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Factors associated with hypertension among adults in Nepal as per the Joint National Committee 7 and 2017 American College of Cardiology/American Heart Association hypertension guidelines: a cross-sectional analysis of the demographic and health survey 2016

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ABSTRACT

Objectives This study investigated the determinants of hypertension in Nepal according to both the Joint National Committee 7 (JNC7) and the American College of Cardiology/American Heart Association (2017 ACC/AHA) guidelines.

Design Cross-sectional study.

Setting This study used data collected from the 2016 Nepal Demographic and Health Survey data.

Participants 13 393 weighted adults aged ≥18 years enrolled by a stratified cluster sampling strategy were included in our analysis.

Primary and secondary outcome measures The primary outcome was hypertension, which was defined according to JNC7 (systolic blood pressure (SBP) ≥140 mm Hg and/or diastolic blood pressure (DBP) ≥90 mm Hg) and 2017 ACC/AHA guidelines (SBP ≥130 mm Hg and/or DBP ≥80 mm Hg). Antihypertensive medication users were also classified as hypertensive. After descriptive analysis, multilevel logistic regression was applied to obtain ORs.

Results About 21% (n=2827) and 44% (n=5918) of the individuals aged ≥18 years were classified as hypertensive according to the JNC7 and 2017 ACC/AHA guidelines, respectively. Following factors were found to be significantly associated with hypertension according to the 2017 ACC/AHA guideline: ≥70 years (adjusted OR (AOR) 5.2; 95% CI 4.3 to 6.2), 50–69 years (AOR 3.9; 95% CI 3.4 to 4.4) and 30–49 years (AOR 2.7; 95% CI 2.4 to 3.0) age groups, male gender (AOR 1.7; 95% CI 1.6 to 1.9), being overweight/obese (AOR 3.0; 95% CI 2.7 to 3.3), residence in provinces 4 (AOR 1.5; 95% CI 1.2 to 2.0) and 5 (AOR 1.5; 95% CI 1.2 to 1.9). No significant association was identified with household wealth status and ecological regions of residence using the 2017 ACC/AHA guideline.

Conclusions Per both guidelines, multiple factors were associated with hypertension. Public health programme aiming to prevent and control hypertension in Nepal should prioritise these factors and focus on individuals with a higher likelihood of hypertension irrespective of educational level, household wealth status and ecological regions of residence.

Strengths and limitations of this study

► The study used a nationally representative sample covering both urban and rural areas including all provinces in Nepal, making the findings of the present study generalisable for Nepal.

► The survey used validated instrument to measure hypertension and validated tools for collecting the data, the probability of measurement error is less likely compared with other studies in Nepal.

► Blood pressure was measured on a single day, while longitudinal measurement is recommended by both the guidelines, creating a possibility of some misclassification bias.

► Except body mass index, the association of hypertension with other metabolic determinants, including diabetes mellitus or dyslipidaemia, family history and lifestyle factors (ie, smoking, physical activity, dietary habit and daily salt consumption), was not evaluated, as those data were not collected.

► The temporal relationship between the outcome variable and the explanatory variables could not be established due to the cross-sectional nature of the study.

INTRODUCTION

In 2017, non-communicable diseases (NCDs) were attributable to around three-quarters

of the total global mortalities and cardiovascular disease (CVD) was the dominant cause of NCD-related mortalities and morbidities.[1] Uncontrolled hypertension is the leading risk factor of CVD.[2 3] In the recent decades, the burden of hypertension is increasing in most low-income and middle-income countries, including countries in South Asia.[4 5]

Nepal is a South Asian country, which is currently facing epidemiological transitions with an increasing burden of NCDs, including hypertension.[6] Different studies estimated the prevalence of hypertension in Nepal from 21% to 34%.[7–12] Two wave of the STEP wise approach to Surveillance (STEPS) survey conducted by WHO estimated that the prevalence of hypertension increased from 21.5% in 2008 to 26.0% in 2013 among Nepalese aged 15–69 years.[8 12] Nepal Demographic and Health Survey (NDHS 2016) is one of the latest surveys using a nationally representative sample to collect data on hypertension.[13] Hasan *et al.* analysed the NDHS 2016 data and estimated that around 20% of the participants aged ≥18 years were hypertensive.[14] The prevalence of hypertension may change due to the introduction of a new guideline, which recategorises the cut-off point of blood pressure for defining hypertension. In 2017, the American College of Cardiology/American Heart Association (ACC/AHA) guideline for the prevention, detection, evaluation and management of high blood pressure in adults was released.[15] This new guideline recategorises the cut-off value of systolic blood pressure (SBP) and diastolic blood pressure (DBP) in defining hypertension.[15] Previously, the seventh report of the Joint National Committee 7 (JNC7) on prevention, detection, evaluation and treatment of high blood pressure or other practised guidelines defined hypertension as the SBP/DBP of ≥140/90 mm Hg.[16] But the new guideline (2017 ACC/AHA) considers a person as hypertensive if the SBP/DBP is ≥130/80 mm Hg, 10 mm Hg lower than the previous cut-off.[15] This lower cut-off has reclassified a significant portion of the population as hypertensive who were previously classified as prehypertensive.[17–19] For instance, about 23% of the Nepalese adults could be reclassified as hypertensive following application of the new guideline, which could have both direct and indirect public health impacts in terms of preventative and curative services.[17]

In addition to estimating the prevalence, identifying the determinants is important to develop effective prevention and control strategies. Considering the change in the prevalence of hypertension, the determinants of hypertension could also differ due to a new cut-off. However, none of the earlier studies investigated determinants of hypertension according to the 2017 ACC/AHA guideline in Nepal. The updated knowledge on the determinants of hypertension according to the modified guideline will assist policy-makers and public health authorities in Nepal to identify those who should be prioritised with prevention and control programme.[20 21]

This study investigated and compared the determinants of hypertension among Nepalese adults using both the JNC7 and 2017 ACC/AHA guidelines. Previous studies found that multiple factors, such as age, sex, body weight, socioeconomic status and regions of residence, are associated with hypertension in Nepal.[14 22 23] Using the recent 2016 NDHS data, we evaluated the association of hypertension with these factors considering both the JNC7 and 2017 ACC/AHA guidelines.

MATERIALS AND METHODS
Study design
The NDHS 2016 was a cross-sectional survey. This survey was implemented by NEW ERA under the supervision of the ministry of health (MoH), Nepal. The NDHS 2016 was conducted from June 2016 to January 2017. The survey used the revised frame of the 2011 National Population and Housing Census as the sampling frame. As a part of the reformation in 2015, Nepal was divided into seven provinces.[13] The provinces were given name as province 1–7. Provinces 2 and 5 are mainly located in the Terai region of Nepal (plain land) and rest of the provinces contain all three ecological regions: the Terai, hills and the mountains (snow-covered Himalayan region). Each of the provinces has different ethnic groups.[24] Each province was further divided into urban and rural areas. The urban and rural areas were also divided into wards, which were considered as the primary sampling unit (PSU) for the survey. In the urban areas, the wards were divided into enumeration areas due to having more households than rural areas.[13]

Sampling and data collection
Stratified cluster sampling of households was used for data collection. In the rural area, a two-stage stratified sampling was used. In the first stage of sampling, PSUs (n=199) were selected by probability proportional to their size, followed by systematic selection of households from an individual PSU. In the urban area, a three-stage stratified sampling was used. After selecting the PSUs (n=184), EAs were randomly selected from PSUs in the second stage. Then, the households were selected by systematic selection in the third stage of sampling. In this way, a total of 11 490 households (5520 households in urban areas and 5970 households in rural areas) were selected.[13]

NDHS used a standard, pretested and validated biomarker questionnaire (in the local context of Nepal) for to collect data on blood pressure measurements and anthropometry measurements (height and weight). All the men and women aged 15 years and above who were residents in half of the selected households were considered eligible for blood pressure measurements. The questionnaire was finalised in English and then translated and pretested in Nepali, Maithili and Bhojpuri language.[13] The data collection took place from 19 June 2016 to 31 January 2017. Trained enumerators carried out the data collection. The data were collected by 16 teams. Each team comprised a supervisor, three female interviewers and one male interviewer. Two female members and

the male member of the team were trained to measure the height and body weight. The male team member also received training on blood pressure measurement. Rigorous monitoring was done by ICF staff, quality control team and technical team from the MoH and the Nepal Health Research Council.[13]

Outcome of interest

Hypertension was considered as the outcome variable of this study. The target group of this study was adult Nepalese men and women aged 18 years and above. With an interval of 5 min between each measurement, for each individual, blood pressure was measured three times using an UA-767F/FAC (A&D Medical) blood pressure monitor. The first measurement was discarded and the average of the second and third measurements was taken to identify the hypertensive status of the respondents. According to the JNC7 guideline, an individual having SBP ≥140 mm Hg and/or DBP ≥90 mm Hg was considered hypertensive.[16] According to the 2017 ACC/AHA guideline, having SBP ≥130 mm Hg and/or DBP ≥80 mm Hg was considered hypertension.[15] Furthermore, the respondents were considered hypertensive irrespective of their blood pressure if they reported that they were taking antihypertensive medications.

Explanatory variables

Based on literature review and structure of the NDHS 2016 dataset, following possible explanatory variables were considered: age, sex, being overweight/obese, educational status, household wealth quintile and place, province and ecological regions of residence. The definitions and categories of study variables are summarised in Online supplementary table 1. Age, sex, educational status and household wealth components were reported by the participants. Place, province and ecological zone of residence were recorded based on the current residence location of the respondents. The body mass index (BMI) was calculated by dividing the respondent's weight (measured in kilogram) by height squared (in metre²). If the BMI of a participant was ≥25 kg/m², then the respondent was considered overweight/obese.[25] The NDHS 2016 used principal component analysis of the selected assets (ie, household construction materials, types of water source and sanitation facilities, electricity and other belongings) to report the household wealth index,[13 26 27] which was further divided into quintiles.

Statistical analysis

First, univariate analyses of the selected variables were performed and were presented in number and percentages. Then, bivariate analyses (ie, cross-tabulation) were carried out between independent variables and the outcome of interest (ie, hypertension) according to both the JNC7 and 2017 ACC/AHA guidelines. The NDHS 2016 sample weight was used during descriptive analyses. After that, multilevel mixed-effects logistic regression analyses were performed to identify the determinants

of hypertension according to both guidelines. During multilevel logistic regression, crude analysis was first performed between the outcome variable and each independent variable. Variables with a p<0.2 were put into the final adjusted model. This predetermined p value was considered sufficient to adjust additional residual effect.[28] Both crude and adjusted ORs (COR and AOR, respectively) were reported along with 95% CIs. Multicollinearity among the covariates was assessed using variance inflation factor and no significant multicollinearity was found. Stata V.13.0 was used for data analysis.[29] The authors followed the guidelines outlined in the 'Strengthening the Reporting of Observational Studies in Epidemiology' statement in writing the manuscript (online supplementary table 2).

Before data collection, written informed consent was taken from the head of the households of the respondents.

Patient and public involvement

Patients and the public were not involved in the design or planning of the study.

FINDINGS
Background characteristics of the respondents

The overall background characteristics of the respondents, as well as the background characteristics according to the hypertension status, are presented in table 1. A total of 13 393 individuals participated in this study of which 69.8% were less than 50 years of age, 58.0% were females and 21.5% were overweight/obese. A substantial proportion (41.6%) of participants had no formal education. More than 60% of the respondents were from the urban areas. About half of the participants were residents of the Terai region (49.6%), followed by people from the Hills (44.0%).

Prevalence and factors associated with hypertension according to guidelines

Among 13 393 participants, around 21.0% (n=2827) and 44.0% (n=5918) of the respondents were classified as hypertensive according to the JNC7 and 2017 ACC/AHA guidelines, respectively. Both guidelines showed that the prevalence of hypertension significantly increased with age (p<0.001) and males were more likely to be hypertensive than females (male vs female: JNC7: 25.4% vs 18.0%, p<0.001; ACC/AHA: 50.9% vs 39.3%, p<0.001). The prevalence of hypertension was higher among the overweight/obese individuals compared with those who had normal weight (overweight/obese vs normal weight: JNC7: 35.6% vs 17.1%, p<0.001; ACC/AHA: 64.1% vs 38.7%, p<0.001). According to both guidelines, the prevalence of hypertension was higher among respondents from the richest quintiles (p<0.001), among residents of province 4 (p<0.001), and from the Hills (p<0.001) compared with participants belonging to other wealth groups, other provinces and other ecological region, respectively (table 1).

Table 1 Distribution of the respondents according to hypertension status under guidelines, n (%) (n=13393)

		Respondents with hypertension under guidelines					
		JNC7			**2017 ACC/AHA**		
Characteristics	**Overall, N=13393 n (%)†**	**Yes (n=2827) n (%)***	**No (n=10566) n (%)***	**P value**	**Yes (n=5918) n (%)***	**No (n=7474) n (%)***	**P value**
Age (years)							
18–29	4337 (32.4)	266 (6.1)	4071 (93.9)	<0.001‡	1079 (24.9)	3257 (75.1)	<0.001‡
30–49	5002 (37.4)	1083 (21.7)	3919 (78.3)		2463 (49.2)	2539 (50.8)	
50–69	3188 (23.8)	1101 (34.5)	2087 (65.5)		1851 (58.1)	1337 (41.9)	
≥70	866 (6.4)	377 (43.5)	489 (56.5)		525 (60.6)	341 (39.4)	
Sex							
Male	5620 (42.0)	1429 (25.4)	4191 (39.7)	<0.001‡	2863 (50.9)	2757 (49.1)	<0.001‡
Female	7773 (58.0)	1398 (18.0)	6375 (82.0)		3055 (39.3)	4717 (60.7)	
Obese/overweight							
No	10513 (78.5)	1802 (17.1)	8711 (82.9)	<0.001‡	4073 (38.7)	6440 (61.3)	<0.001‡
Yes	2880 (21.5)	1025 (35.6)	1855 (64.4)		1845 (64.1)	1034 (35.9)	
Education							
No formal education	5572 (41.6)	1365 (24.5)	4208 (75.5)	<0.001‡	2649 (47.5)	2922 (52.5)	<0.001‡
Primary	2172 (16.2)	473 (21.8)	1698 (78.2)		975 (44.9)	1197 (55.1)	
Secondary	3699 (27.6)	680 (18.4)	3019 (81.6)		1549 (41.9)	2150 (58.1)	
Tertiary	1950 (14.6)	309 (15.8)	1641 (84.2)		745 (38.2)	1205 (61.8)	
Household wealth index							
Poorest	2396 (17.9)	449 (18.7)	1947 (81.3)	<0.001‡	1043 (43.5)	1353 (56.5)	<0.001‡
Poorer	2594 (19.5)	548 (21.1)	2046 (80.9)		1163 (44.8)	1432 (55.2)	
Middle	2666 (19.9)	475 (17.8)	2191 (82.2)		1075 (40.3)	1590 (59.7)	
Richer	2917 (21.8)	554 (19.0)	2363 (81.0)		1201 (41.2)	1715 (58.8)	
Richest	2820 (21.1)	801 (28.4)	2019 (77.6)		1436 (50.9)	1384 (49.1)	
Place of residence							
Urban	8191 (61.2)	1831 (22.4)	6360 (77.8)	0.0147‡	3708 (45.3)	4482 (54.7)	0.1588
Rural	5202 (38.8)	996 (19.1)	4206 (80.9)		2210 (42.5)	2992 (58.5)	
Provinces							
Province 1	2365 (17.7)	475 (20.1)	1889 (79.9)	<0.001‡	1002 (42.4)	1362 (57.6)	<0.001‡
Province 2	2748 (20.5)	440 (16.0)	2308 (84.0)		966 (35.2)	1782 (64.8)	
Province 3	2933 (21.9)	732 (25.0)	2202 (75.0)		1434 (48.9)	1499 (51.2)	
Province 4	1380 (10.3)	398 (28.8)	982 (71.2)		765 (55.4)	616 (44.6)	
Province 5	2184 (16.3)	509 (23.3)	1675 (76.7)		1084 (49.6)	1100 (50.4)	
Province 6	674 (5.0)	109 (16.2)	565 (83.8)		264 (39.2)	410 (60.8)	
Province 7	1109 (8.3)	164 (14.8)	945 (85.2)		404 (36.4)	705 (65.6)	
Ecological region							
Mountain	856 (6.4)	155 (18.1)	701 (81.9)	<0.001‡	351 (41.0)	505 (59.0)	<0.001‡
Hills	5895 (44.0)	1426 (24.2)	4470 (75.8)		2877 (48.8)	3018 (51.2)	
The Terai	6642 (49.6)	1246 (18.8)	5395 (81.2)		2690 (40.5)	3951 (59.5)	

*Row percentage.
†Column percentage.
‡P<0.05.
ACC/AHA, American College of Cardiology/American Heart Association; JNC7, Joint National Committee 7.

The CORs and AORs of the factors associated with hypertension according to both guidelines are presented in table 2. According to the JNC7 guideline, the odds of hypertension increased with age with the highest AOR for the age group ≥70 years (AOR 14.6; 95% CI 11.7 to 18.2), followed by 50–69 years (AOR 8.0; 95% CI 6.8 to 9.6) and 30–49 years (AOR 3.6; 95% CI 3.1 to 4.2) age groups. Males had 50% increased odds of hypertension in comparison to their female counterparts (AOR 1.5; 95% CI: 1.4 to 1.7). Overweight/

Table 2 Results of logistic regression analyses to compare crude and adjusted ORs (COR and AOR) for the factors associated with hypertension according to guidelines

Traits	COR (95% CI)				AOR (95% CI)			
	JNC7		2017 ACC/AHA		JNC7		2017 ACC/AHA	
Age (in years)								
18–29	Ref.		Ref.		Ref.		Ref.	
30–49	4.4***	(3.8 to 5.1)	3.2***	(2.9 to 3.5)	3.6***	(3.1 to 4.2)	2.7***	(2.4 to 3.0)
50–69	8.9***	(7.6 to 10.3)	4.4***	(3.9 to 4.9)	8.0***	(6.8 to 9.6)	3.9***	(3.4 to 4.4)
≥70	14.6***	(12.0 to 17.8)	5.4***	(4.6 to 6.4)	14.6***	(11.7 to 18.2)	5.2***	(4.3 to 6.2)
Sex								
Male	1.6***	(1.5 to 1.8)	1.7***	(1.6 to 1.8)	1.5***	(1.4 to 1.7)	1.7***	(1.6 to 1.9)
Female	Ref.		Ref.		Ref.		Ref.	
Overweight/obesity								
	Ref.		Ref.		Ref.		Ref.	
Yes	2.7***	(2.5 to 3.0)	3.1***	(2.8 to 3.4)	2.7***	(2.4 to 3.0)	3.0***	(2.7 to 3.3)
Education								
No formal education	Ref.		Ref.		Ref.		Ref.	
Primary	0.8***	(0.7 to 0.9)	0.9**	(0.8 to 0.9)	1.1	(0.9 to 1.2)	1.0	(0.9 to 1.1)
Secondary	0.5***	(0.5 to 0.6)	0.7***	(0.6 to 0.7)	1.0	(0.9 to1.2)	1.0	(0.9 to 1.1)
College or higher	0.4***	(0.4 to 0.5)	0.5***	(0.5 to 0.6)	1.0	(0.8 to 1.2)	0.9	(0.8 to 1.1)
Household wealth status								
Poorest	Ref.		Ref.		Ref.		Ref.	
Poorer	1.1*	(1.0 to 1.3)	1.0	(0.9 to 1.2)	1.2	(1.0 to 1.4)	1.0	(0.9 to 1.2)
Middle	1.0	(0.9 to 1.2)	1.0	(0.9 to 1.2)	1.1	(0.9 to 1.3)	1.1	(0.9 to 1.3)
Richer	1.1*	(1.0 to 1.3)	1.0	(0.9 to 1.2)	1.1	(0.9 to 1.4)	1.0	(0.9 to 1.2)
Richest	1.7	(1.4 to 2.0)	1.4***	(1.2 to 0.16)	1.4**	(1.1 to 1.7)	1.1	(0.9 to 1.3)
Place of residence								
Urban	1.2*	(1.0 to 1.4)	1.1	(0.9 to 1.3)	1.1	(1.0 to 1.3)		
Rural	Ref.		Ref.		Ref.			
Provinces								
Province 1	Ref.		Ref.		Ref.		Ref.	
Province 2	0.8*	(0.6 to 1.0)	0.8*	(0.6 to 1.0)	0.9	(0.7 to 1.2)	0.9	(0.7 to 1.2)
Province 3	1.3*	(1.0 to 1.7)	1.4**	(1.2 to 1.8)	1.1	(0.8 to 1.4)	1.3	(1.0 to 1.7)
Province 4	1.6***	(1.3 to 2.0)	1.7***	(1.4 to 2.2)	1.4*	(1.1 to 1.8)	1.5**	(1.2 to 2.0)
Province 5	1.2*	(0.9 to 1.5)	1.3*	(1.1 to 1.7)	1.3*	(1.0 to 1.7)	1.5**	(1.2 to 1.9)
Province 6	0.8*	(0.6 to 1.0)	0.9	(0.7 to 1.1)	1.0	(0.7 to 1.3)	1.0	(0.8 to 1.4)
Province 7	0.7**	(0.5 to 0.9)	0.8	(0.6 to 1.0)	0.8	(0.6 to 1.1)	0.9	(0.7 to 1.2)
Ecological region								
Mountains	Ref.		Ref.		Ref.		Ref.	
Hills	1.6**	(1.2 to 2.1)	1.2	(0.9 to 1.7)	1.6***	(1.2–2.1)	1.2	(0.9 to 1.7)
The Terai	1.2*	(0.9 to 1.6)	1.0	(0.7 to 1.4)	1.1	(0.9–1.5)	1.0	(0.7 to 1.4)
Model fitness								
AIC			11 592.01				16 070.33	

Variables with p<0.2 from unadjusted model were included into multivariable analysis.
*P<0.05, **P<0.01, ***P<0.001.
ACC/AHA, American College of Cardiology/ American Heart Association; ANC, antenatal care; JNC7, Joint National Committee 7.

obesity (AOR 2.7, 95% CI 2.4 to 3.0) also had positive association. The odds of being classified as hypertensive increased with a higher wealth index; only the richest quintile had (AOR 1.4; 95% CI 1.2 to 1.7) significant association. Compared with province 1, respondents living in province 4 (AOR 1.4;95% CI 1.1 to 1.8) and province 5 (AOR 1.3; 95% CI 1.0 to 1.7) were more likely to be hypertensive. Education level, rural–urban

place of residence and ecological zone of residence had no significant association.

Although the magnitude was not the same, similar factors were associated with hypertension according to the 2017 ACC/AHA guideline, except the educational status, household wealth status and the ecological regions (table 2). Hypertension was significantly associated with all three age groups: ≥70 years (AOR 5.2; 95% CI 4.3 to 6.2), 50–69 years (AOR 3.9; 95% CI 3.4 to 4.4) and 30–49 years (AOR 2.7; 95% CI 2.4 to 3.0). Among other factors, male (AOR 1.7; 95% CI 1.6 to 1.9), being overweight/obese (AOR 3.0; 95% CI 2.7 to 3.3), residing in Province 4 (AOR 1.5; 95% CI 1.2 to 2.0) and province 5 (AOR 1.5; 95% CI 1.2 to 1.9) had significant association.

DISCUSSION

This study identified the factors associated with hypertension among Nepalese adults using both the JNC7 and 2017 ACC/AHA guidelines and then compared that across both guidelines. Age, sex, overweight/obesity and province of residence were significantly associated with hypertension according to both guidelines. On the other hand, household wealth status and ecological zone of residence were only significant per the JNC7 guideline. Factors associated with hypertension according to the JNC7 guideline's cut-off in this study were also observed by previous studies that analysed the NDHS 2016 data.[14 22 23]

The odds of hypertension increased with advancing age. Around 60% of the individuals aged ≥70 years were hypertensive according to the 2017 ACC/AHA guideline. It is known that age is a non-modifiable risk factors of hypertension.[30] Previous studies found that the likelihood of having hypertension increases with age due to structural changes in the cardiovascular systems along with other comorbidities.[31] As previously stated, Nepal is currently undergoing demographic transition and the number of aged population is likely to increase in the coming days.[32] As a result, the burden of hypertension is more likely to increase.[33] Public health programme should focus on educating the elderly population about hypertension control.

Males had higher likelihood of hypertension than females. Similar findings were identified in other settings.[34–36] Sex is a non-modifiable risk factor of hypertension.[37] It is hypothesised that endogenous oestradiol in premenopausal females has a protective role against hypertension. Animal models suggest that sex differences in T-cells and activation of the renin–angiotensin system may also contribute to higher blood pressure level among males.[38 39] For prevention and control purposes, public health programme in Nepal should aim to increase awareness among males.

Overweight/obese individuals were three times more likely to be hypertensive than those with a normal BMI in this study. Excessive weight predisposes a person to hypertension, which could increase the risk of CVD.[40] Overweight/obesity causes raised blood pressure by increasing

sympathetic nervous system activity and increased renal sodium retention due to impaired pressure natriuresis.[41] Obesity is also associated with impaired endothelial function which in turn increases the blood pressure.[42] Also overweight/obesity is associated with type 2 diabetes mellitus and chronic kidney diseases, which in turn predispose a person to hypertension.[43] As Nepal is currently going through nutritional transition and the burden of overweight and obesity is increasing in both urban and rural areas, the burden of hypertension is more likely to increase in the upcoming days unless this problem is addressed with a multifaceted approach.[44] Residents in provinces 4 and 5 had higher likelihood of hypertension. These provinces had the highest prevalence of hypertension according to the 2017 ACC/AHA guideline.[17] Further studies are warranted to understand the factors, which influence the high prevalence of hypertension in these provinces. It is also important to focusing regions which had higher prevalence or odds of hypertension in order to reduce the disease burden.

Although similar to previous studies, hypertension cut-off as per the JNC7 guideline had positive association with household wealth status,[22] it was not associated per the 2017 ACC/AHA guideline's cut-off. This may be due to the modification of the SBP/DBP threshold; therefore, a large proportion of individuals belonging to lower wealth quintiles were reclassified as hypertensive.[17] The same explanation could be put forward to understand the association of ecological zones of residence.[17]

The relationships of age, sex, being overweight/obese and province of residence with hypertension according to the both guidelines could be due to the fact that the same factors were associated with prehypertension according to the JNC7 guideline.[22] To prevent complications of hypertension, including reducing the burdens of NCDs in Nepal, prevention and control programme should prioritise these known determinants irrespective of socioeconomic status or place of residence.

To the best of our knowledge, this is the first study that investigated the determinants of hypertension according to the 2017 ACC/AHA guideline and then compared it with the determinants identified according to the JNC7 guideline in the context of Nepal. This study has several strengths. The NDHS 2016 used a nationally representative sample covering both urban and rural area including all provinces in Nepal; these made the findings of the present study generalisable for Nepal. The NDHS 2016 had over a 95% response rate for blood pressure measurement.[13] Moreover, as the NDHS 2016 used validated instrument to measure hypertension and validated tools for collecting data, the probability of measurement error is less in this study, compared with other studies in Nepal.[13]

The limitations of the study also warrant discussion. The NDHS 2016 measured the blood pressure on a single day, while longitudinal measurement is recommended by both guidelines.[9 10] As a result, there may be chances of some misclassification bias. Except BMI, the association

of hypertension with other metabolic determinants, including diabetes mellitus or dyslipidaemia, family history and lifestyle factors (eg, smoking, physical activity, dietary habit, or daily salt consumption), was not evaluated as those data were not collected. Finally, as the NDHS 2016 was a cross-sectional survey, the temporal relationships between the outcome variable and the explanatory variables could not be established.[13]

CONCLUSIONS

Although the number of determinants per the 2017 ACC/AHA guideline was lower than the number of determinants per the JNC7 guideline, this study reidentified several known determinants of hypertension using the new guideline's cut-off points. Associated factors from different levels indicate that a comprehensive approach is required to address the factors associated with hypertension. To reduce the burden of hypertension and its future complications, it is important to prioritise the factors that were positively associated with hypertension; public health programme in Nepal should aim to increase awareness among people who are overweight/obese, members of the older age group, male or residents of provinces 4 and 5.

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