Factors Associated with High Blood Pressure Among Men and Women Age 15 and Older, 2016–2022 Nepal DHS Surveys

DHS Further Analysis Reports No. 149

Kiran Acharya, Ramesh Babu Kafle, Kristin Bietsch, Bhim Prasad Sapkota, Phanindra Prasad Baral

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This is one of 11 reports from a further analysis activity undertaken as part of the follow-up to the 2022 Nepal Demographic and Health Survey (NDHS). ICF provided technical assistance for the activity while USAID Learning for Development coordinated the activity. USAID Learning for Development also provided quality assurance and led the analysis of eight of the 11 reports, coordination with government stakeholders, and dissemination. ICF led the analysis of three of the reports.

This report is a publication of The Demographic and Health Surveys (DHS) Program, which is designed to collect, analyze, and disseminate data on fertility, family planning, maternal and child health, nutrition, and HIV/AIDS. Funding was provided by USAID through The DHS Program (#720-OAA-18C-00083). The opinions expressed here are those of the authors and do not necessarily reflect the views of USAID or other cooperating agencies.

The 2022 NDHS was implemented by New ERA under the aegis of the Ministry of Health and Population of Nepal from January 5, 2022, to June 22, 2022. The funding for the NDHS was provided by USAID. ICF provided technical assistance through The DHS Program, a USAID-funded project providing support and technical assistance in the implementation of population and health surveys in countries worldwide.

The DHS Program assists countries worldwide in the collection and use of data to monitor and evaluate population, health, and nutrition programs. Additional information about The DHS Program can be obtained from ICF, 530 Gaither Road, Suite 500, Rockville, MD 20850, USA; telephone: +1 301-407-6500; fax: +1 301-407-6501; email: info@DHSprogram.com; internet: www.DHSprogram.com.

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PREFACE

The 2022 Nepal Demographic and Health Survey (2022 NDHS) is the sixth survey of its kind implemented in the country as part of the worldwide Demographic and Health Surveys (DHS) Program. It was implemented under the aegis of the Ministry of Health and Population (MoHP) of the Government of Nepal with the objective of providing reliable, accurate, and up-to-date data for the country. The survey received funding from the United States Agency for International Development (USAID). 2022 NDHS information has assisted policymakers and program managers in policy formulation, monitoring, and designing programs and strategies for improving health services in Nepal. The 2022 NDHS is a key data source for tracking the progress of the Nepal Health Sector Strategic Plan 2023–2030 and the Sustainable Development Goal indicators.

The 2022 NDHS further analysis reports provide additional in-depth knowledge and insights into key issues that emerged from the 2022 NDHS. This information provides guidance for planning, implementing, refocusing, monitoring, and evaluating health programs in Nepal. This further analysis is also an important initiative to strengthen the technical capacity of Nepali professionals for analyzing and using large-scale data to better understand specific issues related to the country's needs. We are glad that in the sixth round of the NDHS, we were able to produce 11 further analysis reports. We urge that all policymakers, program administrators, program managers, health workers, and other key stakeholders optimally use the information from these reports in program planning and management. High-quality evidence should be the basis of our health programs planning, implementation, monitoring, and evaluation.

Finally, we would like to appreciate the leadership of the Policy Planning and Monitoring Division, and the efforts of the different individuals of the MOHP, and the Department of Health Services in generating these reports. We are thankful to USAID Nepal for their continued support in implementing the NDHS and further analysis studies in Nepal.

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FOREWORD

The 2022 Nepal Demographic and Health Survey (2022 NDHS) is the sixth nationally representative comprehensive survey conducted as part of the worldwide Demographic and Health Surveys (DHS) Program in the country. The survey was implemented by New ERA under the aegis of the Ministry of Health and Population (MoHP). Technical support for this survey was provided by ICF, with financial support from the United States Agency for International Development (USAID) through its mission in Nepal.

The standard format of the survey's final report included descriptive presentations of findings and trends but not of analytical methods that could ascertain the significance of differences and associations among variables. Thus, although largely sufficient, the final report is limited, particularly in providing answers to "why" questions-answers those are essential for reshaping important policies and programs. After the dissemination of the 2022 NDHS, the MoHP, USAID, and other health development partners convened and agreed on key areas that are necessary for assessing progress, gaps, and determinants in high-priority public health programs being implemented by the MoHP. In this context, 11 further analysis studies have been conducted by Nepali consultants under the direct leadership of the MoHP. The consultants were supported by USAID through the Leaming for Development Activity in Nepal and through The DHS Program.

The primary objective of the analysis studies was to provide more in-depth knowledge and insights into key issues that emerged from the 2022 NDHS. This information provides guidance for planning, implementing, refocusing, monitoring, and evaluating health programs in Nepal. One of the learning objectives is to strengthen the technical capacity of Nepali professionals for analyzing and using data from complex national population and health surveys to better understand specific issues related to country needs.

The further analysis of the 2022 NDHS was the concerted effort of many individuals and institutions, and it is with the great pleasure that we acknowledge the work involved in producing this useful document. The participation and cooperation of the officials of the MoHP and the Department of Health Services are highly valued. We would like to extend our appreciation to USAID Nepal for providing financial support for the further analysis. We would also like to acknowledge The DHS Program for its technical assistance at all stages. Our sincere thanks also goes to the USAID Learning for Development Activity team for the overall management and coordination of the entire process. Our special appreciation goes to the Policy Planning and Monitoring Division, MoHP, for their efforts and dedication to the completion of the further analysis of the 2022 NDHS.

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The further analysis of the 2022 Nepal Demographic and Health Survey (2022 NDHS) was conducted under the aegis of the Policy Planning and Monitoring Division of the Ministry of Health and Population (MoHP). The United States Agency for International Development (USAID) provided financial support, with technical assistance provided by the Demographic and Health Surveys (DHS) Program. Overall coordination, recruitment of local consultants, facilitation, administration, and logistic support were provided by the USAID Learning for Development Activity.

I am indebted to Dr. Bikash Devkota, Additional Secretary of the MoHP, for his unwavering guidance throughout the analysis process. I would like to acknowledge the efforts of Dr. Push pa Raj Poudel, Mr. Ravi Kanta Mishra, Mr. Manoj Tamrakar from the Policy Planning and Monitoring Division/MoHP. My special gratitude goes to all the co-authors for their input, coordination, data analysis, and writing of reports. My special thanks go to the co-authors from the MoHP and the Department of Health Services (DoHS) who provided significant contribution to ensure that the analysis aligned with our data needs and to improve the quality of the reports. My sincere appreciation goes to the peer reviewers: Dr. Gunanidhi Sharma from MoHP, Kabita Aryal, Sagar Dahal, Dr. Abhiyan Gautam, Dr. Uttam Pachya, Dr. Poma Thapa, and Dr. Bibek Lal from the DoHS; Pradeep Poudel from USAID Learning for Development; Tirtha Tamang from the United Nations Population Fund; Milima Dangol; Bidur Bastola from the USAID Adolescent Reproductive Health project; Dr. Rahul Pradhan from the World Health Organization; Abhilasha Gurung, and Naveen Poudyal from the United Nations Children's Fund; and Dr. Saroj Dhakal, Dr. Jaganath Sharma, and Sabita Tuladhar from USAID for reviewing the reports.

Special thanks to Sabita Tuladhar from USAID for her continuous support of this process. My sincere appreciation to Dr. Kerry L. D. MacQuarrie from The DHS Program, Jade Lamb, Tarun Adhikari, Sagar Neupane, Lokesh Bhatta, and Alexandra Cervini from USAID Learning for Development for their hard work in supporting the completion of these 11 further analysis reports.

12.07.2024

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ABSTRACT

Noncommunicable diseases (NCDs) are the leading cause of death in Nepal, projected to account for 79% of deaths by 2040. High blood pressure (HBP), a major risk factor for NCDs, affects one in five individuals. The increase in NCDs is also attributed to factors like tobacco use, poor diet, physical inactivity, and metabolic risks, yet efforts to mitigate their impacts in Nepal are progressing slowly, posing challenges in achieving Sustainable Development Goal Target 3.4 by 2030.

We used data from the 2016 and 2022 Nepal Demographic and Health Surveys, which were nationally representative surveys covering various demographic and health indicators. Using variables common to both surveys, we assessed factors associated with HBP among individuals age 15 and older, with particular attention to the treatment cascade for HBP (awareness, treatment, and control). Descriptive analyses, chi-square tests, and logistic regression were employed to analyze the data, adjusting for the surveys' complex sampling design. The Svyset command in STATA version 17.0 was used to account for inverse probability weighting, clustering, and stratification, ensuring unbiased estimates of population parameters.

In 2022, HBP prevalence was higher among men (22.9%) than women (17.9%), with no significant changes observed from 2016 to 2022 across either sex. Provincial disparities were notable, particularly among women, with decreased odds of HBP in Madhesh, Karnali, and Sudurpaschim provinces compared with Koshi province. Age, education, wealth quintile, rural residence (men), nutritional status (women), and internet exposure were significantly associated with HBP. No significant associations were found between HBP and smoking habit, alcohol consumption, elevation, or indoor air pollution. Levels of awareness of HBP status were moderately high (>75%), with little change between surveys. However, treatment rates increased from less than 25% to more than 50%, leading to slight improvements in HBP control rates (which were less than 25% in both surveys).

Our findings highlight the complex interplay between sociodemographic and environmental factors in HBP management. Recommendations include targeting awareness campaigns for older individuals, considering provincial differences, and emphasizing women's health.

Key words: high blood pressure, noncommunicable disease, NDHS

ACRONYMS AND ABBREVIATIONS

AOR	adjusted odds ratio
BMI	body mass index
CVD	cardiovascular disease
DHS	Demographic and Health Survey
DoHS	Department of Health Services
HBP	high blood pressure
LMIC	low- and middle-income country
MoHP	Ministry of Health and Population
NCD	noncommunicable disease
NDHS	Nepal Demographic and Health Survey
PEN	Package of Essential Noncommunicable Diseases
SDG	Sustainable Development Goal
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

1 INTRODUCTION

High blood pressure (HBP) poses a significant global public health challenge. It impacts approximately 22% of the population age 18 and older worldwide, contributing to an estimated 9.4 million deaths annually.[14,15] HBP stands as the primary cause of various cardiovascular diseases (CVDs), including coronary artery disease, congestive heart failure, renal insufficiency, peripheral vascular disease, and stroke.[1,16–19] Moreover, it stands out as the leading factor behind CVD-related deaths, accounting for 45% of heart disease deaths and 51% of stroke-related deaths.[14]

The prevalence of HBP is on the rise globally, particularly in low- and middle-income countries (LMICs) in Southeast Asia and sub-Saharan Africa.[1,2] A major challenge in managing HBP is the lack of control over blood pressure among diagnosed patients,[3] leading to increased rates of morbidity and mortality, mainly attributed to stroke and ischemic heart disease.[4]

HBP is a primary but preventable risk factor not only for CVDs but also for other noncommunicable diseases (NCDs) such as diabetes.[5,6] Sustainable Development Goal (SDG) Target 3.4 is a one-third reduction in premature mortality from NCDs between 2015 and 2030.[7,8] Although premature mortality caused by NCDs has decreased on a global scale in recent years, this progress is insufficient to meet SDG Target 3.4, particularly in many LMICs.

1.1 Study Rationale

The prevalence of NCDs in Nepal has consistently been rising. Diabetes prevalence, for example, escalated from 3.6% in 2013 to 5.8% in 2019 among adults age 15–69.[11] This trend can be linked to behavioral risk factors such as tobacco use, unhealthy diet, and physical inactivity, as well as metabolic risk factors like HBP and obesity.[12] As per the global burden of disease assessment, NCDs stand as the primary cause of death in Nepal, responsible for more than two-thirds (71%) of the total estimated deaths in 2019.[9] The proportion of deaths attributed to NCDs in Nepal is projected to rise to 79% by 2040.[10] Efforts to alleviate the increase in NCDs in countries like Nepal are advancing at a sluggish pace, and the Government of Nepal is anticipated to fall short of achieving the target outlined in SDG 3.4.[13]

According to the 2015 estimates of HBP prevalence from the World Health Organization (WHO), Nepal ranked third in South Asia at 29.4%, followed only by Afghanistan (30.6%) and Pakistan (30.5%).[15] A study conducted in rural areas of Kathmandu district reported a three-fold increase in HBP prevalence over 25 years.[19] STEPS surveys of NCD risk factors in Nepal revealed an increase in HBP prevalence from 21.5% in 2007[20] to 25.7% in 2014.[21] However, in 2019, the prevalence slightly decreased to 24.5%.[11] Various other studies have presented diverse findings on HBP, showing prevalences ranging from 19.6%[22] to 25.7%[21] at the national level, 15.1%[23] to 38.9%[24] at the subnational level, 21.7%[23] to 48.1%[24] in men, 10.5%[23] to 35.2%[24] in women, 22.5%[25] to 38.6%[26] in rural areas, and 32.5%[27] to 38.9%[24] in urban areas.

According to a systematic review of HBP in Nepal between 2000 and 2020, the country has an overall 20-year pooled HBP prevalence of 28.5%.[28] However, nearly half of patients diagnosed with HBP in Nepal experience uncontrolled blood pressure,[28,29] significantly contributing to elevated mortality rates and overall disease burden.[30] The 2019 STEPS survey in Nepal found that the prevalence of HBP was highest in Gandaki province (29.9%) and lowest in Madhesh province (18.7%).[11] It also identified a significant gender

disparity in the prevalence of HBP, with a higher prevalence among men than women (29.8% versus 19.7%).[11] Approximately one in five individuals age 15–69 in Nepal is affected by HBP, emphasizing the widespread impact of this health concern across genders.[11]

1.2 Objectives

The overall aim of this study was to use data from the 2016 and 2022 Nepal Demographic and Health Surveys to assess the factors associated with HBP among men and women age 15 and older in Nepal. The specific objectives were:

- To determine the background variables associated with HBP among men and women in 2016 and 2022
- To assess changes in the prevalence of HBP and its associated background variables among men and women between the 2016 and 2022 surveys

2 METHODS

2.1 Data Sources

Data from the 2016 Nepal Demographic and Health Survey (NDHS)[22] and the 2022 NDHS[31] were used to assess blood pressure and background variables associated with high blood pressure (HBP) among individuals age 15 and older in Nepal. These two surveys were the fifth and sixth nationally representative population-based surveys, respectively, conducted in Nepal. They collected current estimates of essential demographic and health indicators encompassing fertility, marriage, awareness and use of family planning methods, child feeding practices, nutrition, adult and childhood mortality, awareness and attitudes about HIV/AIDS, women's empowerment, domestic violence, and HBP. The Demographic and Health Surveys (DHS) Program introduced a new module for assessing blood pressure in the 2016 NDHS.

In addition to presenting national estimates, both the 2016 and 2022 NDHS reports provided estimates of key indicators in seven provinces of Nepal. A detailed description of the sampling and methodology employed in these surveys is available in the NDHS final reports.[22,31]

Both the 2016 and 2022 NDHS surveys collected data using the Household Questionnaire, the Woman's Questionnaire, the Man's Questionnaire, and the Biomarker Questionnaire. The Household Questionnaire gathered information at the household level, including the age, wealth quintile, and education level of all household members. The Woman's and Man's Questionnaires gathered individual-level data, limited to individuals age 15–49. The Biomarker Questionnaire was used to record anthropometry, anemia, and blood pressure measurements, as well as to recode individuals who had been told they had HBP and were prescribed medication for it.

In the 2016 NDHS, the Biomarker Questionnaire was administered to a subsample selected for the men's survey. However, in 2022, it was administered exclusively to a subsample *not* selected for the men's survey. Some information for men was available in the household roster, but more detailed information from the men's interviews was not available for 2022 for the households that were selected for the biomarker measurements.

All of the questionnaires, which were based on The DHS Program's model questionnaires, were adapted to address the population and health issues pertinent to Nepal. Details of the questionnaires, including the sampling design and how household were selected for each questionnaire, can be found in the 2016 and 2022 NDHS final reports.[22,31] The DHS surveys conducted in Nepal were approved by the Nepal Health Research Council and the ICF Institutional Review Board. We used de-identified publicly available datasets from The DHS Program's website (www.dhsprogram.com) for this study. Therefore, no separate ethical approval was required.

2.2 Study Variables

Data on blood pressure (the dependent variable) were available for 8,435 women and 6,059 men from the 2016 NDHS and for 5,763 women and 4,334 men from the 2022 NDHS. Average blood pressure was defined as the first blood pressure measurement if only one measurement had been taken, the second

measurement if only two measurements had been taken, and the mean of the second and third measurements if three measurements had been taken during a given survey.

Individuals were classified as having HBP if their systolic blood pressure was 140 mmHg or higher and/or their diastolic blood pressure was 90 mmHg or higher. Those with normal blood pressure who were taking antihypertensive medication were also categorized as having HBP.

Because the study aimed to compare background variables associated with HBP between the two surveys, we also identified the variables common to both surveys and categorized them (Table 1). For ethnicity, we merged categories as necessary due to low sample sizes. For all other variables, we followed the same process using the NDHS standard recode.

Table 1 Description and categorization of background variables

Variable	Description	Categorization
Age	This variable was defined as age of respondents at the time of the survey, measured in completed years.	1. 15–29 2. 30–44 3. 45–59 4. 60–74 5. ≥75
Education	Because the education levels in the 2016 and 2022 surveys were not consistently categorized, we used years of schooling at the time of the survey.	1. 0 years 2. 1–5 years 3. 6–10 years 4. ≥11 years
Marital status	This variable referred to the marital status of respondents at the time of the survey.	1. Never married 2. Married 3. Widowed/divorced/separated
Wealth quintile	The wealth index was calculated using easy-to-collect data on a household's ownership of selected assets, such as televisions and bicycles, materials used for housing construction, water access, and sanitation facilities. With these proxy indicators, households were classified into five quintiles using the standard DHS wealth index. Household wealth index scores were derived using principal component analysis. National wealth quintiles were compiled by assigning the household score to each usual (de jure) household member, ranking each person in the household population by the score, and then dividing the distribution into five equal quintiles (each comprising 20% of the population).	1. Lowest 2. Second 3. Middle 4. Fourth 5. Highest
Nutritional status	Nutritional status was based on body mass index (BMI) derived from the anthropometric measures of height and weight. BMI was calculated by dividing a person's weight in kilograms by the person's height in meters squared (kg/m^2). BMI was not calculated for pregnant women.	1. Thin (BMI <18.5) 2. Normal (BMI 18.5–24.9) 3. Overweight (BMI 25.0–29.9) 4. Obese (BMI ≥30.0)
Ethnicity	Nepal is a multi-ethnic country with diverse languages, religions, and cultural traditions, boasting more than 100 distinct ethnic or caste groups.	1. Brahmin/Chhetri 2. Dalit 3. Janajati 4. Madheshi 5. Muslim/other
Religion	According to the Constitution of Nepal 2015, Nepal is a secular state, whereby "secular" denotes the protection of religious and cultural freedoms, including those passed down through generations.	1. Hindu 2. Other
Media exposure	This variable was constructed based on the frequency of respondents' exposure to radio, television, and newspapers.	1. Not at all 2. Less than once a week 3. At least once a week
Employment status	This variable represented the work status of respondents in the 12 months preceding the survey. Respondents were further asked about the type of earnings they received from their work.	1. Not employed 2. Employed for cash 3. Employed for in kind 4. Employed not paid

Continued…

Table 1—*Continued*

Variable	Description	Categorization
Internet exposure	This variable represented the frequency of internet use in the month preceding the survey.	1. Not at all 2. Less than once a week 3. At least once a week 4. Almost every day
Place of residence	Administrative divisions in Nepal were classified into urban and rural categories. Metropolitan cities, submetropolitan cities, and municipalities were considered urban, and rural municipalities were deemed rural. According to the 2021 census, out of the 6,666,937 households in Nepal, 4,479,662 resided in urban municipalities and 2,187,275 in rural municipalities.	1. Urban 2. Rural
Ecoregion	Nepal, known as a Himalayan country, boasts a remarkably diverse geography. It is divided into three main ecological zones), rather than administrative divisions. Mountain refers to the massive glacier-encrusted Himalayan region in the north. Hill is the Himalayan foothills, also referred to as the Middle Hills. Terai (or Tarai), a belt of jungle and wetlands harboring tigers and elephants, is situated in the flat Ganges Plain in the south.	1. Mountain 2. Hill 3. Terai
Province	In September 2015, Nepal's Constitution introduced the current system of seven provinces, replacing an earlier arrangement that divided the country into 14 administrative zones and five development regions.	1. Koshi 2. Madhesh 3. Bagmati 4. Gandaki 5. Lumbini 6. Karnali 7. Sudurpaschim
Smoking habit	Smoking habit referred to either daily or occasional (less than daily) smoking of tobacco products including manufactured cigarettes, hand-rolled cigarettes, pipes filled with tobacco/sulpha/chilum, cigars/bidi, and water pipes.	1. Yes 2. No
Alcohol consumption	This binary variable indicated whether respondents consumed alcohol.	1. Yes 2. No
Elevation	Elevation was categorized based on the cluster altitude of a residence in meters.	1. 0–1,999 meters 2. ≥2,000 meters
Indoor air pollution	A household was labeled as having indoor air pollution if it exhibited at least one of the following: use of unclean fuel, no separate kitchen for cooking, or any frequency of indoor smoking. Unclean fuel comprised kerosene, charcoal, and wood, while clean fuel comprised electricity, liquified petroleum gas, natural gas, and biogas.	1. Yes 2. No
Pregnancy status	This variable represented the pregnancy status of women at the time of data collection.	1. Yes 2. No

Differences in the care continuum, known as the treatment cascade, from diagnosis to HBP control, are more pronounced in low- and middle-income countries than in high-income countries.[32,33] Comparing data from the 2015 and 2021 Nepal Health Facility Surveys revealed significant changes over time in service availability and in readiness for managing HBP/cardiovascular diseases.[34] Therefore, we also evaluated the HBP treatment cascade by measuring HBP awareness, treatment, and control of HBP among respondents. Awareness was defined as the proportion of people with HBP who reported a previous diagnosis. Treatment was defined as the proportion of those diagnosed with HBP who were taking antihypertensive medication. Control was defined as the proportion of those treated whose blood pressure was controlled.

2.3 Data Analyses

All analyses were conducted using household member (PR) files for women and men age 15 and older at the time of the surveys. Per availability of data from the Woman's and Man's Questionnaires, analyses of the individual background variables (that is, ethnicity, religion, pregnancy status, employment status, media

exposure, internet exposure, smoking habit, and alcohol consumption) were limited to respondents age 15–49. Respondents were excluded from relevant analyses if they did not know how many years of schooling they had received or were missing data on ethnic group, religion, media exposure, employment status, or internet exposure. Pregnant women and respondents who did not consent to height and weight measurements were excluded from analyses of nutritional status.

We conducted descriptive analyses of all independent background variables for both surveys among men and women. Associations between background variables and HBP were separately assessed among men and women for each survey. Additionally, we assessed percentage-point changes in the variables between the 2016 and 2022 NDHS surveys using the chi-square test. Each difference with a p value <.05 was considered statistically significant.

After examining the bivariate association of HBP with different background variables, we examined the factors associated with HBP using multivariate analysis. Logistic regression was performed for HBP and the background variables, separately for women and men age 15 and older. All the variables common to both surveys for men and women were considered. For women, additional information was available in the datasets (IR files) for both surveys. Therefore, we examined additional variables associated with women's HBP by merging the data files (PR and IR files) and then appending the data. The analysis for women was restricted to those age 15–49, as the data in the IR files were for women in that age range.

For both women and men, we also used survey year as an independent variable in the regression analysis to see whether time itself was a significant factor and to be able to compare the factors associated with HBP over time among men and women. For this analysis, all the background variables common to both surveys for men and women were considered. The data obtained from the household member files for the two surveys were appended, and logistic regression was carried out separately for men and women using the appended data. Adjusted odds ratios and 95% confidence intervals were calculated, with significance determined by a p value <.05.

Descriptive analyses of the HBP treatment cascade—awareness, treatment, and control—were also performed. To address the complex sampling design, the Svyset command in STATA version 17.0 was used to account for inverse probability weighting, clustering, and stratification, ensuring unbiased estimates of population parameters.

3 RESULTS

3.1 Background Variables

Table 2 depicts the distribution of women age 15 and older by background variables for the survey years 2016 and 2022. We observed slight changes in education (years of schooling) between the two surveys, as the proportion of women with no education decreased from 48% to 41% and the proportion with more than 10 years of schooling increased from 11% to 16%. In terms of nutritional status, the proportions of women classified as thin and normal decreased, while the proportions classified as overweight and obese increased. Internet exposure drastically increased, as the proportion of women using the internet almost every day rose from 13% in 2016 to 43% in 2022. Although the proportion who reported smoking was quite small and relatively static between the surveys (2.9% in 2016 and 3.5% in 2022), the proportion reporting alcohol consumption increased dramatically from only 0.6% in 2016 to 10.4% in 2022. The proportion living in indoor pollution decreased from 81.7% in 2016 to 67.8% in 2022.

Table 2 Background variables among women and men age 15 and older in 2016 and 2022

	Women				Men			
	2016 NDHS		2022 NDHS		2016 NDHS		2022 NDHS	
Variable	95% CI	N	95% CI	N	95% CI	N	95% CI	N
Age								
15–29	40.7 [39.7, 41.8]	3,436	37.3 [35.9, 38.6]	2,148	34.9 [33.5, 36.5]	2,117	33.7 [32.1, 35.5]	1,462
30–44	28.5 [27.5, 29.6]	2,408	29.1 [28.0, 30.3]	1,679	25.8 [24.5, 27.1]	1,562	26.4 [24.9, 27.9]	1,143
45–59	17.6 [16.7, 18.6]	1,485	18.5 [17.5, 19.6]	1,069	21.3 [20.2, 22.6]	1,293	22.1 [20.6, 23.6]	958
60–74	10.6 [9.9, 11.3]	892	12.0 [11.2, 12.9]	693	14.2 [13.2, 15.3]	861	13.6 [12.5, 14.8]	589
Education								
0 years	48.3 [46.6, 50.0]	4,071	41.4 [39.7, 43.2]	2,383	24.8 [23.1, 26.6]	1,501	19 [17.5, 20.7]	823
1–5 years	13.0 [12.0, 14.0]	1,097	13.1 [12.1, 14.2]	755	19.5 [18.1, 20.9]	1,179	20.2 [18.8, 21.7]	873
6–10 years	27.5 [26.2, 29.0]	2,322	29.2 [27.9, 30.6]	1,683	38.7 [36.9, 40.5]	2,341	39.8 [37.9, 41.6]	1,719
≥11 years	11.2 [10.1, 12.3]	941	16.3 [14.8, 17.8]	936	17.1 [15.5, 18.8]	1,032	21.0 [19.1, 23.1]	908
Marital status								
Never married	15.9 [14.9, 16.9]	1,340	15.9 [14.9, 17.1]	919	22.6 [21.3, 23.9]	1,369	24.6 [23.1, 26.2]	1,066
Married	74.0 [72.8, 75.1]	6,242	72.9 [71.6, 74.2]	4,203	72.4 [71.1, 73.7]	4,387	70.7 [69.0, 72.4]	3,065
Widowed/divorced/ separated	10.1 [9.4, 10.8]	853	11.1 [10.3, 12.0]	641	5.0 [4.3, 5.7]	302	4.7 [4.0, 5.5]	203
Wealth quintile								
Lowest	18.3 [16.0,20.7]	1,540	19.1 [17.1,21.2]	1,099	17.5 [15.2,20.1]	1,062	18.0 [15.9,20.3]	780
Second	19.9 [18.0,21.9]	1,678	21.3 [19.1,23.7]	1,228	18.7 [16.8,20.8]	1,133	19.1 [17.0,21.4]	828
Middle	20.7 [18.9,22.5]	1,743	18.8 [16.9,20.9]	1,086	19.4 [17.5,21.4]	1,175	19.0 [16.9,21.3]	825
Fourth	21.4 [19.0,24.1]	1,808	18.9 [16.9,21.0]	1,089	22.7 [20.3,25.3]	1,375	20.8 [18.6,23.2]	902
Highest	19.8 [17.2,22.6]	1,667	21.9 [19.0,25.1]	1,262	21.7 [18.8,24.9]	1,315	23.0 [19.9,26.5]	999
Nutritional status								
Thin	18.8 [17.4, 20.2]	1,577	14.4 [13.3, 15.5]	825	17.9 [16.7, 19.2]	1,079	14.2 [13.0, 15.5]	612
Normal	59.4 [57.8, 60.9]	4,988	55.9 [54.3, 57.5]	3,210	65.5 [64.1, 66.8]	3,939	61.7 [59.8, 63.6]	2,667
Overweight	16.9 [15.7, 18.1]	1,420	22.7 [21.2, 24.2]	1,302	14.4 [13.4, 15.6]	869	20.1 [18.4, 21.8]	867
Obese	4.9 [4.2, 5.9]	415	7.1 [6.2, 8.1]	406	2.2 [1.8, 2.6]	130	4.0 [3.3, 4.9]	174
Ethnicity								
Brahmin/Chhetri	29.6 [26.9, 32.5]	1,879	28.9 [26.3, 31.7]	1,159	27.7 [24.9, 30.8]	1,134	na	na
Dalit	12.6 [10.6, 14.9]	799	15.1 [13.1, 17.3]	604	11.9 [9.6, 14.6]	485	na	na
Janajati	36.5 [33.3, 39.9]	2,318	36.5 [33.2, 39.8]	1,462	37.9 [34.2, 41.7]	1,548	na	na
Madheshi	16.0 [13.6, 18.8]	1,017	15.3 [13.1, 18.0]	615	17.3 [14.6, 20.3]	705	na	na
Muslim/other	5.2 [3.6, 7.6]	331	4.2 [2.9, 6.1]	169	5.3 [3.6, 7.6]	215	na	na

Continued…

Table 2—*Continued*

	Women				Men			
	2016 NDHS		2022 NDHS		2016 NDHS		2022 NDHS	
Variable	**95% CI**	**N**	**95% CI**	**N**	**95% CI**	**N**	**95% CI**	**N**
Religion								
Hindu	85.7 [83.1, 88.0]	5,440	83.5 [81.1, 85.7]	3,349	85.3 [82.7, 87.6]	3,487	na	na
Other	14.3 [12.0, 16.9]	904	16.4 [14.3, 18.9]	659	14.4 [12.1, 17.1]	590	na	na
Pregnancy status								
No	96.6 [96.1, 97.0]	8,146	95.6 [94.9, 96.2]	3,972	na	na	na	na
Yes	3.4 [3.0, 3.9]	289	4.4 [3.8, 5.1]	184	na	na	na	na
Employment status								
Not employed	49.1 [47.2 ,51.0]	4,142	49.9 [48.3, 51.6]	2,878	42.1 [40.7, 43.6]	2,554	na	na
Employed for cash	22.9 [20.8, 25.1]	1,930	24.4 [22.9, 25.9]	1,407	46 [44.2, 47.9]	2,790	na	na
Employed for in kind	1.8 [1.4, 2.2]	148	3.2 [2.7, 3.9]	186	0.7 [0.4, 1.1]	43	na	na
Employed not paid	26.3 [23.9, 28.7]	2,215	22.4 [20.7, 24.2]	1,292	11.1 [9.7, 12.6]	672	na	na
Media exposure								
Not at all	15.8 [14.1, 17.7]	1,003	21.1 [19.0, 23.3]	846	6.4 [5.3, 7.7]	260	na	na
Less than once a week	21.2 [19.7, 22.8]	1,347	27.2 [25.2, 29.3]	1,092	25.1 [22.9, 27.5]	1,027	na	na
At least once a week	63.0 [60.6, 65.2]	3,994	51.7 [49.1, 54.2]	2,071	68.5 [65.7, 71.1]	2,799	na	na
Internet exposure								
Not at all	77.9 [75.6, 80.1]	4,945	37.5 [35.2, 39.9]	1,504	55.8 [53.2, 58.3]	2,279	na	na
Less than once a week	2.4 [1.9, 2.8]	149	6.0 [5.1, 6.9]	239	5.2 [4.4, 6.1]	213	na	na
At least once a week	6.6 [5.8, 7.6]	421	13.6 [12.4, 15.0]	546	14.2 [12.9, 15.6]	579	na	na
Almost every day	13.1 [11.4, 14.9]	829	42.9 [40.2, 45.7]	1,721	24.9 [22.6, 27.2]	1,015	na	na
Place of residence								
Urban	61.1 [56.5, 65.5]	5,153	67.1 [65.6, 68.5]	3,866	61.7 [57.0, 66.2]	3,741	67.3 [65.4, 69.1]	2,918
Rural	38.9 [34.5, 43.5]	3,282	32.9 [31.5, 34.4]	1,897	38.3 [33.8, 43.0]	2,318	32.7 [30.9, 34.6]	1,416
Ecoregion								
Mountain	6.2 [4.3, 9.0]	526	5.4 [3.8, 7.6]	313	6.2 [4.3, 9.0]	378	5.5 [3.9, 7.8]	240
Hill	44.2 [39.4, 49.2]	3,729	41.2 [37.4, 45.2]	2,375	43.6 [38.7, 48.7]	2,645	40.9 [36.8, 45.2]	1,774
Terai	49.6 [44.9, 54.2]	4,180	53.4 [49.5, 57.2]	3,076	50.1 [45.3, 54.9]	3,037	53.5 [49.4, 57.6]	2,320
Province								
Koshi	17.5 [16.3, 18.9]	1,479	18.0 [16.7, 19.4]	1,038	17.7 [16.3, 19.3]	1,075	18.6 [17.2, 20.2]	808
Madhesh	20.1 [18.6, 21.8]	1,699	19.5 [18.3, 20.7]	1,122	21.1 [19.0, 23.3]	1,276	18.0 [16.4, 19.8]	781
Bagmati	21.2 [18.0, 24.8]	1,789	20.9 [19.3, 22.5]	1,203	22.4 [19.0, 26.3]	1,357	23.2 [21.3, 25.2]	1,005
Gandaki	10.4 [9.5, 11.4]	877	9.8 [8.7, 11.0]	562	10.2 [9.1, 11.4]	616	9.5 [8.3, 10.9]	412
Lumbini	16.7 [15.3, 18.1]	1,406	17.5 [16.4, 18.6]	1,008	16.1 [14.4, 17.9]	974	17.7 [16.1, 19.4]	765
Karnali	5.2 [4.8, 5.7]	440	5.8 [5.3, 6.4]	336	4.8 [4.3, 5.4]	293	5.1 [4.4, 5.9]	223
Sudurpaschim	8.8 [7.9, 9.8]	744	8.6 [7.9, 9.3]	494	7.7 [6.8, 8.7]	468	7.8 [7.0, 8.8]	340
Smoking habit								
Yes	2.9 [2.5, 3.5]	248	3.5 [2.9, 4.1]	139	19.2 [17.6, 20.8]	1,163	na	na
No	97.1 [96.5, 97.5]	8,187	96.5 [95.9, 97.1]	3,870	80.8 [79.2, 82.4]	4,896	na	na
Alcohol consumption								
Yes	0.6 [0.4, 0.9]	52	10.4 [9.2,11.9]	418	2.6 [2.0, 3.3]	155	na	na
No	99.4 [99.1, 99.6]	8,383	89.6 [88.1,90.8]	3,591	97.4 [96.7, 98.0]	5,904	na	na
Elevation								
0–1,999 meters	97.6 [95.6, 98.7]	8,231	97.6 [96.0,98.5]	5,622	97.9 [96.3, 98.8]	5,931	97.4 [95.8, 98.4]	4,223
≥2,000 meters	2.4 [1.3, 4.4]	204	2.4 [1.5,4.0]	141	2.1 [1.2, 3.7]	129	2.6 [1.6,4 .2]	111
Indoor air pollution								
No	18.3 [15.8, 21.2]	981	32.2 [28.7, 35.9]	1,221	18.1 [15.6, 21.0]	703	33.1 [29.4, 36.9]	954
Yes	81.7 [78.8, 84.2]	4,368	67.8 [64.1, 71.3]	2,569	81.9 [79.0, 84.4]	3,174	66.9 [63.1, 70.6]	1,931

CI = confidence interval; na = not available; NDHS = Nepal Demographic and Health Survey

Note: All analyses were conducted using household member files for individuals age 15 and older. Data on the individual background variables of ethnicity, religion, pregnancy status (women), employment status, media exposure, internet exposure, smoking, and alcohol consumption were collected only among individuals age 15–49.

Table 2 also presents the distribution of men age 15 and older in the survey years 2016 and 2022. The proportion of men with more than 10 years of schooling increased from 17% in 2016 to 21% in 2022. In

terms of nutritional status, the proportion of overweight men increased from 14.4% to 20.1%, and the proportion of obese men increased from 2.2% to 4%. In 2016, 19.2% of men reported smoking and 2.6% reported alcohol consumption, but comparative information from 2022 was not available. Similarly to women, the proportion of men living in indoor air pollution decreased from 82% to 67% between the two surveys.

3.2 High Blood Pressure

Table 3 shows high blood pressure (HBP) prevalence, differentials, and changes over time among women age 15 and older by background variables. Overall, 16.8% women had HBP in 2016 and 17.9% had HBP in 2022. However, the difference between the two was not statistically significant. In both surveys, HBP was significantly associated with many background variables among women.

Among women, HBP prevalence significantly increased as age increased and significantly decreased as years of schooling increased. Significantly lower levels of HBP were observed among women who had never married than among other women, although this may have been because unmarried women are typically younger than ever married women. Differences by wealth quintile were significant but with no clear direction, although HBP prevalence was highest among women in the highest wealth quintile in both surveys. As nutritional status measured by body mass index (BMI) increased, HBP prevalence increased in both surveys. Also in both surveys, the prevalence of HBP was significantly higher among Janajati and Dalit women than among women in other ethnic groups.

Ecoregion was significantly associated with HBP among women in 2016, with the highest HBP prevalence in the Hill ecoregion (18.5%); however, this relationship was insignificant in 2022. Provincial differences were significant in both surveys. In 2016, the highest HBP prevalence was observed in Gandaki province (23.8%) and the lowest in Karnali (10.2%); in 2022, the highest was observed in Koshi (24.8%) and the lowest in Madhesh and Karnali (12% each). Smoking habit and alcohol consumption were significantly associated with HBP in both surveys, with significantly higher HBP prevalences among women who smoked (29% in 2016 and 20.9% in 2022) and women who consumed alcohol (24.3% in 2016 and 17.2% in 2022) than among other women. Interestingly, prevalence of HBP was significantly lower among women who were exposed to indoor air pollution than among their counterparts in both surveys.

When examining changes in the prevalence of HBP, disaggregated by various background variables, significant differences (both increases and decreases) were observed over time in selected subgroups of women (Table 3). Overall, for women age 15–29, HBP significantly declined from 4.1% in 2016 to 2.8% in 2022. The prevalence also declined significantly among nonpregnant women (from 17.3% to 9.5%), women from the Madheshi ethnic group (from 8.4% to 4.3%), women from Gandaki province (from 23.8% to 19.4%), unemployed women (from 9.9% to 6.4%), women exposed to the internet less than once a week (from 12.7% to 5.8%), women who did not smoke (from 16.7% to 8.4%), women who consumed alcohol (from 34.3% to 17.2%), and women who did not consume alcohol (from 16.7% to 8.2%). Of note, HBP prevalence significantly increased among women with no education (from 23.2% to 29.2%), widowed/divorced/separated women (from 35.8% to 44.4%), women in the lowest wealth quintile (from 14.9% to 19.4%), and women residing in Koshi province (from 17.7% to 24.8%).

Table 3 Prevalence of high blood pressure among women age 15 and older by background variables in 2016 and 2022: results of bivariate analysis

Variable	2016 NDHS		2022 NDHS		Difference (percentage points)	
	95% CI	*p* value	95% CI	*p* value		*p* value
Total	**16.8 [15.6,18.1]**		**17.9 [16.8,19.2]**		**1.1**	.204
Age						
15–29	4.1 [3.3, 5.0]	.000*	2.8 [2.0, 3.8]	.000*	−1.3	.044*
30–44	15.6 [13.9, 17.4]		13.5 [11.6, 15.7]		−2.1	.143
45–59	29 [25.8, 32.4]		32.6 [29.5, 35.8]		3.6	.130
60–74	40.7 [36.7, 44.7]		43.5 [39.3, 47.8]		2.8	.341
≥75	50.6 [42.8, 58.4]		55.5 [46.2, 64.4]		4.9	.412
Education						
0 years	23.5 [21.5, 25.6]	.000*	29.2 [27.0, 31.4]	.000*	5.7	.000*
1–5 years	14.8 [12.7, 17.3]		18.3 [15.2, 21.8]		3.5	.089
6–10 years	9.2 [7.9, 10.6]		8.3 [6.8, 10.1]		−0.9	.423
≥11 years	9.0 [6.9, 11.8]		6.5 [4.6, 9.2]		−2.5	.142
Marital status						
Never married	3.6 [2.6, 5.0]	.000*	4.7 [3.3, 6.8]	.000*	1.1	.269
Married	17 [15.6, 18.5]		16.8 [15.5, 18.2]		−0.2	.786
Widowed/divorced/separated	35.8 [31.8, 40.1]		44.4 [40.1, 48.9]		8.6	.005*
Wealth quintile						
Lowest	14.9 [12.9, 17.2]	.000*	19.4 [17.1, 22.0]	.038*	4.5	.006*
Second	16.9 [14.9, 19.2]		15.6 [13.5, 18.0]		−1.3	.417
Middle	14.2 [12.3, 16.3]		15.6 [13.3, 18.1]		1.4	.385
Fourth	14.6 [12.4, 17.1]		18 [15.1, 21.3]		3.4	.080
Highest	23.6 [21.0, 26.4]		20.9 [17.3, 24.9]		−2.7	.257
Nutritional status						
Thin	2.8 [1.9, 4.2]	.000*	2.4 [1.4, 4.3]	.000*	−0.4	.650
Normal	7.5 [6.6,8.7]		6.1 [5.0, 7.4]		−1.4	.085
Overweight	21.5 [18.3, 25.1]		14.6 [11.9, 17.8]		−6.9	.003*
Obese	32.6 [27.0, 38.7]		29.5 [23.8, 35.9]		−3.1	.482
Ethnicity						
Brahmin/Chhetri	9.6 [8.1, 11.4]	.014*	8.9 [7.0, 11.3]	.000*	−0.7	.619
Dalit	10.7 [8.5, 13.3]		10.1 [7.8, 13.1]		−0.6	.756
Janajati	12.1 [10.5, 14.0]		11.4 [9.5, 13.8]		−0.7	.623
Madheshi	8.4 [6.8, 10.5]		4.3 [2.9, 6.3]		−4.1	.003*
Muslim/other	8.5 [6.1, 11.8]		5.0 [2.2, 10.7]		−3.5	.226
Religion						
Hindu	10.2 [9.2, 11.4]	.218	8.8 [7.6, 10.1]	.214	−1.4	.094
Other than Hindu	11.6 [9.6, 13.9]		11 [8.5, 14.1]		−0.6	.738
Pregnancy status						
Yes	1.5 [0.5, 4.4]	.000*	0.7 [0.2,3.1]	.000*	−0.8	.403
No	17.3 [16.1, 18.7]		9.5 [8.4,10.7]		−7.8	.000*
Employment status						
Not employed	23.1 [21.4, 25.0]	.000*	25.7 [23.9, 27.6]	.000*	2.6	.053
Employed for cash	12.2 [10.1, 14.6]		11.8 [9.9, 14.0]		−0.4	.820
Employed for in kind	10.5 [6.4, 16.9]		12.2 [7.9, 18.4]		1.7	.653
Employed not paid	9.4 [8.0, 11.0]		8.1 [6.7, 9.9]		−1.3	.252
Media exposure						
Not at all	10.2 [8.2, 12.5]	.273	9.6 [7.3, 12.5]	.564	−0.6	.730
Less than once a week	9.1 [7.5, 11.0]		8.1 [6.3, 10.5]		−1.0	.495
At least once a week	10.9 [9.6, 12.5]		9.5 [8.1, 11.1]		−1.4	.178
Internet exposure						
Not at all	10.9 [9.8, 12.1]	.079	11.3 [9.5, 13.4]	.015*	0.4	.711
Less than once a week	12.7 [7.8, 19.8]		5.8 [3.2, 10.3]		−6.9	.038*
At least once a week	8.1 [5.5, 11.7]		7.8 [5.6, 10.8]		−0.3	.901
Almost every day	8.4 [6.5, 10.8]		8.1 [6.5, 10.1]		−0.3	.847
Place of residence						
Urban	17.2 [15.5, 19.0]	.468	18.3 [16.7, 20.0]	.368	1.1	.367
Rural	16.2 [14.6, 18.0]		17.2 [15.8, 18.8]		1.0	.383

Continued…

Table 3—*Continued*

Variable	2016 NDHS		2022 NDHS		Difference (percentage points)	*p* value
	95% CI	*p* value	95% CI	*p* value		
Ecoregion						
Mountain	16.6 [12.7, 21.4]	.039*	20.2 [12.8, 30.4]	.197	3.6	.469
Hill	18.5 [16.3, 20.9]		19.4 [17.7, 21.2]		0.9	.556
Terai	15.3 [13.9, 16.8]		16.6 [15.0, 18.2]		1.3	.250
Province						
Koshi	17.7 [15.6, 20.0]	.000*	24.8 [21.9, 27.8]	.000*	7.1	.000*
Madhesh	13.1 [11.4, 15.0]		12.0 [9.9, 14.5]		−1.1	.490
Bagmati	19.1 [15.2, 23.7]		20.3 [16.8, 24.4]		1.2	.669
Gandaki	23.8 [20.9, 27.1]		19.4 [17.0, 22.1]		−4.4	.031*
Lumbini	18.8 [15.6, 22.4]		17.6 [15.3, 20.1]		−1.2	.574
Karnali	10.1 [7.6, 13.2]		12.0 [9.3, 15.4]		1.9	.349
Sudurpaschim	10.2 [7.7, 13.3]		14.2 [11.7, 17.1]		4.0	.046
Smoking habit						
Yes	29 [22.3, 36.8]	.000*	20.9 [14.4, 29.2]	.000*	−8.1	.135
No	16.4 [15.2, 17.7]		8.7 [7.7, 9.9]		−7.7	.000*
Alcohol consumption						
Yes	34.3 [22.9, 47.8]	.001*	17.2 [13.2, 22.1]	.000*	−17.1	.002*
No	16.7 [15.5, 18.0]		8.2 [7.2, 9.3]		−8.5	.000*
Elevation						
0–1,999 meters	16.9 [15.7, 18.2]	.147	17.9 [16.7, 19.2]	.952	1.0	.271
≥2,000 meters	11.7 [7.0, 19.1]		18.2 [11.6, 27.2]		6.5	.187
Indoor air pollution						
No	24.1 [20.7, 27.8]	.000*	22.2 [19.1, 25.7]	.001*	−1.9	.461
Yes	16.0 [14.4, 17.8]		16.7 [15.1, 18.3]		0.7	.592

*Statistically significant

CI = confidence interval; NDHS = Nepal Demographic and Health Survey

Note: Data on the individual background variables of ethnicity, religion, pregnancy status (women), employment status, media exposure, internet exposure, smoking habit, and alcohol consumption were collected only among individuals age 15–49. Respective prevalences and differentials were computed based on those data.

Table 4 presents the prevalence of HBP, differentials, and changes over time among men age 15 and older by background variables. HBP prevalence marginally declined from 23.4% in 2016 to 22.9% in 2022, but the difference was insignificant. Age, education, and nutritional status showed significant positive associations with HBP, with the highest prevalence of HBP among obese men (54.4% in 2016 and 48.7% in 2022) and the lowest among thin men (13.6% in 2016 and 12.7% in 2022). Marital status was significantly associated with HBP, with lower HBP prevalence among never married men (6.1% in 2016 and 4.5% in 2022) than among married men (27.7% in 2016 and 28.2% in 2022). Although HBP was also significantly associated with wealth quintile, the direction was not clear.

Urban-rural and provincial differences in men's HBP prevalence were statistically significant in both surveys, whereas differences by ecoregion were significant only in the 2016 survey. HBP prevalence was highest among men living in the Hill ecoregion in 2022 and among urban men in both surveys. In 2016, the prevalence was highest in Gandaki province (30.7%) and lowest in Madhesh (17.6%); in 2022, it was highest in Koshi (26.7%) and lowest in Karnali (17.7%). As was the case for women, the prevalence of HBP was significantly lower among men who were exposed to indoor air pollution than among those not exposed, in both surveys. In 2016, ethnicity and employment status were significantly associated with HBP. Janajatis had the highest HBP prevalence (19.3%), and men from Muslim/other ethnic groups had the lowest (9.7%).

Analysis of changes in HBP prevalence over time among men showed mixed results. In most subgroups, we found no significant changes over time. However, the prevalence of HBP decreased significantly among men age 15–29, those with normal nutritional status, those residing in the Hill ecoregion, and those residing in Gandaki or Lumbini province. In contrast, prevalence increased significantly in the Terai ecoregion, in Koshi province, and in Madhesh province (Table 4).

Table 4 Prevalence of high blood pressure among men age 15 and older by background variables in 2016 and 2022: results of bivariate analysis

	2016 NDHS		2022 NDHS		Difference (percentage points)	
Variable	**95% CI**	***p* value**	**95% CI**	***p* value**		***p* value**
Total	**23.4 [21.7,25.2]**		**22.9 [21.4,24.5]**		**−.5**	**.669**
Age						
15–29	7.1 [5.7, 8.8]	.000*	5.0 [3.9, 6.5]	.000*	−2.1	.044*
30–44	25.1 [22.2, 28.3]		21.0 [18.0, 24.2]		−4.1	.063
45–59	33.3 [29.9, 36.9]		37.0 [33.7, 40.5]		3.7	.135
60–74	40.9 [36.7, 45.3]		41.4 [37.2, 45.7]		0.5	.877
≥75	41.2 [34.0, 48.8]		44.7 [36.7, 53.0]		3.5	.531
Education						
0 years	27.6 [24.7, 30.8]	.000*	30.9 [27.7, 34.3]	.000*	3.3	.154
1–5 years	26.1 [22.7, 29.9]		28.1 [24.8, 31.7]		2.0	.423
6–10 years	20.1 [17.8, 22.6]		19.4 [17.3, 21.7]		−0.7	.673
≥11 years	21.5 [18.2, 25.2]		17.1 [14.1, 20.6]		−4.4	.072
Marital status						
Never married	6.1 [4.5, 8.2]	.000*	4.5 [3.3, 6.1]	.000*	−1.6	.174
Married	27.7 [25.5, 30.0]		28.2 [26.3, 30.2]		0.5	.731
Widowed/divorced/separated	39.6 [33.4, 46.1]		39.2 [32.0, 46.8]		−0.4	.937
Wealth quintile						
Lowest	21.4 [18.6, 24.4]	.000*	18.9 [16.1, 22.1]	.000*	−2.5	.248
Second	23.1 [20.3, 26.3]		20.5 [17.5, 23.7]		−2.6	.22
Middle	19.4 [16.7, 22.4]		21.2 [18.1, 24.5]		1.8	.412
Fourth	20.9 [18.0, 24.2]		23.8 [20.5, 27.5]		2.9	.222
Highest	31.5 [26.7, 36.7]		28.7 [25.3, 32.3]		−2.8	.369
Nutritional status						
Thin	13.6 [11.0, 16.7]	.000*	12.7 [10.2, 15.8]	.000*	−0.9	.647
Normal	20.5 [18.8, 22.3]		18.0 [16.3, 19.7]		−2.5	.04*
Overweight	42.8 [38.4, 47.2]		40.0 [36.3, 43.7]		−2.8	.336
Obese	54.4 [45.5, 63.0]		48.7 [39.6, 58.0]		−5.7	.392
Ethnicity						
Brahmin/Chhetri	16.6 [14.2, 19.4]	.038*	na		na	na
Dalit	16.7 [12.4, 21.9]		na		na	na
Janajati	19.3 [16.2, 22.9]		na		na	na
Madheshi	13.8 [10.6, 17.9]		na		na	na
Muslim/other	9.7 [6.1, 15.2]		na		na	na
Religion						
Hindu	16.9 [15.0, 18.9]	.743	na		na	na
Other	16.4 [12.5, 21.3]		na		na	na
Employment status						
Not employed	29.8 [27.3, 32.3]	.000*	na		na	na
Employed for cash	20.2 [18.0, 22.7]		na		na	na
Employed for in kind	6.3 [2.2, 16.7]		na		na	na
Employed not paid	13.5 [11.0, 16.6]		na		na	na
Media exposure						
Not at all	14.2 [9.9, 20.1]	.14	na		na	na
Less than once a week	14.9 [12.4, 17.8]		na		na	na
At least once a week	17.7 [15.7, 20.0]		na		na	na

Continued…

Table 4—*Continued*

Variable	2016 NDHS 95% CI	2016 NDHS *p* value	2022 NDHS 95% CI	2022 NDHS *p* value	Difference (percentage points)	Difference *p* value
Internet exposure						
Not at all	18.3 [16.4, 20.3]	.049*	na		na	na
Less than once a week	15.2 [10.6, 21.4]		na		na	na
At least once a week	12.1 [9.3, 15.5]		na		na	na
Almost every day	16.5 [12.8, 21.0]		na		na	na
Place of residence						
Urban	25.2 [23.1, 27.5]	.007*	25.3 [23.4, 27.4]	.000*	0.1	.936
Rural	20.5 [18.1, 23.2]		17.9 [15.9, 20.2]		−2.6	.122
Ecoregion						
Mountain	18.0 [14.3, 22.4]	.000*	19.9 [15.8, 24.7]	.546	1.9	.526
Hill	28.0 [25.2, 31.0]		23.0 [20.8, 25.3]		−5.0	.007*
Terai	20.1 [18.2, 22.2]		23.2 [21.0, 25.5]		3.1	.042*
Province						
Koshi	20.8 [18.1, 23.8]	.000*	26.7 [23.3, 30.3]	.017*	5.9	.012*
Madhesh	17.6 [14.8, 20.8]		22.8 [19.2, 26.8]		5.2	.034*
Bagmati	28.7 [24.4, 33.6]		24.5 [21.2, 28.1]		−4.2	.147
Gandaki	30.7 [26.7, 35.0]		23.4 [19.5, 27.8]		−7.3	.019*
Lumbini	24.9 [20.5, 29.9]		18.1 [14.6, 22.4]		−6.8	.031*
Karnali	21.8 [17.2, 27.2]		17.7 [13.8, 22.3]		−4.1	.215
Sudurpaschim	18.2 [15.1 ,21.7]		23.1 [18.9, 27.8]		4.9	.078
Smoking habit						
Yes	28.6 [25.4, 32.0]	.000*	na		na	na
No	22.2 [20.5, 24.0]		na		na	na
Alcohol consumption						
Yes	31 [23.3,39.9]	.050	na		na	na
No	23.2 [21.5,25.0]		na		na	na
Elevation						
0–1,999 meters	23.6 [21.9, 25.3]	.153	23.0 [21.5, 24.6]	.400	−0.6	.653
≥2,000 meters	16.1 [9.0, 26.9]		18.1 [9.9, 30.8]		2.0	.733
Indoor air pollution						
No	32.6 [27.5, 38.1]	.000*	28.0 [24.7, 31.6]	.000*	−4.6	.151
Yes	21.4 [19.2, 23.7]		20.8 [18.8, 23.1]		−0.6	.727

*Statistically significant

CI = confidence interval; na = not available; NDHS = Nepal Demographic and Health Survey

Note: Data in the men's recode were not available in 2022 because the households selected for the men's surveys were not eligible for the biomarker survey.

3.3 Determinants of High Blood Pressure

For both men and women, the overall temporal change in HBP between 2016 and 2022 was statistically insignificant after controlling for other factors during multivariable logistic regression analysis (Table 5). However, age remained a significant factor associated with HBP for both men and women, with adjusted odds ratios (AORs) increasing with age. For example, the odds that men and women age 45–59 would have HBP were 9.2 times higher and 10.5 times higher, respectively, than they were for those age 15–29 (the reference category). Education also had some net effect on determining the likelihood of HBP among men and women. For men, the odds of HBP were 1.4 times higher for those with 1–5 or 6–10 years of schooling than for those with no education (the reference category). However, for women, the odds of HBP were reduced by 40% among those with 10 or more years of schooling when compared with those with no education.

For both men and women, those from the highest wealth quintile had significantly higher odds of HBP (1.5 for women and 1.6 for men) than those from the lowest wealth quintile. Rural residence was associated with decreased odds (AOR = 0.8) of HBP when compared with urban residence, but this association was significant only for men (Table 5). Using Koshi province as the reference, the odds of HBP were significantly lower in Madhesh (AOR = 0.6), Karnali (AOR = 0.6), and Sudurpaschim (AOR = 0.5) among women, but only for Madhesh (AOR = 0.7) among men. Ecoregion, elevation, and exposure to indoor air pollution had no significant effects on men's and women's HBP status after controlling for other factors.

Table 5 Background variables associated with high blood pressure among men and women age 15 and older: results of multivariable analysis

	Women	Men
Variable	**AOR [95% CI]**	**AOR [95% CI]**
Survey year		
2016	ref.	ref.
2022	1.0 [0.8, 1.2]	0.9 [0.7, 1.0]
Age		
15–29	ref.	ref.
30–44	4.4*** [3.4, 5.7]	5.4*** [4.2, 7.0]
45–59	10.5*** [7.8, 14.2]	9.2*** [7.0, 12.1]
60–74	17.9*** [12.8, 25.0]	14.1*** [10.4, 19.0]
≥75	25.4*** [17.0, 37.9]	15.1*** [10.1, 22.5]
Education		
0 years	ref.	ref.
1–5 years	1.4** [1.1, 1.7]	1.4** [1.1, 1.7]
6–10 years	1.0 [0.7, 1.2]	1.4** [1.1, 1.8]
≥11 years	0.6* [0.4, 0.9]	1.2 [0.9, 1.6]
Wealth quintile		
Lowest	ref.	ref.
Second	1.0 [0.8, 1.3]	1.0 [0.8, 1.3]
Middle	1.0 [0.8, 1.3]	0.9 [0.7, 1.3]
Fourth	1.2[0.9, 1.7]	1.2 [0.9, 1.6]
Highest	1.5* [1.1, 2.2]	1.6** [1.2, 2.3]
Residence		
Urban	ref.	ref.
Rural	0.9 [0.8, 1.1]	0.8* [0.7, 1.0]
Ecoregion		
Mountain	ref.	ref.
Hill	0.8 [0.5, 1.2]	1.2 [0.9, 1.6]
Terai	0.7 [0.5, 1.1]	1.2 [0.8, 1.6]
Province		
Koshi	ref.	ref.
Madhesh	0.6*** [0.4, 0.8]	0.7* [0.5, 1.0]
Bagmati	0.9 [0.7, 1.2]	1.0 [0.8, 1.4]
Gandaki	1.0 [0.8, 1.4]	1.1 [0.8, 1.5]
Lumbini	0.9 [0.7, 1.2]	0.9 [0.7, 1.3]
Karnali	0.6** [0.4, 0.8]	1.0 [0.7, 1.4]
Sudurpaschim	0.5*** [0.4, 0.7]	1.0 [0.7, 1.4]
Elevation		
0–1,999 meters	ref.	ref.
≥2,000 meters	0.9 [0.5, 1.5]	0.7 [0.4, 1.2]
Indoor air pollution		
No	ref.	ref.
Yes	0.8 [0.7, 1.1]	0.9 [0.7, 1.2]

* p <.05, ** p <.01, *** p <.001

AOR = adjusted odds ratio; CI = confidence interval, ref. = reference category

Results of logistic regression including additional background variables available for women age 15–49 are presented in Table 6. The temporal effect on women's HBP was statistically insignificant, as before. Age remained significantly associated with HBP among women age 15–49 after controlling for all other factors. As compared with women age 15–29, those age 30–49 had almost 3.5 times higher odds of HBP. Women's nutritional status was significantly associated with HBP. Compared with thin women (BMI <18), women with normal BMI, overweight women, and obese women had more than 2 times, about 4.5 times, and 8.5 times higher odds of HBP, respectively. Of note, pregnant women had significantly lower odds of HBP (AOR = 0.22) than their nonpregnant counterparts. Similarly, compared with women who were not exposed to the internet, those who were exposed almost every day had decreased odds of HBP (AOR = 0.7). Compared with women from Koshi province, those from Sudurpaschim had significantly lower odds of HBP (AOR = 0.5). It is evident that, among the additional variables included in this model, women's nutritional status was the most important factor associated with HBP. It should be noted that behavioral variables (i.e., smoking habit and alcohol consumption), elevation, and indoor air pollution had no significant effect on HBP after controlling for other factors.

Table 6 Background variables associated with high blood pressure among women age 15–49: results of multivariable analysis

Variable	AOR [95% CI]
Survey year	
2016	ref.
2022	0.82 [0.64, 1.05]
Age	
15–29	ref.
30–49	3.46*** [2.53, 4.73]
Education	
0 years	ref.
1–5 years	1.22 [0.93, 1.61]
6–10 years	0.87 [0.63, 1.21]
≥11 years	0.79 [0.50, 1.25]
Marital status	
Never married	ref.
Married	1.28 [0.81, 2.01]
Widowed/divorced/separated	1.76 [0.91, 3.38]
Wealth quintile	
Lowest	ref.
Second	0.98 [0.69, 1.41]
Middle	1.09 [0.74, 1.58]
Fourth	1.02 [0.68, 1.52]
Highest	1.00 [0.63, 1.60]
Nutritional status	
Thin	ref.
Normal	2.18** [1.34, 3.52]
Overweight	4.44*** [2.68, 7.36]
Obese	8.55*** [4.94, 14.80]
Ethnicity	
Brahmin/Chhetri	ref.
Dalit	1.32 [0.91, 1.91]
Janajati	1.24 [0.93, 1.64]
Madheshi	0.83 [0.53, 1.30]
Muslim/other	0.84 [0.42, 1.67]
Religion	
Hindu	ref.
Other	0.86 [0.63, 1.16]

Continued…

Table 4—*Continued*

Variable	AOR [95% CI]
Pregnancy status	
No	ref.
Yes	0.22** [0.07, 0.67]
Employment status	
Not employed	ref.
Employed for cash	0.89 [0.69, 1.16]
Employed for in kind	0.74 [0.41, 1.33]
Employed not paid	0.74* [0.56, 0.96]
Media exposure	
Not at all	ref.
Less than once a week	0.90 [0.65, 1.24]
At least once a week	1.03 [0.76, 1.40]
Internet exposure	
Not at all	ref.
Less than once a week	1.15 [0.62, 2.14]
At least once a week	1.01 [0.70, 1.46]
Almost every day	0.70* [0.52, 0.93]
Place of residence	
Urban	ref.
Rural	0.96 [0.74, 1.24]
Ecoregion	
Mountain	ref.
Hill	0.90 [0.54, 1.50]
Terai	0.83 [0.48, 1.43]
Province	
Koshi	ref.
Madhesh	0.60 [0.36, 1.01]
Bagmati	0.84 [0.55, 1.27]
Gandaki	0.99 [0.64, 1.53]
Lumbini	0.93 [0.62, 1.40]
Karnali	0.72 [0.44, 1.18]
Sudurpaschim	0.50** [0.31, 0.80]
Smoking habit	
No	ref.
Yes	1.37 [0.71, 2.65]
Alcohol consumption	
No	ref.
Yes	1.16 [0.75, 1.79]
Elevation	
0–1,999 meters	ref.
≥2,000 meters	1.15 [0.64, 2.07]
Indoor air pollution	
No	ref.
Yes	0.89 [0.66, 1.21]

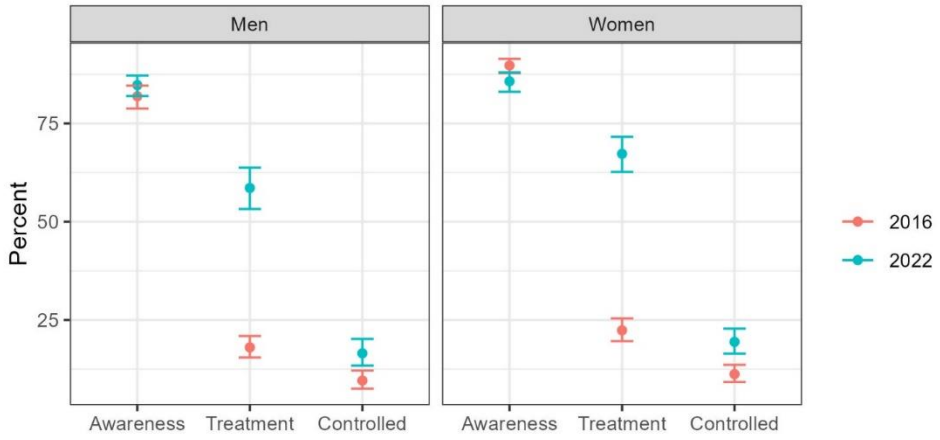
* p <.05, ** p <.01, *** p <.001

AOR = adjusted odds ratio; CI = confidence interval; ref. = reference category

3.4 Treatment Cascade

Although the prevalence of HBP remained statistically unchanged between surveys, we wanted to examine potential differences in the treatment cascade for HBP—awareness, treatment, and control—over the same period. As shown in Figure 1, results were similar for men and women: in both 2016 and 2022, levels of awareness were high, at more than 75%. The major change over time was in treatment: fewer than 25% of men and women with HBP received treatment in 2016, but 59% of men and 67% of women received treatment in 2022. This led to a slight increase in the proportion of individuals whose HBP was controlled, from 10% to 17% among men and from 11% to 19% among women.

Figure 1 Treatment cascade for high blood pressure in men and women



4 DISCUSSION

Based on data from the 2016 Nepal Demographic and Health Survey (NDHS) and the 2022 NDHS, the overall prevalence of high blood pressure (HBP) is higher among men than among women in Nepal. Similar results were obtained in a study of HBP in rural India[35] and in studies from other low- and middle-income countries, including Nepal.[3,28,36,37] When the data were disaggregated by age, the odds of HBP increased with age for both men and women, and HBP prevalence was actually higher for women than for men after age 60. This age-related finding may be attributed to differences in hormonal composition between men and women.[35,38]

Given the rising levels of noncommunicable diseases (NCDs) and HBP globally, as well as the increase in the percentage of overweight or obese adults in Nepal, it is encouraging—and a bit surprising—that our data showed no significant increase in HBP between 2016 and 2022. HBP prevalence did, however, increase significantly among women who were uneducated, women from the lowest wealth quintile, women residing in Koshi province, and widowed/divorced/separated women. Among men, it increased significantly among those living in Terai region and those living in Koshi or Madhesh province. In contrast, HBP prevalence actually decreased significantly among women age 15–29, overweight women, women from the Madheshi ethnic group, nonpregnant women, nonsmoking women, and women from Gandaki province. For men, it declined significantly among those with normal nutritional status, those from the Hill ecoregion, and those residing in Gandaki or Lumbini province. The reasons for changes and differentials in the prevalence of HBP among men and women of different background characteristics could be due to a complex set of behavioral and environmental factors beyond the scope of this analysis. However, understanding the reasons for these findings would help frame strategies and programs for future focused interventions.

In our multivariate analysis, some significant provincial differences in HBP prevalence were found for both men and women. In the analysis, Koshi province was used as a reference category. The results showed that women from Madhesh, Karnali, and Sudurpaschim and men from Madhesh had significantly lower odds of HBP than those from Koshi. Koshi had the highest prevalence of HBP for both men and women in the 2022 survey. As compared with men and women age 15 and older from the lowest wealth quintile, those from the highest wealth quintile had significantly higher odds of HBP (adjusted odds ratios of 1.6 for men and 1.5 for women). This could be explained by the more sedentary lifestyle of wealthy people. Age was the most important factor explaining HBP, and this result has been commonly supported by other research.[35]

Our separate multivariate analysis among women age 15–49 found that nutritional status was significantly associated with HBP, and that overweight or obese women had significantly increased odds of HBP. This aligns with results of research conducted by Neupane et al., indicating a notable correlation between obesity and HBP across various countries represented in the South Asian Association for Regional Cooperation.[36] Similar results were also found in a study conducted in Nepal.[28]

Other research has shown that smoking and alcohol consumption are significantly associated with HBP.[28,29] However, our findings do not support these results, as no net significant association with smoking or alcohol consumption was observed among women age 15–49. The discrepancy could be due to the very small proportions of smokers and consumers of alcohol in the study sample. Literature also shows that inadequate

exercise and sedentary lifestyle are determinants of HBP,[28,29] although we couldn't assess these factors due to data unavailability.

Although the prevalence of HBP did not significantly increase during the study period, the number of people with HBP in Nepal is expected to increase due to the changing age structure of the population. According to census data from Nepal, the proportion of the population over age 50 increased from 15.01% in 2011 to 18.75% in 2021—an increase of nearly 1.5 million people in a decade.[39,40]

Previous studies have reported that the levels of awareness, treatment, and control of HBP in Nepal are alarmingly low with relatively poor progress.[29] However, our results suggest a slightly better scenario. Although we did not find a large increase in control of HBP between the two surveys, our results showed that most people (more than 75%) were aware of their HBP status, and many more were receiving treatment in 2022 than in 2016. The increase in treatment is likely attributed to the concurrent rise in service availability and readiness for HBP since 2015, as indicated by the 2021 National Health Facility Survey.[34] For instance, the data revealed a notable uptick in guideline adherence and trained staff availability, with respective increases of 10 and 12 percentage points between 2015 and 2021. Moreover, the availability of HBP medications rose significantly during this period. The utilization of beta blockers surged from 18% in 2015 to 32% in 2021, while the use of calcium channel blockers increased remarkably from 11% in 2015 to 62% in 2021.[34] Despite these promising results, the treatment level is still substantially lower than the awareness level, and the level of control is quite low. The lack of full awareness, as well as the gap between awareness and control of HBP, among both men and women is of serious concern. Low- and middle-income countries encounter substantial obstacles in diagnosing, treating, and providing care.[41] For instance, a notable portion of individuals diagnosed with HBP by health care workers never receive treatment or are lost to follow-up.[42] Disparities in the treatment cascade, spanning from diagnosis to HBP control, are more pronounced in low- and middle-income countries than in high-income countries.[32,33]

In a study of barriers for treatment and control of HBP in Nepal, misconceptions about HBP and its treatment, as well as difficulties in modifying behavior, were identified as capability barriers.[43] Faith in alternative medicine and fear of the consequences of established treatment were identified as motivational barriers, and lack of communication between patients and providers, stigma related to HBP and fear of its disclosure, and sociocultural factors shaping health behaviors were identified as opportunity barriers.[43] Previous research has also confirmed the need for HBP preventive measures/approaches, as well as strategies for optimizing the HBP treatment cascade.[29] As per the results of our study, the need for such strategies is still relevant. Identifying why people are not on treatment and why people who are on treatment do not have their blood pressure under control is a necessary next step for health officials if Nepal is going to combat the morbidity and mortality associated with HBP.

4.1 Current Policies and Programs

The Public Health Service Act 2018 mentions that every citizen has the right to obtain free basic health services related to NCDs.[43,44] According to this legal provision, basic health services incorporate promotional, diagnostic, and remedial services. This legal framework ensures the rights of citizens to access promotional, diagnostic, and remedial services for NCDs; HBP is obviously included, though not specifically mentioned. The burden of NCDs in Nepal is increasing, and two-thirds of all deaths in the

country are due to NCDs.[44] Sustainable Development Goal 3.4 targets a reduction of premature mortality from NCDs by one-third through prevention and treatment.[8]

The National Multi-Sectoral Action Plan II for NCDs, spanning 2021–25, encompasses comprehensive objectives aimed at elevating the prominence of NCD prevention and control within the national agenda, policies, and programs.[45] Central to this initiative is the endeavor to fortify national capacity and governance structures, facilitating effective leadership and fostering multisectoral collaboration and partnerships to combat NCDs. Furthermore, the plan is geared toward mitigating the risk factors for NCDs while addressing the underlying social determinants that contribute to NCD prevalence, spanning various sectors. A key focus lies in bolstering health systems to ensure the delivery of people-centric, integrated, and equitable care, thereby enhancing the prevention and control of NCDs. Moreover, the establishment of a robust NCD surveillance, monitoring, and evaluation system is envisaged to underpin evidence-based policy-making and program implementation, thereby fostering informed interventions and facilitating progress toward the overarching goals of NCD prevention and control.[45]

Similarly, the Nepal Package of Essential NCDs (PEN) program, comprising the PEN and HEARTS* toolkit,[45] represents a strategic endeavor to bolster health systems in combating NCDs and addressing their underlying social determinants through a people-centered approach to primary health care. Central to this initiative is the aim to enhance both national and local capacity and foster partnerships to expedite the country's response to NCD prevention and control. Emphasizing the reduction of modifiable risk factors for NCDs and the creation of health-promoting environments, the program seeks to mitigate the burden of these diseases by empowering individuals and communities to adopt healthy lifestyles. Through the implementation of evidence-based protocols and the provision of access to essential medicines and technologies, alongside risk-based cardiovascular disease management and team-based care, the Nepal PEN program aspires to forge a comprehensive framework for monitoring and addressing NCDs, thereby contributing to the overarching goal of improving public health outcomes.[45]

4.2 Strengths and Limitations

We used nationally representative data from two recent NDHS surveys to analyze background variables associated with HBP separately for men and women, examining changes between consecutive surveys and in the treatment cascade. The NDHS surveys employed a multi-user upper arm blood pressure monitor with three cuff sizes to accommodate varying arm sizes. Three readings, taken at intervals of 5 minutes or more, were averaged to classify hypertension following World Health Organization (WHO) guidelines. By analyzing data from two consecutive surveys, we could estimate quantities and uncertainties at different time points, aiding policymakers in resource allocation and issue prioritization.

It is crucial to note the cross-sectional nature of the survey, and to caution against interpreting findings causally. One limitation of the 2022 NDHS is that biomarker data, including blood pressure measurements in men, were not obtained from all selected households, hindering observation of individual characteristics and changes among men. Additionally, we analyzed data for both men and women age 15 and older. However, the NDHS primarily focuses on individuals age 15–49, which limited the availability of certain individual characteristics. Moreover, behavioral desirability bias in women's reports of smoking and

* H = healthy-lifestyle counseling; E = evidence-based protocols; A = access to essential medicines and technologies; R = risk-based cardiovascular disease management; T = team-based care; S = systems for monitoring

alcohol consumption might have led to underestimates of their prevalence, obscuring significant associations with HBP. Separate longitudinal studies are recommended to examine these associations more closely.

Furthermore, mixed method studies (qualitative and quantitative) are necessary for deeper understanding of HBP-associated factors. Our analysis was constrained by the variables available in the NDHS. Nevertheless, our findings can inform governments and program planners in addressing NCD-related Sustainable Development Goals.

5 CONCLUSION

5.1 Key Findings

- The prevalence of high blood pressure (HBP) was slightly higher among men than women in both 2016 (23.4% versus 16.8%, respectively) and 2022 (22.9% versus 17.9%, respectively).
- Overall, there were no significant changes in the prevalence of HBP among men and women age 15 and older between 2016 and 2022. However, significant changes were found among subgroups with selected categories of background variables.
- Among men and women age 15 and older, age was a significant predictor of HBP, with increased odds of HBP as age increased. Men and women from the highest wealth quintile had significantly higher odds of HBP than those from the lowest wealth quintile.
- Significant provincial differences were identified, especially for women, with decreased odds of HBP among women from Madhesh, Karnali, and Sudurpaschim provinces when compared with those from Koshi (the reference province). Among men, only those from Madhesh province had significantly lower odds of HBP than those from Koshi province.
- Among women age 15–49, age and nutritional status were significantly associated with HBP. Increases in age and body mass index were associated with higher odds of HBP among women.
- Elevation (measured as average cluster height of residence) and indoor air pollution were not significantly associated with HBP.
- Overall, for both men and women, evaluation of the HBP treatment cascade showed a moderately high level of awareness of HBP status (more than 75%) with little change between 2016 and 2022, a relatively low level of treatment with a substantial increase over time (from less than 25% to more than 50%), and a low level of control (less than 25%) with a slight increase over the study period.

5.2 Key Recommendations

These findings underscore the intricate interplay of sociodemographic and environmental factors in HBP prevention and treatment. It is recommended that policies and programs focus on these two areas and that HBP awareness campaigns target older individuals, particularly focusing on those with lower levels of education and wealth. Additionally, interventions should consider the influence of regional factors, such as rural residence and ecoregion, while emphasizing the significance of women's nutritional status, internet exposure, and pregnancy in HBP prevention and management. People are to be made aware of the lifelong consequences of HBP, the expected lifestyle changes for its prevention, the importance of regular health checkups for early diagnosis, and proper medication for control. To reduce the burden of HBP:

- The federal government should formulate policies and programs focused on strengthening existing capabilities and motivations, and on reducing barriers to treatment and control of HBP.
- Provincial governments should formulate awareness programs focused on behavior change to prevent HBP and ensure service provision, as envisioned in legal framework, to diagnose HBP early and provide treatment.

- Local governments can implement awareness programs aimed at HBP prevention as well as coordinate with provincial and federal governments to effectively manage HBP through early diagnosis and treatment. One strategy for reducing (or slowing the growth of) HBP is to increase programs in provinces and within subpopulations with the highest HBP prevalences.

REFERENCES

1. Mills KT, Bundy JD, Kelly TN, et al. Global disparities of hypertension prevalence and control: A systematic analysis of population-based studies from 90 countries. *Circulation.* 2016;134(6):441–50.

2. Schutte AE, Venkateshmurthy NS, Mohan S, Prabhakaran D. Hypertension in low-and middle-income countries. *Circ Res*. 2021;128(7):808–26.

3. Chow CK, Teo KK, Rangarajan S, et al. Prevalence, awareness, treatment, and control of hypertension in rural and urban communities in high-, middle-, and low-income countries. *JAMA.* 2013;310(9):959–68.

4. Murray CJ, Aravkin AY, Zheng P, et al. Global burden of 87 risk factors in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *Lancet.* 2020;396(10258):1223–49.

5. Fuchs FD, Whelton PK. High blood pressure and cardiovascular disease. *Hypertension.* 2020;75(2):285–92.

6. World Health Organization. *Noncommunicable Diseases Progress Monitor 2022.* World Health Organization; 2022.

7. Howden-Chapman P, Siri J, Chisholm E, Chapman R, Doll CN, Capon A. SDG 3: Ensure healthy lives and promote well-being for all at all ages. *A Guide to SDG Interactions: From Science to Implementation.* International Council for Science; 2017:81–126.

8. Government of Nepal National Planning Commission. *Nepal Sustainable Development Goals: Status and Roadmap: 2016–2030.* Government of Nepal National Planning Commission; 2017.

9. Nepal Health Research Council (NHRC), Ministry of Health and Population (MoHP), Institute for Health Metrics and Evaluation (IHME), Monitoring Evaluation and Operational Research (MEOR). *Nepal Burden of Disease 2019: A Country Report Based on the 2019 Global Burden of Disease Study.* NHRC, MoHP, IHME, and MEOR; 2021.

10. Pandey AR, Chalise B, Shrestha N, et al. Mortality and risk factors of disease in Nepal: Trend and projections from 1990 to 2040. *PLoS One*. 2020;15(12):e0243055.

11. Dhimal M, Bista B, Bhattarai S, et al. *Noncommunicable Disease Risk Factors: STEPS Survey Nepal 2019.* Nepal Health Research Council; 2020.

12. Dahal S, Sah RB, Niraula SR, Karkee R, Chakravartty A. Prevalence and determinants of non-communicable disease risk factors among adult population of Kathmandu. *PLoS One.* 2021;16(9):e0257037.

13. Bennett JE, Kontis V, Mathers CD, et al. NCD Countdown 2030: Pathways to achieving Sustainable Development Goal Target 3.4. *Lancet.* 2020;396(10255):918–34.

14. Nolla Solé JM. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet.* 2012;380(9859):2224–60.

15. World Health Organization. Global health observatory data repository (blood pressure). Updated November 16, 2017. Accessed June 22, 2024. http://apps.who.int/gho/data/view.main.NCDBPAWBv?lang=en

16. World Health Organization. *The World Health Report 2002: Reducing Risks, Promoting Healthy Life.* World Health Organization; 2002.

17. Chobanian AV, Bakris GL, Black HR, et al. Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension*. 2003;42(6):1206–52.

18. Joffres M, Falaschetti E, Gillespie C, et al. Hypertension prevalence, awareness, treatment and control in national surveys from England, the USA and Canada, and correlation with stroke and ischaemic heart disease mortality: A cross-sectional study. *BMJ Open.* 2013;3(8):e003423.

19. Sharma SK, Dhakal S, Thapa L, et al. Community-based screening for chronic kidney disease, hypertension and diabetes in Dharan. *JNMA J Nepal Med Assoc.* 2013;52(189):205–12.

20. Karki K, Dahal B, Regmi A, Poudel A, Gurung Y. *WHO STEPS Surveillance: Noncommunicable Diseases Risk Factors Survey 2008.* Ministry of Health and Population [Nepal], Society for Local Integrated Development Nepal (SOLID Nepal), and World Health Organization; 2008.

21. Aryal K, Neupane S, Mehata S, et al. *Noncommunicable Diseases Risk Factors: STEPS Survey Nepal.* Nepal Health Research Council; 2014.

22. Ministry of Health [Nepal], New ERA, ICF. *Nepal Demographic and Health Survey 2016.* Ministry of Health; 2017.

23. Koju R, Manandhar K, Risal A, Steiner T, Holen A, Linde M. Undertreated hypertension and its implications for public health in Nepal: Nationwide population-based survey. *Kathmandu University Medical Journal.* 2015;13(1):3–7.

24. Khanal MK, Dhungana RR, Bhandari P, Gurung Y, Paudel K. Prevalence, associated factors, awareness, treatment, and control of hypertension: Findings from a cross sectional study conducted as a part of a community based intervention trial in Surkhet, Mid-western region of Nepal. *PLoS One.* 2017;12(10):e0185806.

25. Chataut J, Khanal K, Manandhar K. Prevalence and associated factors of hypertension among adults in rural Nepal: A community based study. *Kathmandu Univ Med J.* 2015;13(4):346–50.

26. Sharma SK, Zou H, Togtokh A, et al. Burden of CKD, proteinuria, and cardiovascular risk among Chinese, Mongolian, and Nepalese participants in the International Society of Nephrology screening programs. *Am J Kidney Dis.* 2010;56(5):915–27.

27. Dhungana RR, Pandey AR, Bista B, Joshi S, Devkota S. Prevalence and associated factors of hypertension: A community-based cross-sectional study in municipalities of Kathmandu, Nepal. *Int J Hypertens.* 2016;2016:1656938.

28. Shrestha DB, Budhathoki P, Sedhai YR, et al. Prevalence, awareness, risk factors and control of hypertension in Nepal from 2000 to 2020: A systematic review and meta-analysis. *Public Health Pract (Oxf).* 2021;2:100119.

29. Dhungana RR, Pandey AR, Shrestha N. Trends in the prevalence, awareness, treatment, and control of hypertension in Nepal between 2000 and 2025: A systematic review and meta-analysis. *Int J Hypertens.* 2021;2021:1–11.

30. Nepal Health Research Council (NHRC), Ministry of Health and Population (MoHP), Monitoring Evaluation and Operational Research (MEOR). *Nepal Burden of Disease 2017: A Country Report Based on the Global Burden of Disease 2017 Study.* NHRC, MoHP, and MEOR; 2019.

31. Ministry of Health and Population [Nepal], New ERA, ICF. *Nepal Demographic and Health Survey 2022.* Ministry of Health and Population; 2023.

32. Gamage DG, Riddell MA, Joshi R, et al. Effectiveness of a scalable group-based education and monitoring program, delivered by health workers, to improve control of hypertension in rural India: A cluster randomised controlled trial. *PLoS Med.* 2020;17(1):e1002997.

33. Perry H, Zulliger R, Scott K, Javadi D, Gergen J. *Case Studies of Large-Scale Community Health Worker Programs: Examples from Bangladesh, Brazil, Ethiopia, India, Iran, Nepal, and Pakistan.* United States Agency for International Development, Maternal and Child Health Integrated Program; 2017.

34. Ministry of Health and Population [Nepal], New ERA, ICF. *Nepal Health Facility Survey 2021: Key Findings.* Ministry of Health and Population, New ERA, and ICF; 2022.

35. Ghosh S, Mukhopadhyay S, Barik A. Sex differences in the risk profile of hypertension: A cross-sectional study. *BMJ Open*. 2016;6(7):e010085.

36. Neupane D, McLachlan CS, Sharma R, et al. Prevalence of hypertension in member countries of South Asian Association for Regional Cooperation (SAARC): Systematic review and meta-analysis. *Medicine.* 2014;93(13):e74.

37. Wang J, Zhang L, Wang F, Liu L, Wang H. Prevalence, awareness, treatment, and control of hypertension in China: Results from a national survey. *Am J Hypertens.* 2014;27(11):1355–61.

38. Rossi P, Francès Y, Kingwell BA, Ahimastos AA. Gender differences in artery wall biomechanical properties throughout life. *J Hypertens.* 2011;29(6):1023–33.

39. Central Bureau of Statistics [Nepal]. *National Population and Housing Census 2011: National Report.* Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics; 2012.

40. National Statistics Office [Nepal]. *National Population and Housing Census 2021: National Report.* Government of Nepal, Office of the Prime Minister and Council of Ministers, National Statistics Office; 2023.

41. Thapa R, Zengin A, Thrift AG. Continuum of care approach for managing non-communicable diseases in low- and middle-income countries. *J Glob Health.* 2020;10(1):010337.

42. Neupane D, McLachlan CS, Mishra SR, et al. Effectiveness of a lifestyle intervention led by female community health volunteers versus usual care in blood pressure reduction (COBIN): An open-label, cluster-randomised trial. *Lancet Glob Health.* 2018;6(1):e66–73.

43. Bhandari B, Narasimhan P, Vaidya A, Subedi M, Jayasuriya R. Barriers and facilitators for treatment and control of high blood pressure among hypertensive patients in Kathmandu, Nepal: A qualitative study informed by COM-B model of behavior change. *BMC Public Health.* 2021;21:1–14.

44. Government of Nepal. *The Public Health Service Act, 2075 (2018).* Nepal Law Commission; 2018. https://www.lawcommission.gov.np/en/wp-content/uploads/2019/07/The-Public-Health-Service-Act-2075–2018.pdf

45. Department of Health Services [Nepal]. *Annual Health Report 2023/24.* Ministry of Health and Population, Department of Health Services; 2024.