Indian Heart Journal 72 (2020) 398–402

Contents lists available at ScienceDirect

Indian Heart Journal

journal homepage: www.elsevier.com/locate/ihj

Original Article

Distribution of hypertension subtypes in a hill tribe of Mizoram, Northeast India

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ARTICLE INFO

Article history:
Received 6 May 2020
Accepted 3 August 2020
Available online 9 August 2020

Keywords:
Blood pressure
IDH
ISH
SDH and Mizoram

ABSTRACT

Objective: Hypertension is a potential risk factor for cardiovascular diseases. With increasing age there is differential rise of systolic and diastolic blood pressure leading to development of various hypertension subtypes which have its own clinical implications. Present study assessed distribution and risk factors of hypertensive subtypes in the hill tribe of Mizoram.

Methods: The present study was a community-based cross-sectional study carried out in Aizawl, Mizoram representing both rural (fourteen villages) and urban (six wards) population and which were selected by PPS method. Individuals aged 18 years and above providing informed verbal consent were included for collection of sociodemographic and clinical data including blood pressure. Of the total 12,313 subjects (Urban: 5853, Rural: 6460) & (Male: 5459, Female: 6854) surveyed, 549 hypertensive subjects who were under antihypertensive treatment were excluded. Hypertension subtype was defined as per standard guidelines.

Results: Out of 11,764 study individuals, 88.03% (CI: 87.43–88.61) were normotensive and 11.97% (CI: 11.39–12.57) individuals were hypertensive. Prevalence of ISH, IDH and SDH were 241(2.05%), 403 (3.43%) and 764 (6.49%) respectively. Older age, unmarried participants, physical inactivity and obesity are found to be associated with ISH. Male gender, older age, higher educational status, physical inactivity, consumption of extra salt, alcohol consumption, use of *tuibur* and high BMI were significantly associated with SDH.

Conclusions: The overall prevalence of hypertension with its subtypes specifically isolated systolic hypertension are low in this hill tribe of Mizoram. It is the right time for initiating intervention programme to modify the risk factors associated with hypertension.

1. Introduction

Hypertension (HTN) is one of the major risk factors for cardiovascular diseases (CVDs) and established as a global health burden.[1] It affects around one billion populations worldwide including 29.2% males and 24.8% females.[2,3] The paradigm for HTN prevalence has been shifted to developing and under developed countries from developed countries due to rapid economic transition, urbanization and lack of preventive strategies. In 2004, 7.5 million deaths (12.8% out of all death) have been attributed to high blood pressure alone.[2,4] Studies from Southeast Asia and India reveal that HTN occurs at younger age which is associated with major cardiovascular disorders.[5] In India, it is becoming a global hub with estimated 26.6% and 24.7% for man and woman respectively in 2014.[6] According to Global Burden of Disease study, India bears 1.63 million deaths in 2016 due to hypertension which is nearly double than in 1990 (0.78 million).[7] Rapid urbanization, lifestyle modifications and social development are the main reasons for high incidence of hypertension in India.[7] Study conducted by ICMR as May Measurement Month in 2017 considered hypertension as a silent killer and campaigned for a global awareness.[8]

Different ethnic groups of NE India including Mizo also revealed a rapid rise in hypertension prevalence during recent decades.[9–12] Increasing age has differential impact on systolic and diastolic blood pressure (SBP and DBP) leading to various hypertension subtypes with distinct clinical significance.[13] Mizo tribe has a low (15.9%) prevalence of HTN (as per JNC VII classification) but there is no data regarding distribution and risk factors associated with

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https://doi.org/10.1016/j.ihj.2020.08.003

hypertension subtypes.[12] The present study aimed to assess these information in Mizos from Mizoram, NE India.

2. Materials and methods

2.1. Ethics statement

Ethical clearance for the study was obtained from institutional ethics committee of ICMR-Regional Medical Research Centre, NE Region, Dibrugarh and was conducted according to the standards of the Declaration of Helsinki. Before collecting relevant socio-demographic and clinical data, informed consent was obtained from study participant.

2.2. Study design and setting

A community-based cross-sectional study was conducted in Aizawl district of Mizoram. We used probability proportional to size (PPS) for sampling. Populations from both rural and urban areas were included. The methodological details are published elsewhere.[12] Briefly, the sampling units were villages (for the rural areas) and wards (for the urban areas). For rural sampling, the approach consisted of randomly selecting a rural block, listing and stratifying all the villages of that block according to their population size (*viz.* 500–1000, 1000–1500, etc.), and identifying 14 villages from the list by PPS. For urban sampling, 6 out of 69 wards were identified by PPS technique. Households were selected from the identified villages/wards using systematic random sampling. Subsequently, individuals in those households aged ≥18 years who provided informed consent for the study were enrolled. A total of number of 12,313 participants was enrolled. Of these, 549 hypertensive individuals who were on anti-hypertensive medications were excluded for the current communication. Thus, the final sample consisted of 11,764 participants (rural: 6244, urban: 5520).

2.3. Data collection and anthropometry

The participants were personally interviewed by trained staff. Information regarding cigarette smoking, alcohol use, consumption of extra salt, chewing *Tuibur* (a local tobacco preparation) and physical activity (mild, moderate or severe) were collected in pre-designed and pre-tested questionnaires. Anthropometric measurements namely height and weight were carried out using anthropometric rod (SECA, 13,601 Benson Avenue, CA 91710 Chino USA) and platform balance (SECA) following World Health Organization (WHO) protocol.[14] Body mass index (BMI), expressed as weight (in kg) divided by height (in meter) squared, was used as the index for obesity (normal, overweight, obese and under weight).

2.4. Blood pressure measurement and case definitions

Blood pressure (BP) measurements were performed by project investigators, trained medical officer and staff using mercury sphygmomanometer with appropriate-sized cuff. The first and the fifth Korotkoff sounds were used to record SBP and DBP respectively. Three seated BP readings were taken for all the participants with the arm supported at the level of heart and with feet on the floor after 15 min of resting. For those participants who had eaten, smoked or consumed alcohol, BP measurements were performed after allowing them to rest for 1 h. The mean of the 3 readings were used in the analysis. However, if the difference among the 3 values exceeded 5 mm Hg, then the extreme value was discarded and the mean of the remaining 2 values was used. Hypertension was defined as per Indian guidelines for Hypertension and Joint National Committee (JNC-VII) cut-offs,[15,16] i.e. SBP ≥140 mm Hg and/or DBP ≥90 mm Hg or under antihypertensive medication. HTN subtypes were further identified based on SBP and DBP values: isolated systolic hypertension (ISH): SBP ≥ 140 mm Hg and DBP < 90 mm Hg, isolated diastolic hypertension (IDH): SBP < 140 mm Hg and DBP ≥ 90 mm Hg, and systolic diastolic hypertension (SDH): SBP ≥ 140 mm Hg and DBP ≥ 90 mm Hg.[16,17]

2.5. Data analysis

We used statistical package for social science (SPSS) version 26 for analyzing the data. The continuous variables were depicted as mean ± standard deviation (SD), while the categorical variables were depicted as count (n) with percentage (%). The proportion of various BP subtypes prevalent in the study population was determined along with the corresponding 95% confidence intervals (CIs), calculated by Wilson's method.[18] Comparison of the categorical variables across the different phenotypes was done by chi-squared (χ^2) test. Continuous variables were compared by one-sided analysis of variance (ANOVA), followed by critical difference analysis by post-hoc Tukey test. We have constructed logistic regression model to analyze adjusted odds ratios with 95% confidence interval. A two-sided p-value ≤ 0.05 was considered as cut-off for statistical significance in all analyses.

3. Results

Present study estimated that, out of 11,764 study individuals, 10,356 were normotensive (88.03%; CI: 87.43–88.61) and 1408 individuals were hypertensive (11.97%; CI: 11.39–12.57) (Table 1). Of the hypertensive individuals, prevalence of hypertensive subtypes such as ISH, IDH and SDH were 241(2.05%), 403(3.43%) and 764 (6.49%) respectively (Table 1). Present study also revealed that significantly higher number of male individuals are affected with IDH (62.5%) compared to ISH (44.8%) and SDH (56.7%) (Table 2). Subjects with ISH were significantly older in age than that of other hypertension subtypes. Number of smokers and BMI were significantly higher in subjects with IDH and SDH than ISH group. Both ISH and SDH showed higher prevalence with increase of age of the participants, but prevalence of IDH decreased after sixty years of age (Fig. 1A, B and 1C).

We have also carried out logistic regression analysis to find out the predictors of hypertension subtypes (Table 3). A number of subtype specific covariates were identified. Older age, unmarried participants, physical inactivity and obesity are found to be associated with ISH (Table 3). Significant predictors for IDH were male gender, older age, higher educational status, physical inactivity, alcohol consumption, use of *tuibur* and high BMI (Table 3). Similarly, male gender, increasing age, higher educational status, physical inactivity, consumption of extra salt (salt as a side dish), alcohol consumption and high Body mass index were significantly associated with SDH (Table 3).

Table 1
Distribution of different blood pressure categories in the studied population.

Blood pressure categories	N	Percent (95% CI)
Normotensive Individuals	10,356	88.03 (87.43–88.61)
Hypertensive individuals	1408	11.97 (11.39–12.57)
ISH	241	2.05 (1.81–2.32)
IDH	403	3.43 (3.11–3.77)
SDH	764	6.49 (6.06–6.95)

Abbreviations: CI, confidence interval; BP, blood pressure; ISH, isolated systolic hypertension; IDH, isolated diastolic hypertension; SDH, systolic diastolic hypertension.

Table 2
Summary characteristics of the study subjects and their comparison across the different blood pressure phenotypes.

Variables	Normotensive (n = 10,356)	ISH (n = 241)	IDH (n = 403)	SDH (n = 764)	Chi-squared statistic/F-statistic	p-value
Sex, male	4666 (45.1)	108 (44.8)	252 (62.5)	433 (56.7)	82.36	<0.0001
Age (years)	38.0[a] ± 15.5	52.2[b] ± 21.2	41.3[c] ± 15.6	49.9[b] ± 18.2	192.77	<0.0001
Physical activity					165.18	<0.0001
Light	1539 (14.8)	62 (25.7)	104 (25.8)	198 (25.9)		
Moderate	5809 (56.1)	141 (58.5)	233 (57.8)	439 (57.5)		
Heavy	3008 (29.0)	38 (15.8)	66 (16.4)	127 (16.6)		
Habitation, rural	5610 (89.8)	108 (1.7)	194 (3.1)	332 (5.3)	43.93	<0.0001
Consumption of extra salt, yes	8739 (84.4)	206 (85.5)	332 (82.4)	668 (87.4)	6.68	0.08
Smoking, yes	3952 (38.2)	90 (37.3)	179 (44.4)	329 (43.1)	13.14	0.004
Alcohol consumption, yes	1069 (10.3)	12 (5.0)	61 (15.1)	98 (12.8)	21.69	<0.0001
Chewing *Tuibur*, yes	8904 (86.0)	199 (82.6)	352 (87.3)	596 (78.0)	39.09	<0.0001
Weight (kg)	51.9[a] ± 9.6	51.9[a] ± 11.7	57.7[b] ± 11.5	56.2[b] ± 12.1	85.05	<0.0001
SBP (mmHg)	114.2 ± 10.7[a]	151.5 ± 37.7[b]	127.5 ± 6.3[b]	154.5 ± 16.0[b]	3300.9	<0.0001
DBP (mmHg)	74.4 ± 7.2[a]	79.9 ± 5.5[b]	92.8 ± 11.5[b]	97.0 ± 8.1[b]	2901.0	<0.0001
Height (cm)	155.9[a] ± 9.4	154.0[b] ± 8.3	159.7[c] ± 8.7	156.5[a] ± 9.2	25.83	<0.0001
BMI (kg/m^2)	21.2[a] ± 3.2	21.7[b] ± 3.7	22.5[c] ± 3.7	22.7[c] ± 3.8	78.36	<0.0001

Abbreviations: CI, confidence interval; BP, blood pressure; ISH, isolated systolic hypertension; IDH, isolated diastolic hypertension; SDH, systolic diastolic hypertension; BMI, body mass index.
Values expressed as count (percentage) or mean ± SD. Comparison of the categorical variables across the different blood pressure phenotypes was done by chi-squared (χ^2) test. On the other hand, comparison of the continuous variables was performed by one-sided analysis of variance (ANOVA), followed by critical difference analysis by post-hoc Tukey test. Means with dissimilar superscript are significantly different.

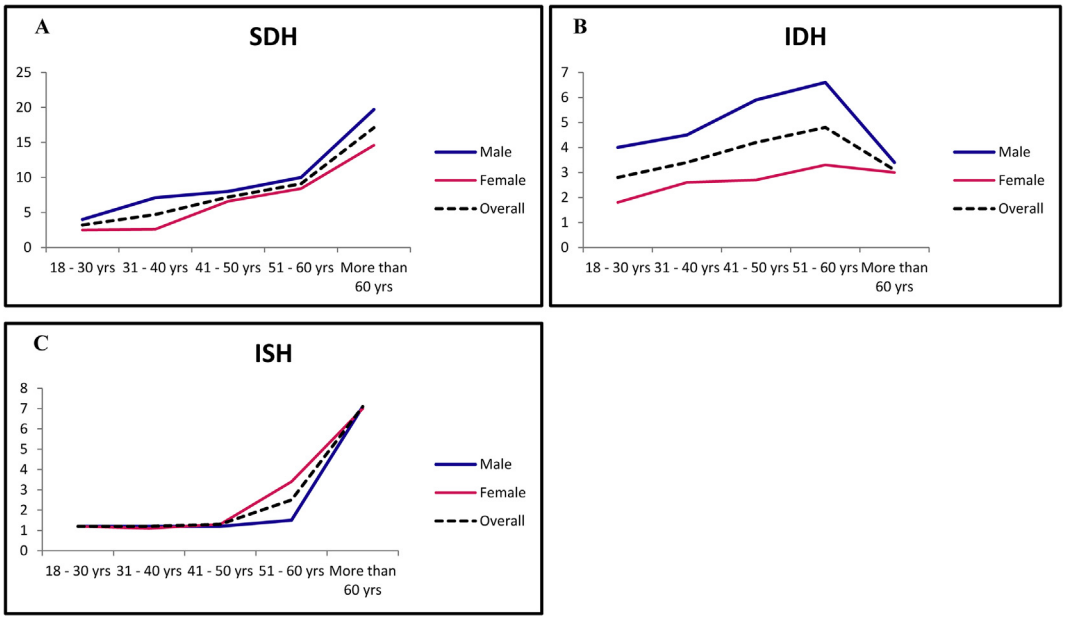

Fig. 1. Distribution of different blood pressure phenotypes with age [A] Distribution of SDH with the age group [B] Distribution of IDH [C] Distribution of ISH.

4. Discussion

High blood pressure is one of the leading risk factor for cardiovascular morbidity and mortality worldwide that kills approximately 9.4 million people annually.[19] Rise of BP with increasing age is a physiological phenomenon due to alteration in arterial and arteriolar stiffness in an individual.[20] Framingham Heart Study postulated that, SBP showed an increasing trend during 30–84 years or more but rise of DBP is limited to the fifth decade of life beyond which there was a gradual decline.[13,21] Such differential rise in SBP and DBP leads to various hypertension subtypes with distinct clinical implications.[22–24] Present communication revealed distribution of hypertension subtypes in a representative hilly tribe from Mizoram, NE India. It was found that prevalence of SDH was highest (6.49%) followed by IDH (3.43%) and ISH (2.05%).

Prevalence of ISH observed in our study was found to be significantly lower than that of earlier studies conducted in different places of the country and in abroad.[25–27] According to 1999–2010 National Health and Nutrition Examination Survey, prevalence of untreated hypertensive adults with ISH was 9.4%, of which 29.4% occurred in the elderly, which were significantly higher in comparison with our findings.[28,29] Differences in geographical distribution of the study population, distinct socio-cultural behaviours with food habits might be the reasons for such differences.[30] Prevalence of ISH showed a linear trend with increase in age, which is an established phenomenon.[31] Prevalence of IDH revealed in our study corroborates with large cross-sectional studies that showed 3.6%–6.2% in the general population.[32] However, our finding was lower in comparison with earlier study conducted in Kanpur, India which was 4.5% with 6.2% in men and 3.1%

Table 3
Independent predictors of hypertension subtypes.

Variables	Category	Adjusted Odds ratio (95% CI), ISH	Adjusted Odds ratio (95% CI), IDH	Adjusted Odds ratio (95% CI), SDH
Sex	Female	Reference	Reference	Reference
	Male	1.01 (0.76–1.36)	1.86[a] (1.47–2.35)	1.32[a] (1.11–1.57)
Age	18–29 years	Reference	Reference	Reference
	30–39 years	1.34 (0.81–2.21)	1.36 (0.98–1.87)	1.64[a] (1.24–2.17)
	40–49 years	1.65 (0.953–2.86)	1.82[a](1.3–2.55)	3.1[a] (2.33–4.13)
	50–59 years	3.44[a] (2.02–5.86)	2.39[a] (1.65–3.45)	4.67[a] (3.43–6.35)
	60 years and above	10.34[a] (6.25–17.09)	1.73[a] (1.12–2.69)	10.08[a] (7.39–13.73)
Educational status	Illiterate	Reference	Reference	Reference
	Up-to middle	0.74 (0.44–1.23)	2.6 (0.95–7.25)	0.87 (0.60–1.26)
	Up to higher secondary	0.83 (0.45–1.5)	3.16[a] (1.13–8.83)	1.12[a] (0.75–1.68)
	Graduate and above	0.86 (0.41–1.83)	3.84[a](1.33–11.11)	1.8[a] (1.14–2.84)
Marital status	Married	Reference	Reference	Reference
	Unmarried	1.92[a] (1.31–2.82)	1.08 (0.82–1.44)	1.27[a] (1.01–1.62)
	Widow/Widower/Separated	1.26 (0.87–1.83)	0.60 (0.38–0.953)	1.19 (0.94–1,51)
Physical activity	Heavy	Reference	Reference	Reference
	Light	1.45 (0.92–2.29)	3.57[a] (2.53–5.05)	2.01[a] (1.54–2.61)
	Moderate	1.51[a] (1.02–2.23)	1.85[a] (1.36–2.51)	1.43[a] (1.14–1.79)
Consumption of extra salt	No	Reference	Reference	Reference
	Yes	1.18 (0.81–1.71)	1.06 (0.81–1.38)	1.52[a] (1.21–1.92)
Smoking	No	Reference	Reference	Reference
	Yes	0.93 (0.69–1.24)	1.13 (0.9–1.42)	0.97 (0.81–1.14)
Alcohol consumption	No	Reference	Reference	Reference
	Yes	0.92 (0.49–1.73)	1.56[a] (1.15–2.17)	2.20[a] (1.69–2.87)
Use of *tuibur*	No	Reference	Reference	Reference
	Yes	0.83 (0.58–1.17)	1.47[a] (1.08–2.02)	0.7 (0.58–0.85)
BMI	Normal	Reference	Reference	Reference
	Overweight	1.43 (0.96–2.13)	1.92[a] (1.47–2.5)	2.03[a] (1.66–2.49)
	Obese	3.21[a] (1.65–6.23)	2.91[a] (1.72–4.92)	3.06[a] (2.08–4.5)
	Underweight	0.96 (0.69–1.35)	0.98 (0.73–1.31)	0.63 (0.49–0.79)

[a] Significant, $p \leq 0.05$.

in women.[33] Our study showed an increasing trend till the age sixty years which was substantiated by earlier study.[32] Increased arterial firmness along with a rise in arteriolar resistance combined the chance of SDH incidence.[23,24,34] Prevalence of SDH found in present study corroborates with earlier findings but significantly lower than that of the studies conducted elsewhere.[35,36]

Hypertension subtypes as a contributor for cardiovascular diseases (CVD) morbidity and mortality are largely under-rated.[36] CVD morbidity, mortality and prognosis depend upon hypertension subtypes.[13] Finn-home study observed higher CVD mortality rate among ISH individuals followed by SDH and IDH.[30,37] Earlier studies revealed that subjects with ISH have a greater risk of death from coronary heart disease (CHD).[38] IDH is a predictor for total mortality related to CVD in middle-aged patients that increased the risk of CVD mortality by 1.7-folds in subjects under 60 years.[36,39] Previous study documented that, IDH (14–24%), was highest and less likely to receive antihypertensive treatment compare to ISH or SDH individuals.[6] Patients with IDH are more likely to develop SDH or ISH, which may increases the risk of stroke, coronary heart disease and end-stage renal disease.[6] In a 31-year follow-up study and among Chinese adult population the adjusted relative risk for CVD mortality was found to be highest among subjects with SDH, followed by IDH and ISH for males.[20,27] Significant association of ISH with older age, physical activity and with BMI observed in present study reflect the results of previous study from Shimla, India.[25] But unlike the Shimla study, we have not found association of ISH and salt consumption but showed significant association with SDH. This maybe because of the fact that, quantification of salt intake is prone to subjective errors.[25,26] The association of ISH with age, smoking, alcohol intake and BMI were similar to the study carried out among Chinese adult population.[40] Association of extra salt (salt as side dish) consumption with SDH warrants initiation of salt restriction intervention program to control hypertension.[41]

Various studied have documented that DBP is elevated by increasing arterial stiffness due to smoking even in younger adults, hence smoking is positively associated with the incidence of IDH.[42,43] Recent findings regarding cardiovascular risk which is mostly associated with DBP until the age of 55, encourage researchers to study about impact of hypertension subtypes on mortality as the same was underestimated.[39] Studies suggested that, controlling of blood pressure to SBP < 140 mmHg and DBP < 90 mmHg decreased the risk of mortality rates among middle aged population.[39] Findings of risk factor analysis of our study substantiate the findings of earlier studies from Asian countries.[19,33,40]

5. Conclusion

The overall prevalence of hypertension with its subtypes is low in this hill tribe of Mizoram. In spite of these, ISH, IDH and SDH may be a silent threat in the population that needs to be addressed by initiating intervention programme to modify the risk factors associated with hypertension and more specifically hypertension subtypes.

What is already known on this subject?

Prevalence of hypertension is low in this hill tribe of Mizoram. Rise of BP with increasing age is a physiological phenomenon due to alteration in arterial and arteriolar stiffness in an individual leading to development of various hypertension subtypes. Different ethnic groups of NE India including Mizo also revealed a rapid rise in hypertension prevalence during recent decades.

What does this study add?

Present communication revealed distribution of hypertension subtypes in a representative hilly population from Mizoram, NE India. Prevalence of SDH was highest (6.49%) followed by IDH (3.43%) and ISH (2.05%). Identification of modifiable risk factors for different hypertension subtypes necessitates undertaking of various intervention strategies to control and prevent hypertension.

Funding acknowledgement

We sincerely acknowledge Indian Council of Medical Research, New Delhi for funding this study.

Conflict of interest

We declare that there are no known conflicts of interest associated with this publication and there has been no financial interest for this work that could have influenced the outcome of the study.

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