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ASSOCIATION BETWEEN PHYSIQUE AND BLOOD PRESSURE IN AN ADULT TRIBAL POPULATION

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Abstract: *The aim of the present study is to explore the association between blood pressure and various anthropometric characteristics including BMI and somatotype components. In order to understand the relationship between physique and blood pressure among adult Santhals, a cross sectional sample of 1,262 adult Santhals, comprising 692 males, aged 18–87 years and 570 females aged 18–83 years, was collected from West Bengal, India. It is found that endomorphic and mesomorphic components decline, whereas ectomorphic component increase with the advancement of age among adult Santhals. Blood pressure (both systolic and diastolic) rises significantly with the increase in endomorphic and mesomorphic components for both the genders. On the other hand, it declines with the increase in ectomorphic component of body physique in both males and females. Results from regression analysis suggest that mesomorphic component has significantly stronger effect on blood pressure as compared to ectomorphic and endomorphic components of physique among adult Santhals of West Bengal, India.*
Keywords: *Physique; Blood pressure; Linear regression; Santhals.*

Introduction

Somatotyping is a unique method for classifying human physique which was first invented by Sheldon et al. (1940) and later on modified by Heath and Carter (1967). Results from applying this method reveal an overall outlook of the human body and hence convey a total picture of the morphological features. Several investigations have demonstrated association between blood pressure and physique. This association helps us to know more about the underlying genetic factors that influence the health of the organism, along with a series of biological and socio-cultural factors. We can also find studies, which concentrate in understanding changes in body composition associated with the ageing process. These studies provide information on the nutritional status of this age group and as a consequence, to their health status (Herrera et al. 2004). From many studies it is evident that factors like body weight, skinfold measurements, BMI and waist circumferences have significant association with blood pressure (Negri et al. 1988, Gerber et al. 1995, Katzmarzyk et al. 1999, Livshits and Gerber 2001, Toselli et al. 2001, Zsákai et al. 2000, 2001, Al-Sendi et al. 2003, Henriksson et al. 2003, Kalichman et al. 2004, Min-hang et al. 2010). According to Malina et al. (1997), individuals with high systolic blood pressure (SBP) and diastolic blood pressure (DBP) are more endomorphic and mesomorphic and less ectomorphic.

The relationship between blood pressure and anthropometric characteristics has been examined extensively, but only a few studies have investigated any connection of somatotype with blood pressure (BP), especially in the context of Indian tribal societies. Keeping these observations in mind, the present study aims at evaluating the association between blood pressure and various anthropometric characteristics, including components of somatotype among the adult Santhal tribes of West Bengal, India.

Subjects and methods

The population sampled in the present study is the indigenous tribe of Ranibandh block of Bankura district of West Bengal, India. The tribal populations inhabiting in Ranibandh block are Santhal, Sardar, Munda and Bumij. Of these, the Santhals are the highest in number. Ranibandh is predominantly a Santhal inhabited region and few of the villages are exclusively inhabited by them. Santhals have been living in southern and western part of West Bengal for at least five hundred years. It has been found that few of the Santhal villages in Bankura district are over three hundred years old (Culshaw 1949). Ethnically, Santhals are settled agriculturists, though food gathering and hunting are their important subsidiary occupations.

The present study concentrates on analyzing a cross sectional sample of 1,262 adult Santhals. The data used in this study was collected from eighteen villages of Ranibandh block of Bankura district of West Bengal, using multi-stage cluster random sampling method. The investigated cohort includes 692 males, aged 18–87 years (mean 44.4 years) and 570 females, aged 18–83 years (mean 41.5 years). Permission was taken from each and every subject for conducting investigation on them. Care was taken that the study participants are healthy or at least not suffering from any cardiovascular or other chronic diseases. They mostly share similar economic and ecological conditions and for generations they lived under the same environmental conditions and have not been exposed to outside genetic flow. Date of birth of each subject was asked and recorded. Decimal age of subjects was calculated using decimal age calendar (Tanner et al. 1969).

Anthropometric measurements were taken on each participant following internationally accepted standards (Martin and Saller 1957). All the measurements were taken on the left side of the subjects, except skinfolds, where measurements were taken on the right side of the subjects following Tanner (1969). The following measurements were taken on both the sexes: stature, body weight, bicondylar humerus, bicondylar femur, mid-upper arm circumference, mid-calf circumference, skinfold at triceps, skinfold at subscapula, skinfold at suprailliac and skinfold at calf. All the anthropometric measurements were taken using anthropometric rod and sliding caliper. Circumferences were measured with the help of steel tape. All the skinfold measurements were taken with the Holtain skinfold caliper. Anthropometric somatotype of each subject was obtained by the formulae proposed by Carter and Heath (1990). To assess nutritional status of the present population, body mass index was calculated as: BMI = body mass (kg)/stature^2 (m^2). Perhaps, it is worth mentioning here that there is a debate among human biologists for new BMI cut-off points for Asian populations, which is not yet redefined (WHO 2004). However, these new cut-off points are mostly related to redefining BMI $\geq$ 25.0 kg/m^2. Since in the present study percentage of such subjects is negligible, it will not influence the conclusion of the present study regarding BMI. Following BMI classification is used in the present study: underweight if BMI < 18.49 kg/m^2, normal weight if BMI = 18.50–24.99 kg/m^2, overweight if BMI $\geq$ 25.00kg/m^2.

Two consecutive readings of systolic blood pressure (SBP) and diastolic blood pressure (DBP) were taken with a sphygmomanometer and a stethoscope after a 10 min rest. Mean arterial pressure (MAP) was calculated using the following formula given by the American Heart Association (2010): MAP = $\{(2\times DBP) + SBP\}/3$.

Statistical computations have been done using SPSS 15.0 for Windows. The chi-square test has been used to evaluate the sex differences in nutritional status. One-way analysis of variance (ANOVA) has been used to examine sex differences in somatotype components and blood pressure. Pearson's correlation coefficient between selected variables and each measure of blood pressure has been calculated after controlling for age. Linear regression has been computed using STATA 11.1 to assess the effect of various factors on blood pressure. Categorical or nominal variables like sex and nutritional status have been incorporated into regression model by means of dummy variables, 'Z' and 'D' respectively. Where,

Z = 1 if males and Z = 0 if females.

Since, nutritional status has three categories, viz. underweight, normal weight and overweight; two dummy variables have been considered. Where,

D1 = 1 if underweight and D1 = 0 otherwise;

D2 = 1 if normal weight and D2 = 0 otherwise.

Results

Age group-wise distributions of different anthropometric measurements for adult Santhal males are given in Table 1.

Table 1. Descriptive statistics (mean±SD) of anthropometric measurements by age for the Santhal males.

Measurements	Age groups (years) 18–20 (N=65)	21–30 (N=162)	31–40 (N=55)	41–50 (N=95)
Stature (cm)	162.26±5.99	163.16±5.83	163.40±6.89	160.88±5.24
Body weight (kg)	49.85±5.04	52.25±6.32	53.47±6.46	48.79±6.52
Bicondylar humerus (cm)	8.03±0.54	8.18±0.42	8.23±0.50	8.04±0.43
Bicondylar femur (cm)	9.27±0.45	9.27±0.42	9.22±0.40	9.10±0.45
Mid upper arm circ. (cm)	24.12±1.55	25.10±1.76	25.60±1.84	24.51±2.02
Mid calf circumference (cm)	31.65±1.83	31.75±2.19	31.44±2.49	29.90±2.32
Skinfold at triceps (mm)	5.35±1.83	5.76±2.46	5.93±3.01	5.37±2.10
Skinfold at subscapula (mm)	8.27±2.03	9.70±3.59	10.48±4.33	9.51±3.52
Skinfold at suprailliac (mm)	4.99±1.80	5.92±2.40	6.40±3.65	5.74±2.27
Skinfold at calf (mm)	5.58±2.13	5.95±2.67	5.61±3.71	4.36±1.70
	51–60 (N=188)	61–70 (N=89)	71 and older (N=38)	Together (N=692)
Stature (cm)	160.32±6.29	158.13±7.38	158.71±6.73	161.12±6.47
Body weight (kg)	47.88±7.00	45.66±6.83	44.13±4.56	49.17±6.94
Bicondylar humerus (cm)	7.94±0.49	7.79±0.52	7.69±0.47	8.01±0.50
Bicondylar femur (cm)	9.14±0.43	9.11±0.44	9.12±0.39	9.18±0.43
Mid upper arm circ. (cm)	24.06±2.25	23.13±2.24	22.08±1.88	24.26±2.17
Mid calf circumference (cm)	29.58±2.43	28.92±2.39	27.29±2.02	30.26±2.62
Skinfold at triceps (mm)	5.58±2.45	5.43±2.08	5.38±2.04	5.57±2.34
Skinfold at subscapula (mm)	9.55±4.83	8.61±4.09	7.81±3.13	9.32±4.00
Skinfold at suprailliac (mm)	6.01±3.04	5.91±2.55	5.76±2.29	5.86±2.66
Skinfold at calf (mm)	4.71±2.76	4.36±2.20	4.48±3.00	5.05±2.67

Descriptive statistics of Santhal males suggests that most of the anthropometric measurements decline with age in this population, especially after the age of 40 years. Whereas, there is a marginal rise in these measurements from the age of 18 years till the age of 40 years. This phenomenon is notably evident in the stature and body weight. Similar trend is also observed among adult Santhal females (Table 2). However in this case, majority of the measurements show a tendency to decline after the age of 30 years, which is little earlier than their counterpart. As compared to other measurements, this incidence is apparent in stature and body weight. In each age group, males are found to be taller and heavier than the females. However, subcutaneous fat deposition is considerably greater in females as compared to males in all the age groups.

Table 2. Descriptive statistics (mean±SD) of anthropometric measurements by age for the Santhal females.

Measurements	Age groups (years) 18–20 (N=59)	21–30 (N=86)	31–40 (N=85)	41–50 (N=202)
Stature (cm)	150.70±6.29	150.81±5.77	149.19±5.02	149.61±6.04
Body weight (kg)	42.85±5.37	42.38±6.09	41.30±6.33	42.94±6.95
Bicondylar humerus (cm)	7.47±0.38	7.38±0.49	7.43±0.46	7.58±0.48
Bicondylar femur (cm)	9.00±0.51	8.77±0.62	8.67±0.58	8.83±0.66
Mid upper arm circ. (cm)	23.69±1.71	23.25±1.95	23.08±2.28	24.00±2.41
Mid calf circ.(cm)	29.82±2.39	29.42±2.19	28.89±2.16	29.49±2.23
Skinfold at triceps (mm)	9.88±3.55	8.07±3.10	7.67±3.59	9.18±4.51
Skinfold at subscapula (mm)	12.57±4.18	10.71±3.79	10.51±4.47	12.59±5.95
Skinfold at suprailliac (mm)	9.77±4.61	8.72±4.66	7.68±4.11	9.87±5.47
Skinfold at calf (mm)	9.86±2.52	8.42±2.93	7.29±2.60	7.96±3.42
	51–60 (N=99)	61 and older (N=39)	Together (N=570)	
Stature (cm)	148.56±5.55	147.10±5.64	149.49±5.83	
Body weight (kg)	40.28±6.00	38.23±5.40	41.82±6.44	
Bicondylar humerus (cm)	7.40±0.48	7.23±0.37	7.46±0.47	
Bicondylar femur (cm)	8.79±0.58	8.68±0.50	8.80±0.61	
Mid upper arm circ. (cm)	23.12±2.03	21.61±2.66	23.40±2.29	
Mid calf circ. (cm)	28.35±2.49	26.95±2.08	29.05±2.38	
Skinfold at triceps (mm)	8.57±3.95	6.93±3.10	8.60±3.97	
Skinfold at subscapula (mm)	11.85±5.16	9.60±5.03	11.66±5.17	
Skinfold at suprailliac (mm)	8.79±4.87	6.41±3.60	8.94±4.95	
Skinfold at calf (mm)	7.64±2.99	5.33±2.34	7.89±3.15	

Table 3 depicts the nutritional status of adult Santhals according to age and sex. On an average, majority of the Santhal males belong to the category 'normal weight', whereas, most of the females are 'underweight'. Overweight is rare in this population and only a negligible percentage of adult Santhals fall into this category, irrespective of sex. Age has a noteworthy effect on the nutritional status in this community. Among males till the age of 40 years, a considerable percentage of them fall into the category 'normal weight'. However after the age of 40 years, they are mostly 'underweight'. The Santhal females also exhibit a similar pattern. In the age group 18–20 years, more than fifty percent (57.6%) of females fall into the category 'normal weight', whereas, rest of the age categories show higher percentage of females falling into the category 'underweight' with an exception of the age group 41–50 years. Statistically significant difference in variation of the frequency of nutritional status for sex (χ^2=7.015; p=0.030) is evident in this population.

Table 3. Nutritional status by age and sex among adult Santhals.

Age groups (years)	Males							Females						
		Under-weight		Normal weight		Over-weight			Under-weight		Normal weight		Over-weight	
	N	N	%	N	%	N	%	N	N	%	N	%	N	%
18–20	65	28	43.1	37	56.9	0	0.0	59	25	42.4	34	57.6	0	0.0
21–30	162	47	29.0	111	68.5	4	2.5	86	45	52.3	39	45.3	2	2.3
31–40	55	13	23.6	41	74.5	1	1.8	85	46	54.1	37	43.5	2	2.4
41–50	95	51	53.7	42	44.2	2	2.1	202	91	45.0	103	51.0	8	4.0
51–60	188	100	53.2	85	45.2	3	1.6	99	61	61.6	35	35.4	3	3.0
61–70	89	52	58.4	37	41.6	0	0.0	39	27	69.2	12	30.8	0	0.0
71 and older	38	29	76.3	9	23.7	0	0.0							
Together	692	320	46.2	362	52.3	10	1.4	570	295	51.8	260	45.6	15	2.6

$\chi^2 = 7.015$; $p = 0.030$

Descriptive statistics of Heath-Carter somatotype components and blood pressure, by age and sex, are shown in Tables 4–5. In each age group, mesomorphy is the dominant component among all the three somatotype components in this tribal population, irrespective of sex (Figure 1). The Santhal males across all age groups are found to be more mesomorphic and ectomorphic and less endomorphic. It is observed that with the increase in age, males become more ectomorphic and less mesomorphic, which is especially apparent after the age of 70. Santhal females on the other hand, show dominance of mesomorphic component over other two somatotype components across the age groups.

Table 4. Descriptive statistics (mean±SD) of somatotype components (in component units) by age and sex among Santhal adults.

Age groups (years)	N	Endomorphy	Mesomorphy	Ectomorphy
			Males	
18–20	65	1.76±0.61	5.15±1.08	3.78±1.10
21–30	162	2.06±0.84	5.34±0.99	3.50±1.18
31–40	55	2.21±1.15	5.37±1.22	3.29±1.17
41–50	95	2.00±0.79	5.05±1.01	3.82±1.29
51–60	188	2.05±1.09	4.91±1.28	3.92±1.60
61–70	89	1.94±0.97	4.78±1.27	3.99±1.68
71 and older	38	1.83±0.86	4.15±1.27	4.40±1.49
Together	692	2.01±0.94	5.03±1.19	3.78±1.41
			Females	
18–20	59	3.53±1.26	5.49±1.10	3.09±1.46
21–30	86	2.97±1.19	5.17±1.28	3.29±1.41
31–40	85	2.78±1.29	5.27±1.13	3.23±1.44
41–50	202	3.42±1.62	5.67±1.41	2.94±1.54
51–60	99	3.19±1.48	5.30±1.15	3.36±1.61
61 and older	39	2.45±1.34	4.83±1.27	3.55±1.73
Together	570	3.16±1.47	5.39±1.29	3.17±1.53

Table 5. Descriptive statistics (Mean±SD) of blood pressure (mmHg) by age and sex among Santhal adults.

Age groups (years)	N	Systolic blood pressure	Diastolic blood pressure	Mean arterial pressure
		Males		
18–20	65	122.34± 7.80	78.40± 9.61	93.05± 7.27
21–30	162	125.00± 8.26	80.96± 8.65	95.64± 7.45
31–40	55	123.89± 9.49	83.47± 8.81	96.95± 8.16
41–50	95	124.55± 9.95	83.08± 7.31	96.91± 7.51
51–60	188	125.15±12.36	82.32± 8.80	96.60± 9.09
61–70	89	128.92±15.16	82.09±10.09	97.70±10.81
71 and older	38	127.84±16.36	80.05±10.17	95.98±11.19
Together	692	125.30±11.41	81.68± 8.98	96.22± 8.73
		Females		
18–20	59	121.39± 7.10	79.29± 8.34	93.32± 6.86
21–30	86	120.26±10.51	78.31± 8.22	92.29± 7.97
31–40	85	118.16±10.19	80.14± 9.50	92.82± 9.18
41–50	202	122.29±12.05	81.47± 8.56	95.07± 9.11
51–60	99	125.45±11.90	82.44± 8.94	96.78± 9.24
61 and older	39	126.82±10.70	82.26±10.02	97.11± 8.74
Together	570	122.13±11.25	80.79± 8.88	94.57± 8.87

Systolic blood pressure (SBP) exhibits an upward tendency with age for both males and females (Table 5). For both males and females, the highest values are observed after 60 years of age. As compared to SBP, diastolic blood pressure (DBP) does not exhibit any trend. For both males and females an erratic tendency has been observed in their DBP. Mean arterial pressure (MAP) also shows an upward trend with age for the males, while for the females an irregular tendency is evident. Results of one-way analysis of variance for sex differences in somatotype components and blood pressure suggest statistically significant difference in all the variables, except for DBP (Table 5). More precisely, endomorphy ($F_{[1,1260]}$= 288.031), mesomorphy ($F_{[1,1260]}$= 27.201), ectomorphy ($F_{[1,1260]}$= 54.589), systolic blood pressure ($F_{[1,1260]}$= 24.413) and mean arterial pressure ($F_{[1,1260]}$= 11.142) differed significantly at 5% probability level between males and females. Whereas, in diastolic blood pressure ($F_{[1,1260]}$= 3.076) there is no statistically significant difference between the sexes of this population.

Correlation coefficients between blood pressure, somatotype components and nutritional status, after adjusted for age effect within the respective sex, are shown in Table 6. All categories of blood pressure, i.e. SBP, DBP and MAP show statistically significant correlations with almost all the variables of nutritional status, barring stature in males. For both males and females all the measures of blood pressure show statistically significant correlation with somatotype components, except for SBP with ectomorphy. Most of the somatotype components exhibit a positive correlation with BP variations, irrespective of sex. Only correlation coefficients between BP measurements and ectomorphy are negative. The correlations between blood pressure and age are statistically significant in both males and females, except with DBP in males. The correlation coefficients for SBP, DBP and MAP between ages are higher for the females than for the males in this community (0.17 vs. 0.11, 0.15 vs. 0.06 and 0.18 vs. 0.09 respectively).

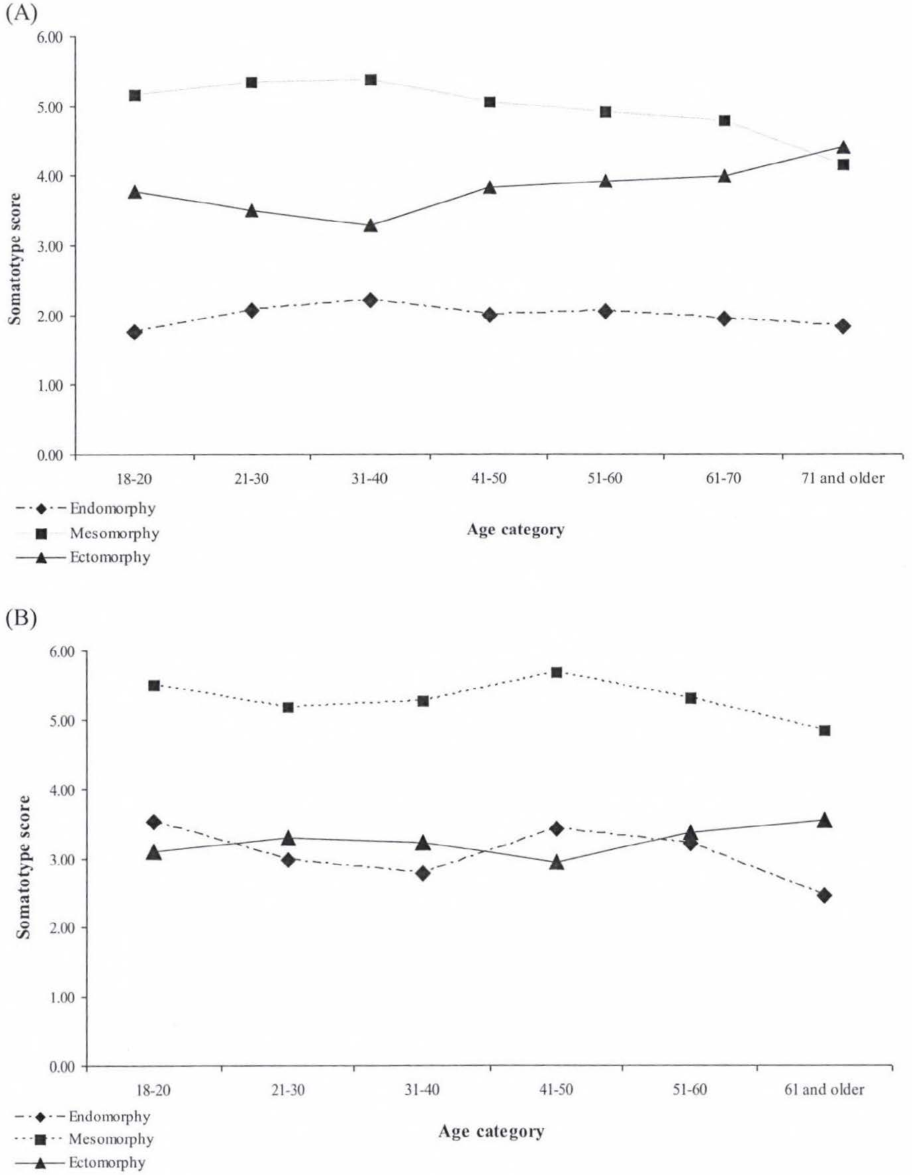

Figure 1. Age specific means for somatotype components according to sex, (A) males and (B) females, for adult Santhals

Table 6. Correlations between blood pressure, somatotype components and nutritional status for Santhal adults (all variables adjusted for age).

Measurements	Systolic blood pressure		Diastolic blood pressure		Mean arterial pressure	
	Males (N=692)	Females (N=570)	Males (N=692)	Females (N=570)	Males (N=692)	Females (N=570)
Endomorphy	0.120*	0.168*	0.084*	0.176*	0.098*	0.188*
Mesomorphy	0.116*	0.147*	0.146*	0.211*	0.156*	0.204*
Ectomorphy	-0.073	-0.048	-0.098*	-0.125*	-0.108*	-0.105*
BMI (kg/m^2)	0.097*	0.091*	0.120*	0.153*	0.128*	0.142*
Stature (cm)	0.071	0.103*	0.052	0.096*	0.052	0.108*
Body weight (kg)	0.128*	0.137*	0.142*	0.194*	0.149*	0.189*

*: statistically significant correlations ($p < 0.05$)

The results of linear regression, which evaluates the effects of physique and other factors on blood pressure, are presented in Table 8. In the regression analysis, 5% probability level is considered for the level of significance. The specification of the linear regression model in this paper includes $age^2 = age \times age$. Through this variable I capture the effect on change in blood pressure due to change in age as age changes.

The effect of age on blood pressure is captured by,

$$\text{Coefficient of age} + 2 \times \text{coefficient of age}^2 \times \text{arithmetic mean of age}. \quad (1)$$

I refer the reader to the appendix of this paper for the exact calculation of this formula.

In the present study, age has been found to significantly influence all the blood pressure measures SBP, DBP and MAP. Positive and statistically significant coefficient of age^2 on SBP reflects that with the increase in age effect of age on SBP increases. Negative and statistically significant coefficient of age^2 on DBP reflects that with the increase in age effect of age on DBP decreases. In the regression model for MAP, age^2 were not incorporated, as the model shows better result without this parameter. However the effect of age on SBP, DBP and MAP calculated by (1), is positive and significant. In other words the younger generation tend to be more prone to high DBP and older generation tend to be more prone to high SBP. The opposite effect of age^2 on SBP and DBP may lead to insignificant effect of age^2 on MAP, which has found.

The effect of body weight on SBP, DBP and MAP is positive and significant, as expected. Different measures of body physique, i.e. endomorphy, mesomorphy and ectomorphy show significant effect on SBP, with the effect of mesomorphy being the strongest. On the other hand, on DBP only mesomorphic component has significant influences and on MAP both mesomorphic and ectomorphic components have a positive and significant effect. The positive and significant effect of mesomorphic component on SBP, DBP and also on MAP shows that its effect on blood pressure in general, is more prominent among the Santhals of West Bengal.

To examine the effect of nutritional status on blood pressure, body mass index (BMI) were calculated. In the regression model BMI was incorporated through dummy variables D1 and D2, to capture the effect of being underweight, normal weight and overweight on blood pressure. It was observed that, BMI has positive and statistically significant influence on DBP and MAP, but not on SBP among Santhals.

Table 7. Result of linear regression: effects of factors on Systolic, Diastolic and Mean arterial blood pressure for Santhal adults[†].

Dependent variables	Parameters	Coefficients	t	P > | t |
Systolic blood pressure	Age	-0.158	-1.41	0.160
	Age^2	0.003	2.42	0.016
	Z	0.940	0.92	0.356
	Body weight	0.288	4.32	0.001
	D1	4.397	1.46	0.146
	D2	3.456	1.33	0.184
	Endomorphy	0.735	2.03	0.043
	Mesomorphy	1.522	3.45	0.001
	Ectomorphy	1.206	2.75	0.006
	Constant	92.133	14.82	0.001
Diastolic blood pressure	Age	0.285	3.25	0.001
	Age^2	-0.002	-2.25	0.025
	Z	-0.611	-0.78	0.437
	Body weight	0.260	4.93	0.001
	D1	5.742	3.06	0.002
	D2	4.217	2.71	0.007
	Endomorphy	0.096	0.36	0.717
	Mesomorphy	1.431	4.21	0.001
	Ectomorphy	0.481	1.45	0.147
	Constant	48.016	10.93	0.001
Mean arterial pressure	Age	0.101	6.32	0.001
	Z	-0.146	-0.19	0.850
	Body weight	0.260	4.99	0.001
	D1	5.050	2.46	0.014
	D2	3.900	2.24	0.025
	Endomorphy	0.226	0.84	0.402
	Mesomorphy	1.493	4.40	0.001
	Ectomorphy	0.691	2.09	0.037
	Constant	64.146	14.58	0.001

[†]: standard errors are robust, Z = dummy variable for sex,
D1 and D2 are dummy variables for nutritional status

Discussion

Anthropometric analysis carried out show that Santhal males are significantly heavier and taller than females in all age groups, whereas subcutaneous fat deposition is significantly higher in females. This observation is in accordance with previous studies (Chiu et al. 2000, Santos et al. 2004, Sidhu et al. 1985 and Antoszewska 1992). All anthropometric variables show a decrease in average values with aging for both the males and the females, which is also evident from the earlier investigations (Santos et al. 2004, Woo et al. 2001, Zamboni et al. 2003, Perissinotto et al. 2002 and Ghosh 2004). It is further observed that the decline in body weight with aging is higher in the females than in the males in this population, which is also observed among Chilean population (Santos et al. 2004). This could be due to the differential pattern of lean body mass and fat body mass loss in different genders.

Results of the present research reveal that the females are more mesomorphic and endomorphic than the males, whereas the males are more ectomorphic than the females. This is also observed in few other populations (Herrera et al. 2004, Kalichman et al. 2004, Buffa et al. 2005, Kalichman and Kobyliansky 2006). It is further evident that, endomorphic and mesomorphic components decline with the increase in age. This decline is partly due to loss of body fat, body water and muscle mass during the period of senescence. Due to the same causal effect, ectomorphic component increases with age in both males and females in this tribal population. Similar pattern of associations in endomorphic and mesomorphic components of somatotype has been documented by Munroe and his co-authors (1969).

In comparison with younger generation, older people tend to have higher SBP. However, DBP tend to decline slightly in older generation as compared to younger generation, as evident from negative coefficient of age^2 with DBP. This observation is also found in other populations (Herrera et al. 2004, Mc. Eniery et al. 2009, Hart et al. 2009, Mitchell et al. 2010 and Stanley et al. 1997). This could be attributed to decreased arterial compliance (as a result of atherosclerosis), resulting in an increase in SBP and decrease in DBP with age. It is perhaps interesting to note here that, a biological trend, which is evident in many of the worldwide mainstream populations, also observed in this genetically isolated tribal population. Nutritional status significantly influences the level of DBP and MAP, without affecting SBP. This is in line with previous investigations (Johannsson et al. 1997, Yamagishi et al. 2004). The mechanism of peripheral vascular resistance could be one of the reasons resulting in rise of DBP and MAP level in consequence with an increase in BMI.

Statistically significant correlations of blood pressure with all body composition indicators, such as somatotype components, body weight and body mass index are observed in the present study. This observation is in line with other populations (Mueller 2003, Herrera et al. 2004, Kalichman et al. 2004, Makgae 2007). Blood pressure (both systolic and diastolic) rises significantly with the increase in endomorphic and mesomorphic components, irrespective of sexes. However, a negative correlation is observed between ectomorphy and both systolic and diastolic blood pressure, including mean arterial pressure.

The present study depicts a statistically significant association between physique and blood pressure, among the Santhals of West Bengal. It is observed that mesomorphic component influence blood pressure more significantly as compared to ectomorphic and endomorphic components in this population.

Appendix

Consider the following linear regression model: $Y=\beta_1 + \beta_2 X + \beta_3 X^2 + \beta_4 Z + \text{Error}$.

Now take the partial derivative: $\delta Y/\delta X = \beta_2 + 2\,\beta_3 X$.

In our model when X is age and Y is blood pressure, effect of age is calculated at the arithmetic mean of X. Now by taking partial derivative of $\delta Y/\delta X = \beta_2 + 2\,\beta_3 X$ with respect to X again we obtain, $\delta/\delta X\,(\delta Y/\delta X) = 2\beta_3$.

Since 2 is a positive constant, coefficient of age^2 captures effect on change in blood pressure due to change in age as age changes. In other words letting Y to denote blood pressure and X to denote age, $\delta Y/\delta X$ = change in blood pressure due to change in age and $\delta/\delta X\,(\delta Y/\delta X)$ = effect on change in blood pressure due to change in age as age changes.

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