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Association of socio-economic status with obesity and hypertension among the adult Angami Naga of Nagaland, North-East India

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Abstract

Background Prevalence of non-communicable diseases (NCDs) has been observed to be rapidly increasing in developing countries. The impact of urbanization has led to the transition of lifestyle and the socio-economic status of many tribal communities in India, who used to be known for the prevalence of underweight and chronic energy deficiencies (CED).

Objective The present study aims to assess the prevalence of obesity and hypertension in relation with the socio-economic status among the adult Angami Naga of Nagaland.

Sample and methods A cross-sectional sample of 194 (108 males and 86 females) adult Angami Naga from Kohima district, Nagaland participated in the study. Information was collected on household's socio-economic particulars. Anthropometric data on height (cm) and body weight (kg), and on both systolic and diastolic blood pressure were measured on each participant. Relative weight status was evaluated through body mass index (BMI). The analysis includes chi square test for sex differences in the prevalence of obesity and hypertension. Linear regression was used to examine the association of socio-economic status with obesity and hypertension.

Results Our results indicate a high prevalence of hypertension among the Angami, for both SBP (50.0% males vs. 29.1% females) and DBP (84.3% males vs. 46.5% females). High prevalence of overweight and obesity (59.3% males vs. 50.0% females) was also observed. According to the regression model, only age and sex were significantly associated with hypertension. For overweight and obesity, only age showed significant association.

Conclusion The main findings of the present study show that age and sex influence hypertension, with males being more susceptible than females. However, overweight and obesity show no sex difference although they are significantly influenced by age. Other unobserved factors that were not captured in the study may also have affected obesity and hypertension in Angami population.

Take home message for students External and/or environmental effects on obesity and hypertension can be multifactorial and population specific. Males appear more susceptible to hypertension than females.

Introduction

Globally, high blood pressure (BP) is estimated to cause 7.1 million deaths per year, which is about 13% of the total deaths. Moreover, overweight and obesity increase the risks of high BP and other non-communicable diseases (NCDs), which are attributable to a body mass index (BMI) above 21 kg/m^2 (WHO 2002). Non-communicable diseases (NCDs) or chronic diseases tend to be of long duration and are known to be the result of a combination of factors including genetics, physiology, environment and behavior. An increasing number of these diseases are attributed to certain combined factors that include rapid unplanned urbanization, globalization of unhealthy lifestyles and also population ageing. Unhealthy diets and a lack of physical activity may show up in people as raised blood pressure, increased blood glucose, elevated blood lipids, overweight and obesity (WHO 2014). A prospective cohort study including 135 population-based studies of adults from 90 countries reports on global disparities of hypertension prevalence, awareness, treatment and control. The prevalence of hypertension decreased in high-income countries, whereas the burden of hypertension appears to increase in low- and middle-income countries indicating an increasing disparity of global hypertension (Mills et al. 2016). Another review study accounting for the difference in mean blood pressure of different populations in the world reported differences in the prevalence of raised blood pressure across regions, with the highest in South Asia and in Central Asia, the Middle East and North Africa, and lowest in the high-income Asia Pacific and high-income Western regions (Zhou et al. 2018). Worldwide, overweight and obesity is a major public health concern, and it has been reported that there are more overweight and obese than underweight adults. Both overweight and obesity have markedly increased over the past four decades (WHO 2021).

India, being a low- and middle-income country, deals with the triple burden of epidemiological transition like many other low- and middle-income countries. For example, it was recently reported that more than 135 million individuals in this country were affected by obesity and the prevalence of obesity in India varies due to age, sex, geographical environment, socio-economic status and many other factors (Ahirwar and Mondal 2019). In fact, the study suggests that the prevalence of overweight will more than double among Indian adults aged 20–69 years between 2010 and 2040, while the prevalence of obesity will triple (Luhar et al. 2020). Alarmingly enough, a country traditionally known for malnutrition is now reported more and more frequently with overweight, obesity, and their consequences (Kalra and Unnikrishnan 2012). Obesity is an important risk factor for NCDs and the increasing prevalence of obesity, hypertension and diabetes, poses enormous implications for the healthcare system in India (Babu et al. 2018). The Indian population is diversified with an imbalance in rural-urban and slum areas. Studies reported on the double burden of malnutrition, with both trends in undernutrition and rapidly rising problems of overweight and obesity (Nguyen et al. 2021). Also, the rural-urban convergence of hypertension in India is due to urbanization of rural populations with consequent changes in lifestyles (sedentariness, high dietary salt, sugar and fat intake) and increase in overweight and obesity (Gupta 2016).

The study and relationship of body mass index (BMI) and hypertension is of particular interest to developing countries, especially among the indigenous populations. Studies on different population groups highlight that there is a high prevalence of hypertension across all socio-economic groups in India (). The National Family Health Survey (NFHS-4) reported that for both males and females, the North-Eastern states (except Meghalaya for men) have a higher prevalence of hypertension than the national average (IIPS and ICF 2017). More specifically, studies among the North-East Indians have reported a high prevalence of hypertension and obesity in different tribal populations of the region (Khual and Limbu 2019; Lalnuneng 2022; Limbu and Khual 2020; Maken and Varte 2013; Marbaniang et al. 2021; Meshram et al. 2021) which according to these studies may be because of the impact of urbanization and modernization processes that have led to a major transition in diet and lifestyle of many tribal communities. This is in contradiction with the studies reported on the tribal or indigenous populations of other parts of India, who are known for a prevalence of undernutrition and CED (Bose et al. 2006; Chakrabarty and Bharati 2010; Das et al. 2008; Ghosh and Bhatrati 2005; Ghosh 2017; Mittal and Srivastava 2006). This inconsistent reporting from various tribal populations of India, compelled us to examine the cardiovascular and nutritional health of the Angami Naga population of North-East India. Furthermore, it is perhaps worth mentioning that the lifestyle and diet of this population has substantially changed in recent decades, with increasing intake of carbohydrate and protein rich food from the markets to their usual diet and living a more sedentary lifestyle. There has been an enormous transition in lifestyle. More people are engaging themselves in less physically demanding jobs: Government or private employed, businesses and others; whereas agriculture has become a secondary option for many. These lifestyle changes can make the above-mentioned population more vulnerable to develop NCDs. With that in mind, the present paper aims to investigate the prevalence of obesity and hypertension among the Angami Naga of Nagaland, North-East India, with special emphasis on their relationship with physical activity and socio-economic status.

Sample and Methods

The Study Area and Population

The Angami Nagas are an indigenous population from Kohima and Dimapur districts of Nagaland, North-East India. The average population density of Kohima district is 183 people per square kilometer. The total area is 1463 square kilometers and had a population of 267,988 as per census 2011 (Census of India 2011). The Angami Naga belong to the Mongoloid group and linguistically fall under the group of the Tibeto-Burman family. In general, they are agriculturists engaged in different agricultural practices, such as dry cultivation of crops on the higher steep slopes of the hills where irrigation of water from the streams is not possible; and wet terrace cultivation, mainly for rice, on the hilly terrains. These are the main traditional means of subsistence. The staple food of the Angami Naga is rice and their diet usually consists of carbohydrate and protein-rich food, especially in terms of rice and red/lean meat with fat. They also consume varieties of local vegetables or greens, cultivated and/or from the wild flora.

The Sample

Cross-sectional data was collected on 194 adults (108 males and 86 females) Angami Naga with age ranges from 18–59 years, from Kohima district, Nagaland. Participants were selected by using the stratified random sampling method, by using age and sex criteria. More specifically, the entire Angami population was stratified into two sexes and various age groups and then above-mentioned age ranges were selected in each sex strata. Later, equivalent numbers of male and female participants were randomly selected from each age strata. Ethical clearance was taken from the board of Institutional Ethics Committee (Human Model) of North-Eastern Hill University. Written and oral information regarding the study was given to the respective village Headmen and written consent was obtained from all the participants who were selected for this study.

Body Mass Index and Blood Pressure

Anthropometric measurements including height and body weight were measured following Carter and Heath (Carter 2002). Height measurements were taken using an anthropometer. The subject was standing straight against an upright wall, touching the wall with heels, buttocks and back; the head was oriented in Frankfort Horizontal (FH) Plane, the heels were touching together and the headboard was lowered until it firmly touched the vertex and reading was taken. Body weight was measured using a portable scale with the subject wearing minimal clothing and standing in the center of the scale platform. Relative weight status was evaluated by calculating body mass index (BMI = weight / height^2; kg/m^2). Standard BMI classification was used following WHO cut-off points for Asian population (WHO 2004) as follows: underweight <18.5 kg/m^2; normal weight 18.5–22.9 kg/m^2; overweight 23.0–24.9 kg/m^2 and obese ≥25.0 kg/m^2. Blood pressure, both systolic (SBP) and diastolic (DBP), was measured using a standard mercury sphygmomanometer (Diamond Mercurial Type Conventional BP Monitor-Deluxe). Measurements were taken on the left hand with the subject seated. Systolic blood pressure was recorded as the first Korotkoff sound. Diastolic blood pressure was taken as the disappearance of the Korotkoff sound (Beevers 2001). Blood pressure categories were defined following Joint National Committee VII protocols (NHLBI 2004), which are as following: normal: SBP<120 mmHg and DBP <80 mmHg; prehypertension: SBP 120–139 mmHg and/or DBP 80–89 mmHg; and hypertension: SBP140 mmHg and/or DBP≥90 mmHg.

Socio-Economic Parameters

An open-ended interview schedule was used to collect information on the socio-economic status (SES) of each participant. Income classes were categorized on the basis of the monthly income and primary occupation of the participants. Data on protein consumption was collected following recall method of the last one week before the survey by developing open-ended and close-ended questions on different types of protein items, like meat, egg, fish etc., following the protocols developed by the Indian Council of Medical Research (ICMR 2010). Data on physical activity was collected by using a list of activities performed and their intensity in terms of metabolic equivalents (METs), and the duration (in minutes) of each participant in the past 24 hours. Types of physical activity and hours spent were calculated using the structured schedule, as prescribed in the Global Physical Activity Questionnaire (GPAQ) developed by WHO (WHO, 2016) and physical activity levels were classified following the tools and techniques developed by Gerrior (Gerrior et al. 2006).

Statistical Analysis

The collected data was analyzed using IBM-SPSS Statistics Version 20. T-test and chi-square test were used to evaluate sex and age group differences in the anthropometric and physiological variables. Linear Regression analysis followed, by considering BMI, SBP and DBP as dependent variables; and age, sex, income class, physical activity level and frequency of protein consumption per week as independent variables. For all the statistical analyses, 5% probability level ($p<0.05$) was used for the level of significance. In the regression model, all the dependent variables were considered simultaneously and the independent categorical variables like sex, income class, physical activity level and frequency of protein consumption per week, were re-coded and incorporated by means of dummy variables, in the following manner:

- Sex: 1=males, 2=females
- Income class: 1=Low Income Group (Monthly family income Rs≤21,000); 2=High Income Group (Monthly family income Rs≥22,000)
- Physical activity level: 1=Inactive, 2=Active
- Protein Consumption (Frequency per week): 1=Low (≤3 times a week), 2=High (≥4 times a week)

Results

Population Characteristics

The background information of socio-economic status of the Angami Naga, based on the variables for this study (Table 1), revealed that the majority of them belonged to the middle- (55.6% males) and low-income class (47.7% females); showing significant difference ($p<0.05$) between the distribution of income level between males and females. Similarly, the majority was found to be 'very active' (60.2% male vs. 86.0% female) according to their physical activity level. However, there was a significant difference ($p<0.001$) in the distribution of activity levels with more males being found in the low active level category than females (Table 1). Protein consumption was found to be mostly three days a week (49.1% males vs. 54.7% females), followed by more than four days a week (34.3% males vs. 23.3% females), irrespective of the sex difference.

Anthropometric and Physiological Characteristics

Descriptive statistical analyses of anthropometric and physiological characteristics revealed statistically significant ($p<0.01$) sex differences in blood pressure, but not in body mass index and age (Table 2). Males had significantly higher levels of blood pressure, in both SBP (138.94±13.64 males vs. 132.14±15.14 females) and DBP (97.19±8.44 males vs. 88.98±9.06 females). BMI was similar in males and females (23.96±4.28 males vs. 23.38±3.82 females).

Prevalence of Obesity and Hypertension

The frequency distribution of BMI and blood pressure, by sex and age groups are presented in Table 3. In particular, overweight and obesity were observed to be high among the adult Angami Naga (59.3% males vs. 50.0% females). Prevalence of overweight+obesity among the females of age group 18–39 years was lower than compared to their male counterpart of the same age group (Table 3).

BMI depends on age. Both males and females tend to show an increase in overweight and obesity with advancing age (Figure 1). In both males and females, the highest prevalence of overweight+obesity was observed in the 40–59 years age category (63.0% males vs. 54.1% females). There was no significant BMI difference among the age groups in both males and females ($p>0.05$; Figure 1).

Table 1 Background information of socio-economic variables among the adult Angami, by sex

Socio-Economic Variables	Male (N=108)		Female (N=86)	
Age group	N	%	N	%
18-39 years	54	50.0	37	43.0
40-59 years	54	50.0	49	57.0
χ^2 Test	0.936			
p-value	0.205			
Income class (per month, in rupees)	N	%	N	%
Low (≤20,000)	27	25.0	41	47.7
Middle (21,000-40,000)	60	55.6	38	44.2
High (≥41,000)	21	19.4	7	8.1
χ^2 Test	12.487			
p-value	**0.002**			
Physical activity level	N	%	N	%
Low active	12	11.1	4	4.7
Active	31	28.7	8	9.3
Very active	65	60.2	74	86.0
χ^2 Test	15.856			
p-value	**0.000**			
Protein consumption (Days per week)	N	%	N	%
Low (≤2)	18	16.7	19	22.1
Medium (3)	53	49.1	47	54.7
High (≥4)	37	34.3	20	23.3
χ^2 Test	3.001			
p-value	0.223			

* Significant p-values are highlighted in bold

Table 2 Descriptive statistics (Mean±SD) of anthropometric and physiological characteristics among adult Angami, by sex

Anthropometric and Physiological Measures	Male		Female		t-value
	Mean	SD	Mean	SD	
Age (years)	38.12	12.24	36.92	11.58	0.71
Body mass index (kg/m^2)	23.96	4.28	23.38	3.82	0.99
SBP≠ (mmHg)	138.94	13.64	132.14	15.14	**3.28**
DBP≠ (mmHg)	97.19	8.441	88.98	9.06	**6.51**

*Significant t-values are highlighted in bold ($p<0.01$)

≠SBP= Systolic Blood Pressure; DBP= Diastolic Blood Pressure

The prevalence of hypertension in systolic blood pressure was significantly higher ($p<0.01$) in males than in their female counterparts (50.0% males vs. 29.1% females). Systolic hypertension was higher in the age group 40–59 years, in both males and females (63.0% males vs. 48.6% females) than in the age group 18–39 years (37.0% males vs. 14.3% females). Nevertheless, it was alarming to observe that in both males and females, systolic pre-hypertension was more prevalent in the 18–39 years age category (55.6% males vs. 75.5% females) than in the 40–59 years age category (33.3% males vs. 48.6% females). Overall, pre-hypertension in systolic blood pressure was significantly more prevalent ($p<0.01$) among females than males (44.4% males vs. 64.0% females). Similarly, hypertension in diastolic blood pressure was significantly more prevalent ($p<0.001$) in males than in females (84.2% males vs. 46.5% females). Diastolic hypertension was more frequent in the 40–59 years age group (96.3% males vs. 70.3% females) than in the 18–39 years age category (72.2% males vs. 28.6% females) (Table 3). Overall, significant age group differences in the prevalence of hypertension were found in both males and females, in systolic (χ^2test=7.296 males and

Table 3 Frequency distribution of body mass index and blood pressure variables among adult Angami, by age groups and sex

Physiological Parameters	Age groups											
	18-39 (N=103)				40-59 (N=91)				All age groups (N=194)			
	Male (N=54)		Female (N=49)		Male (N=54)		Female (N=37)		Male (N=108)		Female (N=86)	
	N	%	N	%	N	%	N	%	N	%	N	%
Body Mass Index												
Underweight	4	7.4	8	16.3	7	13.0	1	2.7	11	10.2	9	10.5
Normal	20	37.0	18	36.7	13	24.1	16	43.2	33	30.6	34	39.5
Overweight and obesity	30	55.6	23	46.9	34	63.0	20	54.1	64	59.3	43	50.0
χ^2Test	2.125				5.455				1.866			
p-value	0.346				0.065				0.393			
Systolic Blood Pressure Categories												
Normal	4	7.4	5	10.2	2	3.7	1	2.7	6	5.6	6	7.0
Prehypertension	30	55.6	37	75.5	18	33.3	18	48.6	48	44.4	55	64.0
Hypertension	20	37.0	7	14.3	34	63.0	18	48.6	54	50.0	25	29.1
χ^2 Test	**6.875**				2.156				**8.739**			
p-value	**0.032**				0.340				**0.013**			
Diastolic Blood Pressure Categories												
Normal	1	1.9	5	10.2	0	0.00	0	0.00	1	0.9	5	5.8
Prehypertension	14	25.9	30	61.2	2	3.7	11	29.7	16	14.8	41	47.7
Hypertension	39	72.2	14	28.6	52	96.3	26	70.3	91	84.3	40	46.5
χ^2 Test	**20.082**				**12.145**				**31.395**			
p-value	**0.000**				**0.001**				**0.000**			

* Significant p-values are highlighted in bold

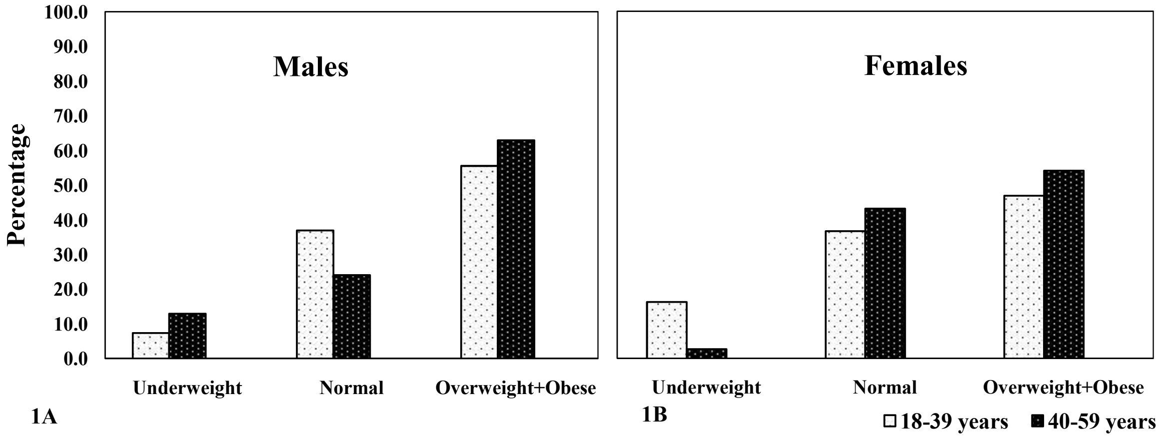

Figure 1 Body Mass Index amongst the adult Angami Naga males (1A) and females (1B), by age groups. χ^2 test (age group differences): males: 2.553 (p-value: >0.05); females: 4.178 (p-value: >0.05).

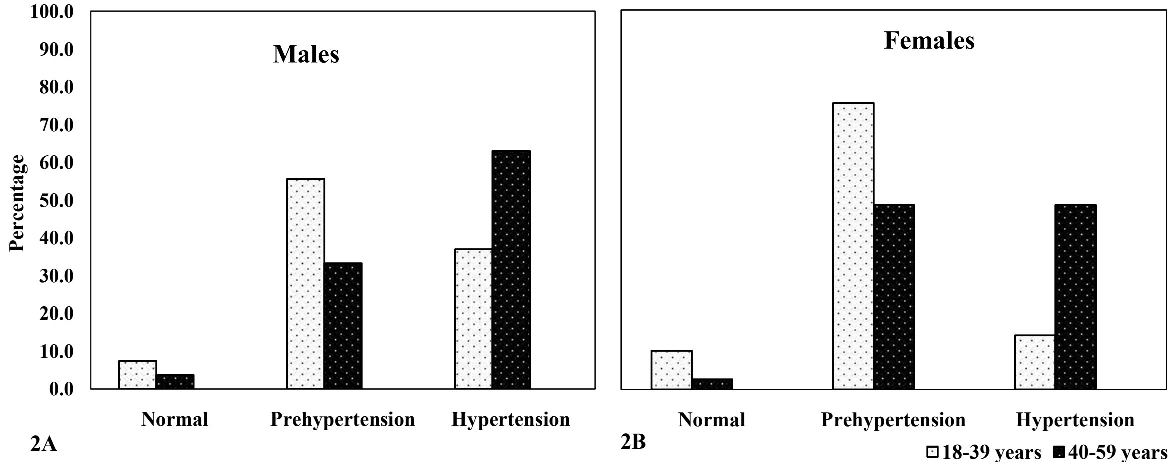

Figure 2 Systolic Blood Pressure amongst the adult Angami Naga males (2A) and females (2B), by age groups, χ^2 test (Age groups differences): Males: 7.296 (p-value: <0.05); Females: 12.642 (p-value: <0.05).

χ^2test=12.642 females, $p<0.05$; Figure 2) and diastolic (χ^2test=11.857 males, $p<0.05$ and χ^2test=16.043 females, $p<0.001$; Figure 3) blood pressures (Figure 2 & 3).

Effect of Demographic and Socio-economic factors on BMI and Blood Pressure

Table 4 presents the results of the linear regression model for the analysis of socio-economic and demographic factors on blood pressure and BMI and shows important influences of age (β= 0.539, $p<0.001$) and sex (β = -6.234, $p<0.05$) on SBP. Similarly, significant effects of age (β= 0.364, $p<0.001$) and sex (β = -8.123, $p<0.001$) were also evident on DBP. Age (β=0.056, $p<0.05$) was significantly associated with BMI, but not sex ($p>0.05$). Socio-economic variables like income class, physical activity level and protein consumption show no significant effects ($p>0.05$) on neither blood pressure nor BMI among the Angami (Table 4). The results show that the adult Angami Naga are susceptible to develop obesity and are also prone to become hypertensive, in both SBP and DBP.

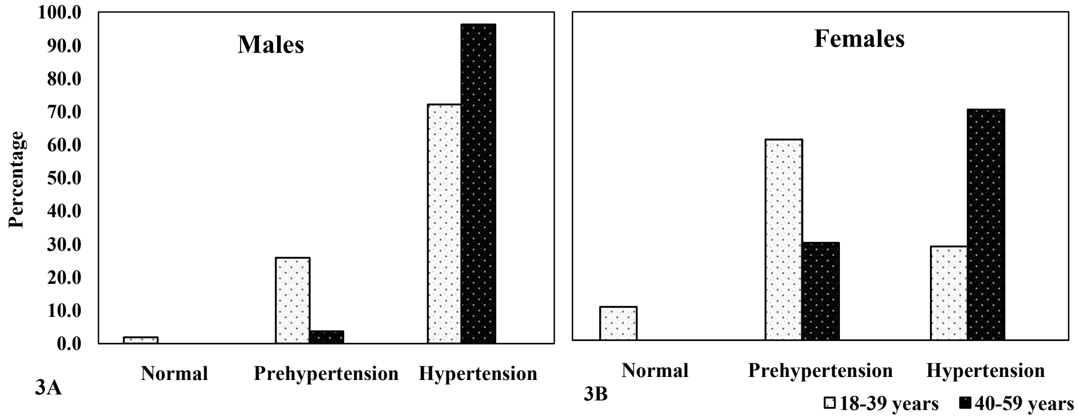

Figure 3 Diastolic Blood Pressure amongst the adult Angami Naga males (3A) and females (3B), by age groups, χ^2 test (age group differences): males: 11.857 (p-value: <0.05); females: 16.043 (p-value: <0.001).

Discussion

The present paper aims to examine the prevalence of obesity and hypertension among the adult Angami Naga. High prevalence of overweight and obesity along with hypertension were observed in both males and females of this community. Several recent studies, in this regard, have reported on the prevalence of NCD risk factors in tribal populations residing in different parts of India (Kandpal et al. 2016; Kshatriya et al. 2016; Sajeev and Soman 2018; Tripathi 2020). Furthermore, a high prevalence of NCD risk factors like obesity and hypertension was also reported from the neighboring populations of North-East India, such as the Padam (Adi) of Arunachal Pradesh (Limbu and Khual 2020), the Mishing of Assam (Misra et al. 2014), the Hmars of Manipur (Lalnuneng and Khongsdier 2017), the tribal populations of Mokokchung, Nagaland (Tushi et al. 2018), Tangkhul Naga of Manipur (Mungreiphy et al. 2011), and the Ao of the Mokokchung District, Nagaland (Maken and Varte 2013). It is alarming to note that indigenous or tribal populations, including the present population, who were known for undernutrition, now suffer from NCD risk factors like obesity and hypertension.

In this study, hypertension was significantly associated with advancing age. Similar results were also observed by previous researchers in many Indian populations, including tribal populations (Lalnuneng 2022) (Lalnuneng and Khongsdier 2017; Mungreiphy et al. 2011; Singh et al. 2017; Tripathi 2020). However, the study from Kolkata showed no effect of age and sex on the cardiovascular disease (CVD) risk factors (Das et al. 2008). In our study, males were more hypertensive than females. Similar results were reported in studies on the prevalence of hypertension in other populations of India (Singh et al. 2017; Tripathi 2020). However, a study on the tribal populations from different regions of India reported contradicting results with higher prevalence of hypertension in females (14.0%) than in their male counterparts (9.2%) (Kshatriya et al. 2016). Sex differences in the prevalence of hypertension may be attributed to differences in dietary habits, lifestyle, physical activity levels and genetic polymorphisms (Ruixing et al. 2008). Considering the significant ($p<0.001$) physical activity level differences between males and females, this could be the primary reason behind the elevated blood pressure among the Angami males. Moreover, no sex influence was observed in the BMI of Angami, suggesting that might not play any role in the sex differences in the prevalence of hypertension in this population. In line with the above-mentioned reasoning, previous studies have also suggested that physical inactivity is positively associated with obesity and blood pressure in adults of Delhi, India (Devi et al. 2020) and also in the population of rural South India (Little et al. 2016). Moreover, high prevalence of hypertension among the hill tribe of the Mizoram (Borah et al. 2020) and the Hmars of Manipur of North-East India (Lalnuneng and Khongsdier 2017) was observed among individuals with low level of physical activity. Contradicting to these studies, even among physically active individuals, a high prevalence of hypertension and obesity was observed among the Wanchos of Arunachal Pradesh, North-East India (Basumatary and Begum 2020). Overweight and obesity were significantly associated with advancing age in the present population. Similarly, age showed significant association with overweight and obesity among the Rengma adults of North-East India (Rengma et al. 2015) and

Table 4 Linear Regression Result: Effect of socio-economic factors on SBP, DBP and BMI

Dependent Variables	Confounding variables	-coefficient	Standard error	t-value	p-value
SBP	Age	**0.539**	0.080	6.761	**0.000**
	Sex	**-6.234**	1.991	-3.132	**0.002**
	Income Class* (LIG vs.HIG)	0.027	2.185	0.012	0.990
	Physical Activity Level (Inactive vs. Active)	-0.793	2.224	-0.357	0.722
	Protein Consumption (Low vs. High)	-2.628	2.210	-1.189	0.236
DBP	Age	**0.364**	0.047	7.766	**0.000**
	Sex	**-8.123**	1.169	-6.946	**0.000**
	Income Class* (LIG vs.HIG)	0.282	1.283	0.219	0.827
	Physical Activity Level (Inactive vs. Active)	0.969	1.306	0.742	0.459
	Protein Consumption (Low vs. High)	-1.500	1.299	-1.155	0.249
BMI	Age	**0.056**	0.025	2.261	**0.025**
	Sex	-0.683	0.616	-1.108	0.269
	Income Class* (LIG vs.HIG)	0.512	0.677	0.757	0.450
	Physical Activity Level (Inactive vs. Active)	1.335	0.689	1.939	0.054
	Protein Consumption (Low vs. High)	0.566	0.684	0.827	0.409

* Significant p-values are highlighted in bold

≠ SBP= Systolic Blood Pressure; DBP= Diastolic Blood Pressure; BMI= Body Mass Index; LIG= Low Income Group; HIG= High Income Group;

the Tangkhul Naga of Manipur (Mungreiphy et al. 2011). Although studies in India have shown that the prevalence of obesity among females was significantly higher as compared to males (Ahirwar and Mondal 2019), our study showed no significant sex difference in BMI. The challenge of controlling obesity and hypertension was observed to be enormous in Asia. Changes in socio-economic status and lifestyle have led to a co-existence of obesity and undernourishment in some Asian countries (Chu and Singh 2021). Studies in different Indian populations showed that the socio-economic conditions does influence BMI and blood pressure of individuals (Borah et al. 2020; Devi et al. 2020; Lalnuneng and Khongsdier 2017; Limbu and Khual 2020; Little et al. 2016; Rengma et al. 2015; Shridhar et al. 2018; Singh et al. 2017). The importance of certain behavioral factors, such as of increased physical activity levels, to reduce the risk of hypertension has been well documented (Börjesson et al. 2016; Liu et al. 2017). Although income status did not show significant associations with hypertension and overweight+obesity in the present study, associations of income and overweight+obesity and hypertension were observed in studies from North-East India (Marbaniang et al. 2021; Rengma et al. 2015). In a prospective cohort study, red meat (both processed and unprocessed) and poultry consumption was associated with a higher risk of hypertension (Zhang and Zhang 2018). A dietary pattern with high meat-consumption was positively associated with cardio-metabolic risk factors in India (Shridhar et al. 2018). In a study on people residing in urban areas of Delhi, Chennai and Karachi reported that high dietary diversity appeared to be protective against cardio-metabolic disease risk factors, yet, with hypertension as one of the risk factors (Kapoor et al. 2018). A study among the North-East Indian population by Marbaniang et al. (Marbaniang et al. 2021) mentioned that the indigenous people of North-East India are habituated in consuming a wide variety of wild edible fruits and local vegetables. Such a diet with fruits, vegetables and low-fat dairy products, as well as enhanced physical activity and controlling sodium intake, had a greater effect on decreasing blood pressure levels in hypertensive adults and on stabilizing weight. However, a study among the population of rural South India reported that animal fat intake (saturated fats in milk products and meat) was negatively associated with BMI (Little et al. 2016). Our result did not show any significant association of protein intake with overweight/obesity and hypertension, even though participants consumed lean/red meat more than thrice a week. It was observed that overweight and obesity and hypertension is prevalent among the Angami, irrespective of their physical activity, income status and meat intake and hence are not influenced by these parameters. In other words, no significant association of socio-economic factors with obesity and hypertension was observed in the present study.

Conclusion

The main findings of the present study showed that Angami males tend to be more susceptible to hypertension than their female counterparts. The prevalence of overweight and obesity along with hypertension seem to be exaggeratedly high among the Angami Naga for both males and females as compared to other neighboring populations of North-East India. As observed in other studies, the impact of sedentary lifestyle, especially in terms of low or very low physical activity may have played a role on the health of this population. These changes must have led to a steady susceptibility to obesity and hypertension, even among the Angami. In the past, people often engaged in vigorous physical activity and strenuous work in the fields; agriculture being the only means of subsistence back then. Perhaps, a diet including carbohydrate with increased protein intake in the form of meat was required at that time. However, with the changed subsistence pattern, the same dietary pattern of meat intake and low physical activity might have resulted into observed prevalence of NCD risk factors. Nevertheless, other unobserved factors not included in the present study may also have affected the present situation of obesity and hypertension. Owing to the limited number of variables in the present study, we suggest a more well-designed introspective study to further elaborate the issues examined in this study on the factors influencing NCD risk factors that lead to metabolic diseases even among the indigenous populations, who were traditionally known for undernutrition and CED.

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