EXPLORING SOCIOECONOMIC FACTORS IN RELATION TO OVERWEIGHT AND OBESITY IN NEPAL: A DEMOGRAPHIC HEALTH SURVEY ANALYSIS

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ABSTRACT

Introduction: Overweight and obesity is growing public health concerns in Nepal. This study explores the prevalence and determinants of overweight and obesity using nationally representative cross-sectional data from the 2016 and 2022 Nepal Demographic and Health Surveys (NDHS).

Methodology: The study included men and women with age 15 years and older. After removing missing data, 14,639 participants from NDHS 2016 and 13,183 from 2022 were retained for analysis. Descriptive analysis, along with univariate and multivariable logistic regression was performed using SAS version 9.4. Concentration index and decomposition analysis was conducted to identify contributors to obesity disparities.

Results: Overweight and obesity showed a 41% relative increase between the two NDHS periods. Key factors including age, marital status, household size, wealth index, and residence were significantly associated with the prevalence of overweight and obesity (P<0.001). The highest odds ratio was in the 31–45 age group (OR=3.51 in 2016; OR=3.57 in 2022), richest quintile (OR=7.31 and 5.41) Male (OR=0.59 and 0.69) and Urban resident (OR=1.87 and 1.67).

Conclusion: The significant increase in overweight and obesity in Nepal highlights the urgent need for interventions addressing socioeconomic disparities, urbanization, and lifestyle factors. Strengthened multi-sectoral strategies are essential to curb this growing public health crisis.

Keywords: *overweight; obesity; Nepal; socioeconomic factors; inequalities*

GENERAL SUMMARY

Overweight and obesity is a growing public health concerns in Nepal, contributing significantly to the burden of non-communicable diseases. Despite efforts to address these issues, limited data are available on their causes and consequences. This study analyzed data from the 2016 and 2022 Nepal Demographic and Health Surveys (NDHS). It included men and women aged 15 and older, with 14,639 participants in 2016 and 13,183 in 2022 after removing incomplete responses. The analysis used SAS version 9.4 for descriptive and bivariate analysis, along with decomposition of socioeconomic factors. Results showed a 41% relative increase in overweight and obesity prevalence over six years. Key factors included age, marital status, household size, income, and urban residency. Middle-aged adults, wealthier individuals, men, and urban residents were at higher risk. These findings highlight the urgent need for community-based interventions, policies to promote healthier lifestyles to reduce obesity and overweight in Nepal.

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BMI: Body Mass Index

CI: Confidence Interval

COPD: Chronic Obstructive Pulmonary Disease

CVD: Cardiovascular Disease

DHS: Demographic Health Survey

HFIAS: Household Food Insecurity Access Scale

ICF International Consulting Firm for Health Surveys

LMIC: Low- and Middle-Income Countries

NCD: Non-Communicable Disease

NDHS: Nepal Demographic and Health Survey

OR: Odds Ratio

SDG: Sustainable Development Goals

STEPS: Non-Communicable Risk Factor Survey

USAID: United States Agency for International Development

WHO: World Health Organization

CHAPTER I-INTRODUCTION

Background

Non-communicable diseases (NCDs) remain a major global public health challenge, significantly contributing to high rates of illness and death worldwide (1). The global health priority has shifted significantly from infectious diseases to non-communicable diseases (NCDs) due to changes in demographic patterns, urbanization, and lifestyle factors (2). The evolving epidemiological landscape, marked by increased life expectancy, urban growth, and economic transitions, has led to a rise in NCDs, including cardiovascular diseases, diabetes, cancer, and mental health disorders (1). This shift reflects the impact of aging populations and changing risk factors such as poor diet, physical inactivity, and environmental pollutants (3). As a result, NCDs have become the leading cause of chronic disability and death, placing a growing burden on healthcare systems worldwide (4).Particularly four primary NCD's-cardiovascular disease, Cancer, Chronic Obstructive pulmonary disease (COPD), and diabetes-are linked by common modifiable risk factors such as tobacco use, unhealth dietary pattern and insufficient physical activity (5).

 Noncommunicable diseases (NCDs) are the leading global cause of death, responsible for 41 million deaths annually, or 74% of all deaths(6). Of these, 17 million occur before age 70, with 86% of premature deaths concentrated in low- and middle-income countries, which shows 77% of the NCD burden. Cardiovascular diseases cause 17.9 million deaths annually, followed by cancers, chronic respiratory diseases, and diabetes, accounting for over 80% of premature NCD mortality (5,6). Key risk factors are tobacco use, physical inactivity, unhealthy diets, harmful alcohol consumption, and air pollution*,* are significantly associated with obesity. Obesity, in turn, contributes to chronic diseases such as cardiovascular disease, type 2 diabetes, and certain cancers, creating a self-reinforcing cycle. Addressing the NCD burden requires early detection, treatment, and coordinated efforts focused on reducing obesity and its determinants.(2).

The increasing prevalence of overweight and obesity has emerged as a substantial and pressing public health challenge with far-reaching implications for the well-being and health of populations worldwide(7). The global prevalence of obesity has tripled since 1975, with over 1.9 billion adults aged 18 years and older reported as overweight in 2016, including more than 650 million classified as obese(1) . In 2016, 39% of adults were overweight, while 13% were obese. Furthermore, overweight and obesity-related conditions contributed to higher mortality rates globally compared to underweight. Similarly, among children, approximately 39 million under the age of 5 were overweight or obese in 2020, whereas over 340 million aged 5-19 was affected in 2016(5).

Historically, obesity was predominantly considered a concern in developed countries (1,2); however, in recent years, a growing epidemic has emerged in low and middle-income countries, including those in South Asia, such as Nepal (1-4). This alarming trend indicates a major change in how obesity is distributed globally. While obesity was once more common in developed countries, there is now a noticeable increase in obesity-related challenges in regions that were previously less affected, such as low- and middle-income countries(8).

In the past, South Asian countries primarily focused on infectious diseases and malnutrition as their major health concerns, while showing less emphasis on addressing overweight and obesity by healthcare stakeholders including healthcare workers, policy makers, and researchers (2-4). However, the rapid rise of the obesity epidemic in South Asian countries, alongside a growing body of evidence indicating that individuals from Southeast Asia face a heightened risk for non-communicable diseases (NCDs) like diabetes mellitus type 2, coronary heart disease, and stroke compared to other regions of world, has prompted a shift in attention (3,4). Alarmingly, South Asia currently exhibits the highest global burden of diabetes patients, with NCDs, including overweight and obesity, accounting for 50% of the adult disease burden in the region(9).

Sociodemographic profile of Nepal:

Nepal, a federal democratic republic with a population of around 30 million, is a landlocked nation in South Asia, situated between China to the north and India to the east, south, and west. The country is geographically divided into three distinct regions: (1) the Terai, (2) the mid-hills and valleys, including the central urban areas of Kathmandu, Bhaktapur, and Lalitpur, and (3) the Himalayan Mountains. This mountainous expanse is notable for hosting eight of the world's ten highest peaks, prominently featuring Mount Everest. A substantial portion of Nepal's population resides in the fertile and humid southern regions. As of 2007, the country reported an adult literacy rate of 57% and a life expectancy of 64 years(10).

The demographic landscape of Nepal is characterized by a rich tapestry of ethnic and cultural diversity, encompassing communities such as the Pahari, Madhesi, Tamang, Newar, and others. Serving as both a cultural and economic nucleus, the capital, Kathmandu, plays a central role. Hinduism holds the predominant religious affiliation, followed by Buddhism and other belief systems. The demographic composition of Nepal features a blend of urban and rural inhabitants, with agriculture serving as a cornerstone of the economy. Despite this diversity, persistent challenges such as poverty, restricted access to healthcare, and educational limitations have exerted a significant influence on the demographic dynamics and overall development trajectory of the country(11).

Overweight and obesity in Nepal:

The interconnected trends of globalization and urbanization have contributed to diverse lifestyle influences, such as a rise in physical inactivity rates, heightened promotion of tobacco and alcohol, and shifts in food cultures, consumption habits, and dietary patterns(5). Furthermore, the widening disparity in health service accessibility and the escalating out-of-pocket expenses for healthcare

are on the rise in low- and middle-Income Countries (LMICs), and Nepal is not exempt from this trend(12).

Nepal is in 143rd position among 191 countries on the global Human Development Index, signifying its status as one of the least developed nations(13).The health landscape of the country is characterized by a concurrent prevalence of communicable and non-communicable diseases(14).Historically, healthcare initiatives, advocacy endeavors, and interventions have been predominantly geared towards communicable diseases(12).

However, contemporary epidemiological patterns reveal a burgeoning impact of non-communicable diseases on morbidity and mortality rates. This shift may be attributable to various socioeconomic determinants influencing health outcomes within the Nepalese population(14).

The definitions of overweight and obesity can vary across continents and regions due to differences in lifestyle, nutritional status, and adjustments to body mass index (BMI) cutoff points. Since this research was conducted in Nepal, the BMI cutoff points and definitions were based on the World Health Organization's South Asian-specific guidelines where, overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to health. A body mass index (BMI), calculated as weight in kilograms divided by height in meters squared (BMI = weight (kg) / height (m)^2), over 25 is considered overweight, and over 30 is obese as per the WHO South Asian Cut off point(15).

Rapid urbanization, changes in dietary patterns, behavioral factors, and significant improvements in the prevention of maternal and child health to raise life expectancy are all contributing factors to the shifting disease patterns in Nepal (12). In the country, more than 44% of deaths and 80% of outpatient contacts are attributed to Non-Communicable Diseases (NCDs). Almost one-third of the

population has hypertension, and 15% has diabetes. The most prevalent NCDs among outpatients include chronic obstructive pulmonary diseases (43%), followed by cardiovascular disease (40%), diabetes mellitus (15%), and cancer (5%)(16). Moreover, earlier studies highlight an elevated level of alcohol and tobacco use in Nepal(17).

In Nepal, the prevalence of overweight and obesity increased from 21% in 2013 and 24.3% in 2019, reflecting a significant rise in recent years (22,24). The ever-rising rates of overweight and obesity and the simultaneous rise in obesity-related NCDs threaten the progress towards achieving the Sustainable Development Goals (SDGs) by 2030, particularly Goal 3, which includes a target of a one-third reduction of premature mortality from NCDs by 2030(18).

The prevalence of overweight and obesity in Nepal increased from 21% in 2013 to 24.3% in 2019 over six years. However, due to the small-scale nature of some studies, these findings are not largely generalizable(19), however the changes in prevalence leading to a considerable strain on the country's healthcare system and contributing significantly to the burden of chronic illnesses such as cardiovascular diseases, type 2 diabetes, and certain cancers (20). With Nepal's population estimated at 30.4 million in 2021 and projected to reach 33.6 million by 2031(21), the combination of rapid population growth and modest economic progress raises serious concerns about ensuring an ample food supply for the expanding population. According to the 2019 STEPS (Noncommunicable Disease Risk Factors) survey conducted in Nepal(22), the prevalence of overweight and obesity in both genders was reported to be 24.3%, with 4.3% of the population being classified obese as per south Asian cutoff for BMI. The STEPS survey, conducted by WHO, focuses on monitoring noncommunicable disease (NCD) risk factors among adults aged 15–69 through self-reported data and physical measurements. In contrast, the NDHS survey, led by the

Ministry of Health, collects nationally representative health and demographic data, including anthropometric measurements, across a broader population, covering all age groups (22).

A lifestyle with limited physical activity and increased availability of unhealthy processed foods, particularly in cities, has led to a subsequent rise in people becoming overweight and/or obese(23). A study conducted in 2013 estimated that about 21% of adults aged 15 to 69 in Nepal were dealing with overweight and/or obesity(24). This study also highlighted differences in overweight and/or obesity rates based on location, with higher rates seen in urban and hilly areas. Earlier research using the Nepal Demography and Health Survey (NDHS) demonstrated that factors such as gender, urban versus rural residence, and higher income class were associated with a higher likelihood of being overweight and/or obese(25)(24).

While personal attributes certainly contribute significantly to one's health outcomes, including their weight, new findings propose that broader aspects at the population level, like where people live, the walkability of their neighborhoods, and the accessibility of food, also have a profound impact on health(26). Past research has predominantly concentrated on the personal traits linked with weight issues within the Nepalese population. However, there exists a gap in understanding the differences in overweight and obesity rates across different geographical areas, as well as the extent to which these variations can be attributed to individual characteristics and geographical factors.

Moreover, socioeconomic elements are acknowledged for their role in influencing geographical disparities in various health outcomes, and it's plausible that they could also contribute to the geographic differences observed in underweight, overweight, and obesity rates. However, there is a shortage of available data that thoroughly delineates these underlying causes. Should such a correlation be identified, this data could offer valuable insights to policymakers and those executing

programs, enhancing their comprehension of the intricate connections between socioeconomic factors, geographic influences, and nutritional distinctions.

This study utilizes data from two survey period of the Nepal Demographic and Health Survey (NDHS) conducted in 2016 and 2022 to explore variations in overweight and obesity across geographic and socioeconomic indicators. Relevant studies indicate that the prevalence of overweight and obesity in Nepal has been rising steadily over the past few years, emphasizing the need for urgent public health action to address this growing challenge. By providing updated prevalence data and highlighting the anticipated upward trend, this study aims to address existing knowledge gaps and emphasize the urgent need for evidence-based interventions and policies to mitigate the growing burden of overweight and obesity in the country.

Statement of problem

Overweight and obesity are increasingly recognized as significant public health challenges in Nepal, with prevalence rates rising sharply, particularly in urban areas(20). Over the last two decades, Nepal has seen a notable shift from issues of undernutrition to the dual burden of malnutrition, where both undernutrition and obesity coexist, reflecting broader global and regional trends. Urbanization, dietary transitions towards processed and calorie-dense foods, and a decline in physical activity have contributed to this rapid increase, particularly among adults and adolescents (27). However, the underlying drivers of this rising epidemic in Nepal remain underexplored, and the complex interplay of socioeconomic, environmental, and lifestyle factors is not yet fully understood(19,25). This limited understanding has led to the underestimation of overweight and obesity as major contributors to the country's non-communicable disease (NCD) burden, hindering effective policy responses and public health interventions(17).

According to the Nepal Demographic Health Survey 2016 and the nationally representative STEPS survey 2019, nearly 19 % of the Nepali population is estimated to be overweight and obese(16,28). This surge may be attributed to the ongoing urbanization and economic transitions within Nepal (16). With the country urbanizing rapidly, its urban population has grown from 17% in 2011 to 21.45% in 2022, compared to 13.9% in 2001(29). This transition triggers lifestyle changes, including decreased physical activity and shifts in dietary habits, which may contribute to the increasing prevalence of overweight and obesity, particularly among children and adolescents(16).

Nepal has conducted relatively few studies on overweight and obesity in recent decades. As of 2022, only 24 research articles and 4 national reports have been published as full papers(30). However, these studies have largely overlooked associated risk factors, particularly wealth-based inequalities. Moreover, many of the published papers are based on small research settings, limiting their ability to generalize findings to national population. While economic status is widely recognized as a major determinant of overweight and obesity, limited data availability and insufficient prioritization by government stakeholders hinder a comprehensive understanding of these issues. Therefore, this study represents a pioneering effort in Nepal to investigate income-based disparities in overweight and obesity and explore the multifaceted contributions of various factors. The insights found from this research are poised to inform policy-making efforts and guide the development of targeted strategies to reduce the prevalence of overweight and obesity.

Rationale of study

Overweight and obesity have rapidly emerged as critical global health issues, significantly affecting populations across all continents, including Asia and Nepal. The global rise in these conditions is primarily driven by changes in dietary behaviors, with increased consumption of energy-dense, nutrient-poor foods, coupled with rising physical inactivity linked to urbanization

and lifestyle shifts. In Asia, the pace of economic growth has amplified these concerns, leading to substantial changes in traditional diets and a marked rise in obesity rates. However, the trends exhibit considerable variation across countries due to cultural, environmental, and socio-economic factors. Nepal, historically burdened with undernutrition, now faces the dual challenge of both undernutrition and rising overweight and obesity rates. This transition, indicative of broader nutrition shifts seen in many low- and middle-income countries, reflects rapid urbanization, changing food environments, and increasing availability of processed, high-calorie foods.

Despite the rising obesity rates, Nepal's public health priorities have largely remained focused on addressing undernutrition and infectious diseases, which have traditionally dominated the national health agenda. The reactive nature of the healthcare system, compounded by recent political restructuring and limited policy focus on non-communicable diseases (NCDs), has hindered comprehensive efforts to tackle obesity. The existing gaps in public health strategies, alongside a lack of robust policy frameworks, underscore the urgent need to understand the socio-economic, environmental, and lifestyle factors contributing to the obesity epidemic in Nepal. This study aims to bridge these critical gaps by utilizing a comprehensive approach to identify the underlying drivers of obesity, focusing on dietary shifts, physical inactivity, socio-economic disparities, and changing lifestyle patterns, thereby informing effective and sustainable NCD prevention strategies.

One of the novel aspects of this research lies in its examination of socio-economic factors and their role on inequalities in obesity, a relatively unexplored area within the Nepalese public health landscape. Traditional views often frame obesity as a condition primarily affecting affluent populations; however, this perspective is evolving as economic transitions reshape dietary habits across all socio-economic groups. Lower-income segments are increasingly exposed to unhealthy food environments, with limited access to nutritious options, heightening their risk of obesity. This

study's use of decomposition analysis offers a comprehensive framework to quantitatively assess the socio-economic disparities in obesity prevalence, allowing for a detailed examination of how factors like income, education, urbanization, and lifestyle choices contribute to obesity risk. By dissecting these determinants, the analysis provides actionable insights that can guide equity-focused public health interventions.

Moreover, this research stands out by utilizing nationally representative data from two cycles of the Nepal Demographic and Health Survey (NDHS), conducted in 2016 and 2022. Previous studies on obesity in Nepal have often been limited by small sample sizes and localized study settings, which restricted the generalizability of their findings. In contrast, this study leverages comprehensive, nationwide datasets that allow for a broader and more accurate assessment of obesity trends across diverse socio-demographic groups. Both NDHS 2016 and 2022 employed a multistage cluster sampling design-using a two-stage approach in rural areas and a three-stage approach in urban areas-to ensure national and subnational representativeness. The surveys targeted men and women aged 15 years and older and collected detailed information on demographics, health behaviors, and anthropometric measurements, including height and weight, using standardized tools and trained survey data collection personnel. Although the core methodology remained consistent across both surveys, NDHS 2022 incorporated improved digital data collection processes, enhancing accuracy and efficiency. Importantly, NDHS is the only nationally representative health survey in Nepal that includes anthropometric data, making its findings highly generalizable and relevant for evidence-informed policy and program development. This robust, longitudinal design enables meaningful comparisons across survey years, offering critical insights into the changing prevalence of obesity and the evolving influence of socioeconomic and lifestyle factors in Nepal.

The findings from this study are expected to fill significant gaps in the current literature and provide a clearer understanding of the national burden of overweight and obesity. By examining wealth-based disparities and socio-demographic influences, this research will offer valuable evidence to inform national health policy and guide strategic interventions aimed at reducing obesity rates. The insights gained will be instrumental in shaping effective, data-driven public health responses, enhancing NCD prevention strategies, and addressing broader health equity issues in Nepal. Additionally, the identification of key contributing factors will help stakeholders prioritize resources, develop tailored community programs, and implement educational initiatives that target the specific needs of vulnerable populations.

In conclusion, this study's comprehensive analysis of socio-economic determinants, wealth-based inequalities, and application of advanced decomposition techniques will provide a nuanced understanding of the obesity epidemic in Nepal. The robust use of nationally representative data and the comparison across two NDHS cycles will offer an unprecedented view of obesity trends and shifts in influencing factors, making the findings pivotal for developing targeted, equitable public health interventions. By addressing the dual burden of malnutrition and focusing on socio-economic disparities, this research aims to support the formulation of effective national strategies to curb the rising obesity epidemic and mitigate its associated health risks, ultimately contributing to improved long-term health outcomes in Nepal.

Operational definition of the study variables

**Dependent variable*:*

Overweight and Obesity- According to the World Health Organization, a Body Mass Index (BMI) over 25 is classified as Overweight, and a BMI over 30 is considered Obesity. In this study, Overweight and Obesity are categorized as having a BMI above 25. In NDHS 2016 and NDHS2022

dataset, HA40 refers to Female body Mass Index and HB40 refers to Male body mass index. The HA40 (female BMI) and HB40 (male BMI) variables were merged to create a new variable, BMI_Combined, which consolidated valid BMI values for both sexes. Values coded as "9998" were treated as missing and excluded from further analysis, as they were flagged and considered potential outliers Then, based upon WHO cutoff, further the variable was categorized to 2 subcategories 1=Overweight/Obesity and 0=Normal weight.

Independent variables:

Height- Height was measured in centimeters using variables HA3 (women) and HB3 (men) in the NDHS 2016 and 2022 datasets. Both variables were combined to create a single height variable. Responses coded as "9994," "9995," and "9996" were flagged as missing values and excluded from analysis.

Weight- Weight was recorded in kilograms using variables HA2 (women) and HB2 (men) in the NDHS 2016 and 2022 datasets. These were combined to form a unified weight variable. Responses coded as "9994," "9995," and "9996" were flagged as missing values and excluded from further analysis.

Age group- Age was recorded using variables HA1 (women) and HB1 (men) in NDHS 2016 and 2022. Both variables were combined, and age was categorized into four groups: 15–30, 31–45, 46–60, and 61+ years.

Sex- Sex was determined using variables HA1 and HB1 in the NDHS dataset. HA1 was defined as Female, and HB1 as Male. If HA1 was non-missing, the individual was classified as female; if HB1 was non-missing, they were classified as male.

Educational level- Education level was determined using variables HA66 (women) and HB66 (men) in NDHS 2016 and 2022. Responses coded as "8" (don't know) were defined as missing. Education was categorized as follows:0 = No education;1 = Primary education;2 = Secondary education;3 = Higher education

Marital status- Marital status was derived from variables HA60 (women) and HB60 (men). Both variables were merged to create a new variable categorized as:1 = Never in union;2 = Others/Married

Number of household members- The number of household members was recorded using the variable HV002 in NDHS 2016 and 2022. This variable was categorized into two groups:0 = 5 or fewer members;1 = More than 5 members

Wealth index-Wealth index was based on the household income index (HV270) provided in NDHS 2016 and 2022. Households were categorized into five quintiles:1 = Poorest;2 = Poorer;3 = Middle;4 = Richer;5 = Richest

Ecological zone- The ecological zone was identified using the variable SHECOREG in NDHS 2016 and 2022. It categorized participants based on their geographic region as follows: 1 = Mountain; 2 = Hill; 3 = Plain/Terai

Type of residence- Type of Residence-Type of residence was determined using the variable HV025 in NDHS 2016 and 2022. It categorized participants based on their living area as follows: 1 = Urban;2 = Rural

Source of drinking water-The source of drinking water was identified using the variable HV201 in NDHS 2016 and 2022. It was categorized as follows:

- Improved: Includes piped water to dwelling/yard/plot, piped to neighbor, public tap/standpipe, tubewell/borehole, protected dug well, protected spring, rainwater, or bottled water.

- Unimproved: Includes unprotected dug well, unprotected spring, tanker truck/cart with a small tank, surface water, or other sources.

Main floor materials-Main floor materials were determined using the variable HV213 in NDHS 2016 and 2022. It was categorized as follows:

- Improved: Includes parquet/polished wood, vinyl/asphalt strips, ceramic tiles, cement, or carpet.

- Unimproved: Includes earth/sand, dung, wood planks, palm/bamboo, or other materials.

Agricultural land ownership-Agricultural land ownership was determined using the variable HV244 in NDHS 2016 and 2022. It was categorized as: 0 = No ownership**;** 1 = Ownership

Household food security level- Household food security level was measured using variables SH145A–SH145I in NDHS 2016 and 2022. These variables followed the FANTA-III protocol for the Household Food Insecurity Access Scale (HFIAS). Responses were scored on a 27-point scale and categorized into the following levels: Secure; Mild Insecure; Moderate Insecure; Severe Insecure.

Table of explanatory variables with corresponding NDHS dataset codes

Figure 1:Categorization of explanatory variables based upon the available categories in NDHS 2016 and NDHS 2022 dataset

Categories/ Variable's	NDHS dataset code		Values/Subcategories of variables	Operational definition
	2016	**2022**		
Height(cm)	HA3, HB3	HA3, HB3	NA	HA3 and HB3 combined, and Women and Men's height variable created. Response "9994","9995" and "9996" defined as missing.
Weight (kg)	HA2, HB2	HA2, HB2	NA	HA2 and HB2 combined, and Women's and Men's weight variable created. Response "9994","9995" and "9996" defined as missing.
BMI (kg/m²)	HA40, HB40	HA40, HB40	NA	HA40 and HB40 combined, and Women's and Men's BMI variable created. Response "9998" defined as missing which is Flagged case as per NDHS operational definition.
Age group	HA1, HB1	HA1, HB1	15-30, 31-45, 46-60 and 61+	HA1 and HB1 combined, and the age groups were categorized in intervals of 15 years,

Sex	HA1, HB1	HA1, HB1	Female, Male	If HA1 variable is not missing, then it is defined as Female and If HB1 Variable is not missing then it is defined as Male.
Education level	HA66 HB66	HA66 HB66	No education, Primary, Secondary, Higher level	Response having "8" refers to don't know as per NDHS definition and those are defined as missing for this study.0=No education,1=Basic,2=Secondary,3=Higher education.
Marital Status	HA60, HB60	HA60, HB60	Never in union, Others	HA60 and HB60 variables are merged, and new variable created.1=Never in union and 2=Others.
Number of Household Members	HV002	HV002	≤5, >5	HV002 variable was re categorized as greater or equals to 5 and Greater than 5
Wealth Index	HV270	HV270	Poorest, Poorer, Middle, Richer,	Based upon household income index, HV270 variable, NDHS categorized household income index to 5 categories.1=Poorest,2=Poorer,3=Middle,4=Richer and 5=Richest.

			Richest	
Ecological Zone	SHECOREG	SHECOREG	Mountain, Hill, Plain/Terai	1=Mountain,2=Hill and 3=Plain/terai.
Type of Residence	HV025	HV025	Urban, Rural	Based upon HV025 response,1=Urban and 2=Rural.
Source of drinking water	HV201	HV201	Improved	Piped in to dwelling/Yard/Plot; Piped to neighbour; Public tap/Standpipe; Tubewell or borehole; Protected dug well; Protected Spring; Rainwater; bottled water
			Unimproved	Unprotected dug well/Spring; Tanker truck/Cart with small tank; Surface water; Other
Type of toilet facility	HV205	HV205	Improved	Flush/Pour flush to piped sewer system/Septic tank/Pit latrine; Ventilated Improved pit (VIP) latrine; pit latrine with slab; composting toilet
			Unimproved	Flush/Pour flush not to sewer/Septic tank/Pit latrine; Pit latrine without slab/Open pit; Other; No facility/Bush/Field

Access to electricity	HV206	HV206	No Yes	0=No and 1=Yes
Household food security level	SH145A-SH145I	HFS1-HFS8	Secure, Mild Secure, Moderate Insecure, Severe Insecure, Insecure	Based upon FANTA-III protocol for Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access. Response was categorized to 27 point and categorized to 5 categories.
Main floor materials	HV213	HV213	Improved Unimproved	Parquet or polished wood; Vinyl or Asphalt strips; Ceramic tiles; Cement; Carpet Earth/sand; Dung; Wood planks; Palm/bamboo; Other
Main wall materials	HV214	HV214	Improved Unimproved	Cement; Stone with lime/Cement; Bricks; Cement blocks; Wood planks/Shingles No wall; Cane/palm/trunks; Mud/sand; Bamboo with mud; Stone with mud; Plywood; Cardboard; reused wood; Metal/galvanized sheet; Other

Main roof materials	HV215	HV215	Improved	Galvanized sheet/Metal; wood; Calamine/cement fibre; ceramic tiles; Cement; roofing shingles
			Unimproved	No roof; Thatch/palm leaf; Mud; Rustic mat; palm/bamboo; Wood planks; Cardboard; Other
Access to media	HV207, HV208, HV221, HV243A	HV207, HV208, HV221, HV243A	No Yes	HV207, HV208, HV221, HV243A Combined and if at least 1 variable has 1 response, then Media access defined as Yes else No.
Access to transportation	HV210, HV211, HV212	HV210, HV211, HV212	No Yes	HV210, HV211, HV212 combined and if at least 1 variable has 1 response, then transport access defined as Yes else No.
Agricultural land ownership	HV244	HV244	No Yes	0=No and 1=Yes
Livestock ownership	HV246	HV246	No Yes	0=No and 1=Yes

| *Accessibility to* | HV247 | HV247 | No | | 0=No and 1=Yes |
| *Banking* | | | Yes | | |

CHAPTER II-LITERATURE REVIEW

Introduction to overweight and obesity

Overweight and obesity are global public health challenges characterized by abnormal or excessive fat accumulation that impairs health(1). The World Health Organization (WHO) defines these conditions based on the Body Mass Index (BMI); a simple metric used to classify individuals. BMI is calculated by dividing a person's weight in kilograms by the square of their height in meters (kg/m²). A BMI between 25.0 and 29.9 indicates overweight, while a BMI of 30.0 or higher signifies obesity(1).

While BMI is a practical and widely used tool, it has limitations, such as not distinguishing between muscle and fat mass. However, it remains an effective indicator for population-level assessments of health risks(31). Overweight and obesity are associated with numerous non-communicable diseases (NCDs), including cardiovascular diseases, type 2 diabetes, and certain cancers such as colorectal, breast, and endometrial cancer. Additionally, obesity is linked to increased healthcare utilization, higher morbidity and disability rates, and increased mortality risk. These conditions arise from complex interactions of genetic, lifestyle, and environmental factors, such as poor diets, sedentary behaviors, and limited access to healthy foods(26,32).

Given the profound social, economic, and health consequences of overweight and obesity, effective public health interventions are essential to reduce their prevalence and improve health outcomes at both national and global levels.

Global variation and trends in obesity prevalence

The global surge in overweight and obesity has become one of the most critical public health challenges of the 21st century(1,33). According to the World Health Organization (WHO), the

global prevalence of obesity has nearly tripled since 1975, with more than 1.9 billion adults classified as overweight in 2016, and over 650 million classified as obese (WHO, 2020)(1). Furthermore, an increasing number of high- and middle-income countries are currently experiencing an epidemic of severe obesity. In high-income populations, severe obesity is expected to double its prevalence from 10 to 20% between 2020 and 2035, posing an enormous threat for healthcare systems(34). This dramatic rise has transcended geographical, socioeconomic, and age-related boundaries, impacting both high-income and low- and middle-income countries(9,35). The shift towards unhealthy dietary habits, high in sugar, fats, and processed foods, alongside increasingly sedentary lifestyles, has played a substantial role in the rise of obesity-related health issues(4). As more populations migrate to urban areas, they are exposed to cheaper, calorie-dense foods, making it increasingly difficult to maintain a balanced diet and leading to a global obesity epidemic(36).

Beyond unhealthy diets and sedentary behavior, additional factors such as food accessibility, education, gender, and income levels contribute to the rise in obesity(36,37). Access to fresh, nutritious food is often limited in low-income communities, forcing individuals to rely on calorie-dense processed foods. Similarly, individuals with lower levels of education may lack awareness of balanced nutrition and the importance of physical activity, contributing to higher obesity rates(23,38,39). Gender disparities are also evident, with women, particularly in low- and middle-income countries, having higher obesity rates due to cultural norms that limit their physical activity(30,40,41). Income level further exacerbates the issue, as wealthier individuals in developing countries are more likely to have sedentary lifestyles and access to unhealthy foods, while undernutrition persists among poorer populations(35,42).

Countries across the globe, regardless of their economic development, are witnessing this alarming rise. In the United States, more than 42% of adults were classified as obese by 2017-2018(43). Similarly, obesity rates in the United Kingdom have steadily increased, with 28% of adults classified as obese in 2019(44). Meanwhile, in developing regions such as sub-Saharan Africa and Latin America, countries traditionally concerned with undernutrition are now facing a dual burden of disease, with both undernutrition and obesity occurring simultaneously(8). In sub-Saharan Africa, for example, the rate of overweight children under five years old has risen by 24% since 2000, reflecting the broader trend of rising obesity in both developing and developed nations(38).

This shift is particularly concerning because healthcare systems in many developing countries are ill-equipped to manage the double burden of undernutrition and obesity. While obesity has risen gradually over the past few decades in high-income countries, its rise in developing countries is occurring at a faster rate, requiring urgent attention. The urban-rural divide is also growing, with urban populations more exposed to processed foods and sedentary lifestyles, while rural areas continue to struggle with food insecurity(45).

The consequences of obesity extend far beyond physical health. Physically, obesity increases the risk of non-communicable diseases (NCDs) such as type 2 diabetes, cardiovascular diseases, and certain cancers(46). Additionally, obesity contributes to musculoskeletal disorders such as osteoarthritis, as excess body weight puts undue strain on the joints. Socially, individuals with obesity often face stigma and discrimination, which can lead to mental health issues such as depression and anxiety(47). On a national level, obesity imposes a significant economic burden on healthcare systems(48). The medical costs associated with obesity are substantial, with the United States alone spending an estimated $147 billion annually as of 2008, and in 2016, the aggregate medical cost due to obesity among adults was $260.6 billion a figure that has likely increased since

then(49). Obesity also results in lost productivity due to absenteeism and disability, further straining national economies(46).

In response to the global obesity epidemic, several initiatives have been launched to address the problem. The WHO's Global Action Plan for the Prevention and Control of NCDs aims to reduce the obesity burden by promoting healthier diets, increasing physical activity, and implementing policies to curb the consumption of unhealthy foods(50). The WHO's "Best Buys" framework emphasizes cost-effective interventions such as regulating food marketing, improving nutritional labeling, and creating environments that encourage physical activity(51). Countries such as Japan and Finland have successfully implemented public health strategies that target obesity(52). Japan's "Metabo Law" promotes regular health checks and waistline monitoring, while Finland's North Karelia Project reduced cardiovascular diseases and obesity through community engagement(52). However, there remains a need for more aggressive, globally coordinated efforts, including partnerships with multinational food corporations, to address the scale of the obesity epidemic effectively.

Asian trends in overweight and obesity

South Asia is home to over 1.56 billion people, with India, Pakistan, and Bangladesh ranking topmost population countries within the continent(53). Given the large population and global presence, addressing the disease burden within South Asian populations remains a crucial priority in global health initiatives(54–56). Non-communicable diseases (NCDs), including obesity, cardiovascular diseases, and diabetes, have become major public health concerns in the region(26). The rise in NCDs is driven by socioeconomic inequalities, rapid urbanization, and shifting dietary patterns(9,57). Traditional Asian diets, which are rich in grains, vegetables, and lean proteins, are being replaced by calorie-dense, processed foods, contributing to the increase in obesity, with adult

prevalence rates reaching around 24% in India, 25.9% in Bangladesh, 16.4% in China, and over 30% in Malaysia(53,58). As populations migrate to urban centers, lifestyles become more sedentary, and access to fast food and sugary beverages rises, further compounding the obesity crisis(56).

The Asia-Pacific region has experienced a notable rise in obesity rates in recent decades. Countries such as Malaysia, Thailand, and Indonesia have reported sharp increases in overweight and obesity prevalence, particularly in urban areas. For instance, in Malaysia, adult obesity rose from approximately 17.7% in 1996 to over 33% in 2019. In Thailand, rates increased from 5.8% in 1991 to 10.0% in 2014, while in Indonesia, urban obesity nearly doubled from 14.0% in 2007 to 28.7% in 2018(59). In Malaysia, over 33% of adults are classified as obese, one of the highest rates in the region(60). Thailand and Indonesia have also witnessed sharp increases, with obesity rates among urban populations rising rapidly due to the adoption of Westernized diets and more sedentary lifestyles(58,61,62).

In contrast, Japan and South Korea have maintained relatively low obesity rates, primarily due to their strong cultural emphasis on healthy eating and active lifestyles(63,64). Japan's traditional diet, rich in fish, vegetables, and rice, has protected the population from the global rise in obesity, but younger generations are increasingly adopting fast food and sugary beverages, leading to rising obesity rates among children and adolescents(63). Similarly, South Korea's public health campaigns have promoted balanced diets and regular physical activity, helping to keep obesity rates low, but the popularity of convenience foods poses a long-term challenge(63,65).

China, with its rapid economic growth and urbanization, has seen a dramatic increase in obesity. Over the past two decades, the prevalence of overweight and obesity has increased by 39% and 97%, (66) respectively. The most recent data indicate that 28.1% of the population is classified as

overweight, while 5.2% is classified as obese. (67). India and Pakistan are also facing rising obesity, with 21% of Indian adults and 38% of Pakistani women classified as obese(68,69). These trends are particularly concerning given the genetic predisposition of South Asians to store fat centrally, increasing their risk of metabolic complications at lower BMI levels(57). Similarly, it has been reported that South Asians have a lower resting energy expenditure than Caucasians with the same BMI resulting more unfavorable body composition with a higher percentage of body fat than Caucasians with an equivalent BMI(70).

The rise in obesity in Asia has profound physical, social, and economic consequences. Physically, obesity increases the risk of NCDs, leading to higher rates of diabetes, hypertension, and heart disease(71). Socially, individuals with obesity face stigma, discrimination, and mental health issues, while economically, the healthcare costs associated with obesity are straining national budgets(72,73). Countries in South Asia, such as Bangladesh and Nepal, face the dual burden of malnutrition and obesity(12)(19), complicating their public health responses and further stressing their limited healthcare systems(56). Addressing these issues requires a multifaceted approach that integrates obesity prevention with efforts to combat undernutrition.

Regional initiatives to address overweight and obesity

Asian countries are actively working to combat rising obesity and associated chronic diseases by implementing national action plans for nutrition and developing food-based dietary guidelines(70,74). Several Southeast Asian countries have introduced diverse community intervention programs aimed at preventing and managing obesity within their populations(74). Singapore's "Healthy Living Master Plan" emphasizes community-based initiatives and public education to promote healthier lifestyles(53,74). South Korea has launched national campaigns targeting school-aged children to promote physical activity and healthy eating(63,75). China has

introduced policies to limit sugary drinks in schools and encourage physical activity among children(66). However, in countries like Bangladesh, Nepal, Bhutan, Myanmar and Pakistan limited infrastructure and resources have hampered the implementation of large-scale public health interventions, making it difficult to effectively tackle the rising obesity rates.(26,59,70,76,77).

Prevalence and variation of overweight and obesity in Nepal

Nepal, a low- to middle-income country, is transitioning from combating infectious diseases to addressing the growing burden of non-communicable diseases (NCDs) such as obesity, cardiovascular diseases, and diabetes(78). As urbanization accelerates, the country is seeing a marked rise in obesity rates, particularly in urban centers. In 2016, a national survey reported that women 32.87% and men 28.77% aged 18 years and above were classified as overweight or obese, and by 2030, this figure is projected to almost double(25). This significant increase underscores the growing public health challenge posed by obesity in a country traditionally associated with issues of undernutrition(79).

The rapid urbanization of Nepalese society has played a key role in the rise of obesity(80). In cities like Kathmandu and Pokhara, access to processed foods high in sugar and fats has increased, while physical activity has decreased due to changes in transportation and employment patterns(25). Urban residents have greater access to fast food, sugary beverages, and convenience foods, contributing to the rise in obesity. In contrast, rural populations continue to face challenges related to undernutrition, although wealthier households in rural areas are also beginning to experience obesity(19,25).

Adolescents in Nepal are more prone to the burgeoning prevalence of obesity compared to other age groups within the population. Approximately 8.3% of adolescents in the country are overweight or obese, a worrying statistic given the long-term health risks associated with

adolescent obesity(12). Studies have shown that adolescents who are overweight or obese are more likely to remain so into adulthood, heightening their risk of developing NCDs such as type 2 diabetes, cardiovascular diseases, and certain cancers(81). The rise in adolescent obesity is particularly concerning, as it not only affects physical health but also mental well-being, increasing the likelihood of depression, low self-esteem, and social isolation. Early intervention is crucial, and public health strategies targeting schools and communities are essential to encourage healthy dietary habits and physical activity among Nepalese adolescents(17).

Socioeconomic disparities in overweight and obesity in Nepal

Socioeconomic disparities play a significant role in shaping obesity trends in Nepal. Wealthier individuals, particularly those living in urban areas, tend to have higher obesity rates, reflecting a global trend where access to calorie-dense foods and reduced physical activity contribute to weight gain(20). In contrast, rural populations, particularly those from lower socioeconomic backgrounds, continue to struggle with undernutrition, presenting Nepal with the dual burden of malnutrition(20,25). This dual burden complicates public health efforts, as policymakers must simultaneously address both undernutrition and rising obesity(82,83). Furthermore, many rural households rely on agriculture and subsistence farming, which promotes physical activity but limits access to diverse, nutrient-rich foods, further complicating the health landscape(84).

The health implications of obesity in Nepal are profound, with obesity serving as a major risk factor for the rise of non-communicable diseases (NCDs)(12,30). Cardiovascular diseases, hypertension, and type 2 diabetes are becoming more prevalent, particularly in urban areas where obesity rates are highest(85). The healthcare system in Nepal is not fully equipped to manage the growing burden of obesity-related diseases, especially in rural areas where healthcare infrastructure remains

underdeveloped(80). As life expectancy increases and the population ages, the healthcare system will face even greater strain, further underscoring the need for public health interventions(17).

Obesity also carries social consequences, as individuals with obesity often experience stigma and discrimination, affecting their mental health and quality of life(21,57,86). Economically, the rising burden of obesity increases healthcare costs and reduces workforce productivity(24). These economic consequences are particularly concerning in a developing country like Nepal, where healthcare resources are limited, and many families struggle with poverty(83). National productivity is also affected, as obesity-related illnesses lead to increased absenteeism, reduced work capacity, and early mortality, posing a significant challenge to Nepal's development goals(13,14).

Addressing obesity in Nepal requires a multi-sectoral approach that focuses on both prevention and treatment. Public health campaigns promoting healthier diets and increased physical activity are essential, particularly in urban areas where obesity rates are rising rapidly(19,20). Schools and communities play a critical role in promoting healthy lifestyles among children and adolescents through initiatives such as school-based nutrition programs and physical activity campaigns(85). Government policies targeting the food environment, such as taxes on sugary drinks and regulations on fast-food advertising, could help reduce the consumption of unhealthy foods.

Collaborative efforts such as the WHO Package of Essential Noncommunicable Disease Interventions(22,79) and the STEPS survey have been instrumental in monitoring NCD risk factors in Nepal(79). The STEPS survey provides valuable data on behavioral and biological risk factors for NCDs, helping policymakers develop targeted interventions. Meanwhile, the PEN package offers a framework for integrating NCD prevention and control into primary healthcare services, enabling early detection and treatment of obesity-related conditions(30).

Addressing the social and economic determinants of obesity is also crucial. Policies that promote equitable access to healthy foods, create safe spaces for physical activity, and address poverty-related barriers to health are essential to reducing the overall burden of obesity(17,84). Strengthening healthcare infrastructure in rural areas, improving access to healthcare services, and building the capacity of healthcare workers are also vital to managing obesity and other NCDs effectively(24).

In conclusion, Nepal faces a significant public health challenge due to the rising prevalence of obesity, particularly in urban areas and among adolescents. Tackling obesity requires a comprehensive approach that integrates public health campaigns, government policies, and healthcare interventions. By focusing on prevention, addressing social and economic determinants, and leveraging collaborative efforts with global partners, Nepal can mitigate the impact of obesity and improve the long-term health outcomes of its population.

Conclusion

Overweight and obesity have become significant public health challenges globally, with prevalence increasing across all regions, age groups, and socioeconomic classes(2,3,48). This rise is driven by unhealthy diets, sedentary lifestyles, and factors such as education, income, and gender disparities(30,40,87). Developing countries now face a dual burden of undernutrition and obesity, complicating healthcare responses. Wealth-based inequalities also contribute, as urban and wealthier populations are more prone to obesity, while rural and low-income groups continue to struggle with undernutrition(33,40,88).

Obesity has profound health consequences, increasing the risk of non-communicable diseases (NCDs) such as type 2 diabetes, cardiovascular diseases, and certain cancers. Socially, individuals

with obesity experience stigma, while economically, rising healthcare costs and reduced productivity strain national resources(47).

Future strategies to curb obesity must focus on prevention and treatment through public health campaigns promoting healthier diets and physical activity. School-based interventions targeting adolescents are crucial to prevent obesity from persisting into adulthood(12). Governments need to implement policies, such as taxing sugary drinks, regulating food marketing, and improving nutritional labeling, to create healthier environments(20). Strengthening primary healthcare with frameworks like the WHO PEN package will ensure early detection and management of obesity-related conditions. Addressing social determinants-such as poverty, access to healthy foods, and safe spaces for exercise-is equally essential(22).

In conclusion, tackling obesity requires coordinated efforts at national and global levels. By integrating public health interventions, policy measures, and healthcare strategies, countries can mitigate the rising obesity epidemic, promote sustainable health practices, and improve long-term population health outcomes. This review highlights critical gaps in understanding the socioeconomic and household environmental factors contributing to obesity in Nepal, which this study aims to address. By analyzing nationally representative data, this research will provide new insights into the drivers of obesity and inform targeted, evidence-based policies to reduce its prevalence. These findings will be instrumental in shaping public health strategies, addressing disparities, and supporting Nepal's progress toward achieving its non-communicable disease prevention goals.

Conceptual framework
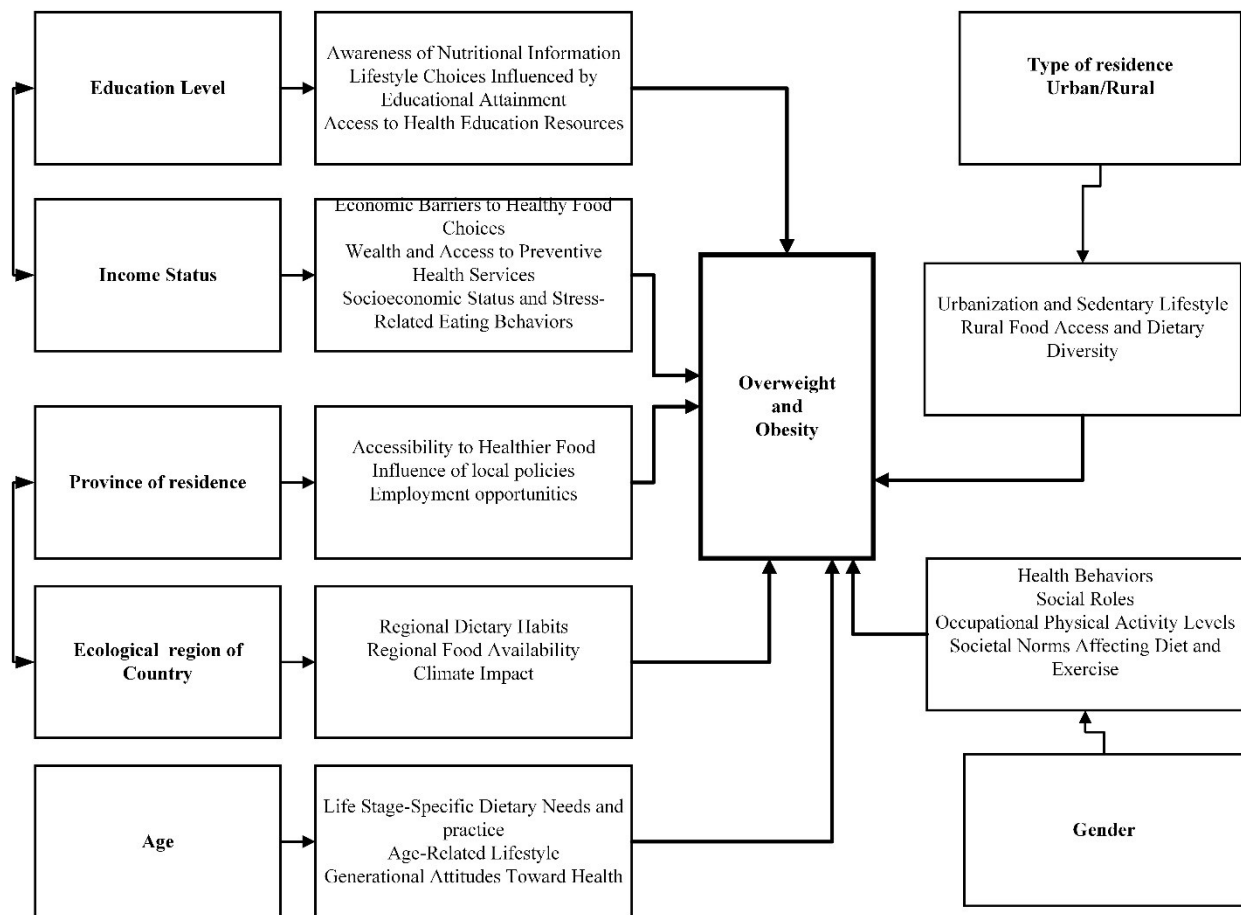
Figure 2: Conceptual framework of the study

Overview of conceptual framework

The conceptual framework for this study illustrates the relationships between sociodemographic, household, and behavioral factors contributing to overweight and obesity in Nepal. Key variables such as education level, income status, province of residence, ecological region, age, gender, and type of residence (urban/rural) were selected based on their relevance in existing literature and their availability in the NDHS. These factors reflect well-established determinants of obesity, such as access to health resources, economic barriers to healthy food, and lifestyle behaviors influenced by urbanization and regional diversity.

This framework is grounded in evidence from global and regional studies on obesity, emphasizing the interplay between individual, social, and environmental determinants. For instance, education influences nutritional awareness and lifestyle choices, income affects access to healthier food options, and regional disparities shape dietary patterns and physical activity levels. While not directly adapted from a single theoretical model, the framework integrates elements from Andersen's Behavioral Model of Healthcare Utilization and ecological models of health behavior to capture the multifaceted nature of obesity determinants.

Study variables

Dependent variables:

- Overweight and Obesity

Independent variables:

- Age

- Sex

- Education level

- Marital status

- Wealth quantile

- Residency (Urban/Rural)

- Ecological region

- Household food security level

- Source of drinking water

- Type of toilet facility

- Main floor materials

- Main wall materials

- Main roof materials

- Access to media

- Access to transportation

- Agricultural land ownership

Research objective:

General objective:

- To examine the prevalence of overweight and obesity in Nepal and identify the socioeconomic and household environmental factors contributing to these conditions.

Specific objective:
- To estimate the prevalence of overweight and obesity among adults using data from the 2022 Nepal Demographic and Health Survey (NDHS).

- To compare the patterns of overweight and obesity prevalence between the 2016 and 2022 NDHS datasets to identify potential changes over time.

- To assess the extent of socioeconomic inequalities in overweight and obesity using the concentration index as a measure of inequality.

- To determine the factors contributing to wealth-based inequalities in obesity by conducting a decomposition analysis.

CHAPTER III- METHODODOLOGY

Study design and setting

Data were analyzed from the Nepal Demographic and Health Survey (NDHS) conducted in 2016 and 2022, both of which are nationally representative, cross-sectional surveys aimed for understanding the health and nutritional status of the Nepalese population. The NDHS is conducted every five years, ensuring coverage of all provinces, districts, and urban and rural areas of Nepal.

The NDHS 2016 employed a stratified multi-stage cluster sampling approach. In rural areas, a two-stage sampling process was used, whereas in urban areas, a three-stage sampling design was adopted to effectively manage urban density. Initially, 383 primary sampling units (PSUs) were selected using probability proportional to ward size. In the subsequent stage, 30 households were systematically sampled from each PSU, resulting in 11,473 households that participated in the survey.

The NDHS 2022 also utilized a similar stratified, multi-stage design, with a total of 476 PSUs selected (248 urban and 228 rural). In the first stage, PSUs were selected with probability proportional to size, ensuring independent selection across each sampling stratum, which consisted of urban and rural areas within each of Nepal's seven provinces. A comprehensive household listing operation was then undertaken to create a sampling frame, from which 30 households were systematically chosen per PSU. This yielded a total sample of 14,280 households, 7,440 in urban areas and 6,840 in rural.

For the current study, a total of 13,183 individuals from NDHS 2022 and 14,639 individuals from NDHS 2016, aged 15 years and above and classified as overweight or obese according to the World

Health Organization cut-off points for South Asia, were included. The detailed methodologies for NDHS 2016 and NDHS 2022 have been published elsewhere(89,90).

Data source

This study utilizes secondary data from the 2016 and 2022 Nepal Demographic and Health Surveys (NDHS), which are publicly available, nationally representative, cross-sectional surveys. The NDHS is part of the global Demographic and Health Surveys (DHS) Program, supported by the United States Agency for International Development (USAID) and implemented by ICF International. The DHS Program has provided technical support for survey implementation in over 90 low- and middle-income countries, gathering crucial health data.

In Nepal, the NDHS is carried out by New ERA in collaboration with the Ministry of Health, ensuring high-quality data collection. These surveys gather comprehensive information on a wide range of health indicators, including fertility, family planning, maternal and child health, nutrition, and infectious diseases such as HIV/AIDS. The data collected serves as a vital resource for monitoring health trends and evaluating national health programs and policies.

The datasets from 2016 and 2022 NDHS provide valuable insights into changes in health indicators over time. Utilizing these datasets allows for a robust analysis of health trends in Nepal, ensuring the findings are grounded in reliable, representative data. This enhances the validity and relevance of the study, contributing to a better understanding of the evolving health landscape in Nepal.

Although the NDHS data are nationally representative and collected using a rigorous two- or three-stage stratified cluster sampling design, this study did not apply sampling weights, primary sampling units (PSU), or strata during statistical analysis. As a result, the findings should not be interpreted as nationally representative. While the NDHS methodology ensures representativeness

at the national level, this specific analysis focused on identifying associations within the sample without accounting for the complex survey design. This methodological limitation has been acknowledged to maintain transparency and guide appropriate interpretation of the findings. Further details on this issue are discussed.

Data collection

The Nepal Demographic Health Survey (NDHS) collected comprehensive data using four standardized questionnaires: Household, Women's, Men's, and Biomarker Questionnaires. The Household Questionnaire captured essential demographic and living condition information from the head of the household. The Women's Questionnaire provided detailed data on women aged 15-49 years, including maternal and child health, reproductive history, and socio-demographic characteristics. The Men's Questionnaire collected information on social and demographic attributes, family planning knowledge, and awareness of sexually transmitted infections (STIs). Anthropometric data, including height and weight, were recorded using the Biomarker Questionnaire for eligible participants. Merged datasets from these surveys offered a robust source of information, made publicly available for secondary research.

This study utilized the Household datasets from NDHS 2016 and 2022, which encompassed socio-demographic variables, wealth indicators, educational status, and broader determinants like place of residence, ecological region, and province-level characteristics. Ethical approval was granted by the Nepal Health Research Council, and informed consent was secured from all participants. The household surveys included 57,278 respondents in NDHS 2022 and 49,064 in NDHS 2016. For rigorous analysis, individuals with missing Body Mass Index (BMI) data and pregnant women were excluded, yielding a final analytic sample of 13,183 for NDHS 2022 and 14,639 for NDHS 2016. Missing data for other variables were handled using a complete-case analysis approach,

whereby only respondents with non-missing values for all key variables were included in the respective analyses. Additionally, flagged cases for extreme or implausible values (e.g., BMI values outside the plausible range as defined by NDHS protocols) were excluded to ensure data quality.

Statistical analysis

Statistical analyses were performed using Statistical Analysis Software (SAS 9.4, English version). The analyses included both dependent and independent variables, which were selected based on their relevance to the study objectives and their alignment with the conceptual framework, incorporating elements of Andersen's Behavioral Model of Healthcare Utilization. This model highlights predisposing, enabling, and need-based factors as determinants of health behaviors, including outcomes such as overweight and obesity. Descriptive statistics were used to summarize the characteristics of the study population and the distribution of overweight and obesity across different sociodemographic and socioeconomic variables.

Descriptive statistics were used to summarize the characteristics of the study population and the distribution of overweight and obesity across sociodemographic and socioeconomic variables. Frequencies (n) and percentages (%) were calculated for categorical variables, while means with standard deviations (mean ± SD) were reported for continuous variables. For skewed continuous data, medians with interquartile ranges (IQRs) were provided to ensure accurate representation. Inferential statistics were employed for bivariate comparisons to assess the association between socioeconomic status (SES) variables and overweight/obesity.

To identify factors associated with overweight and obesity, we employed univariate and multivariable logistic regression analyses. Univariate logistic regression was initially conducted for each independent variable using a binary outcome (overweight/obesity vs. normal

weight/underweight). Variables demonstrating significance ($p < 0.05$) were then included in the multivariable model. The final model was developed using a backward stepwise approach, systematically removing non-significant variables while assessing model fit. Variables were retained if their exclusion caused a significant change in deviance, as determined by the chi-square test. The results of the logistic regression analyses were presented as odds ratios (OR) with 95% confidence intervals (95% CI).

Further, wealth-based inequality in overweight and obesity using a decomposition approach was analysed. This method provided a comprehensive measure of socioeconomic disparities, highlighting the extent of inequality in the prevalence of overweight and obesity across wealth groups and contribution of each factor on overweight and obesity prevalence. Detailed methodological explanations and the underlying decomposition techniques are aligned with established frameworks from relevant public health research(7). This index provided a summary measure of the socioeconomic inequality observed in the prevalence of overweight and obesity.

Spatial distribution of overweight and obesity

The spatial distribution of overweight and obesity was examined using geospatial mapping with ArcGIS (version 2.4). We utilized data from the latest Nepal Demographic Health Surveys (NDHS) of 2016 and 2022, aligned with the current provincial boundaries and local administrative units (clusters). These spatial maps illustrate the geographic variations in overweight and obesity prevalence across the country, offering a visual representation of regional disparities. This analysis provides actionable insights for policymakers, identifying hotspot areas with elevated prevalence rates and informing targeted public health interventions.

Heatmap of overweight and obesity

A heatmap visualization was created in SAS to illustrate the prevalence of overweight and obesity across distinct age groups and household wealth quintiles. This heatmap offers a comprehensive view of the distribution patterns, highlighting variations in obesity prevalence influenced by age and socio-economic status. Unlike cumulative charts, the heatmap presents independent prevalence rates for each demographic segment, providing a more nuanced and granular understanding of the data. The color gradients indicate obesity risk levels, with darker shades representing higher prevalence rates. This visual tool is particularly valuable for stakeholders, as it clearly identifies high-risk groups and demographic disparities and provide data-driven interventions and enhancing informed decision-making for public health strategies.

CHAPTER IV- RESULTS

Results overview

This section provides detailed findings from the analysis of the socioeconomic factors associated with overweight and obesity in Nepal, based on data from the Nepal Demographic Health Survey (NDHS) 2016 and 2022. It includes a descriptive analysis of participant characteristics, bivariate analysis to assess associations between sociodemographic variables and BMI status, and multivariable logistic regression to examine these relationships further. Heatmap visualizations illustrate trends in overweight and obesity across age groups and wealth quintiles, along with a cluster-level distribution of these conditions throughout Nepal. The section also incorporates binary logistic regression and wealth-based inequality decomposition to assess disparities in obesity prevalence and identify key contributing factors.

The findings reveal a notable increase in the prevalence of overweight and obesity, rising from 19.58% in 2016 to 27.58% in 2022, while underweight prevalence decreased from 19.31% to 14.05%. Obesity was more prevalent in urban populations (62.33%) than in rural areas (37.67%). Wealthier individuals, particularly those aged 31-45, showed the highest obesity prevalence. In 2016, higher education was associated with increased obesity risk, whereas by 2022, obesity rates increased more notably among individuals with basic education (p < 0.001). Regarding the geographical pattern of overweight and obesity, the Hill region and major urban centers recorded the highest obesity prevalence, with 51.81% in the Hill region and 62.33% in urban areas in 2022(Table 1 row percentages). Over time, obesity prevalence increased from 49.81% in the Hill region in 2016 to 51.81% in 2022, and from 74.31% to 62.33% in urban areas, highlighting growing socioeconomic disparities and emphasizing the need for targeted public health interventions to address the obesity burden in Nepal.

Baseline characteristics and descriptive statistics of participants

Table 1:Baseline characteristics and descriptive statistics of participants

Categories	NDHS-2022		NDHS-2016	
	All participants (n=13,183)	Overweight & Obesity (n=3196)	All participants (n=14,639)	Overweight & Obesity (n=2624)
Anthropometric Characteristics				
Height(cm)	155.05±8.13	154.79±8.02	155.84±8.51	155.49±8.61
Weight (Kg)	54.19±11.20	67.74±9.38	52.89±10.89	67.82±9.36
BMI (kg/m^2)	22.48±4.08	28.20±2.84	21.71±3.83	28.00±2.68
Socioeconomic factors				
Age				
15-30	5495(41.68%)	783(24.50%)	5884(40.19%)	604(23.02%)
30-45	3899(29.58%)	1451(45.40%)	3872(25.45%)	1110(42.30%)
45-60	2262(17.16%)	684(21.40%)	2932(20.03%)	659(25.11%)
60+	1527(11.58%)	278(8.70%)	1951(13.33%)	251(9.57%)
Sex				
Male	4224(32.04%)	901(28.19%)	6172(42.16%)	958(36.51%)
Female	8959(67.96%)	2295(71.81%)	8467(57.84%)	1666(63.49%)
Education level^				
Illiterate	2839(24.59%)	581(20.87%)	5617(38.38%)	825(31.44%)
Basic education	4028(34.89%)	1029(36.96%)	2381(16.27%)	480(18.29%)
Secondary level	4185(36.25%)	977(35.09%)	4754(32.48%)	868(33.08%)
Higher level	493(4.27%)	197(7.08%)	1884(12.87%)	451(17.19%)
Household level factors				
Marital Status^				
Never union	2570(22.24%)	195(7.00%)	2764(18.88%)	139(5.30%)
Others	8987(77.76%)	2591(93.00%)	11875(81.12%)	2485(94.70%)
Number of household members				
≤5	777(5.89%)	177(5.54%)	983(6.71%)	163(6.21%)
>5	12406(94.11%)	3019(94.46%)	13656(93.29%)	2461(93.79%)
Wealth Index				
Poorest-1	3581(27.16%)	432(13.52%)	3234(22.09%)	208(7.93)
Poorer-2	2824(21.42%)	555(17.37%)	3007(20.54%)	391(14.90%)
Middle-3	2591(19.65%)	569(17.80%)	2887(19.72%)	393(14.98%)
Richer-4	2229(16.91%)	744(23.28%)	2988(20.41%)	622(23.70%)
Richest-5	1958(14.85%)	896(28.04%)	2523(17.23%)	1010(38.49%)
Household environmental factors				
Environmental Factors				
Ecological zone				
Mountain	1109(8.41%)	155(4.85%)	1139(7.78%)	138(5.26%)

Hill	6022(45.68%)	1656(51.81%)	6647(45.41%)	1307(49.81%)
Terai/Plain	6052(45.91%)	1385(43.34%)	6853(46.81%)	1179(44.93%)
Type of residence				
Urban/Town	6965(52.83%)	1992(62.33%)	9255(63.22%)	1950(74.31%)
Rural/Village	6218(47.17%)	1204(37.67%)	5384(36.78%)	674(25.69%)
Household Facilities				
Source of drinking water				
Improved	12837(97.38%)	3140(98.25%)	13853(94.62%)	2540(96.80%)
Unimproved	346(2.62%)	56(1.75%)	786(5.37%)	84(3.20%)
Type of toilet facility				
Improved	12349(93.67%)	3095(96.84%)	12126(83.09%)	2422(92.30%)
Unimproved	834(6.33%)	101(3.16%)	2475(16.91%)	202(7.70%)
Access to electricity				
Yes	12557(95.25%)	3147(98.47%)	13221(90.31%)	2546(97.03%)
No	626(4.75%)	49(1.53%)	1418(9.69%)	78(2.97%)
Household food security level				
Secure	10427(79.09%)	2776(86.86%)	6675(45.60%)	1605(61.17%)
Mild insecure	1858(14.09%)	292(9.14%)	4934(33.70%)	703(26.79%)
Moderateinsecure	535(4.06%)	76(2.38%)	1822(12.45%)	194(7.39%)
Severe insecure	363(2.75%)	52(1.63%)	1208(8.25%)	122(4.65%)
Housing characteristics				
Main floor materials				
Improved	5779(43.84%)	2048(64.08%)	5051(34.50%)	1540(58.69%)
Unimproved	7404(56.16%)	1148(35.92%)	9588(65.50%)	1084(41.31%)
Main wall material				
Improved	6800(51.58%)	2164(67.71%)	6444(44.02%)	1697(64.67%)
Unimproved	6383(48.42%)	1032(32.29%)	8195(55.95%)	927(35.33%)
Main roof material				
Improved	12359(93.75%)	3108(97.25%)	13024(88.97%)	2491(94.93%)
Unimproved	824(6.25%)	88(2.75%)	1615(11.03%)	133(5.07%)
Household possessions				
Access to Media and communication				
Yes	12884(97.73%)	3178(99.44%)	14070(96.11%)	2589(98.67%)
No	299(2.27%)	18(0.56%)	569(3.89%)	35(1.33%)
Access to transportation				
Yes	6553(49.71%)	1805(56.48%)	7077(48.34%)	1470(56.02%)
No	6630(50.29%)	1391(43.52%)	7562(51.55%)	1154(43.98%)
Agricultural land ownership				
Yes	9660(73.28%)	2200(68.84%)	11991(81.91%)	1983(75.57%)
No	3523(26.72%)	996(31.16%)	2648(18.09%)	641(24.43%)
Livestock ownership				
Yes	10366(78.63%)	2191(68.55%)	11573(79.06%)	1656(63.11%)
No	2817(21.37%)	1005(31.45%)	3066(20.94%)	968(36.89%)
Accessibility of banking				
Yes	10445(79.23%)	2741(85.76%)	10502(71.74%)	2202(83.92%)

| No | 2738(20.77%) | 455(14.24%) | 4137(28.26%) | 422(16.08%) |

^ Indicates missing values on specific variables; missing values were excluded from this study.

The table 1 above shows the sociodemographic, socioeconomic, and household environmental characteristics of all participants and those with overweight and obesity from the Nepal Demographic Health Survey (NDHS) 2016 and 2022. Overall, the average height, weight, and BMI of the sample population were 155.05±8.13 cm, 54.19±11.20 kg, and 22.48±4.08 kg/m² in NDHS 2022, compared to 155.84±8.51 cm, 52.89±10.89 kg, and 21.71±3.83 kg/m² in 2016. This indicates a slight increase in average weight and BMI in 2022, with participants with overweight and obesity showing an increase in average BMI from 28.00±2.68 kg/m² in 2016 to 28.20±2.84 kg/m² in 2022.

Socioeconomic factors

The age group shows that the majority of overweight and obese participants were aged 31-45 in both surveys, with an increase from 42.30% in 2016 to 45.40% in 2022. Among all participants, the 15-30 age group remained the largest in both years. The proportion of female participants increased from 57.84% in 2016 to 67.96% in 2022, with an increase in overweight/obesity among females (from 63.49% in 2016 to 71.81% in 2022). Educational levels improved, with a decrease in the illiteracy rate from 38.38% in 2016 to 24.59% in 2022 and an increase in basic education from 16.27% in 2016 to 34.89% in 2022.

However, participants with higher education levels were fewer in 2022 compared to 2016 among overweight and obese individuals, decreasing from 17.19% in 2016 to 7.08% in 2022. Regarding marital status, the majority of participants were married or in union, with an almost all of overweight and obese participants being in the 'other' grouping' (93.00% in 2022). The number of household members remained consistent, with the majority having more than five members in both surveys, showing a slight increase in 2022.

Regarding wealth index of participants, there was a shift towards richer categories, with a decrease in the proportion of participants in the poorest category and an increase in the richest category among overweight and obese participants (28.04% in 2022 vs. 17.23% in 2016). In 2016, the proportion of overweight and obese participants was 7.93% in the poorest category and 38.49% in the richest category. By 2022, these proportions shifted to 13.52% in the poorest category and 28.04% in the richest category.

Household environmental factors

The ecological distribution of participants with overweight and obesity remained consistent, with most participants from the Hill and Terai/Plain regions. Participants from the Hill region constituted 51.81% in 2022, slightly up from 49.81% in 2016, while those from the Terai/Plain region decreased from 44.93% in 2016 to 43.34% in 2022. The type of residence shifted from urban to rural in 2022, with a decrease in urban participants (62.33% in 2022 vs. 74.31% in 2016).

Household facilities improved significantly for overweight/obese, with better access to improved sources of drinking water (98.25% in 2022 vs. 96.80% in 2016), improved toilet facilities (96.84% in 2022 vs. 92.30% in 2016), and electricity (98.47% in 2022 vs. 97.03% in 2016). Food security also saw marked improvement, with an increase in food-secure households from 45.60% in 2016 to 79.09% in 2022. Housing characteristics showed a shift towards improved materials for floors, walls, and roofs, with 64.08% of overweight and obese participants living in houses with improved floor materials in 2022, up from 58.69% in 2016.

Household possessions, such as access to media, communication, and banking services, increased. For instance, access to media and communication among overweight and obese participants increased to 99.44% in 2022 from 98.67% in 2016. However, agricultural land and livestock

ownership saw varied changes, with a decrease in livestock ownership among overweight and obese participants from 63.11% in 2016 to 68.55% in 2022.

Prevalence of underweight, normal weight, overweight and obesity in Nepal

Figure 3:Prevalence of underweight, normal weight, and overweight/obesity in Nepal:2016 and 2022

Prevalence of Underweight,Normal weight and Overweight/Obesity in Nepal		
Underweight (BMI <18.5)	Normal Weight (BMI 18.5-24.9)	Overweight and Obesity (BMI >=25)
2016: 19.31	61.1	19.58
2022: 14.05	58.37	27.58
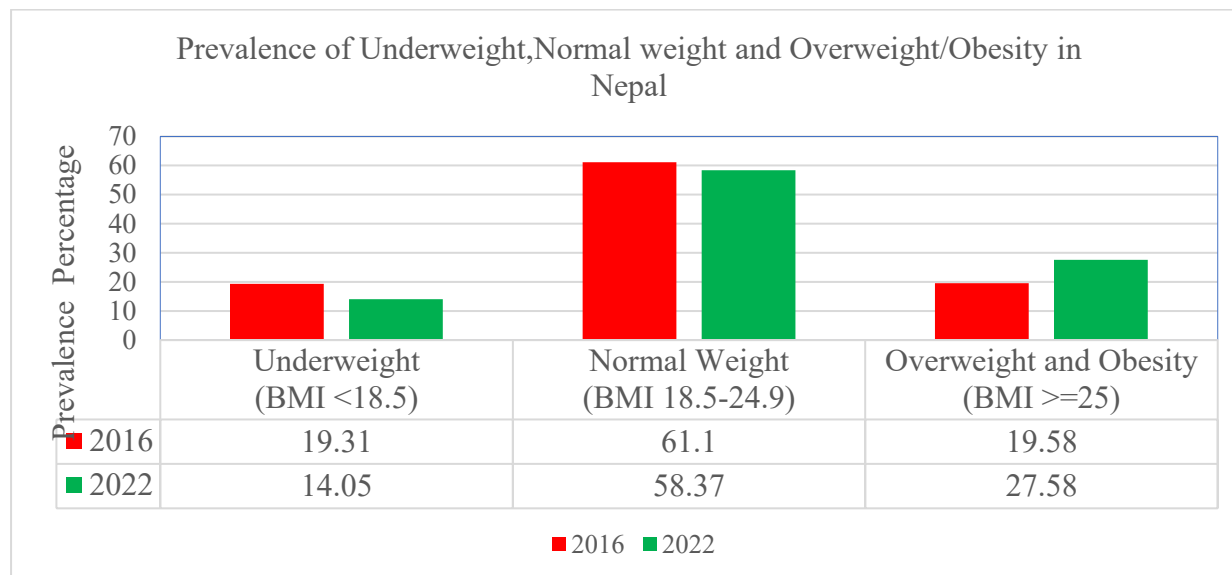
The bar chart above shows the prevalence of underweight, normal BMI, and overweight/obesity in both survey periods, NDHS 2016 and NDHS 2022. In 2016, a higher proportion of the population were within the normal BMI range, with 61.1%. Almost equal proportions of the population were underweighted (19.31%) and overweight or obese (19.58%). By 2022, the prevalence of overweight and obesity was nearly double the prevalence of underweight, while the prevalence of normal weight slightly decreased. Specifically, the 2022 data showed that 14.05% of the population was underweight, 58.37% had a normal weight, and 27.58% were overweight or obese.

Comparing the nutritional status across the two years, it is evident that the prevalence of overweight and obesity increased by 8%, rising from 19.58% in 2016 to 27.58% in 2022. During the same period, the proportion of individuals with a normal weight and those who were underweight

decreased. This trend highlights a significant burden of overweight and obesity, which is rapidly increasing in Nepal. The findings suggest a nutritional transition in Nepal, where undernutrition is decreasing, but overweight and obesity are becoming more prevalent.

Overall, the comparative analysis of NDHS 2016 and NDHS 2022 underscores the need for comprehensive public health strategies to address the dual burden of undernutrition and overweight/obesity. These significant shifts in the BMI distribution of the Nepalese population highlight the urgency of implementing targeted interventions to promote balanced nutrition and healthy lifestyles.

Bivariate analysis of association between sociodemographic variables and BMI status

Table 2:Bivariate analysis of association between sociodemographic variables and BMI status of respondents

Variables	NDHS-2022			NDHS-2016		
	All Participants	Overweight & Obesity	P-Value	All Participants	Overweight & Obesity	P-Value
Socioeconomic Factors						
Age						
15-30	5495(41.68%)	783(14.25%)	**<.0001****	5884(40.19%)	604(23.02%)	**<.0001****
31-45	3899(29.58%)	1451(37.21%)		3872(25.45%)	1110(42.30%)	
46-60	2262(17.16%)	684(30.24%)		2932(20.03%)	659(25.11%)	
61+	1527(11.58%)	278(18.21%)		1951(13.33%)	251(9.57%)	
Sex						
Male	4224(32.04%)	901(28.19%)	**<.0001****	6172(42.16%)	958(36.51%)	**<.0001****
Female	8959(67.96%)	2295(71.81%)		8467(57.84%)	1666(63.49%)	
Education^						
Illiterate	2839(24.59%)	581(20.87%)	**<.0001****	5617(38.38%)	825(31.44%)	**<.0001****
Basic education	4028(34.89%)	1029(36.96%)		2381(16.27%)	480(18.29%)	
Secondary level	4185(36.25%)	977(35.09%)		4754(32.48%)	868(33.08%)	
Higher level	493(4.27%)	197(7.08%)		1884(12.87%)	451(17.19%)	
Household level factors						
Marital Status^						
Never union	2570(22.24%)	195(7.00%)	**<.0001****	2764(18.88%)	139(5.30%)	**<.0001****
Others	8987(77.76%)	2591(93.00%)		11875(81.12%)	2485(94.70%)	
Number of Household Members						
≤5	777(5.89%)	177(5.54%)	**0.6035**	983(6.71%)	163(6.21%)	**0.3225**
>5	12406(94.11%)	3019(94.46%)		13656(93.29%)	2461(93.79%)	
Wealth Index						

Poorest-1	3581(27.16%)	432(13.52%)	**<.0001****	3234(22.09%)	208(7.93)	**<.0001****
Poorer-2	2824(21.42%)	555(17.37%)		3007(20.54%)	391(14.90%)	
Middle-3	2591(19.65%)	569(17.80%)		2887(19.72%)	393(14.98%)	
Richer-4	2229(16.91%)	744(23.28%)		2988(20.41%)	622(23.70%)	
Richest-5	1958(14.85%)	896(28.04%)		2523(17.23%)	1010(38.49%)	
Household Environmental Factors						
Environmental Factors						
Ecological region						
Mountain	1109(8.41%)	155(4.85%)	**<.0001****	1139(7.78%)	138(5.26%)	**<.0001****
Hill	6022(45.68%)	1656(51.81%)		6647(45.41%)	1307(49.81%)	
Terai/Plain	6052(45.91%)	1385(43.34%)		6853(46.81%)	1179(44.93%)	
Type of residence			**<.0001****			
Urban/Town	6965(52.83%)	1992(62.33%)		9255(63.22%)	1950(74.31%)	**<.0001****
Rural/Village	6218(47.17%)	1204(37.67%)		5384(36.78%)	674(25.69%)	
Household Facilities						
Source of drinking water						
Improved	12837(97.38%)	3140(98.25%)	.0011*	13853(94.62%)	2540(96.80%)	**<.0001****
Unimproved	346(2.62%)	56(1.75%)		786(5.37%)	84(3.20%)	
Household Food security level						
Secure	10427(79.09%)	2776(86.86%)	**<.0001****	6675(45.60%)	1605(61.17%)	**<.0001****
Mild insecure	1858(14.09%)	292(9.14%)		4934(33.70%)	703(26.79%)	
Moderate insecure	535(4.06%)	76(2.38%)		1822(12.45%)	194(7.39%)	
Severe insecure	363(2.75%)	52(1.63%)		1208(8.25%)	122(4.65%)	
Household possessions						
Access to media						
Yes	12884(97.73%)	3178(99.44%)	**<.0001****	14070(96.11%)	2589(98.67%)	**<.0001****
No	299(2.27%)	18(0.56%)		569(3.89%)	35(1.33%)	
Access to Transportation						
Yes	6553(49.71%)	1805(56.48%)	**<.0001****	7077(48.34%)	1470(56.02%)	**<.0001****
No	6630(50.29%)	1391(43.52%)		7562(51.55%)	1154(43.98%)	
Agricultural land ownership						
Yes	9660(73.28%)	2200(68.84%)	**<.0001****	11991(81.91%)	1983(75.57%)	**<.0001****
No	3523(26.72%)	996(31.16%)		2648(18.09%)	641(24.43%)	
Livestock ownership						
Yes	10366(78.63%)	2191(68.55%)	**<.0001****	11573(79.06%)	1656(63.11%)	**<.0001****
No	2817(21.37%)	1005(31.45%)		3066(20.94%)	968(36.89%)	

^ Indicates missing values on specific variables; missing values were excluded from this study.

** Indicates statistical high significance; the p-value was < 0.05.

Table 2 presents the bivariate analysis of the association between socioeconomic and household environmental factors with overweight and obesity, revealing several key patterns.

In 2016, age showed a significant association with overweight and obesity patterns (p<0.0001), with the highest proportion of overweight and obese individuals being in the 31–45-year age group (42.30%) and the 61+ age group at 9.57%. Sex differences also showed a significant association

with obesity, with females showing a higher prevalence (63.49%) than males (36.51%) (p<0.0001). The level of educational attainment also plays a significant role in overweight and obesity, with those having secondary level education exhibiting the highest prevalence of overweight and obesity (33.08%) compared to illiterate individuals (31.44%) (p<0.0001). Marital status also influenced BMI, with individuals in unions or previously in unions (categorized as 'Others') accounting for a larger proportion of overweight and obese participants (94.70%) compared to those never in a union (5.30%) (p < 0.0001).

Economic factors, reflected in the wealth index, showed that individuals in the richest quintile had the highest prevalence of overweight and obesity (38.49%), while those in the poorest quintile had the lowest (7.93%) (p<0.0001). This indicates that the overweight and obesity burden in Nepal was more significant in higher wealth groups compared to low wealth quintiles. Place of residence also played a key role, with urban residents having a higher prevalence of overweight and obesity (74.31%) compared to rural residents (25.69%) (p<0.0001). Among ecological regions, the Hill region had the highest prevalence (49.81%), followed by the Terai/Plain (44.93%) and Mountain (5.26%) regions (p<0.0001).

Various household-level factors also showed a significant association with overweight and obesity patterns. Access to improved drinking water was associated with a higher prevalence of overweight and obesity (96.80%) compared to unimproved sources (3.20%, p<0.0001). Food security status, indicated by secure households, was associated with a higher prevalence of overweight and obesity (61.17%) (p<0.0001), and access to media (98.67%) and transportation (56.02%) were also significant factors (p<0.0001) contributing to the prevalence of overweight and obesity in Nepal.

In 2022, age continued to show a significant association with BMI (p<0.0001), with the highest prevalence of overweight and obesity observed in the 31-45 age group (37.21%) and the lowest in

the 15-30 age group (14.25%). Sex differences were pronounced, with females exhibiting a significantly higher prevalence of overweight and obesity (71.81%) compared to males (28.19%) (p<0.0001). Regarding education level, individuals with basic education exhibited the highest prevalence of overweight and obesity (36.96%), whereas respondents with higher education levels had the lowest (7.08%) (p<0.0001). Marital status significantly influenced BMI, with married or previously married individuals (categorized as "Others") showing a much higher prevalence (93.00%) compared to those never in a union (7.00%) (p<0.0001).

Economic factors, as measured by the wealth index, showed a clear gradient in BMI status. Individuals in the richest quintile had the highest prevalence of overweight and obesity (28.04%), whereas those in the poorest quintile had the lowest (13.52%) (p<0.0001). Geographical and environmental factors also played a significant role, with urban residents showing a higher prevalence of overweight and obesity (62.33%) compared to rural residents (37.67%) (p<0.0001). Among ecological regions, individuals in the Hill region exhibited the highest prevalence (51.81%), followed by the Terai/Plain (43.34%) and Mountain (4.85%) regions (p<0.0001). Access to improved drinking water was nearly universal among participants (98.25%), and food security status showed a strong association with BMI, where secure households had the highest prevalence of overweight and obesity (86.86%) (p<0.0001). Additionally, access to media (99.44%) and transportation (56.48%) were significantly associated with higher BMI status (p<0.0001).

Comparison of NDHS 2016 and NDHS 2022

Comparing the data from 2016 and 2022, several key trends and shifts emerge. While age remained a significant factor, the prevalence of overweight and obesity in the 15-30 age group decreased from 23.02% in 2016 to 14.25% in 2022, possibly reflecting changes in lifestyle or health interventions targeted at younger populations. Sex differences persisted, with females consistently

showing higher prevalence rates in both years, though the disparity increased in 2022. Educational attainment's impact on BMI saw a shift, with the highest prevalence moving from those with higher education in 2016 to those with basic education in 2022, suggesting evolving socioeconomic dynamics and health behaviors.

Economic status continued to show a strong association with BMI, though the pattern decreased slightly; the prevalence among the richest quintile decreased from 38.49% in 2016 to 28.04% in 2022. This could indicate improving health equity or effective public health measures targeting wealthier groups. Urban-rural disparities in BMI prevalence also narrowed, with a notable decrease in urban areas from 74.31% in 2016 to 62.33% in 2022, and an increase in rural areas from 25.69% to 37.67%, highlighting potential shifts in urban and rural lifestyles and access to health resources.

The ecological region's impact on BMI remained consistent, with the Hill region showing the highest prevalence in both years, while improvements in drinking water and food security continued to be associated with higher BMI prevalence. These changes underscore the complex interplay of sociodemographic factors on BMI, reflecting broader socioeconomic and environmental transformations over the six-year period. Despite these findings, while key variables contributing to overweight and obesity slightly decreased in 2022, the overall pattern of overweight and obesity still increased compared to 2016, indicating that various other factors also play a role and that targeted interventions are not yet sufficient.

Multivariable logistic regression analysis

Table 3: Multivariable logistic regression analysis of factors associated with being overweight and obese (BMI ≥ 25) compared to normal weight (BMI < 25)

Variables	Sociodemographic factors and BMI status (NDHS 2022)				Sociodemographic factors and BMI status (NDHS 2016)			
	Normal weight		*Overweight/ Obesity*		*Normal weight*		*Overweight/Obesity*	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age								
15-30	*Ref*	---	*Ref*	---	*Ref*	---	*Ref*	---
31-45	0.28	0.25-0.31	3.57	3.22-3.94	0.29	0.26-0.32	3.51	3.15-3.92
46-60	0.38	0.34-0.43	2.61	2.32-2.93	0.40	0.35-0.46	2.53	2.25-2.86
61+	0.75	0.64-0.87	1.33	1.15-1.56	0.78	0.66-0.91	1.29	1.10-1.51
Sex								
Female	*Ref*	---	*Ref*	---	*Ref*	---	*Ref*	---
Male	1.27	1.16-1.39	0.79	0.72-0.86	1.33	1.22-1.46	0.75	0.69-0.82
Education^								
Illiterate	Ref	---	Ref	---	Ref	---	Ref	---
Basic education	0.68	0.60-0.77	1.47	1.30-1.66	0.75	0.69-0.84	1.33	1.19-1.50
Secondary level	0.77	0.69-0.86	1.30	1.17-1.44	0.85	0.75-0.95	1.18	1.05-1.33
Higher level	0.55	0.48-0.62	1.83	1.61-2.08	0.39	0.32-0.47	2.59	2.11-3.17
Marital Status^								
Never union	*Ref*	---	*Ref*	**---**	*Ref*	---	*Ref*	**---**
Others	0.20	0.17-0.24	4.93	4.23-5.75	0.20	0.17-0.24	5.00	4.19-5.96
Number of Household Members								
≤5	*Ref*	---	*Ref*	**---**	*Ref*	---	*Ref*	**---**
>5	0.90	0.76-1.08	1.11	0.93-1.32	0.91	0.77-1.09	1.09	0.92-1.30
Wealth Index								
Poorest-1	*Ref*	---	*Ref*	---	*Ref*	---	*Ref*	**---**
Poorer-2	0.57	0.50-0.66	1.75	1.51-2.02	0.56	0.47-0.67	1.79	1.50-2.11
Middle-3	0.39	0.34-0.44	2.59	2.26-2.98	0.37	0.31-0.43	2.72	2.31-3.20
Richer-4	0.30	0.26-0.35	3.32	2.88-3.81	0.24	0.20-0.28	4.17	3.55-4.91
Richest-5	0.19	0.16-0.21	5.41	4.72-6.20	0.14	0.12-0.16	7.31	6.25-8.55
Ecological region								
Mountain	*Ref*	---	*Ref*	---	*Ref*	---	*Ref*	**---**
Hill	0.43	0.36-0.51	2.33	1.95-2.79	0.56	0.47-0.68	1.78	1.47-2.14
Terai/Plain	0.55	0.46-0.66	1.83	1.53-2.19	0.66	0.55-0.80	1.51	1.25-1.82
Type of residence								
Urban/Town	*Ref*	---	*Ref*	---	*Ref*	---	*Ref*	**---**
Rural/Village	*1.87*	*1.70-2.05*	*0.54*	*0.49-0.59*	*1.67*	*1.54-1.81*	*0.60*	*0.55-0.65*

Household food security level								
Secure	*Ref*	---	*Ref*	---	*Ref*	---	*Ref*	---
Mild Insecure	1.95	1.71-2.22	0.51	0.45-0.59	1.91	1.73-2.10	0.53	0.48-0.58
Moderate Insecure	2.19	1.71-2.80	0.46	0.36-0.58	2.66	2.27-3.11	0.38	0.32-0.44
Severe Insecure	2.17	1.61-2.92	0.46	0.34-0.62	2.82	2.32-3.43	0.36	0.29-0.43
Access to media								
No	*Ref*	---	*Ref*	---	*Ref*	---	*Ref*	---
Yes	0.29	0.21-0.41	3.44	2.44-4.86	0.20	0.12-0.32	5.11	3.17-8.25
Access to transportation								
No	*Ref*	---	*Ref*	---	*Ref*	---	*Ref*	---
Yes	0.69	0.63-0.75	1.46	1.34-1.59	0.70	0.65-0.76	1.43	1.32-1.55
Agricultural land ownership								
No	*Ref*	---	*Ref*	---	*Ref*	---	*Ref*	---
Yes	1.61	1.46-1.78	0.62	0.56-0.69	1.34	1.23-1.46	0.75	0.69-0.82

This table presents the adjusted odds ratios (AORs) and 95% confidence intervals (CIs) from multivariable logistic regression models examining factors associated with being overweight or obese. The binary outcome variable used was BMI_Class, coded as 1 = Overweight/Obese (BMI ≥ 25) and 0 = Not Overweight/Obese (BMI < 25). This reference group includes individuals with BMI values below 25, encompassing both normal weight and underweight categories. The models were run using the event='1' option in SAS to estimate the odds of being overweight/obese. A backward stepwise selection method was used, retaining variables significant at p < 0.05 in the final model.

Table 3 presents the results of a multivariable logistic regression analysis examining the association between sociodemographic, socioeconomic, and environmental variables and BMI status. The outcome variable was binary, with respondents classified as either overweight/obese (BMI ≥ 25) or normal weight (BMI 18.5–24.9). Underweight individuals (BMI < 18.5) were excluded from the

analysis to maintain consistency in comparisons. The final model was developed using a backward stepwise approach, retaining variables with a significance level of $p < 0.05$.

Findings from NDHS 2016

In 2016, age demonstrated a significant association with BMI status. The odds ratio (OR) for being overweight or obese was highest in the 31-45 age group (OR=3.51, 95% CI: 3.15-3.92) compared to the 15-30 age group. Similarly, the 46-60 age group had an OR of 2.53 (95% CI: 2.25-2.86), and the 61+ age group had an OR of 1.29 (95% CI: 1.10-1.51). Sex differences were also significant, with males having lower odds of being overweight or obese (OR=0.75, 95% CI: 0.69-0.82) compared to females.

Educational attainment played a critical role in determining BMI, with those having higher education exhibiting the highest odds of being overweight or obese (OR=2.59, 95% CI: 2.11-3.17), while those with secondary education showed lower odds (OR=1.18,95% CI: 1.05-1.33) compared to those with no education or illiterate. This suggests that despite higher levels of education, obesity remains a problem across all levels of educational attainment.

Marital status was significantly associated with BMI, individuals in unions or previously in unions (categorized as "Others") having much higher odds (OR=5.00, 95% CI: 4.19-5.96) compared to those never in a union. Similarly, the number of household members showed that families with more than 5 members had higher odds (OR=1.09, 95% CI: 0.92-1.30) compared to those with 5 or fewer members.

Economic status, measured by the wealth index, showed that the richest quintile had the highest odds of being overweight or obese (OR=7.31, 95% CI: 6.25-8.55), followed by the richer group (OR=4.17,95% CI:3.55-4.91) compared to the poorest group. Place of residence also played a key

role, with rural residents having lower odds of being overweight/obese (OR= 0.60, 95% CI: 0.55-0.65) compared to urban residents.

Nepal's unique ecological zones significantly associated with BMI. Individuals in the Hill region had higher odds (OR=1.78, 95% CI: 1.47-2.14) compared to those in the Mountain region. Household food security levels were significantly associated with BMI, with severely food-insecure households having lower odds (OR=0.36, 95% CI: 0.29-0.43) compared to food-secure households. Access to media and transportation also significantly influenced BMI, with access to media associated with higher odds of overweight/obesity (OR=5.11, 95% CI: 3.17-8.25), and access to transportation having an OR of 1.43 (95% CI: 1.32-1.55).

Agricultural land ownership was another significant factor, with those owning land having lower odds of being overweight or obese (OR=0.75, 95% CI: 0.69-0.82) compared to those not owning land. This finding suggests that food security and access to resources related to land ownership play a crucial role in BMI status.

Findings from NDHS 2022

In 2022, age remained a significant factor, with the 31-45 age group again showing the highest odds of being overweight or obese (OR=3.57, 95% CI: 3.22-3.94) compared to the 15-30 age group. The 46-60 age group had an OR of 2.61 (95% CI: 2.32-2.93), and the 61+ age group had an OR of 1.33 (95% CI: 1.15-1.56).

Sex differences persisted, with males having lower odds of overweight/obesity (OR=0.79, 95% CI: 0.72-0.86) compared to females (reference category). Educational attainment showed a similar pattern, with those having higher education exhibiting the highest odds of being overweight or

obese (OR=1.83, 95% CI: 1.61-2.08) compared to those with no education (reference category). Higher secondary or high school individuals had the lowest odds (OR=1.30, 95% CI: 1.17-1.44).

Marital status continued to significantly influence BMI, with those in unions or previously in unions (categorized as "Others") having higher odds (OR=4.93, 95% CI: 4.23-5.75) compared to those never in a union (reference category). Similarly, the number of household members showed that families with more than 5 members had higher odds (OR=1.11, 95% CI: 0.93-1.32) compared to those with 5 or fewer members.

Economic factors, defined by household wealth index, still showed a significant association with overweight and obesity, with the richest quintile having the highest odds (OR=5.41, 95% CI: 4.72-6.20) compared to the poorest quintile (reference category). Rural residents had lower odds (OR = 0.54, 95% CI: 0.49-0.59) compared to urban residents (reference category). This depicts that being overweight and obese is more likely in urban areas due to the availability and accessibility of junk food and other lifestyle factors.

Ecological region analysis showed the Hill region with higher odds of overweight/obesity (OR =2.33, 95% CI: 1.95-2.79) compared to the Mountain region (reference category). Household food security levels remained significant, with severely food-insecure households having lower odds (OR=0.46, 95% CI: 0.34-0.62) compared to food-secure households (reference category). Access to media and transportation continued to be influential, with access to media associated with higher odds (OR=3.44, 95% CI: 2.44-4.86), and no access to transportation having an OR of 1.46 (95% CI: 1.34-1.59). Similarly, Agricultural land ownership remained significant, with those owning land having lower odds of being overweight or obese (OR=0.62, 95% CI: 0.56-0.69) compared to those not owning land.

Comparison of NDHS 2016 and NDHS 2022

Comparing the data from 2016 and 2022, several key trends and shifts are evident. Age remained a significant factor, with the prevalence of overweight and obesity consistently highest in the 31-45 age group for both years. However, the odds ratios increased slightly from 3.51 in 2016 to 3.57 in 2022, suggesting that middle-aged individuals continued to be at the highest risk of being overweight and obese.

Sex differences persisted, with females showing consistently higher odds of being overweight or obese in both years, though the disparity slightly decreased in 2022 (OR=0.79). Educational attainment's impact on BMI showed a notable change. In 2016, individuals with higher education had the highest odds of being overweight or obese, being 2.59 times more likely (OR=2.59) to be overweight or obese than those with no education. By 2022, these odds decreased to 1.83 times more likely (OR=1.83) compared to those who were illiterate.

Economic status continued to show a strong association with BMI, though the gradient slightly decreased. The odds for the richest quintile dropped from 7.31 in 2016 to 5.41 in 2022, possibly reflecting improving health equity or effective public health measures targeting wealthier groups. Urban-rural disparities in BMI prevalence also narrowed, with a notable decrease in odds for rural residents from 0.60 in 2016 to 0.55 in 2022.

The ecological region's impact on BMI remained consistent, with the Hill region showing the highest odds in both years (OR=1.78 in 2016 and OR=2.33 in 2022) relative to mountain. Food security continued to be associated with higher BMI prevalence in both years, suggesting that access to resources plays a crucial role in determining BMI status.

Regarding household size, the association with BMI remained relatively stable, with families having more than five members showing slightly higher odds in 2022 (OR=1.11, 95% CI: 0.93-1.32) compared to 2016 (OR=1.09, 95% CI: 0.92-1.30). Similarly, access to transportation also remained a significant factor, with individuals without access to transportation having similar odds of being overweight or obese in both years (2016: OR=1.43, 95% CI: 1.32-1.55; 2022: OR=1.46, 95% CI: 1.34-1.59). Moreover, agricultural land ownership showed a consistent trend, with those owning land having lower odds of being overweight or in both years (2016: OR=0.75, 95% CI: 0.69-0.82; 2022: OR=0.62, 95% CI: 0.56-0.69).

Heatmap for overweight and obesity classified by age group and wealth quintiles

Figure 4:Heatmap for overweight and obesity classified by age group and wealth quintiles (NDHS 2016)

Figure 5:Heatmap for overweight and obesity classified by age group and wealth quintiles (NDHS 2022)
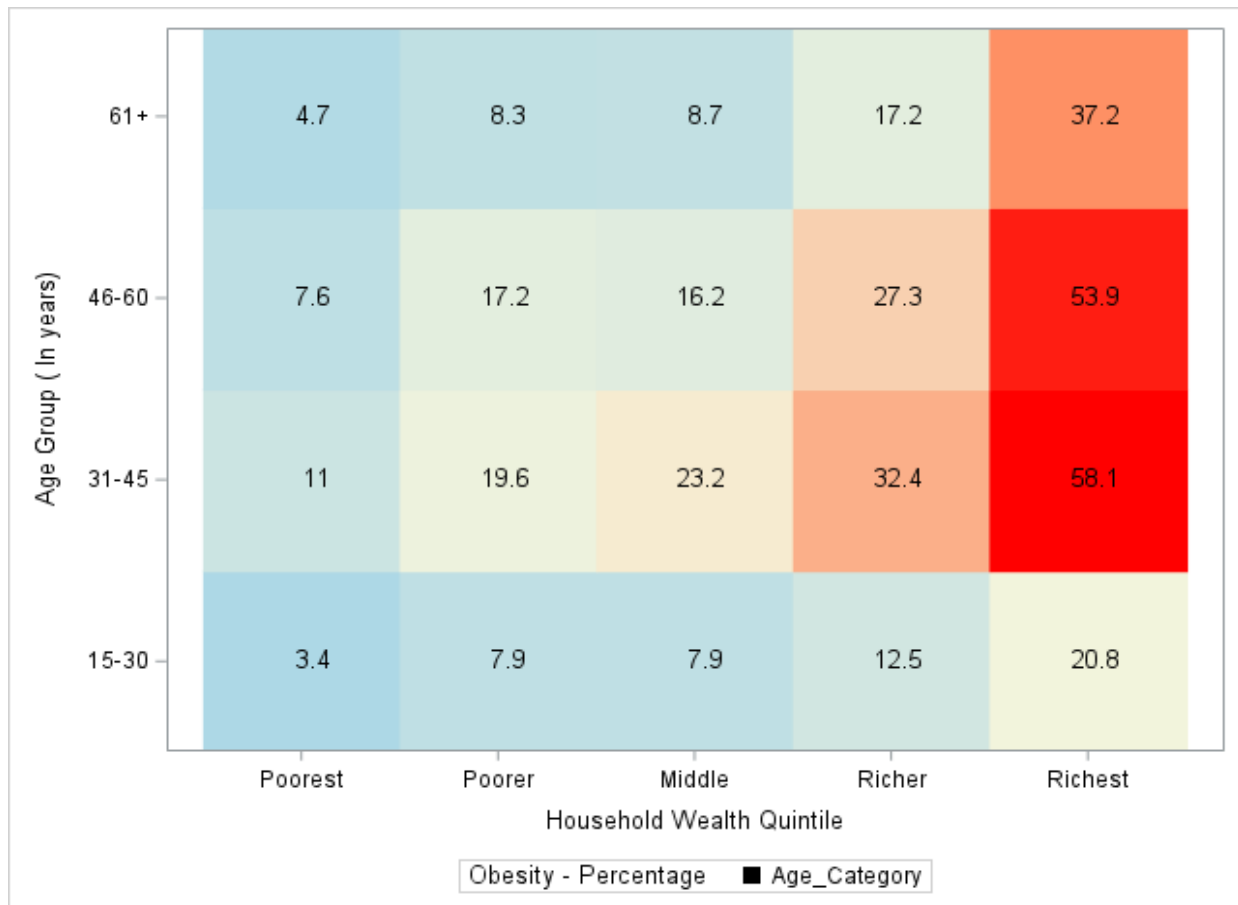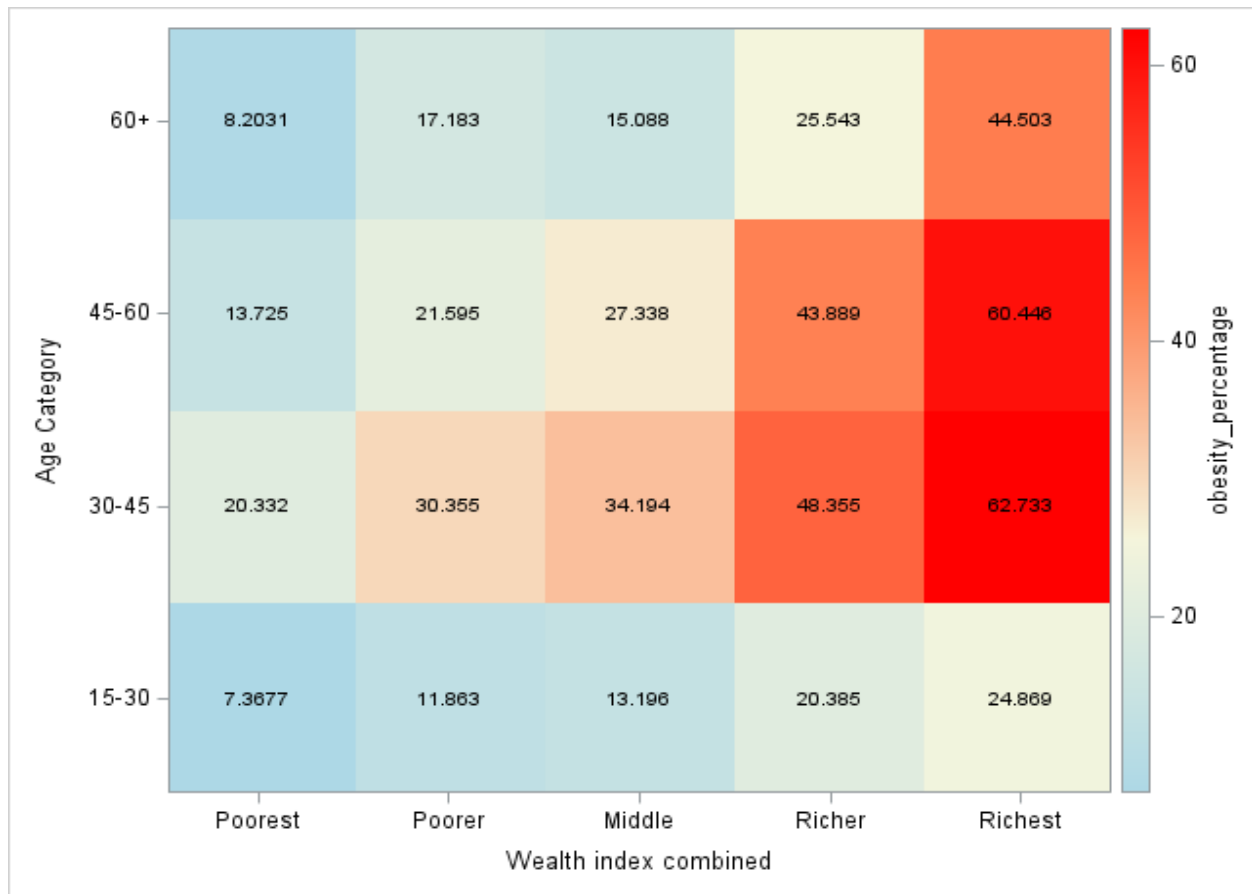
Footnote: Darker red shades indicate higher prevalence of obesity, while lighter shades represent lower prevalence. Age groups are represented on the y-axis, and household wealth quintiles on the x-axis. Data are derived from the NDHS 2016.

The NDHS 2016 heatmap illustrates the prevalence of overweight and obesity across different household wealth quintiles and age groups. The intensity of the color gradient, with dark red

indicating the highest burden and light blue indicating the lowest, visually represents the disparities in overweight and obesity prevalence. The data reveal a clear pattern where the prevalence of overweight and obesity escalates with both increasing age and wealth quintile.

In the youngest age group (15-30 years), the prevalence of obesity is relatively low across all quintiles, peaking at 20.8% in the richest quintile (5th Quintile). Among adults aged 31-45 years, the prevalence increases, reaching the highest level at 58.1% in the richest quintile. This upward trend persists in the 46-60 age group, with the richest quintile showing a prevalence of 53.9%. For respondents aged 61 and above, there is a lower but still notable increase, with a prevalence of 37.2% in the richest quintile. These data suggest a positive correlation between age, socioeconomic status, and obesity risk, with the highest burden observed among adults aged 31-45 years.

The NDHS 2022 heatmap provides updated insights into the burden of overweight and obesity across different age groups and wealth quintiles. Compared to 2016, there is a noticeable increase in obesity prevalence across nearly all categories. For young adults (15-30 years), the prevalence remains lower relative to older groups but shows a slight increase, with the highest rate in the richest quintile at 24.87%. The 30-45 age group exhibits a marked increase in obesity prevalence, with the richest quintile reaching 62.73%. This trend continues in the 45-60 age group, where the highest prevalence is 60.46% in the richest quintile. Respondents aged 60 and above, while showing lower obesity rates compared to middle-aged adults, still demonstrate significant prevalence in the richest quintile at 44.50%.

These findings suggest a significant increase in obesity prevalence over the six-year period, with a more explicit effect observed among wealthier individuals and those in middle to older age groups.

Geospatial distribution of overweight and obesity in Nepal

Figure 6: District and provincial- level distribution of overweight and obesity proportion in Nepal
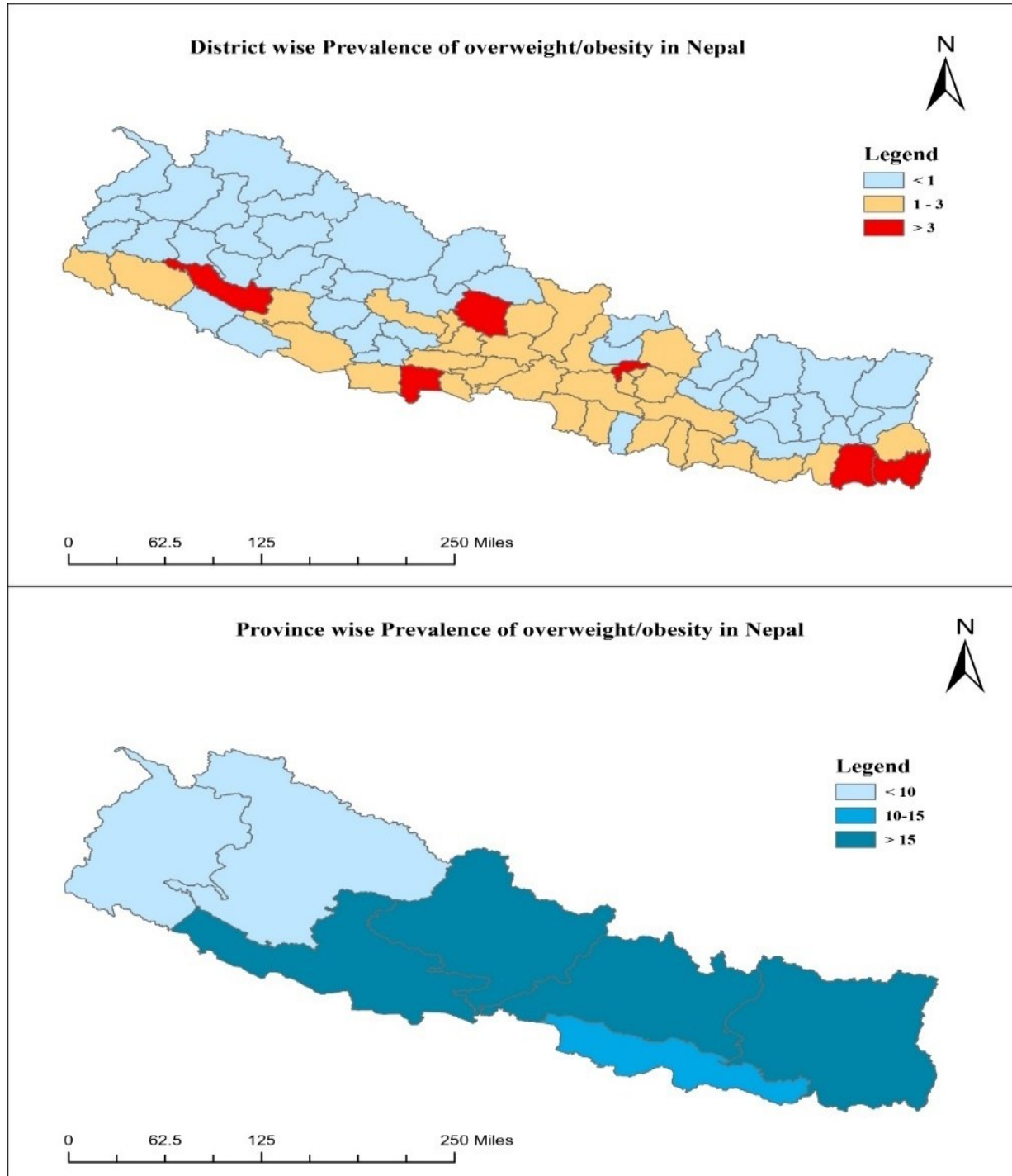
Nepal has recently undergone significant political restructuring, leading to a need for province-level analysis of various health indicators, including overweight and obesity. Thus, the study also aimed to assess the distribution of overweight and obesity patterns across Nepal's districts and provinces, given the country's unique geographic diversity and unequal development.

The district wise prevalence map above illustrates the proportion of overweight and obesity across different districts. Notably, higher proportions of obesity are observed in the districts of Kathmandu, Morang, Rupandehi, Kaski, Surkhet, and Jhapa. These districts are characterized by high urbanization, indicating that socioeconomic factors may significantly influence the rates of overweight and obesity.

At the provincial level, Koshi Province (Province 1), Bagmati Province (Province 3), Gandaki Province (Province 4), and Lumbini Province (Province 5) exhibit higher proportions of overweight and obesity. However, Karnali and Sudurpashchim Provinces (Provinces 6 and 7) report a prevalence of overweight and obesity below 10%.

The findings from geographic distribution of overweight and obesity indicate that overweight and obesity are disproportionately concentrated in districts with higher population densities and provinces with more advanced development indicators, such as Bagmati Province, which includes the capital city, Kathmandu, and other major urban centers. This pattern aligns with global and regional evidence linking urbanization, economic development, and sedentary lifestyles to rising obesity rates.

Binary logistic regression analysis of overweight and obesity by socioeconomic and environmental variables

Table 4:Overweight and Obesity status by socio-economic and environmental variables: A binary logistic regression analysis

Variables	NDHS-2016				NDHS-2022			
Overweight and Obesity*	Unadjusted (OR,95%CI)	Model 1 (OR,95% CI)	Model 2 (OR,95% CI)	Model 3 (Final Model) (OR,95% CI)	Unadjusted (OR,95% CI)	Model 1 (OR,95% CI)	Model 2 (OR,95% CI)	Model 3 (Final Model) (OR,95% CI)
Age								
15-30	ref	Ref	ref	ref	ref	ref	ref	ref
31-45	3.513(3.15-3.92)	3.54(3.17-3.95)	5.62(4.98-6.34)	2.83(2.48-3.23)	3.567(3.23-3.94)	3.59(3.25-3.96)	4.76(4.27-5.31)	2.59(2.29-2.92)
46-60	2.53(2.25-2.86)	2.60(2.30-2.93)	5.61(4.85-6.48)	2.48(2.13-2.91)	2.61(2.32-2.93)	2.71(2.41-3.05)	4.67(3.99-5.47)	2.16(1.82-2.56)
61+	1.29(1.10-1.51)	1.34(0.67-0.81)	3.54(2.94-4.26)	1.42(1.16-1.73)	1.34(1.15-1.56)	1.42(1.22-1.65)	2.70(2.12-3.44)	1.14(0.88-1.48)
Sex								
Female	ref	Ref	Ref	Ref	ref	ref	ref	ref
Male	0.75(0.69-0.82)	0.74(0.67-0.81)	0.48(0.43-0.53)	0.59(0.54-0.66)	0.79(0.72-0.86)	0.76(0.69-0.84)	0.58(0.52-0.64)	0.69(0.62-0.78)
Education^								
Illiterate	ref		ref	ref	ref	ref	ref	ref
Basic education	1.47(1.30-1.66)		2.36(2.06-2.71)	1.70(1.47-1.97)	1.33(1.19-1.49)		2.21(1.95-2.51)	1.59(1.39-1.81)
Secondary level	1.30(1.17-1.44)		3.24(2.84-3.69)	1.73(1.50-1.99)	1.18(1.05-1.33)		2.66(2.32-3.04)	1.39(1.20-1.61)
Higher level	1.83(1.61-2.08)		5.16(4.39-6.05)	1.83(1.53-2.19)	2.59(2.11-3.17)		4.42(3.55-5.51)	1.50(1.17-1.93)
Marital Status^								
Never union	ref			ref	ref	ref	ref	ref
Others	4.99(4.19-5.96)			4.37(3.57-5.35)	4.93(4.23-5.75)			3.97(3.33-4.73)
Number of Household Members								
≤5	ref			Ref	ref	ref	ref	ref
>5	1.11(0.93-1.32)				1.09(0.92-1.29)			
Wealth Index								
Poorest-1	ref			Ref	ref	ref	ref	ref
Poorer-2	2.17(1.82-2.59)			2.28(1.89-2.74)	1.78(1.56-2.04)			1.91(1.63-2.24)
Middle-3	2.29(1.92-2.73)			2.78(2.28-3.36)	2.05(1.78-2.35)			2.52(2.13-2.98)
Richer-4	3.82(3.24-4.51)			4.77(3.94-5.78)	3.65(3.19-4.17)			4.61(3.88-5.47)
Richest-5	9.71(8.26-11.41)			10.93(9.02-13.38)	6.15(5.38-7.03)			6.85(5.73-8.20)
Ecological region								
Mountain	ref			ref	ref	ref	ref	ref
Hill	1.78(1.47-2.14)			1.18(0.96-1.46)	2.33(1.95-2.79)			1.53(1.24-1.89)

68

Terai/Plain	1.51(1.25-1.82)			0.66(0.53-0.81)	1.83(1.53-2.19)			0.81(0.65-1.01)
Type of residence								
Urban/Town	*ref*				*ref*	*ref*	*ref*	*ref*
Rural/Village	0.54(0.49-0.59)				0.60(0.55-0.65)			
Household Food security level								
Secure	*ref*			*ref*	*ref*	*ref*	*ref*	*ref*
Mild insecure	0.53(0.48-0.58)			0.86(0.77-0.96)	0.51(0.45-0.59)			0.81(0.70-0.95)
Moderate insecure	0.38(0.32-0.44)			0.76(0.63-0.90)	0.46(0.36-0.58)			0.70(0.52-0.93)
Severe insecure	0.36(0.29-0.43)			0.84(0.67-1.04)	0.46(0.34-0.62)			0.72(0.51-1.01)
Access to media								
Yes	*ref*				*ref*	*ref*	*ref*	*ref*
No	0.29(0.21-0.41)				0.19(0.12-0.32)			
Access to Transportation								
Yes	*ref*				*ref*	*ref*	*ref*	*ref*
No	0.69(0.63-0.75)				0.69(0.65-0.76)			
Agricultural land ownership								
Yes	*ref*				*ref*	*ref*	*ref*	*ref*
No	1.61(1.46-1.78)				1.34(1.23-1.46)			
Livestock ownership								
Yes	*ref*				*ref*	*ref*	*ref*	*ref*
No	2.76(2.52-3.03)				2.07(1.89-2.27)			

Findings from NDHS 2016

The analysis of the NDHS 2016 data using binary logistic regression with backward elimination identified several significant predictors of overweight and obesity. In the unadjusted model, each predictor was examined individually, providing a baseline understanding of their effects. Model 1 adjusted for age and gender, revealing that these demographic factors are significant predictors even when controlling for one another. Model 2 included age, gender, and education, further refining the analysis and showing the interplay between these variables. The final model used backward elimination to include only the most relevant predictors. During this process, variables such as media access, transport access, number of household members, type of residence, agricultural land ownership, and livestock ownership were removed due to their lack of statistical significance.

Age, gender, education, marital status, wealth index, ecological region, and household food security level all were all strongly associated with the likelihood of being overweight or obese. Specifically, individuals aged 31-45 and 46-60 have notably higher odds of being overweight or obese compared to those aged 15-30, with odds ratios of 2.83 (95% CI: 2.48-3.23) and 2.48 (95% CI: 2.13-2.91), respectively. Similarly, individuals aged 61 and older also have higher odds, although to a lesser extent, with an odds ratio of 1.42 (95% CI: 1.16-1.73).

Gender differences are evident, with males having lower odds of being overweight or obese compared to females, with an odds ratio of 0.59 (95% CI: 0.54-0.66). Educational attainment shows an interesting pattern; higher levels of education correspond to higher odds of overweight or obesity. For instance, those with higher education have an odds ratio of 1.83 (95% CI: 1.53-2.19). Marital status is another significant predictor, with married individuals or those in a union having

substantially higher odds of being overweight or obese than those never in a union, with an odds ratio of 4.37 (95% CI: 3.57-5.35).

The wealth index exhibits a strong gradient effect, where higher wealth is associated with significantly higher odds of being overweight or obese. Individuals in the richest wealth quintile are almost 11 times more likely to be overweight or obese (OR = 10.93, 95% CI: 9.02–13.38) compared to those in the poorest quintile. Ecological region shows varied effects; those in the Terai/Plain region have lower odds compared to the mountain region, with an odds ratio of 0.66 (95% CI: 0.53-0.81. Household food security also impacts the odds, with mild and moderate food insecurity associated with lower odds of overweight or obesity. For example, individuals in mildly insecure households have an odds ratio of 0.86 (95% CI: 0.77-0.96), while those in moderately insecure households have an odds ratio of 0.76 (95% CI: 0.63-0.90).

Findings from NDHS 2022

The analysis of the NDHS 2022 data using binary logistic regression with backward elimination shows several significant predictors of overweight and obesity. In the unadjusted model, each predictor was examined individually, providing a baseline understanding of their effects. Model 1 adjusted for age and gender, revealing that these demographic factors are significant predictors even when controlling for one another. Model 2 included age, gender, and education, further refining the analysis and showing the interplay between these variables. The final model used backward elimination to include only the most relevant predictors. During this process, the variables for the number of household members and the type of place of residence were removed due to their lack of statistical significance.

Age, gender, education, marital status, wealth index, ecological region, and household food security level all show strong correlations with the likelihood of being overweight or obese. Specifically, individuals aged 31-45 and 46-60 have significantly higher odds of being overweight or obese compared to those aged 15-30, with odds ratios of 2.59 (95% CI: 2.29-2.92) and 2.16 (95% CI: 1.82-2.56), respectively. Although individuals aged 61 and older also show higher odds, with an odds ratio of 1.14 (95% CI: 0.88-1.48), this is not statistically significant.

Gender differences are evident, with males having lower odds of being overweight or obese compared to females, with an odds ratio of 0.69 (95% CI: 0.62-0.78). However, education factors play an opposite relation with obesity prediction, where higher educational attainment is associated with higher odds of being overweight or obese. For example, those with basic education have an odds ratio of 1.59 (95% CI: 1.39-1.81), secondary education 1.39 (95% CI: 1.20-1.61), and higher education 1.50 (95% CI: 1.17-1.93), all compared to individuals with no education.

Marital status is another significant predictor; married individuals or those in a union have substantially higher odds of being overweight or obese than those who have never been in a union, with an odds ratio of 3.97 (95% CI: 3.33-4.73). The wealth index exhibits a strong gradient effect, where higher wealth is associated with significantly higher odds of being overweight or obese. The odds ratios increase progressively across wealth categories, peaking at 6.85 (95% CI: 5.73-8.20) for the richest group compared to the poorest.

Ecological region also impacts the likelihood of being overweight or obese. Those living in the hill region have higher odds (OR = 1.53, 95% CI: 1.24-1.89) compared to those in the mountain region, while those in the Terai region have lower, albeit non-significant, odds (OR = 0.81, 95% CI: 0.65-1.01). Household food security level influences these odds as well; individuals in mild insecure households have an odds ratio of 0.81 (95% CI: 0.70-0.95), those in moderately insecure have an

odds ratio of 0.70 (95% CI: 0.52-0.93), and those in severely insecure have an odds ratio of 0.72 (95% CI: 0.51-1.01), though this last finding is marginally non-significant.

Comparison of NDHS 2016 and NDHS 2022

The comparison of findings from the NDHS 2016 and NDHS 2022 data using binary logistic regression with backward elimination reveals several consistent predictors of overweight and obesity. In both surveys, age, gender, education, marital status, wealth index, ecological region, and household food security level show strong association correlations with the likelihood of being overweight or obese. In NDHS 2016, individuals aged 31-45 and 46-60 had notably higher odds of being overweight or obese compared to those aged 15-30, with odds ratios of 2.83 (95% CI: 2.48-3.23) and 2.48 (95% CI: 2.13-2.91), respectively. Similarly, in NDHS 2022, the odds ratios were 2.59 (95% CI: 2.29-2.92) and 2.16 (95% CI: 1.82-2.56), respectively. For those aged 61 and older, the odds ratio was 1.42 (95% CI: 1.16–1.73) in 2016 and 1.14 (95% CI: 0.88–1.48) in 2022, indicating a slight decrease in the strength of association between age and overweight/obesity over time.

Gender differences were consistent across both surveys, with males having lower odds of being overweight or obese compared to females. The odds ratio for males was 0.59 (95% CI: 0.54-0.66) in 2016 and 0.69 (95% CI: 0.62-0.78) in 2022. Education showed a similar pattern in both surveys, where higher levels of education were associated with higher odds of being overweight or obese. For instance, in 2016, those with higher education had an odds ratio of 1.83 (95% CI: 1.53-2.19), while in 2022, the odds ratio was 1.50 (95% CI: 1.17-1.93).

Marital status remained a significant predictor; in 2016, married individuals or those in a union had an odds ratio of 4.37 (95% CI: 3.57-5.35), and in 2022, the odds ratio was 3.97 (95% CI: 3.33-

4.73). The wealth index also exhibited a strong gradient effect in both surveys. In 2016, the odds

ratio for the richest group compared to the poorest was 10.93 (95% CI: 9.02-13.38), while in 2022,

it was 6.85 (95% CI: 5.73-8.20), indicating a decrease in the disparity over time.

Ecological region impacts varied slightly between the surveys. In 2016, those in the Terai/Plain

region had lower odds compared to the mountain region, with an odds ratio of 0.66 (95% CI: 0.53-

0.81), while in 2022, the odds ratio for the Terai region was 0.81 (95% CI: 0.65-1.01), showing a

reduction in significance. Household food security also influenced the odds in both surveys. In

2016, individuals in mildly insecure households had an odds ratio of 0.86 (95% CI: 0.77-0.96), and

in 2022, the odds ratio was 0.81 (95% CI: 0.70-0.95).

Decomposition of concentration index

Table 5:Contribution of socio-demographic characteristics based on the decomposition of concentration index (CI) for overweight and obesity in Nepal (2022)

Socioeconomic variables	Elasticity	Concentration Index (CI)	Absolute Contribution	Percentage contribution
Age				
15-30(ref)				
31-45	-1.36607	0.004	-0.005464	3.1399
46-60	-0.86349	0.006	-0.005181	2.9770
61+ Above	-0.37771	0.007	-0.002644	1.5193
Sub-total	-2.60727	0.017	-0.013289	7.6362
Sex				
Female(ref)				
Male	0.76399	0.007	0.005348	-3.0730
Sub-total	0.76399	0.007	0.005348	-3.0730
Household family members				
5 or below(ref)				
6 or more	0.16417	-0.062	-0.010178	5.8487
Sub-total	0.16417	-0.062	-0.010178	5.8487
Education level				
No education(ref)				
Primary level	-0.40377	0.019	-0.007672	4.4082
Higher level	-0.03593	0.166	-0.005965	3.4273
Sub-total	-0.4397	0.185	-0.013637	7.8355

Wealth Quintile				
Poorest(ref)				
Poorer	-0.60207	0.020	-0.012041	6.9191
Middle	-0.77291	0.030	-0.023187	13.3237
Richer	-1.08776	0.040	-0.043511	25.0018
Richest	-1.20341	0.050	-0.060170	34.5747
Sub-total	-3.66615	0.14	-0.138909	79.8193
Ecological region				
Mountain region(ref)				
Hilly region	-0.70746	-0.010	0.007075	-4.0652
Plain/Terai region	0.44312	-0.020	-0.008862	5.0924
Sub-total	-0.26434	-0.03	-0.001787	1.0272
Food Security level				
Secure(ref)				
Mild Insecure	0.15825	0.025	0.003956	-2.2733
Moderate Insecure	0.05372	0.035	0.001880	-1.0803
Severe Insecure	0.03977	0.045	0.001789	-1.0282
Sub-total	0.25174	0.105	0.007625	-4.3818
Access to media				
No access(ref)				
Yes	0.61329	-0.015	-0.009199	5.2861
Sub-total	0.61329	-0.015	-0.009199	5.2861

The Concentration Index (CI) was employed to quantify socioeconomic inequalities in overweight and obesity, following the methodology outlined by Kakwani, Jenkins, and Lerman. The CI measures the degree of inequality by ranking individuals based on their socioeconomic status and comparing the cumulative distribution of overweight and obesity to the cumulative population distribution. A positive CI indicates that overweight and obesity are concentrated among wealthier groups, while a negative CI suggests a higher burden among poorer groups. In this study, the CI values for overweight and obesity were positive in both survey years, indicating that these conditions are more prevalent among wealthier individuals. To identify the drivers of inequality, the CI was decomposed into contributions from sociodemographic and household factors. Wealth quintiles contributed the largest share (79.82%) to the observed inequality, followed by education and household size. Elasticity for each factor and its individual CI were calculated, and the total

inequality was expressed as the sum of these contributions, with any unexplained inequality captured in the residual term.

The decomposition of the concentration index (CI) for overweight and obesity in Nepal (2022) reveals significant socio-demographic disparities, primarily driven by wealth, age, household structure, and education level, each contributing distinctively to the inequality observed in overweight and obesity prevalence.

Wealth quintile is the most substantial factor, explaining approximately 79.82% of the overall inequality. Higher wealth is strongly associated with a greater prevalence of overweight and obesity, suggesting a wealth-skewed distribution of these health outcomes. The richest quintile alone contributes disproportionately, underscoring the interplay between socioeconomic advantage and increased risk for obesity, likely attributable to enhanced access to energy-dense foods and a shift towards more sedentary lifestyles that accompany economic prosperity. This pro-rich inequality aligns with patterns documented in comparable low- and middle-income settings, where economic resources inadvertently facilitate obesogenic behaviors.

Age also significantly impacts inequality, with individuals aged 31–45 and 46–60 collectively contributing 7.64% to the CI. The marked contributions from these age groups may reflect lifestyle shifts with aging, such as reduced physical activity and increased consumption, influenced by economic stability often achieved during these years. This trend highlights the need for targeted age-specific interventions to mitigate rising obesity rates among adults in their peak productive years.

Household composition, particularly households with six or more members, contributes 5.85% to the inequality. This finding may indicate a familial or shared dietary pattern, where larger

households with pooled resources opt for calorie-dense foods that promote weight gain. The impact of household structure on obesity underlines the importance of considering family-level dynamics in public health interventions aimed at reducing obesity prevalence.

Educational Attainment accounts for 7.84% of the inequality, with primary education levels contributing more than higher education levels. This disparity may stem from variations in health literacy and lifestyle, as individuals with lower educational attainment may have limited access to health information, dietary knowledge, and physical activity opportunities. On the other hand, while higher education typically correlates with better health literacy, it may also be associated with sedentary employment, potentially offsetting health benefits.

Regional disparities between the Hilly and Plain/Terai regions add a modest but noteworthy 1.03% to the CI. The variation in obesity risk across regions likely reflects differences in urbanization, physical activity norms, and dietary practices inherent to these geographic areas, underscoring the influence of environmental and cultural factors on health outcomes.

Finally, Media Access and Food Security contribute to smaller, yet meaningful effects on inequality. Media exposure, accounting for 5.29%, may reinforce sedentary behavior and promote unhealthy dietary habits through advertisements. Food insecurity contributes negatively to the inequality index, as individuals facing mild to severe insecurity may rely on low-cost, calorie-dense foods, thus compounding obesity risk despite resource limitations.

Overall, the findings reveal wealth, age, household size, education, and media exposure as pivotal factors exacerbating obesity disparities, underscoring the necessity for multi-level, targeted interventions that address the socio-economic gradients influencing obesity.

CHAPTER V-DISCUSSION

Discussion

Summary of key Findings

This study aimed to investigate the socioeconomic determinants of overweight and obesity, measured by height and weight, in a nationally representative sample of Nepalese adults, utilizing data from the Nepal Demographic Health Survey (NDHS) of 2016 and 2022. The analysis revealed that the prevalence of overweight and obesity was 19.58% and 27.58%, respectively. This represents an approximately 1.41-fold increase over six years, highlighting that overweight and obesity continue to pose significant public health challenges in Nepal.

The findings indicate that the prevalence of overweight and obesity is notably higher among young adults in both surveys, with a greater incidence observed in females compared to males. Wealth index indicators suggest that individuals from affluent households are more likely to be overweight and obese. This research is one of the pioneering studies to explore the socioeconomic and environmental factors influencing overweight and obesity in the Nepalese population, using a concentration index and decomposition analysis for both survey periods. It provides a crucial reference for policymakers and stakeholders in formulating effective prevention strategies.

The study concluded that several factors, including age, educational attainment, marital status, wealth index, household possessions, media accessibility, land ownership, livestock ownership, modes of transportation, and household environmental conditions (such as the availability of toilet facilities and drinking water), are significantly associated with overweight and obesity. On the other hand, the number of household members did not show a significant association with overweight and obesity. These findings emphasize the importance of addressing various social

determinants to develop comprehensive prevention strategies aimed at reducing the prevalence of obesity and other non-communicable diseases (NCDs) within the Nepalese population.

Trend in prevalence of overweight and obesity

We found very limited studies on the trends of overweight and obesity prevalence, especially those focusing on male and female populations using nationally representative samples for comparison with our findings. Due to differences in methodology in other studies, only several comparable studies were found.

From NDHS 2016 to NDHS 2022, there has been a significant increase in the prevalence of overweight and obesity, rising approximately 1.4-fold over the six-year period. The prevalence rates of overweight and obesity in 2016 were 19.58%, and in 2022 were 27.58%, which aligns with other studies that used the NDHS 2016 dataset(20,24). Although there were slight variations in prevalence with a few other studies, which found the prevalence of overweight and obesity to be 19%(11), 28% overweight and 32% obese (85), and 30% overweight and 5% obese (82), these variations could be attributed to differences in participants' exclusion criteria, BMI cutoff scales for the study, and small study settings that do not represent nationally representative samples. Differences in sampling methods, regional focus, and data collection periods may also account for these discrepancies.

The prevalence rates observed in this study align with findings from neighboring South Asian countries, including India, Bangladesh, and Pakistan, where nationally representative data have reported an increasing trend in overweight and obesity in recent years, reflecting similar patterns across South Asia. (69,91,92). These studies were conducted using nationally representative samples of male and female populations, with data collection methodologies similar to those of the

NDHS 2016 and NDHS 2022 periods. The similarities in findings can be attributed to comparable ecological zones, dietary patterns, physical activities, and socioeconomic conditions across these countries. These factors contribute to a uniform trend in overweight and obesity prevalence in the region.

The present study found an increasing prevalence of overweight and obesity among all age groups, particularly higher among young adults aged 30-45 years (42.30% in 2016 and 45.40% in 2022). This finding is like a few studies conducted in Nepal using the Demographic Health Survey, where the prevalence rate for overweight and obesity among young adults aged 35-49 was 50.1%(20). In contrast, a study using physical examination reported a much higher prevalence of overweight and obesity at 53.6% in the age group of 20–40 years, compared to the prevalence reported in our study. This disparity may be attributed to differences in methodologies, with the referenced study relying on physical measurements and a specific population subgroup, while our findings are based on self-reported data from a nationally representative survey (85). Other similar studies from neighboring countries have reported lower obesity rates in this age group. For example, studies from Bangladesh found obesity prevalence rates of 30.6% for the 31–40-year age group and 31.16% for the 30–40-year age group, (77,7) . while a study from India reported rates of 36.1% and 26.99% for the 30–39-year age groups(68,91). These similar findings are likely due to comparable lifestyle and dietary habits, as well as socioeconomic conditions in Nepal, Bangladesh, and India. Differences in specific age categories and data collection techniques may explain minor variations in reported prevalence rates.

Our study found that in 2016, 63.5% of individuals classified as overweight or obese were female, which aligns with the findings using the nationally representative sample from other settings(24,85). However, this proportion declined to 54.0% in the 2022 NDHS data(93). This

difference might be due to variations in the sampling process and the use of different data. Similarly, descriptive analysis shows 71.81% among all obese participants were females, but there are no recent studies available for comparison with our findings around this time. Differences in study design, sample size, and demographic focus might account for the variations in prevalence rates among female populations.

Nepal is in a transitional phase in terms of economic progress and political restructuring, which may be resulting in changes in lifestyle, food consumption, and socioeconomic status. These changes are evidenced by increased purchasing power and mechanization of work, even in rural areas, leading to more sedentary lifestyles. These factors may contribute to the increase in overweight and obesity among the population. Studies also suggest that physical inactivity, unhealthy dietary patterns, excess abdominal adiposity, low skeletal muscle mass, and increased hepatic fat are typically observed among South Asian populations, which are associated with an increased risk of NCDs such as cardiovascular diseases, type-2 diabetes, renal disease, and other comorbid conditions. Socioeconomic improvements often lead to increased availability of high-calorie foods and reduced physical activity, contributing to rising obesity rates.

On the other hand, a study conducted by Zheng et al.(94) found that a BMI range of 22.6–27.5 was associated with a lower risk of mortality and comorbidities compared to higher BMI categories, such as those classified as obese (BMI ≥ 30). This BMI range overlaps the upper end of the normal weight category (18.5–24.9) and the lower end of the overweight category (25.0–29.9), as per WHO standards. However, this finding contrasts with other studies, which used similar BMI cut-offs and established a strong association between higher BMI (≥25) and increased risk of non-communicable diseases (NCDs). The contradiction underscores the complexity of the relationship

between BMI and health outcomes, suggesting that factors such as genetic predisposition, cultural differences in body composition, lifestyle, and healthcare access may influence these associations.

Addressing the increasing prevalence of overweight and obesity among Nepalese populations should be a priority, as these conditions significantly contribute to the rising burden of NCDs, hindering Nepal's progress toward achieving the Sustainable Development Goals, particularly the goal to reduce premature mortality from NCDs by 2030. Comprehensive public health strategies, including dietary interventions, promotion of physical activity, and education on healthy lifestyles, are essential to combat this growing public health challenge.

Socioeconomic and household environmental factors associated with overweight and Obesity

This study found that socioeconomic factors such as age, sex, education level, and household-level factors like marital status and wealth index were significantly associated with overweight and obesity. The odds of being overweight or obese were 3.51 times higher in the age group of 31-45 years according to the NDHS 2016, and a similar trend was observed in NDHS 2022. This consistent trend could be attributed to the fact that this age group often represents the prime working years, which may lead to more sedentary lifestyles and less time for physical activity, particularly for those engaged in office-based or sedentary occupations. However, the level of physical activity may vary depending on the nature of their work.

Sex differences were also significant, with males having lower odds of being overweight or obese compared to females. In Nepal, this disparity can be attributed to several factors. Cultural and societal norms often restrict women's participation in physical activities outside the home, with many women engaging in primarily sedentary domestic roles. Additionally, traditional dietary patterns may expose women to higher caloric consumption during household food preparation.

This trend was consistent in NDHS 2022. Marital status showed a significant association, with those who were married or in a common-law status having higher odds of being overweight and obese. These findings align with studies conducted in Nepal using similar demographic datasets(11,12,20,24,25,27). The consistent findings across studies conducted within Nepal regarding the prevalence and determinants of overweight and obesity can be attributed to several factors including relatively stable socioeconomic and environmental conditions, the widespread impact of urbanization, and lifestyle changes that affect dietary habits and physical activity levels across the population. Additionally, Nepal's homogeneous cultural and dietary practices, such as high reliance on carbohydrate-rich diets and limited access to diverse food options, contribute to similar obesity rates reported across studies. Furthermore, national health surveys like the NDHS provide standardized data collection methods and benchmarks, ensuring comparable results. The implementation of similar health interventions and policies nationwide also contributes to the observed consistency in findings.

Interestingly, the present study found that higher educational attainment was associated with higher odds of overweight and obesity. This can be attributed to Nepal's socioeconomic context, where educated individuals often hold office-based jobs, such as administrative roles, or managerial roles, which are typically sedentary in nature. These jobs, combined with higher incomes, provide greater access to high calorie, processed foods, contributing to the increased risk of overweight and obesity. Urban living, associated with higher education, limits physical activity due to mechanized transport and fewer recreational spaces. These findings align with studies from Nepal(24,95) and other studies(23,96,97) but contradict other studies(65,81) that found urban populations to engage in more physical activity due to greater access to gyms, parks, and organized fitness programs, highlighting the variability in urban infrastructure and lifestyle patterns across different contexts.

Moreover, the inconsistency could be because in some societies, higher education is associated with greater health literacy and healthier lifestyle choices.

On the other hand, this study revealed that household-level factors such as wealth index showed that the richest quintile had a higher association of being overweight and obese. This finding aligns with studies conducted in Nepal(24,25), neighboring South Asian countries (98)(7,68,91,99) and African regions(100), and other developing countries(101). However, the findings contrast with studies conducted in developed countries from Europe and American regions where the poorer wealth quintile had higher odds of being overweight and obese(40,45,101–103). These variations may be due to varying stages of the nutrition transition and socioeconomic dynamics of developing regions. In Nepal, higher income leads to access to high-calorie foods and sedentary lifestyles, resulting in higher obesity rates among the wealthy. Conversely, in Europe and America, wealthier individuals often have better health literacy, healthier diets, and more physical activity, leading to lower obesity rates among the rich compared to the low-income group. This is supported by studies such as those by Kim, Wang, and Arcan(45) and Templin(101).

In this study, household environmental factors, ecological zone, place of residence, and mode of transportation were significantly associated with overweight and obesity. Prior studies examining the prevalence of overweight and obesity using demographic health surveys also reported similar findings(20,24,41). These findings are consistent with prior demographic health surveys and studies in India and Bangladesh(7,68,91-99)and the United States(45). Urban areas, with their sedentary lifestyles and access to high-calorie foods, exhibited higher obesity rates compared to rural areas, where physical labor is more common. Additionally, reliance on motorized transport, prevalent in urban settings, further contributed to higher obesity rates. This is because motorized transport reduces the need for physical activity, leading to a more sedentary lifestyle (20-21).

Similarly, this study found that land ownership, livestock ownership, and household food security level play a crucial role in overweight and obesity. These findings are consistent with some other studies using similar demographic surveys or from small sampling(104-105),while a study from India found that land ownership and livestock ownership lead to improved nutritional status(106). This conflicting result could be due to contextual differences in land use, agricultural productivity, and the role of livestock in household economies. In Nepal, land and livestock ownership may provide access to high-calorie diets and reduce the need for manual labor, contributing to overweight and obesity, while in India, these assets may improve access to balanced diets and increase physical activity through agricultural work.

The relationship between livestock and land ownership and nutritional health can vary based on the socioeconomic context of a country. In some developing countries, owning livestock and land can lead to obesity due to increased access to animal-source foods which are high in calories(107). Additionally, economic stability from land and livestock ownership can lead to sedentary lifestyles(108). On the other hand, in countries where food security is a challenge, livestock and land ownership can improve nutritional health(109). Livestock provide a regular supply of nutrient-rich Animal Source Foods (ASFs), crucial for a balanced diet. Land ownership allows for cultivation of diverse crops, contributing to a varied diet(108). Thus, the impact of livestock and land ownership on nutritional health is multifaceted and context dependent. Additionally, cultural and social factors also play a role, as higher status associated with land ownership can lead to lifestyle changes that increase obesity risk.

Decomposition of contributing factors for overweight and obesity

The decomposition analysis in the present study reveals that wealth quintile is the predominant driver of overweight and obesity inequality in Nepal, accounting for nearly 80% of the

concentration index (CI) in the NDHS 2022 dataset. This substantial pro-rich disparity mirrors findings from several South Asian countries, where higher economic status enables access to energy-dense, nutrient-poor foods and promotes more sedentary lifestyles(56,110). For instance, in Bangladesh, wealth inequality emerged as the strongest determinant of obesity, with affluent individuals exhibiting markedly higher obesity rates due to dietary transitions and urbanized lifestyles that favor processed foods, thus intensifying obesity prevalence among wealthier socio-economic groups(7,19,41). Similarly, studies from India indicate that urbanization amplifies the impact of wealth on obesity, linking economic prosperity to higher rates of overweight and obesity(68,111-112). This link has been attributed to lifestyle adaptations stemming from social mobility and economic growth, which facilitate behaviors conducive to weight gain and reinforce wealth-based health disparities.

Our findings further underscore the complexity introduced by educational attainment in obesity inequality. While education typically fosters health literacy and preventive practices, our analysis shows that both primary and higher education are positively associated with obesity risk, a pattern consistent with other middle-income countries(100,113). Similar trends have been observed in China and Brazil, where increased educational attainment correlates with urban, sedentary occupations that elevate obesity risk despite enhanced health awareness(103,114-115) . For instance, in China, education contributed nearly 20% to obesity inequality, as individuals with higher education increasingly engage in less physically demanding occupations and adopt calorie-dense diets due to increased disposable income (116). Moreover, research from Thailand supports this association, indicating that rapid socio-economic transitions and urbanization disproportionately impact educated and wealthier populations, further driving obesity rates (105).

These findings underscore an urgent need for public health interventions tailored to the socio-economic landscape of Nepal and similar regions. Programs focused on affluent, urbanized populations and individuals in sedentary occupations may more effectively address the socio-economic factors exacerbating obesity. In alignment with recent recommendations from the World Health Organization (WHO) and the Global Burden of Disease (GBD) study, multi-sectoral strategies-including taxation on processed foods and urban planning that fosters physical activity-are essential to mitigate these health inequities. Together, these studies highlight that obesity inequality is not merely the product of individual behaviors but rather a complex interplay of socio-economic determinants, necessitating policy interventions that are both targeted and socio-culturally responsive.

Strength and limitations of the study

This study possesses several significant strengths. Firstly, by utilizing data from the Nepal Demographic and Health Surveys (NDHS), it benefits from large, nationally representative samples of men and women across both urban and rural areas of Nepal, thereby increasing the generalizability of the findings. Secondly, the NDHS adheres to standardized DHS procedures for data collection, including the use of calibrated measurement tools, trained field staff, and validated questionnaires, thus minimizing measurement error and maximizing both internal and external validity. Thirdly, the application of the World Health Organization (WHO) BMI cut-off points, as used in NDHS reports, strengthens the objectivity and comparability of this study's findings. The use of standardized cut-offs (e.g., BMI $\geq$ 25 for overweight and BMI $\geq$ 30 for obesity) ensures consistency with global benchmarks, allowing for meaningful comparisons across different studies, populations, and time periods. Additionally, this study is among the first to comprehensively examine a wide range of socioeconomic and household environmental factors associated with

overweight and obesity in Nepal, employing decomposition analysis on a nationally representative sample.

Our research significantly contributes to the existing literature on overweight and obesity status in Nepal. Nationally representative data on this topic are scarce, with previous studies often relying on small, homogenous samples from limited geographical areas. This study, based on a large and diverse sample, represents the first comprehensive exploration of socioeconomic and geographical disparities in the prevalence of overweight and obesity in the Nepalese context. The geospatial analyses provided herein could be particularly valuable for the newly formed provincial governments, especially in the context of Nepal's recent federalization, by informing targeted interventions based on local needs.

However, the findings should be interpreted considering several limitations. As a secondary analysis of cross-sectional data from the NDHS, this study cannot establish causal relationships between the investigated factors and the prevalence of overweight and obesity. There is a potential for social desirability bias, where participants might have given responses, they perceived as favorable. The study is also constrained by the variables available in the NDHS dataset, meaning other key predictors of overweight and obesity-such as physical activity level, total energy intake, dietary habits, smoking habit and alcohol consumption-could not be included. Additionally, when predictor variables are correlated, as many socioeconomic indicators used in this study are, the conclusions drawn from stepwise procedures can be influenced by random variation.

While the study suggests the importance of dietary interventions and promotion of physical activity in addressing overweight and obesity, it is acknowledged that these behavioral factors were not assessed in the NDHS dataset and thus were not directly analyzed in this study. References to physical activity and dietary patterns were made in a general public health context, rather than as

findings derived from the analysis. The observed sex differences in overweight and obesity may be influenced by multiple unmeasured factors, including but not limited to cultural norms, hormonal influences, occupational roles, and access to health-related resources. These reflect broader pathways within the social determinants of health (SDOH) framework, which extend beyond lifestyle behaviors alone. Future studies incorporating direct measures of physical activity, diet, and psychosocial factors are needed to better understand the mechanisms driving these disparities.

Another key limitation of this study is the omission of survey weights and complex design variables in the statistical analysis. Although the Nepal Demographic and Health Survey (NDHS) employs a rigorous, multi-stage stratified cluster sampling design-along with sampling weights, primary sampling units (PSU), and stratification-to ensure national representativeness, these elements were not applied in this analysis. As a result, while the NDHS dataset itself is nationally representative, the findings presented in this study should not be interpreted as nationally representative estimates. The analysis instead focuses on assessing associations between sociodemographic and environmental factors and overweight/obesity within the study sample. This methodological decision may limit the generalizability of the results to the broader Nepali population. Future studies incorporating survey design features are recommended to improve the accuracy of population-level inferences.

Additionally, the use of standard adult BMI thresholds (≥ 25 kg/m² for overweight and ≥ 30 kg/m² for obesity) across all individuals aged 15 years and above may not be appropriate for all age groups. According to WHO guidelines, BMI-for-age percentiles are recommended for individuals aged 15–19, while in adults aged 65 and above, BMI may not reliably indicate adiposity or health

risks. Therefore, the application of uniform BMI cutoffs across the full age range may have affected the interpretation of age-related findings.

Another methodological limitation is related to the handling of missing data. Individuals with missing height and weight-required to compute BMI-were excluded from the dataset. For other variables, such as education or marital status, participants were retained if they had valid BMI data. This variable-specific complete case approach (pairwise deletion) resulted in variations in sample size across variables. While this method preserved data, it may introduce bias if the missingness is not completely random. A formal sensitivity analysis was not conducted.

Furthermore, the geospatial mapping in this study was confined to data visualization, suggesting a need for further research to identify area-level hotspots of underweight and overweight/obesity in Nepal. Lastly, the design effect was not incorporated into the data analysis, potentially impacting the precision of the estimates.

Despite these limitations, our study provides valuable insights into the socioeconomic and geographic determinants of weight status in Nepal, offering a foundation for future research and policy interventions.

CHAPTER VI -CONCLUSION

This study provides a comprehensive analysis of the socioeconomic determinants of overweight and obesity in Nepal, utilizing data from the Nepal Demographic Health Surveys (NDHS) of 2016 and 2022. Our findings indicate a striking rise in the prevalence of obesity and overweight, increasing from 19.58% in 2016 to 27.58% in 2022, underscoring an escalating public health concern. Critical factors associated with higher odds of overweight and obesity include age, gender, education, marital status, and wealth. The highest risk was observed in adults aged 31-45, with women consistently showing a higher prevalence than men. Moreover, individuals with higher education levels, those married or in union, and those belonging to the richest wealth quintiles faced significantly elevated risks of being overweight and obesity.

Regional disparities and household food security also emerged as significant predictors. Participants from the Terai/Plain region and households with secure food access exhibited lower obesity rates, while those experiencing food insecurity faced heightened risks, highlighting the complex interplay between economic factors and nutritional health.

Despite this alarming trend, public health strategies in Nepal have traditionally prioritized infectious diseases and maternal health, often overlooking the growing burden of non-communicable diseases (NCDs) like obesity. This imbalance in focus, coupled with Nepal's low literacy rates, limits health literacy and population-level awareness, exacerbating the obesity epidemic. The rapid urbanization, changing dietary patterns, and socioeconomic transitions evident in Nepal necessitate an urgent recalibration of public health policies.

Addressing these identified risk factors requires targeted, evidence-driven interventions. Strengthening primary healthcare with an integrated focus on NCD prevention, bolstering

community health education, and promoting lifestyle modifications are crucial steps. Additionally, fostering multi-sectoral collaboration-engaging stakeholders across healthcare, education, agriculture, and policy-making-will be vital to implement comprehensive, sustainable strategies aimed at reducing obesity prevalence.

The insights from this study not only fill a critical knowledge gap but also offer a foundation for data-driven policy formulation. By utilizing nationally representative data and employing rigorous analytical techniques, this research provides a robust evidence base for designing tailored interventions. Ultimately, these efforts will be key to mitigating the escalating burden of obesity, supporting Nepal's progress towards achieving the Sustainable Development Goals (SDGs), and improving the overall health and well-being of its population.

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APPENDICES

Appendix-1: Research data approval letter

Mar 15, 2024

Laxman Datt Bhatt
Memorial University,Faculty of Medicine,Department of Community Health
Canada
Request Date: 03/14/2024

Dear Laxman Datt Bhatt:

This is to confirm that you are approved to use the following Survey Datasets for your registered research paper titled: "Wealth Based Inequality in Overweight and Obesity:Findings from Nepal Demographic Health Survey":

Nepal

To access the datasets, please login at: https://www.dhsprogram.com/data/dataset_admin/login_main.cfm. The user name is the registered email address, and the password is the one selected during registration.

The IRB-approved procedures for DHS public-use datasets do not in any way allow respondents, households, or sample communities to be identified. There are no names of individuals or household addresses in the data files. The geographic identifiers only go down to the regional level (where regions are typically very large geographical areas encompassing several states/provinces). Each enumeration area (Primary Sampling Unit) has a PSU number in the data file, but the PSU numbers do not have any labels to indicate their names or locations. In surveys that collect GIS coordinates in the field, the coordinates are only for the enumeration area (EA) as a whole, and not for individual households, and the measured coordinates are randomly displaced within a large geographic area so that specific enumeration areas cannot be identified.

The DHS Data may be used only for the purpose of statistical reporting and analysis, and only for your registered research. To use the data for another purpose, a new research project must be registered. All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. Also, be aware that re-distribution of any DHS micro-level data, either directly or within any tool/dashboard, is not permitted. Please reference the complete terms of use at: https://dhsprogram.com/Data/terms-of-use.cfm.

The data must not be passed on to other researchers without the written consent of DHS. However, if you have coresearchers registered in your account for this research paper, you are authorized to share the data with them. All data users are required to submit an electronic copy (pdf) of any reports/publications resulting from using the DHS data files to: references@dhsprogram.com.

Sincerely,

Bridgette Wellington

Bridgette Wellington
Data Archivist
The Demographic and Health Surveys (DHS) Program

Appendix-2: Survey questionnaire description

(Only Relevant Information was taken from the NDHS Survey questionnaire for the "Wealth Based Inequality in Overweight and Obesity" study

HOUSEHOLD CHARACTERISTICS

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES		SKIP
101	What is the main source of drinking water for members of your household?	**PIPED WATER**		
		PIPED INTO DWELLING	11	106
		PIPED TO YARD/PLOT	12	
		PIPED TO NEIGHBOR	13	
		PUBLIC TAP/STANDPIPE	14	
		TUBE WELL OR BOREHOLE	21	
		DUG WELL		
		PROTECTED WELL	31	
		UNPROTECTED WELL	32	
		WATER FROM SPRING		
		PROTECTED SPRING	41	103
		UNPROTECTED SPRING	42	
		RAINWATER	51	
		TANKER TRUCK	61	
		CART WITH SMALL TANK	71	
		SURFACE WATER (RIVER/DAM/		
		LAKE/POND/STREAM/CANAL/		
		IRRIGATION CHANNEL)	81	
		BOTTLED WATER	91	
		OTHER _____	96	103
		(SPECIFY)		
102	What is the main source of water used by your household for other purposes such as cooking and handwashing?	**PIPED WATER**		
		PIPED INTO DWELLING	11	106
		PIPED TO YARD/PLOT	12	
		PIPED TO NEIGHBOR	13	
		PUBLIC TAP/STANDPIPE	14	
		TUBE WELL OR BOREHOLE	21	
		DUG WELL		
		PROTECTED WELL	31	
		UNPROTECTED WELL	32	
		WATER FROM SPRING		
		PROTECTED SPRING	41	
		UNPROTECTED SPRING	42	
		RAINWATER	51	
		TANKER TRUCK	61	
		CART WITH SMALL TANK	71	
		SURFACE WATER (RIVER/DAM/		
		LAKE/POND/STREAM/CANAL/		
		IRRIGATION CHANNEL)	81	
		OTHER _____	96	
		(SPECIFY)		
103	Where is that water source located?	IN OWN DWELLING	1	106
		IN OWN YARD/PLOT	2	
		ELSEWHERE	3	
104	How long does it take to go there, get water, and come back?	MINUTES . . . . [ ][ ][ ]		
		DON'T KNOW	998	
105	Who usually goes to this source to collect the water for your household? RECORD THE PERSON'S NAME AND LINE NUMBER FROM THE HOUSEHOLD SCHEDULE. IF THE PERSON IS NOT LISTED IN THE HOUSEHOLD ROSTER, RECORD '00'.	NAME _____ LINE NUMBER . . . . [ ][ ]		

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
106	In the last month, has there been any time when your household did not have sufficient quantities of drinking water when needed?	YES . . . . 1 NO . . . . 2 DON'T KNOW 8	
107	Do you do anything to the water to make it safer to drink?	YES . . . . 1 NO . . . . 2 DON'T KNOW 8	→ 109

108	What do you usually do to make the water safer to drink?
	
	Anything else?
	
	RECORD ALL MENTIONED.
		BOIL . . . . A
		ADD BLEACH/CHLORINE . . . . B
		STRAIN THROUGH A CLOTH C
		USE WATER FILTER (CERAMIC/
		   SAND/COMPOSITE/ETC) . . . . D
		SOLAR DISINFECTION . . . . E
		LET IT STAND AND SETTLE . . . . F
		
		OTHER _____ X
		              (SPECIFY)
		DON'T KNOW . . . . Z	

109	What kind of toilet facility do members of your household usually use?
	
	IF NOT POSSIBLE TO DETERMINE, ASK PERMISSION TO OBSERVE THE FACILITY.
		FLUSH OR POUR FLUSH TOILET
		  FLUSH TO PIPED SEWER SYSTEM 11
		  FLUSH TO SEPTIC TANK 12
		  FLUSH TO PIT LATRINE 13
		  FLUSH TO SOMEWHERE ELSE 14
		  FLUSH, DON'T KNOW WHERE 15
		PIT LATRINE
		  VENTILATED IMPROVED PIT LATRINE . . 21
		  PIT LATRINE WITH SLAB 22
		  PIT LATRINE WITHOUT SLAB/OPEN PIT . . 23
		
		COMPOSTING TOILET (SLAB) 31
		COMPOSTING TOILET (WITHOUT SLAB) . . 32
		BUCKET TOILET 41
		BIOGAS ATTACHED TOILET 51
		NO FACILITY/BUSH/FIELD 61
		
		OTHER _____ 96
		              (SPECIFY)
			→ 117

110	Do you share this toilet facility with other households?	YES . . . . 1 NO 2	→ 112
111	Including your own household, how many households use this toilet facility?	NO. OF HOUSEHOLDS IF LESS THAN 10 . . . . [0][ ] 10 OR MORE HOUSEHOLDS . . . . 95 DON'T KNOW 98	
112	Where is this toilet facility located?	IN OWN DWELLING . . . . 1 IN OWN YARD/PLOT . . . . 2 ELSEWHERE 3	

113	CHECK 109:
	
	      CODES 12, 13, 21, [ ] OTHER [ ]
	  22, 23, 31, OR 32 CIRCLED ↓
			→ 117

114	Has your (septic tank/pit latrine/composting toilet) ever been emptied?	YES . . . . 1 NO . . . . 2 DON'T KNOW 8	→ 117
115	The last time the (septic tank/pit latrine/composting toilet) was emptied, was it emptied by a service provider?	YES . . . . 1 NO . . . . 2 DON'T KNOW 8	→ 116 → 116

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
115A	The last time the (septic tank/pit latrine/composting toilet) was emptied, who emptied it?	HOUSEHOLD MEMBER .... 1 OTHER .... 2 DON'T KNOW 8	

116	Where were the contents emptied to?	A TREATMENT PLANT 1
		BURIED IN A COVERED PIT 2
		UNCOVERED PIT/BUSH/FIELD/
		    OPEN GROUND 3
		SURFACE WATER (RIVER/DAM/
		    LAKE/POND/STREAM/CANAL/
		    IRRIGATION CHANNEL) 4
		
		OTHER _____ 6
		         (SPECIFY)
		
		DON'T KNOW 8	

117	In your household, what type of cookstove is mainly used for cooking?	ELECTRIC STOVE 01
		SOLAR COOKER 02
		LIQUEFIED PETROLEUM GAS (LPG)/
		    COOKING GAS STOVE 03
		PIPED NATURAL GAS STOVE 04
		BIOGAS STOVE 05
		LIQUID FUEL STOVE 06
		MANUFACTURED SOLID FUEL STOVE 07
		TRADITIONAL SOLID FUEL STOVE 08
		THREE STONE STOVE/OPEN FIRE 09
		SMOKELESS/IMPROVED STOVE 10
		
		NO FOOD COOKED IN HOUSEHOLD 95
		
		OTHER _____ 96
		        (SPECIFY)
			→121
			
			→120
			
			→120
			
			→123
			→120

118	Does the stove have a chimney?	YES .... 1 NO .... 2 DON'T KNOW 8	
119	Does the stove have a fan?	YES .... 1 NO .... 2 DON'T KNOW 8	

120	What type of fuel or energy source is used in this cookstove?	ALCOHOL/ETHANOL 01
		GASOLINE/DIESEL 02
		KEROSENE 03
		COAL/LIGNITE 04
		CHARCOAL 05
		WOOD 06
		STRAW/SHRUBS/GRASS 07
		AGRICULTURAL CROP 08
		ANIMAL DUNG/WASTE 09
		PROCESSED BIOMASS (PELLETS) OR
		    WOODCHIPS 10
		GARBAGE/PLASTIC 11
		SAWDUST 12
		
		OTHER _____ 96
		        (SPECIFY)	

121	Is the cooking usually done in the house, in a separate building, or outdoors?	IN THE HOUSE .... 1 IN A SEPARATE BUILDING .... 2 OUTDOORS .... 3 OTHER _____ 6 (SPECIFY)	→123
122	Do you have a separate room which is used as a kitchen?	YES .... 1 NO 2	

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
123	What does this household use to heat the home when needed?	CENTRAL HEATING . . . . 01 MANUFACTURED SPACE HEATER . . . . 02 TRADITIONAL SPACE HEATER . . . . 03 MANUFACTURED COOKSTOVE . . . . 04 TRADITIONAL COOKSTOVE . . . . 05 THREE STONE STOVE/OPEN FIRE . . . . 06 NO SPACE HEATING IN HOUSEHOLD . . . . . 95 OTHER _____ 96 (SPECIFY)	➤ 125 ➤ 125 ➤ 126 ➤ 125
124	Does it have a chimney?	YES . . . . 1 NO . . . . 2 DON'T KNOW 8	

125	What type of fuel or energy source is used in this heater?	ELECTRICITY 01
		PIPED NATURAL GAS 02
		SOLAR AIR HEATER 03
		LIQUEFIED PETROLEUM GAS (LPG)/
		    COOKING GAS 04
		BIOGAS 05
		ALCOHOL/ETHANOL 06
		GASOLINE/DIESEL 07
		KEROSENE 08
		COAL/LIGNITE 09
		CHARCOAL 10
		WOOD 11
		STRAW/SHRUBS/GRASS 12
		AGRICULTURAL CROP 13
		ANIMAL DUNG/WASTE 14
		PROCESSED BIOMASS (PELLETS) OR
		    WOODCHIPS 15
		GARBAGE/PLASTIC 16
		SAWDUST 17
		
		OTHER _____ 96
		(SPECIFY)	

126	At night, what does your household mainly use to light the home?	ELECTRICITY 01
		SOLAR LANTERN 02
		RECHARGEABLE FLASHLIGHT, TORCH OR
		    LANTERN 03
		BATTERY POWERED FLASHLIGHT, TORCH OR
		    LANTERN 04
		BIOGAS LAMP 05
		GASOLINE LAMP 06
		KEROSENE LAMP 07
		CHARCOAL 08
		WOOD 09
		STRAW/SHRUBS/GRASS 10
		AGRICULTURAL CROP 11
		ANIMAL DUNG/WASTE 12
		OIL LAMP 13
		CANDLE 14
		
		NO LIGHTING IN HOUSEHOLD 95
		
		OTHER _____ 96
		(SPECIFY)	

127	How many rooms in this household are used for sleeping?	ROOMS . . . . □□	
128	Does this household own any livestock, herds, other farm animals, or poultry?	YES . . . . 1 NO 2	➤ 130

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
129	How many of the following animals does this household own? IF NONE, RECORD '00'. IF 95 OR MORE, RECORD '95'. IF UNKNOWN, RECORD '98'. a) Milk cows or bulls? b) Buffalo? c) Horses, donkeys, or mules? d) Goats? e) Sheep? f) Chickens or other poultry? g) Ducks? h) Pigs? i) Yaks?	a) COWS/BULLS .... ☐☐ b) BUFFALO .... ☐☐ c) HORSES/DONKEYS/MULES ..... ☐☐ d) GOATS .... ☐☐ e) SHEEP .... ☐☐ f) CHICKENS/POULTRY .... ☐☐ g) DUCKS .... ☐☐ h) PIGS .... ☐☐ i) YAKS .... ☐☐	
130	Does any member of this household own any agricultural land?	YES .... 1 NO 2	→ 132
131	How many bigha/ropani of agricultural land do members of this household own? IF 95 OR MORE, CIRCLE '950'.	BIGHA .... 1 ☐☐ . ☐ ROPANI .... 2 ☐☐ . ☐ 95 OR MORE BIGHA/ROPANI .... 950 DON'T KNOW 998	
132	Does your household have: a) Electricity? b) A radio? c) A television? d) A non-mobile telephone? e) A computer? f) A refrigerator? g) A table? h) A chair? i) A bed? j) A sofa? k) A cupboard? l) A clock? m) A fan? n) An invertor? o) Dhiki/janto?	YES NO a) ELECTRICITY .... 1 2 b) RADIO .... 1 2 c) TELEVISION .... 1 2 d) NON-MOBILE TELEPHONE .. 1 2 e) COMPUTER .... 1 2 f) REFRIGERATOR .... 1 2 g) TABLE .... 1 2 h) CHAIR .... 1 2 i) BED .... 1 2 j) SOFA .... 1 2 k) CUPBOARD .... 1 2 l) CLOCK .... 1 2 m) FAN .... 1 2 n) INVERTOR .... 1 2 o) DHIKI/JANTO 1 2	
133	Does any member of this household own: a) A watch? b) A mobile phone? c) A bicycle/rickshaw? d) A motorcycle or motor scooter? e) An animal-drawn cart? f) A car/truck/tractor? g) A three wheel tempo/e-rickshaw?	YES NO a) WATCH .... 1 2 b) MOBILE PHONE .... 1 2 c) BICYCLE/RICKSHAW .... 1 2 d) MOTORCYCLE/SCOOTER ..... 1 2 e) ANIMAL-DRAWN CART ..... 1 2 f) CAR, TRUCK, OR TRACTOR .. 1 2 g) THREE WHEEL TEMPO 1 2	

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
134	Does any member of this household have an account in a bank or other financial institution?	YES . . . . 1 NO 2	
135	Does any member of this household use a mobile phone to make financial transactions such as sending or receiving money, paying bills, purchasing goods or services, or receiving wages?	YES . . . . 1 NO 2	
136	How often does anyone smoke inside your house? Would you say daily, weekly, monthly, less often than once a month, or never?	DAILY . . . . 1 WEEKLY . . . . 2 MONTHLY . . . . 3 LESS OFTEN THAN ONCE A MONTH . . . . 4 NEVER 5	
137	Does your household have any mosquito nets?	YES . . . . 1 NO 2	→ 149
138	How many mosquito nets does your household have? IF 7 OR MORE NETS, RECORD '7'.	NUMBER OF NETS . . . . ☐	
138A	How many of these mosquito nets are LLIN?	NONE . . . . 0 NUMBER OF LLIN . . . . ☐ DON'T KNOW 8	→ 149 → 149
138B	Where did you get the LLIN/(s)? Anywhere else?	DISTRIBUTION CAMPAIGN . . . . A GOVERNMENT HEALTH FACILITY . . . . B PRIVATE HEALTH FACILITY . . . . C PHARMACY . . . . D SHOP/MARKET . . . . E CHW . . . . F SCHOOL . . . . G OTHER _____ X (SPECIFY) DON'T KNOW . . . . Z	
138C	Did anyone sleep under an LLIN last night?	YES . . . . 1 NO 2	

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
149	We would like to learn about the places that households use to wash their hands. Can you please show me where members of your household most often wash their hands?	OBSERVED, FIXED PLACE IN DWELLING . . . . . 1 OBSERVED, FIXED PLACE IN YARD . . . . 2 OBSERVED, MOBILE . . . . 3 NOT OBSERVED, NOT IN DWELLING/YARD/PLOT . . . . 4 NOT OBSERVED, NO PERMISSION TO SEE . . 5 NOT OBSERVED, OTHER REASON 6	→ 152
150	OBSERVE PRESENCE OF WATER AT THE PLACE FOR HANDWASHING. RECORD OBSERVATION.	WATER IS AVAILABLE . . . . 1 WATER IS NOT AVAILABLE 2	
151	OBSERVE PRESENCE OF SOAP, DETERGENT, OR OTHER CLEANSING AGENT AT THE PLACE FOR HANDWASHING. RECORD OBSERVATION.	SOAP OR DETERGENT (BAR, LIQUID, POWDER, PASTE) . . . . A ASH, MUD, SAND . . . . B NONE . . . . Y	

152	OBSERVE MAIN MATERIAL OF THE FLOOR OF THE DWELLING.
	
	RECORD OBSERVATION.
		NATURAL FLOOR
		    EARTH/SAND 11
		    DUNG 12
		RUDIMENTARY FLOOR
		    WOOD PLANKS 21
		    PALM/BAMBOO 22
		FINISHED FLOOR
		    PARQUET OR POLISHED WOOD 31
		    VINYL OR ASPHALT STRIPS 32
		    CERAMIC TILES 33
		    CEMENT 34
		    CARPET 35
		
		OTHER _____ 96
		                 (SPECIFY)	

153	OBSERVE MAIN MATERIAL OF THE ROOF OF THE DWELLING.
	
	RECORD OBSERVATION.
		NATURAL ROOFING
		    NO ROOF 11
		    THATCH/PALM LEAF 12
		RUDIMENTARY ROOFING
		    RUSTIC MAT 21
		    PALM/BAMBOO 22
		    WOOD PLANKS 23
		    CARDBOARD 24
		FINISHED ROOFING
		    METAL/GALVANIZED SHEET 31
		    WOOD 32
		    CALAMINE/CEMENT FIBER 33
		    CERAMIC TILES 34
		    CEMENT 35
		    ROOFING SHINGLES 36
		
		OTHER _____ 96
		                 (SPECIFY)	

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
154	OBSERVE MAIN MATERIAL OF THE EXTERIOR WALLS OF THE DWELLING. RECORD OBSERVATION.	**NATURAL WALLS** NO WALLS .... 11 CANE/PALM/TRUNKS .... 12 MUD/SAND .... 13 **RUDIMENTARY WALLS** BAMBOO WITH MUD .... 21 STONE WITH MUD .... 22 METAL/GALVANIZED SHEET .... 23 PLYWOOD .... 24 CARDBOARD .... 25 REUSED WOOD .... 26 **FINISHED WALLS** CEMENT .... 31 STONE WITH LIME/CEMENT .... 32 BRICKS .... 33 CEMENT BLOCKS .... 34 WOOD PLANKS/SHINGLES .... 36 OTHER _____ 96 (SPECIFY)	
155	I would like to check whether the salt used in your household is iodized. May I have a sample of the salt used to cook meals in your household? TEST SALT FOR IODINE.	**SALT TESTED** IODINE PRESENT .... 1 NO IODINE .... 2 **SALT NOT TESTED** HOUSEHOLD USES SALT BUT THERE IS NO SALT IN THE HOUSEHOLD .... 3 HOUSEHOLD DOES NOT USE SALT ..... 4 SALT NOT TESTED _____ 6 (SPECIFY REASON)	

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
	Now I would like to ask you some questions about food. During the last 12 months, was there a time when:		
155A	You or others in your household worried about not having enough food to eat because of a lack of money or other resources?	YES . . . . 1 NO . . . . 2 REFUSED TO ANSWER . . . . 7 DON'T KNOW 8	
155B	Still thinking about the last 12 months, was there a time when you or others in your household were unable to eat healthy and nutritious food because of a lack of money or other resources?	YES . . . . 1 NO . . . . 2 REFUSED TO ANSWER . . . . 7 DON'T KNOW 8	
155C	Was there a time when you or others in your household ate only a few kinds of foods because of a lack of money or other resources?	YES . . . . 1 NO . . . . 2 REFUSED TO ANSWER . . . . 7 DON'T KNOW 8	
155D	Was there a time when you or others in your household had to skip a meal because there was not enough money or other resources to get food?	YES . . . . 1 NO . . . . 2 REFUSED TO ANSWER . . . . 7 DON'T KNOW 8	
155E	Still thinking about the last 12 months, was there a time when you or others in your household ate less than you thought you should because of a lack of money or other resources?	YES . . . . 1 NO . . . . 2 REFUSED TO ANSWER . . . . 7 DON'T KNOW 8	
155F	Was there a time when your household ran out of food because of a lack of money or other resources?	YES . . . . 1 NO . . . . 2 REFUSED TO ANSWER . . . . 7 DON'T KNOW 8	
155G	Was there a time when you or others in your household were hungry but did not eat because there was not enough money or other resources for food?	YES . . . . 1 NO . . . . 2 REFUSED TO ANSWER . . . . 7 DON'T KNOW 8	
155H	Was there a time when you or others in your household went without eating for a whole day because of a lack of money or other resources?	YES . . . . 1 NO . . . . 2 REFUSED TO ANSWER . . . . 7 DON'T KNOW 8	
156	RECORD THE TIME.	HOURS . . . . ☐☐ MINUTES . . . . ☐☐	

112

INTRODUCTION AND CONSENT

Hello. My name is _____. I am working for New ERA to collect data on 2022 Nepal Demographic and Health Survey being conducted under the aegis of the Ministry of Health and Population. We are conducting a survey about health and other topics all over Nepal. The information we collect will help the government to plan health services. Your household was selected for the survey. The questions usually take about 60 to 90 minutes. All of the answers you give will be confidential and will not be shared with anyone other than members of our survey team. You don't have to be in the survey, but we hope you will agree to answer the questions since your views are important. If I ask you any question you don't want to answer, just let me know and I will go on to the next question or you can stop the interview at any time.

In case you need more information about the survey, you may contact the person listed on the card that has already been given to your household.

Do you have any questions?
May I begin the interview now?

SIGNATURE OF INTERVIEWER _____   DATE _____

RESPONDENT AGREES
TO BE INTERVIEWED . .   1

RESPONDENT DOES NOT AGREE
TO BE INTERVIEWED . .   2 ⟶ END

SECTION 1. RESPONDENT'S BACKGROUND

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
101	RECORD THE TIME.	HOURS . . . . ☐☐ MINUTES . . . . ☐☐	
102	What province were you born in?	PROVINCE NO 1 . . . . 01 MADHESH . . . . 02 BAGMATI . . . . 03 GANDAKI . . . . 04 LUMBINI . . . . 05 KARNALI . . . . 06 SUDURPASCHIM . . . . 07 OUTSIDE OF NEPAL 96	⟶104
103	What country were you born in?	COUNTRY _____ ☐☐	
104	How long have you been living continuously in (NAME OF CURRENT CITY, TOWN OR VILLAGE OF RESIDENCE)? IF LESS THAN ONE YEAR, RECORD '00' YEARS.	YEARS . . . . ☐☐ ALWAYS . . . . 95 VISITOR 96	⟶110
105	CHECK 104: 00 - 04 YEARS ☐ 05 YEARS ☐ OR MORE		⟶107
106	In what month and year did you move here?	MONTH . . . . ☐☐ DON'T KNOW MONTH . . . . 98 YEAR . . . . ☐☐☐☐ DON'T KNOW YEAR 9998	
107	Just before you moved here, which province did you live in?	PROVINCE NO 1 . . . . 01 MADHESH . . . . 02 BAGMATI . . . . 03 GANDAKI . . . . 04 LUMBINI . . . . 05 KARNALI . . . . 06 SUDURPASCHIM . . . . 07 OUTSIDE OF NEPAL 96	

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
108	Just before you moved here, did you live in a city (metropolitan or sub-metropolitan or municipality), or in a rural area?	CITY (METROPOLITAN OR SUB- METROPOLITAN OR MUNICIPALITY) . . . . . 1 RURAL AREA 2	

109	Why did you move to this place?	EMPLOYMENT 01
		EDUCATION/TRAINING 02
		MARRIAGE FORMATION 03
		FAMILY REUNIFICATION/OTHER
		   FAMILY-RELATED REASON 04
		FORCED DISPLACEMENT 05
		NATURAL DISASTER 06
		OTHER _____ 96
		               (SPECIFY)	

110	In what month and year were you born?	MONTH . . . . ☐☐ DON'T KNOW MONTH . . . . 98 YEAR . . . . ☐☐☐☐ DON'T KNOW YEAR 9998	
111	How old were you at your last birthday? COMPARE AND CORRECT 110 AND/OR 111 IF INCONSISTENT.	AGE IN COMPLETED YEARS . . . . ☐☐	
112	In general, would you say your health is very good, good, moderate, bad, or very bad?	VERY GOOD . . . . 1 GOOD . . . . 2 MODERATE . . . . 3 BAD . . . . 4 VERY BAD 5	
113	Have you ever attended school?	YES . . . . 1 NO 2	→115
113A	Has (NAME) ever participated in a literacy program or any other program that involves learning to read and write (not including primary school)?	YES . . . . 1 NO 2	→117
115	What is the highest grade you have completed? IF COMPLETED LESS THAN ONE YEAR AT THAT LEVEL, RECORD '00'.	GRADE . . . . ☐☐	

116	CHECK 115:
	
	         GRADE 12 OR ☐ ABOVE GRADE 12 ☐
	            LOWER ↓
			→119

117	Now I would like you to read this sentence to me.
	
	SHOW CARD TO RESPONDENT.
	
	IF RESPONDENT CANNOT READ WHOLE SENTENCE,
	PROBE: Can you read any part of the sentence to me?
		CANNOT READ AT ALL 1
		ABLE TO READ ONLY PART OF
		   THE SENTENCE 2
		ABLE TO READ WHOLE SENTENCE 3
		NO CARD WITH REQUIRED
		   LANGUAGE _____ 4
		            (SPECIFY LANGUAGE)
		BLIND/VISUALLY IMPAIRED 5	

118	CHECK 117:
	
	      CODE '2', '3' ☐ CODE '1' OR '5' ☐
	       OR '4' CIRCLED
	      CIRCLED ↓
			→120

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
119	Do you read a newspaper or magazine at least once a week, less than once a week or not at all?	AT LEAST ONCE A WEEK . . . . 1 LESS THAN ONCE A WEEK . . . . 2 NOT AT ALL 3	
120	Do you listen to the radio at least once a week, less than once a week or not at all?	AT LEAST ONCE A WEEK . . . . 1 LESS THAN ONCE A WEEK . . . . 2 NOT AT ALL 3	
121	Do you watch television at least once a week, less than once a week or not at all?	AT LEAST ONCE A WEEK . . . . 1 LESS THAN ONCE A WEEK . . . . 2 NOT AT ALL 3	
122	Do you own a mobile phone?	YES . . . . 1 NO 2	➤ 124
123	Is your mobile phone a smart phone?	YES . . . . 1 NO 2	
124	In the last 12 months, have you used a mobile phone to make financial transactions such as sending or receiving money, paying bills, purchasing goods or services, or receiving wages?	YES . . . . 1 NO 2	
125	Do you have an account in a bank or other financial institution that you yourself use?	YES . . . . 1 NO 2	➤ 127
126	Did you yourself put money in or take money out of this account in the last 12 months?	YES . . . . 1 NO 2	
127	Have you ever used the Internet from any location on any device?	YES . . . . 1 NO 2	➤ 130
128	In the last 12 months, have you used the Internet? IF NECESSARY, PROBE FOR USE FROM ANY LOCATION, WITH ANY DEVICE.	YES . . . . 1 NO 2	➤ 130
129	During the last one month, how often did you use the Internet: almost every day, at least once a week, less than once a week, or not at all?	ALMOST EVERY DAY . . . . 1 AT LEAST ONCE A WEEK . . . . 2 LESS THAN ONCE A WEEK . . . . 3 NOT AT ALL 4	
130	What is your religion?	HINDU . . . . 01 BUDDHIST . . . . 02 MUSLIM . . . . 03 KIRAT . . . . 04 CHRISTIAN . . . . 05 OTHER _____ 96 (SPECIFY)	
131	What is your caste/ethnic group?	HILL BRAHMIN . . . . 01 HILL CHHETRI . . . . 02 TERAI BRAHMIN/CHETTRI . . . . 03 OTHER TERAI CASTE . . . . 04 HILL DALIT . . . . 05 TERAI DALIT . . . . 06 NEWAR . . . . 07 HILL JANAJATI . . . . 08 TERAI JANAJATI . . . . 09 MUSLIM . . . . 10 OTHER _____ 96 (SPECIFY)	

			SKIP
201	CHECK CAPI OUTPUT FOR "LIST ELIGIBLE INDIVIDUALS/BIOMARKERS". RECORD THE LINE NUMBER, NAME, AGE, AND MARITAL STATUS FOR ALL ELIGIBLE WOMEN IN 202, 203, AND 204 ON THIS PAGE AND SUBSEQUENT PAGES STARTING WITH THE FIRST ONE LISTED. IF MORE THAN TWO WOMEN, USE ADDITIONAL QUESTIONNAIRE(S).		

	WOMAN 1		SKIP
202	CHECK CAPI OUTPUT AND RECORD NAME AND LINE NUMBER OF WOMAN.	NAME _____ LINE NUMBER . . . . ☐☐	
203	CHECK CAPI OUTPUT FOR AGE:	15-17 YEARS . . . . 1 18-49 YEARS . . . . 2 50 YEARS AND ABOVE 3	→204A
204	CHECK CAPI OUTPUT FOR MARITAL STATUS:	CODE 4 (NEVER IN UNION) . . . . . 1 OTHER 2	→205
204A	CHECK CAPI OUTPUT: HOUSEHOLD SELECTED ☐ HOUSEHOLD NOT SELECTED ☐ FOR BLOOD PRESSURE ↓ FOR BLOOD PRESSURE		→ **228**
205	WEIGHT IN KILOGRAMS.	KG. . . . . ☐☐☐.☐☐ NOT PRESENT . . . . 99994 REFUSED . . . . 99995 OTHER 99996	→207
206	WAS THE WOMAN WEARING ONLY LIGHTWEIGHT CLOTHING?	YES . . . . 1 NO 2	
207	HEIGHT IN CENTIMETERS.	CM. . . . . ☐☐☐.☐ NOT PRESENT . . . . 9994 REFUSED . . . . 9995 OTHER 9996	→209
208	WAS THE RECORDED MEASUREMENT INTERFERED WITH BY BRAIDED OR ORNAMENTED HAIR?	YES . . . . 1 NO 2	
209	ENTER BIOMARKER SPECIALIST NUMBER (MEASURER).	☐☐☐☐ BIOMARKER SPECIALIST NUMBER	
210	ENTER INTERVIEWER NUMBER OF ASSISTANT MEASURER. IF NO ASSISTANT MEASURER, ENTER 9999.	☐☐☐☐ INTERVIEWER NUMBER	
211	TODAY'S DATE:	DAY . . . . ☐☐ MONTH . . . . ☐☐ YEAR . . . . ☐☐☐☐	
211A	CHECK CAPI OUTPUT: HOUSEHOLD SELECTED ☐ HOUSEHOLD NOT SELECTED ☐ FOR BLOOD PRESSURE ↓ FOR BLOOD PRESSURE		→ **BP254**
212	CHECK 203: AGE 15-17 ☐ AGE 18-49 ☐ YEARS YEARS		→BP214
	AGE 50 YEARS ☐ AND ABOVE		→BP214
213	CHECK 204: OTHER ☐ CODE 4 ☐ (NEVER IN UNION)		→BP217

| 201 | CHECK CAPI OUTPUT FOR "LIST ELIGIBLE INDIVIDUALS/BIOMARKERS". RECORD THE LINE NUMBER, NAME, AGE, AND MARITAL STATUS FOR ALL ELIGIBLE WOMEN IN 202, 203, AND 204 ON THIS PAGE AND SUBSEQUENT PAGES STARTING WITH THE FIRST ONE LISTED. IF MORE THAN TWO WOMEN, USE ADDITIONAL QUESTIONNAIRE(S). |

	WOMAN 2		SKIP
202	CHECK CAPI OUTPUT AND RECORD NAME AND LINE NUMBER OF WOMAN.	NAME _____ LINE NUMBER .... ☐☐	
203	CHECK CAPI OUTPUT FOR AGE:	15-17 YEARS .... 1 18-49 YEARS .... 2 50 YEARS AND ABOVE 3	→ 204A
204	CHECK CAPI OUTPUT FOR MARITAL STATUS:	CODE 4 (NEVER IN UNION) ..... 1 OTHER 2	→ 205
204A	**CHECK CAPI OUTPUT:** HOUSEHOLD SELECTED ☐ HOUSEHOLD NOT SELECTED ☐ FOR BLOOD PRESSURE ↓ FOR BLOOD PRESSURE		→ **228**
205	WEIGHT IN KILOGRAMS.	KG. .... ☐☐☐.☐☐ NOT PRESENT .... 99994 REFUSED .... 99995 OTHER 99996	→ 207
206	WAS THE WOMAN WEARING ONLY LIGHTWEIGHT CLOTHING?	YES .... 1 NO 2	
207	HEIGHT IN CENTIMETERS.	CM. .... ☐☐☐.☐ NOT PRESENT .... 9994 REFUSED .... 9995 OTHER 9996	→ 209
208	WAS THE RECORDED MEASUREMENT INTERFERED WITH BY BRAIDED OR ORNAMENTED HAIR?	YES .... 1 NO 2	
209	ENTER BIOMARKER SPECIALIST NUMBER (MEASURER).	☐☐☐☐ BIOMARKER SPECIALIST NUMBER	
210	ENTER INTERVIEWER NUMBER OF ASSISTANT MEASURER. IF NO ASSISTANT MEASURER, ENTER 9999.	☐☐☐☐ INTERVIEWER NUMBER	
211	TODAY'S DATE:	DAY .... ☐☐ MONTH .... ☐☐ YEAR .... ☐☐☐☐	
211A	**CHECK CAPI OUTPUT:** HOUSEHOLD SELECTED ☐ HOUSEHOLD NOT SELECTED ☐ FOR BLOOD PRESSURE FOR BLOOD PRESSURE		→ BP254
212	CHECK 203: AGE 15-17 ☐ AGE 18-49 ☐ YEARS YEARS AGE 50 YEARS ☐ AND ABOVE		→ BP214 → BP214
213	CHECK 204: OTHER ☐ CODE 4 ☐ (NEVER IN UNION)		→ BP217

| 300 | CHECK CAPI OUTPUT: | HOUSEHOLD SELECTED FOR BLOOD PRESSURE ☐ | HOUSEHOLD NOT SELECTED FOR BLOOD PRESSURE ☐ | → END |

| 301 | CHECK CAPI OUTPUT FOR "LIST ELIGIBLE INDIVIDUALS/BIOMARKERS". RECORD THE LINE NUMBER, NAME, AGE, AND MARITAL STATUS FOR ALL ELIGIBLE MEN IN 302, 303, AND 304 ON THIS PAGE AND SUBSEQUENT PAGES STARTING WITH THE FIRST ONE LISTED. IF MORE THAN TWO MEN USE ADDITIONAL QUESTIONNAIRE(S). |

	MAN 1		SKIP
302	CHECK CAPI OUTPUT AND RECORD NAME AND LINE NUMBER OF MAN.	NAME _____ LINE NUMBER .... ☐☐	
303	CHECK CAPI OUTPUT FOR AGE:	15-17 YEARS .... 1 18 YEARS AND ABOVE 2	
304	CHECK CAPI OUTPUT FOR MARITAL STATUS:	CODE 4 (NEVER IN UNION) ...... 1 OTHER 2	
305	WEIGHT IN KILOGRAMS.	KG. .... ☐☐☐.☐☐ NOT PRESENT .... 99994 REFUSED .... 99995 OTHER 99996	→ 307
306	WAS THE MAN WEARING ONLY LIGHTWEIGHT CLOTHING?	YES .... 1 NO 2	
307	HEIGHT IN CENTIMETERS.	CM. .... ☐☐☐.☐ NOT PRESENT .... 9994 REFUSED .... 9995 OTHER 9996	→ 309
308	WAS THE RECORDED MEASUREMENT INTERFERED WITH BY BRAIDED OR ORNAMENTED HAIR?	YES .... 1 NO 2	
309	ENTER BIOMARKER SPECIALIST NUMBER (MEASURER).	☐☐☐☐ BIOMARKER SPECIALIST NUMBER	
310	ENTER INTERVIEWER NUMBER OF ASSISTANT MEASURER. IF NO ASSISTANT MEASURER, ENTER 9999.	☐☐☐☐ INTERVIEWER NUMBER	
311	TODAY'S DATE:	DAY .... MONTH .... YEAR	
312	CHECK 303:	AGE 15-17 YEARS ☐	AGE 18 YEARS AND ABOVE ☐ → BP314
313	CHECK 304:	OTHER ☐	CODE 4 (NEVER IN UNION) ☐ → BP317

300	CHECK CAPI OUTPUT:	HOUSEHOLD SELECTED ☐ FOR BLOOD PRESSURE	HOUSEHOLD NOT SELECTED ☐ FOR BLOOD PRESSURE	→ END

301	CHECK CAPI OUTPUT FOR "LIST ELIGIBLE INDIVIDUALS/BIOMARKERS". RECORD THE LINE NUMBER, NAME, AGE, AND MARITAL STATUS FOR ALL ELIGIBLE MEN IN 302, 303, AND 304 ON THIS PAGE AND SUBSEQUENT PAGES STARTING WITH THE FIRST ONE LISTED. IF MORE THAN TWO MEN USE ADDITIONAL QUESTIONNAIRE(S).		

	MAN 2		SKIP
302	CHECK CAPI OUTPUT AND RECORD NAME AND LINE NUMBER OF MAN.	NAME _____ LINE NUMBER .... ☐☐	
303	CHECK CAPI OUTPUT FOR AGE:	15-17 YEARS .... 1 18 YEARS AND ABOVE 2	
304	CHECK CAPI OUTPUT FOR MARITAL STATUS:	CODE 4 (NEVER IN UNION) ..... 1 OTHER 2	
305	WEIGHT IN KILOGRAMS.	KG. .... ☐☐☐.☐☐ NOT PRESENT .... 99994 REFUSED .... 99995 OTHER 99996	→ 307
306	WAS THE MAN WEARING ONLY LIGHTWEIGHT CLOTHING?	YES .... 1 NO 2	
307	HEIGHT IN CENTIMETERS.	CM. .... ☐☐☐.☐ NOT PRESENT .... 9994 REFUSED .... 9995 OTHER 9996	→ 309
308	WAS THE RECORDED MEASUREMENT INTERFERED WITH BY BRAIDED OR ORNAMENTED HAIR?	YES .... 1 NO 2	
309	ENTER BIOMARKER SPECIALIST NUMBER (MEASURER).	☐☐☐☐ BIOMARKER SPECIALIST NUMBER	
310	ENTER INTERVIEWER NUMBER OF ASSISTANT MEASURER. IF NO ASSISTANT MEASURER, ENTER 9999.	☐☐☐☐ INTERVIEWER NUMBER	
311	TODAY'S DATE:	DAY .... ☐☐ MONTH .... ☐☐ YEAR .... ☐☐☐☐	
312	CHECK 303:	AGE 15-17 ☐ YEARS	AGE 18 YEARS ☐ AND ABOVE	→ BP314
313	CHECK 304:	OTHER ☐	CODE 4 ☐ (NEVER IN UNION)	→ BP317

Appendix-3: Strobe checklist for observational cross-sectional studies

STROBE Statement-Checklist of Items that should be addressed in Report of Observational Studies	Item Number	Recommendation
TITLE and ABSTRACT	1	(a) Indicate the study's design with a commonly used term in the title or the abstract
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found
INTRODUCTION		
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
METHODS		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection

Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed Case-control study—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study Size	10	Explain how the study size was arrived at

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding
		(b) Describe any methods used to examine subgroups and interactions
		(c) Explain how missing data were addressed
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed Case-control study—If applicable, explain how matching of cases and controls was addressed Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy
		(e) Describe any sensitivity analyses
RESULTS		
Participant	13*	(a) Report the numbers of individuals at each stage of the study—e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram

Descriptive data	14*	(a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate the number of participants with missing data for each variable of interest
		(c) Cohort study—Summarise follow-up time (e.g., average and total amount)
Outcome data	15*	• Cohort study—Report numbers of outcome events or summary measures over time. • Case-control study—Report numbers in each exposure category, or summary measures of exposure • Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(b) Report category boundaries when continuous variables were categorized

		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses
DISCUSSION		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.
Interpretations	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
OTHER INFORMATION		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

Give such information separately for cases and controls in case-control studies, and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.