Cardiometabolic Risk Factors Among Rural and Non-Rural Adults in Nepal

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Abstract

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Disparities in cardiometabolic diseases, including heart disease, stroke, diabetes, and kidney disease, have been documented globally across socioeconomic status. While decreasing in high-income nations, cardiovascular disease (CVD) mortality and noncommunicable disease (NCD) prevalence have increased in low- and middle-income countries (LMICs). The burden of cardiometabolic disorders remains a major concern in Nepal where their distribution in rural and urban areas are poorly understood. We combined data from the Dhulikhel Heart Study (DHS), an observational cohort study representing an urban setting, and the Personalized Health Program (PHP), which collected similar data in four rural regions, to compare the prevalence of selected risk factors for cardiometabolic disease by rural/urban setting in Nepalese adults. We assessed the associations between two outcomes, overweight/obesity and hypertension, with rural/urban residency and selected demographic and lifestyle characteristics of the sample. The data from DHS (N=1061) and PHP (N=3288) were harmonized to provide variables with the same values. Overweight/obesity was defined as BMI $\geq$ 25 and hypertension was defined as systolic blood pressure $\geq$ 140 or diastolic blood pressure $\geq$ 90. Covariates included age, gender, ethnicity, education, marital status, smoking, alcohol use, and physical activity. Multivariable logistic regression was used to evaluate the odds of increased overweight/obesity and hypertension by rural/urban setting adjusted for potential confounders. In adjusted models, living in an urban setting increased the odds of being overweight/obese two-fold (OR:2.14, 95% CI: 1.57-2.93, $p<0.001$). Increased age, female gender, higher education, being married, Newar ethnicity, and current consumption of alcohol were significant association with being overweight/obese. The odds of having hypertension were also doubled for urban residents (OR:2.12, 95% CI:1.55-2.90, $p< 0.001$) adjusted for demographic and lifestyle. Gender, age, education, marital status, ethnicity, and physical activity were also significantly associated with hypertension. These results provide

insights into the distribution and impact of behavioral and lifestyle-related risk factors on cardiometabolic conditions in different settings in Nepal. The findings may be used to inform targeted interventions and tailored healthcare approaches to address the specific challenges faced by each population.

Background and Significance

The rising worldwide burden of cardiometabolic disease is becoming a major public health concern. Cardiovascular diseases (CVDs) alone were expected to be responsible for 17.9 million deaths worldwide in 2019.[1] Existing data from 2014 shows that diabetes affects 8.5 percent of the population aged 18 and older globally and, is responsible for 1.5 million deaths every year.[2] Between 1990 and 2010 CVD alone was responsible for 59 percent of premature deaths in terms of years of life lost in India. Despite its heterogeneity in frequency of occurrence across different regions, CVD has emerged as a top cause of mortality in India as a whole.[3] In Nepal, according to data from 2019, 12.4% of deaths were due to ischemic heart disease (IHD), 7.8% due to stroke, 1.8% due to diabetes, 1.3% due to hypertensive heart disease, and 2.6% due to chronic kidney diseases making cardiometabolic disease the leading cause of death.[4] The Global Burden of Disease (GBD) data shows that the total number of deaths from CVDs has almost doubled from 1990 to 2017 in Nepal. Cardiovascular diseases contributed to 27% of total deaths and 13% of total DALYs in 2017.[5]

A hospital-based study in Nepal found a 31 % prevalence of NCDs among admitted patients, as well as a 40% prevalence of cardiovascular (CVD) diseases, followed by diabetes mellitus at 12%. The most common cardiovascular disease was hypertension (47%), cerebrovascular accident (16%), congestive cardiac failure (11%), ischemic heart disease (7%), rheumatic heart disease (5%), and myocardial infarction (2%). Further, the study reported that the majority of the population experiencing CVD and associated diseases were young adults which compromises 65.4 % of the population in Nepal.[2,6] Nepal currently is experiencing a double burden of communicable and non-communicable diseases, with NCDs accounting for approximately half of the burden primarily due to cardiovascular, diabetes, CKD and chronic respiratory diseases.[5]
Various studies suggest that we have started to see a reduction in CVD-related death in high and middle-income countries over the past 5 decades and an emerging increment in low-income countries.[7,8] These studies suggest high low-density lipoprotein cholesterol, smoking, air pollution, a diet poor in whole grains, and a diet low in fruits and vegetables are the leading risk factors associated with most metabolic diseases.[9] Two recent studies on cardiometabolic risk factors in Nepal reported that the prevalence of cardiometabolic and behavioral risks varied by different socio-demographic statuses among the urban population; for example, alcohol consumption is more prevalent among men, while obesity is more common among the Dalit, Janajati, and Madhesi ethnic groups. Additionally, those with no formal education are more likely to smoke.[10,11]

Very few studies have compared rural vs non-rural differences in cardiometabolic risk factors. One comparative study in the United States by Banerjee et al. 2015 suggests there is a significant relationship between rural residence and cardiometabolic syndrome.[12] In Nepal, where governmental and private health resources are limited, it is important to better understand the distribution of cardiometabolic diseases and their risk factors across the country. This will be most beneficial for targeting specific regions for the implementation of cardiometabolic disease prevention programs. Such programs can be both feasible and effective, resulting in increased detection of patients with cardiometabolic disease risk factors and subsequent treatment for required cases. The goal of this study is to better understand the distribution of cardiometabolic risk factors in Nepal, both rural and urban. Determining the relationships between lifestyle-related cardiometabolic risk variables and their impact on blood pressure and BMI in rural and non-rural adults is an important step to inform policy for development and design of effective prevention programs.

Specific Aims

The specific aims of this study are (1) To determine the prevalence of behavioral and selected lifestyle-related cardiometabolic risk factors (smoking, alcohol consumption and, physical inactivity) among adults (18 years and older) in a rural and non-rural population in Nepal; (2) To compare the blood pressure measurements between rural and non-rural adults; and (3) To assess the associations between behavioral and lifestyle-related cardiometabolic risk factors and hypertension and BMI (overweight or obesity) among rural and non-rural adults.

Methods

Study Population

The study participants were adults who were living in the Dhulikhel Municipality of Kavre, Nepal for the non-rural population, and individuals who were residing in the designated areas of the Dhulikhel Hospital outreach centers: Thansing, Bolde, Manekharka, and Dorpu, for the rural population.

Study Design

This was a cross-sectional study of data merged from the Dhulikhel Heart Study (DHS) and Personalized Health Program (PHP). For the non-rural population (DHS), this study utilized data from the DHS second wave which took place between 2022 and 2023. DHS was first created in 2013 to study the prevalence and risk factors for cardiovascular disease in adults living in Dhulikhel, Nepal. The initial survey (wave 1) took place between 2013 and 2015. The study included residents of Dhulikhel who were 18 years or older and had lived there for at least six months.[13] The data from DHS includes current and past medical conditions, anthropometry assessment, women's and reproductive health, Immunization, mental health, physical exercise, vital signs, health expenditure, socioeconomic and environmental determinants of health. For the rural population, we used the data from PHP, which was collected in 2022-23. PHP is an extension of healthcare services that includes much of the same data as DHS, i.e. current and past medical conditions, anthropometry assessment, women's and reproductive health, Immunization, mental health, physical exercise, vital signs, health expenditure, socioeconomic and environmental determinants of health, and promotes continuity of care with the goal of changing the passive nature of health service delivery. To acquire a complete picture of a regional population’s health, PHP conducted household surveys in four areas near Dhulikhel Hospital outreach centers (ORCs): Thansing, Bolde, Manekharka, and Dorpu. For this research study, data from both DHS and PHP, including body mass index, blood pressure, social demographic variables of age, gender, education level and occupation, and lifestyle variables of smoking habits, alcohol consumption and physical activity, were utilized.

Inclusion Criteria

Participants in DHS aged 18 years and older residing in Dhulikhel Municipality were the study participants for the non-rural population. For the rural population, individuals aged 18 and older living in 4 selected rural outreach centers of Thansing, Bolde, Manekharka, and Dorpu, operated by Dhulikhel Hospital, who have lived there for 10 years or longer were included.

Sample Size

Both projects used census sampling to identify participants. DHS second wave had enrolled 1061 participants aged 18 and above at the time data was received March 2023. PHP had 3288 enrolled participants 18 years and above from 4 sites collected from November 2022 through May 2023. The total sample size for these analyses was 4349.

Procedures

Both data sources will be reviewed for quality and relevance through meetings with program team members. Data will be collected and structured after the data sources have been evaluated. The organized data will be examined statistically to address study aims and provide findings. The results will then be disseminated appropriately.

Data Collection Tools

Both data sets used a household survey as a data collection method using questions adapted from Dhulikhel Hospital's prior cohort DHS wave 1. In both studies, research assistants collected data in-person interviewing participants in their own homes. Program coordinators oversaw training, tool design, and data quality assurance. Data were acquired using the digital data collecting tool ComCare application for PHP and RedCap applications was used for Dhulikhel Heart Study. Data were sent to Dhulikhel Hospital for cleaning and conversion into user-friendly data files. Both studies received IRB approval to conduct the surveys from the Nepal Health Research Council which oversees research in Nepal.

Statistical Analysis

The data were analyzed with R (4.1.2). statistical software. This study examined the estimation of the proportion of behavioral and lifestyle risk factors separately in rural and urban populations. Demographic and risk factor data were described with continuous variables presented as means and standard deviations and categorical variables presented as counts and percentages. Multivariable logistic regression was used to evaluate the associations between urban vs rural residency and study outcomes. Outcome variables were defined as (1) obesity/overweight: BMI $\geq$ 25.[14] and (2) hypertension: systolic BP ≥ 140 or diastolic BP ≥ 90 based on European Society of Hypertension and European Society of Cardiology guidelines.[15] The adjusted odds ratios were calculated to examine associations between the main exposure (urban vs rural) and the outcomes of obesity/overweight and hypertension. We also examined lifestyle-related co-variates such as smoking, alcohol consumption, and physical activity as well as sociodemographic variables as potential confounders. The results of this analysis are presented as odds ratios (OR) with 95% confidence intervals (CI) using a hierarchical model for adjustment. The first model presents the results from the bivariate analysis (unadjusted), a second model presents results adjusting for social demographic variables (age, gender, education, ethnicity, and marital status), and the final model presents adjustment for lifestyle factors (smoking, alcohol consumption and physical activity).

Results

The majority of the study participants were female, accounting for 55.4% of the total sample. The percentage of females was slightly higher in urban area with 54.2% of participants in the rural area and 58.9% residing in the urban area. Data on gender was available on all participants in the rural area with only 0.1% of respondents missing this at the urban site. The age distribution of participants was diverse, with most (20.2%) falling within the 25-34 age range. The mean age of participants was 45.7 years, with a standard deviation of 18.4 years. The median age was 44 years, ranging from 18 to 99 years. The age distribution was relatively similar between rural and urban participants. The largest ethnic group among the participants was Magar/Tamang/Rai/Limbu, accounting for 39.1% of the total sample. In the rural area, this ethnic group constituted 44.1% of participants, while in the urban area, they accounted for 23.6%. The Newar ethnic group had the highest representation in the urban area, with 34.7% of participants. Only 0.25% of participants in the urban setting had missing data regarding ethnic groups.

Most of the participants were married, comprising 79.0% of the total sample. In both rural and urban areas, the married participants constituted a similar proportion (about 78-79%) of the respective populations. About 10% of participants in both settings were single. While a small number of constituted participants who were separated or widowed. Only a few cases of missing data were found (0.16 %) in the urban area. The education level varied among the participants, with the highest proportion (32.9%) having no formal education. In the rural area, 33.9% of participants had no education, while in the urban area, it was 32.6%. Completing secondary education (6-10 years) was relatively higher among urban participants (30.9%) compared to rural participants (16.67%). University-level education or higher educated participants were more common in the urban area (9.4%) compared to the rural area (3.0%). A significant number of participants had informal education, a total of 19.6% of the total sample.

Table 1. Baseline characteristics of study participants by rural/urban residence

Characteristics	Rural (N= 3288)		Urban (N=1061)		Total (N=4349)	
	(n)	(%)	(n)	(%)	(n)	(%)
Gender						
Male	1,505	45.77	429	40.43	1934	44.47
Female	1,783	54.23	625	58.90	2408	55.37
Missing			7	0.67	6	0.14
Age (years)						
18-24	392	11.92	106	9.99	498	11.45
25-34	682	20.74	198	18.66	880	20.23
35-44	585	17.79	200	18.85	785	18.05
45-54	573	17.43	206	19.42	779	17.91
55-64	510	15.51	157	14.8	667	15.34
≥65	546	16.61	169	15.93	715	16.44
Missing			25	2.36	25	0.57
Mean (SD)	45.53 (18.64)		46.09 (18.77)		45.66 (18.44)	
Median (Min: Max)	44 (18:99)		45 (18:96)		44 (18:99)	
Ethnic Group						
Brahmin	384	11.07	205	19.30	590	13.57
Chhetri/Thakuri/Sanyasi	334	10.02	156	14.70	490	11.27
Newar	536	16.03	368	34.70	904	20.79
Magar/Tamang/Rai/Limbu	1,468	44.07	250	23.60	1,718	39.05
Sherpa/Bhote	267	8.01	7	0.70	274	6.03
Dalit(kami/Sarki/damai/gaine/badi)	299	9.01	63	5.90	362	8.32
Missing			12	1.10	11	0.25
Marital Status						

Characteristics	Rural (N= 3288)		Urban (N=1061)		Total (N=4349)	
	(n)	(%)	(n)	(%)	(n)	(%)
Single	332	10.01	113	10.65	445	10.23
Married	2,600	79.08	834	78.61	3,434	78.96
Separated	37	1.13	13	1.23	50	1.15
Widow	319	9.07	95	8.95	413	9.5
Missing			7	0.57	7	0.16
Education						
None	1,072	32.60	360	33.93	1,432	32.93
Primary Schooling (0-5)	402	12.23	123	11.59	525	12.07
Secondary education (6-10)	548	16.67	328	30.91	876	20.14
Higher Secondary Education (11-12)	319	9.07	138	13.00	457	10.51
University Level or Higher	106	3.00	100	9.43	206	4.74
Informal Education	841	26.00	12	1.13	853	19.61

Table 2 provides information on the behavioural and lifestyle characteristics of the study participants. Among all the participants, 14.9% reported being current smokers. In the rural area, 13.9% of participants were current smokers, while in the urban area, it was higher at 18.0%. In the rural area, about a third of smokers (30.0%) began smoking before the age of 18, while in the urban area, this more than doubled (67.3%) indicating earlier access to tobacco in the city. The mean age of smoking across all participants was 21.4 years, with a standard deviation of 10.10 years. The median age to start smoking was 19 years, ranging from 4 to 66 years. About 23.6% of participants reported being current alcohol consumers and the prevalence of alcohol use was higher in the rural area (24.5%) compared to the urban area (20.6%). In the rural area, more than two-thirds of alcohol users (69.1%) started consuming alcohol before the age of 18, while in the urban area, this proportion was slightly lower (50.6%). Across all participants, the mean age for beginning to drink alcohol was 16.9 years, with a standard deviation of 6.4 years. The median age for alcohol use was 15 years, ranging from 1 to 65 years. In terms of vigorous activity, 17.18%

of participants engaged in its weekly while 71.79% reported engaging in moderate activity weekly. More than half reported participating in recreational activity (54.6%) weekly. The mean duration of sedentary behaviour was 225.9 minutes (approximately 3 hours and 45 minutes) per day. The median duration of sedentary behaviour was 240 minutes (4 hours) per day, ranging from 50 to 720 minutes. Converting the reported amounts of exercise into daily metabolic equivalent time (MET), the mean MET score was 7119.7, with a standard deviation of 5320.2. The median MET activity level was 6720, ranging from 56 to 33,600. Differences in activity level by area of residence showed that those living in rural areas (7728.9 MET) were far more active than those in the urban area (5382.1 MET). Overall, about 15% of the total participants had missing data on MET activity in this study.

Table 2. Behavioral and lifestyle characteristics of participants by rural/urban residence

Characteristics	**Rural**		**Urban**		**Total**	
	(n)	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**
Smoking Behavior Current						
Yes	457	13.90	191	18.00	648	14.90
No	2426	73.78	870	82.00	3296	75.79
Missing	405	12.32			405	9.31
Smoking - Beginning Age						
<18	137	29.98	148	67.27	285	42.10
18-24	136	29.76	48	21.82	184	27.18
25-34	102	22.32	19	8.64	121	17.87
35-44	58	12.69	3	1.36	61	9.01
45-54	22	4.81	1	0.45	23	3.40
55-64	2	0.44			2	0.30
65+			1	0.45	1	0.15
Mean (SD)	23.9 (10.20)		16.1 (7.60)		21.4 (10.10)	
Median (Min: Max)	21 (4:60)		15 (5:66)		19 (4:66)	
Alcohol Use Current						
Yes	805	24.48	219	20.64	1024	23.55
No	2483	75.52	797	75.59	3280	74.55

Characteristics	Rural		Urban		Total	
	(n)	(%)	(n)	(%)	(n)	(%)
Missing			45	3.77	45	3.10
Alcohol Use - Beginning Age						
<18	574	69.07	124	50.61	698	64.78
18-24	207	24.91	73	29.80	280	26.02
25-34	45	5.42	29	11.84	74	6.88
35+	5	0.60	19	7.76	24	2.23
Mean (SD)	16.07 (4.96)		19.54 (9.37)		16.86 (6.42)	
Median (Min: Max)	15 (2:56)		17 (1:65)		15 (1:65)	
Vigorous Activity (weekly)						
Yes	469	14.26	278	26.2	747	17.18
No	2,411	73.33	772	72.76	3,183	73.19
Missing	408	12.41	11	1.04	419	9.63
Moderate Activity (weekly)						
Yes	2,382	72.45	740	69.75	3,122	71.79
No	498	15.15	308	29.03	806	18.53
missing	408	12.41	13	1.23	421	9.68
Recreational Activity (weekly)						
Yes	1,803	54.84	572	53.91	2,375	54.61
No	1,077	32.76	475	44.77	1,552	35.69
missing	408	12.41	14	1.32	422	9.7
Sedentary Behavior Daily Summary (min)						
Mean (SD)	216.83 (96.26)		251.30 (131.60)		225.88 (107.73)	
Median (Min: Max)	240 (60:600)		240 (50:720)		240 (50:720)	
MET Activity/Week						
Mean (SD)	7728.88 (5286.90)		5382.08 (5052.98)		7119.73 (5320.20)	

Characteristics	Rural		Urban		Total	
	(n)	(%)	(n)	(%)	(n)	(%)
Median (Min: Max)	6720 (56:30240)		4000 (80:33600)		6720 (56:33600)	
Missing	578	17.58	111	10.46	689	15.84

*MET = metabolic equivalents.

Table 3 contains details on the outcome variables collected in our study including BMI classified according to WHO guidelines,[14] levels of blood pressure, and hypertension. In this study, the primary outcome related to BMI was being classified as obese or overweight with a BMI greater than or equal to 25. Hypertension was defined using guidelines from the European Society of Hypertension and European Society of Cardiology guidelines as having systolic blood pressure (BP) greater than or equal to 140 mm/Hg or diastolic BP greater than or equal to 90 mm/Hg.[15]

A very small percentage of participants in both areas were underweight with 2.8% of rural residents and 3.9% of urban residents having a BMI below 18.5. A higher proportion of participants living in rural areas (61.3%) were classified in the “normal” range of having a BMI of 18.5-24.9 compared to 42.51% in the urban area. BMI was higher in urban areas with those in the overweight category (25-29.9) comprising 33.7% of participants while in the rural area it was 28.5%. Being obese (BMI $\geq$ 30) was found in only 6.1% of participants in the rural area but in 17.2% in the urban area. The percentage of missing data for the BMI variable was low at1.8%. In terms of the BMI-related outcome used in this study, 34.6% of the study participants in rural areas were overweight/obese whereas 50.9% of study participants in urban areas were overweight/obese. These figures confirm that obesity was more prevalent in urban areas.

In general, blood pressure was found to be lower in rural residents with 51.1% of participants having systolic BP below 130, compared to 64.6% in the urban area. In the rural area, 22.1% of participants had systolic BP between 130 and 139, while in the urban area, it is 13.7%. High blood pressure was consistently found in urban participants with 12.0% of rural and 15.5 of urban residents having a systolic BP between 140 and 159 and 2.7% of rural and 4.7 of urban participants having systolic BP equal to or above 160. The percentage of missing data for the systolic BP variable was 9.6%. Trends for diastolic blood pressure were similar to those found for systolic blood pressure. In the rural area, 35.8% of participants had diastolic BP below 80, compared to 38.6% in the urban area. In the rural area, 26.9% of participants had diastolic BP between 80 and 84, while in the urban area, it was 17.5%. In the rural area, 4.3% of participants had diastolic BP between 85 and 89, compared to 15.3% in the urban area. High blood pressure, diastolic BP equal to or above 90, was found in 20.9% of rural and 27.0% of urban residents. The percentage of missing data for the diastolic BP variable was also 9.6%. Of those participants who had blood pressure measured, 70.9% of participants living in the rural area did not have hypertension as per our defined criteria, compared to 67.0% in the urban area. Prevalence of hypertension was slightly higher in the urban regions with 33.0% meeting the criteria while 29.0% rural residents had hypertension.

Table 3. Study outcomes in participants by rural/urban residence

Outcome	Rural		Urban		Total	
	n	(%)	n	(%)	n	(%)
BMI						
<18.5	91	2.77	41	3.86	132	3.04
18.5-24.9	2015	61.28	451	42.51	2466	56.70
25 - 29.9	937	28.50	358	33.74	1296	29.78
>30	199	6.05	182	17.15	381	8.76
Missing	46	1.40	29	2.73	75	1.76
Mean (SD)	24.19 (3.59)		25.77 (4.89)		24.58 (4.00)	
Median (Min: Max)	23.74 (14.50:48)		25.23 (15.62:55.52)		23.93 (14.50:55.52)	
Systolic BP						
<130	1679	51.06	685	64.56	2364	54.36
130 - 139	727	22.11	145	13.67	872	20.05
140-159	393	11.95	164	15.46	557	12.81
>=160	90	2.74	50	4.71	140	3.22
Missing	399	12.14	17	1.60	416	9.57
Mean (SD)	123.52 (15.70)		124.93 (18.69)		123.89 (16.56)	
Median (Min: Max)	120 (80:210)		122 (74:204)		120 (74:210)	
Diastolic BP						
<80	1177	35.80	410	38.64	1587	36.49
80-84	883	26.86	186	17.53	1069	24.58

Outcome	Rural		Urban		Total	
	n	(%)	n	(%)	n	(%)
85-89	142	4.32	162	15.27	304	6.99
>=90	686	20.86	286	26.96	972	22.35
Missing	400	12.17	17	1.60	417	9.59
Mean (SD)	79.11 (11.40)		83.14 (82:46)		80.18 (11.52)	
Median (Min: Max)	80 (50:140)		82 (46:132)		80 (46:140)	
Hypertension*						
No	2048	62.29	700	65.98	2748	63.19
Yes	840	25.55	344	32.42	1184	27.22
Missing	400	12.17	17	1.60	417	9.59

*Hypertension = systolic blood pressure $\geq$140 or diastolic blood pressure $\geq$ 90

Table 4 provides the associations between being overweight/obese by rural/urban setting unadjusted and adjusted for demographic and lifestyle covariates. In the unadjusted model, those living in urban areas had two-fold higher odds of being overweight/obese compared to those living in rural areas (OR: 2.03, 95% CI:1.76–2.34) with a p-value of < 0.001 indicating a significant association between urban residency and being overweight/obese. Moreover, the association remained significant after adjustment for covariates. After adjusting for the demographics, we found that living in the urban setting had a 1.74 (95% CI:1.48–2.05) times higher odds of being overweight/obese (p-value < 0.001). After adjusting demographic and lifestyle covariates the association remained significant, with urban residents having 2.14 (95% CI:1.57–2.93) times higher odds of being overweight/obese than rural residents (p-value < 0.001).

Results from these analyses showed that all demographic variables were significantly associated with being obese/overweight in the fully adjusted model. After controlling for other demographic and lifestyle factors, we found that females had 1.38 times the odds of being overweight/obese, with a p-value of 0.004. There was a higher odd of being overweight/obese with age when compared to the reference group of 18–24-year-old participants. After controlling for demographic and lifestyle factors, there was an increased odds of being overweight/obese across all age categories compared to the reference group. An association between ethnicity and being overweight/obese was also found with ethnicity other than Bramin having a reduced odds of overweight/obesity (compared to Brahmin as the reference group). After adjusting for demographics and lifestyle, we found that higher education was associated with a greater odd of being overweight/obese compared to the reference group no education with a p-value of 0.002. There was also a significant association between marital status and being overweight/obese in which married persons had a higher odd of being overweight/obese than single individuals after adjusting for demographic and lifestyle covariates.

The association between current smoking and being overweight/obese was not statistically significant. We did find, however, a significant association between current alcohol use and being overweight/obese after adjusting for the lifestyle and demographic covariates with alcohol users having a reduced odds of overweight/obesity (OR: 0.80, 95% CI: 0.66 – 0.98, p-value: 0.035). The association between MET levels and being overweight/obese was not statistically significant. In summary, the data suggests that living in urban areas, being female, older age, higher education levels, and being married are associated with higher odds of being overweight/obese. Current alcohol use was associated with a lower odd of being overweight/obese. However, smoking and MET levels do not show significant associations with being overweight/obese in the analyses.

Table 4. Associations between being overweight/obese and rural/urban residence unadjusted and adjusted for demographic and lifestyle characteristics.

	Unadjusted Model		Adjusted for Demographics		Adjusted for Demographics and Lifestyle	
Variable in Model	Odds Ratio (95% CI) *	p-value	Odds Ratio (95% CI) *	p-value	Odds Ratio (95% CI) *	p-value
Residence		<0.0.001		<0.001		<0.001
Rural	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Urban	2.03 (1.76 – 2.34)		1.74 (1.48 – 2.05)		2.14 (1.57 – 2.93)	
Gender				<0.001		0.004
Male						
Female			1.44 (1.26 -1.66)		1.38 (1.15 – 1.65)	
Age (years)				<0.001		<0.001
18-24			1.00 (reference)		1.00 (reference)	
25-34			2.72 (2.04 – 3.63)		2.56 (1.84 – 3.56)	
35-44			4.19 (3.07 – 5.71)		3.66 (2.55 – 5.24)	
45-54			4.03 (2.90 – 5.61)		3.45 (2.35 – 5.06)	
55-64			3.27 (2.31 – 4.63)		2.59 (1.73 – 3.89)	
65+			2.80 (1.94 – 4.05)		2.48 (1.48 – 4.17)	
Ethnicity				0.003		0.021
Bramhin			1,00 (reference)		1.00 (reference)	
Chhetri/Thakuri/Sanyasi			0.93 (0.72 – 1.21)		0.82 (0.59 – 1.15)	
Newar			1.14 (0.91 – 1.43)		0.79 (0.58 – 1.06)	
Magar/Tamang/Rai/Limbu			0.80 (0.65 – 0.98)		0.64 (0.48 – 0.84)	
Sherpa/Bhote			0.89 (0.65 – 1.21)		0.66 (0.46 – 0.95)	
Dalit(kami/Sarki/damai/gaine/badi)			1.05 (0.79 – 1.40)		0.82 (0.58 – 1.16)	
Education				<0.001		0.002

	Unadjusted Model		**Adjusted for Demographics**		**Adjusted for Demographics and Lifestyle**	
Variable in Model	**Odds Ratio (95% CI) ***	**p-value**	**Odds Ratio (95% CI) ***	**p-value**	**Odds Ratio (95% CI) ***	**p-value**
None			1,00 (reference)		1.00 (reference)	
Primary Schooling (0-5)			1.17 (0.92 – 1.48)		1.22 (0.91 – 1.63)	
Secondary Education (6-10)			1.77 (1.41 – 2.24)		1.95 (1.46 – 2.60)	
Higher Secondary Education (11-12)			1.72 (1.27 – 2.32)		1.64 (1.14 – 2.37)	
University Level or Higher			1.60 (1.12 – 2.29)		1.49 (0.95 – 2.34)	
Informal Education			1.25 (1.03 – 1.53)		1.42 (1.13 – 1.79)	
Marital Status				0.009		0.044
Single			1.00 (reference)		1.00 (reference)	
Married			1.33 (1.09 – 1.77)		1.39 (1.01 – 1.95)	
Separated			1.09 (0.57 – 2.09)		1.01 (0.48 – 2.13)	
Widow			0.95 (0.65 – 1.39)		0.98 (0.59 – 1.62)	
Current Smoking						0.083
No					1.00 (reference)	
Yes					1.22 (0.97 – 1.53)	
Current Alcohol Use						0.035
No					1.00 (reference)	
Yes					0.80 (0.66 – 0.98)	
MET*						0.163
< 600 MET >=600					1.25 (0.91 – 1.71)	

*MET= metabolic equivalents.

In Table 5, models evaluating associations between rural/urban residency and hypertension are shown in unadjusted models and those adjusted for demographics lifestyle covariates. In the unadjusted model, the odds of having hypertension in urban areas were 1.19 times higher (95% CI: 1.02-1.39) than in the rural areas, p-value = 0.009. After controlling for demographic factors, the odds increased to 1.27 (95% CI: 1.05-1.53), and the relationship remained statistically significant (p-value <0.001). After controlling for demographic and lifestyle factors, the odds ratio increased to 2.12 (95% CI: 1.55-2.90), and the association of being hypertensive and urban residency remained highly significant with an p-value < 0.001.

Females, according to the data, had a lower risk of hypertension than males. After adjusting for demographic and lifestyle characteristics, the odds of having hypertension for females was 0.59 (95% CI: 0.48-0.71) lower than for men (p-value <0.001). In comparison to the youngest age group of 18-24 years, the odds of hypertension increased with age. In models which were adjusted for demographic and lifestyle covariates, older age increased the odds of having hypertension (p-value of <0. 001). Higher education levels were also associated with an increased odds of hypertension when compared to the reference group of no education (p < 0.05). Marital status was not associated with the odds of having hypertension nor were any of the lifestyle factors including current smoking, current alcohol consumption, and physical activity as measured by METs (p> 0.05). In summary, the finding of our study suggests that residency, gender, age, ethnicity, and education status are associated with higher odds of being hypertensive. Taking demographics and lifestyle factors into account, urban residency is associated with being hypertensive whereas females have a lower risk of hypertension. However, marital status, current smoking, current alcohol consumption, and MET levels have no significant association with being hypertensive in the analysis.

Table 5. Associations between hypertension* and rural/urban setting unadjusted and adjusted for demographic and lifestyle covariates.

	Unadjusted Model		Adjusted for Demographics		Adjusted for Demographics and Lifestyle	
Variable in Model	**Odds Ratio (95% CI) ***	**p-value**	**Odds Ratio (95% CI) ***	**p-value**	**Odds Ratio (95% CI) ***	**p-value**
Residency		0.924		0.009		<0.001
Rural	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Urban	1.19 (1.02 – 1.39)		1.27 (1.05 -1.53)		2.12 (1.55 – 2.90)	
Gender				<0.001		<0.001
Male			1.00 (reference)		1.00 (reference)	
Female			0.54 (0.46 – 0.63)		0.59 (0.48 – 0.71)	
Age				<0.001		<0.001
18-24			1.00 (reference)		1.00 (reference)	
25-34			1.64 (1.14 – 2.35)		1.78 (1.20 – 2.63)	
35-44			2.91 (2.00 – 4.24)		2.96 (1.95 – 4.49)	
45-54			4.07 (2.76 – 6.00)		4.44 (2.88 – 6.86)	
55-64			4.08 (2.73 – 6.11)		4.15 (2.64 – 6.52)	
65+			5.00 (3.18 – 7.88)		5.33 (3.09 – 9.18)	
Ethnicity				<0.001		<0.001
Bramhin			1.00 (reference)		1.00 (reference)	
Chhetri/Thakuri/Sanyasi			1.70(1.26 – 2.30)		1.54 (1.06 – 2.23)	
Newar			2.08 (1.60 – 2.70)		1.88 (1.35 – 2.63)	
Magar/Tamang/Rai/Limbu			1.56 (1.22 – 2.00)		1.52 (1.11 – 2.08)	
Sherpa/Bhote			2.94 (2.08 – 4.17)		2.86 (1.94 – 4.21)	
Dalit(kami/Sarki/damai/gaine/badi)			2.26 (1.63 – 3.14)		2.10 (1.43 – 3.08)	
Education				0.018		0.038

None			1.00 (reference)		1.00 (reference)	
Primary Education (0-5)			0.92 (0.71-1.20)		1.02 (0.75-1.39)	
Secondary Education (6-10)			0.86 90.67-1.11)		1.02 (0.75-1.40)	
Higher Secondary Education (11-12)			0.95 (0.67 -1.33)		1.12 (0.75 – 1.68)	
University Level or Higher			1.05 (0.70 – 1.56)		1.31 (0.81 – 2.12)	
Informal Education			1.32 (1.06 – 1.63)		1.11 (1.11 – 1.77)	
Marital Status				0.127		0.22
Single			1.00 (reference)		1.00 (reference)	
Married			1.14 (0.82-1.59)		1.03 (0.71-1.49)	
Separated			1.13 (0.56-1.59)		0.80 (0.36-1.77)	
Widow			1.59 (1.03-2.46)		1.48 (0.88-2.46)	
Current Smoking						0.60
No					1.00 (reference)	
Yes					1.06 (0.84 – 1.33)	
Current Alcohol Use						0.12
No					1.0 (reference)	
Yes					0.84 (0.68 -1.04)	
MET**						0.008
< 600 MET					1.0 (reference)	
$\geq$600 MET					1.83 (1.28-2.62)	

*Hypertension = systolic blood pressure $\geq$140 or diastolic blood pressure $\geq$ 90

**MET=metabolic equivalents.

Discussion

This study examined the traditional risk factors for cardiometabolic disorders focusing on hypertension and obesity/overweight in Nepal's rural and urban populations. This is the first study to do examine these relationships. The findings showed a substantial relationship between being obese/overweight and living in an urban area in unadjusted (bivariate), adjusted for demographics, and adjusted for demographic and lifestyle variables (multivariate) models. Similarly, the results demonstrated an association between urban living and hypertension in both unadjusted and adjusted models.

Results from our study can be compared to several others conducted in low-and-middle-income countries. A national level study in Ghana found that 44% of individuals who spent their childhood and adult life in the same urban environment were obese. These findings suggest that residing in urban areas throughout life may contribute to an increased risk of obesity.[16] Similarly another study in Bangladesh reported more than half 53% of the study population who were residing in the urban areas were overweight/obese while only one third 33% of the study participants from the rural site were obese,[17] Our study further supports that urban residence increases the odds of being obese. In Nepal, living in an urban environment more than doubled the odds of being overweight/obese compared to rural residency with $p < 0.001$ indicating a strong association.

Several other studies have consistently demonstrated higher obesity prevalence among women compared to men. Additionally, individuals with a higher level of education had a higher prevalence of obesity compared to those with less education, perhaps indicating higher income. Older age was identified as a factor associated with overweight or obesity, being currently married was associated with being overweight/obese.[18–21] Findings of our study indicate that females were more likely to be overweight /obese compared to males; this association persisted even after controlling for demographic and lifestyle factors, with females having 1.38 times the odds of being overweight or obese)p-value = 0.004) after adjusting for demographic and lifestyle factors. Likewise, we found that education levels play a role with higher educated individuals being more overweight/obese compared to the reference group of no education (p-values = 0.002). after adjusting for demographic and lifestyle covariates. Moreover, being married also demonstrated an association with being overweight or obese after adjusting for demographic and lifestyle covariates.

A national-level study conducted among women in Ghana found that the place of residence did not play a significant role in determining the occurrence of hypertension.[22] A study conducted in India suggests that the occurrence of hypertension is increasing at a national level, and urban areas exhibit a greater prevalence of hypertension when compared to their rural counterparts. [23] Similarly, our study provides compelling evidence that residing in urban areas substantially increases the odds of developing hypertension. We found that after adjusting for demographics and lifestyle in the multivariate model, the odds of hypertension in urban areas were more than doubled (p-value < 0.001) suggesting strong associations between urban residence and the likelihood of having hypertension when compared to rural areas.

Numerous studies have consistently indicated a higher prevalence of hypertension in males compared to females. A systematic review conducted in South Asia, with a large sample size of 220,539 participants, reported a greater occurrence of hypertension in men than in women. In terms of lifestyle, another study highlighted a significant association between smoking, drinking, and an increased prevalence of hypertension. Additionally, it is widely observed that blood pressure tends to rise with age across various populations with hypertension being more prevalent among older individuals.[13,24–28] Our study also strongly supports that age is associated with hypertension with higher odds observed as age increased. Females had a lower odd of hypertension compared to males. Among different ethnic groups, Sherpa/Bhote and Dalit individuals had higher odds of hypertension compared to Bramhins. However, our study indicated educational level, marital status, current smoking, and current alcohol use do not show significant associations with hypertension in the fully adjusted model. The findings from our study suggest that urban residency, older age, being male, and certain ethnic backgrounds are associated with an increased risk of hypertension.

This study has a number of strengths and weaknesses that should be acknowledged. Major strengths include the rigorous and standardized data collection completed by trained enumerators, the large sample size, and the inclusion of physical measurements (e.g., height, weight and blood pressure) made in a low resource setting. A major limitation of this study was we use secondary data, and we had no control over how or what data were collected. In addition, this study setting was in specific regions of the country and may not be generalizable to all of Nepal. Another limitation of the study is the lack of information pertaining to the use of medication to manage hypertension and its inclusion in our definition of hypertension. Omission of this data could potentially lead to the misclassification of hypertensive individuals within the normal group, thereby affecting results. Regardless, this study has brought valuable insights to understanding risk factors for cardiometabolic diseases regionally that may be used to help develop public health policy in Nepal.

Conclusion

In conclusion, this study examined the relationships between traditional risk factors for cardiometabolic disorders, hypertension and obesity/overweight, in Nepal's rural and urban population. The findings consistently revealed a significant association between living in urban areas and increased prevalence of obesity/overweight and hypertension, even after adjusting for demographic and lifestyle factors. Moreover, the study highlighted a higher prevalence of obesity among women compared to men and among individuals with higher education levels. Older age was identified as a risk factor for overweight/obesity and hypertension. Additionally, the study found a higher prevalence of hypertension in males and identified certain ethnic backgrounds as being associated with an increased risk of hypertension. These findings emphasize the importance of addressing urban residence, gender, education, age, and ethnicity as key factors in the prevention and management of cardiometabolic conditions in Nepal's population. Our results and those from future studies are critical to inform targeted interventions and tailored healthcare approaches to address the specific challenges faced by each population.

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