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Rural-Urban Differences in Hypertension among the Hmars of Manipur in Northeast India

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ABSTRACT This paper aims to identify the risk factors for the rural-urban differences in hypertension. A cross-sectional sample of 1,207 adult Hmars (18-70 years) was collected from rural and urban areas of Manipur, India. The results showed that there were significant differences in blood pressure and hypertension within and between the two settings. Urban participants had higher rates of hypertension than their rural counterparts at a given age or physical activity level, but similar at the same BMI level. Hypertension was higher in men than women, but urban men had higher risk of hypertension than their rural counterparts, whereas rural and urban women experienced a similar risk. Using multivariate-logistic regression, the rural-urban difference (OR = 1.55; CI = 1.75-2.06, $p < 0.01$) in hypertension was mainly due to variation in physical activity and household income. These results indicated that there was an intra-variation in acculturation within the Hmar community.

INTRODUCTION

According to recent United Nations estimates (UN 2015), the population of India will represent the highest world's population share by 2024. In addition, urbanization has accelerated after independence, and it has become more striking during the last two decades or so. At present, the urban population of India is about 32.5 percent and it is expected to reach 38.2 percent by 2030 and 47.8 percent by 2050. The consequences of such increasing urbanization may be positive and negative in nature. While urbanization is instrumental in bringing about economic, social and political developments, it is also associated with different socioeconomic, health and nutritional problems. As for health and nutritional problems, urbanization is associated with the increased prevalence of non-communicable chronic diseases (NCDs), such as obesity, hypertension, diabetes mellitus, and coronary heart diseases due to changes in lifestyles and dietary patterns towards energy-dense and high-fat diets (Popkin 2002; Khongsdier 2008; Hawkes et al. 2017; Mitra et al. 2017; Popkin 2017).

Hypertension is a major cause of morbidity and mortality in both developed and developing countries. Its burden is greater in developing countries than in developed countries (WHO 2013). In India, the prevalence of hypertension among adults aged 18 years and above increased from 22.9 percent (23.4% in males and 22.3% in females) in 2010 to 25.9 percent (25.4% in males and 24.8% in females) in 2014 (WHO 2015). Many studies from India have shown that the prevalence of hypertension is higher in urban than in rural areas (Kumar et al. 2006; Gupta 2008; Midha et al. 2009; Kaur 2012; Kumar et al. 2013). A meta-analysis of 12 studies in urban India and 10 studies in rural India (Midha et al. 2013) showed that the prevalence of hypertension was high in urban population (40.8%) compared to the rural population (17.9%).

The increasing prevalence of hypertension in rural population is also a matter of concern (Anchala et al. 2014; Satheesh et al. 2017; Singh et al. 2017). Recently, it has been estimated that the prevalence of hypertension in India during the last 20 years has become stabilized in urban areas (25-30%), but it has increased in rural areas from fifteen to twenty-five percent due to rapid urbanization of rural populations (Gupta 2016). Although changes in dietary habits and sedentary lifestyles may help prevent the prev-

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alence of obesity and hypertension, the causes and pathways of rural-urban difference and convergence of hypertension still remain unclear. Many studies show that hypertension is associated with a variety of biological, socioeconomic, demographic, psychological and socio-cultural factors (Ward 1983; Williams and Collins 1995; Dressler 1996; Bell et al. 2004; Lam 2011; Ghosh et al. 2016), which may mediate the rural-urban differences.

In Northeast India, urbanization is associated with change in dietary and physical activity patterns, which may predispose many individuals to obesity, diabetes and hypertension (Khongsdier 2008). In Manipur, the correlation between urbanization and blood pressure is not yet clearly understood especially among the Hmars. Although the process of urbanization and development is slow in Manipur compared to other states of India, considerable changes have taken place in recent years, especially in the Imphal East and Imphal West districts due to the process of urbanization and modernization. These two districts are the most developed and urbanized districts of Manipur in terms of administrative, educational, economic, and other socio-cultural aspects of development. The present paper aims to describe the rural-urban distribution of blood pressure and hypertension and their associated factors, and to identify the risk factors accounting for the rural-urban differences in hypertension among the Hmar adults.

METHODOLOGY

Study Area and Sample

The Hmars are one of the tribes of Northeast India belonging to the Kuki-Chin-Mizo ethnic group and are recognized as a Schedule Tribe under the 6th Schedule of the Constitution of India. They mostly inhabit the hills of Southern Manipur, Mizoram, Meghalaya, Tripura, Cachar and North Cachar hills of Assam in India and a portion of them have settled in Bangladesh and Myanmar (Thiek 2013). In Manipur, they are mainly concentrated in the Churachandpur district, but many of them have also settled in the Imphal East and Imphal West district. The Hmars residing in urban areas are engaged in administrative, manufacturing, mechanical pursuits, trade commerce and other non-agricultural occupations. However, in rural areas, agriculture is the main occupation. A cross-sectional sample of 615 adults from 5 rural villages of Churachandpur sub-division was collected by following a systematic random sampling at the village level, but not at the household and individual levels. An informed consent was obtained from each participant prior to the commencement of the study. A similar sample size of 592 urban adults (aged 18-70 years) was collected from the Imphal East and Imphal West. An attempt was made to include only those Hmars who migrated and/or resided in Imphal for more than 10 years.

Blood Pressure and Anthropometric Data

Data on blood pressure was recorded using a standard mercury sphygmomanometer and a stethoscope (Beevers et al. 2001) in which the mean of three readings were taken five minutes apart. Systolic blood pressure (SBP) was recorded as the first Korotkoff sound, and diastolic blood pressure (DBP) was recorded when the Korotkoff sound disappeared (Sherwood 2009). All measurements were taken on the left hand (for consistency) while the participant was seated. Each participant was asked to relax and take rest for 10 minutes before taking the measurement. Untreated blood pressure values of SBP 120-139 mmHg and/or DBP 80-89 mmHg were classified as pre-hypertension, whereas hypertension was defined as SBP $\geq$ 140 mmHg and/or DBP $\geq$ 90 mmHg (Chobanian et al. 2003).

Anthropometric measurements, such as height and weight were taken following standard techniques (Lohman et al. 1989). Body mass index (BMI) = weight (in kilograms)/height (in meters^2) was used to assess the nutritional status, and BMI categories were classified according to international classification (WHO 1995).

Behavioral and Socio-demographic Data

Data on physical activity was collected from each participant by using the WHO Global Physical Activity Questionnaire (GPAQ) based on a recalled method of one week (WHO 2005; Bull et al. 2009). This questionnaire has 16 questions arranged in three different domains including sedentary behaviors, such as activity at work, travelling to and from places, and recreational activities (WHO 2005; Bull et al. 2009). With respect to transport domain, the frequency and duration of all walking and cycling for transport was considered (WHO 2005; Bull et al. 2009). As for work and recreational/leisure time domain, questions were asked about the frequency and duration of two different categories of activity in terms of energy requirement or intensity (vigorous or moderate intensity) (WHO 2005; Bull et al. 2009). Metabolic equivalents (MET) were used to define the intensity of physical activities and analysis of GPAQ data. MET is the ratio of a person's working metabolic rate relative to the resting metabolic rate (WHO 2005; Bull et al. 2009). One unit of MET was defined as the energy cost of sitting quietly, equivalent to a caloric consumption of 1 kcal/kg/hour, which is 4 METs for moderately active, and 8 METs for vigorously active (WHO 2005; Bull et al. 2009).

MET scores were calculated separately for individual domains and sub-domains to assess physical activity. For the calculation of a categorical indicator, the total time spent on physical activity during the last one week before the survey, number of days as well as the intensity of physical activity was considered (WHO 2005; Bull et al. 2009). Following the WHO (WHO 2005) recommendations on physical activity for health, physical activity for the present paper was classified as *Physically Active* for adults with moderate and vigorous-intensity physical activity achieving at least 600 MET-minutes, and *Physically Inactive* for adults who did not meet the above-mentioned criteria.

Data on tobacco consumption was also collected from each participant. Participants were categorized as tobacco users and non-tobacco users. Tobacco users include those participants who smoked and/or used smokeless tobacco products. Data on socioeconomic and demographic parameters, such as age, sex, marital status, family size, household income, was collected directly from each participant, using appropriate schedules. Data on socioeconomic status was based on per capita monthly income of households, which were classified as follows:

Above 75th percentile (> Rs 7875) = High Income Group (HIG)

50th to 75th percentile (Rs 4000 – Rs 7875) = Middle Income Group (MIG)

Below 50th percentile (< Rs 4000) = Low Income Group (LIG)

Statistical Analysis

Data analysis was carried out using Statistical Package for the Social Sciences (SPSS) software, version 20, with a level of significance at five percent. The results were presented into two categories as inter-variation in terms of rural-urban differences in blood pressure and hypertension for each categorical independent variable, and intra-variation in blood pressure and hypertension by independent variables within each setting. Descriptive statistics were generated in terms of sample size, percentage, mean, and standard deviation. Student t-test was used to test the differences between two means. Categorical variables like sex, BP, nutritional status, physical activity, tobacco consumption, and socioeconomic status were summarized by count and percentages. Chi square test was performed to test if there was any relationship between hypertension and other independent variables. Analysis of variance (ANOVA) was used to test the differences in mean SBP and DBP according to rural-urban setting, sex, age, nutritional status, physical activity levels, tobacco use and socioeconomic status. Multivariate logistic regression analysis was carried out to estimate odds ratios (OR) with ninety-five percent confidence intervals (CI) for testing the rural-urban differences by considering hypertension as dependent variable and other covariates under different models.

RESULTS

Baseline Characteristics

Table 1 shows that about fifty-two percent of the participants were females in both rural areas and urban areas. About 26.7 percent of the participants in rural areas and 24.2 percent in urban areas belonged to the aged group 50 years and above, although it was not statistically significant ($\chi^2 = 0.31$, $p > 0.05$). The overall prevalence of pre-hypertension (40.9%) and hypertension (24.7%) in urban areas was higher than in rural areas ($p < 0.001$). Also, the prevalence of overweight was significantly higher in urban areas (40%) than in rural (24.4%) areas ($\chi^2 = 33.89$, $p < 0.001$). On the other hand, the proportion of physically active individuals based on GPAQ was significantly higher in rural than urban areas ($\chi^2 = 11.05$, $p < 0.001$). Tobacco consumption was higher in urban areas (25.8%) than in rural areas (16.6%), and the difference was statistically significant ($\chi^2 = 15.52$, $p < 0.001$). Table 1 also shows that a majority of the participants in urban areas belonged to the higher

Table 1: Baseline characteristics by rural-urban setting

Characteristics	Rural (%)	Urban (%)
Sex		
Male	296 (48.1)	286 (48.3)
Female	319 (51.9)	306 (51.7)
Age		
<50 years	451 (73.3)	449 (75.8)
≥50 years	164 (26.7)	143 (24.1)
Blood Pressure		
Normal	284 (46.2)	204 (34.5)
Pre-hypertension	224 (36.4)	242 (40.9)
Hypertension	107 (17.4)	146 (24.7)
BMI		
Underweight	46 (7.5)	36 (6.1)
Normal	419 (68.1)	319 (53.9)
Overweight	150 (24.4)	237 (40.0)
Physical Activity		
Active	542 (88.1)	481 (81.2)
Inactive	73 (11.9)	111 (18.7)
Tobacco Use		
Yes	102 (16.6)	153 (25.8)
No	513 (83.4)	439 (74.2)
Income Group		
Low	410 (66.7)	171 (28.9)
Middle	164 (26.7)	158 (26.7)
High	41 (6.7)	263 (44.4)

income groups, whereas in rural areas about sixty-seven percent of the participants belonged to the low income group. The unequal distribution of household income between rural and urban areas was highly significant ($p < 0.001$).

Rural-Urban Blood Pressure and Correlates

Results of one-way ANOVA show that the mean SBP (Table 2) and DBP (Table 3) were significantly heterogeneous in terms of sex ($p < 0.001$), age ($p < 0.001$) and BMI categories ($p < 0.001$) in both rural and urban areas. In other words, there were significant differences between the sexes, age and BMI categories in mean SBP and DBP in both rural and urban areas. The differences in mean SBP (Table 2) and DBP (Table 3) were statistically significant with respect to physical activity for urban areas but not for rural areas. With respect to tobacco consumption, there was no significance difference in mean SBP and DBP in both rural and urban areas. The mean SBP and DBP increased with increasing income level, but the differences in mean SBP and DBP between income groups were signifi-

Table 2: Means and standard deviations of SBP (mm Hg) by rural-urban setting and other independent variables

Characteristics	Rural			Urban			
	N	Mean	SD	N	Mean	SD	t-value
Sex							
Male	296	125.11	14.77	286	129.46	14.59	3.58***
Female	319	116.5	14.14	306	119.04	15.16	2.16*
F-Statistics			54.48***			72.50***	
Age							
< 50 years	451	119.41	13.52	449	121.83	14.29	2.62**
≥ 50 years	164	124.05	18.28	143	131.1	17.99	3.40***
F-Statistics			11.62***			40.01***	
BMI							
Underweight	46	112.78	11.89	36	113.44	15.65	0.22
Normal	418	119.45	14.96	319	121	14.52	1.42
Overweight/Obese	151	126.4	14.42	237	129.82	15.44	2.18*
F-Statistics			19.66***			33.29***	
Physical Activity							
Active	542	120.42	15.32	481	123.12	15.87	2.77**
Inactive	73	122.33	12.97	111	128.19	14.66	2.76**
F-Statistics			1.04			9.45**	
Tobacco Use							
No	102	119.66	15.28	153	123.42	15.41	1.92
Yes	513	120.84	15.03	439	124.3	15.89	3.45**
F-Statistics			0.52			0.35	
Income Group							
Low	410	120.59	14.84	171	121.6	15.92	0.73
Middle	164	119.83	15.98	163	124.5	16.02	2.64**
High	41	124.41	13.22	258	125.44	15.35	0.4
F-Statistics			1.53			3.16*	

***$p \leq 0.001$; ** $p \leq 0.01$; *$p \leq 0.05$

cant only in urban area. Overall, it indicates that blood pressure is correlated with rural-urban setting, sex, age and BMI categories. Physical activity and household income also play a role especially in urban areas.

As for the rural-urban differences in blood pressure, it was found that the mean values of SBP and DBP were significantly higher in urban males and females compared to their rural counterparts ($p < 0.001$). Similarly, the mean values of SBP and DBP were significantly higher in urban than in rural areas for both the age groups < 50 and ≥ 50 years. With respect to BMI, overweight individuals in urban areas were significantly higher in mean SBP ($t = 2.18$, $p < 0.05$) and DBP ($t = 2.11$, $p < 0.05$), compared to their counterparts in rural areas. Urban participants who were physically active and inactive also had higher SBP and DBP compared to their rural counterparts ($p < 0.001$). There were also significant differences between rural and urban areas among the individuals belonging to the middle-income group with respect to SBP ($t = 2.64$, $p < 0.01$), despite the absence of statistical difference with respect to DBP ($t = 1.91$, $p > 0.05$).

Prevalence of Hypertension

Table 4 shows the prevalence of hypertension by place of residence and other independent variables. It was found that the prevalence of hypertension was significantly higher in urban (24.7%) than in rural (17.4%) areas ($\chi^2 = 9.61$, $p < 0.01$). Table 4 shows that males had a higher prevalence of hypertension than women in both rural ($\chi^2 = 19.05$, $p < 0.001$) and urban ($\chi^2 = 24.47$, $p < 0.001$) areas. Urban males also had a higher risk of hypertension than their rural counterparts ($\chi^2 = 6.95$, $p < 0.01$), but the rural-urban differences were not statistically significant in females ($\chi^2 = 3.01$, $p > 0.05$), indicating that both rural and urban females experienced a similar risk of hypertension. The prevalence of hypertension was also higher in the individuals aged 50 years and above compared to those who were aged < 50 years in both rural ($\chi^2 = 12.11$, $p < 0.001$) and

Table 3: Means and standard deviations of DBP (mm Hg) by rural-urban setting and other independent variables

Characteristics	*Rural*			*Urban*			
	N	*Mean*	*SD*	*N*	*Mean*	*SD*	*t-value*
Sex							
Male	296	81.09	10.67	286	84.23	10.89	3.51***
Female	319	75.58	9.79	306	76.51	11.12	1.11
F-Statistics			44.58***			72.66***	
Age							
<50 years	451	77.6	10.1	449	78.85	11	1.76
≥ 50 years	164	79.98	11.66	143	84.61	12.6	3.34***
F-Statistics			6.12**			27.65***	
BMI							
Underweight	46	74.78	9.62	36	72.78	11.51	0.86
Normal	419	77.04	10.42	319	77.54	10.64	0.64
Overweight/Obese	150	82.62	10.11	237	85.01	11.28	2.11*
F-Statistics			19.05***			40.52***	
Physical Activity							
Active	542	78.13	10.62	481	79.5	11.91	1.94
Inactive	73	79	10.37	111	83.46	9.95	2.92**
F-Statistics			0.43			10.58***	
Tobacco Use							
No	102	76.87	10.41	153	78.77	10.8	1.39
Yes	513	78.71	11.81	439	80.75	11.92	3.08**
F-Statistics			2.02			3.28	
Income Group							
Low	410	78.42	10.5	171	77.72	10.82	0.73
Middle	164	77.49	10.91	163	79.88	11.67	1.91
High	41	79.27	0.2	258	82.14	11.89	0.4
F-Statistics			0.66			7.65**	

***$p \leq 0.001$; ** $p \leq 0.01$; *$p \leq 0.05$

Table 4: Prevalence of hypertension by rural-urban setting and other independent variables

Characteristics	Rural		Urban		χ^2–value
	N	Prevalence of hypertension (%)	N	Prevalence of hypertension (%)	
Sex					
Male	296	72 (24.3)	286	98 (34.3)	6.95**
Female	319	35 (11.0)	306	48 (15.7)	3.01
χ^2 –value		19.05***		27.47***	
Age					
< 50 years	451	64 (14.2)	449	87 (19.4)	4.33*
≥ 50 years	164	43 (26.2)	143	59 (41.3)	7.79**
χ^2 –value		12.11***		27.51***	
BMI (kg/m²)					
< 25	465	61 (13.1)	355	58 (16.3)	1.74
≥ 25	150	46 (30.7)	237	88 (37.1)	1.7
χ^2 –value		24.55***		33.07***	
Physical Activity					
Active	542	95 (17.5)	481	109 (22.7)	4.21*
Inactive	73	12 (16.4)	111	37 (33.3)	6.43**
χ^2 –value		0.53		5.53*	
Tobacco Use					
No	102	13 (12.7)	153	30 (19.6)	2.05
Yes	513	94 (18.3)	439	116 (26.4)	9.03**
χ^2–value		1.84		2.84	
Income Group					
Low	410	65 (15.8)	171	32 (18.7)	0.71
Middle	164	32 (19.5)	163	39 (23.9)	0.94
High	41	10 (24.4)	258	75 (29.1)	0.38
χ^2 –value		2.58		6.00*	

***$p \leq 0.001$; **$p \leq 0.01$; *$p \leq 0.05$

urban (χ^2 = 27.51, p < 0.001) areas. The rural-urban differences were statistically significant in both the age groups (p < 0.05), suggesting that both rural and urban participants experienced a different risk of hypertension even in the same age group. It was also found that the risk of hypertension was higher among the individuals with greater BMI in both rural and urban areas (rural - χ^2 = 24.55, p < 0.001; and urban - χ^2 = 33.07, p < 0.001), and both rural and urban participants experienced a similar risk of hypertension at the same BMI categories. As for physical activity, physically inactive individuals had higher rates of hypertension than those who were active, and it was significant in urban areas (χ^2 = 5.53, p < 0.05) but not in rural areas. The chi-square test for the rural-urban differences indicates that both physically active and inactive individuals in urban areas had higher rates of hypertension than their counterparts in rural areas. It was also found that there was no statistical difference between tobacco users and non-users in both the settings. However, urban tobacco users had a greater risk of hypertension than their rural counterparts (χ^2 = 9.03, p < 0.01). Table 4 further shows that the prevalence of hypertension increased with increasing levels of household income, and the differences were significant in urban areas (χ^2 = 6.00, p < 0.05) but not in rural areas. As in the case of BMI, there were no statistical differences between rural and urban areas in respect of hypertension at each level of household income.

Risk Factors for Rural-Urban Differences in Hypertension

Table 5 shows that the urban Hmars had about 1.55 times the risk of being hypertensive compared to their counterparts in rural areas (OR = 1.55; CI = 1.75 – 2.06, p < 0.01). When sex, age, physical activity, BMI and household income were included as covariates in model-2, the rural-urban difference in hypertension was not significant (OR = 1.25; CI = 0.89 – 1.76, p > 0.05), suggesting that it was mainly due to differences in these covariates between the two settings. However, physical activity and household in-

Table 5: Odds ratio (OR) derived from logistic regression analysis for the risk factors of hypertension

Models	*N*	*Prevalence (%) (95% CI)*	*Odds ratio*	*B*	*p-level*
Model-1					
Rural	615	107 (17.4)	-	-	-
Urban	592	146 (24.7)	1.55 (1.75 - 2.06)	0.44	0.002
Model-2					
Rural	615	107 (17.4)	-	-	-
Urban	592	146 (24.7)	1.25 (0.89- 1.76)	0.22	0.197
Model-3					
Rural	615	107 (17.4)	-	-	-
Urban	592	146 (24.7)	1.40 (1.04 - 1.90)	0.34	0.028
Model-4					
Rural	615	107 (17.4)	-	-	-
Urban	592	146 (24.7)	1.24 (0.90 -1.71)	0.22	0.179

Model-1 includes hypertension as dependent variable and rural-urban setting as covariate.
Model-2 includes hypertension as dependent variable and rural-urban setting, age, sex, physical activity, BMI, and household income as covariates.
Model-3 includes hypertension as dependent variable and rural-urban setting, sex, age, and BMI as covariates.
Model-4 includes hypertension as dependent variable and rural-urban setting, physical activity, and household income as covariates.

come were associated with hypertension only in urban areas, whereas sex, age and BMI were associated with hypertension in both the settings (Table 4). When only sex, age and BMI were included in model-3 (Table 5), it was found that the rural-urban difference in hypertension was significant (OR = 1.40; CI = 1.04 – 1.90, $p < 0.05$), indicating that these three variables were not the major contributing factors to the variation in hypertension between rural and urban areas. When physical activity and household income were included in model-4, the rural-urban difference in hypertension was not significant (OR = 1.24; CI = 0.90 – 1.71, $p > 0.05$), suggesting that these two variables accounted for the rural-urban variation in hypertension. Therefore, the result of logistic regression analysis in Table 5 indicates that the rural-urban difference in the prevalence of hypertension is mainly accounted for by the differences between these two settings in physical activity and household income.

DISCUSSION

The present paper shows that the prevalence of tobacco consumption, physical inactivity and overweight were significantly higher in urban than in rural areas. The proportion of individuals belonging to the low income group was, however, higher in rural than in urban areas. This paper also supports the general observation that blood pressure or hypertension is higher in urban than in rural areas (Nirmala 2001; Gupta 2004; Midha et al. 2013; Anchala et al. 2014; Gouda and Prusty 2015; Oommem et al. 2016, Mitra et al. 2017; Prabhakaran et al. 2017).

The rural-urban difference in the prevalence of hypertension appears as though it was due to the differences in sex, age, BMI, physical activity, and household income. However, physical activity and household income were associated with hypertension only in urban areas, whereas sex, age and BMI were associated with hypertension in both rural and urban areas. When physical activity and household income were controlled, the rural-urban difference in the prevalence of hypertension was not significant. So, it is likely that the rural-urban difference in hypertension was mainly due to the variation in physical activity and household income between the two settings. These results should, however, be interpreted with caution. Firstly, while physical inactivity may be a contributing factor to hypertension, the relationship between socioeconomic status and hypertension is highly inconsistent. For example, household income appeared to be inversely associated with hypertension in developed countries (Colhoun et al. 1998; Brummett et al. 2011), whereas a positive association is reported in Southeast Asian countries (Busingye et al. 2014). In Vietnam, economic status was positively associated with hypertension in men, but negatively associated among women (Minh et al. 2006). Studies in Korea have revealed that education was inversely associated with hypertension, although it was not clearly perceptible with respect to household income (Baek et al. 2015; Park et al. 2016). So, the relation between hypertension and socioeconomic status is likely to be confounded by a number of biological, behavioral, psychological, and socio-cultural factors (Bell et al. 2004; Lam 2011; Cois and Ehrlich 2014; Kaczmarek et al. 2015).

Secondly, urbanization and economic development may be associated with hypertension, but they should not be considered the causal factors of hypertension (Lam 2011; Swaminathan et al. 2017). The association between socioeconomic status and hypertension may be considered a mirror of the complex interaction between socioeconomic status and other underlying factors that can change in the course of time due to the influence of other psychological, social and cultural factors. Sedentary lifestyles and changing patterns of dietary intakes, for example, are the underlying factors for obesity and hypertension, thereby mediating the socioeconomic or rural-urban difference in blood pressure (Marmot and Mustard 1994; Dressler 1999; Dressler and Bindon 2000). These underlying factors are again confounded by economic, social and cultural factors at different strata of the society, thereby producing different outcomes. As observed in the present paper, the prevalence of hypertension varied not only between rural and urban areas, but also within rural and urban areas of the same community. This also explains to a certain extent why the nature of the relationship between socioeconomic status and hypertension is inverse or direct depending upon the degree of acculturation of health promoting behaviors in the society. In the first half of the 20th century, coronary heart disease was described as a "disease of affluence" in Western countries, because its increased prevalence was associated with increased economic development, "affecting first the more privileged and subsequently the less privileged" (Marmot and Mustard 1994). The present situation in developed countries is that obesity and coronary heart disease, including hypertension were higher in the lower socioeconomic strata (Matthews et al. 2002; Galobardes et al. 2003; Brummett et al. 2011). One possible explanation is that awareness of the etiology of NCDs and health promoting behaviors were first adopted by those members in the higher socioeconomic strata of societies. Nevertheless, blood pressure varies substantially in relation to social and cultural factors, and thereby it is important to take into consideration the socio-cultural context of the risk factors for hypertension (Dressler and Santos 2000).

The present findings further indicate that men have higher blood pressure than women as reported by many cross-sectional studies in India (Majumdar et al. 1994; Gupta and Kapoor 2010; Ghosh et al. 2016; Gopalakrishnan et al. 2017; Nagendra et al. 2017; Simon et al. 2017). However, men are reported to have higher blood pressure than women mainly before the fifth decade of life, and thereafter it tends to increase in women (Reckelhoff 2001; Dubey et al. 2002; Maranon and Reckelhoff 2013). Although the causes of sex differences in blood pressure remain unclear, there is certain evidence that androgens, such as testosterone, could play an important role in regulating the sex differences in blood pressure (Reckelhoff 2001; Dubey et al. 2002). Other studies suggested that natural menopause might be responsible for higher blood pressure, irrespective of age and BMI (Zanchetti et al. 2005; Coylewright et al. 2008). In this paper, it was observed that although men had in general higher rates of hypertension than women, urban men had also a higher risk of hypertension than their rural counterparts, but both rural and urban females experienced a similar risk of hypertension. It is likely that these results are also due to the variation in social and cultural stresses within the Hmar community. Nonetheless, the causes of sex differences in blood pressure are still not fully understood, but it is likely to be associated not only with biological factors but also with behavioral, psychological and socio-cultural factors (Ward 1983; Dressler 1999; Reckelhoff 2001; Ghosh et al. 2016).

As observed in this paper, the positive association between BMI and blood pressure is generally reported in Indian populations (Nirmala 2001; Allender et al. 2010; Ghosh et al. 2016; Raghavendra et al. 2017; Simon et al. 2017). This observation is also consistent with earlier anthropological studies of blood pressure in traditional and modernizing populations (McGarvey and Baker 1979; Schall 1995). This paper further indicates that physical activity plays a very important role in regulating hypertension in urban areas, although it was not clearly perceptible in rural areas. The important role of physical activity in reducing blood pressure has been well documented (Barengo et al. 2005; Huai et al. 2013; Diaz and Shimbo 2013; Borjesson et al. 2016; Ball et al., 2017). In addition, both physically active and inactive persons in urban areas had higher rates of hypertension than their counterparts in rural areas. Similarly, urban tobacco users had a greater risk of hypertension than their rural counterparts, despite the absence of statistical difference between tobacco users and non-users in both the settings. All these results indicate that there is an intra-variation in acculturation within the Hmar community. It is likely that the urban Hmars have a higher level of bio-behavioral and psychological stress as compared to their rural counterparts. Further studies are needed to identify those bio-behavioral (for example, diet, physical activity, salt and tobacco consumption) and psychological (for example, stress, depression, hostility, etc.) factors that are correlated with socioeconomic status, and affect the biological pathways of hypertension.

CONCLUSION

This paper presented the results into two broad categories of inter-variation in terms of rural-urban differences in blood pressure and hypertension for each categorical independent variable, and intra-variation in blood pressure and hypertension by independent variables within each setting. The results showed that there were significant differences in blood pressure and hypertension within and between rural and urban areas of the Hmar community. It was found that age, sex and BMI were associated with hypertension in both rural and urban areas. The rural-urban differences in hypertension were mainly accounted for by physical activity and household income. However, these factors seemed to operate differently within urban and rural areas. It was observed that physical activity and household income were not associated with hypertension in rural areas, as it was in urban areas. It was also observed that both physically active and inactive persons in urban areas had higher rates of hypertension than their counterparts in rural areas, but the difference between physically active and inactive persons was significant only in urban areas. Also, although men had higher rates of hypertension than women in both the settings, urban men had also higher risk of hypertension than their rural counterparts, but both rural and urban females experienced a similar risk of hypertension. Again, urban tobacco users had a greater risk of hypertension than their rural counterparts, despite the absence of statistical difference between tobacco users and non-users in both the settings. Using multivariate-logistic regression models, the overall rural-urban difference in the prevalence of hypertension was not significant, after controlling for physical activity and household income. These results indicate that there is an intra-variation in acculturation or modernization within the Hmar community.

RECOMMENDATIONS

This paper is limited to few behavioral and socioeconomic factors, but it suggests the importance of intra and inter-variation analysis to understand how the biological pathways of hypertension is linked to socioeconomic status, which is again correlated with different bio-behavioral and psychological factors. Future studies are needed to identify the risk factors of hypertension within and between populations with different modes of acculturation or modernization, especially in developing countries like India. Such studies are likely to shed more light on the complex relationship between hypertension and other socioeconomic, behavioral and psychological factors. It is evident from the present study that these factors operate differently within urban and rural areas or at different strata of society.

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