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Socioeconomic Risk Factors of Hypertension and Blood Pressure Among Persons Aged 15-49 in Nepal: A Cross-Sectional Study

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ABSTRACT

Objectives

Hypertension has been on the rise in Nepal for the past few decades. Estimates suggest that nearly 45 percent of the country's population currently has hypertension. This study had two objectives. The first was to examine the prevalence of hypertension in Nepal, in accordance with the American College of Cardiology and American Heart Association 's 2017 definition for diastolic blood pressure and systolic blood pressure. The second was to examine the association between various socio-economic factors, including ethnicity, occupation, and food security status, and hypertension.

Setting and Design

We used data from the 2016 Nepal Demographic and Health Survey, which is a nationally representative cross-sectional survey. Multiple linear regression was used to study the association of hypertension with socio-economic factors. Logistic regression was used to conduct the sensitivity analysis.

Participants

Our sample consisted of 9,827 adults between the ages of 15 and 49 years.

Results

Our analysis showed that the mean (se) of hypertension prevalence in the study population was 0.36 (0.01). The mean (se) diastolic and systolic blood pressure were 76.4 (0.26) and 111.5 (0.31), respectively. Relative to Brahmins / Chhetris, individuals from other ethnic

groups had higher levels of hypertension. Association of hypertension with food security status and occupation was modest. Consistent with the existing literature, our results showed that age, gender, provincial location, and body mass index were associated with hypertension. The results were similar when the outcome measures were diastolic blood pressure and systolic blood pressure.

Conclusion

There are substantial disparities in hypertension prevalence in Nepal. These disparities extend across ethnic groups, occupational status, and food security status. Differences also persist across different provinces. As hypertension continues to take a toll on increasingly a greater number of Nepalis, more research is needed to better understand the disparities and gradients that exist across various socio-economic factors.

ARTICLE SUMMARY

Strengths and limitations of the study

- There are no studies that examine hypertension / blood pressure for Nepalese adults aged 15 to 49 years using the 2017 definition of American College of Cardiology (ACC) and American Heart Association (AHA).
- This study used a nationally representative cross-sectional data to estimate the prevalence and drivers of hypertension / blood pressure for Nepalese adults between the ages of 15 and 49 years.
- This is the first study, to our knowledge, to use nationally representative data to examine specifically the association of hypertension / blood pressure with ethnicity, occupation, and food security status.
- In addition to using hypertension as a binary outcome, this study examined blood pressure as a continuous outcome, thus mitigating any cutoff point issues that are frequently associated with the change in the definition of hypertension.
- This is an associational study based on cross-sectional data, and as such, does not make any causal claims to the findings.

A. INTRODUCTION

Hypertension is a major risk factor for cardiovascular diseases (CVDs) and a significant contributor to the growing burden of non-communicable diseases (NCDs) in low-and-lower-middle-income countries (LMICs). Nearly two-thirds of the people with hypertension live in LMICs and about one in every third person in LMICs has hypertension.[1], [2] Nepal is no exception to the hypertension trend that has been observed in other LMICs. A recent analysis found that the prevalence of hypertension among Nepalese adults is 44.2 percent.[3] The number varies by sub-groups. It is nearly 30 percentage points higher for those with body mass index (BMI) of 30 or more, 20 percentage points higher for people older than 70, and 6 percentage points higher for those from the richest quintile.

Existing studies on hypertension in Nepal have focused predominantly on the prevalence of and factors associated with hypertension.[3–7] Among the most studied factors include age, sex, BMI, education level, marital status, wealth index, and smoking and drinking status. Existing studies have not explored much the role of ethnicity, occupation, and household food security status. Emerging literature from other parts of the world looks at the role of unmet social needs (for example, food security) and health outcomes,[8] and suggests a high positive correlation between unmet social needs and poor health outcomes. The role of food security status has not been studied well in the context of Nepal. Additionally, there is limited evidence on the association of hypertension with ethnicity and occupation.

Our study contributes to the literature in a few ways. First, this is the first Nepal-based multivariate study, to our knowledge, that uses a nationally representative data to understand the association of hypertension with ethnicity, occupation, and food security. Using food security as an important determinant for hypertension and blood pressure, the study also contributes to the

growing literature on the role of unmet social needs on health and health outcomes. Second, this study looks at three different outcome measures for hypertension. In addition to the binary measure of hypertension, the study uses continuous measures of blood pressure (corresponding to diastolic and systolic blood pressure measurements). Few studies have examined the change in hypertension prevalence using the new definition but the evidence on Nepal is still limited overall. [3,9] Using the continuous measure of systolic and diastolic blood pressure allows us to study the risk of high blood pressure without relying too much on a single binary outcome. Systolic and diastolic blood pressure are measures of risk that do not rely on a particular cutoff. The use of these measures mitigates the cutoff point issues associated with the change in the definition of hypertension. Additionally, there is evidence that systolic blood pressure is a predictor of risk for CVDs.[10]

Finally, our study focuses on a much younger population (15-49 years) than the earlier studies. Even though the younger population is less likely to suffer from hypertension, it is still susceptible to the risks of hypertension due to changes in lifestyle, unmet social needs, occupational status, and other correlates including sex and BMI.

B. METHODS

B.1: Data Source

We used data from Nepal Demographic and Health Survey (NDHS), 2016. Data were collected from June 2016 to January 2017 by New ERA with support from the Ministry of Health. The NDHS provides up-to-date estimates of the basic demographic and health indicators as well as a comprehensive overview of population, maternal, and child health issues in Nepal.

B.2: Survey Design

The sampling frame used for the 2016 NDHS was an updated version of the frame from the 2011 National Population and Housing Census. The frame was updated since the urban/rural classification changed at the ward level in 2014 and 2015. The sample was stratified and selected in two stages in rural areas and three stages in urban areas. In rural areas, wards were selected as the primary sampling units (PSUs) and households were selected from the sample PSUs. In urban areas, wards were selected as the PSUs. One Enumeration areas (EA) was selected from each PSU and then households were selected from the sample EAs. Our sample consisted of a total of 9,827 individuals aged 15-49 years. All these individuals had complete information on our variables of interest.

B.3: Outcome Measures

Our main outcome variable was hypertension, defined in line with the 2017 American College of Cardiology (ACC) / American Heart Association (AHA) guidelines (systolic blood pressure ≥130 mm Hg and/or diastolic blood pressure ≥80 mm Hg). Individuals were also considered hypertensive if they reported taking antihypertensive medications. Our additional outcomes included measures for systolic blood pressure (SBP) and diastolic blood pressure (DBP). The survey measured respondents' blood pressure three times. The average of the second and the third reading was used.

B.4: Explanatory Variables

Our main explanatory variables were ethnicity, occupation, and food security status. Ethnicity was divided into 6 ethnic groups.[11] Occupational status was divided into 7 categories. Household food security status was divided into 4 categories: food secure, mildly

food insecure, moderately food insecure, and severely food insecure. The four groups were created using the questionnaires that focused on food insecurity for the household as a unit. The questions, arranged in order of severity and frequency of occurrence, captured households' perceptions of food vulnerability or stress and behavioral responses to food insecurity. The questions followed the Household Food Insecurity Access Scale developed by USAID's Food and Nutrition Technical (FANTA) project.

Other explanatory variables included provincial location, rural/urban status, ecological region, sex, age group, BMI category, highest level of education, sex of the household head, and household wealth index. Nepal has seven provinces and three ecological regions. Age was categorized into 7 groups (15-19, 20-24, and so on). Similarly, BMI was categorized into four groups: thin (BMI <18.5), normal (BMI >=18.5 and BMI <25), overweight (BMI >=25 and BMI <30), and obese (BMI >=30). Educational attainment was grouped into four categories: no education and/or preschool, primary, secondary, and higher secondary. The household wealth index, derived using data on household assets and other household characteristics such as access to water and sanitation facilities, categorizes households into five quintiles (from poorest to the richest). Additional independent variables included current work / employment status, media use, marital status, and tobacco use. A dummy variable for media use was created based on the frequency of the use of internet, radio, television, or reading of newspaper or magazine. Tobacco use, also a dummy variable, included any use of tobacco.

B.5: Statistical Analysis

We used multivariate linear regression to understand and quantify the magnitude of the association between the outcome measures (i.e., hypertension, DBP, and SBP) and the independent variables. Our key independent variables were ethnicity, occupation, and food

security status. We also included other independent variables (such as sex, BMI, education, and others) that have been widely used in the hypertension literature. All tests were two- tailed and a p value of < 0.05 was considered statistically significant. We applied sample weight calculated in the DHS and adjusted for clustering using the "svy" command in Stata. As a sensitivity analysis, we ran a multivariate logistic regression model on the binary outcome measure of hypertension. These results are presented as supplementary online content (SOC).

All the statistical analysis was performed in Stata 15.1 (StataCorp). Approval to access and use the DHS data was obtained from the ICF International.

B.6. Patient and Public Involvement

Study participants or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

C. RESULTS

We present descriptive statistics in **Table 1**. In our study sample comprising of 9,827 people between the ages of 15-49 years, 36% had hypertension. The mean values of SBP and DBP were 112 and 76 respectively. At 32%, Janjatis were the largest ethnic group. Nearly 41 % of the study population was self-employed in agriculture while 25 % of the population did not work or held other occupations. Around 50% of the people lived in food-secure households. Nearly 73 % of the study population was married and 26% used tobacco products. Additionally, 50% of the people lived in the Terai region, 63% resided in urban areas, 61 % were females, and

26 % lived in households headed by females. Approximately 70 % of the study population used media of some kind in the week prior to the survey.

Table 1: Characteristics of the Study Population

	Mean	SE	N
Hypertension (ACC/AHA, 2017)	0.36	0.01	3493
Hypertension (JNC 7)	0.13	0.01	1284
Systolic BP	111.54	0.31	9827
Diastolic BP	76.38	0.26	9827
Ethnicity/Caste			
Brahmins / Chhettris	0.30	0.01	2983
Other Terai Castes	0.15	0.01	1486
Dalits	0.12	0.01	1220
Newars	0.05	0.01	476
Janjatis	0.32	0.02	3137
Muslim and Other ethnicities	0.05	0.01	525
Occupation			
Did Not Work and Other Occupations	0.25	0.01	2470
Professional/Technical/Managerial	0.06	0.00	541
Clerical	0.03	0.00	271
Sales/ Services	0.13	0.01	1314
Agricultural - Self Employed	0.41	0.01	4014
Skilled Manual	0.07	0.00	652
Unskilled Manual	0.06	0.00	565
Currently working (yes=1, no=0)	0.66	0.01	6513
Household food insecurity			
Food Secure	0.48	0.01	4668
Mildly Food Insecure	0.23	0.01	2286
Moderately Food Insecure	0.22	0.01	2119
Severely Food Insecure	0.08	0.01	753
Age categories			
15-19	0.21	0.00	2062
20-24	0.16	0.01	1605
25-29	0.15	0.00	1435
30-34	0.14	0.00	1396
35-39	0.13	0.00	1302
40-44	0.11	0.00	1097
45-49	0.09	0.00	929

Body mass index (BMI)				
	Thin	0.17	0.01	1623
	Normal	0.63	0.01	6237
	Overweight	0.16	0.01	1570
	Obese	0.04	0.00	398
Highest level of education				
	No Education, Preschool	0.25	0.01	2424
	Primary level	0.18	0.01	1738
	Secondary level	0.41	0.01	4018
	Higher level	0.17	0.01	1647
Wealth quintiles				
	Poorest	0.17	0.01	1639
	Poorer	0.19	0.01	1840
	Middle	0.20	0.01	1970
	Richer	0.23	0.01	2232
	Richest	0.22	0.01	2145
Provinces				
	Province 1	0.17	0.01	1693
	Province 2	0.20	0.01	1981
	Bagmati	0.22	0.02	2168
	Gandaki	0.10	0.01	951
	Lumbini	0.17	0.01	1639
	Karnali	0.06	0.00	541
	Sudurpaschim	0.09	0.00	854
Ecological region				
	Mountain	0.06	0.01	607
	Hill	0.44	0.03	4276
	Terai	0.50	0.02	4944
Urban residence		0.63	0.02	6213
Marital status				
	Never Married	0.25	0.01	2486
	Married	0.73	0.01	7156
	Widowed	0.01	0.00	122
	Divorced	0.01	0.00	63
Sex of the member (female=1, male=0)		0.61	0.01	6015
Head of household is female (yes=1, no=0)		0.26	0.01	2507
Weekly exposure to media (yes=1, no=0)		0.69	0.01	6760
Use tobacco products (yes=1, no=0)		0.26	0.01	2553

ACC / AHA = American College of Cardiology / American Heart Association; JNC 7 = Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure; SE = Standard Error; BP = Blood Pressure

Table 2 shows the results for ordinary least squares (OLS)-based multivariable analysis. The table includes results for all the three outcome measures: *hypertension* (measured as a binary variable), *DBP* (measured as a continuous variable), and *SBP* (measured as a continuous variable). Our results on hypertension (presented in Panel A of Table 2) suggest the following: compared to *Brahmins / Chhetris*, *Janjati* (estimate: 0.06; CI: 0.02 - 0.09; $p < 0.01$), *Muslim and other ethnicities* (estimate: 0.09; CI: 0.02 - 0.16; $p < 0.01$), *Terai/Madhesi* (estimate: 0.06; CI: 0.01 - 0.12; $p < 0.05$), and *Dalits* (estimate: 0.05; CI: 0.00 - 0.09; $p < 0.05$) were associated with higher rates of hypertension. Individuals employed in professional, technical, and managerial professions collectively (estimate: 0.10; CI: 0.04 - 0.16; $p < 0.01$) were associated with increased hypertension compared to those who did not work or were employed in other jobs. Moderately food insecure household had lower rates of hypertension (estimate: -0.03; CI: -0.06 - -0.00; $p <0.05$) compared to households with no issue of food insecurity. Compared to the youngest population in the study sample (i.e., 15- to 19-year-olds), older adults had higher rates of hypertension. More notably, the magnitude of the association between hypertension and age became stronger for older age groups. Compared to individuals in the lowest BMI category, those in the higher BMI categories had higher rates of hypertension. In terms of the geographic location, individuals residing in the Gandaki province (estimate: 0.12; CI: 0.06-0.18; $p<0.001$) and Province 5 (estimate: 0.12; CI: 0.06-0.18; $p<0.001$) had higher levels of hypertension. Individuals in richer households were less likely to be hypertensive compared to individuals in the poorest households. For example, individuals residing in the richest (estimate: -0.10; CI: -0.15- -0.04; $p<0.001$) and the second richest (estimate: -0.08; CI: -0.13- -0.03; $p<0.01$) households were less likely to be hypertensive compared to individuals living in the poorest households. Compared to males, females had lower levels of hypertension (estimate: -0.09, CI: -

0.11 - -0.06; p < 0.001). No significant association was recorded between hypertension and the use of tobacco products, current working status, marital status, media use, and the place of residence (in terms of ecological zones).

Our results on the association between DBP, presented in Panel B **Table 2**, suggest the following: compared to *Brahmins/Chhetris*, *Terai/Madhesis* (estimate: 1.75; CI: 0.46-3.05; p<0.01), *Dalit* (estimate: 1.69; CI: 0.59-2.80; p<0.01), *Janjatis* (estimate: 1.27; CI: 0.42-2.12; p<0.01), and *Muslim and other* (estimate: 2.94; CI: 1.45-4.44; p<0.001) individuals were more likely to have higher readings of blood pressure. Occupation wise, individuals working in sales and services (estimate: 1.39; CI: 0.30-2.49; p<0.05) had higher readings for blood pressure. Food insecurity was negatively associated with blood pressure. Individuals from severely food insecure (estimate: -1.46; CI: -2.54- -0.38; p<0.01) households had lower levels of blood pressure. Blood pressure was increasing in age groups as well as in BMI – older people and people with higher BMI had higher levels. Some education (regardless of primary, secondary, or higher) was associated with a higher level of DBP. Individuals living in Gandaki province (estimate: 2.76; CI: 1.15-4.38; p<0.001) and Province 5 (estimate: 2.66; CI: 1.18-4.14; p<0.001) had higher levels of blood pressure. Finally, females had lower levels of blood pressure compared to males. No significant association was recorded between DBP and the use of tobacco products, current working status, marital status, media use, and the place of residence (in terms of ecological zones).

Finally, we present results with SBP as the outcome measure. These results, which are very similar to the results for hypertension and DBP, are also presented in Panel C of Table 2. The results suggest the following: compared to *Brahmins / Chhetris*, all the other ethnic groups (including the *Newars*) had higher levels of SBP. Food insecure households had lower levels of

SBP compared to food secure households. As with the other two outcome measures (i.e., hypertension and DBP), SBP was increasing in age and BMI. Individuals who lived in Gandaki province and Province 5 had higher levels of SBP compared to individuals who lived in Province 1. Females had lower levels of SBP compared to males. No significant association was recorded between SBP and tobacco use, current working status, education, marital status, media use, and the place of residence (in terms of the ecological zones).

Table 2: Multivariate Regression Results

	Hypertension ACC/AHA, 2017 (Panel A)		Diastolic BP (Panel B)		Systolic BP (Panel C)	
Variables	Coefficient	95% CI	Coefficient	95% CI	Coefficient	95% CI
Ethnicity/Caste						
Brahmins/Chhetris (reference)						
Other Terai Castes	0.06*	(0.01 - 0.12)	1.75**	(0.46 - 3.05)	1.94*	(0.39 - 3.49)
Dalits	0.05*	(0.00 - 0.09)	1.69**	(0.59 - 2.80)	1.76**	(0.45 - 3.07)
Newars	0.07	(-0.02 - 0.16)	1.10	(-0.60 - 2.81)	2.00*	(0.24 - 3.77)
Janjatis	0.06**	(0.02 - 0.09)	1.27**	(0.42 - 2.12)	2.43***	(1.36 - 3.51)
Muslim and other ethnicities	0.09**	(0.02 - 0.16)	2.94***	(1.45 - 4.44)	1.89*	(0.04 - 3.74)
Occupation						
Did Not Work and Other occupations (Reference)						
Professional/Technical/Managerial	0.10**	(0.04 - 0.16)	1.18	(-0.22 - 2.58)	1.22	(-0.58 - 3.02)
Clerical	0.06	(-0.02 - 0.14)	1.21	(-0.69 - 3.12)	1.84	(-0.70 - 4.38)
Sales/ Services	0.04	(-0.01 - 0.09)	1.39*	(0.30 - 2.49)	1.32	(-0.09 - 2.73)
Agricultural - Self Employed	-0.01	(-0.05 - 0.03)	-0.21	(-1.14 - 0.72)	0.32	(-0.74 - 1.38)
Skilled Manual	0.02	(-0.04 - 0.08)	0.34	(-1.14 - 1.82)	0.91	(-0.78 - 2.60)
Unskilled Manual	0.02	(-0.03 - 0.08)	0.56	(-0.66 - 1.79)	1.74*	(0.12 - 3.36)
Currently working (yes=1, no=0)	-0.01	(-0.04 - 0.03)	0.03	(-0.88 - 0.94)	0.38	(-0.66 - 1.43)
Household food insecurity						
Food Secure (Reference)						
Mildly Food Insecure	-0.02	(-0.05 - 0.00)	-0.39	(-1.03 - 0.26)	-0.52	(-1.35 - 0.32)
Moderately Food Insecure	-0.03*	(-0.06 - -0.00)	-0.52	(-1.24 - 0.20)	-1.02*	(-1.88 - -0.17)
Severely Food Insecure	-0.04	(-0.10 - 0.01)	-1.46**	(-2.54 - -0.38)	-2.21**	(-3.69 - -0.72)
Age categories						
15-19 (Reference)						
20-24	0.04*	(0.00 - 0.07)	0.95*	(0.15 - 1.75)	0.78	(-0.11 - 1.68)
25-29	0.10***	(0.06 - 0.14)	3.15***	(2.13 - 4.17)	2.15***	(0.99 - 3.31)
30-34	0.18***	(0.13 - 0.22)	5.09***	(4.17 - 6.01)	3.84***	(2.65 - 5.03)
35-39	0.25***	(0.20 - 0.30)	7.21***	(6.13 - 8.28)	6.51***	(5.10 - 7.92)
40-44	0.29***	(0.23 - 0.34)	8.23***	(7.12 - 9.34)	9.45***	(8.10 - 10.80)

45-49	0.34***	(0.28 - 0.40)	9.35***	(7.95 - 10.75)	11.99***	(10.34 - 13.64)
Body mass index (BMI)						
Thin (Reference)						
Normal	0.10***	(0.08 - 0.13)	2.72***	(2.11 - 3.32)	4.25***	(3.49 - 5.01)
Overweight	0.28***	(0.24 - 0.32)	7.64***	(6.72 - 8.55)	9.83***	(8.71 - 10.94)
Obese	0.38***	(0.32 - 0.45)	10.21***	(8.77 - 11.64)	14.28***	(12.24 - 16.32)
Highest level of education						
No Education, Preschool (Reference)						
Primary level	0.02	(-0.02 - 0.05)	1.32***	(0.61 - 2.04)	-0.01	(-1.03 - 1.01)
Secondary level	0.04*	(0.00 - 0.07)	1.65***	(0.89 - 2.41)	-0.05	(-1.00 - 0.90)
Higher level	0.04	(-0.01 - 0.09)	2.09***	(0.91 - 3.27)	-0.57	(-1.94 - 0.80)
Wealth quintiles						
Poorest (Reference)						
Poorer	-0.02	(-0.06 - 0.02)	-0.18	(-1.07 - 0.71)	-0.20	(-1.38 - 0.97)
Middle	-0.04	(-0.09 - 0.00)	-1.01	(-2.12 - 0.10)	-1.14	(-2.53 - 0.26)
Richer	-0.08**	(-0.13 - -0.03)	-1.95*	(-3.51 - -0.39)	-1.89*	(-3.52 - -0.27)
Richest	-0.10***	(-0.15 - -0.04)	-1.97**	(-3.27 - -0.67)	-1.58	(-3.16 - 0.00)
Provinces						
Province 1 (Reference)						
Province 2	-0.00	(-0.06 - 0.05)	-0.41	(-1.92 - 1.10)	-1.00	(-2.87 - 0.87)
Bagmati	0.04	(-0.02 - 0.09)	0.82	(-0.75 - 2.40)	-0.11	(-1.97 - 1.75)
Gandaki	0.12***	(0.06 - 0.19)	2.76***	(1.15 - 4.38)	2.57**	(0.63 - 4.50)
Lumbini	0.12***	(0.06 - 0.18)	2.66***	(1.18 - 4.14)	3.18***	(1.33 - 5.03)
Karnali	0.04	(-0.02 - 0.10)	1.08	(-0.56 - 2.71)	0.31	(-1.54 - 2.17)
Sudurpaschim	0.04	(-0.02 - 0.09)	0.47	(-0.91 - 1.85)	1.31	(-0.38 - 3.00)
Ecological region						
Mountain (Reference)						
Hill	0.04	(-0.01 - 0.09)	0.24	(-1.11 - 1.59)	1.47	(-0.15 - 3.09)
Terai	0.01	(-0.05 - 0.07)	-0.69	(-2.20 - 0.82)	0.35	(-1.42 - 2.13)
Urban residence	-0.01	(-0.05 - 0.02)	-0.16	(-1.15 - 0.83)	-0.38	(-1.54 - 0.79)
Marital status						
Never Married (Reference)						
Married	-0.01	(-0.04 - 0.03)	-0.13	(-0.87 - 0.61)	-0.63	(-1.55 - 0.28)
Widowed	0.01	(-0.10 - 0.12)	0.67	(-1.63 - 2.98)	1.07	(-2.00 - 4.15)
Divorced	-0.03	(-0.16 - 0.10)	0.65	(-2.65 - 3.95)	-0.36	(-4.88 - 4.16)
Sex of the member (Reference=male)	-0.09***	(-0.11 - -0.06)	-1.93***	(-2.59 - -1.26)	-8.15***	(-8.96 - -7.35)
Head of household is female	0.00	(-0.02 - 0.03)	0.10	(-0.50 - 0.71)	-0.03	(-0.82 - 0.77)
Exposure to media (yes=1, no=0)	-0.00	(-0.03 - 0.02)	-0.15	(-0.74 - 0.43)	-0.34	(-1.13 - 0.44)
Use tobacco products (yes=1, no=0)	0.02	(-0.01 - 0.06)	0.70	(-0.12 - 1.52)	0.46	(-0.54 - 1.46)
Constant	0.08	(-0.00 - 0.16)	68.31***	(66.49 - 70.12)	106.30***	(103.99 - 108.60)
Observations	9,827		9,827		9,827	
R-squared	0.16		0.22		0.26	

This table presents results for multivariate linear regression (linear probability) model. Outcome variables are shown in the top row. Hypertension, a binary indicator, is defined according to the 2017 American College of Cardiology/ American Heart

Association (ACC/AHA) hypertension guidelines. The results adjust for cluster-sampling design and weights. CI = Confidence Interval.

*** p<0.001
** p<0.01
* p<0.05

Our findings from the sensitivity analysis were very similar to our main findings. See table A1 of the SOC for details.

D. DISCUSSION

Using cross-sectional data, our study examined hypertension and its correlates for Nepal. Our analysis, based on the 2016 DHS data, found that around 36 % of individuals between the ages of 15-49 in Nepal are hypertensive, suggesting a significant fraction of adults with an elevated risk of cardiovascular diseases. Given the existing evidence that younger population is more likely to have undiagnosed hypertension,[12] population at risk for CVD in Nepal may be higher than what is reported, further underscoring the treatment gap and the need for addressing the gap.

Our study identified multiple factors associated with hypertension (a binary measure), DBP (a continuous measure), and SBP (a continuous measure). Across all three outcome measures, we found that relative to Brahmins / Chhetris, other ethnic groups have higher levels of hypertension. This finding could be explained by a few factors. First, access issues may be especially pronounced for certain ethnic groups, as suggested by some of the existing evidence.[11] Brahmins / Chhetris have always been two of the most privileged groups in Nepal. Relative to other ethnic groups, these two groups have historically enjoyed, on average, greater social and political advantage in the country. This advantage likely translates into access to

healthcare as well as other social determinants of health (such as education, employment, housing, and others). Second, the differences in hypertension rates across the groups also reflects, to some extent, ethnicity-specific food and cultural practices and preferences.[13]

We found that, for the most part, food insecurity was associated with a lower rate of hypertension, DBP, and SBP. This finding is somewhat counterintuitive because available evidence from LMICs suggests that food insecurity is associated with unfavorable health outcomes such as obesity.[14] Since obese people are more likely to be hypertensive than non-obese people, we would expect to see a positive association between food insecurity and hypertension. Our seemingly discrepant finding might be a function of the underlying mechanism, which operates not through the "high-energy, processed foods" but likely through the food unavailability route, among others. We found that jobs that are more office-oriented were associated with high blood pressure and hypertension. The reasons might be that individuals who work on these jobs are mentally more stressed but end up doing limited physical work. In terms of geographic locations, Gandaki Province and Province 5 (or Lumbini province) show higher rates of hypertension and blood pressure. In terms of geographic locations, Gandaki Province and Province 5 (or Lumbini province) show higher rates of hypertension and blood pressure. It is unclear, ex-ante, the reason for geographic variation in the prevalence of hypertension. We do not find any evidence of urban residence, marital status, household head, exposure to media, and the use of tobacco products affecting blood pressure or hypertension.

Few studies have looked at the change in hypertension status in Nepal using the new definition.[3,4,9] These studies have reported higher risks of hypertension among people who are older, males, and have higher BMI.[15,16] Our results suggest similar association. In addition, DBP and SBP also show clear positive association with age, gender, and BMI. Further,

our results suggest that hypertension and blood pressure (diastolic and systolic) increase monotonically with age and increasing BMI.

It is important to understand the differences in hypertension prevalence among different ethnic groups and the underlying causes of these differences. Similarly, more research needs to be done to better understand geographic disparities. An important dimension to consider on this could be the ethnic composition of the different provinces and relatedly, the food and cultural practices that accompany different ethnic groups. Nepal has been seeing an increasing trend in BMI over time. [17] Any future policy should target individuals with high BMI in Nepal.

Limitations

There are limitations to this study. First, though we found certain ethnicities had higher rates of hypertension, we were unable to disentangle as to why this might be the case. Second, we could not rule out the selection of individuals into certain occupations. Relatedly, we also could not measure the type of work done in each occupational setting and how these affected measures of blood pressure. Type of work done may hide variation in blood pressure due to the demands of jobs within occupations. Third, food insecurity likely did not sufficiently capture the spectrum of unmet social needs that might be driving the variation. Finally, this study was based on individuals between the ages of 15 to 49 years. It is therefore important to recognize that hypertension for this group was lower than the overall adult population (which comprises of the elderly population.

E. CONCLUSION

Our study showed that certain ethnic groups and occupations were associated with higher rates of hypertension. These groups also had higher levels of SBP and DBP. We found that food insecurity was associated with reduced likelihood of hypertension, and lower levels of DBP and SBP. Consistent with the findings of the existing research, increasing age, male sex, and higher BMI were correlated with hypertension as well as SBP and DBP. Geographically, two provinces (Gandaki and Province 5) had higher rates of hypertension. More research is required to understand the impact of NCDs among different occupations and ethnic groups. It is also important to understand geographic disparities in terms of hypertension prevalence and the related risks.

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CONTRIBUTORS

BT and SJ jointly conceived and planned the overall project. SJ sought approval for data use and led the data analysis. BT and SJ jointly wrote the draft and revised the paper.

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COMPETING INTEREST

None declared.

PATIENT CONSENT FOR PUBLICATION

Not applicable.

ETHICS APPROVAL

This study was based on the analysis of de-identified, secondary data that are publicly available. We obtained permission to use the data from ICF International / Demographic Health Survey (DHS) team.

DATA AVAILABILITY STATEMENT

No additional data are available.

SUPPLEMENTARY ONLINE CONTENT

Available, online only.

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Supplementary Online Content

For

Socio-economic Risk Factors of Hypertension and Blood Pressure Among Persons Aged 15-49 in Nepal: A Cross-Sectional Study

Table A1: Logistic regression results using ACC/AHA 2017 definition for hypertension

Variables	OR	95% CI
Ethnicity/Caste		
Brahmins/Chhetris (Reference)		
Other Terai Castes	1.38*	(1.03 - 1.84)
Dalits	1.26*	(1.00 - 1.58)
Newars	1.41	(0.91 - 2.21)
Janjatis	1.34**	(1.12 - 1.59)
Muslim and Other ethnicities	1.64**	(1.15 - 2.33)
Occupation		
Did Not Work and other occupations (Reference)		
Professional/Technical/Managerial	1.62**	(1.18 - 2.21)
Clerical	1.34	(0.92 - 1.95)
Sales/ Services	1.22	(0.92 - 1.60)
Agricultural - Self Employed	0.95	(0.76 - 1.20)
Skilled Manual	1.12	(0.83 - 1.51)
Unskilled Manual	1.14	(0.85 - 1.53)
Currently working (yes=1, no=0)	0.96	(0.79 - 1.17)
Household food insecurity		
Food Secure (Reference)		
Mildly Food Insecure	0.88	(0.76 - 1.02)
Moderately Food Insecure	0.84*	(0.72 - 0.99)
Severely Food Insecure	0.79	(0.59 - 1.05)
Age categories		
15-19 (Reference)		
20-24	1.31*	(1.05 - 1.64)
25-29	1.85***	(1.44 - 2.38)
30-34	2.69***	(2.07 - 3.49)
35-39	3.73***	(2.88 - 4.84)
40-44	4.35***	(3.30 - 5.73)
45-49	5.58***	(4.03 - 7.72)
Body mass index (BMI)		
Thin (Reference)		
Normal	1.90***	(1.58 - 2.28)
Overweight	4.10***	(3.27 - 5.15)
Obese	6.73***	(4.83 - 9.39)
Highest level of education		
No Education, Preschool (Reference)		
Primary level	1.05	(0.89 - 1.24)
Secondary level	1.18	(1.00 - 1.40)
Higher level	1.18	(0.91 - 1.54)
Wealth quintiles		
Poorest (Reference)		

	Poorer	0.92	(0.75 - 1.12)
	Middle	0.80*	(0.64 - 1.00)
	Richer	0.66**	(0.50 - 0.87)
	Richest	0.60***	(0.46 - 0.80)
Provinces			
	Province 1 (Reference)		
	Province 2	0.96	(0.71 - 1.31)
	Bagmati	1.20	(0.89 - 1.62)
	Gandaki	1.85***	(1.35 - 2.54)
	Lumbini	1.80***	(1.33 - 2.44)
	Karnali	1.25	(0.91 - 1.72)
	Sudurpaschim	1.22	(0.91 - 1.64)
Ecological region			
	Mountain (Reference)		
	Hill	1.23	(0.93 - 1.64)
	Terai	1.04	(0.76 - 1.42)
Urban residence		0.93	(0.77 - 1.13)
Marital status			
	Never Married (Reference)		
	Married	0.93	(0.76 - 1.14)
	Widowed	1.03	(0.61 - 1.72)
	Divorced	0.86	(0.46 - 1.61)
Sex of the member (Reference=male)		0.64***	(0.55 - 0.73)
Head of household is female		1.03	(0.89 - 1.19)
Weekly exposure to media (yes=1, no=0)		0.98	(0.85 - 1.12)
Use tobacco products (yes=1, no=0)		1.10	(0.94 - 1.29)
Constant		0.12***	(0.07 - 0.18)
N		9,827	

This table presents results for multivariate logistic regression. Hypertension (the outcome variable) was defined as per the ACC/AHA 2017. OR = Odds Ratio. CI = Confidence Interval.

*** p<0.001
** p<0.01
* p<0.05.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7
		(*e*) Describe any sensitivity analyses	9, 16
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-11
		(b) Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	15*	Report numbers of outcome events or summary measures	7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14-15

		(*b*) Report category boundaries when continuous variables were categorized	14-15
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9, 16
Discussion			
Key results	18	Summarise key results with reference to study objectives	16-17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	18
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Socioeconomic Risk Factors of Hypertension and Blood Pressure Among Persons Aged 15-49 in Nepal: A Cross-Sectional Study

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ABSTRACT

Objectives

Estimates suggest that nearly 45 percent of the Nepal's population currently has hypertension. This study had two objectives. The first was to examine the prevalence of hypertension, in accordance with the American College of Cardiology and American Heart Association 's 2017 definition for diastolic blood pressure and systolic blood pressure. The second was to examine the association between various socio-economic factors (including ethnicity, occupation, and food security status) and hypertension.

Setting and Design

We used nationally representative data from the 2016 Nepal Demographic and Health Survey. Multivariate analysis was used to study the association of hypertension with socio-economic factors: logistic regression was used for hypertension and linear regression was used for DBP and SBP.

Participants

Our sample consisted of 9,827 adults between the ages of 15 and 49 years.

Results

Our analysis showed that the mean (se) of hypertension prevalence in the study population was 0.36 (0.01). The mean (se) diastolic and systolic blood pressure were 76.4 (0.26) and 111.5 (0.31), respectively. Relative to Brahmins / Chhetris, individuals from other ethnic groups had higher levels of hypertension. Association of hypertension with food security status

and occupation was modest. Consistent with the existing literature, our results showed that age, gender, provincial location, and body mass index were positively associated with hypertension. The results were similar when the outcome measures were diastolic blood pressure and systolic blood pressure. When stratified by sex, we found key differences mainly in terms of by occupation and ethnicity.

Conclusion

There are substantial disparities in hypertension prevalence in Nepal. These disparities extend across ethnic groups, occupational status, and food security status. Differences also persist across different provinces. As hypertension continues to be increasingly more significant, more research is needed to better understand the disparities and gradients that exist across various socio-economic factors.

ARTICLE SUMMARY

Strengths and limitations of the study

- This is the first study, to our knowledge, to use nationally representative data to examine specifically the association of hypertension / blood pressure with ethnicity, occupation, and food security status.
- In addition to using hypertension as a binary outcome, this study uses systolic and diastolic blood pressure as a continuous outcome measure, thereby addressing cutoff-point issues linked with recent changes in definition of hypertension.
- Study sample only includes adults between the ages of 15-49 years.
- This is an associational study based on cross-sectional data, and therefore, the findings cannot be used make causal claims.

A. INTRODUCTION

Hypertension is a major risk factor for cardiovascular diseases (CVDs) and a significant contributor to the growing burden of non-communicable diseases (NCDs) in low-and-lower-middle-income countries (LMICs). Nearly two-thirds of the people with hypertension live in LMICs and about one in every third person in LMICs has hypertension.[1,2] With the increasing growth in the share of elderly populations, hypertension also stands to be a major risk factor for cognitive impairment and dementia in LMICs.[3]

Nepal is no exception to the hypertension trend that has been observed in other LMICs. A recent analysis found that the prevalence of hypertension among Nepalese adults is 44.2 percent.[4] The number varies by sub-groups. It is nearly 30 percentage points higher for those with body mass index (BMI) of 30 or more, 20 percentage points higher for people older than 70, and 6 percentage points higher for those from the richest quintile. Existing studies on hypertension in Nepal have focused predominantly on the prevalence of and factors associated with hypertension.[4–8] Among the most studied factors include age, sex, BMI, education level, marital status, wealth index, and smoking and drinking status. Existing studies of hypertension in Nepal have not explored the role of ethnicity, occupation, and household food security status. Studies outside of Nepal have looked at the role of unmet social needs (for example, food security) and health outcomes,[9] and suggests a high positive correlation between unmet social needs and poor health outcomes.

Our study contributes to the literature in a few ways. First, this is the first Nepal-based multivariate study, to our knowledge, that uses a nationally representative data to understand the association of hypertension with ethnicity, occupation, and food security. Using food security as an important determinant for hypertension and blood pressure, the study also contributes to the

growing literature on the role of unmet social needs on health and health outcomes. Second, this study looks at three different outcome measures. In addition to the binary measure of hypertension, the study uses continuous measures of blood pressure (corresponding to diastolic and systolic blood pressure measurements). Few studies have examined the change in hypertension prevalence using the new definition but the evidence on Nepal is still limited overall. [4,10] Using the continuous measure of systolic and diastolic blood pressure allows us to study the risk of high blood pressure without relying too much on a single binary outcome. Systolic and diastolic blood pressure are measures of risk that do not rely on a particular cutoff. The use of these measures mitigates the cutoff point issues associated with the change in the definition of hypertension. Additionally, there is evidence that systolic blood pressure is a predictor of risk for CVDs.[11] We also stratified our analysis by sex to capture if there are substantial differences by sex.

Finally, our study focuses on a much younger population (15-49 years) than the earlier studies. Even though the younger population is less likely to suffer from hypertension, it is still susceptible to the risks of hypertension due to changes in lifestyle, unmet social needs, occupational status, and other correlates including sex and BMI.

B. METHODS

B.1: Data Source

We used data from Nepal Demographic and Health Survey (NDHS), 2016. Data were collected from June 2016 to January 2017 by New ERA with support from the Ministry of

Health. The NDHS provides up-to-date estimates of the basic demographic and health indicators as well as a comprehensive overview of population, maternal, and child health issues in Nepal.

B.2: Survey Design

The sampling frame used for the 2016 NDHS was an updated version of the frame from the 2011 National Population and Housing Census. The frame was updated since the urban/rural classification changed at the ward level in 2014 and 2015. The sample was stratified and selected in two stages in rural areas and three stages in urban areas. In rural areas, wards were selected as the primary sampling units (PSUs) and households were selected from the sample PSUs. In urban areas, wards were selected as the PSUs. One Enumeration areas (EA) was selected from each PSU and then households were selected from the sample EAs. Our sample consisted of a total of 9,827 individuals aged 15-49 years. All these individuals had complete information on our variables of interest.

B.3: Outcome Measures

Our main outcome variable was hypertension, defined in line with the 2017 American College of Cardiology (ACC) / American Heart Association (AHA) guidelines (systolic blood pressure ≥130 mm Hg and/or diastolic blood pressure ≥80 mm Hg). Individuals were also considered hypertensive if they reported taking antihypertensive medications. Our additional outcomes included measures for systolic blood pressure (SBP) and diastolic blood pressure (DBP). The survey measured respondents' blood pressure three times. The average of the second and the third reading was used.

B.4: Explanatory Variables

Our main explanatory variables were ethnicity, occupation, and food security status. Ethnicity was divided into 6 categories.[12] Occupational status was divided into 7 categories. Household food security status was divided into 4 categories: food secure, mildly food insecure, moderately food insecure, and severely food insecure. The four categories were created using the questionnaires that focused on food insecurity for the household as a unit. The questions, arranged in order of severity and frequency of occurrence, captured households' perceptions of food vulnerability or stress and behavioral responses to food insecurity. The questions followed the Household Food Insecurity Access Scale developed by USAID's Food and Nutrition Technical (FANTA) project. [13]

Other explanatory variables included provincial location, rural/urban status, ecological region, sex, age group, BMI category, highest level of education, sex of the household head, and household wealth index. Nepal has seven provinces and three ecological regions. Age was categorized into 7 groups (15-19, 20-24, and so on). Similarly, BMI was categorized into four groups: thin (BMI <18.5), normal (BMI >=18.5 and BMI <25), overweight (BMI >=25 and BMI <30), and obese (BMI >=30). Educational attainment was grouped into four categories: no education and/or preschool, primary, secondary, and higher secondary. The household wealth index, derived using data on household assets and other household characteristics such as access to water and sanitation facilities, consists of five quintiles (from poorest to the richest). Additional independent variables included current work / employment status, media use, marital status, and tobacco use. A dummy variable for media use was created based on the frequency of the use of internet, radio, television, or reading of newspaper or magazine. Tobacco use, also a dummy variable, included any use of tobacco.

B.5: Statistical Analysis

We used multivariate regression analysis to understand and quantify the magnitude of the association between the outcome measures (i.e., hypertension, DBP, and SBP) and the independent variables. We used logit model for our binary outcome variable (hypertension) and linear models for the two continuous outcome variables (DBP and SBP). Key independent variables were ethnicity, occupation, and food security status. We also included other independent variables (such as sex, BMI, education, and others) that have been widely used in the hypertension literature. Additionally, when the outcome was hypertension, we stratified the analysis by sex. All tests were two- tailed and a p value of < 0.05 was considered statistically significant. We applied sample weight calculated in the DHS and adjusted for clustering using the "svy" command in Stata.

All the statistical analysis was performed in Stata 15.1 (StataCorp). Approval to access and use the DHS data was obtained from the ICF International.

B.6. Patient and Public Involvement

Study participants or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

C. RESULTS

We present descriptive statistics in **Table 1**. In our study sample comprising of 9,827 people between the ages of 15-49 years, 36% had hypertension. The mean values of SBP and

DBP were 112 and 76 respectively. At 32%, *Janjatis* were the largest ethnic group. Nearly 41% of the study population was self-employed in agriculture while 25% of the population did not work or held other occupations. Around 50% of the people lived in food-secure households. Nearly 73% of the study population was married and 26% used tobacco products. Additionally, 50% of the people lived in the Terai region, 63% resided in urban areas, 61% were females, and 26% lived in households headed by females. Approximately 70% of the study population used media of some kind in the week prior to the survey.

Table 1: Characteristics of the Study Population

	Mean*	SE	N
Hypertension (ACC/AHA, 2017)	0.36	0.01	3493
Hypertension (JNC 7)	0.13	0.01	1284
Systolic BP	111.54	0.31	9827
Diastolic BP	76.38	0.26	9827
Ethnicity/Caste			
Brahmins / Chhettris	0.30	0.01	2983
Other Terai Castes	0.15	0.01	1486
Dalits	0.12	0.01	1220
Newars	0.05	0.01	476
Janjatis	0.32	0.02	3137
Muslim and Other ethnicities	0.05	0.01	525
Occupation			
Did Not Work and Other Occupations	0.25	0.01	2470
Professional/Technical/Managerial	0.06	0.00	541
Clerical	0.03	0.00	271
Sales/ Services	0.13	0.01	1314
Agricultural - Self Employed	0.41	0.01	4014
Skilled Manual	0.07	0.00	652
Unskilled Manual	0.06	0.00	565
Currently working (yes=1, no=0)	0.66	0.01	6513
Household food insecurity			
Food Secure	0.48	0.01	4668
Mildly Food Insecure	0.23	0.01	2286
Moderately Food Insecure	0.22	0.01	2119

	Severely Food Insecure	0.08	0.01	753
Age categories				
	15-19	0.21	0.00	2062
	20-24	0.16	0.01	1605
	25-29	0.15	0.00	1435
	30-34	0.14	0.00	1396
	35-39	0.13	0.00	1302
	40-44	0.11	0.00	1097
	45-49	0.09	0.00	929
Body mass index (BMI)				
	Thin	0.17	0.01	1623
	Normal	0.63	0.01	6237
	Overweight	0.16	0.01	1570
	Obese	0.04	0.00	398
Highest level of education				
	No Education, Preschool	0.25	0.01	2424
	Primary level	0.18	0.01	1738
	Secondary level	0.41	0.01	4018
	Higher level	0.17	0.01	1647
Wealth quintiles				
	Poorest	0.17	0.01	1639
	Poorer	0.19	0.01	1840
	Middle	0.20	0.01	1970
	Richer	0.23	0.01	2232
	Richest	0.22	0.01	2145
Provinces				
	Province 1	0.17	0.01	1693
	Province 2	0.20	0.01	1981
	Bagmati	0.22	0.02	2168
	Gandaki	0.10	0.01	951
	Lumbini	0.17	0.01	1639
	Karnali	0.06	0.00	541
	Sudurpaschim	0.09	0.00	854
Ecological region				
	Mountain	0.06	0.01	607
	Hill	0.44	0.03	4276
	Terai	0.50	0.02	4944
Urban residence		0.63	0.02	6213
Marital status				
	Never Married	0.25	0.01	2486
	Married	0.73	0.01	7156
	Widowed	0.01	0.00	122

	Divorced	0.01	0.00	63
Sex of the member (female=1, male=0)		0.61	0.01	6015
Head of household is female (yes=1, no=0)		0.26	0.01	2507
Weekly exposure to media (yes=1, no=0)		0.69	0.01	6760
Use tobacco products (yes=1, no=0)		0.26	0.01	2553

ACC / AHA = American College of Cardiology / American Heart Association; JNC 7 = Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure; SE = Standard Error; BP = Blood Pressure. *Multiply the Mean values by 100 to get the values in percent.

Table 2 shows results for multivariate regression models for all three outcome measures: hypertension (measured as a binary variable), DBP (measured as a continuous variable), and SBP (measured as a continuous variable). Our results for hypertension, presented in terms of adjusted odds ratios (AOR) in Panel A of Table 2, suggest the following: compared to *Brahmins / Chhetris*, *Janjatis* (AOR: 1.34; CI: 1.12 – 1.59; $p < 0.01$), *Other Terai castes* (AOR: 1.38; CI: 1.03 - 1.84; $p<0.05$), *Muslim and other ethnicities* (AOR: 1.64; CI: 1.15 – 2.33; $p < 0.01$) and *Dalits* (AOR: 1.26; CI: 1.00 – 1.58; $p < 0.05$) had higher odds of hypertension. Individuals employed in professional, technical, and managerial professions collectively (AOR: 1.62; CI: 1.18 – 2.21; $p < 0.01$) also had higher odds of hypertension compared to those who did not work or were employed in other jobs. Moderately food insecure household had lower odds of hypertension (AOR: 0.84; CI: 0.72 - 0.99; $p <0.05$) compared to households with no issue of food insecurity. Compared to the youngest population in the study sample (i.e., 15- to 19-year-olds), older adults had higher adjusted odds of hypertension. More notably, there was an age gradient in the adjusted odds of having hypertension. As implied by the magnitude of the AOR, the association between hypertension and age was stronger for older age groups. Compared to individuals in the lowest BMI category, those in the higher BMI categories had higher odds of hypertension. In terms of the geographic location, individuals residing in Gandaki province (AOR: 1.85; CI: 1.35-2.54; $p<0.001$) and Lumbini province (AOR: 1.80; CI: 1.33-2.44; $p<0.001$) had higher odds of hypertension. Individuals in richer households had lower odds of

hypertension compared to individuals in the poorest households. For example, individuals residing in the richest (OR: 0.60; CI: 0.46-0.80; p<0.001) and the second richest (OR: 0.66; CI: 0.50-0.87; p<0.01) households had lower odds of hypertension compared to individuals living in the poorest households. Compared to males, females had lower odds (OR: 0.64, CI: 0.55- 0.73; p < 0.001). No significant association was recorded between hypertension and the use of tobacco products, current working status, marital status, media use, and the place of residence (in terms of ecological zones).

Our results on the association between DBP, presented in Panel B **Table 2**, suggest the following: compared to *Brahmins/Chhetris*, *Dalit* (estimate: 1.69; CI: 0.59-2.80; p<0.01), *Janjatis* (estimate: 1.27; CI: 0.42-2.12; p<0.01), and *Muslim and other* (estimate: 2.94; CI: 1.45-4.44; p<0.001) individuals had higher readings of blood pressure. Occupation wise, individuals working in sales and services (estimate: 1.39; CI: 0.30-2.49; p<0.05) had higher readings for blood pressure. Food insecurity was negatively associated with blood pressure. Individuals from severely food insecure (estimate: -1.46; CI: -2.54- -0.38; p<0.01) households had lower levels of blood pressure. Blood pressure was increasing in age groups as well as in BMI – older people and people with higher BMI had higher levels. Some education (regardless of primary, secondary, or higher) was associated with a higher level of DBP. Individuals living in Gandaki province (estimate: 2.76; CI: 1.15-4.38; p<0.001) and Lumbini province (estimate: 2.66; CI: 1.18-4.14; p<0.001) had higher levels of blood pressure. Females had lower levels of blood pressure compared to males. No significant association was recorded between DBP and the use of tobacco products, current working status, marital status, media use, and the place of residence (in terms of ecological zones).

Finally, we present results with SBP as the outcome measure. These results, which are very similar to the results for hypertension and DBP, are presented in Panel C of Table 2. The results suggest the following: compared to *Brahmins / Chhetris*, all the other ethnic groups (including the *Newars*) had higher levels of SBP. Food insecure households had lower levels of SBP compared to food secure households. As with the other two outcome measures (i.e., hypertension and DBP), SBP was increasing in age and BMI. Individuals who lived in Gandaki province and Province 5 (or Lumbini province) had higher levels of SBP compared to individuals who lived in Province 1. Females had lower levels of SBP compared to males. No significant association was recorded between SBP and tobacco use, current working status, education, marital status, media use, and the place of residence (in terms of the ecological zones).

Table 2: Association of Hypertension, Diastolic Blood Pressure (DBP), and Systolic Blood Pressure (SBP) with Social, Economic, and Geographic variables

	Hypertension ACC/AHA, 2017 (Panel A)		Diastolic BP (Panel B)		Systolic BP (Panel C)	
Variables	AOR	CI (95%)	Coeff.	CI (95%)	Coeff.	CI (95%)
Ethnicity/Caste						
Brahmins/Chettris (Ref)						
Other Terai Castes	1.38*	(1.03 - 1.84)	1.75**	(0.46 - 3.05)	1.94*	(0.39 - 3.49)
Dalits	1.26*	(1.00 - 1.58)	1.69**	(0.59 - 2.80)	1.76**	(0.45 - 3.07)
Newars	1.41	(0.91 - 2.21)	1.10	(-0.60 - 2.81)	2.00*	(0.24 - 3.77)
Janjatis	1.34**	(1.12 - 1.59)	1.27**	(0.42 - 2.12)	2.43***	(1.36 - 3.51)
Muslim and Other Ethnicities	1.64**	(1.15 - 2.33)	2.94***	(1.45 - 4.44)	1.89*	(0.04 - 3.74)
Occupation						
Did Not Work / Other Occupations (Ref)						
Professional/Technical/Managerial	1.62**	(1.18 - 2.21)	1.18	(-0.22 - 2.58)	1.22	(-0.58 - 3.02)
Clerical	1.34	(0.92 - 1.95)	1.21	(-0.69 - 3.12)	1.84	(-0.70 - 4.38)
Sales/ Services	1.22	(0.92 - 1.60)	1.39*	(0.30 - 2.49)	1.32	(-0.09 - 2.73)
Agricultural - Self Employed	0.95	(0.76 - 1.20)	-0.21	(-1.14 - 0.72)	0.32	(-0.74 - 1.38)
Skilled Manual	1.12	(0.83 - 1.51)	0.34	(-1.14 - 1.82)	0.91	(-0.78 - 2.60)
Unskilled Manual	1.14	(0.85 - 1.53)	0.56	(-0.66 - 1.79)	1.74*	(0.12 - 3.36)
Currently Working (yes=1, no=0)	0.96	(0.79 - 1.17)	0.03	(-0.88 - 0.94)	0.38	(-0.66 - 1.43)
Household Food Insecurity						
Food Secure (Ref)						
Mildly Food Insecure	0.88	(0.76 - 1.02)	-0.39	(-1.03 - 0.26)	-0.52	(-1.35 - 0.32)
Moderately Food Insecure	0.84*	(0.72 - 0.99)	-0.52	(-1.24 - 0.20)	-1.02*	(-1.88 - -0.17)
Severely Food Insecure	0.79	(0.59 - 1.05)	-1.46**	(-2.54 - -0.38)	-2.21**	(-3.69 - -0.72)
Age Categories						
15-19 (Ref)						

20-24	1.31*	(1.05 - 1.64)	0.95*	(0.15 - 1.75)	0.78	(-0.11 - 1.68)
25-29	1.85***	(1.44 - 2.38)	3.15***	(2.13 - 4.17)	2.15***	(0.99 - 3.31)
30-34	2.69***	(2.07 - 3.49)	5.09***	(4.17 - 6.01)	3.84***	(2.65 - 5.03)
35-39	3.73***	(2.88 - 4.84)	7.21***	(6.13 - 8.28)	6.51***	(5.10 - 7.92)
40-44	4.35***	(3.30 - 5.73)	8.23***	(7.12 - 9.34)	9.45***	(8.10 - 10.80)
45-49	5.58***	(4.03 - 7.72)	9.35***	(7.95 - 10.75)	11.99***	(10.34 - 13.64)
Body Mass Index (BMI)						
Thin (Ref)						
Normal	1.90***	(1.58 - 2.28)	2.72***	(2.11 - 3.32)	4.25***	(3.49 - 5.01)
Overweight	4.10***	(3.27 - 5.15)	7.64***	(6.72 - 8.55)	9.83***	(8.71 - 10.94)
Obese	6.73***	(4.83 - 9.39)	10.21***	(8.77 - 11.64)	14.28***	(12.24 - 16.32)
Highest Level of Education						
No Education, Preschool (Ref)						
Primary level	1.05	(0.89 - 1.24)	1.32***	(0.61 - 2.04)	-0.01	(-1.03 - 1.01)
Secondary level	1.18	(1.00 - 1.40)	1.65***	(0.89 - 2.41)	-0.05	(-1.00 - 0.90)
Higher level	1.18	(0.91 - 1.54)	2.09***	(0.91 - 3.27)	-0.57	(-1.94 - 0.80)
Wealth Quintiles						
Poorest (Ref)						
Poorer	0.92	(0.75 - 1.12)	-0.18	(-1.07 - 0.71)	-0.2	(-1.38 - 0.97)
Middle	0.80*	(0.64 - 1.00)	-1.01	(-2.12 - 0.10)	-1.14	(-2.53 - 0.26)
Richer	0.66**	(0.50 - 0.87)	-1.95*	(-3.51 - -0.39)	-1.89*	(-3.52 - -0.27)
Richest	0.60***	(0.46 - 0.80)	-1.97**	(-3.27 - -0.67)	-1.58	(-3.16 - 0.00)
Provinces						
Province 1 (Ref)						
Province 2	0.96	(0.71 - 1.31)	-0.41	(-1.92 - 1.10)	-1	(-2.87 - 0.87)
Bagmati	1.2	(0.89 - 1.62)	0.82	(-0.75 - 2.40)	-0.11	(-1.97 - 1.75)
Gandaki	1.85***	(1.35 - 2.54)	2.76***	(1.15 - 4.38)	2.57**	(0.63 - 4.50)
Lumbini	1.80***	(1.33 - 2.44)	2.66***	(1.18 - 4.14)	3.18***	(1.33 - 5.03)
Karnali	1.25	(0.91 - 1.72)	1.08	(-0.56 - 2.71)	0.31	(-1.54 - 2.17)
Sudurpaschim	1.22	(0.91 - 1.64)	0.47	(-0.91 - 1.85)	1.31	(-0.38 - 3.00)
Ecological Region						
Mountain (Ref)						
Hill	1.23	(0.93 - 1.64)	0.24	(-1.11 - 1.59)	1.47	(-0.15 - 3.09)
Terai	1.04	(0.76 - 1.42)	-0.69	(-2.20 - 0.82)	0.35	(-1.42 - 2.13)
Urban Residence	0.93	(0.77 - 1.13)	-0.16	(-1.15 - 0.83)	-0.38	(-1.54 - 0.79)
Marital Status						
Never Married (Ref)						
Married	0.93	(0.76 - 1.14)	-0.13	(-0.87 - 0.61)	-0.63	(-1.55 - 0.28)
Widowed	1.03	(0.61 - 1.72)	0.67	(-1.63 - 2.98)	1.07	(-2.00 - 4.15)
Divorced	0.86	(0.46 - 1.61)	0.65	(-2.65 - 3.95)	-0.36	(-4.88 - 4.16)
Sex of the Member (Ref=male)	0.64***	(0.55 - 0.73)	-1.93***	(-2.59 - -1.26)	-8.15***	(-8.96 - -7.35)
Head of Household is Female (yes=1, no=0)	1.03	(0.89 - 1.19)	0.1	(-0.50 - 0.71)	-0.03	(-0.82 - 0.77)
Weekly Exposure to Media (yes=1, no=0)	0.98	(0.85 - 1.12)	-0.15	(-0.74 - 0.43)	-0.34	(-1.13 - 0.44)
Used Tobacco Products (yes=1, no=0)	1.1	(0.94 - 1.29)	0.7	(-0.12 - 1.52)	0.46	(-0.54 - 1.46)
Constant	0.12***	(0.07 - 0.18)	68.31***	(66.49 - 70.12)	106.30***	(103.9 - 108.6)
N	9,827		9,827		9,827	

This table presents results for multivariate regression models. Adjusted Odds-Ratio (AORs) estimates of logit specification is given in Panel A. Estimates in panels B and C are presented as linear coefficient estimates. Outcome variables are shown in the top row. As an example, an AOR of 1.85 (in panel A) for Gandaki providence implies that people living in that province had 1.85 times higher odds of hypertension relative to those in province 1 adjusted for other variables. Hypertension, a binary indicator, is defined according to the 2017 American College of Cardiology/ American Heart Association (ACC/AHA) hypertension guidelines. The results adjust for cluster-sampling design and weights. CI = Confidence Interval. Ref. = Reference. Coeff. = Coefficient. *** p<0.001, ** p<0.01, * p<0.05.

Table 3 presents results stratified by sex. We see that occupation is positively associated with hypertension for males only. Other categories that suggest somewhat differential association for the two sexes include ethnicity, food security, wealth, education, provincial and ecological residence, tobacco use and female headed household. Increasing age and BMI is positively associated with hypertension for both males and females. Compared to individuals who are thin, those who are normal, overweight, or obese are more likely to be associated to hypertension.

Table 3: Association of Hypertension with Social, Economic, and Geographic variables Stratified by Sex

	Hypertension			
	Female		Male	
VARIABLES	Adjusted Odds-ratio (AOR)	CI (95%)	Adjusted Odds-ratio (AOR)	CI (95%)
Ethnicity/Caste				
Brahmins/Chettris (Reference)				
Other Terai Castes	1.17	(0.85 - 1.62)	1.66*	(1.08 - 2.56)
Dalits	1.31	(1.00 - 1.72)	1.17	(0.73 - 1.87)
Newars	1.30	(0.82 - 2.08)	1.72*	(1.01 - 2.90)
Janjatis	1.33*	(1.07 - 1.65)	1.33*	(1.04 - 1.71)
Muslim and Other ethnicities	1.61*	(1.10 - 2.38)	1.60*	(1.02 - 2.49)
Occupation				
Did Not Work and other occupations (Reference)				
Professional/Technical/Managerial	1.35	(0.88 - 2.07)	2.83***	(1.65 - 4.85)
Clerical	1.49	(0.84 - 2.66)	2.19*	(1.20 - 4.02)
Sales/ Services	0.79	(0.56 - 1.12)	2.59***	(1.61 - 4.17)
Agricultural - Self Employed	0.77	(0.55 - 1.07)	1.74*	(1.11 - 2.73)
Skilled Manual	0.78	(0.47 - 1.30)	2.28***	(1.46 - 3.56)
Unskilled Manual	0.85	(0.55 - 1.31)	2.47***	(1.48 - 4.10)
Currently working (yes=1, no=0)	1.13	(0.87 - 1.46)	0.83	(0.58 - 1.18)
Household food insecurity				
Food Secure (Reference)				
Mildly Food Insecure	0.98	(0.82 - 1.17)	0.74**	(0.59 - 0.92)
Moderately Food Insecure	0.86	(0.71 - 1.06)	0.82	(0.61 - 1.10)
Severely Food Insecure	0.85	(0.63 - 1.15)	0.73	(0.49 - 1.08)
Age categories				
15-19 (Reference)				
20-24	1.12	(0.85 - 1.48)	1.54*	(1.07 - 2.22)
25-29	1.63**	(1.18 - 2.25)	2.16***	(1.45 - 3.20)
30-34	2.15***	(1.54 - 3.00)	3.67***	(2.46 - 5.48)
35-39	3.03***	(2.21 - 4.17)	4.93***	(3.22 - 7.54)
40-44	4.33***	(3.10 - 6.05)	4.49***	(2.94 - 6.84)
45-49	5.00***	(3.39 - 7.37)	6.88***	(4.29 - 11.05)
Body mass index (BMI)				

Thin (Reference)				
Normal	2.06***	(1.62 - 2.62)	1.67***	(1.27 - 2.18)
Overweight	4.28***	(3.23 - 5.67)	4.32***	(2.93 - 6.35)
Obese	8.07***	(5.25 - 12.39)	5.69***	(3.01 - 10.78)
Highest level of education				
No Education, Preschool (Reference)				
Primary level	1.04	(0.84 - 1.28)	1.17	(0.88 - 1.56)
Secondary level	1.12	(0.88 - 1.41)	1.37*	(1.02 - 1.85)
Higher level	0.98	(0.72 - 1.35)	1.52*	(1.03 - 2.25)
Wealth quintiles				
Poorest (Reference)				
Poorer	1.03	(0.81 - 1.32)	0.75*	(0.58 - 0.99)
Middle	0.85	(0.64 - 1.11)	0.71*	(0.51 - 0.98)
Richer	0.65*	(0.46 - 0.92)	0.66*	(0.46 - 0.94)
Richest	0.62*	(0.43 - 0.90)	0.56**	(0.38 - 0.84)
Provinces				
Province 1 (Reference)				
Province 2	1.16	(0.80 - 1.68)	0.72	(0.48 - 1.09)
Bagmati	1.25	(0.86 - 1.81)	1.12	(0.77 - 1.63)
Gandaki	2.17***	(1.50 - 3.16)	1.55*	(1.03 - 2.32)
Lumbini	1.80**	(1.26 - 2.57)	1.91**	(1.28 - 2.86)
Karnali	1.23	(0.83 - 1.82)	1.29	(0.87 - 1.93)
Sudurpaschim	1.04	(0.70 - 1.54)	1.55*	(1.10 - 2.19)
Ecological region				
Mountain (Reference)				
Hill	1.18	(0.80 - 1.72)	1.38*	(1.00 - 1.89)
Terai	1.18	(0.78 - 1.79)	0.87	(0.59 - 1.28)
Urban residence	0.91	(0.73 - 1.13)	0.96	(0.76 - 1.23)
Marital status				
Never Married (Reference)				
Married	0.87	(0.68 - 1.11)	0.85	(0.62 - 1.16)
Widowed	0.91	(0.50 - 1.64)	2.44	(0.59 - 10.00)
Divorced	0.84	(0.37 - 1.93)	0.97	(0.37 - 2.58)
Sex of the member (Reference=male)				
Head of household is female	0.95	(0.81 - 1.11)	1.40**	(1.09 - 1.80)
Weekly exposure to media (yes=1, no=0)	0.98	(0.81 - 1.17)	0.96	(0.77 - 1.20)
Use tobacco products (yes=1, no=0)	0.97	(0.77 - 1.24)	1.22*	(1.01 - 1.48)
Constant	0.09***	(0.05 - 0.15)	0.07***	(0.04 - 0.13)
Observations	6,089		3,738	
R-squared				

This table presents results for logit models. Adjusted Odds-Ratio (AORs) estimates of logit specification for female is given in the first Panel and for male in the second panel. Hypertension, a binary indicator, is defined according to the 2017 American College of Cardiology/ American Heart Association (ACC/AHA) hypertension guidelines. The results adjust for cluster-sampling design and weights. CI = Confidence Interval. Ref. = Reference. *** p<0.001, ** p<0.01, * p<0.05.

D. DISCUSSION

Using cross-sectional data, our study examined hypertension and its correlates for Nepal. Our analysis, based on the 2016 DHS data, found that around 36% of individuals between the ages of 15-49 in Nepal are hypertensive, suggesting a significant fraction of adults with an elevated risk of cardiovascular diseases. Given the existing evidence that younger population is more likely to have undiagnosed hypertension,[14] population at risk for CVD in Nepal may be higher than what is reported, further underscoring the treatment gap and the need for addressing the gap.

Our study identified multiple factors associated with hypertension (a binary measure), DBP (a continuous measure), and SBP (a continuous measure). Across all three outcome measures, we found that relative to *Brahmins / Chhetris*, other ethnic groups have higher odds of hypertension. This finding could be explained by a few factors. First, access issues may be especially pronounced for certain ethnic groups, as suggested by some of the existing evidence.[11] *Brahmins / Chhetris* have always been two of the most privileged groups in Nepal. Relative to other ethnic groups, these two groups have historically enjoyed, on average, greater social and political advantage in the country. This advantage likely translates into access to healthcare as well as other social determinants of health (such as education, employment, housing, and others). Second, the differences in hypertension rates across the groups may also reflect, to some extent, ethnicity-specific food and cultural practices and preferences.[15]

We found that, for the most part, food insecurity was associated with a lower rate of hypertension, DBP, and SBP. This finding is somewhat counterintuitive because available evidence from LMICs suggests that food insecurity is associated with unfavorable health outcomes such as obesity.[16] Since obese people are more likely to be hypertensive than non-obese people, we would expect to see a positive association between food insecurity and

hypertension. Our seemingly discrepant finding may be a function of the underlying mechanism, which operates not through the "high-energy, processed foods" but likely through the food unavailability route, among others. We found that jobs that are more office-oriented were associated with high blood pressure and hypertension. The reasons might be that individuals who work on these jobs are mentally more stressed but end up doing limited physical work. In terms of geographic locations, Gandaki Province and Province 5 (or Lumbini province) show higher rates of hypertension and blood pressure. In terms of geographic locations, Gandaki Province and Province 5 (or Lumbini province) show higher rates of hypertension and blood pressure. It is unclear, ex-ante, the reason for geographic variation in the prevalence of hypertension. We did not find any evidence of urban residence, marital status, household head, exposure to media, and the use of tobacco products affecting blood pressure or hypertension.

When stratified by sex, we found both similarities and differences in terms of the association between socio-economic several factors. Our results complement earlier work that has also shown that hypertension and/or prehypertension were associated with being overweight or obese, tobacco use, alcohol consumption, age group, education, and the place of residence[7,17] While earlier studies included individuals that were older, our study included only individuals who were no more than 49 years. Compared to other studies, our study instead uses occupation, ethnicity and food security as additional covariates that influence hypertension.

Few studies have looked at the change in hypertension status in Nepal using the new definition.[4,5,10] These studies have reported higher risks of hypertension among people who are older, males, and have higher BMI.[18,19] Our results suggest similar association. In addition, DBP and SBP also show clear positive association with age, gender, and BMI. Further,

our results suggest that hypertension and blood pressure (diastolic and systolic) increase monotonically with age and increasing BMI.

It is important to understand the differences in hypertension prevalence among different ethnic groups and the underlying causes of these differences. Similarly, more research needs to be done to better understand geographic disparities. An important dimension to consider on this could be the ethnic composition of the different provinces and relatedly, the food and cultural practices that accompany different ethnic groups. Nepal has been seeing an increasing trend in BMI over time. [17] Any future policy should target individuals with high BMI in Nepal.

Limitations

There are limitations to this study. First, though we found certain ethnicities had higher rates of hypertension, we were unable to disentangle as to why this might be the case. Second, we could not rule out the selection of individuals into certain occupations. Relatedly, we also could not measure the type of work done in each occupational setting and how these affected measures of blood pressure. Type of work done may hide variation in blood pressure due to the demands of jobs within occupations. Third, food insecurity likely did not sufficiently capture the spectrum of unmet social needs that might be driving the variation. Finally, this study was based on individuals between the ages of 15 to 49 years. It is therefore important to recognize that hypertension for this group was lower than the overall adult population (which comprises of the elderly population).

E. CONCLUSION

Our study showed that certain ethnic groups and occupations were associated with higher rates of hypertension. These groups also had higher levels of SBP and DBP. We found that food insecurity was associated with reduced likelihood of hypertension, and lower levels of DBP and SBP. Consistent with the findings of the existing research, increasing age, male sex, and higher BMI were correlated with hypertension as well as SBP and DBP. Geographically, two provinces (Gandaki and Province 5) had higher rates of hypertension. More research is required to understand the impact of NCDs among different occupations and ethnic groups. It is also important to understand geographic disparities in terms of hypertension prevalence and the related risks.

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CONTRIBUTORS

BT and SJ jointly conceived and planned the overall project. SJ sought approval for data use and led the data analysis. BT and SJ jointly wrote the draft and revised the paper.

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COMPETING INTEREST

None declared.

PATIENT CONSENT FOR PUBLICATION

Not applicable.

ETHICS APPROVAL

This study was based on the analysis of de-identified, secondary data that are publicly available. We obtained permission to use the data from ICF International / Demographic Health Survey (DHS) team.

DATA AVAILABILITY STATEMENT

No additional data are available.

SUPPLEMENTARY ONLINE CONTENT

Available, online only.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7
		(*e*) Describe any sensitivity analyses	9, 16
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-11
		(b) Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	15*	Report numbers of outcome events or summary measures	7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14-15

		(*b*) Report category boundaries when continuous variables were categorized	14-15
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9, 16
Discussion			
Key results	18	Summarise key results with reference to study objectives	16-17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	18
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Socioeconomic Risk Factors of Hypertension and Blood Pressure Among Persons Aged 15-49 in Nepal: A Cross-Sectional Study

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Socioeconomic Risk Factors of Hypertension and Blood Pressure Among Persons Aged 15-49 in Nepal: A Cross-Sectional Study

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ABSTRACT

Objectives

This study estimated the prevalence of hypertension, in accordance with the American College of Cardiology and American Heart Association ‘s 2017 guidelines, and examined the association between various socio-economic factors and systolic blood pressure (SBP), diastolic blood pressure (DBP), and hypertension.

Setting and Design

We used nationally representative data from the 2016 Nepal Demographic and Health Survey. Multivariate analysis was used to study the association of hypertension with socio-economic factors: logistic regression was used for hypertension and linear regression was used for DBP and SBP.

Participants

Our sample consisted of 9,827 adults between the ages of 15 and 49 years.

Results

The prevalence of hypertension was 36 %. The mean diastolic and systolic blood pressure were 76.4 and 111.5, respectively. Janjatis (adjusted odds ratio (AOR): 1.34, CI: 1.12 – 1.59), Other Terai castes (AOR: 1.38, CI: 1.03 - 1.84), Muslim & other ethnicities (AOR: 1.64, CI: 1.15 – 2.33); and Dalits (AOR: 1.26, CI: 1.00 – 1.58) had higher odds of hypertension. Individuals employed in professional, technical, and managerial professions collectively (AOR: 1.62; CI: 1.18 – 2.21) also had higher odds of hypertension. Moderately food insecure household had

lower odds of hypertension (AOR: 0.84; CI: 0.72 - 0.99) compared to households with no issue of food insecurity. Results were similar for SBP and DBP. When stratified by sex, there were differences mainly in terms of occupation and ethnicity.

Conclusion

There are substantial disparities in hypertension prevalence in Nepal. These disparities extend across ethnic groups, occupational status, and food security status. Differences also persist across different provinces. As hypertension continues to be increasingly more significant, more research is needed to better understand the disparities and gradients that exist across various socio-economic factors.

ARTICLE SUMMARY

Strengths and limitations of the study

- This is the first study, to our knowledge, to use nationally representative data to examine specifically the association of hypertension / blood pressure with ethnicity, occupation, and food security status.
- In addition to using hypertension as a binary outcome, this study uses systolic and diastolic blood pressure as a continuous outcome measure, thereby addressing cutoff-point issues linked with recent changes in definition of hypertension.
- Study sample only includes adults between the ages of 15-49 years.
- This is an associational study based on cross-sectional data, and therefore, the findings cannot be used make causal claims.

A. INTRODUCTION

Hypertension is a major risk factor for cardiovascular diseases (CVDs) and a significant contributor to the growing burden of non-communicable diseases (NCDs) in low-and-lower-middle-income countries (LMICs). Nearly two-thirds of the people with hypertension live in LMICs and about one in every third person in LMICs has hypertension.[1,2] With the increasing growth in the share of elderly populations, hypertension also stands to be a major risk factor for cognitive impairment and dementia in LMICs.[3]

Nepal is no exception to the hypertension trend that has been observed in other LMICs. A recent analysis found that the prevalence of hypertension among Nepalese adults is 44.2 percent.[4] The number varies by sub-groups. It is nearly 30 percentage points higher for those with body mass index (BMI) of 30 or more, 20 percentage points higher for people older than 70, and 6 percentage points higher for those from the richest quintile. Existing studies on hypertension in Nepal have focused predominantly on the prevalence of and factors associated with hypertension.[4–8] Among the most studied factors include age, sex, BMI, education level, marital status, wealth index, and smoking and drinking status. Existing studies of hypertension in Nepal have not explored the role of ethnicity, occupation, and household food security status. Studies outside of Nepal have looked at the role of unmet social needs (for example, food security) and health outcomes,[9] and suggests a high positive correlation between unmet social needs and poor health outcomes.

Our study contributes to the literature in a few ways. First, this is the first Nepal-based multivariate study, to our knowledge, that uses a nationally representative data to understand the association of hypertension with ethnicity, occupation, and food security. Using food security as an important determinant for hypertension and blood pressure, the study also contributes to the

growing literature on the role of unmet social needs on health and health outcomes. Second, this study looks at three different outcome measures. In addition to the binary measure of hypertension, the study uses continuous measures of blood pressure (corresponding to diastolic and systolic blood pressure measurements). Few studies have examined the change in hypertension prevalence using the new definition but the evidence on Nepal is still limited overall. [4,10] Using the continuous measure of systolic and diastolic blood pressure allows us to study the risk of high blood pressure without relying too much on a single binary outcome. Systolic and diastolic blood pressure are measures of risk that do not rely on a particular cutoff. The use of these measures mitigates the cutoff point issues associated with the change in the definition of hypertension. Additionally, there is evidence that systolic blood pressure is a predictor of risk for CVDs.[11] We also stratified our analysis by sex to capture if there are substantial differences by sex.

Finally, our study focuses on a much younger population (15-49 years) than the earlier studies. Even though the younger population is less likely to suffer from hypertension, it is still susceptible to the risks of hypertension due to changes in lifestyle, unmet social needs, occupational status, and other correlates including sex and BMI.

B. METHODS

B.1: Data Source

We used data from Nepal Demographic and Health Survey (NDHS), 2016. Data were collected from June 2016 to January 2017 by New ERA with support from the Ministry of

Health. The NDHS provides up-to-date estimates of the basic demographic and health indicators as well as a comprehensive overview of population, maternal, and child health issues in Nepal.

B.2: Survey Design

The sampling frame used for the 2016 NDHS was an updated version of the frame from the 2011 National Population and Housing Census. The frame was updated since the urban/rural classification changed at the ward level in 2014 and 2015. The sample was stratified and selected in two stages in rural areas and three stages in urban areas. In rural areas, wards were selected as the primary sampling units (PSUs) and households were selected from the sample PSUs. In urban areas, wards were selected as the PSUs. One Enumeration areas (EA) was selected from each PSU and then households were selected from the sample EAs. Our sample consisted of a total of 9,827 individuals aged 15-49 years. All these individuals had complete information on our variables of interest.

B.3: Outcome Measures

Our main outcome variable was hypertension, defined in line with the 2017 American College of Cardiology (ACC) / American Heart Association (AHA) guidelines (systolic blood pressure ≥130 mm Hg and/or diastolic blood pressure ≥80 mm Hg). Individuals were also considered hypertensive if they reported taking antihypertensive medications. Our additional outcomes included measures for systolic blood pressure (SBP) and diastolic blood pressure (DBP). The survey measured respondents' blood pressure three times. The average of the second and the third reading was used.

B.4: Explanatory Variables

Our main explanatory variables were ethnicity, occupation, and food security status. Ethnicity was divided into 6 categories.[12] Occupational status was divided into 7 categories. Household food security status was divided into 4 categories: food secure, mildly food insecure, moderately food insecure, and severely food insecure. The four categories were created using the questionnaires that focused on food insecurity for the household as a unit. The questions, arranged in order of severity and frequency of occurrence, captured households' perceptions of food vulnerability or stress and behavioral responses to food insecurity. The questions followed the Household Food Insecurity Access Scale developed by USAID's Food and Nutrition Technical (FANTA) project. [13]

Other explanatory variables included provincial location, rural/urban status, ecological region, sex, age group, BMI category, highest level of education, sex of the household head, and household wealth index. Nepal has seven provinces and three ecological regions. Age was categorized into 7 groups (15-19, 20-24, and so on). Similarly, BMI was categorized into four groups: thin (BMI <18.5), normal (BMI >=18.5 and BMI <25), overweight (BMI >=25 and BMI <30), and obese (BMI >=30). Educational attainment was grouped into four categories: no education and/or preschool, primary, secondary, and higher secondary. The household wealth index, derived using data on household assets and other household characteristics such as access to water and sanitation facilities, consists of five quintiles (from poorest to the richest). Additional independent variables included current work / employment status, media use, marital status, and tobacco use. A dummy variable for media use was created based on the frequency of the use of internet, radio, television, or reading of newspaper or magazine. Tobacco use, also a dummy variable, included any use of tobacco.

B.5: Statistical Analysis

We used multivariate regression analysis to understand and quantify the magnitude of the association between the outcome measures (i.e., hypertension, DBP, and SBP) and the independent variables. We used logit model for our binary outcome variable (hypertension) and linear models for the two continuous outcome variables (DBP and SBP). Key independent variables were ethnicity, occupation, and food security status. We also included other independent variables (such as sex, BMI, education, and others) that have been widely used in the hypertension literature. Additionally, when the outcome was hypertension, we stratified the analysis by sex. All tests were two- tailed and a p value of < 0.05 was considered statistically significant. We applied sample weight calculated in the DHS and adjusted for clustering using the "svy" command in Stata.

All the statistical analysis was performed in Stata 15.1 (StataCorp). Approval to access and use the DHS data was obtained from the ICF International.

B.6. Patient and Public Involvement

Study participants or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

C. RESULTS

We present descriptive statistics in **Table 1**. In our study sample comprising of 9,827 people between the ages of 15-49 years, 36% had hypertension. The mean values of SBP and

DBP were 112 and 76 respectively. At 32%, *Janjatis* were the largest ethnic group. Nearly 41% of the study population was self-employed in agriculture while 25% of the population did not work or held other occupations. Around 50% of the people lived in food-secure households. Nearly 73% of the study population was married and 26% used tobacco products. Additionally, 50% of the people lived in the Terai region, 63% resided in urban areas, 61% were females, and 26% lived in households headed by females. Approximately 70% of the study population used media of some kind in the week prior to the survey.

Table 1: Characteristics of the Study Population

	Mean*	SE	N
Hypertension (ACC/AHA, 2017)	0.36	0.01	3493
Hypertension (JNC 7)	0.13	0.01	1284
Systolic BP	111.54	0.31	9827
Diastolic BP	76.38	0.26	9827
Ethnicity/Caste			
Brahmins / Chhettris	0.30	0.01	2983
Other Terai Castes	0.15	0.01	1486
Dalits	0.12	0.01	1220
Newars	0.05	0.01	476
Janjatis	0.32	0.02	3137
Muslim and Other ethnicities	0.05	0.01	525
Occupation			
Did Not Work and Other Occupations	0.25	0.01	2470
Professional/Technical/Managerial	0.06	0.00	541
Clerical	0.03	0.00	271
Sales/ Services	0.13	0.01	1314
Agricultural - Self Employed	0.41	0.01	4014
Skilled Manual	0.07	0.00	652
Unskilled Manual	0.06	0.00	565
Currently working (yes=1, no=0)	0.66	0.01	6513
Household food insecurity			
Food Secure	0.48	0.01	4668
Mildly Food Insecure	0.23	0.01	2286
Moderately Food Insecure	0.22	0.01	2119

	Severely Food Insecure	0.08	0.01	753
Age categories				
	15-19	0.21	0.00	2062
	20-24	0.16	0.01	1605
	25-29	0.15	0.00	1435
	30-34	0.14	0.00	1396
	35-39	0.13	0.00	1302
	40-44	0.11	0.00	1097
	45-49	0.09	0.00	929
Body mass index (BMI)				
	Thin	0.17	0.01	1623
	Normal	0.63	0.01	6237
	Overweight	0.16	0.01	1570
	Obese	0.04	0.00	398
Highest level of education				
	No Education, Preschool	0.25	0.01	2424
	Primary level	0.18	0.01	1738
	Secondary level	0.41	0.01	4018
	Higher level	0.17	0.01	1647
Wealth quintiles				
	Poorest	0.17	0.01	1639
	Poorer	0.19	0.01	1840
	Middle	0.20	0.01	1970
	Richer	0.23	0.01	2232
	Richest	0.22	0.01	2145
Provinces				
	Province 1	0.17	0.01	1693
	Province 2	0.20	0.01	1981
	Bagmati	0.22	0.02	2168
	Gandaki	0.10	0.01	951
	Lumbini	0.17	0.01	1639
	Karnali	0.06	0.00	541
	Sudurpaschim	0.09	0.00	854
Ecological region				
	Mountain	0.06	0.01	607
	Hill	0.44	0.03	4276
	Terai	0.50	0.02	4944
Urban residence		0.63	0.02	6213
Marital status				
	Never Married	0.25	0.01	2486
	Married	0.73	0.01	7156
	Widowed	0.01	0.00	122

	Divorced	0.01	0.00	63
Sex of the member (female=1, male=0)		0.61	0.01	6015
Head of household is female (yes=1, no=0)		0.26	0.01	2507
Weekly exposure to media (yes=1, no=0)		0.69	0.01	6760
Use tobacco products (yes=1, no=0)		0.26	0.01	2553

ACC / AHA = American College of Cardiology / American Heart Association; JNC 7 = Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure; SE = Standard Error; BP = Blood Pressure. *Multiply the Mean values by 100 to get the values in percent.

Table 2 shows results for multivariate regression models for all three outcome measures: hypertension (measured as a binary variable), DBP (measured as a continuous variable), and SBP (measured as a continuous variable). Our results for hypertension, presented in terms of adjusted odds ratios (AOR) in Panel A of Table 2, suggest the following: compared to *Brahmins / Chhetris*, *Janjatis* (AOR: 1.34; CI: 1.12 – 1.59; $p < 0.01$), *Other Terai castes* (AOR: 1.38; CI: 1.03 - 1.84; $p<0.05$), *Muslim and other ethnicities* (AOR: 1.64; CI: 1.15 – 2.33; $p < 0.01$) and *Dalits* (AOR: 1.26; CI: 1.00 – 1.58; $p < 0.05$) had higher odds of hypertension. Individuals employed in professional, technical, and managerial professions collectively (AOR: 1.62; CI: 1.18 – 2.21; $p < 0.01$) also had higher odds of hypertension compared to those who did not work or were employed in other jobs. Moderately food insecure household had lower odds of hypertension (AOR: 0.84; CI: 0.72 - 0.99; $p <0.05$) compared to households with no issue of food insecurity. Compared to the youngest population in the study sample (i.e., 15- to 19-year-olds), older adults had higher adjusted odds of hypertension. More notably, there was an age gradient in the adjusted odds of having hypertension. As implied by the magnitude of the AOR, the association between hypertension and age was stronger for older age groups. Compared to individuals in the lowest BMI category, those in the higher BMI categories had higher odds of hypertension. In terms of the geographic location, individuals residing in Gandaki province (AOR: 1.85; CI: 1.35-2.54; $p<0.001$) and Lumbini province (AOR: 1.80; CI: 1.33-2.44; $p<0.001$) had higher odds of hypertension. Individuals in richer households had lower odds of

hypertension compared to individuals in the poorest households. For example, individuals residing in the richest (OR: 0.60; CI: 0.46-0.80; p<0.001) and the second richest (OR: 0.66; CI: 0.50-0.87; p<0.01) households had lower odds of hypertension compared to individuals living in the poorest households. Compared to males, females had lower odds (OR: 0.64, CI: 0.55- 0.73; p < 0.001). No significant association was recorded between hypertension and the use of tobacco products, current working status, marital status, media use, and the place of residence (in terms of ecological zones).

Our results on the association between DBP, presented in Panel B **Table 2**, suggest the following: compared to *Brahmins/Chhetris*, *Dalit* (estimate: 1.69; CI: 0.59-2.80; p<0.01), *Janjatis* (estimate: 1.27; CI: 0.42-2.12; p<0.01), and *Muslim and other* (estimate: 2.94; CI: 1.45-4.44; p<0.001) individuals had higher readings of blood pressure. Occupation wise, individuals working in sales and services (estimate: 1.39; CI: 0.30-2.49; p<0.05) had higher readings for blood pressure. Food insecurity was negatively associated with blood pressure. Individuals from severely food insecure (estimate: -1.46; CI: -2.54- -0.38; p<0.01) households had lower levels of blood pressure. Blood pressure was increasing in age groups as well as in BMI – older people and people with higher BMI had higher levels. Some education (regardless of primary, secondary, or higher) was associated with a higher level of DBP. Individuals living in Gandaki province (estimate: 2.76; CI: 1.15-4.38; p<0.001) and Lumbini province (estimate: 2.66; CI: 1.18-4.14; p<0.001) had higher levels of blood pressure. Females had lower levels of blood pressure compared to males. No significant association was recorded between DBP and the use of tobacco products, current working status, marital status, media use, and the place of residence (in terms of ecological zones).

Finally, we present results with SBP as the outcome measure. These results, which are very similar to the results for hypertension and DBP, are presented in Panel C of Table 2. The results suggest the following: compared to *Brahmins / Chhetris*, all the other ethnic groups (including the *Newars*) had higher levels of SBP. Food insecure households had lower levels of SBP compared to food secure households. As with the other two outcome measures (i.e., hypertension and DBP), SBP was increasing in age and BMI. Individuals who lived in Gandaki province and Province 5 (or Lumbini province) had higher levels of SBP compared to individuals who lived in Province 1. Females had lower levels of SBP compared to males. No significant association was recorded between SBP and tobacco use, current working status, education, marital status, media use, and the place of residence (in terms of the ecological zones).

Table 2: Association of Hypertension, Diastolic Blood Pressure (DBP), and Systolic Blood Pressure (SBP) with Social, Economic, and Geographic variables

	Hypertension ACC/AHA, 2017 (Panel A)		Diastolic BP (Panel B)		Systolic BP (Panel C)	
Variables	AOR	CI (95%)	Coeff.	CI (95%)	Coeff.	CI (95%)
Ethnicity/Caste						
Brahmins/Chettris (Ref)						
Other Terai Castes	1.38*	(1.03 - 1.84)	1.75**	(0.46 - 3.05)	1.94*	(0.39 - 3.49)
Dalits	1.26*	(1.00 - 1.58)	1.69**	(0.59 - 2.80)	1.76**	(0.45 - 3.07)
Newars	1.41	(0.91 - 2.21)	1.10	(-0.60 - 2.81)	2.00*	(0.24 - 3.77)
Janjatis	1.34**	(1.12 - 1.59)	1.27**	(0.42 - 2.12)	2.43***	(1.36 - 3.51)
Muslim and Other Ethnicities	1.64**	(1.15 - 2.33)	2.94***	(1.45 - 4.44)	1.89*	(0.04 - 3.74)
Occupation						
Did Not Work / Other Occupations (Ref)						
Professional/Technical/Managerial	1.62**	(1.18 - 2.21)	1.18	(-0.22 - 2.58)	1.22	(-0.58 - 3.02)
Clerical	1.34	(0.92 - 1.95)	1.21	(-0.69 - 3.12)	1.84	(-0.70 - 4.38)
Sales/ Services	1.22	(0.92 - 1.60)	1.39*	(0.30 - 2.49)	1.32	(-0.09 - 2.73)
Agricultural - Self Employed	0.95	(0.76 - 1.20)	-0.21	(-1.14 - 0.72)	0.32	(-0.74 - 1.38)
Skilled Manual	1.12	(0.83 - 1.51)	0.34	(-1.14 - 1.82)	0.91	(-0.78 - 2.60)
Unskilled Manual	1.14	(0.85 - 1.53)	0.56	(-0.66 - 1.79)	1.74*	(0.12 - 3.36)
Currently Working (yes=1, no=0)	0.96	(0.79 - 1.17)	0.03	(-0.88 - 0.94)	0.38	(-0.66 - 1.43)
Household Food Insecurity						
Food Secure (Ref)						
Mildly Food Insecure	0.88	(0.76 - 1.02)	-0.39	(-1.03 - 0.26)	-0.52	(-1.35 - 0.32)
Moderately Food Insecure	0.84*	(0.72 - 0.99)	-0.52	(-1.24 - 0.20)	-1.02*	(-1.88 - -0.17)
Severely Food Insecure	0.79	(0.59 - 1.05)	-1.46**	(-2.54 - -0.38)	-2.21**	(-3.69 - -0.72)
Age Categories						
15-19 (Ref)						

20-24	1.31*	(1.05 - 1.64)	0.95*	(0.15 - 1.75)	0.78	(-0.11 - 1.68)
25-29	1.85***	(1.44 - 2.38)	3.15***	(2.13 - 4.17)	2.15***	(0.99 - 3.31)
30-34	2.69***	(2.07 - 3.49)	5.09***	(4.17 - 6.01)	3.84***	(2.65 - 5.03)
35-39	3.73***	(2.88 - 4.84)	7.21***	(6.13 - 8.28)	6.51***	(5.10 - 7.92)
40-44	4.35***	(3.30 - 5.73)	8.23***	(7.12 - 9.34)	9.45***	(8.10 - 10.80)
45-49	5.58***	(4.03 - 7.72)	9.35***	(7.95 - 10.75)	11.99***	(10.34 - 13.64)
Body Mass Index (BMI)						
Thin (Ref)						
Normal	1.90***	(1.58 - 2.28)	2.72***	(2.11 - 3.32)	4.25***	(3.49 - 5.01)
Overweight	4.10***	(3.27 - 5.15)	7.64***	(6.72 - 8.55)	9.83***	(8.71 - 10.94)
Obese	6.73***	(4.83 - 9.39)	10.21***	(8.77 - 11.64)	14.28***	(12.24 - 16.32)
Highest Level of Education						
No Education, Preschool (Ref)						
Primary level	1.05	(0.89 - 1.24)	1.32***	(0.61 - 2.04)	-0.01	(-1.03 - 1.01)
Secondary level	1.18	(1.00 - 1.40)	1.65***	(0.89 - 2.41)	-0.05	(-1.00 - 0.90)
Higher level	1.18	(0.91 - 1.54)	2.09***	(0.91 - 3.27)	-0.57	(-1.94 - 0.80)
Wealth Quintiles						
Poorest (Ref)						
Poorer	0.92	(0.75 - 1.12)	-0.18	(-1.07 - 0.71)	-0.2	(-1.38 - 0.97)
Middle	0.80*	(0.64 - 1.00)	-1.01	(-2.12 - 0.10)	-1.14	(-2.53 - 0.26)
Richer	0.66**	(0.50 - 0.87)	-1.95*	(-3.51 - -0.39)	-1.89*	(-3.52 - -0.27)
Richest	0.60***	(0.46 - 0.80)	-1.97**	(-3.27 - -0.67)	-1.58	(-3.16 - 0.00)
Provinces						
Province 1 (Ref)						
Province 2	0.96	(0.71 - 1.31)	-0.41	(-1.92 - 1.10)	-1	(-2.87 - 0.87)
Bagmati	1.2	(0.89 - 1.62)	0.82	(-0.75 - 2.40)	-0.11	(-1.97 - 1.75)
Gandaki	1.85***	(1.35 - 2.54)	2.76***	(1.15 - 4.38)	2.57**	(0.63 - 4.50)
Lumbini	1.80***	(1.33 - 2.44)	2.66***	(1.18 - 4.14)	3.18***	(1.33 - 5.03)
Karnali	1.25	(0.91 - 1.72)	1.08	(-0.56 - 2.71)	0.31	(-1.54 - 2.17)
Sudurpaschim	1.22	(0.91 - 1.64)	0.47	(-0.91 - 1.85)	1.31	(-0.38 - 3.00)
Ecological Region						
Mountain (Ref)						
Hill	1.23	(0.93 - 1.64)	0.24	(-1.11 - 1.59)	1.47	(-0.15 - 3.09)
Terai	1.04	(0.76 - 1.42)	-0.69	(-2.20 - 0.82)	0.35	(-1.42 - 2.13)
Urban Residence	0.93	(0.77 - 1.13)	-0.16	(-1.15 - 0.83)	-0.38	(-1.54 - 0.79)
Marital Status						
Never Married (Ref)						
Married	0.93	(0.76 - 1.14)	-0.13	(-0.87 - 0.61)	-0.63	(-1.55 - 0.28)
Widowed	1.03	(0.61 - 1.72)	0.67	(-1.63 - 2.98)	1.07	(-2.00 - 4.15)
Divorced	0.86	(0.46 - 1.61)	0.65	(-2.65 - 3.95)	-0.36	(-4.88 - 4.16)
Sex of the Member (Ref=male)	0.64***	(0.55 - 0.73)	-1.93***	(-2.59 - -1.26)	-8.15***	(-8.96 - -7.35)
Head of Household is Female (yes=1, no=0)	1.03	(0.89 - 1.19)	0.1	(-0.50 - 0.71)	-0.03	(-0.82 - 0.77)
Weekly Exposure to Media (yes=1, no=0)	0.98	(0.85 - 1.12)	-0.15	(-0.74 - 0.43)	-0.34	(-1.13 - 0.44)
Used Tobacco Products (yes=1, no=0)	1.1	(0.94 - 1.29)	0.7	(-0.12 - 1.52)	0.46	(-0.54 - 1.46)
Constant	0.12***	(0.07 - 0.18)	68.31***	(66.49 - 70.12)	106.30***	(103.9 - 108.6)
N	9,827		9,827		9,827	

This table presents results for multivariate regression models. Adjusted Odds-Ratio (AORs) estimates of logit specification is given in Panel A. Estimates in panels B and C are presented as linear coefficient estimates. Outcome variables are shown in the top row. As an example, an AOR of 1.85 (in panel A) for Gandaki providence implies that people living in that province had 1.85 times higher odds of hypertension relative to those in province 1 adjusted for other variables. Hypertension, a binary indicator, is defined according to the 2017 American College of Cardiology/ American Heart Association (ACC/AHA) hypertension guidelines. The results adjust for cluster-sampling design and weights. CI = Confidence Interval. Ref. = Reference. Coeff. = Coefficient. *** p<0.001, ** p<0.01, * p<0.05.

Table 3 presents results stratified by sex. We see that occupation is positively associated with hypertension for males only. Other categories that suggest somewhat differential association for the two sexes include ethnicity, food security, wealth, education, provincial and ecological residence, tobacco use and female headed household. Increasing age and BMI is positively associated with hypertension for both males and females. Compared to individuals who are thin, those who are normal, overweight, or obese are more likely to be associated to hypertension.

Table 3: Association of Hypertension with Social, Economic, and Geographic variables Stratified by Sex

	Hypertension			
	Female		Male	
VARIABLES	Adjusted Odds-ratio (AOR)	CI (95%)	Adjusted Odds-ratio (AOR)	CI (95%)
Ethnicity/Caste				
Brahmins/Chettris (Reference)				
Other Terai Castes	1.17	(0.85 - 1.62)	1.66*	(1.08 - 2.56)
Dalits	1.31	(1.00 - 1.72)	1.17	(0.73 - 1.87)
Newars	1.30	(0.82 - 2.08)	1.72*	(1.01 - 2.90)
Janjatis	1.33*	(1.07 - 1.65)	1.33*	(1.04 - 1.71)
Muslim and Other ethnicities	1.61*	(1.10 - 2.38)	1.60*	(1.02 - 2.49)
Occupation				
Did Not Work and other occupations (Reference)				
Professional/Technical/Managerial	1.35	(0.88 - 2.07)	2.83***	(1.65 - 4.85)
Clerical	1.49	(0.84 - 2.66)	2.19*	(1.20 - 4.02)
Sales/ Services	0.79	(0.56 - 1.12)	2.59***	(1.61 - 4.17)
Agricultural - Self Employed	0.77	(0.55 - 1.07)	1.74*	(1.11 - 2.73)
Skilled Manual	0.78	(0.47 - 1.30)	2.28***	(1.46 - 3.56)
Unskilled Manual	0.85	(0.55 - 1.31)	2.47***	(1.48 - 4.10)
Currently working (yes=1, no=0)	1.13	(0.87 - 1.46)	0.83	(0.58 - 1.18)
Household food insecurity				
Food Secure (Reference)				
Mildly Food Insecure	0.98	(0.82 - 1.17)	0.74**	(0.59 - 0.92)
Moderately Food Insecure	0.86	(0.71 - 1.06)	0.82	(0.61 - 1.10)
Severely Food Insecure	0.85	(0.63 - 1.15)	0.73	(0.49 - 1.08)
Age categories				
15-19 (Reference)				
20-24	1.12	(0.85 - 1.48)	1.54*	(1.07 - 2.22)
25-29	1.63**	(1.18 - 2.25)	2.16***	(1.45 - 3.20)
30-34	2.15***	(1.54 - 3.00)	3.67***	(2.46 - 5.48)
35-39	3.03***	(2.21 - 4.17)	4.93***	(3.22 - 7.54)
40-44	4.33***	(3.10 - 6.05)	4.49***	(2.94 - 6.84)
45-49	5.00***	(3.39 - 7.37)	6.88***	(4.29 - 11.05)
Body mass index (BMI)				

Thin (Reference)				
Normal	2.06***	(1.62 - 2.62)	1.67***	(1.27 - 2.18)
Overweight	4.28***	(3.23 - 5.67)	4.32***	(2.93 - 6.35)
Obese	8.07***	(5.25 - 12.39)	5.69***	(3.01 - 10.78)
Highest level of education				
No Education, Preschool (Reference)				
Primary level	1.04	(0.84 - 1.28)	1.17	(0.88 - 1.56)
Secondary level	1.12	(0.88 - 1.41)	1.37*	(1.02 - 1.85)
Higher level	0.98	(0.72 - 1.35)	1.52*	(1.03 - 2.25)
Wealth quintiles				
Poorest (Reference)				
Poorer	1.03	(0.81 - 1.32)	0.75*	(0.58 - 0.99)
Middle	0.85	(0.64 - 1.11)	0.71*	(0.51 - 0.98)
Richer	0.65*	(0.46 - 0.92)	0.66*	(0.46 - 0.94)
Richest	0.62*	(0.43 - 0.90)	0.56**	(0.38 - 0.84)
Provinces				
Province 1 (Reference)				
Province 2	1.16	(0.80 - 1.68)	0.72	(0.48 - 1.09)
Bagmati	1.25	(0.86 - 1.81)	1.12	(0.77 - 1.63)
Gandaki	2.17***	(1.50 - 3.16)	1.55*	(1.03 - 2.32)
Lumbini	1.80**	(1.26 - 2.57)	1.91**	(1.28 - 2.86)
Karnali	1.23	(0.83 - 1.82)	1.29	(0.87 - 1.93)
Sudurpaschim	1.04	(0.70 - 1.54)	1.55*	(1.10 - 2.19)
Ecological region				
Mountain (Reference)				
Hill	1.18	(0.80 - 1.72)	1.38*	(1.00 - 1.89)
Terai	1.18	(0.78 - 1.79)	0.87	(0.59 - 1.28)
Urban residence	0.91	(0.73 - 1.13)	0.96	(0.76 - 1.23)
Marital status				
Never Married (Reference)				
Married	0.87	(0.68 - 1.11)	0.85	(0.62 - 1.16)
Widowed	0.91	(0.50 - 1.64)	2.44	(0.59 - 10.00)
Divorced	0.84	(0.37 - 1.93)	0.97	(0.37 - 2.58)
Sex of the member (Reference=male)				
Head of household is female	0.95	(0.81 - 1.11)	1.40**	(1.09 - 1.80)
Weekly exposure to media (yes=1, no=0)	0.98	(0.81 - 1.17)	0.96	(0.77 - 1.20)
Use tobacco products (yes=1, no=0)	0.97	(0.77 - 1.24)	1.22*	(1.01 - 1.48)
Constant	0.09***	(0.05 - 0.15)	0.07***	(0.04 - 0.13)
Observations	6,089		3,738	
R-squared				

This table presents results for logit models. Adjusted Odds-Ratio (AORs) estimates of logit specification for female is given in the first Panel and for male in the second panel. Hypertension, a binary indicator, is defined according to the 2017 American College of Cardiology/ American Heart Association (ACC/AHA) hypertension guidelines. The results adjust for cluster-sampling design and weights. CI = Confidence Interval. Ref. = Reference. *** p<0.001, ** p<0.01, * p<0.05.

D. DISCUSSION

Using cross-sectional data, our study examined hypertension and its correlates for Nepal. Our analysis, based on the 2016 DHS data, found that around 36% of individuals between the ages of 15-49 in Nepal are hypertensive, suggesting a significant fraction of adults with an elevated risk of cardiovascular diseases. Given the existing evidence that younger population is more likely to have undiagnosed hypertension,[14] population at risk for CVD in Nepal may be higher than what is reported, further underscoring the treatment gap and the need for addressing the gap.

Our study identified multiple factors associated with hypertension (a binary measure), DBP (a continuous measure), and SBP (a continuous measure). Across all three outcome measures, we found that relative to *Brahmins / Chhetris*, other ethnic groups have higher odds of hypertension. This finding could be explained by a few factors. First, access issues may be especially pronounced for certain ethnic groups, as suggested by some of the existing evidence.[11] *Brahmins / Chhetris* have always been two of the most privileged groups in Nepal. Relative to other ethnic groups, these two groups have historically enjoyed, on average, greater social and political advantage in the country. This advantage likely translates into access to healthcare as well as other social determinants of health (such as education, employment, housing, and others). Second, the differences in hypertension rates across the groups may also reflect, to some extent, ethnicity-specific food and cultural practices and preferences.[15]

We found that, for the most part, food insecurity was associated with a lower rate of hypertension, DBP, and SBP. This finding is somewhat counterintuitive because available evidence from LMICs suggests that food insecurity is associated with unfavorable health outcomes such as obesity.[16] Since obese people are more likely to be hypertensive than non-obese people, we would expect to see a positive association between food insecurity and

hypertension. Our seemingly discrepant finding may be a function of the underlying mechanism, which operates not through the "high-energy, processed foods" but likely through the food unavailability route, among others. We found that jobs that are more office-oriented were associated with high blood pressure and hypertension. The reasons might be that individuals who work on these jobs are mentally more stressed but end up doing limited physical work. In terms of geographic locations, Gandaki Province and Province 5 (or Lumbini province) show higher rates of hypertension and blood pressure. In terms of geographic locations, Gandaki Province and Province 5 (or Lumbini province) show higher rates of hypertension and blood pressure. It is unclear, ex-ante, the reason for geographic variation in the prevalence of hypertension. We did not find any evidence of urban residence, marital status, household head, exposure to media, and the use of tobacco products affecting blood pressure or hypertension.

When stratified by sex, we found both similarities and differences in terms of the association between socio-economic several factors. Our results complement earlier work that has also shown that hypertension and/or prehypertension were associated with being overweight or obese, tobacco use, alcohol consumption, age group, education, and the place of residence[7,17] While earlier studies included individuals that were older, our study included only individuals who were no more than 49 years. Compared to other studies, our study instead uses occupation, ethnicity and food security as additional covariates that influence hypertension.

Few studies have looked at the change in hypertension status in Nepal using the new definition.[4,5,10] These studies have reported higher risks of hypertension among people who are older, males, and have higher BMI.[18,19] Our results suggest similar association. In addition, DBP and SBP also show clear positive association with age, gender, and BMI. Further,

our results suggest that hypertension and blood pressure (diastolic and systolic) increase monotonically with age and increasing BMI.

It is important to understand the differences in hypertension prevalence among different ethnic groups and the underlying causes of these differences. Similarly, more research needs to be done to better understand geographic disparities. An important dimension to consider on this could be the ethnic composition of the different provinces and relatedly, the food and cultural practices that accompany different ethnic groups. Nepal has been seeing an increasing trend in BMI over time. [17] Any future policy should target individuals with high BMI in Nepal.

Limitations

There are limitations to this study. First, though we found certain ethnicities had higher rates of hypertension, we were unable to disentangle as to why this might be the case. Second, we could not rule out the selection of individuals into certain occupations. Relatedly, we also could not measure the type of work done in each occupational setting and how these affected measures of blood pressure. Type of work done may hide variation in blood pressure due to the demands of jobs within occupations. Third, food insecurity likely did not sufficiently capture the spectrum of unmet social needs that might be driving the variation. Finally, this study was based on individuals between the ages of 15 to 49 years. It is therefore important to recognize that hypertension for this group was lower than the overall adult population (which comprises of the elderly population).

E. CONCLUSION

Our study showed that certain ethnic groups and occupations were associated with higher rates of hypertension. These groups also had higher levels of SBP and DBP. We found that food insecurity was associated with reduced likelihood of hypertension, and lower levels of DBP and SBP. Consistent with the findings of the existing research, increasing age, male sex, and higher BMI were correlated with hypertension as well as SBP and DBP. Geographically, two provinces (Gandaki and Province 5) had higher rates of hypertension. More research is required to understand the impact of NCDs among different occupations and ethnic groups. It is also important to understand geographic disparities in terms of hypertension prevalence and the related risks.

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CONTRIBUTORS

BT and SJ jointly conceived and planned the overall project. SJ sought approval for data use and led the data analysis. BT and SJ jointly wrote the draft and revised the paper.

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COMPETING INTEREST

None declared.

PATIENT CONSENT FOR PUBLICATION

Not applicable.

ETHICS APPROVAL

This study was based on the analysis of de-identified, secondary data that are publicly available. We obtained permission to use the data from ICF International / Demographic Health Survey (DHS) team.

DATA AVAILABILITY STATEMENT

No additional data are available.

SUPPLEMENTARY ONLINE CONTENT

Available, online only.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7
		(*e*) Describe any sensitivity analyses	9, 16
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-11
		(b) Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	15*	Report numbers of outcome events or summary measures	7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14-15

		(*b*) Report category boundaries when continuous variables were categorized	14-15
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9, 16
Discussion			
Key results	18	Summarise key results with reference to study objectives	16-17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	18
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.