Principal Component Analysis of the physique in young adults of Punjab

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ABSTRACT

The present cross-sectional study was conducted on 400 Punjabi subjects (200 females and 200 males) of 20- 25 years of age to assess the principal components of physique of young adults. Height, weight, circumferences of the waist and hip, skinfolds of the biceps, triceps and subscapular, bi-acromial diameter and bi-iliocristal diameter were the anthropometric measurements taken on each subject. Systolic and diastolic blood pressure was also measured for each individual. Principal component analysis was applied on 12 variables to extract the components of physique. The principal component analysis extracted 5 major components of physique in adults of Punjab and these factors explained 74.20% and 80% variance in females and males respectively. Factor 1 in both sexes had high loading of adiposity. Factor 2 in females was representing masculinity, whereas factor 2 in males represented obesity or bulkiness like traits. Factor 3 in females was reflecting android (abdominal) body fat, whereas in males it had shown characteristics of masculinity related traits. Factor 4 in females had indicated a high load score of blood pressure characteristics, whereas in males it represented android (abdominal) body fat. The factor 5 was showing the high load score of blood pressure in the males.

Key words: North Indians, Punjabi, Anthropometry, Leanness, Musculinity, Adiposity, Factor analysis.

INTRODUCTION

Principal component factor analysis (PCFA) is a multivariate statistical technique. It is used to reduce larger sets of the data into a smaller set of a variable (Meigs, 2000). It is a most refined technique used to identify associations between the variables. Anthropometry and physiometry are basic parameters that are being used by various scientists for extraction the of PCFA. There are many studies on PCFA of the Indian populations. By using PCFA various scientists extracted cardiovascular disorder risk traits, metabolic syndrome risk traits, and obesity risk traits as a major risk component in various populations. Cardiovascular disorder had been analyzed as a major factor in the population of Punjab (Badaruddoza *et al*., 2015; Kaur *et al*., 2012; Badaruddoza *et al*., 2011). The risk of metabolic syndrome had been extracted in various populations (Ghosh, 2005; Ghosh, 2007; Hanley *et al*., 2004; Hanley *et al*., 2002). Vikram et al., 2009 had studied the principal factor analysis in Asian Indian adolescents and revealed metabolic syndrome as a major component. Metabolic syndrome risk had been extracted as a main causal factor in Bangalee of the middle age group and adolescents (Ghosh 2007; Ghosh, 2005). Insulin sensitivity, obesity, metabolic risk traits had been found as dominating risk factors for diabetic patients (Hanley et al., 2004; Hanley et al., 2002). Obesity trait was seen as a major component in various populations (Badaruddoza et al., 2015; Vikram et al., 2009; Goodman et al., 2005 and Young et al., 2002). Central obesity and blood pressure were two major risk factors of male and female patients with type 2 diabetes (Badaruddoza et al., 2010). Trunk-extremity fat was extracted as a major component in various populations (Baumgartner et al., 1986; Deutsch, et al., 1985). Few of them had analyzed fat at a centripetal region (Badaruddoza et al., 2010; Ghosh, 2007; Ghosh, 2005; Mueller et al., 1986) in various populations. It has been observed that previous studies were based on principal component analysis, but their main concern was for the patients with metabolic syndrome, insulin sensitivity, diabetic, elderly and adolescents. There is a paucity of data on young adults of Punjab. Therefore the present study was designed to explore the components of physique in young adults by using the principal component factor analysis.

MATERIAL AND METHODOLOGY

The present cross-sectional study was conducted on a total of 400 subjects (200 males and 200 females) within the age range of 20-25 years. The selected students voluntarily or

actively participated in the study and it was also assured that their personal information would not be disclosed. Data collection was done on the students of Punjabi University in the year 2012-2014. The students of Punjabi University, Patiala come from different areas of Punjab. A pre written consent information sheet was obtained from them. The present study was approved by the institutional ethical research committee of Punjabi University, Patiala in the year 2012.

Height (cm), weight (kg), the circumferences of waist and hip (cm), the skinfolds of biceps, triceps and subscapular (mm) and the diameters of bi-acromial and bi-iliocristal (cm) were the measurements taken on each subject by following the methodology of Lohman *et al*. (1988). Height was taken with the help of a standardized anthropometric rod and the measurement was recorded to the nearest 0.1cm; the weight was taken with the help of a standardized electronic weighing scale and the measurement was recorded to the nearest 0.1 kg; the circumferences (waist and hip) were taken with a standardized steel tape and the measurement was recorded to the nearest 0.1cm; skinfolds(biceps, triceps and subscapular) were taken with the help of a skinfold caliper and the measurement was recorded to the nearest 1mm, the body diameters (bi-acromial and bi-iliocristal) were taken with the help of the standardized anthropometric compass and measurement was recorded to the nearest 0.1 cm by using a standardized anthropometric compass.

Blood Pressure (BP) was also recorded for each individual. Blood Pressure (BP) was measured in mm Hg by using the sphygmomanometer. Two consecutive measurements were taken on each subject to get actual value and the mean of the two values was recorded (AHA, 1981).

BMI or Body mass index and androgyny score were calculated by using their respective formula in Microsoft excel. Descriptive analysis was done using SPSS 16.0 version. Principal component factor analysis was used to extract the components. It is a multivariate, data reduction, statistical tool. It reduces a large number of inter-correlated variables into smaller set of principal components, and it is done on the basis of correlation matrix. It is a rectangular array of the correlation coefficients that show the amount of association of variables with each other. PCFA (varimax) was used to extract components from the variables as varimax rotation, an orthogonal rotation which makes interpretation easier.

RESULTS

Table 1 displays the sex specific mean, standard deviation and comparison of measurements that were used in principal component factor analysis of young Punjabi adults. The table depicts that males had significantly higher values of height, weight, circumferences of waist and hip, SBP, DBP, BMI and androgyny score as compared to those of females. The females had significantly higher values of biceps, triceps, subscapular skinfold and WHR as compared to those of males.

Table 1: Descriptive statistics of the variables included in factor analysis of Punjabi female and male

Variable	Females		Males		t – value
	Mean	S.D.	Mean	S.D.	
Height (cm)	158.1	5.4	171.10	6.34	22.23***
Weight (kg)	51.86	9.2	67.10	23.28	8.70***
Waist circumference (cm)	69.14	6.1	81.00	7.30	18.00***
Hip circumference (cm)	93.05	6.2	94.42	6.67	2.14*
Biceps skinfold (mm)	8.33	3.03	5.00	2.14	12.74***
Triceps skinfold (mm)	16.31	4.73	9.00	4.00	16.77***
Subscapular skinfold (mm)	16.74	5.58	13.01	5.35	6.86***
Bi-acromial Diameter(cm)	35.21	1.68	39.26	2.27	21.7***
Bi-iliocristal Diameter(cm)	28.64	2.00	29.36	1.86	4.1***
SBP (mm Hg)	116.11	9.80	122.25	9.18	6.50***
DBP (mm Hg)	78.60	5.6	79.98	6.44	2.30*
BMI (kg/m²)	20.57	3.5	22.86	7.37	4.00***
WHR	0.74	0.44	0.85	0.54	2.24*
Androgyny Score	77.01	4.5	88.43	6.14	21.36***

* $p < 0.05$, ** $p < 0.01$,*** $p<0.001$

Instead of Bi-acromial and Bi-iliocristal diameter remaining all other variables were in included in factor analysis. Pearson correlations between the 12 variables were assigned in the Table 2. The upper triangle depicted correlation in females and thelower triangle corresponded to the correlation in males. In both the groups, majority of the variables showed correlations among all the variables. Weight, waist and hip circumference, biceps, triceps and subscapular skinfold, BMI and WHR had shown significantly interrelated values. All the 12

variables (including anthropometric, body indices and blood pressure measurements) had shown significantly correlated values.

Table 2: Correlation matrix of the variables included in factor analysis

Variable	Height	Weight	WC	HC	B SKF	T SKF	S SKF	SBP	DBP	BMI	WHR	AS
Height	....	0.25**	0.11	0.22**	-0.11	-0.04	-0.09	0.07	-0.08	-0.13*	-0.07	0.26**
Weight	0.24**	.....	0.71**	0.75**	0.52**	0.56**	0.54**	0.18**	0.11	0.92**	0.21**	0.28**
WC	0.19**	0.37**	.....	0.74**	0.53**	0.56**	0.55**	0.10	0.08	0.69**	0.65**	0.20**
HC	0.27**	0.35**	0.72**	.....	0.58**	0.67**	0.57**	0.13*	0.09	0.69**	0.03	0.20**
B SKF	-0.06	0.20*	0.54**	0.49**	.....	0.77**	0.71**	0.10	0.10	0.60**	0.14*	0.06
T SKF	0.02	0.21**	0.57**	0.58**	0.78**	.....	0.70**	0.14*	0.12	0.60**	0.08	0.07
S SKF	-0.04	0.22**	0.61**	0.60**	0.69**	0.72**	.....	0.13*	0.16*	0.58**	0.17**	0.06
SBP	0.10	0.12*	0.22**	0.29**	0.26**	0.24**	0.38**	.....	0.14*	0.15*	-0.02	0.04
DBP	0.14	0.01	0.02	-0.01	0.10	0.10	0.03	0.21**	.....	0.13*	0.02	0.16*
BMI	0.03	0.98**	0.36**	0.32**	0.21**	0.23**	0.24**	0.10	0.00	.....	0.24**	0.18**
WHR	-0.03	0.13	0.62**	-0.09	0.21**	0.16*	0.18**	-0.01	0.05	0.15*	.....	0.07
AS	0.16**	0.04	0.24**	0.34**	0.12*	0.07	0.25**	0.33**	-0.04	0.03	-0.06	.....

(WC = Waist circumference, HC = Hip circumference, B SKF= Biceps skinfold, T SKF = Triceps skinfold, S SKF = Subscapular skinfold, SBP = Systolic blood pressure, DBP =Diastolic Blood pressure, BMI =Body mass index, WHR =Waist hip ratio, AS =Androgyny score), Upper triangle represents to correlation for females and lower triangle represents to correlation for males

* $p < 0.05$, ** $p < 0.01$

The correlation analysis revealed that weight, waist and hip circumferences, skinfolds of biceps, triceps and subscapular had shown strong associations among themselves. PCFA is used to extract communalities among variables. These communalities were further used to

frame a picture of the components. The characteristics of derived principal components from 12 variables were calculated (Table 3). The PCFA extracted 4 factors among the Punjabi females of the study, and 5 factors among Punjabi males, which explained 74.20% and 80% variance, respectively. Factor 1 in both the sexes had shown high loading with weight, circumferences (waist and hip), skinfolds (biceps, triceps and subscapular) and BMI that reflected overweight and obesity.

Table 3: Comparison of the factor loading (rotated component), variance among young adult males and females of Punjabi Population

Variable	Factor 1 (Adiposity)		Factor 2 (Muscularity/Obesity)		Factor 3 (Leanness/Muscularity)		Factor 4 (Blood pressure/Leanness)		Factor 5 (Blood Pressure)	
	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males
Height	0.02	-0.14	**0.85**	0.15	-0.13	**0.73**	-0.14	0.13	_	0.01
Weight	**0.78**	0.12	0.40	**0.98**	0.22	0.13	0.11	0.07	_	0.02
WC	**0.70**	**0.62**	0.22	0.23	**0.62**	0.32	-0.02	**0.61**	_	-0.03
HC	**0.84**	**0.70**	0.34	0.26	-0.03	0.47	0.02	-0.07	_	-0.07
B SKF	**0.84**	**0.88**	-0.17	0.05	0.02	-0.08	0.05	0.12	_	0.11
T SKF	**0.87**	**0.87**	-0.07	0.10	-0.05	-0.03	0.06	0.10	_	0.08
S SKF	**0.81**	**0.87**	-0.14	0.08	0.08	0.12	0.13	0.08	_	0.07
SBP	0.14	0.32	0.12	0.23	-0.15	0.39	**0.56**	-0.14	_	**0.60**
DBP	0.03	-0.01	-0.07	0.01	0.10	-0.09	**0.85**	0.09	_	**0.90**
BMI	**0.81**	0.17	0.09	**0.97**	0.28	-0.02	0.15	0.05	_	0.01
WHR	0.07	0.10	-0.05	0.05	**0.95**	-0.08	0.05	**0.96**	_	0.03
AS	0.05	0.20	**0.62**	-0.08	0.19	**0.71**	0.33	-0.11	_	0.04
Eigen values	5.05	4.21	1.45	1.72	1.28	1.45	1.11	1.12	_	1.10
Total variance %	42.06	35.12	12.11	14.34	10.73	12.11	9.29	9.35	_	9.20
Accumulative variance	42.06	35.12	54.18	49.50	64.91	61.57	74.20	70.93	_	80.10

Loading≥0. 50 are in **bold** (WC = Waist circumference, HC = Hip Circumference, B SKF = Biceps skinfold, T SKF = Triceps skinfold, S SKF = Subscapular skinfold, SBP = Systolic blood pressure, DBP = Diastolic Blood pressure, BMI = Body mass index, WHR = Waist hip ratio, AS = Androgyny score)

Factor 2 in females was predominantly loaded with height and androgyny score which corresponded to masculinity. Factor 2 in males had shown high loadings with weight and

BMI which represented additional/secondary overweight and obesity like traits. Factor 3 showed high loadings of the waist circumference and waist-hip ratio in the females, which reflected android obesity in females with an explained variance of 11%. The males had high loadings of height and androgyny score with factor 3, which indicated masculinity related traits. Factor 4 in females was loaded with the systolic and diastolic blood pressure values which represented blood pressure characteristics. Factor 4 in males had shown high loadings with waist circumference and waist-hip ratio, which corresponded to android obesity. The factor 5 was loaded with systolic and diastolic blood pressure in the males, which was a factor for blood pressure.

DISCUSSION

The correlation analysis revealed that weight, waist and hip circumference, skinfolds of biceps, triceps and subscapular had shown associations among themselves. Therefore, it provides us with a good reason for going ahead with factor analysis. Principal component factor analysis (PCA) extracted 5 factors in males and 4 factors in females whose Eigen values were more than 1. Factor 1 in both the sexes had shown high loadings of weight, circumferences and skinfolds that represented adiposity and fatness. Factor 2 in females showed high saturations with height and androgyny score, which corresponded to masculinity. Factor 2 in males had high loadings with the body weight and BMI. This corresponded to bulkiness/obesity like traits. Factor 3 in females had shown high saturations with waist circumference and waist hip ratio that represented the android (abdominal) or internal body fat. In males factor 3 has shown a high load score with height and androgyny score representing masculinity. Factor 4 in females is highly correlated with systolic and diastolic blood pressure characteristics, whereas in males factor 4 indicated high saturations with waist circumference and waist hip ratio that represented android (abdominal) or internal body fat. Factor 5 in males had given high loadings which corresponded to blood pressure characteristics. Thus out of 11 anthropometric measurements, only 5 factors of Physique were extracted thus summarizing the information of measurements.

Skibinska (1977) studied factor analysis on skeletal measurements of Warsaw students. They analyzed that length of bones, size of hands, feet and body breadths were major skeletal measurements of Warsaw students.

Susanne et al. (1988) had analyzed the components of physique in young adults. It was found that in males, major components of physique were muscular fatness and skeletal fatness while in females, major components were muscular-trunk fatness, skeletal and limb fatness.

Watson (1984) analyzed physique of the sportsmen. They concluded that physique of sportsmen is related to 7 factors viz. circumferences and bone widths, skeletal length, skinfolds on trunk, leg and triceps, muscle size, trunk length and pelvic depth.

Lambert et al. (2004) had suggested three uncorrelated factors among the children and adolescents. The data were collected in Quebec child and adolescent's health and social survey. These risk factors included glucose, lipids and blood pressure.

Goodman et al. (2005) had identified four uncorrelated factors among adolescents such as adiposity, cholesterol, carbohydrate-metabolism and blood pressure.

Ghosh (2005) also identified four uncorrelated risk factors among middle aged Bangalee individual. Principal component factor analysis had extracted central obesity as factor 1, subcutaneous fat as factor 2, lipid profile and blood glucose as factor 3 and blood pressure as factor 4.

Badaruddoza et al. (2011) studied cardiovascular risk factors among north Indian population of Punjab. Factors analyzed in both sexes did not have a similar pattern of loadings. Factor 1 in males had high loadings of lipids, whereas in females had high loadings of blood pressure. Factor 2, in males had been identified as a main factor, but in females had high saturation with the level of lipids and known as lipid factor. Factor 3 in males corresponded to blood pressure, whereas in females it had shown high loadings of obesity.

Badaruddoza and Brar (2015) had identified atherosclerosis and blood pressure/ hypertension as major risk components in adolescents of Punjab.

The present study was undertaken to assess the components of physique by using PCFA as a statistical technique as there was very little information to factor analysis of the young adult age groups in Punjab. Very limited research has been carried out on the physique of young adults of Punjab by using principal component factor analysis. Few studies have been done factor analysis of anthropometric measurements and they extracted obesity, subcutaneous fat and differential type of fat patterning as major components. The present study had included 12 variables in factor analysis and extracted 4 uncorelated factors (adiposity, masculinity, internal body fat and blood pressure characteristics) in females and 5 uncorelated (adiposity,

bulkiness or obesity, masculinity, internal body fat and blood pressure characteristics) in males.

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