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Principal Component Factor Analysis of Cardiovascular Risk Factors among Punjabi Female Population

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Abstract: *Background*: The cardiovascular diseases are one of the primary causes of total mortality in India. However, systematic population based data related cardiovascular risk factors are very scanty in Punjab state of India. Therefore, present study was undertaken to analyze cardiovascular risk factors among females of Brahmin and Jat sikh population using principal component analysis (PCFA). It has been used for seventeen factors including anthropometric, physiometric, metabolic and glucose tolerance. *Method:* A total of 428 females (199 Brahmin and 229 Jat sikh) were recruited for the present study to identify cardiovascular risk factors. Blood samples from 100 (50 Brahmin and 50 Jat Sikh) out of total 428 individuals were obtained. Different anthropometric, physiometric and metabolic variables were taken. Principle component factor analysis (PCFA) was applied to extract orthogonal components. Relationships between components were explained by factor loadings. *Results:* PCFA reduced 16 risk factors to 7 uncorrelated components that explained maximum (87%) of the total variance among the females of both the groups. Factor 1 has high loading of the traits that reflects obesity related traits like body mass index (BMI), waist circumference (WC), hip circumference (HC) and waist to hip ratio (WHR) for both female populations and explained the largest portion of total variance (36% for Brahmin; 34% for Jat Sikh). Factor 2 is loaded predominantly with total cholesterol (TC), high density and low density lipoproteins (HDL & LDL), LDL-HDL ratio and TC-HDL ratio for Brahmin female population. Comparably factor 2 is loaded with SBP, DBP and pulse pressure (PP) among Jat Sikh female population. Therefore, factor 2 is identified as responsible for dyslipidemia for Brahmin and hypertension for Jat Sikh. *Conclusion:* Factor analysis reduced 16 inter-correlated cardiovascular risk factors to 7 newly defined factors. As these factors are uncorrelated, each one can be interpreted to represent a distinct phenotype underlying cardiovascular risk in the females of Brahmin and Jat Sikh Punjabi population.

Key words: Factor analysis · Punjabi · Cardiovascular risk factors

INTRODUCTION

Cardiovascular diseases (CVD) are expected to be the leading cause of morbidity and mortality in developing countries by 2020 and estimated more than 19 million deaths annually [1]. The prevalence of CVD is known to be very high in the people of India. It has risen four-fold in the past four decades. CVD already causes 29% of all deaths in the country [2]. Along with the burden of CVD in developing countries, the burden of its risk is also increasing [3]. The identification of the components of multiple risk factors may be one aspect in the way to curb the increasing incidence of CVDs among Indian populations. In epidemiological and population based studies the technique of anthropometric measurement such as BMI, WHR, waist circumference and subcutaneous skinfold thickness are used to assess adiposity, topography of adiposity and their relationship with cardiovascular risk factors. Various statistical techniques could be applied to examine the association between the risk factors and cardiovascular diseases [4-6]. To simplify dimensions of cardiovascular risk, multivariate data reduction techniques such as principal component factor analysis (PCFA) have been employed to extract uncorrelated factors from numerous inter-correlated phenotypes [7-8]. In view of above consideration, the present work was undertaken to analyze the cardiovascular risk factors among females of Brahmin and Jat Sikh Punjabi population using principal component factor analysis (PCFA). It is a multivariate correlation technique and has been used to provide insight into the underlying structure of CVD risk factors which is

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characterized by physiological complexity and strong statistical inter-correlation among themselves. Majority of previous factor analysis, however, have been used only on metabolic syndrome and insulin sensitivity [9-12]. In the present study, factor analysis has been used for seventeen risk factors including metabolic and glucose tolerance.

MATERIALS AND METHODS

A total of 428 adult females (199 from Brahmin and 229 Jat Sikh) were recruited for the present study to identify cardiovascular risk factors using principal component factor analysis. Two population groups, Jat Sikh and Brahmin were studied. These groups were determined by affiliation of religion. Females from Amritsar, Jalandhar, Phagwara and Mehta Chowk were included in the present study spanning from January, 2009 to May, 2010. The study was approved by the appropriate ethical research committee of Guru Nanak Dev University on February, 2009. The recruitment of the samples was done on the house to house basis with pre-informed consent. This cross-sectional stydy was carried out in two stage sampling method. The first stage, households of subjects belonging to Brahmin and Jat Sikh (two religion groups) were identified in the selected study areas. In the second stage, purposive sampling has been done. Only females who gave willingness to participate in the study were identified and recruited. Blood samples from 100 (50 each from two groups) out of the total 428 individuals were obtained. For data collection personal interviews were held with each subject. General information about name, caste, religion, address, sex, date of birth, education status and occupation was obtained along with the anthropometric, physiometric and metabolic variables. The information regarding any existing disease or disorder was also obtained. All the information obtained from as individual was recorded on the pre-designed proformas.

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 [13-14]. 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. The physiometric variables included measurement of systolic blood pressure (SBP), diastolic blood pressure (DBP) and pulse rate. Two consecutive readings as recommended by the American Heart Association and others were recorded for each of SBP and DBP and the averages were used [15-16]. 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. 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. 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 (TC), triglycerides (TG), high and low density lipoproteins (HDL, LDL and VLDL).

Statistical Analysis: The comparison of means for the two samples were done by using Student's 't' test. Data was screened using SPSS version 16.0. Principal components analysis was used to extract orthogonal components. The initial solution, principal component 1 explained the maximum variance, while successive components explained progressively smaller portions of the total variance. Principal components were simplified by orthogonal rotation (varimax). Relationships between components are explained by factor loadings, values greater than or equal to 0.4 were used to indicate meaningful correlations between the component and the variable.

RESULTS

Table 1 represents comparison of means, standard deviation (SD) and significant values of the original measurements of anthropometric, physiometric and metabolic variables used in Principal Component Factor Analysis (PCFA) among females of Punjabi Brahmin and Jat Sikh female population. The mean ages of both castes were 39.55 and 40.38 years, respectively. The nine quantitative phenotypes such as hip circumference, SBP, DBP, pulse rate (PR), total cholesterol (TC), triglyceride (TG), HDL, VLDL and fasting glucose among 17 phenotypes indicated significant ($p<0.05$) caste specific differences in trait variance. Brahmin females were observed to have significantly higher values pertaining to body mass index (BMI), waist circumference (WC), hip circumference, pulse rate, total cholesterol (TC), high density and low density lipoproteins (HDL & LDL) and fasting glucose. Jat Sikh females have higher values of

Table 1: Phenotypic characterstics of anthropometric, physiometric and metabolic variables included in factor analysis among females of Punjabi Brahmin (n=199; n for biochemical analysis=50) and Jat Sikh (n=229; n for biochemical analysis=50) population

	Brahmin			Jat Sikh		
Variables	Mean±S.D.	Skewness	Kurtosis	Mean±S.D.	Skewness	Kurtosis
Age (years)	39.55±11.93	0.52	0.16	40.38±10.19	0.33	0.05
BMI	24.88±5.32	0.47	0.25	24.08±4.94	0.52	0.01
WC (cm)	90.29±6.48	0.48	0.47	88.86±10.19	0.66	0.27
HC (cm)	98.71±6.82	0.48	0.31	97.11±7.36*	0.65	0.84
WHR	0.91±0.09	0.21	0.15	0.91±0.10	0.19	0.17
SBP (mmHg)	129.44±10.61	0.48	0.31	134.71±10.63**	0.66	0.31
DBP (mmHg)	82.55±7.58	0.12	0.56	86.77±11.10**	0.13	0.58
PP	46.89±11.25	0.78	0.83	47.93±11.64	0.30	0.96
PR	82.16±10.38	0.65	0.04	80.16±9.97*	0.36	0.49
TC (mg/dl)	179.48±16.34	0.60	0.12	165.53±15.84**	0.41	0.38
TG (mg/dl)	167.68±20.08	0.99	0.45	206.70±20.03**	0.73	0.50
HDL (mg/dl)	67.75±11.27	0.70	0.61	51.95±10.69**	0.48	0.90
LDL (mg/dl)	78.18±15.44	0.93	0.56	72.23±12.41	0.16	0.61
VLDL (mg/dl)	33.53±10.81	0.99	0.45	41.34±11.60*	0.73	0.50
LDL-HDL ratio	1.719±2.0	0.61	0.85	2.10±1.84	0.17	0.05
TC-HDL ratio	3.32±2.34	0.67	0.35	4.88±7.083	0.77	0.03
Glu (mg/dl)	104.02±10.84	0.93	0.86	75.49±10.33**	0.95	0.42

BMI=body mass index; WC=waist circumference; WHR=waist-to-hip ratio; SBP=systolic blood pressure; DBP=diastolic blood pressure; PP=pulse pressure; PR=pulse rate; TC=total cholesterol; TG=triglyceride; HDL=high density lipoprotein; LDL= low density lipoprotein; VLDL=very low density lipoprotein; Glu=Fasting glucose.

**-Significant at 0.01 level (2-tailed)

*-Significant at 0.05 level (2-tailed)

Table 2: Correlation matrix (bivariate) of cardiovascular risk factors included in factor analysis among females of Punjabi Brahmin and Jat Sikh population

	Age	BMI	WC	WHR	SBP	DBP	PP	PR	TC	TG	HDL	LDL	VLDL	Glu
Age		0.387**	0.495**	0.578**	0.446**	0.352**	0.388**	-0.215**	0.289	0.275	0.039	0.124	0.275	-0.076
BMI	0.377**		0.892*	0.621**	0.344**	0.354**	0.247	-0.024	0.058	0.182	0.246	-0.175	0.182	0.029
WC	0.509**	0.828**		0.754**	0.447**	0.451**	0.327**	0.022	-0.069	0.026	0.495	-0.389*	0.026	0.086
WHR	0.351**	0.438**	0.697**		0.470**	0.393**	0.395**	-0.016	-0.123	0.092	0.187	-0.261	0.092	-0.015
SBP	0.521**	0.384**	0.458**	0.282**		0.728**	0.0906**	-0.076	0.044	0.092	0.002	0.002	0.092	-0.088
DBP	0.383**	0.332**	0.262**	0.079	0.633**		0.368**	0.109	0.151	0.041	0.233	-0.035	0.041	-0.143
PP	0.361**	0.225**	0.379**	0.300**	0.777**	0.004		-0.17*	-0.044	0.088	-0.149	0.026	0.088	-0.018
PR	-0.262**	-0.205**	-0.195**	-0.043	-0.18	-0.193**	-0.075		0.001	0.203	-0.057	-0.038	0.203	-0.189
TC	0.103	0.246	0.22	0.231	0.422*	0.312	0.425	0.008		0.349	0.042	0.710**	0.349	0.304
TG	0.393	-0.226	0.061	0.235	-0.072	-0.094	-0.023	0.124	0.207		-0.065	-0.026	1.000**	0.053
HDL	0.089	-0.14	-0.042	-0.021	0.352	0.369	0.225	-0.152	0.246	0.029		-0.583**	-0.065	0.094
LDL	-0.248	0.421*	0.146	0.024	0.116	0.041	0.171	0.025	0.418*	-0.536**	0.511		-0.026	0.183
VLDL	0.393	-0.226	0.061	0.235	-0.072	-0.094	-0.023	0.124	0.207	1.000**	0.029	-0.536**		0.053
Glu	0.126	0.222	0.296	0.199	-0.008	0.087	-0.119	0.269	-0.067	0.088	-0.102	-0.039	0.088	

BMI=body mass index; WC=waist circumference; WHR=waist-to-hip ratio; SBP=systolic blood pressure; DBP=diastolic blood pressure; PP=pulse pressure; PR=pulse rate; TC=total cholesterol; TG=triglyceride; HDL=high density lipoprotein; LDL= low density lipoprotein; VLDL=very low density lipoprotein; Glu=Fasting glucose.

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

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

Upper triangle corresponds for Brahmin, lower triangle for Jat Sikh Punjabi population

age, SBP, DBP, pulse pressure (PP), triglyceride TG) and very low density lipoprotein (VLDL). Skewness after adjustment varied from 0.12 (DBP) to 0.99 (TG and VLDL) for Brahmin and 0.13 (DBP) to 0.95 (Glucose) for Jat Sikh female population. Kurtosis after adjustment varied from 0.12 (TC) to 0.86 (Glucose) for Brahmin and 0.01 (BMI) to 0.96 (PP) for Jat Sikh population. This demonstrates normal distribution for the traits in the study for performing principal component factor analysis.

Pearson's correlations among fourteen normally distributed variables are presented in table 2. The upper triangle correlations correspond to the Brahmin and lower triangle refers to the Jat Sikh females. In both the groups strong correlations were observed among age, BMI, waist circumference, WHR, SBP, DBP and pulse pressure (PP). Therefore, all anthropometric and physiometric variables are significantly incorrelated which demonstrated the structure of the factors among females of Punjabi Brahmin and Jat Sikh female populations.

Table 3: Comparison of factor loading (rotated component), variances and communalities among females of Brahmin and Jat Sikh Punjabi population

	Component															
	Factor 1		Factor 2		Factor 3		Factor 4		Factor 5		Factor 6		Factor 7		Communalities	
Variables	Brahmin	Jat Sikh	Brahmin	Jat Sikh	Brahmin	Jat Sikh	Brahmin	Jat Sikh	Brahmin	Jat Sikh	Brahmin	Jat Sikh	Brahmin	Jat Sikh	Brahmin	Jat Sikh
BMI	0.898	0.892	0.009	0.266	0.202	0.141	0.251	0.175	0.143	0.003	0.049	0.114	0.101	0.054	0.945	0.933
WC (cm)	0.878	0.907	0.255	0.257	0.319	0.011	0.031	0.155	0.024	0.063	0.065	0.096	0.055	0.115	0.947	0.94
HC (cm)	0.797	0.827	0.318	0.315	0.221	0.123	0.169	0.130	0.058	0.174	0.147	0.097	0.221	0.089	0.890	0.862
WHR	0.723	0.711	0.082	0.139	0.342	0.074	0.342	0.348	0.042	0.211	0.120	0.205	0.21	0.107	0.825	0.75
SBP (mm Hg)	0.340	0.194	0.080	0.902	0.778	0.149	0.285	0.053	0.049	0.092	0.403	0.261	0.102	0.049	0.985	0.955
DBP (mm Hg)	0.379	0.136	0.042	0.941	0.815	0.140	0.045	0.070	0.004	0.065	0.301	0.037	0.003	0.076	0.902	0.941
PP	0.181	0.203	0.074	0.580	0.449	0.114	0.389	0.016	0.065	0.251	0.704	0.448	0.126	0.184	0.907	0.689
PR	0.173	0.066	0.101	0.183	0.223	0.083	0.500	0.088	0.258	0.852	0.441	0.070	0.174	0.235	0.633	0.839
TC (mg/dl)	0.042	0.099	0.555	0.252	0.119	0.047	0.230	0.161	0.295	0.053	0.294	0.869	0.355	0.013	0.891	0.86
TG (mg/dl)	0.034	0.061	0.042	0.044	0.040	0.037	0.068	0.980	0.980	0.047	0.012	0.065	0.057	0.028	0.975	0.974
HDL (mg/dl)	0.234	0.124	0.706	0.246	0.139	0.889	0.160	0.022	0.074	0.030	0.375	0.182	0.385	0.001	0.893	0.901
LDL (mg/dl)	0.199	0.195	0.919	0.046	0.002	0.653	0.071	0.522	0.059	0.013	0.008	0.462	0.235	0.029	0.950	0.953
VLDL (mg/dl)	0.034	0.061	0.042	0.044	0.040	0.037	0.068	0.980	0.980	0.047	0.011	0.065	0.057	0.028	0.975	0.974
LDL-HDL ratio	0.113	0.211	0.962	0.055	0.092	0.859	0.010	0.364	0.030	0.118	0.071	0.046	0.011	0.074	0.953	0.939
TC-HDL ratio	0.107	0.154	0.955	0.222	0.093	0.907	0.0004	0.206	0.079	0.033	0.083	0.014	0.006	0.088	0.945	0.947
Glu (mg/dl)	0.142	0.217	0.051	0.039	0.173	0.083	0.060	0.073	0.028	0.162	0.254	0.093	0.804	0.900	0.769	0.905
Eigenvalues	9.24	8.73	4.33	4.94	2.46	3.03	2.04	2.01	1.96	1.54	1.52	1.42	1.16	1.10	-	-
% of variance explained	35.6	33.6	16.6	19.0	9.5	11.6	7.9	7.7	7.6	5.9	5.8	5.5	4.5	4.2	-	-
Cumulative %	35.6	33.6	52.2	52.6	61.7	64.2	69.6	71.9	77.2	77.8	83.0	83.3	87.5	87.5	-	-

BMI=body mass index; WC=waist circumference; WHR=waist-to-hip ratio; SBP=systolic blood pressure; DBP=diastolic blood pressure; PP=pulse pressure; PR=pulse rate; TC=total cholesterol; TG=triglyceride; HDL=high density lipoprotein; LDL= low density lipoprotein; VLDL=very low density lipoprotein, Glu=fasting glucose.

.Loadings ≥ 0.4 are in bold; Factors satisfying the eigenvalues ≥ 1 are included.

The characteristics of derived principal components from 16 parameters are detailed in table 3 among the two Punjabi female populations. The PCFA extracted 7 factors which explained nearly 87% of total variance of the 16 original quantitative traits among both the female populations. Factor 1 has high loading of the traits that reflects obesity related traits like BMI, WC, HC and WHR for both female populations and explained the largest portion of total variance (36% for Brahmin; 34% for Jat Sikh). Factor 1 is a strong indicator for atherosclerosis. Factor 2 is loaded predominantly with total cholesterol (TC), HDL, LDL, LDL-HDL ratio and TC-HDL ratio for Brahmin female population. Comparably factor 2 is loaded with SBP, DBP and PP among Jat Sikh female population. Therefore, factor 2 is identified as responsible for dyslipidemia for Brahmin hypertension for Jat Sikh. Factor 3 is loaded with SBP, DBP and PP for Brahmin, which is strong indicator for essential hypertension and with HDL, LDL, LDL-HDL ratio and TC-HDL ratio for Jat Sikh female population, which is strong indicator of ischemic stroke and heart attack risk. Factor 4 contains high loadings of PR for Brahmins and TG, VLDL and LDL for Jat Sikh population. Factor 5 contains high loadings of TG and VLDL for Brahmins and PR for Jat Sikh. Factor 6 is loaded with SBP, PP and PR for Brahmins and PP and TC for Jat Sikh. Factor 7 contains high loadings of fasting glucose which reflects the risk of type 2 diabetes among both female groups. Communality is the variance in observed variables accounted by common factors. The estimates of communality may be interpreted as the reliability of the indicators. If an indicator scored a low communality then the factor model is not working for that indicators and possibly it should be removed from the model. A communality of 0.75 seems high and below 0.5 is to be considered as low communality. The common greater communality estimates (>0.9) have been found on BMI, WC, SBP, DBP, TG, LDL, VLDL, LDL-HDL and TC-HDL ratio among both the groups. However, SBP, TG and VLDL have maximum communalities among both the populations. Therefore, these three parameters (SBP, TG and VLDL) may be considered as good predictors of CVD.

DISCUSSION

The major objective of the present study is to determine significant cardiovascular risk factors through principal component factor analysis (PCFA) among females of Brahmin and Jat Sikh population in Punjab. The present two populations are unique to study complex

multifactorial disorders like cardiovascular risk factors. The combination of geography, cultures and sharing of the same environment has minimized the differences in life style factors among the females of Brahmin and Jat Sikh population in Punjab. Therefore, the homogeneous environment shared by individual is of great importance and significance in study of complex disorders, especially, which is influenced by life style factors. Therefore, the current study focused to identify most important multiple risk factors through PCFA, with varimax rotation, to reduce 16 inter-correlated variables into groups of 7 independent factors. These data reduction method identified 7 factors that explained 87% of variance among females of both Brahmin and Jat sikh population such as BMI, WC, HC, WHR, SBP, DBP, TC, VLDL, HDL, TG, LDL-HDL, TC-HDL and fasting glucose were strongly loaded (>0.7) and identified as strong independent predictor of cardiovascular diseases among both female populations. However, the present findings are consistent with other factor analyses studies related to cardiovascular risk factors with high loadings of many components [7-11, 17]. Therefore, in the present study factor analysis has been applied to investigate the clustering of variables that are thought to be important components of cardiovascular diseases. The first factor grouped with BMI, WC, HC and WHR (loading > 0.4) for both the populations. The second factor grouped with TC, HDL, LDL, LDL-HDL ratio and TC-HDL ratio for females of Brahmin population and SBP, DBP and PP for females of Jat Sikh population with maximum loading. The third factor grouped with SBP, DBP and PP for Brahmin and HDL, LDL, LDL-HDL ratio and TC-HDL ratio for Jat Sikh with maximum loading. The fourth factor grouped with PR for Brahmin and TG, LDL and VLDL for Jat Sikh population with maximum loading. The fifth factor grouped with TG and VLDL for Brahmin population and pulse pressure for Jat Sikh population with maximum loading. The sixth factor grouped with SBP, PP and PR for Brahmin and pulse pressure (PP) and total cholesterol (TC) for Jat Sikh population with maximum loading. The seventh factor has been identified as level of random glucose for both populations. Therefore, the present findings have made two major contributions to the literature: (i) majority of the studies have reported metabolic variables as core factors [18-20]. However, the present analysis has shown that BMI, WHR and waist circumference are core predictors for cardiovascular diseases (ii) different risk components for cardiovascular diseases have been identified among the two different populations except factor 1, which is common to both the populations. It is interesting to observe the pattern of clustering of the variables. BMI, WHR and waist circumference seem to load more than blood pressures. Therefore, it may be concluded that BMI, WHR and waist circumference played more important role than blood pressure to the occurrence of cardiovascular diseases. The association of central obesity, hypertension, glucose and dyslipidemia with cardiovascular diseases has been observed in number of ethnic groups worldwide. Studies across the population demonstrated that these multiple risk factors played important role in occurrence of cardiovascular diseases [21-23]. Therefore, identification of the components of phenotypes of cardiovascular risk factors and how its phenotypic expression differs across the ethnic/caste groups could be helpful in understanding the etiology of cardiovascular diseases. Various statistical techniques could be applied to examine the association between the risk factors and cardiovascular diseases. Principal component factor analysis (PCFA) is one such approach to identify these associations. As far as India is concerned, very little work has so far been undertaken to identify the underlying factors/components among the Indians. But, no such work has been undertaken on the females of Punjabi population. Hence, the present work would be considered as a reference for future work. The present study has several strengths as well as some limitations such as (i) some inconsistent loading pattern for different variables have been observed in the two groups which made the results hard to be interpreted (ii) the study is lacking with the observation among male counter parts (iii) longitudinal analysis in this and other populations will be required to validate the present findings (iv) the limitation of factor analysis is that the investigator is forced to retain the number of factors with respect to eigenvalues (>1) however, it has been observed that some risk traits have low eigenvalues but act as important predictors.

REFERENCES

1. Murray, C.J.L. and A.D. Lopez, 1997. Mortality by cause for eight regions of the world: Global Burden of Disease Study. Lancet, 349: 1269-1276.
2. World Health Federation, 7. Heart Beat:Worldplace Wellness in India. Geneva, Switzerland: World Health Federation; 2009.
3. WHO. World Health Report - Reducing Risks, Promoting Healthy Life. Geneva, Switzerland: World Health organization; 2002.

4. Badaruddoza, Afzal, M., 1999. Age specific difference in blood pressure among inbred and non-inbred North Indian Children. J. Biosciences, 24: 177-184.
5. Badaruddoza, Afzal, M., 2000. Trend of blood pressure in North Indian Children. Indian J. Physiol. Pharmacol., 44: 304-310.
6. Badaruddoza Kumar, R., 2009. Cardiovascular risk factor and familial aggregation of blood pressure with respect to anthropometric variables in a scheduled caste population in Punjab, a North Indian state. Anthropol Anz, 67: 111-119.
7. Bellis, C., R.M. Hughes, K.N. Begley, S. Quinlan, R.A. Lea, S.C. Heath, *et al*. 2005. Phenotypical characterisation of the isolated Norfolk Island population focusing on epidemiological indicators of cardiovascular disease. Hum. Hered, 60: 211-219.
8. Goodman, E., L.M. Dolan, J.A. Morrison and S.R. Daniels, 2005. Factor Analysis of Clustered Cardiovascular Risks in Adolescence: Obesity Is the Predominant Correlate of Risk Among Youth. Circulation, 111: 1970-1977.
9. Shmulewitz, D., S.B. Auerbach, T. Lehner, M.L. Blundell, J.D. Winick, L.D. Youngman, *et al*., 2001. Epidemiology and factor analysis of obesity, type II diabetes, hypertension and dyslipidemia (syndrome X) on the island of Kosrae, Federated States of Micronesia. Hum Hered, 51: 8-19.
10. Tang, W., M.B. Miller, S.S. Rich, K.E. North, J.S. Pankow, I.B. Borecki, *et al*. 2003. Linkage Analysis of a Composite Factor for the Multiple Metabolic Syndrome The National Heart, Lung and Blood Institute Family Heart Study. Diabetes; 52: 2840-2857.
11. Cai, G., SA. Cole, J.H. Freeland-Graves, J.W. MacCluer, J. Blangero and A.G. Comuzzie, 2004. Principal component for metabolic syndrome risk maps to chromosome 4p in Mexican Americans: the San Antonio Family Heart Study. Hum. Biol., 76: 651-665.
12. He, L.N., Y.J. Liu, P. Xiao, L. Zhang, Y. Guo, T.L. Yang, *et al*., 2008. Genomewide linkage scan for combined obesity phenotypes using principal component analysis. Ann. Hum. Genet., 72: 319-326.
13. Singh, I.P. and M.K. Bhasin, 1968. Anthropometry. Delhi: Kamla Raj Enterprises.
14. Weiner, J.S. and J.A. Lourie, 1981. Practical Human Biology. London: Academic Press.
15. American Heart Association. 1981. Report of subcommittee of post graduate education committee recommendation for human blood pressure determination of sphygmomanometer. Circulation, 64: 510A-599B.
16. Londe, S. and D. Goldring, 1976. High blood pressure in children: Problems and Guidelines for evaluation and treatment. Am. J. Cardiol., 37: 650-657.
17. Austin, M.A., K.L. Edwards, M.J. McNeely, W.L. Chandler, D.L. Leonetti and P.J. Talmud, 2004. Heritability of multivariate factors of the metabolic syndrome in nondiabetic Japanese Americans. Diabetes, 53: 1166-1169.
18. Donahue, R.P., R.D. Abbott, E. Bloom, D.M. Reed and K. Yano, 1987. Central obesity and coronary heart disease in men. Lancet, 1: 821-824.
19. Chen, W., S.R. Srinivasan, A. Elkasabany and G.S. Berenson, 1999. Cardiovascular risk factors clustering fators of insulin resistance syndrome (Syndrome X) in a biracial (Black White) population of children, adolescent and young adults. Am. J. Epidemiol., 150: 667-674.
20. Hanley, A.J.G., A.J. Karter, A. Festa, R.D. Agostino, L.E. Wagenknecht, P. Savage, *et al*., 2002. Factor Analysis of Matabolic Syndrome using directly measured insulin sensitivity. Diabetes, 51: 2642-2647.
21. Wu, C.J., J.D. Lin, J.C. Li, F.C. Hsiao, C.H. Hsich, S.W. Kuo, *et al*., 2008. Factor analysis of metabolic syndrome using direct measurement of insulin resistance in Chinese with different degrees of glucose tolerance. Indian J. Med. Res., 127: 336-343.
22. Ghosh, A., 2005. Factor analysis of metabolic syndrome among the middle-aged Bengalee Hindu men of Calcutta, India. Diabetes Metab. Res. Rev., 21: 58-64.
23. Badaruddoza, Barna, B. and A.J.S. Bhanwer, 2010. Comparison of factor loadings for anthropometric and physiometric measures among type 2 diabetic males, pre- and post-menopausal females in North Indian Punjabi population. Nature Sci., 2: 741-747.