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To Identify Appropriate Anthropometric, Life Style and Metabolic Predictors in Assessment of Cardiovascular Disease Risk Factors among Punjabi Females in India

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ABSTRACT This study was conducted to find appropriate anthropometric, life style and metabolic predictors of cardiovascular diseases in female population in Punjab. A total of 500 healthy females belonging to Punjabi population were randomly recruited for present cross-sectional study. The mean systolic and diastolic blood pressures were 129.03±11.89 and 78.60±10.57 mm Hg. Many common variables such as body mass index (BMI), waist circumference (WC) and waist-to-hip ratio (WHR) have significant ($p<0.001$) correlation with SBP and DBP. The results of multivariate analysis showed that BMI, WC, pulse pressure and sedentary activity have statistically significant ($p<0.001$) impact on the elevation of SBP and DBP. The maximum prevalence of pre-hypertension (25%) and hypertension (12.7%) have been found among high risk group of waist circumference measurement and the same trend has been found for waist-to-hip ratio classification such as 34% pre-hypertension and 15.7% hypertension among high risk WHR group. With respect to life style, the maximum prevalence of pre-hypertension (26%) has been found among females having sedentary life style. WC and WHR showed higher sensitivity (WC= 77% for pre-hypertension and 95% for hypertension; WHR= 81% for pre-hypertension and 97% for hypertension) in the diagnosis of pre-hypertension and hypertension. Therefore, it may be concluded that the waist-to-hip ratio and waist circumference are the best indicators to predict the risk of cardiovascular disease incidence in females compared with BMI and other risk factors.

INTRODUCTION

It is widely accepted that overweight and obese people are more prone to wide range of cardiovascular diseases. Body mass index (BMI), waist circumference (WC) and waist-to-hip ratio (WHR) are usually used to assess the obesity (Wei et al. 1997; Ho et al. 2003; Welborn and Dhariwal 2007; Huxley et al. 2010). According to World Health Organization estimates, 16.7 million people around the globe die of cardiovascular disease each year (WHO 2003; Flegal et al. 2005) which is over 29% of all deaths globally. Presently, cardiovascular disease is more prevalent in India and China than any other economically developed countries in the world. Furthermore, women will continue to experience disproportionately high mortality from cardiovascular diseases. It is estimated that by 2040, women in countries like India, China, Russia, Brazil and South Africa will have higher percentage of deaths for cardiovascular diseases than men. The major risk factors for cardiovascular diseases in women are dyslipidemia, diabetes mellitus, abdominal obesity, sedentary lifestyle, and poor nutrition (Despres and Lemieux 2006; Litwin 2008). Different anthropometric indices such as body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR) and skinfold thickness, metabolic indices such as level of cholesterol (CHO) and triglycerides (TG), lifestyle habits and sedentary activity were analyzed to identify the association between adiposity and cardiovascular risk factors by many investigators (Akpinar et al. 2007; Haskell et al. 2007; Adedoyin et al. 2008; Khan et al. 2008; Badaruddoza and Caplash 2012; Ghai et al. 2012; Hwang et al. 2012; Giudice et al. 2012; Spaan et al. 2012). Most of the studies have shown linear relationship between anthropometric traits and the risk to develop cardiovascular disease and they have also reported that larger waist circumferences (WC) and waist to hip ratio (WHR) may be significantly associated with a higher risk of developing cardiovascular diseases (Folsom et al. 2000; Lissner et al. 2001; Seidell et al. 2001; Lakka et al. 2002; Heitmann et al. 2004; Price et al. 2006). Therefore, it is suggested that BMI, WC or WHR may each perform better in predicting cardiovascular risk in specific populations with respect to age, gender, and ethnicity. It is also documented

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from various studies that BMI is less significant at predicting an increased relative risk of cardiovascular disease than waist circumference in women (Stevens et al. 1998; Rexrode et al. 2001; Byers 2006; Litwin 2008). This is due to the fact that central obesity is so common in women, and thus, increased waist circumference might produce a higher relative risk in women than in men. It has found that elevated waist circumference was associated with cardiovascular diseases and even in normal weight women (Litwin 2008; Zhang et al. 2008). However, other investigators concluded that BMI is clinically equivalent to waist circumference in predicting major CVD events (Ridker et al. 2005; Gelber et al. 2008; Litwin 2008). Although the associations between anthropometric indices and cardiovascular risk have been consistently observed in many populations. However, the studies related to predict pre-hypertension and hypertension with respect to anthropometric, lifestyle and metabolic indicators are very limited in this population. Therefore, the primary objective of the current study is to investigate a few specific anthropometric, metabolic traits and life style habits for predicting the risk of cardiovascular disease among Punjabi female population in India.

MATERIAL AND METHODS

Sample Design

The estimated sample size to detect association of mean blood pressure and quantitative variables was 455 subjects (calculated through SPSS power analysis) with an alpha error of 5% and a statistical power of 90%. The final sample size with 10% contingency due to non-response/ recording error/illness was rounded as 455×1.10=500 subjects. Therefore, a total of 500 females within the age group of 20- 65 years were recruited for the present cross-sectional study to identify the significant predictors of risk factor for cardiovascular diseases among north Indian Punjabi females. Data were collected in Punjabi population from Amritsar and Gurdaspur district in Punjab (a north Indian state). Written informed consent was obtained from all subjects prior to their participation. Study was carried out through various surveys and subsequent visits to the populations in two districts. These populations were divided into 50 groups (25 groups in each district) of known geographic location and population counts. It is assumed that these groups were homogeneous with respect to their life style and socio-economic status. Subjects were selected randomly from these groups in numbers weighted to require sample size. Therefore, subjects were selected by multistage sampling methods. Pregnant women and who were using an anti-hypertensive medication were excluded from the study. The present study was approved by the Guru Nanak Dev University appropriate research ethics committee in the year 2009. For data collection personal interviews were held with each subject. General information about name, caste, religion, address, sex, education status, family history of hypertension, food habits, frequency of regular physical activities, exercises and inter-caste marriage were interviewed using a pre-designed questionnaire. The age of all selected individuals was determined directly from their date of birth certificate of municipality or school. All the information obtained from an individual was recorded on the pre-designed proforma. All measurements have been taken by single investigator, with same instrument therefore, intra and inter-observer variability for taking measurements is very negligible.

Measurements

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, however the variation of two reading is very negligible. The measurements were taken with the help of standard mercury sphygmomanometer (Diamond, Model No. BPMR112, India) in a sitting position with the right forearm placed horizontal on the table. The recordings were taken as recommended by the American Heart Association (Kirkendall et al. 1981). 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. The anthropometric measurements taken were height (cm), weight (kg), waist circumference (cm), hip circumference (cm) and four skinfolds (biceps, triceps, subscapular and suprailiac). All the anthropometric measurements were taken on each individual using standard anthropometric technique (Singh and Bhasin 1968; Weiner and Lourie 1981). 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. Fasting blood sample from 200 out of total selected 500 individuals were randomly obtained for biochemical analysis. Fasting time for glucose and biochemical measurement was defined as >12 hours before venous blood draw. From each individual 3.5ml of blood was drawn by venipuncture and stored in tubes containing 500ml (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 minutes. 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 semiautomatic biochromatic analyzer (model CHEM-7, Germany). The metabolic variables included were total cholesterol (CHO) triglycerides (TG) and high and low density lipoproteins (HDL and LDL).

Cut-off Points and Scoring Methods Followed

For anthropometric parameters the cut-off points were used on WHO classification (WHO 1997) such as for BMI: underweight <18.5 kg/m^2, normal >18.5-24.9 kg/m^2, overweight >25.0-29.9 kg/m^2 and obesity >30 kg/m^2; for WC: no risk <95 cm, medium risk >95-101 cm, high risk e”101 cm; for WHR: no risk <0.90, medium risk >0.90-1.0, high risk >1.0. For pre-hypertension and hypertension the cut-off values were used on the definition of hypertension published by seventh Joint National Committee on Prevention, Detection, Evaluation and Treatment of high blood pressure guidelines (Chobanian et al. 2003): a cut-off point of >140/90 mmHg for hypertension, >120-139/>80-89 mmHg for prehypertension; for cholesterol: normal <200 mg/dL, medium risk > 200- 239 mg/dL, high risk >240 mg/dL; for triglycerides normal <150 mg/dL, medium risk >150-199 mg/dL, high risk >200 mg/dL. The risk level of fasting glucose is > 110 mg/dL.

In the present study three lifestyle variables have been collected such as food habit, active lifestyle and sedentary lifestyle. As there were no gold standard scoring methods available for these soft data, therefore, for simple statistical analysis a numeric score for yes/no, present/absent of favorable/unfavorable (dichotomous categories) have been given. The subject have been divided into two categories with respect to nature of the food habits such as vegetarian (score given 1) and non-vegetarian (score given 2). According to physical activity level the subjects were divided into two categories such as sedentary lifestyle (score given 1) (subject spend maximum time on daily basis in watching television, sleeping, reading and desk working) and active lifestyle (subject spend maximum time on daily basis in working/cycling/swimming/jogging/ health club/sports/domestic work) (score given 2).

Statistical Analysis

The statistical analysis was carried out using SPSS version 17.0 software (SPSS Inc., Chicago, USA). Descriptive statistics were expressed as mean±SD. Pearson's partial correlation coefficients for all anthropometric, life style habits and metabolic variables were explored for their relationship with SBP and DBP with controlling age effect. Linear regression was used to see the effects of age and all other variables on blood indices. Multivariate models were created based on the results of univariate analysis. Chi-square test was used to analyze association between different categories of risk factors and distribution of pre-hypertension, hypertension and normal. Odds ratio with 95% confidence level was used to determine the relative risk of pre-hypertension and hypertension with respect to different studied risk factors in the study population. Measures of sensitivity, specificity, positive and negative predictive values and accuracy of anthropometric, life style habits and metabolic variables to predict pre-hypertension and hypertension were calculated using WHO and International Society of Hypertension guidelines (WHO-ISH 1999) as the gold standard. The $p<0.05$ level was selected as the criterion of statistical significance.

RESULTS

The mean values of SBP, DBP, anthropometric and metabolic variables affecting blood pressures are presented in Table 1. The mean age of the study group was 37.55±10.73 (range 20-65) years. The mean values for SBP and DBP were 129.03±11.89 (range 86-181) mm Hg and

Table 1: The mean values of different anthropometric, physiometric and metabolic variables measured in Punjabi females

Variables	*Min-max*	*Mean*	*SD*	*N*
Age (years)	20-65	37.55	10.73	500
Height (cm)	144-174	159.59	5.75	500
Weight (kg)	36-90	59.98	10.33	500
BMI (kg/m^2)	13.43-35.99	23.55	4.67	500
Waist circumference(cm)	41- 127	89.23	13.70	500
Hip circumference (cm)	59- 125	95.72	10.02	500
WHR	0.73- 1.27	0.932	0.096	500
Biceps skinfold (mm)	3- 36	12.23	2.32	500
Triceps skinfold (mm)	5-45	27.93	2.76	500
Subscapular skinfold(mm)	4-41	21.93	2.72	500
Suprailiac skinfold (mm)	4-42	19.81	2.78	500
SBP (mm Hg)	86- 181	129.03	11.89	500
DBP (mm Hg)	46-115	78.60	10.57	500
Pulse pressure	14- 102	49.50	11.97	500
Pulse rate	54- 120	82.75	10.18	500
Cholesterol (mg/dl)	129 -241	172.93	18.94	200
Triglyceride (mg/dl)	52-281	111.81	20.92	200
HDL(mg/dl)	31-81	51.56	12.51	200
Fasting glucose (mg/dl)	51- 125	96.95	15.30	200
LDL(mg/dl)	44-145	95.12	29.31	200
VLDL(mg/dl)	10- 56	22.39	10.96	200
LDL-HDL Ratio	0.65- 5.78	2.07	0.66	200
CHO-HDL Ratio	0.87- 10.57	3.47	0.76	200

BMI= body mass index; WHR= waist-to-hip ratio; SBP= systolic blood pressure; DBP= diastolic blood pressure; LDL= low density lipoprotein ; VLDL= very low density lipoprotein ; HDL= high density lipoprotein; CHO=cholesterol.

Table 2: The partial correlation of anthropometric, metabolic and life style variables with systolic and diastolic blood pressure with controlling of age effect among Punjabi females

Variables	*SBP*		*DBP*	
	R	*P*	*R*	*p*
Height (cm)	-0.024	0.598	-0.017	0.693
Weight (kg)	0.044	0.323	0.078	0.082
Body mass index (BMI) (kg/m^2)	0.198	0.000	0.201	0.000
Waist circumference (cm)	0.235	0.000	0.199	0.000
Hip circumference (cm)	0.065	0.151	0.046	0.312
Waist-to-hip ratio (WHR)	0.182	0.000	0.132	0.003
Biceps skinfold (mm)	0.142	0.002	0.065	0.152
Triceps skinfold (mm)	0.083	0.067	0.079	0.080
Subscapular skinfold (mm)	0.097	0.031	0.116	0.010
Suprailiac skinfold (mm)	0.110	0.016	0.075	0.097
Pulse rate	-0.333	0.460	0.030	0.502
Pulse pressure	0.718	0.000	0.283	0.000
Physical activity	0.012	0.812	0.033	0.522
Food habit	0.026	0.618	-0.002	0.970
Sedentary activity	0.103	0.046	0.052	0.316
Cholesterol (CHO) (mg/dl)	-0.031	0.500	-0.007	0.633
Triglyceride (TG) (mg/dl)	-0.033	0.463	-0.022	0.633
High density lipoprotein (HDL) (mg/dl)	-0.040	0.372	-0.071	0.116
Fasting Glucose (mg/dl)	0.014	0.749	-0.019	0.674
Low density lipoprotein (LDL) (mg/dl)	0.007	0.988	0.037	0.403
Very low density lipoprotein (VLDL) (mg/dl)	-0.034	0.448	-0.022	0.627
LDL-HDL Ratio	0.160	0.000	0.025	0.345
CHO-HDL Ratio	0.198	0.000	0.034	0.366

78.60±10.57 (range 46-115) mm Hg. The mean values of cholesterol and triglyceride were 172.93±18.94 (range 129-241) mg/dL and 111.81±20.92 (range 52-281) mg/dL. The mean values of BMI, WC and WHR were 23.55±4.67 (range 13.43-35.99) kg/m^2, 89.23±13.70 (range 41-127) cm and 0.932±0.096 (range 0.73-1.27) respectively.

The Pearson's partial correlation matrix for the association between anthropometric, life style and metabolic indicators and each of SBP and DBP with controlling age effect is presented in Table 2. BMI, WC, WHR, sub-scapular skinfold and pulse pressure indicated a significant positive correlation with both SBP and DBP. However, no metabolic variables were significantly correlated with the cardio-vascular parameters. Biceps and suprailiac skinfolds, sedentary lifestyle, LDL-HDL ratio and CHO-HDL ratio were significantly correlated with SBP only.

The results of the univariate and multivariate analysis to evaluate the effects of these studied variables on SBP and DBP are presented in Table 3. Weight, BMI, WC, HC, WHR, sub-scapular and suprailiac skinfolds and pulse pressure with both SBP and DBP; age, biceps and triceps skinfolds, sedentary lifestyle and cholesterol with only SBP showed strong association in univariate analysis but in age adjusted multivariate anal-

Table 3: The results of univariate and multivariate models representing the association of systolic and diastolic blood pressure with anthropometric, life style and metabolic variables

Variables	*SBP*						*DBP*					
	Univariate			*Multivariate*			*Univariate*			*Multivariate*		
	B	*P*	*95% CI of B*	*B*	*P*	*95% CI of B*	*B*	*P*	*95% CI of B*	*B*	*P*	*95% CI of B*
Age (years)	0.146	0.003	0.050-0.241	0.552	0.000	0.380-0.723	-0.025	0.647	-0.137-0.085	-	-	-
Height (cm)	-0.053	0.712	-0.339-0.232	-	-	-	-0.009	0.987	-0.340-0.340	-	-	-
Weight (kg)	0.308	0.003	0.109-0.507	-0.006	0.893	-0.12- 0.12	0.233	0.000	0.104-0.361	0.022	0.607	-0.064 – 0.11
BMI (kg/m^2)	0.772	0.000	0.466-1.079	0.779	0.000	0.451-1.108	0.543	0.000	0.321-0.765	0.521	0.000	0.283-0.758
WC (cm)	0.737	0.000	0.490-0.983	0.754	0.000	0.340-1.168	0.441	0.000	0.260-0.621	0.559	0.000	0.257-0.861
HC (cm)	0.919	0.002	0.352-1.486	-0.002	0.987	-0.33- 0.33	0.527	0.006	0.154-0.900	-0.059	0.635	-0.30- 0.186
WHR	35.402	0.000	19.45-51.34	-1.38	0.914	-26.37-23.61	18.356	0.002	6.716-29.997	-7.617	0.403	-25.5- 10.26
BSF (mm)	0.587	0.001	0.248-0.925	0.334	0.001	0.145-0.524	0.141	0.222	-0.087-0.369	-	-	-
TSF (mm)	0.456	0.010	0.112-0.800	0.0105	0.936	-0.248 – 0.27	0.180	0.120	-0.047-0.408	-	-	-
SSSF (mm)	0.554	0.000	0.286-0.823	0.029	0.769	-0.169- 0.228	0.353	0.000	0.177-0.528	0.164	0.026	0.020-0.308
SISF (mm)	0.695	0.000	0.389-1.001	0.355	0.076	-0.038-0.747	0.215	0.044	0.006-0.424	0.037	0.528	-0.078- 0.153
Pulse rate	-0.060	0.332	-0.183-0.062	-	-	-	0.023	0.601	-0.065-0.112	-	-	-
Pulse pressure	0.779	0.000	0.712-0.845	0.991	0.000	0.982-1.001	-0.216	0.000	-0.282-0.149	-0.276	0.000	-0.28 - 0.15
Physical activity	0.238	0.872	-0.2.66- 3.14	-	-	-	0.623	0.541	-1.37-2.62	-	-	-
Food habit	1.016	0.520	-2.82- 4.85	-	-	-	-0.037	0.882	-2.69- 2.61	-	-	-
Sedentary activity	3.50	0.05	0.006- 6.99	3.25	0.05	0.005- 5.69	1.23	0.32	-1.19- 3.65	-	-	-
Cholesterol (mg/dl)	-0.215	0.050	-0.431-0.000	-0.002	0.943	-0.069- 0.065	-0.011	0.853	-0.132-0.109	-	-	-
Triglyceride (mg/dl)	-0.076	0.185	-0.190-0.038	-	-	-	-0.005	0.866	-0.068-0.057	-	-	-
HDL (mg/dl)	-0.202	0.371	-0.653-0.249	-	-	-	0.090	0.418	-0.144-0.340	-	-	-
Fasting Glucose (mg/dl)	-0.025	0.828	-0.256-0.206	-	-	-	-0.0008	0.988	-0.125-0.123	-	-	-
LDL (mg/dl)	-0.123	0.301	-0.360-0.114	-	-	-	-0.030	0.593	-0.162-0.094	-	-	-
VLDL (mg/dl)	-0.383	0.184	-0.955-0.189	-	-	-	-0.020	0.875	-0.337-0.288	-	-	-

ysis only BMI, WC and pulse pressure remained associated ($p<0.001$) with both SBP and DBP. Age and sedentary lifestyle were the only factors affecting SBP, surprisingly, none of the metabolic variables except cholesterol with SBP in univariate model and food habits showed significant association in any of the models.

Table 4 showed the chi-square analysis of the association between the distribution of percentage of pre-hypertensive, hypertensive and normotensive with different anthropometric, lifestyle and metabolic indicators. The chi-square test revealed a statistically significant association between prevalence of pre-hypertension, hypertension with categories of BMI, WC, WHR, lifestyle, level of cholesterol and triglyceride. However, food habits have not shown any significant association with prevalence of pre-hypertension and hypertension. It is also indicated from the magnitude of the chi-square values that WC has strongest association with the prevalence of hypertension.

Table 5 showed a comparison of the performance of different indicators such as BMI, WC, WHR, biceps and triceps skinfolds, food habit, levels of cholesterol and triglycerides to identify pre-hypertension and hypertension. Sensitivity evaluates how good the test is at detecting positive disease in true cases. In this context WHR and WC have found maximum sensitivity to identify both true pre-hypertensive and hypertensive individuals (81%, 77% and 97%, 95% for pre-hypertensive and hypertensive respectively). Specificity estimates how likely patients without disease can be correctly ruled out. Therefore, levels of triglycerides and food habits have higher specificity (82%, 80% and 82%, 79% for pre-hypertension and hypertension respective-

Table 4: Chi-square analysis of association between the distribution of pre-hypertension, hypertension, normotensive and different risk factor category of anthropometric, life style and metabolic indicators

Risk factors	*Pre-hypertension N (%)*	*Hypertension N (%)*	*Normal N (%)*	χ^2	***p***
BMI (kg/m²)				29.93	0.0001
Normal	116 (23.30)	40 (8.00)	165 (33.00)		
Overweight	62 (12.30)	30 (6.00)	35 (7.00)		
Obese	22 (4.30)	15 (3.00)	15 (3.00)		
Waist Circumference (cm)				156.33	0.0001
No risk	46 (9.30)	10 (2.00)	84 (16.70)		
Medium	29 (5.70)	12 (2.30)	44 (9.00)		
High	124 (25.00)	64 (12.70)	87 (17.30)		
WHR				15.64	0.0015
No risk	10 (2.00)	2 (0.30)	30 (6.00)		
Medium	19 (3.70)	5 (1.00)	20 (4.00)		
High	171 (34.30)	79 (15.70)	164 (33.00)		
Biceps Skinfold (mm)				4.46	0.347
Normal	76 (15.30)	30 (6.00)	87 (17.30)		
Overweight	108 (21.70)	54 (10.70)	113 (22.70)		
Obese	15 (3.00)	2 (0.30)	15 (3.00)		
Triceps Skinfold (mm)				5.58	0.232
Normal	113 (22.70)	50 (10.00)	141 (28.30)		
Overweight	62 (12.30)	29 (5.70)	56 (11.30)		
Obese	25 (5.00)	7 (1.30)	17 (3.30)		
Food Habit				0.27	0.873
Veg	163 (32.70)	70 (14.00)	172 (34.30)		
Non-veg	37 (7.30)	15 (3.00)	43 (8.70)		
Life Style				17.67	0.0001
Sedentary	132 (26.30)	39 (7.70)	128 (25.57)		
Active	72 (14.43)	48 (9.70)	81 (16.30)		
Cholesterol(mg/dl)				11.66	0.020
Normal	33 (16.60)	60 (30.30)	18 (8.87)		
Medium	7 (3.33)	6 (3.00)	7 (3.33)		
High	20 (10.00)	44 (22.12)	5 (2.45)		
Triglyceride(mg/dl)				21.74	0.0002
Normal	32 (16.60)	61 (29.96)	55 (27.22)		
Medium	7(3.33)	6 (3.00)	7 (3.33)		
High	20 (10.00)	7 (3.34)	5 (2.78)		

Table 5: Estimated sensitivity, specificity, positive and negative predictive values and accuracy of the measures of selected anthropometric, life style habits and metabolic indicators to predict pre-hypertension and hypertension among Punjabi females

Indicators	*Sensitivity (95% CI)*		*Specificity (95% CI)*		*Predictive value (95% CI)*				*Accuracy (95% CI)*	
					Positive		*Negative*			
	Pre-hyper-tension	*Hyper-tension*	*Pre-hyper-tension*	*Hyper-tension*	*Pre-hyper-tension*	*Hyper-tension*	*Pre-hyper-tension*	*Hyper-tension*	*Pre-hyper-tension*	*Hyper-tension*
BMI	0.42 (0.35-0.53)	0.53 (0.42-0.64)	0.77 (0.70-0.82)	0.76 (0.70-0.82)	0.63 (0.54- 0.71)	0.47 (0.37- 0.58)	0.59 (0.53- 0.64)	0.80 (0.74- 0.86)	0.61 (0.57- 0.65)	0.64 (0.60- 0.68)
WC	0.77 (0.70-0.82)	0.95 (0.91-0.97)	0.39 (0.33-0.46)	0.39 (0.33-0.46)	0.54 (0.48- 0.60)	0.58) (0.53- 0.64)	0.64 (0.56- 0.73)	0.89 (0.80- 0.95)	0.60) (0.55- 0.64)	0.74. (0.70- 0.78)
WHR	0.81 (0.75-0.89)	0.97 (0.91-0.99)	0.14 (0.10-0.20)	0.15 (0.09-0.19)	0.51 (0.46- 0.56)	0.31 (0.26- 0.37)	0.39 (0.29- 0.51)	0.94 (0.77- 0.99)	0.54 (0.50- 0.58)	0.63 (0.58- 0.67)
BSF	0.62 (0.55- 0.69)	0.65 (0.54- 0.75)	0.40 (0.34- 0.47)	0.41 (0.33- 0.48)	0.49 (0.43- 0.55)	0.30 (0.24- 0.37)	0.53 (0.45- 0.61)	0.74 (0.65- 0.82)	0.54) (0.50- 0.58)	0.55 (0.50- 0.59)
TSF	0.44 (0.36- 0.50)	0.42 (0.31- 0.53)	0.65 (0.59- 0.72)	0.66 (0.60- 0.72)	0.54 (0.46- 0.62)	0.33 (0.24- 0.43)	0.55 (0.49- 0.62)	0.74 (0.67- 0.80)	0.55 (0.53- 0.57)	0.53 (0.49- 0.57)
Food Habit	0.19 (0.14- 0.25)	0.18 (0.11- 0.28)	0.80 (0.74- 0.85)	0.79 (0.73- 0.84)	0.46 (0.35- 0.57)	0.26 (0.16- 0.39)	0.51 (0.46- 0.57)	0.71 (0.65- 0.77)	0.49 (0.44- 0.53)	0.37 0.37
CHO	0.45 (0.32- 0.58)	0.45 (0.36- 0.55)	0.60 (0.40- 0.77)	0.59 (0.40- 0.76)	0.69 (0.52- 0.82)	0.80 (0.68- 0.89)	0.35 (0.23- 0.50)	0.23 (0.15- 0.34)	0.54) (0.50- 0.58)	0.60 (0.56- 0.54)
TG	0.46 (0.33- 0.59)	0.18 (0.10- 0.29)	0.82 (0.70- 0.90)	0.82 (0.74- 0.88)	0.69 (0.52- 0.82)	0.52 (0.32- 0.72)	0.63 (0.52- 0.82)	0.47) (0.38- 0.57)	0.67 (0.63- 0.71)	0.50 (0.46- 0.54)

BMI= body mass index; WC=waist circumference; WHR= waist-to-hip ratio; BSF=biceps skinfold; TSF=triceps skinfold; CHO=total cholesterol; TG=triglycerides ly) to identify the negative results in the case of pre-hypertension and hypertension. Accuracy represents true results, either true positive or true negative in the population. In this context, the present results revealed that level of triglycerides have maximum accuracy (67%), followed by BMI (61%) and WC (60%) to identify pre-hypertension, whereas, WC has maximum accuracy (74%) followed by BMI (64%) and WHR (63%) to identify hypertension.

DISCUSSION

The major objective of the present study is to compare the appropriateness of anthropometric, physiometric and lifestyle variables for predicting the risk of cardiovascular diseases among Punjabi females in Punjab. The study represents a multivariate model which includes individual data with respect to blood pressure phenotypes (dependent variables, SBP and DBP). The other metric anthropometric variables such as age, height, weight, BMI, waist-to-hip ratio, waist circumference, hip circumference and skinfolds; lifestyle variables such as food habit (vegetarian and non-vegetarian) and life style (sedentary and active) and metabolic variables such as cholesterol, triglyceride, fasting glucose HDL, LDL and VLDL are included. Therefore, the present study can be used to derive the biological relationship between blood pressure phenotypes and other studied variables among Punjabi females. Further the present study would also help to understand the interactions between different anthropometric, physiometric and lifestyle indicators with hypertension/ pre-hypertension among Punjabi females. The study highlights the prevalence of pre-hypertension and hypertension among Punjabi females which was classified with the indicators of BMI, waist circumference and waist-to-hip ratio etc. It also indicated the emergence of cardiovascular disease and their risk factors as major contributors to the burden of ill health in Punjabi females.

The positive and significant associations between many indicators such as BMI, waist circumference, waist-to-hip ratio, skinfolds, pulse pressure and sedentary life style with elevated blood pressure have been observed. These finding suggest that the indicators like waist circumference, waist-to-hip ratio, food habit, sedentary life style, levels of cholesterol and triglyceride are equally valid and useful for epidemiological and clinical research; however, further study is needed to support the present observation.

In the present population among Punjabi females, an increasing trend of the prevalence of hypertension has been observed. The comparatively high prevalence of hypertension and pre-hypertension among Punjabi females may be contributable to changes in dietary habits, sedentary life style and the rates of overweight and obesity. The association between increased BMI, waist circumference, waist-to-hip ratio, triglyceride and sedentary life style are consistent with findings from many other studies (Nirmala et al. 1993; Gupta et al. 1997; Chadha et al. 1999; Silventoinen et al. 2003; Badaruddoza and Kumar 2009; Badaruddoza and Sawhney 2009; Badaruddoza et al. 2010; Bishnoi et al. 2010; Nascimento et al. 2011; Ghai et al. 2012).

The present study has also reported 33% of overall prevalence of hypertension and significant effect of metabolic syndrome among Punjabi females. However, no other studies are available from this population to compare the present study with respect to metabolic syndrome. When the associations between different anthropometric, physiometric and environmental indicators with the occurrence of cardiovascular disease were analyzed in multivariate models then it was observed that BMI, waist circumference and pulse pressure have an independent impact on the occurrence of elevated blood pressure. The increased risk of cardiovascular disease associated with abdominal obesity independent of BMI and WC may indicate the adverse effects of fat located within abdominal cavity among Punjabi females. However, we cannot exclude the possibility that these associations found are due to common factors like sedentary life style and food habit. In the present observation the most important indicators were waist circumference, waist-to-hip ratio, life style and level of triglycerides among Punjabi females. It is interesting to note that vegetarian population has higher frequency of pre-hypertension and hypertension incidences although the differences are not statistically significant. This is due to the fact that vegetarian females consume more junk food which may explain the presence of higher blood pressure in vegetarian population. In conclusion, the study results suggested that WC and WHR have been found to be best predictors of blood pressure indices due to its higher sensitivity, specificity and overall accuracy in Punjabi females. Age was also found to be the strongest factor affecting blood pressure in females. Therefore, measurement of WC alone can be a better clinical alternative to BMI for detecting adult female with possible health risk due to obesity and cardiovascular diseases.

LIMITATIONS OF THE STUDY

The present study has several strengths as well as some limitations such as: (i) the cross-sectional sampling design do not allow inferences to be drawn with respect to casual relationships among the variables (ii) the samples studied are only representative of adult females residing in Amritsar and Gurdaspur districts and therefore may not generalize for Punjab (iii) all studied variables are age dependant, however age grouping analysis has not been done. Despite these limitations this study provides important data regarding the prevalence and correlation of Punjabi female specific cardiovascular disease risk factors. This study further add strong evidence for high prevalence of cardiovascular disease risk factors among Punjabi females which would be useful for health screening strategies to reduce the burden of cardiovascular disease in Amritsar and Gurdaspur district in Punjab.

REREFERENCES

Adedoyin RA, Mbada CE, Bisiriyu LA, Adebayo RA, Balogun MO, Akintomide AO 2008. Relationship of anthropometric indicators with blood pressure levels and the risk of hypertension in Nigerian adults. *Int J Gen Med,* 1: 33-40.

Akpinar E, Bashan I, Bozdemir N, Saatci E 2007. Which is the best anthropometric technique to identify obesity: Body mass index, waist circumference or waist-hip ratio? *Coll Antropol,* 31: 387-393.

Badaruddoza, Caplash S 2011. Receiver operating characteristics (ROC) analysis in pre-menarcheal Punjabi girls to detect excess adiposity. *Asian J Pharm Clin Res,* 5: 114-119.

Badaruddoza, Kumar R 2009. Cardio-vascular risk factor and familial aggregation of blood pressure with respect to anthropometric variables in a scheduled caste population in Punjab, a north Indian state. *Anthrop Anz,* 67: 111-119.

Badaruddoza, Kaur R, Barna B 2010. Estimation of familial association of blood pressure with BMI and WHR among type 2 diabetic and non-diabetic Punjabi population in Punjab, India. *Trans Biomed,*1: 1-6.

Badaruddoza, Sawhney R 2009. Familial aggregation of blood pressure with respect to anthropometric variables in a business community of Punjab, a north Indian state. *Coll Anthrop,* 33: 1023-1032.

Bishnoi D, Kaur T, Badaruddoza 2010. Predictor of cardiovascular disease with respect to BMI, WHR and lipid profile in females of three population groups. *Biol Med,* 2: 32-41.

Byers T 2006. Overweight and mortality among baby boomers—now we're getting personal. *The New Eng J Med,* 355: 758–760.

Chadha SL, Vasan RS, Sarma PS, Shekhwat S, Tandon R, Gopinath N 1999. Age- and height- specific reference limits blood pressure for Indian children. *Natl Med J India*, 12**:** 150-156.

Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, Jones DW, Materson BJ, Oparil S, Wright JT Jr, Roccella EJ 2003. Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension*, 42: 1206-1252.

Despres JP, Lemieux I 2006. Abdominal obesity and metabolic syndrome. *Nature,* 444: 881–887.

Folsam AR, Prineas RJ, Kaya SA, Munger RG 1990. Incidence of hypertension and stroke in relation to body fat distribution and other risk factors in older women. *Stroke,* 21: 701-706.

Folsom AR, Kushi LH, Anderson KE 2000. Associations of general and abdominal obesity with multiple health outcomes in older women: The Iowa Women's Health Study. *Arch Inter Med,* 160: 2117–2128.

Gelber RP, Gaziano JM, Orav EJ, Manson JE, Buring JE, Kurth T 2008. Measures of obesity and cardiovascular risk among men and women. *The J Am Coll Cardiol,* 52: 605–615.

Ghai NR, Jacobsen SJ, VanDenEeden SK, Ahmed AT, Haque R, Rhoads GG, Quinn VP 2012. A comparison of lifestyle and behavioral cardiovascular disease risk factors between Asian Indian and White non-Hispanic men. *Ethn Dis,* 22: 168-174.

Giudice R, Izzo, R, Manzi M.V, Pagnano G, Santoro M, Rao M.A. Di Renzo G, De Luca N, Trimarco V, 2012. Lifestyle-related risk factors, smoking status and cardiovascular disease. *High Blood Press Cardiovasc Prev,* 19: 85-92.

Gupta R, Agarwal VS, Gupta VP, Soangra MR 1997. Correlation of smoking, blood pressure levels and hypertension prevalence in urban and rural subjects. *JAPI*, 45: 919-922.

Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, Macera CA, Heath GW, Thompson PD, Bauman A 2007. Physical activity and public health: Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation* 116: 1081-1093.

Heitmann BL, Frederiksen P, Lissner L 2004. Hip circumference and cardiovascular morbidity and mortality in men and women. *Obes Res,* 12: 482–487.

Ho SY, Lam TH, Janus ED 2003. The Hong Kong cardiovascular risk factor prevalence study steering committee. Waist to stature ratio is more strongly associated with cardiovascular risk factors than other simple anthropometric indices. *Ann Epidemiol,* 13: 683-691.

Huxley R, Mendis S, Zheleznyakov E, Reddy S, Chan J 2010. Body mass index, waist circumference and waist: Hip ratio as predictors of cardiovascular risk-a review of the literature. *Eur J Clin Nutr,* 64: 16-22.

Hwang IC, Suh SY, Seo AR, Ahn HY, Yim E 2012. Association between metabolic components and subclinical atherosceloris in Korean Adults. *Korean J Fam Med*, 33: 229-236.

Khan A, Haq FU, Pervez MB, Saleheen D, Frossard PM, Ishaq M, Hakeem A, Sheikh HT, Ahmad U 2008. Anthropometric correlates of blood pressure in normotensive Pakistani subjects. *Int J Cardiol*, 124: 259-262.

Kirkendall WM, Feinleib M, Freis ED, Mark AL 1981. Recommendations for human blood pressure determination by sphygmomanometers. *Stroke*,12: 555A-564A.

Lakka HM, Lakka TA, Tuomilehto J, Salonen JT 2002. Abdominal obesity is associated with increased risk of acute coronary events in men. *Eur Heart J*, 23: 706–713.

Lissner L, Bjorkelund C, Heitmann BL, Seidell JC, Bengtsson C 2001. Larger hip circumference independently predicts health and longevity in a Swedish female cohort. *Obes Res*, 9: 644–646.

Litwin SE 2008. Which measure of obesity best predict cardiovascular risk? *The J Am Coll Cardiol*, 52: 616-619.

Nascimento LR, Coelli AP, Cade NV, Mill JG, Molina MCB 2011. Sensitivity and specificity in the diagnosis of hypertension with different methods. *Rev Saude Publica*, 45: 837-844.

Nirmala A, Reddy PC, Reddy KN 1993. Influence of adiposity on blood pressure in an Andhra Pradesh population. *J Indian Anthropol Soc*, 28**:** 139-145.

Price GM, Uauy R, Breeze E, Bulpitt CJ, Fletcher AE 2006. Weight, shape, and mortality risk in older persons: Elevated waist-hip ratio, not high body mass index, is associated with a greater risk of death. *The Am J Clin Nutr*, 84: 449–460.

Rexrode KM, Buring JE, Manson JE 2001. Abdominal and total adiposity and risk of coronary heart disease in men. *The Int J Obes Relat Metabol Dis*, 25: 1047–1056.

Ridker PM, Cook NR, Lee IM 2005. A randomized trial of low-dose aspirin in the primary prevention of cardiovascular disease in women. *The New Eng J Med*, 352: 1293–1304.

Seidell JC, Perusse L, Despres JP, Bouchard C 2001.Waist and hip circumferences have independent and opposite effects on cardiovascular disease risk factors: The Quebec Family Study. *The Am J Clin Nutr*, 74: 315–321.

Silventoinen K, Jousilathti P, Vartiainan E, Tuomilehto J 2003. Appropriateness of anthropometric obesity indicators in assessment of coronary heart disease risk among Finnish men and women. *Scan J Public Health*, 31: 283-290.

Singh IP, Bhasin MK 1968. *Anthropometry*. Delhi: Kamla Raj Enterprises.

Spaan JJ, Sep SJ, van Balen VL, Spaanderman ME, Peeters LL 2012. Metabolic syndrome as a risk factor for hypertension after preeclampsia. *Obstet Gynecol*, 120: 311-317.

Stevens J, Cai J, Pamuk ER, Williamson DF, Thun MJ, Wood JL 1998. The effect of age on the association between body-mass index and mortality. *The New Eng J Med*, 338: 1–7.

Wei M, Gaskill SP, Haffner SM, Stern MP 1997. Waist circumference as the best predictor of non-insulin dependent diabetes mellitus (NIDDM) compared to body mass index, waist/hip ratio and other anthropometric measurements in Mexican Americans –a 7 year prospective study. *Obes Res*, 5: 16-23.

Weiner JS, Lourie JA 1981. *Practical Human Biology*. London: Academic Press.

Welborn TA, Dhariwal SS 2007. Prefered clinical measures of central obesity for predicting mortality. *Eur J Clin Nutr*, 61: 1373-1379.

WHO 2003. *World Health Report: Shaping the Future*. Geneva.

WHO 1997. *Obesity, Preventing and Managing the Global Epidemic*—Report of a WHO Consultation on Obesity. Geneva:World Health Organization.

WHO-ISH World Health Organization-International Society of Hypertension Guidelines for the Management of Hypertension 1999. Guidelines Subcommittee. *Hypertension*, 17: 151-183.