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Age-Sex and Diurnal Variation of Blood Pressure in Different Nutritional States among the Adult Telegas of Kharagpur in West Bengal, India

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A B S T R A C T

An anthropological investigation among the endogamous Telega population (106 adult individuals including 51 males and 55 females) in the district of Paschim Medinipur of West Bengal, India shows wide range of age-sex as well as diurnal variation of mean blood pressure (MBP) with reference to different nutritional status. Distribution of MBP shows distinct bias for sexes separately on different occasions and in association with age and other physiological conditions like menopause in females. Records of increase of blood pressure from morning to evening also indicate clear diurnal change in both male as well as in the female samples with some variations when compared between the two sexes. Results also help us to understand and to record the variation of blood pressure as a physiometric trait in the population under study. Data indicate that nearly 30% of males and more than 30 % of females are living at the level of undernutrition. Nutritional status is measured by anthropometric measurements, e.g. height, weight, mid arm circumference (MUAC) and further calculation of body mass index (BMI). Distribution of MBP at different BMI and MUAC levels and Pearson correlation and regression analysis – all suggest that age, BMI and MUAC have significant impacts on BMI with some sex-related variations.

Key words: *age-sex, BMI, MUAC, MBP, adults*

Introduction

In an epidemiological study on blood pressures among the endogamous Telugu-speaking population of suburban areas near Kharagpur, Paschim Medinipur, apart from recording blood pressure in the population, attempts have been made to examine the influence of sex, mid arm circumference (MUAC), body weight and height.

Blood pressure is one of the most important physiological characters. It is sensitive to socioeconomic conditions, urbanization, activity patterns, diet, body weight and fat, other physical and cultural conditions apart from having a strong genetic as well as physiological components[1]. Research work over decades, related to ethnic, age-sex and diurnal variations of blood pressure and its association with different physical, physiological and nutritional conditions in different rural semi-urban and urban population had been conducted in India as well as abroad[1,2]. Reports from rural and urban areas of Delhi[1], central India[3], north and south Indian samples[4], Agra[5] and Allahabad[6] are a few to mention in this regard.

A series of systematic anthropological studies in India have been conducted in Visakhapatnam area[7–10] in Southern part of Andhra Pradesh. However, systematic anthropological and epidemiological study remains to be conducted in endogamous populations from Eastern India. Present study is relevant in that context.

Sander and Klingelhofer[11] studied the relationship between circadian blood pressure changes and development of early carotid atherosclerosis in 208 hypertensive and 216 normotensive patients older than 55 years. No significant differences regarding age, sex, smoking, diabetes, cholesterol, and triglycerides were found between both patient groups. Bose and Mascie-Taylor[12] reported similar associations between age and systolic and diastolic blood pressure among the Asian and European men. Profant and Dimsdale[2] reported variable findings regarding the role of race in diurnal blood pressure patterns. Work Site Blood Pressure Study[13] reported on the

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sex-specific associations of depression, anxiety, awake physical activity; sleep quality (assessed by nocturnal physical activity) with diurnal blood pressure variation in a nonpsychiatric sample. In a study[14] among twenty-four young Chinese subjects (12 males and 12 females), mean blood pressure demonstrated a significant variation ($df=4$, $F=8.46$, $p<0.01$) across time. The difference was due to the reduced mean blood pressure at 9:00 am compared with other sessions.

In a comparative investigation[15] among the Bengalee Hindu elderly persons in the city of Kolkata, India, significant differences were found between normotensive and hypertensive subjects in mean values for body mass index. The study revealed that hypertensive individuals have significantly enhanced levels of central body fat distribution. In a similar study[16] among the Bengalee Hindu older women (aged 50 years and above), results revealed that hypertensive subjects had significantly greater mean values of weight, body mass index (BMI), compared with normotensive subjects. In a cross sectional study[17] of Bengalee ethnicity, significant results of sexual dimorphism were found with regard to waist and mid arm circumference and body mass index and mean arterial blood pressure. Another important study on the relationship of age and body mass index with mean arterial blood pressures showed that age had significant correlation with body mass index and waist circumference. However, the correlations of body mass index with the blood pressures, as mentioned above were weaker[18,19].

So far, very little attention has been paid in India to the assessment of the influence of height, body weight and mid arm circumference on blood pressure. However, systematic epidemiological study remains to be conducted in other areas and endogamous genetic populations from Eastern India. Present study is relevant in that context. The results of the effect of arm girth on blood pressure in the Bushman of Kalahari desert[20] and in Britain[21] have stimulated the similar investigation in Telega sample in this paper. Studies also reveal that relation between arm girth and blood pressure has a practical importance because, arm girth varies with age, sex, weight and physical demands of occupation. In the present study, an attempt has also been made to study such effects among the Telega endogamous population using body mass index (BMI) and mid arm circumference (MUAC) and their association with blood pressure.

Materials and Methods

A bio-anthropological investigation of blood pressure has been carried out in the semi urban municipality area of Kharagpur, Paschim Medinipur. Both systolic and diastolic blood pressures were determined by standard calculation method of 106 (one hundred & six) adults, of which 51 are males and 55 are females. The range of age for both male and female is from 20 to more than 60 years. The subjects belong to a Telugu speaking Telaga endogamous caste. These adult individuals, belonging to a single gene pool, have similar physical as well as socio-economic environments. Inclusion criteria included that all the individuals of the sample have been living at Kharagpur or vicinity for 10 years continuously. The data set was thoroughly checked and verified through family studies, along with other relevant information on history of migration, marriage, health and disease etc. Hence, the sample may be considered to be a representative one for the entire Telega population of the region.

Background of the people

The Telagas are a Telugu caste of cultivators of the state of Andhra Pradesh in India who were formally soldiers in the armies, of the Hindu Sovereigns of Telegana. The Telagas are Vaishnavites and have Brahmins for their priests. It was found from the family history (Pedigrees are not included this paper) that the ancestors of these people had migrated through generations from Srikakulam district of Andhra Pradesh as railway employees since late 1880's.

Apart from the Srikakulam district, a small section of Telaga population also migrated from Vishakhapatnam, East Godavari district of Andhra Pradesh. Adult males in a majority of the families are employed as drivers, mechanics, clerks etc. in the South Eastern Railway. A few of them are working in Government office, and / or owners of small shops, grocery, stationery etc. as well as worker of other shop owners of Kharagpur.

Measurement of blood pressure

Blood pressure measurements were taken on left arm with a mercury sphygmomanometer and a standard stethoscope placed at the heart level of the subject who as been rested in relaxed and supine position on a bed. Systolic (SBP) and diastolic (DBP) blood pressures were recorded to the nearest mmHg as the appearance (Phase I) and disappearance (Phase V) of Korotkoff sounds, respectively. Since the main target of the study was to examine circadian rhythm or diurnal variation in blood pressure, it was necessary to record the blood pressure from each of the individuals about 3 times a day (at least after 45 minutes of each meal)..

(a) Morning (MBPI) 7–10 A.M.

(b) Afternoon (MBPII) 2–3 P.M.

(c) Evening (MBPIII) 7 P.M. to 9 P.M.

Mean blood pressure (MBP) have been calculated out of values of the systolic and diastolic blood pressures. The calculation of MBP is 1/3 of the systolic blood pressure (SBP) +2/3 of the diastolic blood pressure (DBP)[14]. However, the calculated values of both the mean blood pressure (MBP) = (1/3 SBP+2/3 DBP) as well as mean arterial blood pressure[17] (MAP) = [DBP+1/3 (SBP-DBP)] are same.

Anthropometric measurements

Besides recording blood pressure, anthropometric measurements like height vertex (in cm.), mid arm circumference (MUAC in cm) and body weight (in kg) were also taken. All anthropometric measurements of lightly

clothed subjects were taken by the investigators using standard anthropometric techniques[22]. Height and weight were taken to the nearest 1mm and 0.5 kg, using standard Martin's anthropometer and weighing scale (Doctor Beliram and Sons, New Delhi, India), respectively. Circumferences were measured to the nearest 1 mm. using a standard and highly flexible inelastic measuring tape (Triced, Shanghhai, China).

Estimation of body mass index (BMI)

Body Mass Index (BMI) was computed following the standard formula[23].

$$\text{BMI (kg/m}^2\text{)} = \text{Weight (kg)} / \text{Height}^2 \text{ (m}^2\text{)}.$$

Statistical analyses

The statistical analysis included calculation of mean with standard error. The samples of each sexes were analyzed separately. All other statistical analyses including Pearson Correlation and regression were performed using the Statistical Package for Social Sciences (SPSS) Programme (Version 7.0).

Results

Mean age of both sexes represent standard adult population. The base-line anthropometric and blood pressure characteristics of the subjects are presented in Table 1. The mean values of age, BMI, MUAC, and MBP of both the sexes are given below in the table. Results show that the males are taller and heavier than females. Results on sex variation show males with higher values in body weight, MUAC and blood pressure (MBP) indicating poor health and nutritional status of Telega females compared[23] to the males. However, data show that the entire population is under stress with respect to health and nutrition[23].

In table 2, the percentage of the working force of the population for both the sexes is substantial and the proportions of both male and female groups are almost same (above 70%). According to WHO standard[23], both the male as well as female Telegas exhibit moderately subnormal nutritional status in all ages when measured by BMI levels (around 20.30±0.36 for males and 20.16± 0.35 for females). At the same time Pearson correlation between MBP and BMI is also quite significant (0.01 level)) for both the sexes. Age-related changes in blood pressure show higher MBP for males in comparison to the females in the age groups of 20–39 years as well as in the range of 55 years and above. In this young-adult age-group (20–39 years), females are having physiologically subnormal[24,25] blood pressure (MBP in mm/Hg, 88.87±1.81).

Women of this reproductive age also exhibit some degree of low nutritional status (BMI 19.82±0.39). Both the sexes show a tendency of hypertension with the advancement of age (40 years and above). However, in females, higher MBP than the males as well as a consistent rise of MBP is observed in the age groups of 40–54 years. In the senile age-groups (60 years and above), percentage of population for both the sexes is low (3–7%) indicating shorter life span for the Telegas, which is due to poor health and nutrition. High degree of hypertension further indicates low socio-economic status as well as psychosomatic stress for the senile people of Telega population (Table 2).

Distribution of MBP shows highest frequency for males (45.10%) in the range of 90–99.9 mm/Hg whereas in female sample, distribution of MBP values exhibits highest frequency (56.37%) in the lower range of 80–89.9 mm/Hg (Table 3). This result further substantiates the

TABLE 1
MEAN VALUES (±SE) OF VARIABLES IN ADULT MALE AND FEMALE TELEGAS.

Variables	Male (n=51)	Female (n=55)
Age (in years)	32.08±11.35	34.18±12.79
Stature (cm)	160.26±0.94	150.33±1.0
Body weight (kg)	52.08±1.0	45.62±1.0
BMI(kg/m^2)	20.30±0.36	20.16±0.35
MUAC (cm)	24.54±0.4	23.52±0.3
MBP (mm/Hg).	94.5±1.2	92.0±1.4

±SE – Standard errors, BMI – Body Mass Index, MUAC – Mid Arm Circumference, MBP – Mean Blood Pressure.

TABLE 2
AGE-RELATED CHANGES IN MEAN BLOOD PRESSURE (MBP) AND BODY MASS INDEX (BMI) AMONG THE ADULT TELEGA MALE AND FEMALE SAMPLES.

Age-group (in years)	Male (n=51)			Female (n=55)		
	%	MBP (mm/Hg) X±SE	BMI (kg/m^2) X±SE	%	MBP (mm/Hg) X±SE	BMI (kg/m^2) X±SE
20–39	74.51	94.60±3.66	20.20±0.43	72.73	88.87±1.81	19.82±0.39
40–59	21.57	99.32±3.62	20.42±0.81	20.00	97.32±6.20	21.12±0.96
60+	3.92	102.12±7.68	21.52±0.27	7.27	108.96±8.51	20.92±1.20
	Pearson Correlation (all ages of the adults) between MBP and BMI = 0.442 (significance at 0.01 level – 2 tailed)			Pearson Correlation (all ages of the adults) between MBP and BMI = 0.483 (significance at 0.01 level – 2 tailed)		

X±SE – mean and standard errors.

TABLE 3
DISTRIBUTION OF MEAN BLOOD PRESSURE IN ADULT TELEGA MALES AND FEMALES

MBP (mm/Hg)	Male (n=51) %	X±SE	Female (n=55) %	X±SE
70.0–79.9	0.00	0.0±0.00	1.82	78.8±0.00
80.0–89.9	33.33	85.8±0.12	56.37	85.45±0.16
90.0–99.9	45.10	94.85±0.22	23.63	95.5±0.39
100.0–109.9	13.72	106.2±0.08	9.09	101.3±0.13
110.0 +	7.84	114.7±0.05	9.10	114.0±0.03

X±SE – mean and standard errors.

previous result (Table 2) that more females are having physiologically below normal MBP and a remarkable percentage of both the males and females are hypertensive.

Results show (Table 4) consistent rise in the values of MBP in both the sexes since morning to evening. These results however, conform to some previous data on blood pressure representing different populations, which show rise of blood pressure in individual from morning to evening[2,13,14].

TABLE 4
DIURNAL VARIATION OF MEAN BLOOD PRESSURE (MBP) AMONG THE ADULT TELEGA MALE AND FEMALE SAMPLES.

Blood pressure	Male (N=51) X±SE	Female (N=55) X±SE
MBP I (morning)	93.34±1.25	91.65±1.34
MBP II (afternoon)	94.64±1.36	91.92±1.55
MBP III (evening)	95.37±1.25	92.48±1.31

X±SE – mean and standard errors.

Distribution of diurnal variation of mean blood pressure (MBP) shows that the highest frequency of males are in the range of 90.00–100 mm/Hg and for female section it is 80–90 mm/Hg. These results conform to the sex-specific normal physiological association and variation of blood pressure in humans[24–25] (Table 5).

In table 6, consistent and correlated values were found between BMI levels and blood pressure (MBP) in both the sexes. More than 25 % of males and nearly 30 % of females of Telega population has been found to be in the undernutrition level (BMI 10.0–18.49). Physiologically subnormal MBP has been recorded (Table 6) in the underweight (<18.5, Asia-Pacific cut-off points of BMI) or undernutrition level (BMI 10.0–18.49), according to WHO recommendations[23]. Whereas, normal MBP was found to be correlated with the normal range of BMI (18.5–24.99). Further results indicate that the overweight female Telegas are hypertensive when higher MBP values were recorded in the moderately (Grade I overweight[23] or obesity level-I of Asia-Pacific classification) higher BMI levels (25.0–29.9). No male has been found in the overweight category (25.0 and above), as measured by BMI levels.

Distribution of mean blood pressure (MBP) in different MUAC levels indicating variable nutritional status in cases of both the male as well as in female sections indicate similar results like the previous one (Table 6). Physiologically appropriate values of MBP in the normal range of MUAC (above 23.0 in case of male and above 22.0 in case of female) have been clearly noted in case of both the male as well as female samples having normal health and nutrition (Table 7). This result indicates further the association of mean blood pressure with nutritional status of individuals, irrespective of sex.

Blood pressure (MBP) had moderately significant correlations (p=<0.01) among the males with age (r= 0.374), BMI (r=0.442) and MUAC (r = 0.303). However, in the female section, correlation of MBP shows moderate significance (p=<0.01) with age (r=0.602) and with BMI (r=0.483) but correlation is weaker with MUAC

TABLE 6
DISTRIBUTION OF MEAN BLOOD PRESSURE IN DIFFERENT BODY MASS INDEX (BMI) LEVELS AMONG THE ADULT TELEGA MALE AND FEMALE GROUPS

BMI	Male (N=51)		Female (N=55)	
	%	X±SE	%	X±SE
10.0–18.49	25.49	83.65±0.66	29.09	84.97±0.92
18.50–24.99	74.51	96.40±3.43	65.45	92.08±2.83
25.0–26.99	0.00	0.00±0.00	5.45	105.30±10.99

X±SE – mean and standard errors.

TABLE 5
DISTRIBUTION OF DIURNAL VARIATION OF MEAN BLOOD PRESSURE (MBP) AMONG THE ADULT TELEGA MALE AND FEMALE SAMPLES

MBP (Range)	Male (N=51)			Female (N=55)		
	MBP I %	MBP II %	MBPIII %	MBP I %	MBP II %	MBPIII %
70.0–79.99	0.0	0.0	0.0	3.64	5.45	1.82
80.0–89.99	47.06	35.29	19.60	47.27	49.09	45.45
90.0–99.99	35.29	41.18	56.86	38.18	25.45	32.73
100.0–109.99	13.73	15.68	11.76	1.82	9.09	10.90
110.0 +	3.92	7.84	11.76	9.09	10.91	9.09

TABLE 7
DISTRIBUTION OF MEAN BLOOD PRESSURE IN DIFFERENT MID ARM CIRCUMFERENCE (MUAC) LEVELS AMONG THE ADULT TELEGA MALES AND FEMALES

MUAC	Male (N=51)		MUAC	Female (N=55)	
	%	X±SE		%	X±SE
18.0–22.99 (below 23.0)	35.30	89.93±2.81	18.0–21.99 (Below 22.0)	30.0	83.70±1.12
23.0–29.9 (above 23.0)	64.70	96.74±3.65	22.0–27.99 (Above 22.0)	70.0	94.45±3.0

X ± SE – mean and standard errors.

TABLE 8
PEARSON CORRELATION COEFFICIENT OF BLOOD PRESSURE (MBP) WITH AGE, BMI AND MUAC AMONG THE ADULT TELEGAS (MALE AND FEMALE SAMPLES)

Variables	Male (N=51)	Female (N=55)
AGE	0.374**	0.602**
BMI	0.442**	0.483**
MUAC	0.303**	0.341*

* correlation is significant at the 0.01 level (2 tailed)
** correlation is significant at the 0.05 level (2 tailed)

(r=0.341 at p<0.05 level). Thus Table 8 exhibits moderate impact of age, BMI and MUAC on blood pressure which are less significant in both the sexes.

Simple linear regression analyses were undertaken (Table 9) to examine the impact of age, BMI and MUAC on mean blood pressure (MBP). Results demonstrated that BMI (t=5.490 for male and t=3.445 for females) had a significant effect on MBP in both the sexes (p<0.0001).

Age (t=5.490) also had significant effect on MBP in the female sample (p<0.0001) and impact is weaker in case of the males (p<0.05). However, regression analyses exhibited that MUAC had smaller impact (p<0.05) on MBP in both male as well as female samples of Telega population.

Discussion

The results of this study reflect wide range of age-related variation of blood pressure in male and female sections of the Telega population of Kharagpur in Paschim Medinipur district of West Bengal. Important findings with respect to the association of MBP with nutritional status measured by BMI and MUAC indicate a large section of the adult Telega population (more than 25% of males and nearly 30% of females) is suffering from undernutrition. Especially the females are undergoing lack of nutrition in the child-bearing or reproductive age-groups (20–39 years). Hence this gender-bias for women in poor health reflects the impact of social and economic factors and neglect for women section of child-bearing age in this endogamous population. From epidemiological point of view, this crisis is alarming for any population. This rise of MBP may be an indication of possible association with menopause. This result of physiological association of MBP and menopause needs further verification in the larger samples and in other population also. Correlation of blood pressure (MBP) with age, BMI, and MUAC are significant for both the sexes and data also have shown that age and BMI have significant impact on blood pressure Hence, it is apparent, conforming to the previous studies in this area[5,10,15] that blood pressure (MBP) as one of the basic indicators may be used in measuring at preliminary level, the nutritional status of human populations. The overall undernutrition along with physiologically abnormal[24,25] blood-pressure (high or low) with changes of age and the absence of people over 65 years irrespective of sex, indicate shorter life-span for both the sexes in the Telega population under study. The results of this investigation showing sex-specific as well as physiological association and diurnal variation of blood pressure contribute important information with reference to the particular population from this part of India.

TABLE 9
REGRESSION ANALYSES OF MBP (DEPENDENT VARIABLE), SEPARATELY WITH AGE, BMI AND MUAC AMONG THE ADULT TELEGAS (MALES AND FEMALES)

Independent Variables	Sex	B	SeB	Beta	t	R^2	Adjusted R^2
AGE	Male	0.288	0.102	0.374	2.820*	0.140	0.122
	Female	0.477	0.087	0.602	5.490***	0.363	0.351
BMI	Male	1.515	0.440	0.442	3.445***	0.195	0.179
	Female	1.865	0.465	0.483	4.013***	0.233	0.219
MUAC	Male	0.108	0.048	0.303	2.225*	0.092	0.073
	Female	0.177	0.067	0.341	2.643*	0.116	0.100

B refers to regression coefficient. SeB refers to standard error of B. Beta refers to estimated regression coefficient. *** p<0.0001; ** p<0.001; * p<0.05.

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DOBNO-SPOLNE I DNEVNE VARIJACIJE SREDNJE VRIJEDNOSTI KRVNOG TLAKA KOD RAZLIČITIH NUTRICIJSKIH STATUSA ODRASLIH OSOBA POPULACIJE TELEGA IZ KHARAGPURA U ZAPADNOM BENGALU, INDIA

SAŽETAK

Antropološko istraživanje endogamne populacije Telega (106 odraslih osoba, što uključuje 51 muškarca i 55 žena) u okrugu Paschim Medinipur u zapadnom Bengalu, India, pokazuje širok raspon dobno-spolnih te dnevnih varijacija srednje vrijednosti krvnog tlaka (eng. mean blood pressure, MBP) u odnosu na različit nutricijski status. Raspodjela srednje vrijednosti krvnog tlaka (MBP) pokazuje značajno odstupanje među spolovima u različitim slučajevima zasebno, ali i u vezi s dobi i drugim fiziološkim uvjetima, kao što je menopauza kod žena. Podaci o povećanju krvnog tlaka od jutra do večeri također pokazuju jasne dnevne promjene i kod muških i kod ženskih ispitanika, uz određene varijacije među spolovima. Rezultati nam isto tako pomažu razumjeti i zabilježiti promjene krvnog tlaka kao fiziometrijsko svojstvo u istraživanoj populaciji. Podaci pokazuju da gotovo 30% muškaraca i više od 30% žena živi na stupnju pothranjenosti. Nutricijski status izmjeren je pomoću antropometrijskih mjera, primjerice visine, težine, obujma središnjeg dijela ruke (eng. mid arm circumference, MUAC) te izračuna indeksa tjelesne mase (eng. body mass index, BMI). Raspodjela srednje vrijednosti krvnog tlaka (MBP) prema različitim indeksima tjelesne mase (BMI), obujmima središnjeg dijela ruke (MUAC), Pearsonovoj korelaciji i regresijskoj analizi, sve to ukazuje da dob, BMI i MUAC imaju značajan učinak na BMI s nekim spolno-zavisnim varijacijama.