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PREVALENCE OF PREHYPERTENSION AND HYPERTENSION AMONG TRIBAL ADULTS OF INDIA

ABSTRACT: Objective: The objective of the present study is to estimate the prevalence of essential hypertension and prehypertension among the tribes of India. Methods: We have conducted a cross-sectional study among1066 males and 1090 females (Total 2156) in the 20–60 years age group (years) belonging to nine major Indian tribes. The present study included nine tribes belonging to West Bengal (Santal, Oraon, and Kora), Odisha (Bhumij, Santal, and Bathudi), and Gujarat (Dhodia, Kukna, and Chaudhari). The prevalence of essential hypertension and prehypertension was estimated among the participants on the basis of gender and age (years). The selected tribal villages were identified on the basis of having access to basic amenities. Analysis of hypertension and prehypertension was also made among underweight, normal and overweight/obese individuals. Findings: The prevalence of prehypertension and essential hypertension among the studied tribes was found to be 15.1% and 11.8% respectively. High Risk Isolated Hypertension (HRIH) was observed to be more than 10 percent among 7 of the 9 tribes and as a result, the percentage of individuals at risk (Hypertensive + HRIH) jumps to more than 20.0% among all the tribes. Females showed higher prevalence for both prehypertension (15.5%) and essential hypertension (14.2%) as compared to males (14.7% and 9.3% respectively). Age group (years) wise differences showed a sharp rise in prevalence of hypertension from the age (years) category above 39 years. A possible early aging condition was observed among both males and females. The average SBP among the tribes was observed to be much higher than national average. About 9.0% of the individuals in low BMI (kg/m^2) were hypertensive indicating undernutrition as a potential risk factor for hypertension. Conclusion: The present findings exhibit women with higher rate of prevalence of hypertension along with an elevated risk for hypertension (higher percentage of prehypertensive women). The post 40 years period caries a higher vulnerability to CVD risks in the Indian tribal population. Additionally, an alarming prevalence of High Risk Isolated Systolic hypertension seems to have decisive roles if it gets converted to hypertension.

KEY WORDS: Hypertension – Prehypertension – Tribal Adults – High Risk Isolated Hypertension

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INTRODUCTION

Hypertension affected one billion people worldwide by 2013 bringing death to nine million of them (WHO 2013). Hypertension is a key comorbidity factor of cardiovascular diseases (CVDs) (Whelton *et al.* 2018), overweight/obesity (Kannel 2000, Hall 1994, Dı'az 2002) and undernutrition (Sawaya *et al.* 2005, Galal 2002). The association of hypertension with nutritional extremes in the same society indicates the reflexivity of nutritional transition on human physiological function. It is noteworthy that World Health Organization (WHO) global report on hypertension (2011) shows low- and middle-income countries at the highest risk of raised blood pressure (WHO 2013). Global burden of disease (GBD) review in 2012 reported a 47.8% increase in hypertension related CVD incidences by the year 2010 (Lozano *et al.* 2012).

Furthermore, hypertension is the third most prevalent risk factor for the disease burden in South Asia (Lim *et al.* 2012). Like all other developing countries, large scale urbanization/modernization has been taking place in India with effective changes in the lifestyles leading to appreciable increase in the prevalence of chronic metabolic conditions like cardio vascular diseases (CVD), diabetes, hypertension and metabolic syndromes (McKeigue *et al.* 1991, Prabhakaran *et al.* 2005, Sarkar *et al.* 2006, Ghosh 2007, Mohan *et al.* 2007, Misra, Khurana 2009, Mishra *et al.* 2009, Kamble *et al.* 2010).

Hypertension has emerged as a major public health problem in India (Patel *et al.* 2011). The global burden of disease (GBD) review in 2012 in its Indian context, suggested a consistent increase in prevalence of hypertension in this largest South Asian country with 25-30% prevalence in Urban and 10–15% in rural areas (Lozano *et al.* 2012). Gupta (2016) finds the urban-rural prevalence of hypertension in India in a conversance mode highlighting a steady 28–33% prevalence rate in urban areas while rural prevalence rate experiencing a sharp rise from 10-12% by early years of 21st century to 24–27% in recent years (Gupta 2016); overall prevalence rate is estimated to be at 29.8% (Anchala *et al.* 2014).

Considering the rapid urbanization along with modernity driven life style changes, Indian tribal population are experiencing a paradigm shift. Further the onset of CVD in India occurs 10–15 years early to western countries (Sharma, Ganguly 2005, Gupta *et al.* 2013, Wasay *et al.* 2014), so the risk of an earlier occurrence of such a risk among the tribal populations looms high due to their lower life expectancy with a rapidly and increasingly changing life style. However, it has broadly been a traditional wisdom that hypertension and CVD like health risks do not occur in majority of tribes and indigenous groups. It has been a long standing perception that tribes always adhere to paleo-nutritional practices and live in remote forests-away from modern life styles. But findings juxtaposing the prevalence and risk of hypertension among the tribes, moreover at an alarming rate, have provoked to rethink and reexamine the status and such a perception in a larger context. It is important to note that most studies reporting prevalence of hypertension among tribal groups are very much limited in various aspects like coverage and type of tribal groups, up-to-date in prevalence status, sample size and comprehensiveness. It may be mentioned that few systematic studies (Mukhopadhyay, Mukhopadhyay 2001, Kusuma *et al.* 2004, Manimunda *et al.* 2011) suggested an upward trend in prevalence and risk of hypertension among tribes of India. The last large scale study covering the broad tribal landscape was conducted in the year 2007-2008 by National Nutrition Monitoring Bureau (NNMB) (NNMB 2009). The NNMB in its study on hypertension prevalence among the tribes of India demonstrated an approximate prevalence of 25% among the men (17.5% stage I and 7.7% stage II hypertension) and 23% among the women (15.5% stage I and 7.5% stage II hypertension) (NNMB 2009). But NNMB findings surprisingly report the hypertension prevalence as high as 50–54% in Odisha, 36–45% in Kerala and 32–34.5% in West Bengal tribal groups. Arecent meta-analysis on prevalence of hypertension among Indian tribes demonstrated a 16.1% prevalence rate which further demonstrated a considerable heterogeneity in prevalence pattern among various tribes (Rizwan *et al.* 2014).

National Nutrition Monitoring Bureau (2009) reported that increasing access to development has led to an 'improvement', though marginal, in the nutritional status despite a well visible decline in the food and nutrient intake. Such observations indicate the typical urban pattern of food and nutritional pattern.

Furthermore, prehypertension (in its high range) is associated with elevated risks of CVD related mortality (Huang *et al.* 2013). Guo *et al.* (2013) in their review of association of prehypertension and CVDs observed that prehypertension leads to 1.44-fold risk for total CVDs, 1.72-fold for stroke and 1.79-foldfor myocardial infractions (Guo *et al.* 2013). Pednekar *et al.* (2009) have shown an increased risk among pre-hypertensive

men towards cerebrovascular disease deaths (Pednekar *et al.* 2009). There are fewer systematic findings (Hathur *et al.* 2013) reporting the status of prehypertension among the tribes which is very important from the health management point of view.

Putting the above dimensions in perspective, it is vital to conduct comprehensive studies to explore such highly contrasting, yet alarming observations on the prevalence of hypertension among these indigenous and highly vulnerable populations.

Realizing the imperativeness of large scale studies, the present study with its comprehensive report on the status of prehypertension and hypertension conditions, carries a lot of significance. Furthermore, high undernutritional problems being a major and long standing issue among Indian tribal groups, we have explored the co-prevalence of undernutrition and hypertension phenomenon among the tribes. The present study also examines the prevalence of hypertension among the overweight and/or obese individuals that has least been explored in tribal context in India. Such co-prevalence of hypertension and the double burden of malnutrition (undernutrition along with obesity) were estimated in separate nutritional states categorized on the basis of Body Mass Index (BMI) (kg/m^2) among nine major Indian tribes from different geographic locations in three states.

MATERIAL AND METHODS

Ethical statement

Prior ethical clearance to conduct the research was obtained from the Institutional Review Committee, Department of Anthropology, University of Delhi. Informed written consent from the participants of the study was obtained prior to the actual commencement of the study.

The Declaration of Helsinki (DoH, Finnish: *Helsingin julistus*, Swedish: *Helsingforsdeklarationen*) is a set of ethical principles regarding human experimentation developed originally in 1964 for the medical community by the World Medical Association (WMA) (WMA 2013).

Area and people

The present study included nine tribes belonging to West Bengal (Santal, Oraon, and Kora), Odisha (Bhumij, Santal, and Bathudi), and Gujarat (Dhodia, Kukna, and Chaudhari) (*Figure 1*). The selected groups are major Indian tribes.

Indian tribal populations are socially and economically underprivileged groups. However, because of industrial growth and other developmental activities, several tribal people of West Bengal and Odisha are migrating and accepting menial jobs which alter their dietary habits as well.

Although all the studied groups have access to basic amenities such as water, electricity, education, and health care, there are disparities in the availability of these facilities because of social and economic inequities.

Community activities such as traditional folk singing and dancing practices, among the Santals, Dhodias, and Chaudharis, are being replaced by television and video shows. Similarly, modern entertainment equipment, such as television sets and radios are present in most households.

The present study findings reveal that alcohol consumption was higher among the tribes of West Bengal and Odisha, both in men and women. However, alcohol consumption among the tribes of Gujarat was lower than that among the tribes of the other two states.

Sample

The sample collection was based on a multi-stage sampling method. Three states were selected from two different regions, two from the eastern region (West Bengal and Odisha) and one from the western region (Gujarat) of India. Three tribes were selected from each state based on their predominant distribution. Furthermore, a total of 66 tribal villages from the four districts in three states were chosen on the basis of their residence in the acculturated areas of development. These villages are the original tribal settlements with access to developmental activities. These areas are comparatively closer to the 'urban centers' than to the typical countryside habitation. Village listings for each of the tribe were prepared on the basis of their population concentration. We first estimated the number of men and women into four 10-year age interval groups (20–60 years) across several villages with the preponderance of specific tribal inhabitants in the population. A sample size of 30 men and women from each of the four 10-year age interval groups was selected using systematic random sampling.

Therefore, the study comprised a total sample size of 2156 adult tribal participants, with 1066 men and 1090 women (four less than the target sample size).

Exclusion criteria were as follows: growth and developmental disorders, severe health issues in the past year, and the existence of any secondary cause of

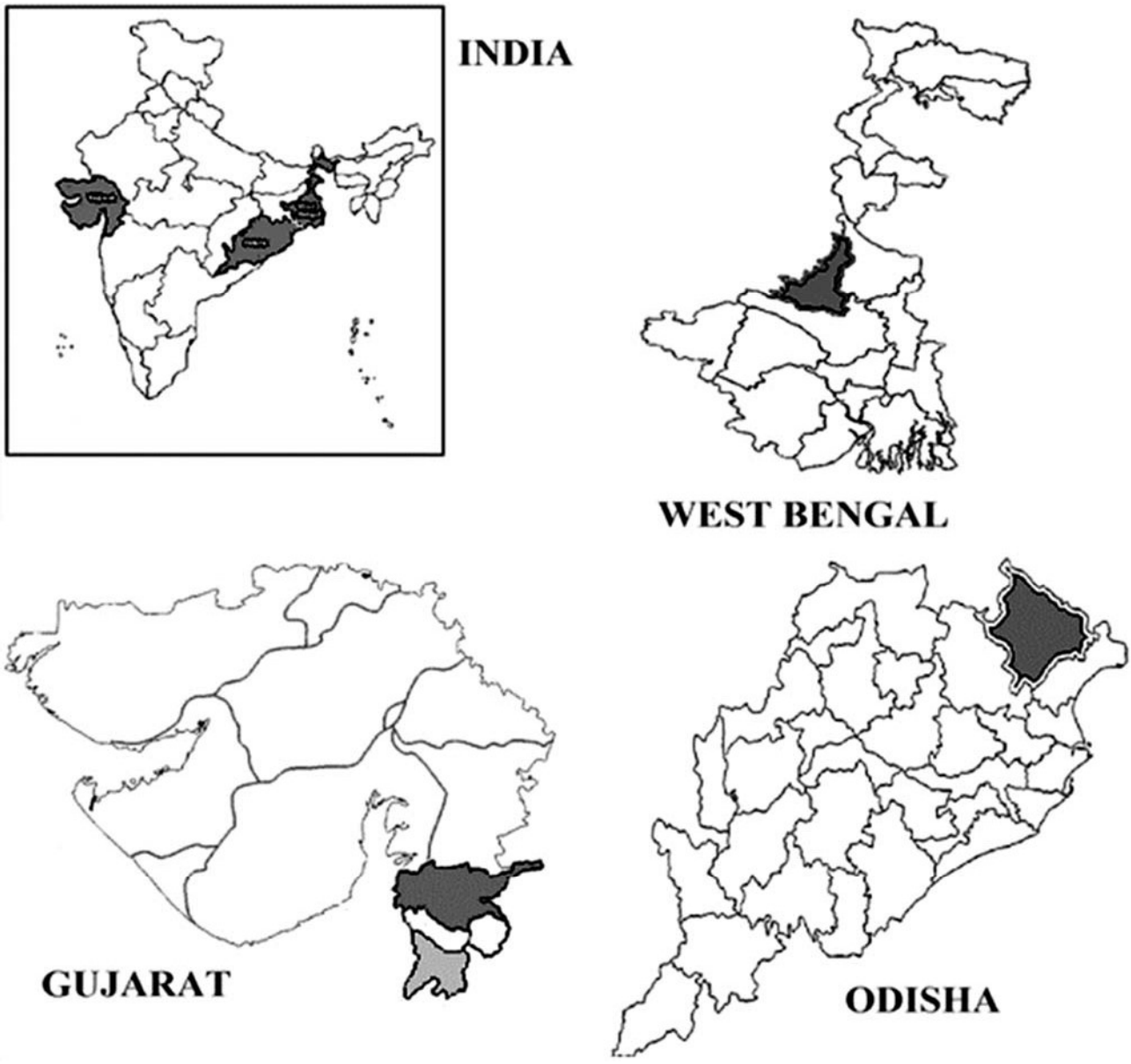

FIGURE 1: Geographic locations of the selected districts in West Bengal, Odisha and Gujarat on map of India.

hypertension. Individuals who had the aforementioned conditions have not been included in the present study. The sample size for the present study was tested at 5.0% level of significance, with a power of 80.0%. Participants who avoided the sampling were excluded.

Field survey design

The present cross-sectional study was conducted between January 2011 and December 2013 in five different phases to collect data on selected biomarkers. Each tribe was identified as one cluster, and data from every cluster were collected during the same time.

Measurement of anthropometric and metabolic variables

The primary information of the participants such as name, tribe name, age (years) and sex were recorded in a structured questionnaire format. Standard techniques were followed while taking all the anthropometric measurements (Lohman *et al.* 1988). The standing height (cm) and weight (kg) was measured to the nearest

of 0.1 cm and 0.1 kg, respectively. Stature was measured using a movable anthropometer while the weight (kg) was measured by using Omeron Karada Scan Body Composition Monitor (HBF-375), participants were encouraged to remove their shoes and heavy clothing before the measurements. Body Mass Index (BMI) was calculated as weight in kilogram (kg) divided by height in meter squared (m^2): kg/m^2. Systolic and diastolic blood pressure (SBP and DBP respectively) were recorded twice using a standard mercury sphygmomanometer on the right arm of the participants. A minimum 15-minute rest before the measurement and a 5-minute interval between two measurements were ensured. The average of the two measurements was recorded.

Research team and sample collection method

Two trained anthropologists guided by the principal investigator constituted the field research team for the data collection. To avoid measurement and data entry

TABLE 1: Descriptive statistics of anthropometric and derived variables among studied tribes.

Name of the tribes	Sex	Sample Size	SBP (mmHg)	DBP (mmHg)	BMI (kg/m^2)
Santal (West Bengal)	Males	123	127.5±18.2	79.7±11.1	19.9±2.6
	Females	122	123.9±24.0	78.6±13.2	19.5±3.2
	Total	245	125.7±21.3	79.1±12.2	19.7±2.9
Kora	Males	114	124.9±21.0	80.3±11.5	18.9±2.0
	Females	121	124.5±22.3	79.3±14.1	17.6±2.9
	Total	235	124.7±21.6	79.8±12.9	18.3±2.6
Oraon	Males	112	124.1±15.4	79.6±9.9	19.6±2.5
	Females	124	130.9±20.0	84.7±14.0	18.1±2.8
	Total	236	127.7±18.3	82.3±12.5	18.8±2.8
Santal (Odisha)	Males	121	125.8±16.9	76.1±13.1	20.2±2.8
	Females	119	125.4±15.1	82.2±10.6	20.3±3.0
	Total	240	125.6±16.0	79.1±12.3	20.3±2.9
Bhumij	Males	116	128.7±21.4	76.4±13.3	20.9±3.1
	Females	122	129.9±25.1	82.9±13.2	19.7±2.9
	Total	238	129.4±23.4	79.7±13.6	20.3±3.1
Bathudi	Males	119	125.4±17.9	75.8±11.6	19.5±2.8
	Females	121	132.8±23.2	86.2±14.7	18.0±2.8
	Total	240	129.1±21.0	81.1±14.2	18.6±3.3
Dhodia (Gujarat)	Males	121	129.0±20.4	80.2±11.6	20.5±3.2
	Females	120	129.6±20.4	82.3±13.5	20.7±3.5
	Total	240	129.3±20.4	81.2±12.6	20.6±3.3
Kukna	Males	120	128.4±17.4	79.3±11.1	20.3±3.1
	Females	120	127.1±16.8	80.1±9.5	19.9±2.9
	Total	240	127.8±17.1	79.7±10.3	20.1±3.0
Chaudhari	Males	120	125.7±23.5	75.1±11.5	19.8±3.1
	Females	121	123.7±21.7	80.1±13.8	18.9±2.9
	Total	241	124.7±22.5	77.6±12.9	19.4±3.0
Total	Males	1066	126.7±19.3	78.1±11.83	20.0±2.9
	Females	1090	127.6±21.4	81.9±13.2	19.2±3.1
	Total	2156	127.1±20.4	80.0±12.7	19.6±3.1

bias, all measurements were taken by one anthropologist, while all data were entered in the datasheet by another. During the study, the same instruments were used for recording the measurements of all the sampled selected participants. The selected villages were informed before the commencement of the study.

Individual classifications

High BMI has been treated as a strong indicator of obesity and hypertension in various populations. Furthermore, the "obesity paradox" has been reported which indicated that low BMI was associated with hypertension (He *et al.* 1994, Jones *et al.* 1994). Therefore, we considered both low and high BMI statuses as predictors of CVD risks. According to the WHO guidelines for Asian populations, individuals with BMI<18.5 kg/m^2 were considered as underweight; ≥18.5 kg/m^2 but <23 kg/m^{2}as normal; ≥23 kg/m^2 but <27.5 kg/m^2 as overweight; ≥27.5 kg/m^{2}as obese (WHO 2000).

Hypertension categories were defined according to the 8th US JNC recommendations (James *et al.* 2014). Systolic Blood Pressure (SBP) ≥130 mmHg and less than 140 mmHg was consider as prehypertensive SBP while ≥140 mmHg as hypertensive. Similarly, Diastolic Blood Pressure (DBP) ≥85 mmHg and less than 90 mmHg was consider as prehypertensive while DBP ≥90 mmHg as hypertensive. Participants with blood pressure ≥130/85 mmHg were considered as pre-hypertensive while with blood pressure ≥140/90 mmHg were considered as hypertensive (James *et al.* 2014). We did not sub divide the pre-hypertension and hypertension into their various categories. We observed a substantial proportion of the sampled participants in Isolated Systolic Hypertension along with a prehypertensive DBP. We tried to calculate the risk of elevated Blood Pressure (BP) in such participants by further categorising them as High Risk Isolated Hypertension (HRIH) for convenience where the SBP was ≥140 (hypertensive) and DBP was 85–89 mmHg (prehypertensive).

Statistical analysis

After incorporating and systematizing the data into Microsoft Excel 2007, further analyses were conducted using SPSS version 16.0 for Windows (SPSS Inc., Chicago, Illinois, USA). The data were cross-checked several times to ensure its validity and accuracy. Descriptive statistics, such as mean and standard deviation (SD), were used for the selected anthropometric and physiological variables. The prevalence of normal and selected risk categories was calculated for each selected variable in percentages, with a 95% confidence interval (CI). The age differentiated prevalence percentages of pre-hypertension and hypertension in men, women, and the overall population were calculated. Mean SBP and DBP statuses were calculated and analysed by using line graphs to explain the risks in different contexts. The patterns of mean SBP among the general Indian population in the past 30 years and those observed among men, and women, and the overall population were compared, and the results were plotted as line graphs.

FINDINGS

Table 1 presents the demographics and population characteristics of the selected tribes of India. An optimized average SBP status among males and females of majority of the tribes signifies an increased risk among them. Such a trend becomes more pronounced by comparing it with the trend of SBP at national level in general Indian population (*Figure 2*). This significantly explains the elevated CVD risk level among the Indian tribes.

On the other hand, the mean BMI trend among the tribes and the general Indian population shows a high discrepancy (*Figure 3*) which is indicative of serious inequality in access to proper food among Indian tribal groups in comparison to the nontribal population. The mean BMI status among males and females in each tribe demonstrates a gender variation (*Table 1*). A low or very low status of mean BMI in the population symbolizes that a considerably large portion in the population is in the bracket of undernutrition (ranging from mild to severe forms) which drags the overall average BMI status in the population to a BMI extreme. High SBP which is indicative of elevated CVD risk is generally experienced among individuals with elevated BMI (Kannel 2000, Hall 1994, Dı'az 2002). On contrary, the finding of the present study highlighting elevated average SBP among most of the tribes along with the mean BMI being pushed to the lower end of normality (around 18.5 kg/m^2) demonstrates the increased risk of CVD among those who have suffered from undernutrition recently or have undergone prolonged stress. Further, females in Oraon and Bathudi tribes exhibit an average BMI status of<18.5 kg/m^{2}while their average SBP is shooting to pre-hypertensive condition which indicates their worsening cardiovascular health on one hand, and the possible

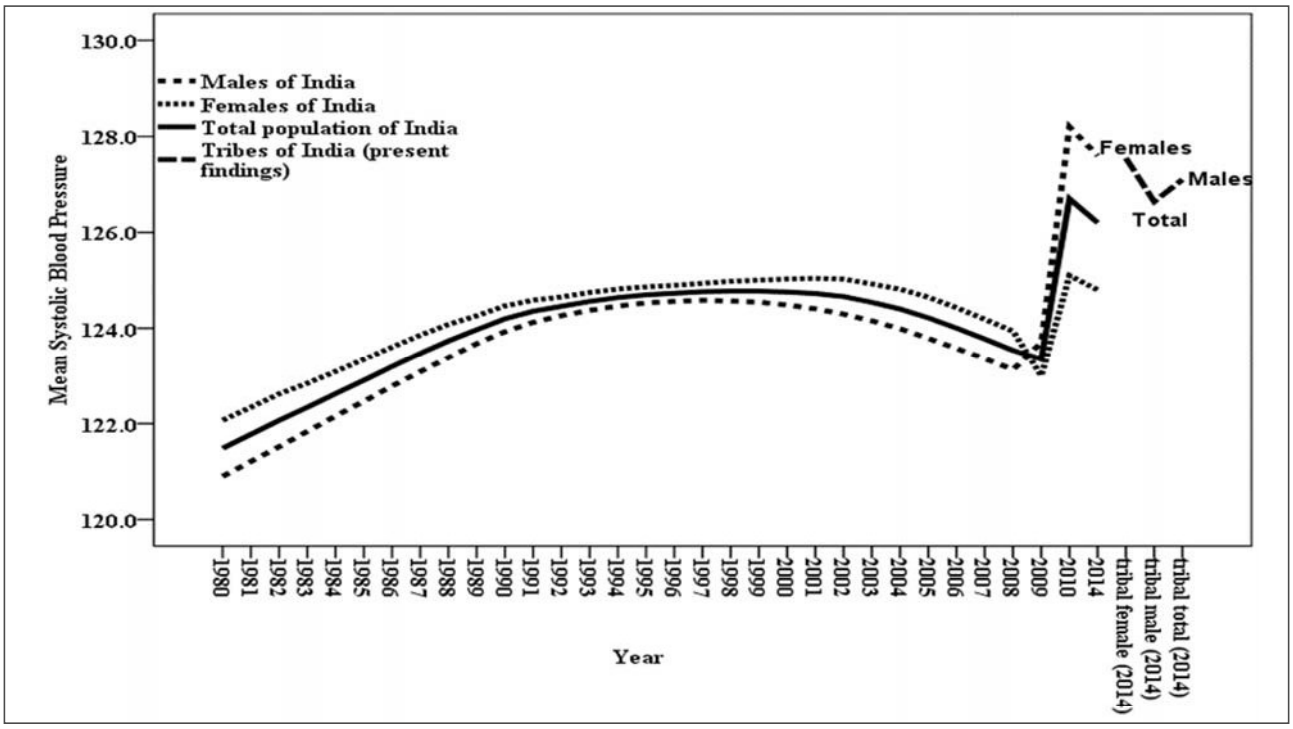

FIGURE 2: Trend of SBP between general population of india and studied tribal populations.

FIGURE 3. Trend of BMI (Kg/m^2) in general population of india and the observed bmi pattern among the tribal populations in the present study.

association of risk of hypertension with increasing magnitude of undernutrition on other.

The average SBP (*Figure 4*) among various age groups in the three states and the total pooled population shows a trend where the SBP in the 45 years and above age cohort is taking a leap in to the pre-hypertensive condition in Odisha, Gujarat and total pooled population while such risk in West Bengal was observed to set up earlier. The young age groups in Odisha show a comparatively better cardiovascular health than the rest of the two states while the risk of hypertension was also observed to increase among the Odisha elder population group.

Figure 5 represents the average DBP among various age groups in the three states and the total pooled population. It shows an elevation of risk in DBP from 35 upto 50 years age cohort while the fall in DBP starts after the age of 50 years.

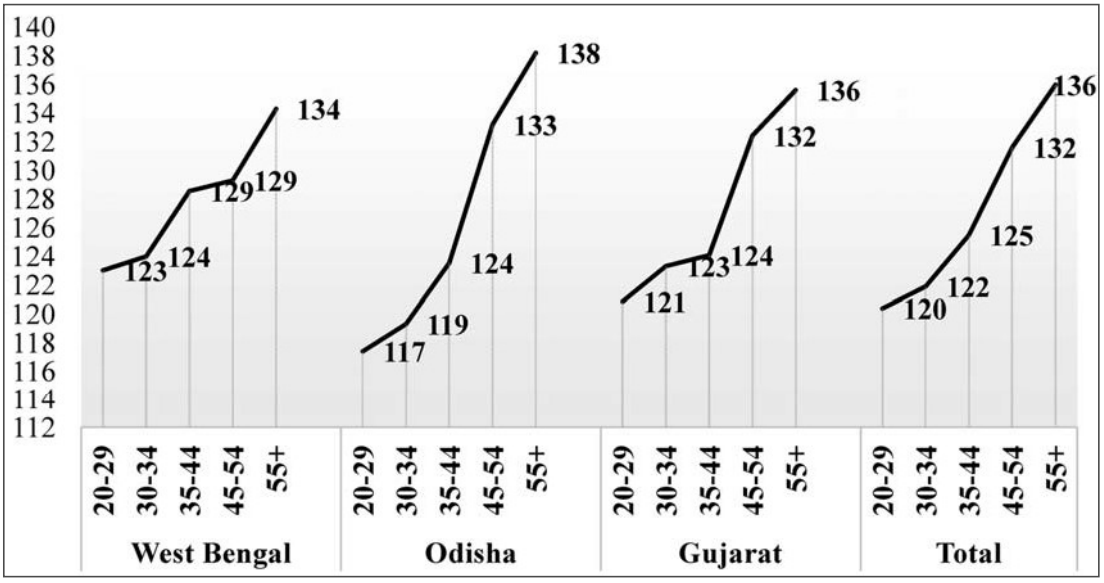

FIGURE 4: Age group (years) wise distribution of mean sbp among studied tribes in three states.

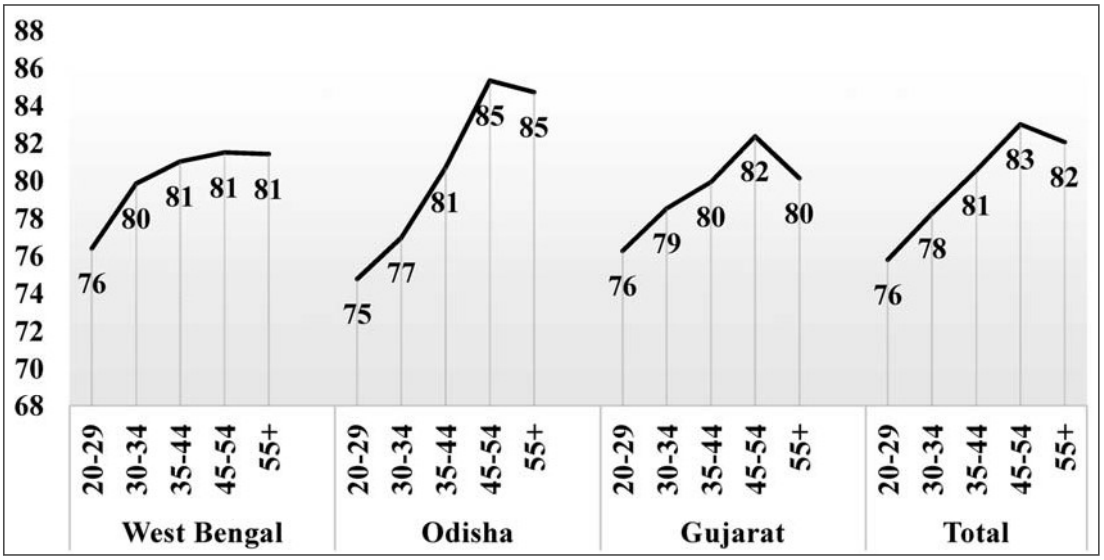

FIGURE 5: Age group (years) wise distribution of mean dbp among studied tribes in three states.

TABLE 2: Age (years) and sex wise prevalence of normal bp, prehypertensive and hypertensive systolic blood pressure (mmhg) among the tribes.

Systolic Blood Pressure (mmHg) (%)											
Names of the tribes	**Blood Pressure variables**	**Age group (years)**								**Total**	
		20-29		**30-39**		**40-49**		**50+**			
		M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
West Bengal Santal	Normotensive	57.6	75.0	40.0	78.6	36.7	43.3	26.7	20.0	40.6	54.2
	Prehypertensive	33.3	25.0	53.3	21.4	36.7	30.0	43.3	26.7	41.5	25.8
	Hypertensive	9.1	0.0	6.7	0.0	26.6	26.7	30.0	53.3	17.9	20.0
Kora	Normotensive	58.6	86.7	63.3	54.8	40.7	53.3	35.7	16.7	50.0	52.9
	Pre-hypertensive	41.4	13.3	30.0	29.0	29.6	26.7	35.7	26.7	34.2	24.0
	Hypertensive	0.0	0.0	6.7	16.1	29.6	20.0	28.6	56.7	15.8	23.1
Oraon	Normotensive	44.8	66.7	43.3	43.3	46.7	30.0	34.8	3.2	42.9	36.3
	Pre-hypertensive	41.4	30.3	50.0	40.0	36.7	26.7	47.8	41.9	43.8	34.7
	Hypertensive	13.8	3.0	6.7	16.7	17.7	43.3	17.4	54.8	13.4	29.0
Odisha Santal	Normotensive	30.0	48.4	53.3	32.1	36.4	43.3	34.2	36.7	38.3	40.3
	Pre-hypertensive	60.0	41.9	40.0	57.1	36.4	30.0	36.8	50.0	43.3	44.5
	Hypertensive	10.0	9.7	6.7	10.7	27.3	26.7	28.9	13.3	18.3	15.1
Bhumij	Normotensive	53.6	75.0	46.4	33.3	37.9	36.7	32.3	13.3	42.2	40.2
	Pre-hypertensive	32.1	15.6	28.6	46.7	34.5	43.3	25.8	30.0	30.2	33.6
	Hypertensive	14.3	9.4	25.0	20.0	27.6	20.0	41.9	56.7	27.6	26.2
Bathudi	Normotensive	50.0	32.3	50.0	33.3	48.1	30.0	26.7	23.3	43.7	29.8
	Pre-hypertensive	40.0	54.8	46.9	43.3	29.6	16.7	43.3	30.0	40.3	36.4
	Hypertensive	10.0	12.9	3.1	23.3	22.2	53.3	30.0	46.7	16.0	33.9
Gujarat Dhodia	Normotensive	40.0	43.3	37.5	60.0	30.3	23.3	38.5	20.0	36.4	36.7
	Pre-hypertensive	50.0	46.7	40.6	26.7	36.4	40.0	26.9	46.7	38.8	40.0
	Hypertensive	10.0	10.0	21.9	13.3	33.3	36.7	34.6	33.3	24.8	23.3
Kukna	Normotensive	43.8	53.3	40.0	46.7	42.9	36.7	23.3	10.0	23.3	36.7
	Pre-hypertensive	40.6	36.7	46.7	46.7	25.0	36.7	30.0	56.7	30.0	44.2
	Hypertensive	15.6	10.0	13.3	6.7	32.1	26.7	46.7	33.3	46.7	19.2
Chaudhari	Normotensive	45.2	66.7	55.2	63.3	46.7	48.4	23.3	26.7	42.5	51.2
	Pre-hypertensive	38.7	33.3	37.9	33.3	46.7	32.3	33.3	30.0	39.2	32.2
	Hypertensive	16.1	0.0	6.9	3.3	6.7	19.4	43.3	43.3	18.3	16.5
Total	Normotensive	46.7	60.9	47.2	49.8	40.6	38.4	30.5	18.8	41.3	42.1
	Pre-hypertensive	43.4	33.0	41.7	37.9	34.8	31.4	35.7	37.6	39.0	35.0
	Hypertensive	9.9	6.1	11.1	12.3	24.6	30.3	33.8	43.5	19.7	22.9

TABLE 3: Age (years) and sex wise prevalence (%) of normal bp, prehypertensive and hypertensive diastolic blood pressure (mmhg) among the tribes.

Diastolic Blood Pressure (mmHg) (%)											
Names of the tribes	**Blood Pressure variables**	**Age group (years)**								**Total**	
		20–29		**30–39**		**40–49**		**50+**			
		M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
West Bengal Santal	Normotensive	69.7	65.6	40.0	75.0	50.0	66.7	53.3	26.7	53.7	55.8
	Prehypertensive	21.2	25.0	46.7	32.1	33.3	16.7	26.7	33.3	31.7	25.8
	Hypertensive	9.1	21.9	13.3	0.0	16.7	16.7	20.0	40.0	14.6	18.3
Kora	Normotensive	72.4	83.3	63.3	58.1	33.3	63.3	46.4	30.0	54.4	58.7
	Pre-hypertensive	20.7	13.3	36.7	22.6	48.1	16.7	28.6	30.0	33.3	20.7
	Hypertensive	6.7	3.3	0.0	19.4	18.5	20.0	25.0	40.0	12.3	20.7
Oraon	Normotensive	69.0	66.7	60.0	50.0	46.7	33.3	47.8	16.1	56.3	41.9
	Pre-hypertensive	24.1	18.2	26.7	33.3	30.0	10.0	34.8	35.5	28.6	24.2
	Hypertensive	6.9	15.2	13.3	16.7	23.3	56.7	17.4	48.4	15.2	33.9
Odisha Santal	Normotensive	76.7	51.6	66.7	50.0	59.1	40.0	60.5	50.0	65.8	47.9
	Pre-hypertensive	20.0	25.8	23.3	28.6	27.3	26.7	15.8	26.7	20.8	26.9
	Hypertensive	3.3	22.6	10.0	21.4	13.6	33.3	23.7	23.3	13.3	25.2
Bhumij	Normotensive	85.7	62.5	64.3	46.7	55.2	40.0	58.1	26.7	65.5	44.3
	Pre-hypertensive	10.7	21.9	14.3	33.3	27.6	20.0	25.8	36.7	19.8	27.9
	Hypertensive	3.6	15.6	21.4	20.0	17.2	40.0	16.1	36.7	14.7	27.9
Bathudi	Normotensive	76.7	38.7	81.3	36.7	77.8	26.7	56.7	36.7	74.0	34.7
	Pre-hypertensive	3.3	38.7	9.4	50.0	14.8	20.0	26.7	40.0	15.1	37.2
	Hypertensive	6.7	22.6	9.4	13.3	7.4	53.3	16.7	23.3	10.9	28.1
Gujarat Dhodia	Normotensive	70.0	60.0	53.1	70.0	45.5	40.0	65.4	30.0	57.9	50.0
	Pre-hypertensive	13.3	33.3	18.8	13.3	30.3	36.7	11.5	43.3	19.0	31.7
	Hypertensive	16.7	6.7	28.1	16.7	24.2	23.3	23.3	26.7	23.1	18.3
Kukna	Normotensive	75.0	53.3	53.3	60.0	46.4	60.0	53.3	33.3	57.5	51.7
	Pre-hypertensive	15.6	43.3	26.7	30.0	32.1	26.7	30.0	33.3	25.8	33.3
	Hypertensive	9.4	3.3	20.0	10.0	21.4	13.3	16.7	33.3	16.7	15.0
Chaudhari	Normotensive	77.4	63.3	72.4	50.0	73.3	54.8	46.7	46.7	67.5	53.7
	Pre-hypertensive	19.4	23.3	24.1	43.3	26.7	25.8	43.3	33.3	28.3	31.4
	Hypertensive	3.2	13.3	3.4	6.7	0.0	19.4	10.0	20.0	4.17	14.9
Total	Normotensive	74.6	60.6	61.6	54.6	53.9	47.2	54.5	32.8	61.4	48.9
	Pre-hypertensive	2.6	26.9	25.1	31.6	30.1	22.1	26.7	34.7	24.7	28.8
	Hypertensive	1.1	12.5	13.3	13.8	16.0	30.6	18.8	32.5	13.9	22.3

The classification of the age groups in to five age cohorts (20–29 years, 30–34 years, 35–44 years, 45–54 years and 55+ years), shows the cardiovascular health of young individuals in 20–34 age segment as normal, on average; individuals in the age group of 35 years and above show consistent increase in SBP and DBP. It can also be seen that individuals in the age group of 45 years and above age cohort are prehypertensive with respect to SBP.

Table 2 represents the prevalence of normal, prehypertensive and hypertensive SBP among the males and females in nine tribes in four age groups. On an average, the prevalence of pre-hypertension is high among the males while hypertension rate prevails at a higher rate among the females across all the tribes and age groups.

Few observations reporting SBP among the women were of high concerns. Most importantly, though a major portion of women are normotensive during their two early age group cohorts, such a trend significantly changes among them while moving towards the two late age groups. Further, though the pre-hypertensive trait is less prevalent among women in comparison to men, such a status does not contribute to CVD health of women when hypertension is considered. Particularly, tribes like Oraon and Bathudi show a consistent trend of increased prevalence of isolated hypertensive SBP. Except for Santals of Odisha, one third of the females among all other tribes in the age group of 50 years and above are suffering from isolated systolic hypertension, out of which 4 tribes show such prevalence with more than 50.0%.

Table 3 represents the prevalence of normotensive, pre-hypertensive and hypertensive DBP among the males and females in nine tribes in four age groups. The trend of DBP shows a similar pattern like SBP. On an average, the prevalence of prehypertension is higher among the males while hypertension rate prevails at a much higher rate among the females in most of the age groups in all the tribes.

Table 4 presents the prevalence of blood pressure (SBP/DBP) categories such as normotension, pre-hypertension, High Risk Isolated Hypertension (HRIH) and hypertension among the males and females in the nine tribes across the four age groups. The trend in blood pressure prevalence shows a similar pattern like SBP. On an average, the prevalence of pre-hypertension is higher among the males while hypertension rate prevails at a higher rate among the females in all the tribes across most of the age groups.

TABLE 4: Age (years) and sex wise prevalence (%) of normal bp, prehypertension and hypertension among the tribes.

Blood pressure (mmHg) (%)											
Names of the tribes	**Blood Pressure variables**	**Age group (years)**								**Total**	
		20–29		**30–39**		**40–49**		**50+**			
		M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
West Bengal Santal	Normotensive	75.8	78.1	50.0	96.4	53.3	73.3	56.7	30.0	59.4	68.0
	Prehypertensive	15.2	12.5	36.7	10.0	16.7	10.0	20.0	20.0	22.0	13.1
	Hypertensive	3.0	0.0	6.7	0.0	10.0	16.7	20.0	40.0	9.8	13.9
	HRIH	6.1	9.4	6.7	0.0	20.0	0.0	3.3	10.0	8.9	4.9
Kora	Normotensive	75.9	86.7	76.7	67.7	51.9	66.7	53.6	40.0	64.9	65.3
	Pre-hypertensive	20.7	10.0	16.7	9.7	14.8	10.0	14.3	3.3	16.7	8.3
	Hypertensive	0.0	0.0	0.0	9.7	11.1	16.7	17.9	30.0	7.0	14.1
	HRIH	3.4	3.3	6.7	12.9	22.2	6.7	14.3	26.7	11.4	12.4
Oraon	Normotensive	72.4	81.8	66.7	70.0	53.3	36.7	56.5	16.1	62.5	51.6
	Pre-hypertensive	17.2	6.1	20.0	13.3	20.0	3.3	26.1	22.6	20.5	11.3
	Hypertensive	3.4	3.0	6.7	16.7	13.3	40.0	13.0	35.5	8.9	23.4
	HRIH	6.9	9.1	6.7	0.0	13.3	20.0	4.3	25.8	8.0	13.7

TABLE 4: Continued.

Blood pressure (mmHg) (%)											
Names of the tribes	**Blood Pressure variables**	**Age group (years)**								**Total**	
		20–29		**30–39**		**40–49**		**50+**			
		M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
Odisha Santal	Normotensive	80.0	61.3	76.7	53.6	63.6	60.0	60.5	56.7	70.0	58.0
	Pre-hypertensive	13.3	12.9	13.3	21.4	9.1	13.3	10.5	16.7	11.7	16.0
	Hypertensive	0.0	3.2	6.7	7.1	13.6	20.0	21.1	3.3	10.8	8.4
	HRIH	6.7	22.6	3.3	17.9	13.6	6.7	7.9	23.3	7.5	17.6
Bhumij	Normotensive	85.7	81.3	71.4	56.7	55.2	46.7	58.1	30.0	67.2	54.1
	Pre-hypertensive	7.1	3.1	7.1	13.3	20.7	16.7	6.5	13.3	10.3	11.5
	Hypertensive	3.6	9.4	14.3	6.7	17.2	20.0	16.1	30.0	12.9	16.4
	HRIH	3.6	6.3	7.1	23.3	6.9	16.7	19.4	26.7	9.5	18.0
Bathudi	Normotensive	80.0	48.4	81.3	46.7	77.8	33.3	60.0	40.0	74.8	42.1
	Pre-hypertensive	6.7	25.8	9.4	33.3	3.7	6.7	20.0	20.0	10.1	21.5
	Hypertensive	0.0	3.2	3.1	13.3	3.7	43.3	13.3	16.7	5.0	19.0
	HRIH	13.3	22.6	6.3	6.7	14.8	16.7	6.7	23.3	10.1	17.4
Gujarat Dhodia	Normotensive	73.3	66.7	53.1	80.0	45.5	46.7	65.4	40.0	58.7	58.3
	Pre-hypertensive	13.3	23.3	9.4	3.3	12.1	26.7	3.8	23.3	9.9	19.2
	Hypertensive	3.3	6.7	9.4	6.7	15.2	23.3	23.1	20.0	12.4	14.2
	HRIH	10.0	3.3	28.1	10.0	27.3	3.3	7.7	16.7	19	8.3
Kukna	Normotensive	75.0	66.7	60.0	66.7	50.0	63.3	53.3	36.7	60.0	58.3
	Pre-hypertensive	15.6	23.3	20.0	20.0	17.9	16.7	10.0	26.7	15.8	21.7
	Hypertensive	6.3	3.3	13.3	0.0	21.4	10.0	13.3	23.3	13.3	9.2
	HRIH	3.1	6.7	6.7	13.3	10.7	10.0	23.3	13.3	10.8	10.8
Chaudhari	Normotensive	80.6	80.0	75.9	70.0	73.3	64.5	50.0	50.0	70.0	66.1
	Pre-hypertensive	9.7	13.3	20.7	23.3	20.0	12.9	10.0	20.0	15.0	17.4
	Hypertensive	3.2	0.0	3.4	3.3	0.0	12.9	6.7	20.0	3.3	9.1
	HRIH	6.5	6.7	0.0	3.3	6.7	9.7	33.3	10.0	11.7	7.4
Total	Normotensive	77.6	72.4	67.9	66.9	57.8	54.6	57.1	37.6	65.3	58.0
	Pre-hypertensive	13.2	14.3	17.0	16.4	15.2	12.9	13.2	18.5	14.7	15.5
	Hypertensive	2.6	3.2	7.0	7.1	11.7	22.5	16.2	24.4	9.3	14.2
	HRIH	6.6	10.0	8.1	9.7	15.2	10.0	13.5	19.6	10.8	12.3

The risk of hypertension among younger population groups (<30 years) in both males and females is observed to be less than 4% among all the tribes except for the Dhodia, Kukna and Bhumij tribes where the prevalence was found to be more than 5.0%. However, with the increase in age, this prevalence rate among females was observed to be higher than males in most of the age groups.

We calculated the HRIH by considering the individuals with hypertensive SBP and pre-hypertensive

DBP condition. High Risk Isolated Hypertension shows a typical trend in various age categories. High Risk Isolated Hypertension exhibit a higher prevalence rate among females in seven of the nine tribes in 20–29 years age group; six of the nine tribes in 30–39 years age group and seven of the nine tribes in the age group 50 years and above. However, females in five of the nine tribes show a lower prevalence rate in 40–49 age groups. Overall, High Risk Isolated Hypertension is observed to be a persistent risk among women.

Table 5 represents the tribe wise distribution of normal, risk and hypertensive individuals in SBP, DBP and BP categories. The prevalence of High Risk Systolic Prehypertension was observed to vary between 29.0 and 44.0% among the various tribes while the prevalence of Isolate Systolic Hypertension ranged between 16.0 and 27.0%.

The prevalence of Isolate Diastolic Prehypertension was observed to be low, varying between 23.0 and 30.0% among the tribes while the prevalence of Isolate Diastolic Hypertension ranged between 9.0 and 25.0%.

Prehypertension was found to vary between 11.0 and 19.0% and hypertension between 6.0 and 17.0%. Furthermore, the High Risk Isolated Hypertension was found to vary between 9.0 and 14.0% (excluding Santals of West Bengal and Odisha).

Table 6 represents the age group wise distribution of normal, risk and hypertensive individuals in SBP, DBP and BP categories. Prehypertension status with respect to SBP, DBP and BP in various age groups shows an inconsistent trend. With respect to the increase in age.

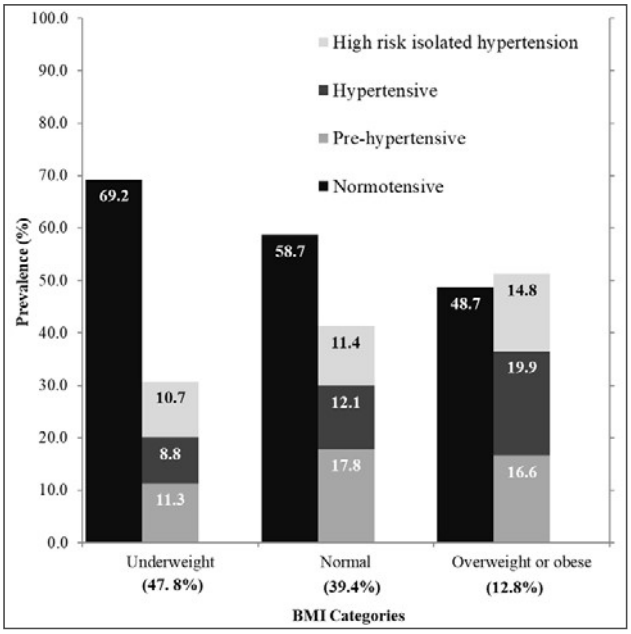

FIGURE 7: Distribution (%) of normal, prehypertension, high risk and hypertension categories among the underweight, normal and overweight and/or obese bmi categories.

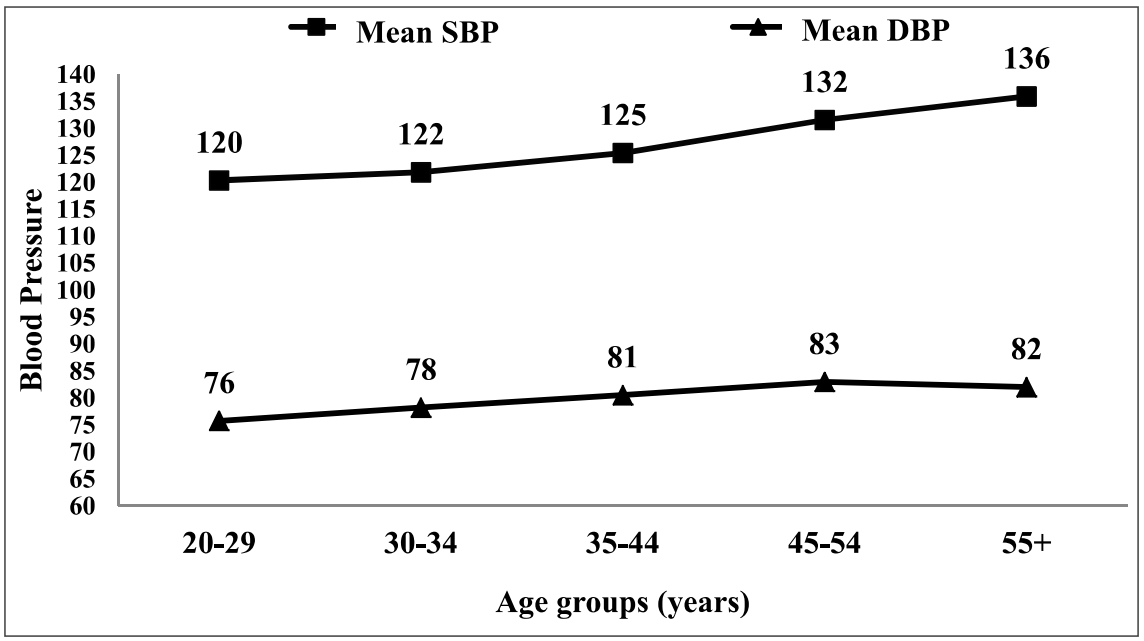

FIGURE 6: Age group wise distribution of mean sbp and dbp (sex combined).

TABLE 5: Tribe wise distribution (%) of normal, risks and hypertensive individuals in various blood pressure (mmhg) categories.

Names of the tribes	Normotensive	Pre-hypertensive	Hypertensive	High Risk Isolated Hypertension
Systolic Blood Pressure (mmHg)				
Santal (WB)	47.3	33.7	18.9	-
Kora	51.5	28.9	19.6	-
Oraon	39.4	39.0	21.6	-
Santal (Odisha)	39.3	43.9	16.7	-
Bhumij	41.2	31.9	26.9	-
Bathudi	36.7	38.3	25.0	-
Dhudia (Gujarat)	36.5	39.4	24.1	-
Kukna	37.1	40.0	22.9	-
Chaudhari	46.9	35.7	17.4	-
Total	41.7	36.9	21.3	-
Diastolic Blood Pressure (mmHg)				
Santal (WB)	54.7	28.8	16.5	-
Kora	56.6	26.8	16.6	-
Oraon	48.7	26.3	25.0	-
Santal (Odisha)	56.9	23.8	19.2	-
Bhumij	54.6	23.9	21.4	-
Bathudi	54.2	26.3	19.6	-
Dhudia (Gujarat)	53.9	25.3	20.7	-
Kukna	54.6	29.6	15.8	-
Chaudhari	60.6	29.9	9.5	-
Total	55.1	26.8	18.1	-
Blood pressure (mmHg)				
Santal (WB)	63.7	17.6	11.8	6.9
Kora	65.1	12.3	10.6	11.9
Oraon	56.8	15.7	16.5	11.0
Santal (Odisha)	64.0	13.8	9.6	4.0
Bhumij	60.5	10.9	14.7	13.9
Bathudi	58.3	15.8	12.1	13.8
Dhudia (Gujarat)	58.5	14.5	13.3	13.7
Kukna	59.2	18.8	11.3	10.8
Chaudhari	68.0	16.2	6.2	9.5
Total	61.6	15.1	11.8	11.6

TABLE 6: Age group (years) wise distribution (%) of normal, risks and hypertensive individuals in blood pressure (mmhg) categories.

Age groups (years)	Normotensive	Pre-hypertensive	Hypertensive	Normotensive	Pre-hypertensive	Hypertensive	Normotensive	Pre-hypertensive	Hypertensive	High Risk Isolated Hypertension
	Systolic Blood Pressure			Diastolic Blood Pressure			Blood Pressure			
20–29	53.9	38.1	8.0	67.7	22.1	10.2	75.0	13.8	2.9	8.3
30–39	48.5	39.8	11.7	58.1	28.3	13.5	67.4	16.7	7.0	8.9
40–49	39.5	33.0	27.5	50.5	26.0	23.5	56.2	14.0	17.3	12.5
50+	24.6	36.7	38.7	43.6	30.7	25.7	47.3	15.8	20.3	16.6

On the other hand, hypertensive status in SBP, DBP and BP demonstrates a clear trend of increase with age. There are two types of trends in prevalence rate observed within the four age groups. It is most striking to find that the rate of increase in prevalence of hypertension in the age groups of 20–29 and 30–39 years is steady, but it takes a double or more percentage points jump while entering into 40–49 years age group. Further, this rate of increase slows down to the next age group.

Figure 7 exhibits the distribution of normotensive, prehypertensive and hypertensive among the underweight, normal and overweight and/or obese categories. There are two striking features observable from the figure; firstly, the individuals in underweight category demonstrate a 8.8% hypertension prevalence with another 10.7% at very high risk along with 11.3% in pre-hypertensive states; secondly, individuals in the normal weight category also show an increased prevalence in hypertension (12.1%) prehypertension (17.8%) and High Risk Isolated Hypertension (11.4%). It is also important to note that in the overweight/obese category, the percentage of total individuals in the categories of High Risk Isolated Hypertension (14.8%), prehypertensive (16.6%) and hypertensive (19.9%) is higher than the normal individuals. A high prevalence of prehypertension among normal population group is another cause of concern.

DISCUSSION

Hypertension is increasingly becoming a major physio-metabolic health problem among Indian tribes. Increased prevalence of prehypertension and High Risk Isolated Hypertension are additional causes of concern.

The differential cardiovascular risk status on the basis of gender and age explains the epidemiological status and transition of non-communicable disease among these indigenous population groups.

The meta-analysis on hypertension prevalence among Indian tribes (Rizwan *et al.* 2014) finds no sex difference in hypertension prevalence rate. Studies have found women at higher risk (Amoah 2003, Cappuccio *et al.* 2004) while other studies including from India argued the lowered risk among women (Gupta, Kapoor 2010, De Munter *et al.* 2011, Hathur *et al.* 2013). The NNMB report demonstrates a marginal low prevalence among tribal women (25.0% among men and 23.0% among women). The present findings exhibit women with higher rate of prevalence of hypertension along with an elevated risk for hypertension (higher percentage of prehypertensive women).

Women with increased prevalence of undernutrition along with a higher prevalence rate of hypertension were the most vulnerable as observed in the present study. Majority of females in their young age showed a normotensive SBP in comparison to their male counterparts while this trend reversed with the increase in age. It indicates the vulnerability of elderly women towards increased risk of cardiovascular diseases. Schall (1995) demonstrated the profound role of age among women in comparison to their male counterparts while considering the cardiovascular health status (Schall 1995). This study has reported elevated and wider range of hypertension among men and women in elderly age group, putting women at higher risk; such risk was more

than double in traditional tribes than modernized ones while the prevalence rate of hypertension in traditional society is less than the modern societies. Further, in his meta-analysis on hypertension, he showed tribal women in traditional society were at marginally higher risk than men while men were distinctly at higher risk than women in modernized tribes; the prevalence rate was more than double both among men and women in the modernized tribes in comparison to the traditional groups. In the studied tribal women context, ageing is a risk factor for undernutrition, particularly for acute form along with the manifold risk of hypertension. So, the vulnerability of elderly women is extremely high.

The observations from the present findings, highlighting the increased prevalence of nutritional morbidity status among women in young age indicates their possible progression to compromised immunity in later period of life. This might possibly be playing the role of one of the strong confounding factors in growing age and prior to menopause in certain cases, towards early progression to hypertension and increased risk of cardiovascular diseases among them in comparison to their male counterparts. Bathudi females presented an inquisitive case as they were the group that was found to suffer the worst of all in the nine tribes in terms of nutritional security by presenting the lowest average BMI- a status below the range of normal category (*Table 1*). At the same time, the trend of hypertension prevalence and such risks among the female Bathudis demonstrated a tendency which is opposite to the average trend observed among the women of other tribal groups; younger women are less affected by hypertension in other tribes. It is observable from the Table 2 that Bathudi females are under the risk of CVDs both in young age as well as in the later phase of life. It further highlights the possible association of prolonged suffering from high rate of undernutrition with risks of hypertension.

Systolic Blood Pressure has been considered as a stronger predictor of CVD related morbidity and mortality over DBP (Wiggers 1932, Stamler *et al.* 1993, Lewington *et al.* 2002). The present findings show increase in SBP with the increase of age, which correlates to a similar finding by another study (Schillaci *et al.* 2009), indicating the stiffening of arteries caused by ageing. DBP rises up to approximately 50 years which along with aging, starts falling by 60 years of age (Burt *et al.* 1996). In the present study, such a fall in DBP started at an early age, by 45 years. Thus, the findings from SBP and DBP demonstrate the initiation of the aging process at an age as early as 45 years among the tribal groups. Further while comparing the SBP of the selected tribes with the 35 year trend of SBP in Indian population (*Figure 2*), it shows a pattern where the average SBP among almost all the tribes observed in the present study is higher than the trend of average SBP of national Indian population during 35 years. It indicates the prevailing higher risk among the Indian tribes.

Furthermore, it is most striking to find that the rate of increase in prevalence of hypertension in the age groups of 20–29 and 30–39 years though is steady; it takes a double or more percentage points jump while entering into 40–49 years age group. Further, this rate of increase in prevalence rate slows down in the next age group. So, it can be said that the post 40 years period caries a higher vulnerability to CVD risks in the Indian tribal population. Additionally, an alarming prevalence of High Risk Isolated Systolic hypertension seems to be have decisive roles if gets converted to hypertension.

A close pattern of mean blood pressure (SBP and DBP) demonstrating the CVD risk status was observed among the three pairs of tribes in each of the three states (Kora and Santal in West Bengal; Bathudi and Bhumij in Odisha; Kukna and Dhodia in Gujarat) as compared to the remaining three individual tribes (Oraon in West Bengal; Santal in Odisha and Chaudhari in Gujarat). It is here noteworthy that the habitation of such paired tribes was in close proximity to each other that indicates the geographical closeness and possible similar life style practices among them.

The findings of the present study become important because there is only few sporadic reporting (Hathur *et al.* 2013) on prehypertension among Indian tribes. Moreover, the present study, as per our knowledge, is the first large scale report on prehypertension status among tribes of India. Findings from Framingham, JNC-7 and MCS India study have identified prehypertension as an independent CVD risk factor (Vasan *et al.* 2001, Chobanian *et al.* 2003, Pednekar *et al.* 2009). Framingham study finds prehypertension causing mortality among men and women at 1.6 and 2.5 HR (hazard ratio) (Vasan *et al.* 2001). It was observed in the present study that there was a 15.1% (*Table 5*) prevalence of pre-hypertension in the pooled population with 14.7% and 15.5% (*Table 4*) among men and women respectively. Age group wise analysis of blood pressure categories show that the prevalence of prehypertension in the age group below 40 years is much higher in SBP in comparison to DBP and BP categories in the corresponding age group.

The age group wise distribution of hypertension (in SBP, DBP and BP categories) shows a sudden leap in prevalence while transiting to the 40–49 years age group

and above. The frequency of prehypertensive individuals in the age group of 30–39 years in the SBP, DBP and BP categories was found to be 39.8%, 28.3% and 16.7% respectively, which was very high across all the four age groups (*Table 6*). This possibly contributed to a sudden increase in the prevalence percentage of hypertensive individuals in the 40–49 years age group in SBP, DBP and BP categories with prevalence rates at 27.5%, 23.5% and 17.3% respectively which is much higher than the corresponding figures of hypertension in the preceding age group of 30–39 years for SBP, DBP and BP categories. Thus, this physio-metabolic transition from a younger period of life (30–39 years age group) to older age (40–49 years age group) explains a significant shift in the cardio-metabolic health status among the Indian tribes.

High Risk Isolated Hypertension (HRIH) has been observed to carry similar adverse prognosis like hypertension (Lloyd-Jones and Levy 2007, Pednekar *et al.* 2009). Considering more than 10.0% prevalence rate of High Risk Isolated Hypertension among 7 of the 9 tribes, the percentage of individual at risk (Hypertension + HRIH) jumps to more than 20.0% among all the tribes (*Table 5*). Age group wise difference shows that the prevalence rate took a shoot with beginning of 40–49 years age group which further explains the increase of vulnerability by the starting of 40–49 years of age.

The benefits of development in various sectors leading to income generation have resulted in a significant amount of mainstreaming of Indian tribes (Behura 1995, Deshingkar, Start 2003, Deshingkar, Grimm 2004, Deshingkar 2005). A number of tribal groups are capitalizing on economic opportunities that are available to them, with a desire to acquiring a better life style with modern life comforts (Rogaly *et al.* 2002, Dayal, Karan 2003, Karan 2003). Urbanization and modernity consistently lead to rise in prevalence of prehypertension and hypertension; the key causative factors are population growth, ageing and behavioral risk factors, such as falling physical activity, weight gain, persistent stress, changing lifestyle, unhealthy diet and harmful use of alcohol (WHO 2013). Our study generated the finding highlighting an increased preference for foreign and country made alcohol among the tribes against their traditional ones. Furthermore, their increasing access to urban areas is catalyzing their choices driving towards urban life style patterns. Other socio-cultural practices like community dance, traditional singing are fast being replaced with video shows, music album and film songs. Thus, such a rapidly emerging trend among the tribal groups demonstrate the changing status of their life style that is making them vulnerable to acquire hypertension, prehypertension and such CVD related mortality and morbidity risks.

Hawkes (2006) demonstrated that the globalization-driven nutritional transition has brought significant changes in food habits. Such changes have further deepened the status of nutritional inequality among the rich and poor; the poor are the worst affected by a cultural convergence towards low quality diets (such as inexpensive vegetable oil and trans-fat) (Hawkes 2006). Such a state of life style is a major cause behind the increasing CVD risk in poor nutritional conditions among the Indian tribes. Furthermore, their shrinking food basket and high dependence on supplied processed food under various schemes of state and central governments has severely hampered their food sovereignty. National Nutrition Monitoring Bureau (NNMB 2009) showed a rise in intake of fats, oils, sugar at overall level in the tribal population with a comparatively higher consumption by the women along with a fall in intake of vegetables. Explaining the nutrient intake trend of Indian tribes in last 20 years, it highlights a fall among both males and females in intake of nutrient components including protein, calcium, vitamin A and iron in comparison to previous decades. The report suggests an essential 'food gap' among the Indian tribes due to the highly pronounced dietary energy and protein inadequacy. The report concluded its finding with the observation that increasing access to development has led to an improvement, though marginal in the nutritional status, despite a well visible decline in the food and nutrient intake. Further on the dietary front, other studies have reported excess intake of salt as an important associated factor of increasing prevalence of hypertension at international (Hollenberg *et al.* 1996, Neal *et al.* 2007, Ha 2014) as well as Indian tribal (Gupta *et al.* 2012, Meshram *et al.* 2012) and general population context (Vimala *et al.* 2009). Studies in metabolic risk factors like Cholesterol, HDL, LDL, Blood sugar, Triglyceride are almost unexplored in Indian tribal context. It is here noteworthy that in Asia-Pacific regions, the hazards of higher blood pressure are being experienced at all levels of metabolic risks while the hazards of metabolic risks in western countries are being experienced at all levels of blood pressure (APCSC 2005).

Therefore, providing mere nutritional literacy or dietary information or accessibility is not sufficient for better nutrition; a better food policy is required to improve the affordability of this economically deprived section to enhance their access to better quality of foods (Harris-Fry *et al.* 2015).

The NNMB-2009 report (NNMB 2009) demonstrated that 44.0% tribal men and 38.0% tribal women have heard about the hypertension, while only 8.4% adult population were aware of the disease. Low level of ignorance was also observed in other studies (Laxmaiah *et al.* 2015). So, it is necessary to increase the awareness regarding the etiology of the elevated blood pressure level. Studies in hypertension among Indian tribes was very scanty till the early years of 21st century which, though has taken certain pace in recent years, is still inadequate from policy framing point of view.

It is thus imperative that any epidemiological condition needs a consistent and extensive tracking for timely and successful intervention. Non-communicable diseases, particularly those diseases involving changing lifestyle and dietary practices, such as hypertension, CVDs, obesity need much intensive and longitudinal observation. Vague traditional wisdoms arguing tribes being away from life style diseases are still prevalent which need to be dispelled. Strengthening disease surveillance system in tribal inhabited areas is highly warranted. Hypertension being a major attributing factor towards causation of up to two third CVD incidences, underscores the immediate need of strategies to address the issue of elevated level of blood pressure (Martiniuk *et al.* 2007).

The present study has brought out several important findings along with the prevalence of hypertension risk among the tribal population in general and the tribal women in particular. The situation became more alarming when it is found that nearly 9.0% of underweight tribal individuals show hypertension (*Figure 7*). Moreover, a high prevalence of prehypertension among the individuals classified as normal by BMI (*Figure 7*) is of great concern. It is therefore, desirable that the physio-metabolic risk factors afflicting tribal groups of India should be screened immediately for timely and successful intervention before it is too late.

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