), Diastolic Blood Pressure (DBP), Systolic Blood Pressure (SBP), inferior margin, Indo-Aryan ethnic groups, Total Cholesterol (CHO), Triglycerides (TG)

INTRODUCTION

It has been predicted from different studies that CVDs will be the most important cause of mortality in India by the year 2015 (Yusuf *et al*., 2004; Gupta *et al*., 2004a, 2007; Shah and Mathur, 2010). Therefore, it is important to understand its precise etiology and mechanisms (Gupta *et al*., 2007; Das *et al*., 2008; Sulaiman *et al*., 2009; Rabadi, 2010). It is quite clear that some risk factors such as high cholesterol and triglyceride concentration, increased level of total cholesterol to high density lipoprotein cholesterol ratio, Type 2 Diabetes Mellitus (T2DM) and central or visceral obesity for atherosclerosis are particularly more prevalent in present Indian population especially in Punjabi population in Punjab (Gupta *et al*., 2007; Badaruddoza *et al*., 2010a; 2010b; Kumar and

Badaruddoza, 2010; Kaur *et al*., 2010; Ghosh *et al*., 2003; Ghosh, 2007a; Rurik *et al*., 2004). Urban-rural comparisons and migration studies would be able to indicate the consequences of modernization in increasing the prevalence of CVD risk factors. The migration from rural to urban has been attributed to reduced levels of physical activity and the dietary changes that occur with effective modern westernization (Ghosh, 2006; Deepa *et al*., 2009). In India, most of studies pertaining to CVD risk factors are either case control in nature or have considered urban (Ghosh *et al*., 2003; Gupta *et al.*, 2007) and rural people (Venkatramana and Reddy, 2002; Mohan *et al*., 2001) separately. Keeping this view in mind, the present investigation was aimed to study the urban-rural trend of CVD risk factors in the adult male Punjabi population with the hypothesis that adverse CVD risk

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factors is associated with increasing urbanization and modernization. In 2003, the prevalence of CVD in India was estimated to be 3-4% in rural areas (two-fold higher compared with 40 years ago) and 8-10% in urban areas (six-fold higher compared with 40 years ago), with a total of 29.8 million affected (14.1 million in urban areas and 15.7 million in rural areas) according to population-based cross-sectional surveys (Gupta *et al*., 2004a).

Hypertension is even more prevalent (20-40% among urban and 12-17% among rural adults) and was affecting an estimated 118 million inhabitants in India in 2000; this number is projected to almost double to 214 million in 2025 (Kearney *et al*., 2005; Goyal and Yusuf, 2006). The increasing risks of obesity and diabetes in India especially in Punjab like prosperous state have been attributed to increased consumption of saturated fats, sugars and sedentary behavior associated with urbanization and westernization. Therefore, the primary objectives of the current study are: (i) to describe the basic design for regression relationship and correlation between blood pressure phenotypes, anthropometric measurements and metabolic variables (ii) to determine strength and association of anthropometric and metabolic measurements with the relative risk of cardiovascular disease in urban and rural origin Punjabi males.

MATERIALS AND METHODS

Sampling design: The Punjabi people are Indo-Aryan ethnic groups and Punjabi identity is primarily cultural and linguistic. Punjabi population may be defined as similar genotypic groupings and aggregate of similar cultural practices, life style pattern, social influence and similar ethnic characteristics with Punjabi speaking and at least reside in Punjab for last 20 years (Badaruddoza *et al*., 2010b). A total of 200 urban and 200 rural males in the age group 20-55 years were recruited for the present study to identify the significant predictors of risk factor for cardiovascular diseases among urban and rural origin Punjabi male population. The much older individuals were not included in the present study because blood pressure increases among older population (Jani and Rajkumar, 2006). The subjects were taking medicine to control the blood pressure have not been included in the present study. Data were collected from Punjabi population in urban and rural areas of Amritsar and Gurdaspur districts in the state of Punjab spanning from June, 2009 to January, 2010. Written informed consent was obtained from all subjects prior to their participation. Study was carried out through subsequent visits of randomly selected male subjects from two districts. The study was approved by the Guru Nanak Dev University appropriate research ethics committee in the year 2010. The recruitment of the samples was done on the house to house basis with pre informed consent.

Measurement of Physiometric variables: The physiometric variables included measurement of Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and pulse rate. Two consecutive readings were recorded for each of SBP and DBP and the averages were used. The measurements were taken with the help of mercury sphygmomanometer in a sitting position with the right forearm placed horizontal on the desk. The recordings were taken as recommended by the American Heart Association (1980). An appropriate sized cuff was fitted on the arm of the subject and was inflated to about 20 mm Hg above the point at which the radial pulse disappeared. The pressure within the cuff was then, released at a rate of approximately 2 mm Hg sec^{-1} and while osculating with a stethoscope placed over the brachial artery. The onset of sound (Korotkoff-phase I) was taken as indicative of systolic blood pressure and the disappearance of sound (Korotkoff- phase V) was taken as indicative of diastolic blood pressure. Korotkoff phase was taken as recommended by the American Heart Association. All efforts were made to minimize the factors which might affect blood pressure like anxiety, fear, stress, laughing and recent activity (Badaruddoza and Afzal, 1999). The radial artery at the wrist is most commonly used to feel the pulse. It was counted over one minute. Pulse pressure is calculated through SBP and DBP using the following formula:

Pulse pressure= SBP-DBP

Anthropometric measurements: The anthropometric measurements taken were height (cm), weight (kg), waist circumference (cm), hip circumference (cm) and three skinfolds (mm) (biceps, triceps and subscapular). All the anthropometric measurements were taken on each individual using standard anthropometric techniques (Weiner and Lourie, 1981). The age of the individuals was determined directly from their reported date of birth. The height was measured using anthropometric rod with the subject standing erect position with the head in the ear-eye plane. The reading was then, recorded to the nearest 0.1 cm. The weight of the subject was measured in kilograms by making him stand on a weighing machine with minimal clothing. Weight was recorded with an allowance deducted for clothing to the nearest 0.5 kg. Waist circumference was measured using a steel tape. The measurement is taken mid-way between the inferior margin of the last rib and the crest of the ilium in a horizontal plane with relaxed abdomens. The tape was fitted snuggly without

compressing the soft tissue. Hip circumference of the subject was taken with steel tape fitted around the pelvis at the point of maximal protrusion of buttocks while the subject was standing with his feet close to each other. The readings were recorded for WC and HC to the nearest 0.1 cm. The subcutaneous skin fold thickness over the biceps, triceps and sub scapular muscle were taken with the help of Harpenden's caliper. The values for BMI expressed as the ratio of body weight divided by body height squared (in kg m^{-2}) and WHR defined as waist circumference divided by hip circumference.

Metabolic and glucose measurements: Fasting time for glucose and biochemical measurement was defined as>12 hours before blood draw. From each individual 3.5ml of blood was drawn by venipuncture and stored in tubes containing 500µL (0.5M) EDTA as an anticoagulant. Tubes were serially (labeled properly) numbered and then transferred on ice to the laboratory. The samples were centrifuged at 2500-3000 rpm for 10 min. Plasma appeared as supernatant and was separated for further analysis. The absorbance of the standard and each test sample was read against the blank at 505 nm or 505/670 nm on the Erba Mannhiem biochromatic analyzer. The metabolic variables included were Total Cholesterol (CHO) Triglycerides (TG) and high and low density lipoproteins (HDL and LDL).

Statistical analysis: All statistical analyses such as means, standard deviations, t-test, odds ratio, correlation, regression and multivariate analysis were performed using SPSS software 17.0 version. The p<0.05 level was selected as the criterion of statistical significance.

RESULTS

Descriptive statistics and inter-comparisons of means for anthropometric, physiometric and metabolic variables are presented in Table 1 among urban and rural male Punjabi population. The mean values of height, BMI, waist circumference, three skinfolds (biceps, triceps and subscapular), SBP, DBP, pulse pressure, pulse rate, total cholesterol, triglycerides, fasting glucose and LDL have been found significantly higher (p<0.001) among rural male Punjabi population. However the mean values of age, weight, hip circumference, HDL and VLDL have been found higher in urban male population but the differences is not significant. The skewness after adjustments varied from 0.03 (CHO-HDL ratio) to 0.72 (triglycerides) in urban population and 0.04 (triceps skinfold) to 1.38 (triglycerides and VLDL) in rural population, which demonstrates normal distributions for the traits in the study.

Estimates of correlation coefficients for SBP and DBP with other anthropometric and metabolic variables along with significant levels are presented in Table 2 among urban and rural male Punjabi population. Weight, body mass index, waist circumference, triceps and sub-scapular skinfolds, pulse pressure, total cholesterol and triglycerides are found significantly correlated (p<0.001) with SBP and DBP among both urban and rural male Punjabi population, whereas, hip circumference and WHR are found significant correlation (p<0.001) with SBP and DBP in rural population. Fasting glucose and LDL are significantly correlated with SBP and DBP in urban male population. Biceps skinfold with SBP in both urban and rural population, LDL-HDL and CHO-HDL ratios with SBP in urban population are found significant (p<0.001). It is interesting to note that HDL is significant and negatively correlated with SBP and DBP in both urban and rural population.

In multiple regression models, standardized regression coefficients with associated Standard Errors (SE) and percent of variance (R^2) accounted by regression for SBP and DBP are given in Table 3 among both rural and urban male Punjabi population. Regression coefficients for weight, body mass index, waist circumference, WHR, triceps skinfold, subscapular skinfold, pulse pressure, total cholesterol and triglycerides for SBP and DBP have been found significant (p<0.001) among both urban and rural male Punjabi population. Among rural male Punjabi population, the regression coefficients of hip circumference for SBP and DBP; biceps skinfold for SBP are found significant (p<0.001), whereas, urban male Punjabi population, the regression coefficients of HDL for SBP; fasting glucose for SBP and DBP are found significant (p<0.001). It is indicated that all R² values for almost all variables are negligible. Very few R² are found significantly higher such as HDL (33%) and pulse pressure (54%) for SBP and height, pulse pressure (14%) for DBP among urban male Punjabi population; pulse pressure (49%) for SBP and LDL-HDL (20%), pulse pressure (14%), cholesterol (11%) for DBP among rural male Punjabi population.

The analysis was further continued by calculation of significant predictors of SBP and DBP with respect to other major variables through multivariate regression analysis among urban and rural male Punjabi population (Table 4). The result revealed that body mass index, waist circumference, waist-to-hip ratio, pulse pressure, total cholesterol, HDL, LDL-HDL and CHO-HDL ratios have significant (p<0.001) impact and are strong predictors of SBP and DBP among urban male Punjabi population.

Table 1: Descriptive statistics for different anthropometric, physiometric and metabolic variable among the urban (n=200) and rural (n=200) male Punjabi population

Variables	Urban			Rural		
	Mean	SD	Skewness	Mean	SD	Skewness
Age (years)	38.13	16.84	0.35	36.37	16.43	0.83
Height (cm)	167.99	6.83	0.60	169.94**	7.59	0.42
Weight (kg)	66.40	13.73	0.31	66.05	13.44	0.45
BMI (kg m^{-2})	23.51	3.55	0.40	27.74**	3.94	0.33
W C (cm)	90.95	11.13	0.63	95.04**	11.39	0.69
H C (cm)	96.30	14.42	0.53	94.48	8.44	0.58
WHR	0.95	0.09	0.18	0.95	0.09	0.73
B SF (mm)	12.61	7.55	0.67	15.77*	5.25	1.36
TSF (mm)	22.41	9.00	0.07	24.32**	9.44	0.04
SSSF (mm)	23.09	6.44	0.37	27.08**	3.99	0.21
SBP (mm Hg)	131.60	15.76	0.54	132.95**	13.62	0.63
DBP (mm Hg)	81.38	11.47	0.43	81.53**	10.51	0.22
Pulse Pressure	50.18	15.83	0.62	51.63**	13.79	0.30
Pulse Rate	81.09	12.17	0.63	80.19**	10.93	0.36
CHO (mg dL^{-1})	158.41	23.66	0.67	174.71**	20.28	1.36
TG (mg dL^{-1})	95.95	28.09	0.72	110.47**	25.31	1.38
HDL (mg dL^{-1})	54.16	10.39	0.56	53.72	12.08	0.40
Glucose	92.08	10.21	0.31	105.08**	11.66	1.25
LDL	83.26	21.31	0.13	101.88*	22.16	0.49
VLDL	20.99	7.61	0.72	19.09	7.06	1.38
LDL-HDL	1.61	0.54	0.15	2.05	0.842	1.15
CHO-HDL	3.01	0.66	0.03	3.42	0.925	0.99

BMI: Body Mass Index; WC: Waist Circumference; HC: Hip Circumference; WHR: Waist-to-Hip Ratio; BSF: Biceps Skinfols; TSF: Triceps Skinfold; SSSF: Subscapular Skinfold; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; CHO: Total choleSterol; TG: Total Triglycerides; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein; VLDL: Very Low Density Lipoprotein

Table 2: Comparison of correlation coefficients with level of significance for blood pressure phenotypes with anthropometric, physiometric and metabolic variables among urban and rural males

Variables	SBP		DBP	
	Urban	Rural	Urban	Rural
Age (years)	0.01	0.15	0.06	0.19*
Height (cm)	0.12	0.21*	0.07*	0.01
Weight (kg)	0.25**	0.40**	0.23**	0.24**
BMI (kg m^{-2})	0.23**	0.35**	0.22**	0.27**
Waist Circumference (cm)	0.27**	0.30**	0.23**	0.22**
Hip circumference (cm)	0.14	0.29**	0.07	0.23**
WHR	0.11	0.16*	0.12	0.18*
Biceps skin fold (mm)	0.24*	0.22**	0.15	0.10
Triceps skin fold (mm)	0.18*	0.23**	0.22*	0.28**
Sub scapular skin fold (mm)	0.16*	0.25**	0.21**	0.27**
Pulse Pressure	0.74**	0.70**	0.37**	0.38**
Pulse Rate	0.04	0.05	0.03	0.09
Cholesterol (mg dL^{-1})	0.23**	0.39**	0.22**	0.26**
Triglyceride (mg dL^{-1})	0.33**	0.26**	0.34**	0.39**
HDL (mg dL^{-1})	-0.58**	-0.26**	-0.32**	-0.23**
Glucose	0.30**	0.08	0.67**	0.13
LDL	0.38**	0.04	0.32**	0.03
VLDL	0.13	0.06	0.33	0.09
LDL-HDL	0.56**	0.12	0.09	0.05
CHO-HDL	0.55**	0.09	0.14	0.08

BMI: Body Mass Index; WHR: Waist-to-Hip Ratio; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein; VLDL: Very Low Density Lipoprotein; **: Correlation is significant at the 0.01 level (2-tailed); *: Correlation is significant at the 0.05 level (2-tailed)

However, among urban male population, hip circumference and VLDL for both SBP and DBP, height, weight and fasting glucose for SBP and LDL for DBP have been identified as significant predictors. Similarly, rural male population, height and weight for both SBP and DBP; triglyceride for SBP; hip circumference, fasting glucose and VLDL for DBP have been identified as significant predictors.

The total studied samples have been classified for prehypertension and hypertensive individual with respect to different available anthropometric indicators. Table 5 depicted distribution of prehypertensive and hypertensive with respect to cut off values of body mass index, waist circumference, waist-to-hip ratio, biceps skinfold, triceps skinfold and sub scapular skinfold. Based on body mass index (<25 normal, ≥ 25-30 overweight, ≥ 30 obese) cut off values, the difference of prevalence of hypertension (pre and hyper) are not statistically significant between urban and rural population. However, tendency to develop hypertension is higher among rural population as compared to urban population. Based on waist circumference cut offs (<94cm = no risk, 94-101cm = medium risk, >101cm = high risk), the difference of prevalence of hypertension (pre and hyper) is also not significantly different. However similar percentages of hypertension have been found among rural and urban population (9.3%) whereas prehypertension percentage is significantly higher among urban population (13.3%) as compared to rural population (7.3%). Based on waist-to-hip ratio cut offs (<0.90 = no risk, 0.90-1.0 = medium risk, > 1.0 = high risk),

Table 3: Standardized regression coefficient and standard error (SE) with significant level and percent of variance (R²) for SBP and DBP with anthropometric, physiometric and metabolic variables in multiple regressions model among urban and rural Punjabi males

	SBP				DBP			
	Urban		Rural		Urban		Rural	
Variables	Coefficient ± S.E	R^2	Coefficient ± S.E	R²	Coefficient ± S.E	R²	Coefficient ± S.E	R²
Age (years)	0.11 ± 0.08	0.06	0.12 ± 0.07	0.02	0.14 ± 0.08	0.13	0.12 ± 0.07	0.04
Height (cm)	0.28 ± 0.18	0.01	0.26± 0.14	0.04	0.11 ± 0.09	0.14	0.19± 0.11	0.10
Weight (kg)	0.29 ± 0.09**	0.06	0.40± 0.08**	0.16	0.20 ±0.07**	0.05	0.19±0.06**	0.06
BMI (kg m⁻²)	0.72 ± 0.28**	0.04	1.23± 0.27**	0.13	0.56± 0.20**	0.05	0.71 ± 0.21**	0.07
WC (cm)	0.49 ± 0.23**	0.03	0.75± 0.20**	0.08	0.48 ± 0.17**	0.05	0.43 ± 0.16*	0.04
HC (cm)	0.39 ± 0.23	0.02	1.18 ± 0.32**	0.08	0.13 ± 0.11	0.14	0.72± 0.25*	0.05
WHR	20.21 ± 5.24**	0.01	24.95± 5.72**	0.03	16.66± 7.08*	0.01	17.06± 7.84*	0.02
BSF (mm)	0.29 ± 0.17	0.02	0.58± 0.21**	0.05	0.23 ± 0.12	0.02	0.20± 0.16	0.01
TSF (mm)	0.31 ± 0.14**	0.03	0.34± 0.12**	0.05	0.27 ± 0.10**	0.05	0.31± 0.09**	0.08
SSSF (mm)	0.39± 0.19**	0.03	0.84 ± 0.27**	0.06	0.38± 0.14**	0.05	0.73± 0.21**	0.07
Pulse Pressure	0.73 ± 0.09**	0.54	0.57 ± 0.06**	0.49	0.27 ±0.06**	0.14	0.28 ±0.06**	0.14
Pulse Rate	0.18 ± 0.11	0.06	0.19 ± 0.11	0.14	0.09± 0.06	0.05	0.08 ± 0.07	0.09
CHO (mg dL⁻¹)	0.38 ± 0.12**	0.14	0.55± 0.13**	0.09	0.33± 0.11*	0.05	0.43 ± 0.15**	0.11
TG (mg dL⁻¹)	0.55±0.09**	0.15	0.42±0.10**	0.12	0.62± 0.09**	0.11	0.44±0.11**	0.01
HDL (mg dL⁻¹)	-0.74±0.29**	0.33	-0.17±0.12	0.03	0.22±0.13	0.10	0.25±0.20	0.05
Glucose	0.39 ± 0.13**	0.09	0.19 ± 0.11	0.13	0.88±0.27**	0.45	0.15 ± 0.11	0.02
LDL	0.24 ± 0.16	0.14	0.22 ±0.16	0.13	0.27± 0.17	0.01	0.22 ± 0.15	0.07
VLDL	0.24 ± 0.19	0.02	0.11± 0.07	0.10	0.58 ± 0.41	0.11	0.18± 0.14	0.09
LDL-HDL	0.91 ± 0.74	0.31	1.82 ± 1.28	0.01	2.21 ± 1.99	0.01	0.81 ± 0.70	0.20
CHO-HDL	1.41 ± 0.90	0.11	1.61±1.12	0.17	2.94 ± 1.65	0.02	2.12±1.99	0.09

BMI: Body Mass Index; WC: Waist Circumference; HC: Hip Circumference; WHR: Waist-to-Hip Ratio; BSF: Biceps Skinfols; TSF: Triceps Skinfold; SSSF: Subscapular Skinfold; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; CHO: Total Cholesterol; TG: Total Triglycerides; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein; VLDL: Very Low Density Lipoprotein

Table 4: Estimation of significant predictors of SBP and DBP through multivariate regression analysis among urban and rural Punjabi males

	SBP				DBP			
	Urban		Rural		Urban		Rural	
Variables	Coefficient	SD	Coefficient	SD	Coefficient	SD	Coefficient	SD
Age (years)	0.13	0.09	0.04	0.08	0.02	0.07	0.10	0.06
Height (cm)	0.92**	0.22	0.43*	0.11	0.09	0.12	0.42**	0.12
Weight (kg)	1.59**	0.20	0.43*	0.21	0.21	0.12	0.48**	0.13
BMI (kg m⁻²)	3.47**	0.35	0.21*	0.09	0.34*	0.09	2.55**	0.77
WC (cm)	0.19**	0.03	0.33*	0.10	0.32*	0.11	0.34**	0.11
HC (cm)	0.18*	0.08	0.77	0.50	0.13*	0.05	0.12*	0.01
WHR	3.99**	0.25	7.30**	1.25	1.76**	0.49	7.28**	1.92
BSF (mm)	0.06	0.03	0.19	0.11	0.30	0.09	0.25	0.20
TSF (mm)	0.16	0.10	0.16	0.11	0.20	0.14	0.25	0.21
SSSF (mm)	0.19	0.11	0.12	0.10	0.27	0.17	0.45	0.32
Pulse pressure	0.74**	0.05	0.72**	0.06	0.26**	0.05	0.26**	0.06
Pulse rate	0.08	0.07	0.09	0.08	0.08	0.07	0.05	0.04
CHO (mg dL⁻¹)	0.12*	0.04	0.22**	0.10	0.16**	0.06	0.17**	0.05
TG (mg dL⁻¹)	0.08	0.01	0.26*	0.06	0.20	0.12	0.08	0.07
HDL (mg dL⁻¹)	1.35*	0.36	0.30**	0.11	0.58*	0.22	0.44**	0.11
Glucose	0.28*	0.14	0.20	0.16	0.14	0.11	1.11**	0.13
LDL	0.22	0.19	0.18	0.12	0.42*	0.21	0.28	0.20
VLDL	1.16*	0.32	0.25	0.13	1.67*	0.45	1.41*	0.41
LDL-HDL	14.57**	2.15	22.13**	5.45	7.25*	2.97	94.92*	32.70
CHO-HDL	19.23**	3.36	22.36**	3.20	22.36**	3.20	84.85*	22.42

BMI: Body Mass Index; WC: Waist Circumference; HC: Hip Circumference; WHR: Waist-to-Hip Ratio; BSF: Biceps Skinfols; TSF: Triceps Skinfold; SSSF: Subscapular Skinfold; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; CHO: Total Cholesterol; TG: Total Triglycerides; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein; VLDL: Very Low Density Lipoprotein

the difference of prevalence is again found insignificant among urban and rural male Punjabi population. However, prevalence rate of hypertension in rural male population is higher (9.3%) as compared to (4%) in urban population. Based on biceps skinfold cut off values the difference of prevalence is statistically significant (p<0.001) between urban and rural population. The percentage of hypertension is maximum in rural population (18%) as compared to urban population (3.3%). The same trends have been found in prehypertension category. Based on

triceps skinfold cut off values the difference of prevalence is statistically significant (p<0.001) between urban and rural population and the percentage of hypertension is much higher in rural population (22.61%) as compared to urban population (10%). The similar trend has been found in prehypertension category (rural 32%; urban 14%). Based on subscapular skinfold cut off values, the difference of prevalence of hypertension have been statistically significant (p<0.001) between urban and rural population.

Table 5: Comparison of Prevalence of Prehypertension and Hypertension with respect to selected anthropometric indicators between urban (n = 200) and rural (n = 200) Punjabi Males

Risk Factor	Pre-hypertension		Hypertension		Normal	
	Urban (%)	Rural (%)	Urban (%)	Rural (%)	Urban (%)	Rural (%)
BMI:						
Normal	40 (26.6)	57 (38)**	18 (12)	28 (18.6)	30(20)	21(14)
Overweight	26(17.3)	17(11.3)	15(10)	14(9.3)	7(4.6)	3(2)
Obese	6(4)	2(1.3)	7(4.6)	6(4)	1(0.66)	1(0.66)
WC:						
No risk	38(25.3)	54(36)*	20(13.3)	26(17.3)	26(17.3)	21(14)
Medium risk	14(9.3)	11(7.3)	6(4)	6(4)	5(3.33)	3(2)
High risk	20(13.3)	11(7.3)	14(9.3)	14(9.3)	7(4.6)	1(0.66)*
WHR:						
No risk	19(12.6)	23(15.3)	8(5.3)	11(7.3)	15(10)	7(4.6)
Medium risk	35(23.3)	42(28)	26 (17.3)	23(15.3)	17(11.3)	14(9.3)
High risk	18(12)	11(7.3)	6(4)	14(9.3)	6(4)	4(2.6)
BSF:						
Normal	63(42)	24(16)*	35(23.3)	21(14)*	37(24.6)	7(4.6)*
Obese	9(6)	52(34.6)**	5(3.3)	27(18)**	1(0.66)	14(9.3)**
TSF:						
Normal	51(34)	28(18.6)*	25(16.6)	14(9.3)	32(21.3)	14(9.3)*
Obese	21(14)	48(32)**	15(10)	34(22.6)**	6(4)	11(7.3)
SSF:						
Normal	61(40.6)	55(36.6)	36(24)	24(16)	35(23.3)	19(12.6)*
Obese	11(7.3)	21(14)	8(5.3)	24(16)**	3(2)	6(4)

BMI: Body Mass Index; WC: Waist Circumference; WHR: Waist -to- Hip Ratio; BISF: Biceps Skinfold; TSF: Triceps Skinfold; SSF: Subscapular Skinfold

Table 6: Comparison of relative prevalence for various risk factors with cardiovascular disease (hypertension and prehypertension) in between urban and rural Punjabi males presented as odds ratio, significant levels and 95% confidence level (lower and upper bound)

	Hypertension					Pre-hypertension				
	Odds Ratio	95% confidence interval		Z value	P value	Odds Ratio	95% confidence interval		Z value	P value
		Lower bound	Upper bound							
BMI (kg m^{-2})	1.71	0.730	3.980	3.95	<0.001	2.40	1.19	4.80	6.76	<0.001
WC (cm)	1.18	0.510	2.720	2.75	<0.005	2.19	1.12	4.26	6.37	<0.001
WHR	1.89	0.670	5.260	3.61	<0.001	1.21	0.59	2.47	3.32	<0.001
BSF	0.11	0.060	0.048	0.35	NS	0.07	0.03	0.15	0.15	NS
TSF	0.25	0.100	0.610	0.55	NS	0.24	0.12	0.47	0.68	NS
SSF	0.22	0.085	0.568	0.45	NS	0.47	0.21	1.05	1.13	NS
CHO (mg dL^{-1})	0.50	0.080	17.420	0.40	NS	0.88	0.52	1.51	3.52	<0.001
TG (mg dL^{-1})	1.50	0.100	21.540	1.10	NS	2.0	0.35	11.27	2.26	<0.05
HDL	0.50	0.090	2.690	0.58	NS	5.60	0.89	31.24	6.38	<0.001
CHO-HDL Ratio	2.0	0.360	10.910	2.30	<0.05	0.32	0.06	1.61	0.38	NS

BMI: Body Mass Index; WC: Waist Circumference; WHR: Waist-to-Hip Ratio; BSF: Biceps Skinfols; TSF: Triceps Skinfold; SSF: Subscapular Skinfold; CHO:Total cholesterol; TG: Total triglycerides; HDL: High Density Lipoprotein; NS: Not Significant at least at 5% level of probability

Table 6 presents the results of odds ratio and significant levels for the comparison of prevalence of prehypertension and hypertension with respect to different anthropometric and metabolic indicators between rural male Punjabi populations. The results showed that body mass index, waist circumference, waist-to-hip ratio and CHO-HDL indicators are the best significant indicators for detection of hypertension among urban and rural male Punjabi population. However, increasing body mass index and waist-to-hip ratio have strong relation with cardiovascular disease as indicated in odds ratio. As indicated in the table that body mass index, waist circumference, WHR, total cholesterol, triglycerides and HDL have a strong relationship with the occurrence of prehypertension among urban and rural male Punjabi population. The subjects with higher body mass index (OR 2.4; 95% CI: 1.19- 4.8) and waist-to-hip ratio (OR 1.21; 95% CI: 0.59- 2.47) have significantly higher likelihood to develop prehypertension among urban and rural male Punjabi population.

DISCUSSION

The major objective of the present study is to determine strength and association of anthropometric and metabolic measurements with the relative risk of cardiovascular disease in urban and rural region Punjabi males. The present study represents multivariate analysis model which include data with respect to blood

pressure phenotypes (dependent variables SBP and DBP). Other independent anthropometric variables are also included such as weight, body mass index, waist circumference, hip circumference, waist-to-hip ratio, biceps skinfold, triceps skinfold, subscapular skinfold and metabolic variables such as cholesterol, triglycerides, HDL, fasting glucose, LDL, VLDL, LDL-HDL and CHO-HDL. Therefore it is important to develop simple and effective anthropometric and metabolic indices for the screening of cardiovascular risk subjects in the population. Hence, the present study is the attempt to derive few specific predictors for cardiovascular disease especially in male Punjabi population. The results indicate that obesity and metabolic related parameters are almost equally important indicators for cardiovascular risk factors in both urban and rural male population. The result showed higher correlation coefficient existing between many common variables such as body mass index, waist circumference, triceps skinfold and pulse pressure with SBP and DBP in both urban and rural male Punjabi population.

Many published literature have existed on the relationship between blood pressure and other metric measurements (Reddy *et al*., 2005; Gupta *et al*., 2007; Erem *et al*., 2008; Cassani *et al*., 2009; Adedoyin *et al*., 2009; Jahangeer *et al*., 2010; Ahmadi *et al*., 2010; Jahromi *et al*., 2010). Many studies have been done on Indian population to identify the positive association between cardiovascular disease and many metric variables (Badaruddoza *et al*., 2009; 2010a; 2010b; Gupta *et al*., 2007; Parale *et al*., 2008; Badaruddoza and Kumar, 2009; Badaruddoza and Sawhney, 2009; Shah and Mathur, 2010). The results of present study indicated that SBP and DBP have positive association with waist-to-hip ratio, body mass index, waist circumference, skin folds, pulse pressure, HDL and triglycerides. These relationships have a great significance despite the fact that all these parameters have a prime role to play for occurrence of cardiovascular diseases. These relationships have been recognized between urban and rural male Punjabi population. These results are also in agreement with many Indian studies (Ghosh, 2007a; Gupta and Gupta, 2010; Shah and Mathur, 2010). It is reported that hypertension is more prevalent (20-40%) among urban and (12-17%) among rural adults and was affecting an estimated 118 million inhabitants in India in 2000; this number is projected to almost double to 214 million in 2025 (Kearney *et al*., 2005; Shah and Mathur, 2010). However the present study overall indicated that rural Punjabi male populations have a higher tendency to develop hypertension as compared to urban male

population. It was observed from present analysis that rural males have significantly (p<0.001) higher mean values of cardiovascular risk factors such as body mass index, waist circumference, waist-to-hip ratio, fasting glucose, total cholesterol and triglycerides as compared with their urban counterparts. It means rural population has significantly higher central adiposity as compared to urban male counterparts. This is due to the fact that rural male Punjabi population have consumed more dietary products and lead a more sedentary life due to the overuse of mechanized substances for agriculture and also personal use. However, many anthropometric and metabolic variables have not found significant differences for the two groups due to the fact of modernization in villages regions which change their style of living. However, significant differences on waist circumference, waist-to-hip ratio, body mass index, LDL, total cholesterol, VLDL, HDL and blood pressure among urban and rural population have been reported in many studies Ghosh, 2007b; Latiffah and Hanachi, 2008; Gupta *et al*., 2009;Badaruddoza *et al*., 2010a). The prevalence of increased adiposity, high blood pressure and elevated metabolic profiles are significantly higher in rural subjects compared to their urban male counterparts (for maximum studied values) in the present population. Earlier studies on Indian population have reported greater prevalence of cardiovascular risk factors in urban subjects (1990; Mohan *et al*., 2001; Gupta *et al*., 2004b; Gupta and Gupta, 2010).

The present study has several strengths as well as some limitations such as (i) only one cross sectional study would not be sufficient to develop the hypothesis that habitat (urban/rural) has no difference on occurrence of cardiovascular disease (ii) the present study was performed only on a limited number of sample sizes. Therefore it may not be representative of Punjabi population (iii) ethnic and cultural homogeneity is not strictly identified (iv) furthermore, longitudinal studies involving rural and urban cohort would be more useful to examine the present hypothesis.

CONCLUSION

This type of study is very scanty in Punjabi population in Punjab that demonstrates cross-sectional higher trends in dyslipidemia, elevated blood pressure and central obesity in rural as compared to urban. Therefore it seems that present urban and rural populations with respect to occurrence of cardiovascular disease are not absolutely in the same line of other studies. Hence further research with greater sample size is required to find out these noble

identifications. These changes may be indicating shifting of epidemiological transition in rural Punjab population. Other reasons may be the ethic predisposition to cardiovascular disease in addition to other risk factors in Punjabi population.

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