Predictor of cardiovascular disease with respect to BMI, WHR and lipid profile in females of three population groups

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Abstract
The present study focused on females of three population groups namely Bishnoi, Sikh and Hindu from two Northern states of India (Punjab and Rajasthan) with the primary objectives (i) to describe the basic design for regression relationship and correlation between the phenotypes of blood pressure, anthropometric measurements and metabolic variables and (ii) to compare the three population groups and find out the significant predicators for cardiovascular disease. A total of 310 females were recruited from the three population groups. All the anthropometric and physiometric measurements were taken on each individual using standard technique. Females of Hindu population were at a higher risk, Sikh at a moderate and Bishnoi at lower risk in case of comparison with respect to BMI, weight, waist circumference, total cholesterol, triglyceride, HDL and Cho-HDL ratio. Since waist circumference is a measure of android obesity, it is found to be a significant predictor of cardiovascular disease across all the three populations. Physical inactivity, on the other hand, demonstrated a strong association with the elevation of cardiovascular disease risk. It can now be concluded that cardiovascular disease in females should not be taken casually, rather cardiovascular disease risk factors should be addressed much earlier than menopause.

Keywords: Cardiovascular risk factor; Females; Body mass index; Waist to hip ratio.

Introduction

The cardiovascular disease (CVD) burden afflicts both men and women, with deaths accounting for 34% of all the deaths in women and 28% in men in 2007 (Rosamond et al., 2007). So, now look beyond the popular belief of CVD being a more prominent in the men. It was reported that out of a total of 9.4 million deaths in India in 1990, CVD caused 2.3 million that is 25% deaths (Murray and Lopez, 1997). It is expected that by 2020, there would be a 111% rise in CVD deaths in India (Rodgers et al., 2000). Many previous studies have suggested significant effects of body weight, height, cholesterol, pulse rate, BMI, different skin fold, obesity, nutrition, smoking, oral contraceptive use, menopausal status, stress and physical activity on blood pressure (Jackson et al., 1985; Pan et al., 1986; Mathews et al., 1987; Sobolski et al., 1987; Pérusse et al., 1989; Badaruddoza and Afzal, 2000; Sidhu et al., 2004; Badaruddoza et al., 2008; 2009 and 2010; Badaruddoza and Hundal, 2009; Badaruddoza and Kumar, 2009). Taking that into account, the present study focused on females of three population groups, namely Bishnoi, Sikh and Hindu. The subjects were enrolled from two Northern states of India (Punjab and Rajasthan). The primary objectives of the current study are: (i) to describe the basic design for regression relationship and correlation between the phenotypes of blood pressure, anthropometric measurements and metabolic variables. (ii) to compare the three population groups and find out the significant predicators for CVD in the given populations.

Materials and Methods

Sample

A total of 310 females were recruited for the present study to identify the predictors of risk factor for cardiovascular diseases. Three population groups, such as Bishnoi, Sikh and Hindu were identified. Females from Amritsar, Batala, Phagwara and Ludhiana cities in Punjab and Hanumangarh Town, Mehnawali and Krishanpura areas of Rajasthan were included in the present study spanning from August 2008 to January 2009. The recruitment of the samples was done on the house-to-house basis with pre-informed consent. Females of the Bishnoi population group range in age from 16-45 years whereas the mean is 28.74±8.21 (for Bishnoi Females, N = 110). The ages of females of Sikh population group range in age from 16-45 years with mean 30.50±9.47 (N=100). Females of the Hindu population group range in age from 16-45 years with mean 29.61±8.91 (N=100). Blood samples were obtained for biochemical analysis (Lipid Profile). From each individual 3.5ml of blood was drawn by venipuncture and stored in tubes containing 500µl (0.5M) EDTA as an

anticoagulant. For data collection personal interviews were held with each subject. General information about name, caste, religion, address, sex, date of birth, education status and inter caste marriage was obtained. All the information obtained from as individual was recorded on the pre-designed proforma.

Measurements

Both the anthropometric and physiometric measurements were included in the present study. The anthropometric measurements taken were height (cm), weight (kg), waist circumference (cm) and hip circumference (cm). All the anthropometric measurements were taken on each individual using standard anthropometric technique (Singh and Bhasin, 1968; Weiner and Lourie, 1981). The physiometric variables included 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 table. The recordings were taken as recommended by the American Heart Association (1981). 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. Mean Arterial blood pressure (MBP) was calculated for each of the two readings taken for SBP and DBP by using the formula MBP = DBP + (SBP- DBP)/3 (Pérusse et al., 1989). The pulse rate was counted over one minute. Pulse pressure is calculated through SBP and DBP using the following formula: Pulse pressure = SBP - DBP. Pulse pressure is calculated through SBP and DBP using the following formula: Pulse pressure= SBP- DBP.

The information of following environmental variables related lifestyle has been collected.

Physical activities: The subjects have been divided into many categories with respect to nature of physical activities such as never walking, cycling, swimming, jogging and domestic work. *Sports*: The subjects have been divided according to the nature of sports such as tennis, hockey, football and others. *Food habits*: The subjects have been divided into two categories with respect to nature of their food habits such as vegetarian and non-vegetarian. *Physical fitness*: The subjects have been divided into three categories according to their physical fitness in daily life such as bad, normal and good. *Sedentary activities*: The subjects have been divided according to their daily time spent (hours) watching TV, sleeping and others. The metabolic variables included were total cholesterol (CHO) Triglycerides (TG), High-density lipoproteins (HDL) and Lactate dehydrogenase (LDH).

Results

Table 1 presents inter- comparison of means and significant values among three population groups. It is interesting to note that all major variables have a significant difference ($p<0.001$) among the three groups of population. Further, it was noticed that except metabolic variables, all other variables have maximum significant inter-religion differences. The range of t values is 26.30 (BMI) to 195.43 (SBP). Table 2 depicts comparison of correlation coefficients for blood pressure with metric, environmental and metabolic variables between the females of Bishnoi, Sikh and Hindu population. All the three population groups demonstrate significant correlation for almost all measured variables such as age, weight, BMI, waist and hip circumferences, WHR, pulse rate, pulse pressure, occupation, reading, economic status and LDH with SBP and DBP. Cholesterol, triglycerides and watching TV (hours spent per day) were correlated for Sikh population and height was correlated for Bishnoi population for SBP and DBP. The magnitude of correlation coefficient for almost all measured metric variables are high among Bishnoi population for SBP and DBP followed by Sikh and Hindu for SBP and Hindu and Sikh for DBP. The results were further continued by calculation of significant predictors of SBP and DBP with respect to other measured variables through multivariate regression analysis among the three populations (Table 3 and 4). The results revealed that in general age, height, waist and hip circumferences, WHR, reading (hours spend per day), cholesterol, triglyceride and Cho-HDL ratio have significant ($p<0.001$) impact and are strong predictors of SBP and DBP among females of three populations. Therefore, it may be concluded that dependable variables (SBP and DBP) can only be predicted from a linear combination of many independent variables such as age, waist circumference, hip

circumference, WHR, BMI, cholesterol, triglyceride, Cho-HDL ratio and reading (hours spent per day) among the females of three populations. Findings of Meta Analysis indicated that the risk for the occurrence of elevated blood pressure have insignificant association with females of three population groups. However, the levels of odds ratio are almost similar among females of three populations (Bishnoi, 0.750: 0.385-1.461; Sikh, 0.778:0.417-1.450; Hindu, 0.751: 0.409-1.378) and showing that the risk factors have similar association with the prevalence higher blood pressure (Table 5).

Discussion

The present study represents a multivariate model which includes individual data with respect to blood pressure phenotypes (dependent variable, SBP, DBP and MBP); other metric independent variables such as age, height, weight, BMI, waist and hip circumferences, WHR, pulse pressure and pulse rate; environmental variables such as occupation, economic status, food habit, physical activities, sedentary activities (reading, watching TV and sleeping) and metabolic variables such as cholesterol, triglycerides, HDL, LDH and Cho-HDL ratio. In the comparison of three populations (Bishnoi, Sikh and Hindu) with respect to BMI, weight, waist circumference, total cholesterol, triglyceride, HDL and Cho-HDL ratio, females of Hindu population were found to have an increased risk to develop this CVD as compared to the females of Bishnoi and Sikh population. However, females of Bishnoi population have minimum risk to develop CVD with respect to WHR, BMI and metabolic variables. This may be attributed to the life style and food habit of this group. The females of the Sikh population are at a moderate risk for this disease.

The data clearly showed that WHR is more appropriate and important long-term predictor for CVD risk factor as compared to BMI. However, significant independent relationships were found for almost all the anthropometric variables with the blood pressure phenotypes (SBP, DBP and MBP) among all the three populations. Age and weight are relatively important risk factors for CVD in women. However, impact of other variables such as waist and hip circumferences on CVD might be explained in the casual pathways leading to this disease. This hypothesis has been supported by many authors (Rhoads et al., 1978; Feinleib et al., 1979; Meade et al., 1979; Hubert et al., 1983). BMI is widely used as a measure of adiposity in epidemiological studies. However, BMI variability in the present study has been found significant for only Bishnoi population group. It is believed that BMI does not account for the wide variations of the fat distributions. It is a measure of general obesity as opposed to android obesity, which is believed to be a greater risk factor for CVD (Bender et al., 2002). Waist and hip circumferences along with WHR were found significant across all the three population groups in the present study. There is evidence that stresses on the role of waist circumference in prediction of elevated blood pressure in subjects <65 years of age (Yalcin et al., 2005), as in present study. Thus, WHR turns out to be a superior predictor because it includes waist circumference that is positively related and hip circumference that is negatively related to hypertension and CVD risk (Siedell et al., 2001; Heitman et al., 2004; Okura et al., 2004). The hypothesis that WHR is a better predictor for assessing the risk of development of CVD in females as compared to BMI (Lean et al., 1995; Rexorde et al., 2001; Janssen et al., 2002; Yalcin et al., 2005) is strengthened by the present study.

In the light of the present analysis, it is suggested that metabolic variables such as total cholesterol, triglycerides and Cho-HDL ratio are significant predictors of CVD risk in the groups studied. High levels of plasma cholesterol and triglycerides are well-established risk factors for CVD (Bass et al., 1993; Austin et al., 2000). The superiority of Cho-HDL ratio in CVD risk assessment has been established by numerous studies (Stampfer et al., 1991; Shai et al., 2004). Evidence has suggested that HDL is important for prediction of CVD (Meagher, 2004; Mosca et al., 2004). The association of HDL and triglycerides as predictors for coronary events is independent of the total cholesterol level and has a greater predictive potential in females (Castelli, 1992; Castelli et al., 1992). The significance of triglycerides as a predictor of CVD is also demonstrated by the present study. However, HDL does not show any significant association except in the Bishnoi population for SBP. This trend may be attributed to the small sample size. Association of environmental factors such as measures of sedentary lifestyle or physical inactivity with elevation in CVD risk is well-established (Pate et al., 1995; Rastogi et al., 2004). The present study demonstrates that sedentary activities such as number of hours

spent reading per day have a strong association with CVD risk. Physical inactivity is a factor that can be easily modified and thus can be helpful in prevention of CVD. In the light of the present analysis, it is suggested that waist and hip circumference, WHR, cholesterol, triglycerides and Cho-HDL ratio are considerably significant predictors of CVD risk as compared to BMI and HDL in females of the three population groups.

Therefore, it may be concluded from the present study that CVD is a serious epidemic in the female population across all the three groups examined. The present results suggest that CVD risk factors should be addressed in females starting much earlier than menopause. It is also recommended that female specific predictors should be found and studied for better and more effective preventive cardiology.

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Table 1- Intercomparison of means and standard deviations through't' test with significant value among the females of three populations.

	Bishnoi (n=110)		**Shikh (n=100)**		**Hindu (n=100)**		**Mean Difference at 95%**	**t**	**p**
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**			
Age (years)	28.74	8.21	30.50	9.47	29.61	8.91	23.43-31.80	58.29	<0.000
Height (cm)	162.18	5.72	155.80	6.63	155.33	6.53	148.26-167.3	71.46	<0.000
Weight (kg)	57.40	8.70	58.31	8.19	59.65	10.63	55.64-61.26	89.45	<0.000
BMI (kg/m²)	21.80	2.97	23.97	4.80	24.80	4.60	19.67-27.37	26.30	<0.001
Waist Circumference (cm)	80.15	9.00	79.20	9.61	81.15	13.11	77.74-82.59	142.40	<0.000
Hip circumference (cm)	98.32	8.05	95.53	7.04	98.02	9.41	93.48-101.09	110.02	<0.000
WHR	0.81	0.05	0.83	0.07	0.82	0.08	0.79-0.84	142.03	<0.000
SBP (mm Hg)	126.23	10.05	125.45	10.33	124.04	10.78	122.48-128.0	195.42	<0.000
DBP (mm Hg)	84.45	6.75	86.50	8.16	83.72	9.20	81.31-88.47	102.02	<0.000
MBP (mm Hg)	98.25	7.00	99.40	9.79	96.81	8.90	94.93-101.38	131.01	<0.000
Pulse Pressure	41.79	9.71	38.95	8.77	40.42	8.28	36.86-43.91	49.25	<0.000
Pulse Rate	74.50	8.76	81.74	10.19	83.47	8.19	68.08-91.72	29.08	<0.001
Cholesterol (mg/dl)	164.44	31.62	140.09	56.79	193.22	52.21	99.84-231.98	10.81	<0.008
Triglyceride (mg/dl)	110.74	42.03	116.12	47.94	159.84	90.00	62.00-195.80	8.29	<0.014
HDL (mg/dl)	87.14	2.91	84.51	5.51	88.79	4.28	81.45-92.18	69.66	0.000
LDH (IU/L)	334.59	152.32	304.50	213.72	255.03	147.0	198.25-397.8	12.85	<0.006
CHO-HDL Ratio	1.91	0.35	1.65	0.643	2.18	0.61	1.25-2.57	12.51	<0.006

Table 2 - Comparison of correlation coefficients with level of significance for blood pressure phenotypes with anthropometric, physiometric, environmental and metabolic variables among females of three groups of population.

Variables	SBP			DBP			MBP		
	Bishnoi	**Sikh**	**Hindu**	**Bishnoi**	**Sikh**	**Hindu**	**Bishnoi**	**Sikh**	**Hindu**
Age (years)	0.510**	0.266**	0.245**	0.264**	0.129	0.303**	0.440**	0.192*	0.307**
Height (cm)	0.306**	0.019	0.026	0.260**	0.006	0.071	0.329**	0.005	0.050
Weight (kg)	0.522**	0.238*	0.351**	0.413**	0.249**	0.367**	0.538**	0.260**	0.387**
BMI (kg/m²)	0.430**	0.247**	0.354**	0.342**	0.265**	0.388**	0.442**	0.277**	0.399**
Waist Circumference (cm)	0.494**	0.313**	0.239*	0.565**	0.227*	0.323**	0.624**	0.281**	0.311**
Hip circumference (cm)	0.473**	0.287**	0.289**	0.447**	0.259**	0.344**	0.542**	0.282**	0.348**
WHR	0.227**	0.227*	0.132	0.356**	0.092	0.223*	0.341**	0.167	0.197**
Pulse Pressure	0.735**	0.498**	0.451**	0.216*	0.263**	0.156	0.248**	0.026	0.056
Pulse Rate	0.131	0.382**	0.224*	0.137	0.243**	0.163	0.021	0.318**	0.182
Occupation	0.283**	0.247**	0.176	0.193*	0.143	0.263**	0.265**	0.198*	0.244*
Economic Status	0.092	0.377**	0.195*	0.102	0.273**	0.288**	0.102	0.311**	0.260**
Food Habit	0.089	0.069	0.010	0.076	0.101	0.029	0.069	0.113	0.030
Physical Activity	0.018	0.059	0.155	0.204*	0.012	0.042	0.117	0.029	0.077
TV	0.004	0.189*	0.145	0.008	0.020	0.212*	0.029	0.099	0.192*
Sleeping	0.142	0.034	0.034	0.149	0.089	0.061	0.160	0.073	0.027
Reading	0.326**	0.265**	0.158	0.273**	0.252**	0.231*	0.347**	0.270**	0.204*
Cholesterol (mg/dl)	0.017	0.190*	0.133	0.204*	0.114	0.282**	-	-	-
Triglyceride (mg/dl)	0.058	0.298**	0.145	0.036	0.377**	0.292**	-	-	-
HDL (mg/dl)	0.452**	0.029	0.217*	0.036	0.201*	0.286**	-	-	-
LDH (IU/L)	0.197*	0.422**	0.314**	0.010	0.201*	0.184*	-	-	-
CHO-HDL Ratio	0.101	0.116	0.165	0.346**	0.165	0.322**	-	-	-

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 3 - Calculation of significant predictors of SBP with respect to anthropometric, physiometric, environmental and metabolic variables among females of three groups of population through multivariate regression analysis.

Variables	Bishnoi		Sikh		Hindu	
	Coefficient	**P**	**Coefficient**	**p**	**Coefficient**	**p**
Age (years)	0.579	<0.001	0.108	<0.010	0.306	<0.050
Height (cm)	0.621	<0.001	0.107	<0.050	0.304	<0.001
Weight (kg)	0.009	<0.001	0.420	<0.001	0.199	<0.010
BMI (kg/m²)	1.198	<0.001	0.691	NS	1.520	<0.001
Waist Circumference (cm)	1.181	<0.001	0.827	<0.001	3.120	<0.048
Hip circumference (cm)	0.395	<0.001	0.436	<0.001	2.938	<0.025
WHR	83.546	<0.001	55.921	<0.001	301.058	<0.047
Pulse Pressure	0.483	<0.001	0.404	<0.001	0.176	NS
Pulse Rate	0.205	<0.001	0.337	<0.001	0.198	<0.050
Occupation	-1.725	<0.001	-4.849	<0.002	-0.534	NS
Physical Activity	6.781	<0.001	25.436	<0.001	0.709	NS
TV	0.353	<0.001	1.379	NS	1.253	NS
Sleeping	0.239	NS	0.688	NS	0.082	NS
Reading	-1.757	<0.002	-2.509	<0.011	-1.029	<0.007
Cholesterol (mg/dl)	0.331	<0.001	0.160	<0.001	-0.169	<0.001
Triglyceride (mg/dl)	0.216	<0.001	0.470	<0.001	0.310	<0.001
HDL (mg/dl)	1.454	<0.029	0.082	NS	0.458	NS
LDH (IU/L)	0.006	<0.001	0.019	NS	0.021	NS
CHO-HDL Ratio	3.649	<0.001	1.823	<0.001	2.431	<0.001

NS: Not significant at least at 5% level of probability.

Table 4 - Calculation of significant predictors of DBP with respect to anthropometric, physiometric, environmental and metabolic variables among females of three groups of population through multivariate regression analysis.

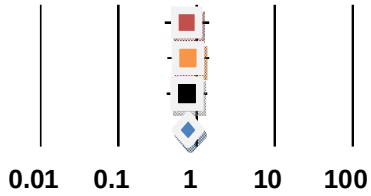
Variables	Bishnoi		Sikh		Hindu	
	Coefficient	**P**	**Coefficient**	**p**	**Coefficient**	**p**
Age (years)	0.183	<0.031	0.612	<0.001	0.327	<0.024
Height (cm)	0.909	<0.050	0.110	NS	0.116	NS
Weight (kg)	-0.869	NS	0.440	<0.001	-0.047	NS
BMI (kg/m²)	2.897	NS	0.463	<0.001	1.175	NS
Waist Circumference (cm)	1.551	<0.004	1.181	<0.001	-3.909	<0.007
Hip circumference (cm)	0.915	<0.039	-0.730	<0.001	3.596	<0.001
WHR	114.260	<0.034	-113.040	<0.050	388.202	<0.003
Pulse Pressure	-0.495	<0.015	-0.533	<0.001	-0.824	NS
Pulse Rate	0.168	NS	0.305	<0.010	0.198	<0.015
Occupation	-1.303	NS	-2.975	<0.046	-1.390	NS
Physical Activity	5.951	NS	-16.749	<0.002	-2.402	NS
TV	0.169	NS	-0.019	NS	1.938	<0.044
Sleeping	0.353	<0.013	1.130	NS	-1.173	NS
Reading	-0.939	<0.013	-2.294	<0.010	-1.453	<0.036
Cholesterol (mg/dl)	0.290	<0.001	0.110	NS	-0.160	<0.001
Triglyceride (mg/dl)	0.300	<0.001	0.125	<0.022	-0.460	<0.001
HDL (mg/dl)	-0.668	NS	-0.756	NS	-0.823	NS
LDH (IU/L)	-0.011	NS	-0.008	NS	-0.004	NS
CHO-HDL Ratio	8.674	<0.050	2.693	NS	-5.602	<0.001

NS: Not significant at least at 5% level of probability.

Table 5

Meta analysis for elevated blood pressure among females of three groups of population.

Study name	Odds ratio	Lower limit	Upper limit	Z-Value	p-Value
Bishnoi	0.750	0.385	1.461	-0.845	0.398
Sikh	0.778	0.417	1.450	-0.791	0.429
Hindu	0.751	0.409	1.378	-0.925	0.355
Fixed	0.760	0.528	1.094	-1.479	0.139



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