Blood Pressure and Body Composition in Healthy Adults

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INTRODUCTION

In adults, several variables like age, weight, height, body mass index, waist hip ratio and body fat are related to blood pressure (Stamler et al., 1975, 1978; Johnson et al., 1975; Siervogel et al., 1982; Dyer and Elliott, 1989; Sandin et al., 1990; Nirmla et al., 1993; Valdez et al., 1993; Sidhu and Kumari, 1992; Vijayalakshmi et al., 1997; Babu et al., 1998; Krishnaswamy and Vijayalakshmi, 1998; NFI 1999; Venkatramana et al., 2001, 2003; Bassuk and Manson, 2006). Long-term prospective data (WHO 2000; Pi-Sunyer, 1993) suggests that obesity is an independent risk factor for hypertension and cardiovascular morbidity and mortality. There is evidence that increased body weight or obesity is predominantly due to an increase in the amount of fat (Forbes, 1978). For this reason it becomes vital to detect the association between variables of blood pressure and body composition.

Few previous studies of the determinants of blood pressure have been based on measures of body composition that allow a separation of total body mass into total body fat and fat free mass (Stamler et al., 1975, 1978; Voors et al., 1977; Siervogel et al., 1982; Sandin et al., 1987; Sidhu and Kumari, 1995, 2002). The majority of these studies are from developed countries. Only limited studies are available from developing countries like India. Indeed the alarming increase in the prevalence of obesity along with a concurrent rise in that of hypertension are the biggest health challenges of the 21st century for the developing countries. Therefore in the present study an attempt has been made to report the relationship of total body fat and fat free mass with blood pressure among the students and employees of Guru Nanak Dev University, Amritsar (Punjab)

MATERIAL AND METHODS

The present study is based on a cross-sectional sample, randomly collected from 176 healthy students and employees (75 males and 101 females) of Guru Nanak Dev University Amritsar (Punjab). All participating individuals were 20-45 years of age. Height and weight measurements were taken on each subject using standard protocol given by Weiner and Lourie (1981). Blood pressure levels i.e. systolic blood pressure (SBP) diastolic blood pressure (DBP) measured after the subject has rested at least 15 minutes with the help of mercury sphygmomanometer and stethoscope by ansculatatory method (Rose and Blackburn, 1968). Three readings were taken 5 minutes apart and their mean values were used in the subsequent analysis. Mean arterial pressure (MAP =0.33SBP+0.67 DBP) and Pulse Pressure (PP=SBP-DBP) were calculated using standard method.

Body Fat Analyzer (Body stat – 1500, UK made) was used to study the body composition by Bioelectrical Impedance Method. Bioelectrical impedance (BIA) is a noninvasive, simple, quick and inexpensive method for measuring body composition. It is based on the principle that the resistance to an applied electrical current is inversely related to the amount of fat free mass with in the body. Analysis was done by standard methodology. The readings were recorded after entering the sex, age, height and weight of the subject.

Descriptive statistics, coefficient of determination and partial correlation coefficient (age effect removed) have been performed for the analysis of the present data.

RESULTS AND DISCUSSION

Table 1 shows the sex specific means and standard deviations of the age adjusted variables and of blood pressure and body composition. Significant sex difference between means were observed for all the studied variables except for pulse pressure and total body fat. Males have higher values of blood pressure and fat free mass while females have more total body fat.

Effect of age on blood pressure has been identified in various studies (Stamler et al., 1975; Sambasivarao and Veerraju, 1981; Siervogel et al., 1982; Sandin et al., 1990; Babu et al., 1998; Whelton et al., 2002; Sidhu et al., 2005), therefore it is important to investigate and remove age effects before attempting to determine the

Table 1: Age adjusted variables and the proportion of total variation accounted for by the age adjustment among healthy males and females.

Variable	*Males (75)*			*Females (101)*			
	Mean	*S.D.*	R^2 *(coefficient of determination)*	*Mean*	*S.D.*	R^2 *(coefficient of determination)*	*Sex difference t-value*
Systolic blood pressure (mmHg)	125.37	15.90	0.25	116.32	11.85	0.23	4.30*
Diastolic blood pressure (mmHg)	86.17	11.10	0.35	77.69	11.41	0.31	5.09*
Mean Arterial blood pressure (mmHg)	98.94	12.07	0.38	90.23	9.93	0.28	5.22*
Pulse Pressure (PP mmHg)	39.30	10.56	0.02	38.94	12.56	0.06	0.15
Total body fat (Kg)	17.19	6.88	0.44	18.29	6.68	0.08	0.90
Fat Free Mass (Kg)	52.70	8.70	0.01	37.83	6.45	0.10	12.90*

*significant at 5% level

Table 2: Partial correlations between body composition variables and blood pressure after covariance adjustment for age in Punjab males and females

Variable	*Body Composition Variables*			
	Males (75)		*Females (101)*	
	Total Body fat	*Fat Free Mass*	*Total Body fat*	*Fat Free Mass*
Systolic blood pressure (mmHg)	0.31	0.08	0.29*	0.14
Diastolic blood pressure (mmHg)	0.14	0.04	0.24*	0.02
Mean Arterial blood pressure (mmHg)	0.26*	0.05	0.31*	0.04
Pulse Pressure (mmHg)	0.19*	0.06	0.05	0.09

* $P<0.01$

relationship between body composition and blood pressure. In the present study, body weight was partitioned into total fat and fat free mass. Sex specific multiple regression analysis of body composition and blood pressure on age were performed to determine the effect of age on these variables. In this study the coefficient of determination (R^2) indicated that an appreciable proportion of the total variation in some variables was "accounted for" by age effects. The R^2 values may be interpreted as indicating the proportion of the total variance of the outcome measures (SBP, DBP, MAP and PP) that is explained by age. In the present sample (Table 1) as based on R^2, there was a significant age effect in each sex on SBP, DBP and MAP, being slightly more in males than females. Pulse pressure showed little age effect in both sexes. On the other hand total body fat and fat free mass showed little age effect in females, but significant effect on total body fat in case of males. The above mentioned age effect in females, was removed before calculating the relationship between blood pressure and body composition variables. Partial correlation coefficient (age effect removed) between blood pressure and body composition variable were performed, sex specifically. It is evident from table 2, that in males, SBP, MAP and PP were significantly correlated with total body fat. In females the picture was almost similar except that DBP which also significantly correlated with total body fat. But there was no association between fat free mass and any measure of blood pressure in both sexes. This proves that the increased fatness contributing to increased body mass may be responsible for the association between blood pressure and weight among adults. Several studies (Nirmla et al., 1993; Mukhopadhyay et al., 1996; Sowers, 2003 and Bassuk and Manson, 2006) have also established a significant effect of obesity on blood pressure.

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REFERENCES

Babu, B.V., Kusuma, Y.S and Naidu, J.M.: The influence of age, sex and obesity on blood pressure level in tribal population. *Ind. J. Physiol. Pharmacol.,* **42:** 543-547(1998).

Bassuk, S.S. and Manson, J.E.: Overview of the obesity epidemic and its relationship to cardiovascular disease. Pp. 1-32. In: *Obesity and Cardiovascular Diseases* M.K. Robinson and A. Thomas. (Eds.) Taylor and Francis, New York (2006).

Dyer, A.R. and Elliott, R: The Intersalt Study: relations of body mass index to blood pressure. INTERSALT Co-operative Research Group. *J. Hum. Hypertens.,* **3:** 299-308 (1989).

Forbes, G.B.: Body Composition in adolescence. Pp. 239-272. In: *Human Growth* Vol. 2 *Postnatal Growth.* F. Falkner and J.M. Tanner (Eds.) Plenum Press, New York (1978).

Johnson, A., Cornoni, J., Cassal, J., Tyrder, H., Deyden, S. and Hames, C.: Influence of race, sex and weight on blood pressure behavior in young adults. *Am. J. Cardiol.,* **35:** 523-525 (1975).

Mukhopadhyay, B., Mukhopadhyay, S and Majumdar , P.P.: Blood pressure profiles of Lepchas of the Sikkim Himalays. Epidemiological study. *Hum Biol.,* **68:** 131-145(1996).

Krishnaswamy, K. and Vijayalakshmi, K.: Studies on obesity and hypertension in high socio-economic group. *Ann. Rep.* NIN, Hyderabad: 77 (1998).

NFI (Nutrition Foundation of India): Obesity in the urban middle class in Delhi. *Scientific Report Ser. No.,* **15:** 18-19 (1999).

Nirmala, A., Reddy, P.C. and Reddy, K.N.: Influence of adiposity on blood pressure in an Andhra population. *Ind J. Anthrop. Soc.,* **28:** 139-145(1993).

Pi-Sunyer, F.X.: Medical hazards of obesity. *Ann. Int. Med.,* **119:** 655-660 (1993).

Rose, G.A and Blackburn, H.: Cardiovascular survey methods. *WHO, Monograph series no.* **56:** 90-95 (1968).

Sambasivarao, R. and Veerraju, P.: Influence of body weight on blood pressure in rural population of coastal Andhra Pradesh. Ind. Practit., 34:129-139 (1981).

Sandin, M., Ugalde, M., Montero, P. and Sanchez, C.: Relationship between blood pressure and variable of body composition in 6 to 15 years olds. Longitudinal study. *J. Hum. Ecol.,* **1:** 37-48 (1990).

Sandin, M. Sanchez, C., Ugalde, M.: Temporal and social variability in the association between body fat and blood pressure in married couples. *Int. J. Anthrop.,* **2:** 125-132 (1987).

Sidhu, S. and Kumari, K.: Blood pressure and body composition in adult Bazigar females of Punjab. *Anthrop. Kozl.,* **37:** 79-81 (1995).

Sidhu, S. and Kumari, K.: Blood pressure and body composition in adult scheduled caste females of Punjab. *South Asian Anth.,* **2:**17-19(2002).

Sidhu, Sand Kumari, K.: Blood pressure and body composition in adult Bania females of Punjab. *J. Hum Ecol.,* **3:**157-158 (1992).

Siervogel, R.M., Roche, A.E., Chumlea, W.C., Morris, J.G., Webb, P. and Knittle, J.E.: Blood Pressure, body composition and fat tissue cellularity in adults. *Hypertension,* **4:** 382-386 (1982).

Sowers, J.R.: Obesity as a cardiovascular risk factor. *Am. J. Med.,* **115:** 375-415 (2003).

Stamler, J., Berkson, D., Dyer, A., Lepper, H., Lindberg, H., Paul, O., McKean, H., Rhomberg, P., Schoenberger, J., Shekells,R. and Stamler, R.: Relationship of multiple variable to blood pressure. Pp.307-356. Findings from Chicago epidemiological studies: In: *Epidemiology and control of Hypertension*. O. Paul (Ed..). Miami Symposia Specialists (1975).

Stamler , R., Stamler, J., Riedlinger, W.F., Algera, G and Roberts, R.H.: Weight and blood pressure: Findings in hypertension screening of 1 million Americans. *J. Am. Med. Assc.,* **240:** 1607 (1978).

Valdez, R., Seidell, J.C., Ahn, Y. I. and Weiss, K.M..: A new index of abdominal adiposity as an indicator of risk for cardiovascular disease. A cross population study. *Ind. J. Obes.,* **17:** 77-82 (1993).

Venkatramana, P., Vam, C and Chenga Reddy, P.: Association of body mass index, body fat distribution and fat patterning with blood pressure in two populations of Andhra. *J Hum Ecol.,* **12:** 63-68 (2001).

Vijayalakshmi, K., Krishna, T.P., Raghuram, T.C. and Krishnswamy, K.: Abdominal adiposity and metabolic alterations in hypertension – A case control study. *Asia Pacific J. Clin. Nutr.,* **6:**180-185 (1997).

Voors, A.W., Webber, L.S., Frerichs, R.R. and Berenson, G.S.: Body height and body mass as determinants of basal blood pressure in children. The Bogalusa Heart Study. *Am. J. Epidemiol.,* **106:** 101-108 (1977).

Weiner, J.S. and Lourie, J.A.: *Human Biology: A Guide to Field Methods. Practical Human Biology.* Academic Press Inc., New York (1981).

Whelton, P.K., He. J., Apple, L.J., cutler , J.A., Hanvas, S., Kotchen, T.A. et al..: Primary prevention of hypertension clinical and public health advisory from the National High Blood Pressure Education Program. *J. Am. Med. Assoc.,* **288:** 1882-1888 (2002).

World Health Organization: *Obesity.: Prevention and Managing the Global Epidemic.* WHO, Geneva (2000).

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ABSTRACT In the present study, an attempt has been made to report the relationship between blood pressure and body composition variables (fat free mass and total body fat) in 176, (75 male and 101 female) healthy students and employees of Guru Nanak Dev University, Amritsar (Punjab), who were 20 to 45 years of age. Bioelectrical impedance method was used for the estimation of body composition. In both males and females, after adjusting for age, there were highly significant, positive partial correlations between systolic blood pressure, diastolic blood pressure and mean arterial blood pressure and total body fat, but no significant correlations existed between fat free mass and any measure of blood pressure. These findings suggest that body fat may be an important component in high blood pressure.

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