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Research Paper

Inequalities in undiagnosed hypertension among adult Nepalese population: Evidence from a nationally representative survey

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ABSTRACT

Introduction: With one in every five adults suffering from hypertension and three-fifth of these patients undiagnosed, Nepal faces an enormous problem of undiagnosed hypertension. This study aims to assess the prevalence and determinants of undiagnosed hypertension in Nepal and to examine the extent of socioeconomic inequalities in undiagnosed hypertension in Nepal.

Methods: This study used the nationally representative Nepal Demographic and Health Survey 2016 data. Undiagnosed hypertension was defined having systolic blood pressure (SBP) ≥140 mm Hg or diastolic blood pressure (DBP) ≥90 mmHg and being told two or more times by health professionals to lower/control blood pressure. Multiple logistic regression analysis was used for identifying determinants associated with undiagnosed hypertension. Further, socioeconomic inequalities in the prevalence of undiagnosed hypertension were estimated using Concentration Index (CI).

Results: The study results show that out of total 2831 hypertensive patients, 1611 (56.9%) were undiagnosed. In the adjusted model, older age, overweight/obesity, higher wealth quintiles had less odds of being undiagnosed. Male gender and residing in Province 7 had higher odds of being undiagnosed. Overall CI showed that poor patients were disproportionately affected by undiagnosed hypertension (CI: 0.21, Standard Error (SE) of CI: 0.03). The poor (Q1)-to-rich (Q5) ratio was 1.57 showed again that poorest patients in Nepal had higher prevalence of undiagnosed hypertension than richest patients.

Conclusion: Poor patients are disproportionately affected by undiagnosed hypertension in Nepal. Awareness should be created specially among the poor wealth quintiles regarding checking blood pressure regularly. Innovative implementation strategies required to be developed to detect undiagnosed case and provide treatment accordingly.

1. Introduction

Hypertension is an established risk factor for ischemic heart disease, cerebrovascular diseases and chronic kidney disease [1]. Hypertension has become the leading cause of mortality and disability globally [2]. According to a 2015 estimate, around 1.13 billion adults had high blood pressure (BP) and majority of them were living in low-and-middle income countries (LMICs) [3]. The burden is more in the South Asian nations, where more than one-fourth (27%) of the adult population are suffering from hypertension [4].

Nepal, a South Asian country, is currently undergoing an epidemiological transition where the burden of non-communicable diseases including hypertension has surpassed the burden of communicable diseases [5]. As per 2016 estimate, every one in five adults in Nepal were suffering from hypertension [6,7]. It has been observed that majority of the cases of hypertension remains undiagnosed in LMICs [8]. It was also estimated that more than three-fifths of the cases of hypertension in adult Nepalese population remain undiagnosed [9]. Undiagnosed hypertension is particularly fatal because in the absence of timely treatment it leads to the micro vascular and macro vascular catastrophes [1].

Knowledge about the existing inequalities in the prevalence of undiagnosed hypertension will help the public health managers and policy makers in Nepal to design the hypertension prevention and control program accordingly. However, there has been limited data regarding the inequalities in the prevalence of undiagnosed hypertension in adult Nepalese population. This study aimed to bridge the gap by analyzing the latest nationally representative data from 2016 Nepal Demographic and

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Abbreviations

95%CI	95% Confidence Interval
AOR	Adjusted Odds Ratio
BCC	Behavioral Change Communication
BP	Blood Pressure
CI	Concentration Index
DBP	Diastolic Blood Pressure
EA	Enumeration Area
JNC7	Joint National Committee Seven
LMIC	Low- and Middle-Income Country
MOH	Ministry of Health
NCD	Non-communicable Disease
NDHS	Nepal Demographic and Health Survey
OOPE	Out-of-Pocket Expenditure
PCA	Principal Component Analysis
PSU	Primary Sampling Unit
SBP	Systolic Blood Pressure
SDG	Sustainable Development Goal
SE	Standard Error

Health Survey (NDHS 2016) and find out the existing inequalities in the prevalence of undiagnosed hypertension in Nepalese adults aged ≥18 years.

2. Methods

2.1. Study design

This study analyzed data from the NDHS 2016. This nationally representative survey was implemented by NEW ERA, a local research firm having wide experience in conducting field surveys, under the stewardship of the Nepal Ministry of Health (MOH) between June 2016 and January 2017 [10].

The survey utilized stratified cluster sampling of households for data collection. Two-staged and three-staged stratified sampling techniques were used in the rural and urban areas, respectively. In the rural area, at the first phase, primary sampling units (PSUs) (n = 199) were selected by probability proportional to size method. Then, households were systematically selected from individual PSU. In the urban area, following the selection of the PSUs (n = 184), enumeration areas (EAs) were randomly selected from each PSU. The households were then selected by systematic selection in the final stage of sampling. Final data were collected from 11,490 households (5520 urban households and 5970 rural households). The detailed methodology and data collection procedure of the NDHS 2016 can be found elsewhere [10].

2.2. Outcome of interest

The target group of this study was adult (aged ≥18 years) Nepalese men and women. The outcome of interest for this study was undiagnosed hypertension. UA-767F/FAC (A&D Medical) BP monitors were used to measure the BP. Cuffs of small, medium, or large size were used according to the arm circumference of the respondent. The BP of each individual was measured three times. The first measurement was discarded and the average of the second and third measurement was reported as the BP of the respondent [10]. In this study BP was defined according to the Joint National Committee Seven (JNC7) guideline. An individual having a systolic blood pressure (SBP) ≥140 mmHg, a diastolic blood pressure (DBP) ≥90 mmHg, or using antihypertensive medications at the time of the survey irrespective of BP level was considered to be hypertensive [11]. An SBP <120 mmHg and DBP <80 mmHg was reported as a normal BP [11].

Among these hypertensive respondents, undiagnosed hypertension was defined having SBP ≥140 mm Hg or DBP ≥90 mmHg and being told two or more times by health professionals to lower/control blood pressure [12].

2.3. Explanatory variables

Explanatory variables included: age (18–29, 30–49, 50–69, ≥70 years); gender (female, male); educational attainment (no education, primary, secondary, college and higher education); marital status (never married, married, widowed/divorced); body mass index (BMI) (Underweight/normal, Overweight/Obese); household wealth index (poorest, poorer, middle, richer, richest); place (urban, rural), province (Province 1–7), and ecological region (mountain, hill, the Terai) of residence. Household wealth index was calculated based on principal component analysis (PCA) of the selected assets, i.e., construction materials used for roof and floor of household, types of water source and sanitation facilities, availability of electricity, and other belongings (television, bicycle, etc.) [10].

2.4. Statistical analysis

Descriptive analysis using calculating percentages of categorical variables was performed to describe the characteristics of the sample. Bivariate analysis using Chi-square test was performed to assess the differentials in the prevalence of undiagnosed hypertension across sociodemographic characteristics. All analyses were survey-weighted to account for the complex survey design and generalizability of the findings.

Multiple logistic regression models were fitted to investigate potential determinants of undiagnosed hypertension. Unadjusted logistic regression models were also fitted to find out the effect of individual factors on the outcome variable. The results of unadjusted and multiple logistic regression analyses were presented in terms of unadjusted odds ratios (OR) and adjusted odds ratios (AOR) along with their respective 95% confidence intervals (CIs).

The concentration index (CI), along with standard error (SE), was estimated to show the inequity in the prevalence of undiagnosed hypertension across different sociodemographic groups. In calculating C, we ranked the households according to the wealth index score generated from PCA. Distribution of undiagnosed hypertension was measured by plotting a concentration curve representing the cumulative proportion of undiagnosed hypertension in Y-axis and cumulative proportions of the population in X-axis. If the prevalence of undiagnosed hypertension is equally distributed across socioeconomic groups, the concentration curve will coincide with the diagonal. In contrast, if there are inequalities in the prevalence of undiagnosed hypertension, the concentration curve will deviate from the diagonal.

The CI is defined as twice the area between the concentration curve and the diagonal [13–15]. The index value can range between −1 and +1, a positive value implies prevalence of undiagnosed hypertension is more concentrated among the better-off socioeconomic group and a negative value implies prevalence is more concentrated among less affluent group [14,16]. STATA 16.0 was used to perform all analyses [17].

3. Results

3.1. Characteristics of the study population

Characteristics of the study population is furnished in Table 1. Among the hypertensive patients, more than one-third (38.9%) were 50–69 years old, and 50.6% were men, almost half (48.3%) had no education, more than four-fifths (81.5%) were married, more than half (52.5%) were overweight/obese, more than a quarter (28.3%) belonged to richest wealth quintile. Almost two-third of the hypertensive patients (64.8%) resided in the urban areas, half (50.4%) resided in the Hill region, and one-quarter (25.8%) of the study population were residents of province 3.

Table 1
Characteristics of study population with hypertension and with prevalence of undiagnosed hypertension, (weighted N = 2831).

Characteristics	Total		Undiagnosed Hypertension (%)	*p*-value
	Frequency (n)	Percentage (%)		
Age (in Years)				<0.001
18–29	267	9.4	77.8	
30–49	1085	38.3	65.4	
50–69	1101	38.9	52.7	
≥70	378	13.4	49.9	
Gender				<0.001
Female	1398	49.4	56.2	
Male	1432	50.6	62.9	
Education				0.485
No education	1365	48.3	57.9	
Primary education	474	16.8	61.6	
Secondary education	680	24.0	61.8	
College and higher	309	10.9	59.1	
Marital Status				<0.001
Never married	103	3.6	79.4	
Married	2308	81.5	59.6	
Widowed/ Divorced	420	14.8	54.7	
Body Mass Index (BMI)				<0.001
Underweight/ Normal	1343	47.5	69.0	
Overweight/ Obese	1488	52.5	51.1	
Wealth index				<0.001
Poorest	449	15.9	73.6	
Poor	550	19.4	64.2	
Middle	476	16.8	62.8	
Richer	555	19.6	59.1	
Richest	801	28.3	47.0	
Place of residence				0.007
Urban	1834	64.8	57.1	
Rural	997	35.2	64.3	
Ecological zone				0.638
Mountain	155	5.5	61.4	
Hill	1427	50.4	60.5	
The Terai	1249	44.1	58.3	
Province of Residence				0.008
Province 1	475	16.8	55.5	
Province 2	443	15.6	57.1	
Province 3	732	25.8	56.7	
Province 4	399	14.1	58.0	
Province 5	509	18.0	64.5	
Province 6	109	3.9	73.4	
Province 7	164	5.8	70.8	
Total	2831	100.0	59.6	

3.2. Prevalence of undiagnosed hypertension

Out of total 2831 hypertensive patients, 1611 (56.9%) were undiagnosed (Table 1). More than three-quarters (77.8%) of 18–29 years hypertensive patients were undiagnosed, while almost half (49.9%) of the hypertensive patients aged ≥70 years were undiagnosed. More men (62.9%) were undiagnosed that the female (56.2%). More patients with secondary education (61.8%) and with primary education (61.6%) were undiagnosed than patients with no education (57.9%), while more patients who were never married (79.4%) were undiagnosed than those who were widowed/divorced (54.7%). More patients who were underweight/normal (69.0%) were undiagnosed than those who were obese/overweight (51.1%), while more patients who belonged to poorest wealth quintile (73.6%) were undiagnosed than patients from richest wealth quintile (47.0%). In terms of residence, more rural patients (64.3%) than urban patients (57.1%), more residents of mountain region (61.4%) than residents of the Terai region (58.3%), and residents of Province 6 (73.4%) than Province 1 (55.5%) had undiagnosed hypertension.

3.3. Prevalence of obesity by age group

We also checked the prevalence of obesity by age group of the respondents with undiagnosed hypertension. Almost three-fifths (59.1%) of the undiagnosed hypertensive patients aged 30–49 years were overweight/obese, while more than two-fifths (40.8%) of the undiagnosed hypertensive patients aged 18–29 years were overweight/obese (Results not shown in table).

3.4. Determinants of undiagnosed hypertension

In unadjusted models, age, gender, marital status, wealth index, place of residence, and province of residence were significantly associated with undiagnosed hypertension (Table 3). In the adjusted model, the results were almost similar to the results from the unadjusted models. In this model, 50–69 years old patients (adjusted Odds Ratio (AOR):0.35, 95% Confidence Interval (95%CI):0.22–0.54), patients aged ≥70 years (AOR:0.25, 95%CI:0.15–0.41) were less likely to be undiagnosed than 18–29 years old patients. Men had higher odds (AOR:1.31, 95% CI:1.07–1.62) of being undiagnosed than females. Whereas, overweight/obese had lower odds of being undiagnosed (AOR:0.50, 95% CI:0.41–0.61) than underweight/normal BMI patients. Patients from

Table 2
Factors associated with undiagnosed hypertension among adult Nepalese patients.

Characteristics	Unadjusted Models (N = 2831)		Adjusted Model (N = 2827)	
	COR	95% CI	AOR	95% CI
Age (in Years)				
18–29	1.00	–	1.00	–
30–59	0.54**	0.38–0.76	0.72	0.47–1.09
50–69	0.32***	0.23–0.44	0.35***	0.22–0.54
≥70	0.28***	0.19–0.42	0.25***	0.15–0.41
Gender				
Female	1.00	–	1.00	–
Male	1.33**	1.13–1.55	1.31*	1.07–1.62
Education				
No education	1.00	–	1.00	–
Primary education	1.17	0.90–1.50	0.89	0.66–1.20
Secondary education	1.18	0.92–1.50	0.97	0.70–1.34
College and higher	1.05	0.77–1.43	0.95	0.64–1.42
Marital Status				
Never married	1.00	–	1.00	–
Married	0.38***	0.23–0.63	0.61	0.33–1.11
Widowed/Divorced	0.31***	0.18–0.54	0.66	0.34–1.28
Body Mass Index (BMI)				
Underweight/Normal	1.00	–	1.00	–
Overweight/Obese	0.47	0.39–0.56	0.50***	0.41–0.61
Wealth index				
Poorest	1.00	–	1.00	–
Poor	0.64**	0.50–0.83	0.68*	0.51–0.91
Middle	0.61**	0.45–0.82	0.63**	0.44–0.89
Richer	0.52***	0.39–0.69	0.57**	0.41–0.79
Richest	0.32***	0.24–0.43	0.37***	0.26–0.55
Place of residence				
Urban	1.00	–	1.00	–
Rural	1.35**	1.09–1.69	1.04	0.83–1.29
Ecological zone				
Mountain	1.00	–	1.00	–
Hill	0.96	0.64–1.46	1.22	0.84–1.80
The Terai	0.89	0.57–1.35	1.31	0.80–2.15
Province of Residence				
Province 1	1.00	–	1.00	–
Province 2	1.06	.76–1.50	1.02	0.69–1.50
Province 3	1.04	0.74–1.48	1.37	0.91–2.08
Province 4	1.11	0.82–1.50	1.23	0.88–1.74
Province 5	1.45*	1.04–2.04	1.41	0.99–2.00
Province 6	2.21***	1.44–3.40	1.63	0.99–2.69
Province 7	1.94**	1.25–3.02	1.59*	1.03–2.46

Table 3
Socioeconomic inequalities in undiagnosed hypertension in Nepal.

Variables	Poorest (Q1) (%)	Richest (Q5) (%)	Q1-Q5	Q1:Q5	Concentration index (C)	Standard error (SE)	p-Value
Total	73.6	47	26.6	1.57	−0.21	0.03	<0.001
Age (in Years)							
18–29	79	65.6	13.4	1.20	−0.15	0.06	0.013
30–49	74.4	58.4	16	1.27	−0.14	0.04	<0.001
50–69	72.5	36.6	35.9	1.98	−0.28	0.04	<0.001
≥70	71.7	23.6	48.1	3.04	−0.33	0.06	<0.001
Gender							
Female	74.2	38.2	36	1.94	−0.30	0.03	<0.001
Male	73	55.3	17.7	1.32	−0.13	0.03	<0.001
Education							
No education	72.9	29.4	43.5	2.48	−0.30	0.03	<0.001
Primary education	76.2	58	18.2	1.31	−0.10	0.06	0.075
Secondary education	73.4	51.4	22	1.43	−0.24	0.05	<0.001
College and higher	74.4	56.1	18.3	1.33	−0.12	0.08	0.129
Marital Status							
Never married	82.6	64.2	18.4	1.29	−0.21	0.10	0.038
Married	74.3	48.7	25.6	1.53	−0.21	0.03	<0.001
Widowed/Divorced	68.8	29.1	39.7	2.36	−0.27	0.06	<0.001
Body Mass Index (BMI)							
Underweight/Normal	76	59.9	16.1	1.27	−0.11	0.03	0.001
Overweight/Obese	67.3	43.1	24.2	1.56	−0.18	0.04	<0.001
Place of residence							
Urban	71.4	46.7	24.7	1.53	−0.20	0.04	<0.001
Rural	74.9	49.5	25.4	1.51	−0.19	0.04	<0.001
Ecological zone							
Mountain	75.4	32.4	43	2.33	−0.31	0.08	0.001
Hill	73	50.1	22.9	1.46	−0.20	0.04	<0.001
The Terai	74.3	43.8	30.5	1.70	−0.22	0.04	<0.001
Province of Residence							
Province 1	73.6	46.6	27	1.58	−0.23	0.05	<0.001
Province 2	58.7	43.8	14.9	1.34	−0.13	0.08	0.115
Province 3	74.7	46.9	27.8	1.59	−0.27	0.06	<0.001
Province 4	68.7	54.2	14.5	1.27	−0.06	0.05	0.236
Province 5	62.9	44.7	18.2	1.41	−0.15	0.06	0.013
Province 6	81.9	50.9	31	1.61	−0.25	0.07	<0.001
Province 7	88.5	45.7	42.8	1.94	−0.37	0.06	<0.001

richest wealth quintile (AOR:0.37, 95% CI:0.26–0.55), richer quintile (AOR:0.57, 95% CI:0.41–0.79), middle quintile (AOR:0.63, 95% CI:0.44–0.89), and poorer quintile (AOR:0.68, 95%CI:0.51–0.91) had lower odds of being undiagnosed than patients from poorest quintile. Patients residing in the Province 7 had higher odds of being undiagnosed (AOR:1.59, 95%CI:1.03–2.46) than those who resided in the Province 1 (Table 2).

3.5. Socioeconomic inequalities in undiagnosed hypertension

Socioeconomic inequalities in undiagnosed hypertension is presented in Table 3. Overall CI showed that poor patients were disproportionately affected by undiagnosed hypertension (CI:-0.21, Standard Error (SE) of CI:0.03). The poor (Q1)-to-rich (Q5) ratio was 1.57 showed again that poorest patients in Nepal have higher prevalence of undiagnosed hypertension than richest patients. The inequalities in undiagnosed hypertension was higher among ≥70 years old (CI:-0.33, SE:0.06), female (CI:-0.30, SE:0.03), patients with no education (CI:-0.30, SE:0.03), widowed/divorced (CI:-0.27, SE:0.06), overweight/obese (CI:-0.18, SE:0.04), urban residents (CI:-0.20, SE:0.04), residents of Mountain region (CI:-0.31, SE:0.08), and residents of Province 7 (CI:-0.37, SE:0.06). While disparities in undiagnosed hypertension was lower in rural areas (CI:-0.19, SE:0.04), Hill region (CI:-0.20, SE:0.04), and there was no significant inequalities in undiagnosed hypertension in Provinces 2 and 4.

4. Discussion

This study aimed to examine the inequalities in prevalence of undiagnosed hypertension in adult Nepalese population (≥18 years). This study has found that around three-fifth of the adult Nepalese hypertensive individuals had undiagnosed hypertension. The study identified that 18–29 years old individuals, male gender, individuals with underweight/normal BMI, those who belonged to the poorest wealth quintiles and resided in Province 7 had higher odds of having undiagnosed hypertension.

In our study, the prevalence of undiagnosed hypertension was 59.6%. This estimate is almost similar to the estimate generated from neighboring Bangladesh (59.9%), although the Bangladeshi study included individuals aged ≥35 years [8]. The prevalence was lower than that of neighboring North India, where the prevalence of undiagnosed hypertension was approximately 70% among individuals aged 18–69 years [18]. This discrepancy is may be due to the differences between the contexts of the studies. The burden of undiagnosed hypertension indicates the performance of a health system [8] and apparently the health system of Nepal is not performing well. In well-functioning health systems like USA, Australia, South Korea the prevalence of undiagnosed hypertension is lower than the LMICs [19].

We found that older adults and female hypertensive patients had lower odds of being undiagnosed for hypertension. This is similar to the previous studies conducted in Nepal [20,21] and in other South Asian country settings, i.e., Bangladesh [22] and India [23]. Pregnant women get their BP checked during antenatal care visit. In Nepal, the proportion of pregnant women attending all four antenatal care visits has increased from 9% in 1994 [24] to 59% in 2016 [25]. This explains why the females were less likely to have undiagnosed hypertension. Similarly, the older people get in contact with the health system more frequently compared to their younger counterparts [26]. The risk of cardiovascular disease increases after 35–40 years of age [27,28] and after this age people visit the health care facilities more frequently than the younger individuals [8].

BMI was found to be a significant correlate of undiagnosed

hypertension. Overweight and obese individuals had lower odds of having undiagnosed hypertension compared to their underweight and normal weight counterparts. Overweight and obesity is an established risk factor of hypertension [29]. It is also a known risk factor for cardiovascular diseases and Type 2 Diabetes Mellitus [30–33]. As a result, overweight/obese individuals are more likely to get their blood pressure checked compared to those with lower BMI.

The study showed that the likelihood of having undiagnosed hypertension decreased significantly with increasing wealth index. This is consistent with a South Asian multi-country study [34]. Again, the equality analysis has shown that the distribution of prevalence of undiagnosed hypertension disproportionately affected the poor economic quintiles. The participants from rich wealth quintiles have better access to health care facilities [35,36]. Apart from poor access to care, the individuals from the poorest wealth quintiles find difficulties to attend hypertension screening in the health facilities due to direct and indirect medical costs. This is attributable to income loss as a result of long waiting times in the health facilities, time spent for transportation as well as associated expenditures [37,38].

Being resident of Province 7 increased the likelihood of having undiagnosed hypertension. Regional differences in undiagnosed hypertension burden was also observed in Bangladesh [8]. Province 7 was part of previous far-western developmental region of Nepal. Ghimire et al. (2018) found that nearly four-fifth of the households belonged to the lowest 40% of the wealth quintiles in this region [39]. This may be the reason of higher burden of undiagnosed hypertension in this region.

Out-of-pocket expenditure (OOPE) remains very high in Nepal. In 2015, OOPE constituted more than 60% of total health expenditure in Nepal [40]. Gupta et al. analyzed the data between 1995-1996 and 2010–2011 and found a 700% increase in the average per capita OOPE. The poorest households primarily bear this burden. That means the proportion of households which incurred OOPE are mainly in the poorest quintile [41]. Saito et al. (2014) conducted a cross-sectional study in the in the urban Kathmandu Valley and found that suffering from non-communicable disease including cardiovascular disease, hypertension and diabetes mellitus is associated with OOPE [42]. Same findings were also found in Ghimire et al.'s study which used a nationally representative sample [39].

The higher burden of undiagnosed hypertension with the majority of the burden imposed on the poorest households is an ominous sign for the Nepalese health system. Government of Nepal is committed to achieve sustainable developmental goals (SDGs) by 2030. In order to achieve SDGs, Nepal has to reduce deaths from NCDs from 43.7% in 2014 to 14.5% in 2030 [43]. Nepal needs to focus on prevention, early detection and control of hypertension to achieve this target. The government of Nepal has formulated 'Multisectoral Action Plan for the Prevention and Control of Non-Communicable Diseases (2014–2020)' in order to tackle NCDs including hypertension [44]. Hypertension related services has been integrated in the health system [45]. In Nepal, the basic health care delivery units named as the health posts provide support to screen hypertension, refer them to higher facilities and provide behavioral change communication (BCC) messages. At the health posts, follow-up of low risk patients also take place. At the primary health care centers, confirmatory diagnosis of hypertension is being made and management and follow up of high risk patients are being conducted. Complicated cases are referred to the district hospital and higher facilities [46]. However, 2015 Nepal Health Facility Survey revealed that the primary health care facilities lacked appropriate service guidelines and trained staffs for diagnosis and control of cardiovascular diseases including hypertension [47]. The health care facilities should be strengthened in order to improve the early detection of hypertension, especially among the poor.

This study has some notable strengths and limitations. As this study utilized NDHS 2016 dataset, which utilized a nationally representative sample, the findings of this study can be generalizable to the target population of Nepal. NDHS 2016 used calibrated tools for measure hypertension, height and weight as well as validated questionnaires for data collection. As a result, the possibility of measurement error in less than any other survey in Nepal. However, the limitations of the study warrant discussion. NDHS 2016 was a cross-sectional survey. As a result, the temporal relationship between independent variables and the outcome variable (undiagnosed hypertension) could not be established in this study. BP was measured in a single day contrary to the longitudinal measurement recommended by all the established guidelines [11,48]. Measuring BP in a single day may induce white coat hypertension [49], which indicates that otherwise normotensive individuals show high BP when measured. Although it is recommended to measure BP in both arms while measuring for the first time [50], DHS does not measure BP in both arms.

5. Conclusion

This study identified a very high burden of undiagnosed hypertension among Nepalese adults. Young adults (18–29 years), male gender, individuals with underweight/normal BMI, belonged to the poorest wealth quintiles and residing in Province 7 were more likely to have undiagnosed hypertension. When controlled for the covariates, the distribution of prevalence of undiagnosed hypertension was towards the poor economic quintiles. Awareness should be created specially among the poor wealth quintiles regarding checking blood pressure regularly. Innovative strategies are needed to be developed and implemented to detect undiagnosed hypertension cases.

Ethical approval

In order to obtain ethical approval, the NDHS survey protocols were submitted to the Nepal Health Research Council as well as to the ICF Institutional Review Board in Calverton, MD, USA. Informed consent was taken from the respondents.

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Data availability statement

Data may be made available upon request to the ICF International, Maryland, USA.

Declaration of competing Interest

The authors have no conflicts of interest to declare.

CRediT authorship contribution statement

Mohammad Rifat Haider: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Writing - original draft, Writing - review & editing. **Rajat Das Gupta:** Conceptualization, Methodology, Investigation, Writing - original draft, Writing - review & editing.

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