

BMJ Open Socioeconomic inequalities in overweight and obesity among young adult women in Nepal between two cross-sectional surveys in 2001 and 2022

Sujata Shakya ^{1,2}, Pilvikki Absetz,¹ Subas Neupane¹

To cite: Shakya S, Absetz P, Neupane S. Socioeconomic inequalities in overweight and obesity among young adult women in Nepal between two cross-sectional surveys in 2001 and 2022. *BMJ Open* 2025;**15**:e094353. doi:10.1136/bmjopen-2024-094353

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<https://doi.org/10.1136/bmjopen-2024-094353>).

Received 28 September 2024
Accepted 08 July 2025



© Author(s) (or their employer(s)) 2025. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ Group.

¹Unit of Health Sciences, Faculty of Social Sciences, Tampere University, Tampere, Pirkanmaa, Finland

²Central Department of Public Health, Tribhuvan University Institute of Medicine, Kathmandu, Bagmati, Nepal

Correspondence to

Sujata Shakya;
sujata.shakya@tuni.fi

ABSTRACT

Objective To examine the socioeconomic inequalities in overweight-obesity and their changes in two decades, among young adult women aged 18–29 years in Nepal.

Design Cross-sectional study based on Demographic and Health Surveys conducted in 2001 and 2022.

Setting Nepal.

Participants Data of young adult women aged 18–29 years were included for the study.

Outcome measures Socioeconomic inequalities in education, occupation and household wealth were analysed through regression-based inequality indices: the Relative Index of Inequality, the Slope Index of Inequality and the Concentration Index. A concentration curve was constructed to evaluate whether overweight-obesity skewed towards poverty or wealth.

Results We found an increase in the prevalence of overweight-obesity prevalence between 2001 (3.99%) and 2022 (15.45%), mostly in the oldest group (25–29 years), and among Janajati and rural residents. Socioeconomic gradients favoured wealthier, educated and employed women. A downward shift in wealth status was initially associated with a lower prevalence of overweight and obesity among women, but over time, it became linked to a higher prevalence.

Conclusions The social gradient of overweight-obesity from 2001 to 2022 favoured women with higher socioeconomic status, and this shows a decreasing trend.

INTRODUCTION

According to the WHO, obesity is considered a ‘global epidemic,’ with a significant and steady increase in overweight and obesity prevalence.¹ Overweight and obesity have been estimated to contribute to 16% of the global burden of disease.² The prevalence of obesity has nearly doubled worldwide and tripled in low- and middle-income countries (LMICs) over the past three decades.^{3–4} This global epidemic reflects significant changes in behavioural patterns in LMICs such as the adoption of Western lifestyles characterised by high caloric intake and a sedentary lifestyle.⁵ This has led to a double-disease burden, with increasing obesity rates and

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study is based on nationally representative surveys.
- ⇒ It provides strong evidence of socioeconomic differences between two decades.
- ⇒ We had to use proxy measures on socioeconomic status such as asset-based wealth index, education and occupation.
- ⇒ We could not compare data with men since Demographic and Health Survey 2001 data do not include men’s information.

the prevalence of other non-communicable diseases (NCDs) in addition to the high prevalence of communicable diseases.⁶ WHO has highlighted that this rising trend poses an imminent global threat, associated with health risks and deaths.^{7,8}

While obesity was once a primary concern among middle-aged adults, there is now a rising trend among adolescents and young adults due to economic progress and industrialisation.⁹ Young adulthood is a crucial phase during which significant lifestyle challenges and role changes are faced, leading to stress and ultimately increased risk of weight gain. Most importantly, the health risks stemming from habits formed during this period of life can persist into adulthood and beyond.^{10–13} A systematic review indicates that in LMICs, the prevalence of overweight and obesity among young adults is approximately 12% and 29%, respectively.¹⁴ This problem has affected both urban and rural areas in Sub-Saharan Africa and South Asia, including Nepal, where a rapid increase has been observed.^{15–18} In 2014, WHO reported overweight and obesity prevalence in Nepal at 16.7% and 2.9%, respectively.³ Various studies in Nepal among young adults have also shown high rates of overweight and obesity.^{15–17} This is

concerning, especially for an LMIC like Nepal, where undernutrition remains a persistent issue, but preventive measures are lacking.¹⁹

Understanding the socioeconomic variations in NCDs has been challenging due to multifactorial causes and long latency periods. Previous studies show socioeconomic variations in overweight and obesity among young adults in European nations over time. Initially, high socioeconomic status (SES) was linked to overweight and obesity, but this trend gradually shifted to higher risk of obesity and overweight among those with lower SES.²⁰ This changing pattern of socioeconomic differences, previously observed in high-income countries (HICs), is now extending to LMICs as well.²¹ An increase in the country's gross domestic product has been positively linked to a rapid rise in overweight prevalence among lower-income groups due to decreased income inequality.²² While most of the LMICs, including India, Bangladesh and Sub-Saharan Africa, are still in the earlier phase of socioeconomic pattern with positive relation between SES and overweight/obesity,^{23–26} a recent cross-sectional study from Nepal also showed positive association of overweight/obesity with SES indicators such as income and education.²⁷

Evidence shows that women have a higher likelihood of being overweight or obese due to various reasons like physiological or hormonal responses, pregnancy-related weight gain, changes in diet, decreased physical activity, depression, etc.²⁸ The upward trend of overweight and obesity in LMICs has been observed more rapidly in rural areas.¹⁸ With the change in technology and lifestyle, the problem has been on the rise among adults with low SES. In 10 out of 37 LMICs, lower SES was associated with increasing overweight prevalence. This increasing rate of obesity among low SES groups has significant implications for the distribution of health inequalities.²⁹

In Nepal, there is still a lack of sufficient evidence to explain the trends of the pattern of socioeconomic differentials in overweight and obesity, especially among young adults. Most of the studies assessed the socioeconomic factors associated with overweight/obesity during a particular period,^{18 30–33} and another study assessing the socioeconomic inequality focused only on a specific year and among reproductive age group women.³⁴ None of these studies from Nepal have particularly studied the trend in the young adult group. Our study provided information on the changes in overweight and obesity in a two-decade period and the pattern of socioeconomic differences observed among young women specifically. Therefore, this study aims to evaluate the socioeconomic inequalities in overweight and obesity among young adult women in Nepal in two time points over two decades (2001–2022). SES is studied in terms of education, occupation and wealth. We presume that overweight and obesity have increased among low SES women in two decades, similar to the high-income nations.

METHODS

This study used national-level cross-sectional datasets from the Demographic and Health Survey (DHS), comparing data from 2001 with the latest survey in 2022 to identify the changes in socioeconomic inequalities over these two decades.

Demographic and Health Surveys

DHSs, conducted every 5 years in LMICs, provide crucial demographic and health indicators³⁵ conducted among children and adult population. We used data from Nepal's DHSs, which were conducted under the control of the Ministry of Health and Population, Nepal. DHS employed a multistage stratified cluster sampling technique using a probability proportional to the size of the population. House-to-house structured interviews were conducted among the sampled population aged 15–49 years. In the 2001 survey, there were 8726 women and 2261 men participants,³⁶ while in the 2022 survey, 14845 women and 4913 men were interviewed.³⁷ We extracted data for young adult women from the DHSs. The definition of youth or young adult varies across different contexts and studies,^{14 38} ranging 16–30 years or even 18–25 years, depending on the human development and sociological, occupational, sexual and/or emotional indices.¹⁴ For this study, we considered a young adult as a person aged 18–29 years, recognising that this age group faces distinct developmental challenges and significant health issues. We analysed the data of women only for comparability, since there were no men's data in the 2001 survey. Altogether, there were 6204 women aged 18–29 years in the two surveys, 3352 from the 2001 survey and 2852 from the 2022 survey.

Measurement of variables

Overweight and obesity

Overweight and obesity are the outcome variables for this study. These were assessed using Body Mass Index (BMI), which was measured as the ratio of weight (kg) and the square of height (m²). Weight was measured using calibrated Seca scales (model number SECA874U), and height was measured with a ShorrBoard measuring board by trained enumerators. For flagged cases, height and weight measurements were repeated to ensure accuracy.³⁷ Overweight and obesity are categorised based on the WHO classification³⁹: overweight (BMI ≥ 25 kg/m² and < 30.0 kg/m²) and obesity (BMI ≥ 30.0 kg/m²). In this study, we defined overweight or obesity as a binary response variable with BMI ≥ 25 kg/m² versus all others for performing regression analysis. We merged overweight and obesity into a single outcome to prevent low cell values during analysis.

Wealth index

The wealth index, a composite measure of a household's cumulative living standard,⁴⁰ was calculated in the DHS dataset by using principal component analysis of the components, which included household ownership of

selected assets like televisions, bicycles, etc; housing characteristics like construction materials and types of water access and sanitation facilities. The wealth index was categorised into five wealth quintiles (richest, richer, middle, poorer and poorest).

Education

In the original dataset, highest educational level was categorised into no education and/or preschool, primary, secondary and higher, which was used in our analysis.

Occupation

Occupation was originally classified into not working, professional/technical/managerial, clerical, sales and service, skilled manual, unskilled manual, agriculture and others. We merged these categories and reclassified them into not working, manual work and non-manual work for analysis.⁴¹

Sociodemographic characteristics

Sociodemographic characteristics of the participants assessed were age in years (<20, 20–24, 25–29), marital status (never married, married/living together, widow/divorced), ethnicity (Brahmin/Chhetri, Janajati, others), place of residence (urban, rural), and ecological zone (mountain, hill, terai).

Statistical analysis

The analysis was performed in SPSS V.29.0.1.0 (171) and STATA V.17.0. We weighted the data using individual sampling weights which were provided for the primary sampling unit by the DHS programme within the dataset. This was done to make the data representative of the study population and to adjust for variations in the probability of sample selection.⁴² The missing values were already imputed as necessary before releasing the data by the DHS programme. The descriptive results were calculated and presented as weighted frequency and percentage for the categorical variables and mean and SD for the continuous variables.

Socioeconomic inequalities were assessed based on education, occupation and wealth quintile.^{24 34 43 44} We executed the 'svy' command in STATA to consider complex sampling designs and the sampling weights in the regression analysis. Regression-based inequality indices were calculated using generalised linear models with logit function to study the socioeconomic inequalities in overweight-obesity. The regression models for the outcome were calculated against the relative rank of each of the socioeconomic indicators, which ranged from 0 to 1. The inequality indices used were the Relative Index of Inequality (RII), Slope Index of Inequality (SII), concentration curves and concentration indices. SII captures the absolute difference in overweight-obesity between the socioeconomically deprived and advantaged, whereas RII represents the proportionate difference in overweight-obesity across the distribution of socioeconomic position.⁴⁵ The regression models were adjusted for residence, ethnicity, education and occupation for

wealth-related inequality; residence, ethnicity, occupation and wealth quintile for educational inequality and residence, ethnicity, education and wealth quintile for occupation-related inequality. We calculated concentration indices and generated concentration curves to assess the presence of socioeconomic inequality and determine whether overweight-obesity is more pronounced among the poor or rich.⁴⁶ However, the concentration curve was presented only for 2022 due to very low prevalence of overweight-obesity among young women in 2001 data. The concentration curve illustrates the cumulative proportion of the population based on socioeconomic indicators on the horizontal axis and the cumulative proportion of overweight-obesity on the vertical axis. The concentration index quantifies the degree of socioeconomic inequality and is twice the area between the concentration curve and the 45-degree line of equality. It ranges from -1 to +1, with zero indicating no inequality, a negative value indicating concentration towards the poor and a positive value indicating concentration towards the rich.

Patient and public involvement

Being the study based on secondary data, there was no involvement of patient and public in the design, conduct, reporting and dissemination of the study results.

RESULTS

A total of 6204 young women were studied in this study from two surveys conducted in 2001 and 2022. **Table 1** presents the distribution of sociodemographic characteristics of the study participants by the survey years. The mean age of the women was comparable in both surveys with an average age of 23.72 years in 2001 and 23.27 years in 2022. In 2001, the highest proportion of women (44.00%) was aged in the age group of 25–29 years, while in 2022, the highest proportion (43.09%) was in the age group of 20–24 years. A significant proportion of the participants belonged to the 'Janajati' ethnic group, more than a quarter, and resided in the Terai region in both surveys. In 2001, 90.35% lived in rural areas, which was surpassed by urban dwellers in 2022 (68.83%). Nearly all women (98.05%) were married or living together with a partner in 2001, whereas this figure decreased to 70.51% in 2022. The average years of schooling showed a sharp increase, going from 2.29 (SD: 3.54) years in 2001 to 8.38 (SD: 4.33) years in 2022. In 2001, nearly two-thirds of the participants (63.34%) had no education or preschool education, which sharply declined to 9.61% in 2022. The secondary education became dominant in 2022 (54.63%). The majority of the women were engaged in manual work in both years, and the proportion of those doing non-manual work increased suddenly from 5.29% to 16.44% during the study period. In 2001, 21.40% of the participants belonged to the poorest wealth quintile, which decreased to 17.15% in 2022. Conversely, the proportion of those in the richer groups increased from

Table 1 Sociodemographic characteristics of the young women in 2001 and 2022 (socioeconomic inequalities in overweight and obesity among young adult women in Nepal between 2001 and 2022)

Sociodemographic characteristics	2001	2022
	N (%) n=3352	N (%) n=2852
Age group (in years)		
15–19	424 (12.66)	486 (17.04)
20–24	1453 (43.35)	1229 (43.09)
25–29	1475 (44.00)	1137 (39.87)
Mean (SD) age	23.72 (3.30)	23.27 (3.40)
Ethnicity		
Brahmin/Chhetri	1095 (32.68)	778 (27.28)
Janajati	1143 (34.10)	1036 (36.33)
Others*	1114 (33.23)	1038 (36.40)
Place of residence		
Urban	323 (9.65)	1963 (68.83)
Rural	3028 (90.35)	889 (31.17)
Ecological zone		
Mountain	221 (6.60)	132 (4.63)
Hill	1378 (41.11)	1117 (39.17)
Terai	1753 (52.29)	1603 (56.21)
Current marital status		
Never married	–	812 (28.47)
Married/living together	3286 (98.05)	2011 (70.51)
Widow/divorced/separated	65 (1.95)	29 (1.02)
Education		
No education/preschool	2123 (63.34)	274 (9.61)
Primary	557 (16.61)	844 (29.59)
Secondary	612 (18.25)	1558 (54.63)
Higher	60 (1.80)	176 (6.17)
Mean (SD) years of schooling	2.29 (3.54)	8.38 (4.33)
Occupation		
Not working	694 (20.71)	962 (33.73)
Manual work	2479 (74.00)	1421 (49.82)
Non-manual work	177 (5.29)	469 (16.44)
Wealth quintile		
Richest	675 (20.14)	614 (21.53)
Richer	660 (19.69)	607 (21.29)
Middle	637 (19.01)	600 (21.04)
Poorer	662 (19.75)	542 (19.00)
Poorest	717 (21.40)	489 (17.15)

*Others include Muslim, Dalit, Madhesi, etc.

19.69% in 2001 to 21.29% in 2022. This proportional increase was also observed in the richest and the middle wealth quintile groups.

Table 2 illustrates the prevalence of overweight-obesity among women by sociodemographic characteristics in the 2001 and 2022 surveys as well as the percentage difference between the two surveys. In 2001, the prevalence of overweight-obesity was 3.99%, and it surged to 19.44% in 2022, marking a substantial average increase of 15.45%. The table also presented a marked difference between the age cohorts in the magnitude of the increase in overweight-obesity prevalence, with the smallest increase observed in the youngest cohort (15–19 years), at 4.99%, and the largest increase occurring in the oldest cohort (25–29 years), which rose by over five-fold.

Similarly, we found the highest increase in the prevalence of overweight-obesity among the Janajati ethnic group, with a 16.51% rise, while rural residents experienced a 13.07% increase. In addition, the residents from the hill region had the highest increase in the prevalence of overweight-obesity (18.32% rise) followed by Terai residents (13.77% increase). Conversely, the married or living together groups showed a sudden (18.80%) increase in prevalence during the same period.

The prevalence of overweight-obesity was remarkably increased among the richer (24.05% increase) and the middle-income groups (15.83% increase). In contrast, the poorest group experienced the smallest increase, at 10.05%, between 2001 and 2022. In terms of education, the most substantial upswing in overweight-obesity prevalence, at 16.70%, was among individuals with primary education. There was only a slight difference in the prevalence of overweight-obesity among non-manual workers, while manual workers had a notable 15.60% increase.

Socioeconomic differences among women were assessed based on wealth quintile, level of education and occupation. The crude and adjusted estimates showed that the overweight-obesity rate is more pronounced among individuals in the top level of wealth distribution (table 3). In 2001, the adjusted RII estimates showed that overweight-obesity was 75% lower among women belonging to the bottom of the wealth distribution compared with those at the top. By 2022, this percentage had decreased to 62%. This change in the RIIs from 2001 to 2022 indicated a decrease in wealth-related socioeconomic inequality in overweight-obesity. A similar pattern was depicted for both education and occupation. In 2001, the RII estimates were significant in almost all the adjusted models for wealth quintile and education, but not for occupation. Whereas, in the 2022 survey, the RII estimates were significant in the adjusted model for wealth quintile and occupation but not for education, which is worth noting.

Transitioning from the richest to the poorest wealth group was associated with an estimated 84 fewer cases of overweight-obesity per 1000 population in 2022 when adjusted for education, occupation, place of residence and ethnicity (table 4). This difference between the richest and the poorest wealth group was lower compared

Table 2 Changes in per cent of overweight-obesity among young women by sociodemographic characteristics between 2001 and 2022 (socioeconomic inequalities in overweight and obesity among young adult women in Nepal between 2001 and 2022)

Sociodemographic characteristics	Overweight-obesity		Per cent difference between two surveys
	2001	2022	
	N (%) n=3346*	N (%) n=2824*	
Overall overweight-obesity	134 (3.99)	549 (19.44)	15.45
Age-group (in years)			
15–19	6 (1.43)	31 (6.42)	4.99
20–24	44 (3.03)	175 (14.44)	11.41
25–29	84 (5.63)	343 (30.38)	24.75
Ethnicity			
Brahmin/Chhetri	38 (3.47)	137 (17.70)	14.23
Janajati	78 (6.84)	241 (23.35)	16.51
Others	18 (1.62)	171 (16.80)	15.27
Place of residence			
Urban	47 (14.60)	408 (21.02)	6.42
Rural	87 (2.88)	141 (15.95)	13.07
Ecological zone			
Mountain	8 (3.64)	20 (15.04)	11.86
Hill	65 (4.73)	257 (23.05)	18.32
Terai	61 (3.48)	272 (17.25)	13.77
Current marital status			
Never married	–	83 (10.34)	10.34
Married/living together	133 (4.05)	455 (22.85)	18.80
Widow/divorced/separated	1 (1.54)	10 (33.33)	31.79
Wealth quintile			
Richest	81 (12.05)	147 (24.30)	12.25
Richer	14 (2.12)	157 (26.17)	24.05
Middle	12 (1.88)	105 (17.71)	15.83
Poorer	15 (2.27)	81 (15.08)	12.81
Poorest	12 (1.68)	57 (11.73)	10.05
Education			
No education/preschool	33 (1.56)	33 (12.04)	10.48
Primary	30 (5.39)	184 (22.09)	16.70
Secondary and above	71 (10.58)	331 (19.28)	8.70
Occupation			
Not working	44 (6.35)	171 (18.02)	11.67
Manual work	60 (2.42)	255 (18.02)	15.60
Non-manual work	30 (17.05)	123 (26.74)	9.69

*Total number of BMIs assessed.
BMI, body mass index.

with that in 2001, which shows a decrease in socioeconomic gradients. All the adjusted models were significant in 2022 but mostly insignificant in 2001.

Figure 1 presents the concentration curve to show the inequality in overweight-obesity among women in 2022 based on the wealth quintile. The figure shows the

curve lying below the equity line, which indicates that the overweight-obesity is more concentrated towards the wealthier groups.

A similar interpretation can be done from the Concentration Index based on the wealth quintile, which is significant and positive (0.16, 95% CI: 0.11 to 0.20) showing the

Table 3 Relative socioeconomic inequalities in overweight-obesity among women in 2001 and 2022 (socioeconomic inequalities in overweight and obesity among young women in Nepal between 2001 and 2022)

Socioeconomic indicators	Relative index of inequality (RII)	
	2001	2022
Wealth quintile		
Crude	0.05 (0.02–0.12)	0.38 (0.26–0.54)
Adjusted model*	0.25 (0.07–0.86)	0.38 (0.25–0.57)
Education		
Crude	0.04 (0.02–0.09)	0.93 (0.65–1.32)
Adjusted model†	0.10 (0.03–0.29)	1.58 (0.99–2.52)
Occupation		
Crude	0.69 (0.13–3.53)	0.63 (0.44–0.91)
Adjusted model‡	0.50 (0.20–1.25)	0.66 (0.48–0.90)

*Adjusted for education, occupation, place of residence and ethnicity.
†Adjusted for wealth quintile, occupation, place of residence and ethnicity.
‡Adjusted for wealth quintile, education, place of residence and ethnicity.

Table 4 Absolute socioeconomic inequalities in overweight-obesity among women in 2001 and 2022 (Socioeconomic inequalities in overweight and obesity among young women in Nepal between 2001 and 2022)

Socioeconomic indicators	Absolute inequality (SII)	
	2001	2022
Wealth quintile		
Adjusted model*	0.98 (0.96–1.01)	0.84 (0.79–0.90)
Education		
Crude	0.87 (0.83–0.91)	0.99 (0.92–1.06)
Adjusted model†	0.93 (0.88–0.99)	0.66 (0.52–0.85)
Occupation		
Crude	0.99 (0.97–1.02)	0.92 (0.87–0.98)
Adjusted for education	0.98 (0.94–1.02)	0.92 (0.87–0.98)
Adjusted for wealth quintile	0.97 (0.93–1.01)	0.92 (0.86–0.98)
Adjusted for residence and ethnicity	0.98 (0.95–1.01)	0.92 (0.86–0.98)

*Adjusted for education, occupation, place of residence and ethnicity.
†Adjusted for wealth quintile, education, place of residence, and ethnicity.
SII, Slope Index of Inequality.

overweight-obesity pro-rich (table 5). In the 2001 survey, all the indices were found positive, showing concentration towards wealthier, educated and employed groups, whereas the indices were found negative in 2022 for

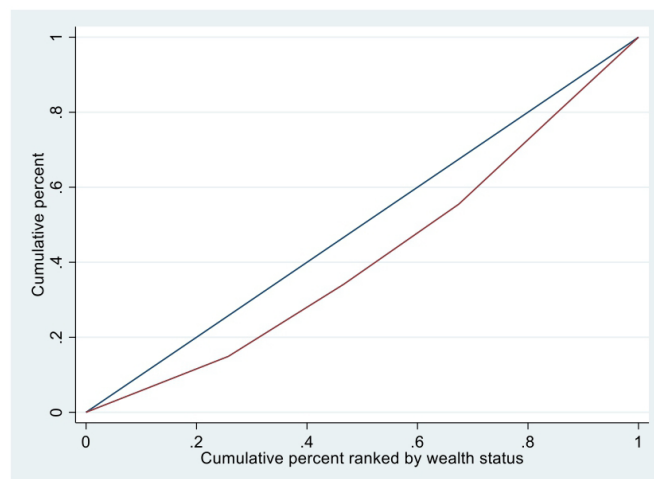


Figure 1 Concentration curve for overweight-obesity among women according to wealth quintile in 2022 (socioeconomic inequalities in overweight and obesity among young adults in Nepal, 2023).

education and occupation. This shows a higher concentration of overweight-obesity among less educated and not working groups in 2022.

DISCUSSION

To our knowledge, this is the first study examining the socioeconomic differences in overweight-obesity among young women in Nepal over a two-decade period. This study showed a remarkable increase in the prevalence of overweight-obesity between 2001 and 2022, particularly in the age cohort of 25–29 years, residents of hilly regions, married women and the wealthier group. This may be the first signal of a changing trend similar to what has already been seen in HICs.²¹ The gap between the highest and lowest SES has narrowed in 2022, revealing that overweight-obesity tends to deviate towards less wealthy, less educated and unemployed young women.

We found major changes in the sociodemographic profile of young women during the 20-year study period. A general increase in wealth was reflected by a decrease in the proportion of individuals in the poorest groups and an increase in the proportion of wealthier groups. The mean years of schooling also showed a rapid increase with a sharp decrease in the proportion of uneducated/preschool groups. This indicates an improved population level of education among young women. Similarly, a noticeable increase in the percentage of women engaged in non-manual work reflects a rise in sedentary work within the population leading to a large change in energy expenditure in daily life. A sharp increase in the prevalence of overweight-obesity between 2001 and 2022 was noted in our study, consistent with other studies among adults.^{29–47} The Janajati group and the rural dwellers exhibited a rapid upsurge in the prevalence during the same period. This trend aligns with another study which depicted shrinking rural-urban differences in overweight

Table 5 Concentration Index of overweight-obesity among young women based on socioeconomic indicators (socioeconomic inequalities in overweight and obesity among young adult women in Nepal between 2001 and 2022)

Socioeconomic indicators	2001			2022		
	CIX	SE	95% CI	CIX	SE	95% CI
Wealth quintile	0.652	0.041	0.573 to 0.732	0.158	0.023	0.113 to 0.202
Education	0.704	0.024	0.657 to -0.751	-0.037	0.020	-0.081 to 0.007
Occupation	0.378	0.056	0.268 to -0.488	-0.0004	0.024	-0.046 to -0.047

CI, Confidence Interval; CIX, Concentration Index; S. E., Standard Error.

in many LMICs.²⁸ We also found a substantial increase in overweight-obesity prevalence among married or cohabiting individuals and those with primary education. This increasing prevalence of overweight-obesity among those with primary education and rural residence between 2001 and 2022 probably signifies a potential gradual shift of overweight/obesity prevalence towards the lower SES group.

Regarding socioeconomic differences in overweight and obesity, cross-national comparisons in 37 developing countries found positive associations between higher SES and overweight prevalence among women in 27 developing countries.²⁶ In line with this, our study also found a rapid increase in the proportion of overweight-obesity from 2001 to 2022 among wealthier and middle-income groups, and the smallest increase was seen among the poorest group. The overweight-obesity was consistently higher among the wealthier groups compared with the lower ones, in line with general trends among university students in LMICs.⁴⁸ The similar pattern is seen in most of the developing countries including Nepal, in which obesity was found to be positively associated with income/wealth in adults.^{21 27} However, this contrasts with studies among adults in HICs like Australia, USA and England,⁴⁹⁻⁵¹ where lower socioeconomic groups are at an increased risk of obesity and its complications. Most of the LMICs exhibit a pattern of overweight-obesity being more prevalent among wealthier groups of women,^{52 53} since these groups often have greater access to food, especially high-fat and high-calorie diets and tend to engage in less physical activity due to sedentary lifestyles,^{12 13 53 54} contributing to an increased risk for overweight and obesity. In our study, overweight-obesity was found higher among the most educated groups compared with the less educated ones in both the 2001 and 2022 surveys. In other words, overweight-obesity was found to be reduced with the shift from the most educated group to the least. This is similar to the other studies conducted in Bangladesh and Ethiopia which found that educated women had a higher prevalence of overweight and obesity.^{23 52} A systematic review of the studies in developing countries depicted education as a SES indicator highlighting that educated groups of adults were more likely to be obese compared with less educated ones.²¹ The similar positive association between education and overweight/obesity is also found in a study in Nepal.²⁷ This might be explained by an increased

likelihood of performing a sedentary job by educated persons⁵⁵ which increases the risk for overweight and obesity. Moreover, another study found linkage between overweight and decreased physical activity, such as lack of exercise, oversleeping, etc, among young adults.⁵⁴ This might also be attributed to a positive relation between higher wealth index or income and education.^{56 57}

Socioeconomic differences were found to be more prominent among wealthier groups as compared with the poorer groups. An earlier study among women in middle-income countries showed that education modifies the association of wealth with obesity.⁵⁸ Therefore, we controlled for education and other variables such as ethnicity and place of residence in the regression models to minimise their confounding bias. The adjusted difference decreased during the 20 years and remained significant even after adjusting for factors such as place of residence, ethnicity, education and occupation. This reduction in socioeconomic differences might be attributed to increasing prevalence of overweight/obesity even among the rural residents and middle-income and less educated groups. This might have resembled the picture of HICs depicting socioeconomic differences favouring high SES earlier and gradually deviating towards low SES.²⁰ Furthermore, transitioning from the top to the bottom quintile of wealth was associated with a decreased prevalence of overweight-obesity, highlighting a growing issue among young women with higher SES. The concentration curve of the 2022 survey showed a higher prevalence of overweight-obesity among the upper wealth quintile groups. Both the concentration indices for the 2001 and 2022 surveys are positive, indicating a concentration of overweight-obesity towards the wealthier groups. Consistent with our findings, another study conducted among Bangladeshi adult women showed a similar trend, where the concentration curve and index indicated a high concentration of overweight-obesity among women from upper wealth quintiles, highlighting a pro-rich wealth-based socioeconomic gradient.²³ The pattern of concentration indices showed a slight shift, with overweight-obesity initially being more concentrated among more educated and employed groups, but, in 2022, it shifted towards less educated and not working groups. This shift may signify a gradual change in the socioeconomic differences, moving from the higher socioeconomic groups towards

lower socioeconomic groups, similar to the trends observed in HICs.²⁰ Daly *et al* also found a changing relationship between obesity and SES among young adults in the Philippines, in which obesity is currently more prone to lower SES groups.⁵⁹ This might be attributed to easy availability and affordability of readymade food which leads to the attraction of young adults towards fast food.¹⁴ Moreover, technology facilitated production of cheap vegetable oils which led to increased consumption of energy-dense and processed food among low-income groups.²²

Strengths and limitations

Our study findings are based on nationally representative surveys, providing strong evidence of socioeconomic differences in overweight and obesity between two time points of about two decades. However, the study is subject to some limitations. First, we were unable to include household income and expenditure as the direct measures of SES since these were not available in the DHS surveys. Therefore, we had to use the asset-based wealth index, education and occupation as the proxy measures. Second, the DHS data do not include detailed information on health habits related to occurrence of overweight or obesity such as dietary patterns and physical activity, which may contribute to socioeconomic differences in overweight-obesity. Third, DHS 2001 data do not include men's information on BMI, hence we were not able to compare the overweight-obesity prevalence among men between the two periods. Therefore, we had to exclude men's data from the 2022 dataset also and include women's data only for comparability. Fourth, we included only two time points, 2001 and 2022 since our study aim was set to estimate the changes in socioeconomic inequalities and not to identify the trend across time. Furthermore, we did not find a sufficient literature focusing on young women to compare with our findings. Therefore, we have included a few other studies focusing on all young adults or all adult women, etc. Finally, the presentation of socioeconomic differences in the form of a concentration curve was not possible for 2001 data due to the very low percentage of overweight-obesity among women.

Implications

Our study contributes to a better understanding of the socioeconomic differences in overweight-obesity between 2001 and 2022. The results, representing the national picture, can inform society and policymakers about the burden of socioeconomic gradients in overweight and obesity that is gradually deviating towards lower SES over this period. This information can assist policymakers in predicting future scenarios and serve as a foundation for a national strategy to mitigate present and future health risks associated with overweight and obesity among Nepalese youths. Additionally, it provides baseline data for further

descriptive and analytical studies and for planning interventions to tackle the rising overweight-obesity epidemic in different socioeconomic groups.

CONCLUSION

We found that overweight and obesity have been rapidly increasing over the past two decades, which is a matter of significant concern and requires urgent intervention. As in most other LMICs, the prevalence of overweight and obesity is still concentrated in the wealthier, more educated and employed groups of young women, though gradually shifting towards the lower SES group. This indicates a prevailing socioeconomic gradient in overweight and obesity that must be addressed through targeted measures. However, as population levels of education and wealth are increasing, measures are also needed to prevent the simultaneous increase in overweight and obesity among those climbing the socioeconomic ladder, as well as the transition of the overweight and obesity epidemic towards those with lower socioeconomic positions, as has been witnessed in HICs. Policy-makers should develop both local and national policies to prevent overweight and obesity and to address socioeconomic disparities among young women.

X Subas Neupane @neupanesubas1

Acknowledgements We would like to thank the DHS programme for providing us access to the NDHS datasets. Finally, we are thankful to Ms. Nira Joshi, Deputy Director, New Era, and Mr. Kiran Acharya, Senior Research Officer, New Era, for guiding us in getting clear about the design and process of the DHS surveys and the datasets.

Contributors SS: conceptualisation, data curation, methodology, validation, formal analysis, visualization, writing – original draft, writing – review and editing. SN: conceptualisation, methodology, formal analysis, validation, formal analysis, visualization, writing – review and editing, supervision. PA: conceptualisation, writing – review and editing, supervision. The corresponding and first author, SS, is the guarantor for this manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Ethical approval for the DHSs was obtained from the Nepal Health Research Council (NHRC) ethical review board. Informed consent for the surveys was obtained from all the participants before the interviews. As our analysis used publicly available, deidentified data with no direct involvement of human subjects, additional ethical approval was not required for this study. We obtained formal permission from the DHS programme to access the data.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Data are publicly available to use upon permission.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

 Sujata Shakya <http://orcid.org/0000-0003-0341-595X>

REFERENCES

- 1 Huang TTK, Glass TA. Transforming Research Strategies for Understanding and Preventing Obesity. *JAMA* 2008;300:1811.
- 2 Hossain P, Kawar B, El Nahas M. Obesity and diabetes in the developing world--a growing challenge. *N Engl J Med* 2007;356:213–5.
- 3 World Health Organisation (WHO). Global status report on noncommunicable diseases 2014. 2014. Available: <https://www.who.int/nmh/publications/ncd-status-report-2014/en/>
- 4 Lobstein T, Jackson-Leach R, Moodie ML, et al. Child and adolescent obesity: part of a bigger picture. *The Lancet* 2015;385:2510–20.
- 5 Haidar YM, Cosman BC. Obesity epidemiology. *Clin Colon Rectal Surg* 2011;24:205–10.
- 6 Vaidya A, Shakya S, Krettek A. Obesity Prevalence in Nepal: Public Health Challenges in a Low-Income Nation during an Alarming Worldwide Trend. *IJERPH* 2010;7:2726–44.
- 7 World Health Organisation (WHO). Obesity: preventing and managing the global epidemic. 2000. Available: <https://portaldeboaspraticas.iff.fiocruz.br/biblioteca/who-obesity-preventing-and-managing-the-global-epidemic/>
- 8 Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *The Lancet* 2004;363:157–63.
- 9 Lowry R, Galuska DA, Fulton JE, et al. Physical activity, food choice, and weight management goals and practices among US college students. *Am J Prev Med* 2000;18:18–27.
- 10 Butler SM, Black DR, Blue CL, et al. Change in diet, physical activity, and body weight in female college freshman. *Am J Health Behav* 2004;28:24–32.
- 11 Burke V, Mori TA, Giangiulio N, et al. An innovative program for changing health behaviours. *Asia Pac J Clin Nutr* 2002;11 Suppl 3:S586–97.
- 12 Burke V, Beilin LJ, Dunbar D, et al. Changes in health-related behaviours and cardiovascular risk factors in young adults: associations with living with a partner. *Prev Med* 2004;39:722–30.
- 13 Linné Y, Dye L, Barkeling B, et al. Weight development over time in parous women—The SPAWN study—15 years follow-up. *Int J Obes* 2003;27:1516–22.
- 14 Poobalan A, Aucott L. Obesity Among Young Adults in Developing Countries: A Systematic Overview. *Curr Obes Rep* 2016;5:2–13.
- 15 Nepal G, Tuladhar ET, Dahal S, et al. Lifestyle Practices and Obesity in Nepalese Youth: A Cross-sectional Study. *Cureus* 2018;10:e2209.
- 16 Piryani S, Baral KP, Pradhan B, et al. Overweight and its associated risk factors among urban school adolescents in Nepal: a cross-sectional study. *BMJ Open* 2016;6:e010335.
- 17 Pandey A, Sapkota S. Prevalence and Knowledge on Obesity Among School Going Adolescents of Kaski, Nepal. *J Nepal Paedr Soc* 2018;38:63–8.
- 18 Balarajan Y, Villamor E. Nationally representative surveys show recent increases in the prevalence of overweight and obesity among women of reproductive age in Bangladesh, Nepal, and India. *J Nutr* 2009;139:2139–44.
- 19 Adhikari N, Adhikari M, Shrestha N, et al. Nutrition and food security in Nepal: a narrative review of policies. *Nutr Rev* 2023;81:1612–25.
- 20 World Health Organisation (WHO). Social determinants of health: key concepts. 2013. Available: <https://www.who.int/news-room/q-a-detail/social-determinants-of-health-key-concepts>
- 21 Dinsa GD, Goryakin Y, Fumagalli E, et al. Obesity and socioeconomic status in developing countries: a systematic review. *Obes Rev* 2012;13:1067–79.
- 22 Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. *Nutr Rev* 2012;70:3–21.
- 23 Hasan E, Khanam M, Shimul SN. Socio-economic inequalities in overweight and obesity among women of reproductive age in Bangladesh: a decomposition approach. *BMC Womens Health* 2020;20:263.
- 24 Let S, Tiwari S, Singh A, et al. Spatiotemporal change in wealth-based inequalities in overweight/obesity among women of reproductive age in India, 2015–2021. *Clin Epidemiol Glob Health* 2023;24:101458.
- 25 Neupane S, K.c. P, Doku DT. Overweight and obesity among women: analysis of demographic and health survey data from 32 Sub-Saharan African Countries. *BMC Public Health* 2015;16:1–9.
- 26 Jones-Smith JC, Gordon-Larsen P, Siddiqi A, et al. Cross-national comparisons of time trends in overweight inequality by socioeconomic status among women using repeated cross-sectional surveys from 37 developing countries, 1989–2007. *Am J Epidemiol* 2011;173:667–75.
- 27 Bhattarai S, Nerhus Larsen R, Shrestha A, et al. Association between socioeconomic positions and overweight/obesity in rural Nepal. *Front Nutr* 2022;9:952665.
- 28 Ford ND, Patel SA, Narayan KMV. Obesity in Low- and Middle-Income Countries: Burden, Drivers, and Emerging Challenges. *Annu Rev Public Health* 2017;38:145–64.
- 29 Jones-Smith JC, Gordon-Larsen P, Siddiqi A, et al. Emerging disparities in overweight by educational attainment in Chinese adults (1989–2006). *Int J Obes* 2012;36:866–75.
- 30 Shariful Islam M, Ola O, Alaboson J, et al. Trends and socioeconomic factors associated with overweight/obesity among three reproductive age groups of women in Nepal. *Lifestyle Medicine* 2022;3:1–9.
- 31 Rana K, Ghimire P, Chimoriya R, et al. Trends in the Prevalence of Overweight and Obesity and Associated Socioeconomic and Household Environmental Factors among Women in Nepal: Findings from the Nepal Demographic and Health Surveys. *Obesities* 2021;1:113–35.
- 32 Kinnunen TI, Bastola K, Neupane S. Trends in the Prevalence of Overweight and Obesity Among Women of Reproductive Age. *J Nepal Health Res Counc* 2021;19:252–8.
- 33 Kinnunen TI, Neupane S. Prevalence of overweight among women of childbearing age in Nepal: trends from 2001 to 2011 and associations with socio-demographic factors. *Matern Child Health J* 2014;18:1846–53.
- 34 Rai A, Gurung S, Thapa S, et al. Correlates and inequality of underweight and overweight among women of reproductive age: Evidence from the 2016 Nepal Demographic Health Survey. *PLoS One* 2019;14:e0216644.
- 35 DHS overview. The demographic and health surveys program. 2024 Available: <https://dhsprogram.com/Methodology/Survey-Types/DHS.cfm>
- 36 Family Health Division. Nepal demographic and health survey 2001. Calverton, Maryland, USA, 2002.
- 37 Ministry of Health and Population. Nepal demographic and health survey 2022. Kathmandu, Nepal, 2023.
- 38 Young Adult Health and Well-Being: A Position Statement of the Society for Adolescent Health and Medicine. *Journal of Adolescent Health* 2017;60:758–9.
- 39 World Health Organisation (WHO). Physical status: the use and interpretation of anthropometry. 1995. Available: <https://pubmed.ncbi.nlm.nih.gov/8594834/>
- 40 Wealth index. The demographic and health surveys program. 2022. Available: <https://dhsprogram.com/topics/wealth-index/>
- 41 Callister P, Didham R. Occupational structure - defining and measuring occupations [internet]. TE ARA - the Encyclopedia of New Zealand; 2025. Available: <http://www.teara.govt.nz/en/occupational-structure/page-1>
- 42 Coates J, Swindale A, Bilinsky P. *Household Food Insecurity Access Scale (HFIAS) for measurement of food access: indicator guide*. Washington DC: Food and Nutrition Technical Assistance (FANTA), FHI 360, 2007.
- 43 Australian Institute of Health and Welfare (AIHW). *Inequalities in overweight and obesity and the social determinants of health*. Canberra, 2021:1–66.
- 44 Candio P, Mujica FP, Frew E. Socio-economic accounting of inequalities in excess weight: a population-based analysis. *BMC Public Health* 2023;23:721.
- 45 Caleyachetty R, Kumar NS, Bekele H, et al. Socioeconomic and urban-rural inequalities in the population-level double burden of child malnutrition in the East and Southern African Region. *PLOS Glob Public Health* 2023;3:e0000397.
- 46 O'Donnell O, van DE, Wagstaff A, et al. *Analyzing health equity using household survey data, a guide to techniques and their implementation*. Washington DC: The World Bank, 2008.
- 47 Usmanov MM, Chimed-Ochir O, Batkhorol B, et al. Obesity, Burden of Ischemic Heart Diseases and Their Ecological Association: The Case of Uzbekistan. *Int J Environ Res Public Health* 2022;19:10447.
- 48 Peltzer K, Pengpid S, Samuels TA, et al. Prevalence of overweight/obesity and its associated factors among university students from 22 countries. *Int J Environ Res Public Health* 2014;11:7425–41.
- 49 Hayes A, Tan EJ, Killedar A, et al. Socioeconomic inequalities in obesity: modelling future trends in Australia. *BMJ Open* 2019;9:e026525.
- 50 National Health Service 75 Digital. Health survey for England 2018 [NS]. England, 2019. Available: <https://digital.nhs.uk/data-and>



- information/publications/statistical/health-survey-for-england/2018/summary
- 51 Zare H, Gaskin DD, Thorpe RJ. Income Inequality and Obesity among US Adults 1999-2016: Does Sex Matter? *Int J Environ Res Public Health* 2021;18:7079:1–13.
- 52 Yeshaw Y, Kebede SA, Liyew AM, *et al.* Determinants of overweight/obesity among reproductive age group women in Ethiopia: multilevel analysis of Ethiopian demographic and health survey. *BMJ Open* 2020;10:e034963.
- 53 Chowdhury MAB, Adnan MM, Hassan MZ. Trends, prevalence and risk factors of overweight and obesity among women of reproductive age in Bangladesh: a pooled analysis of five national cross-sectional surveys. *BMJ Open* 2018;8:e018468.
- 54 Elfaki BA. Factors contributes to overweight and obesity among young adults. *ijhs* 2023;7:698–709.
- 55 Mustar YS, Nissa FAK, Hariyanto A, *et al.* Self-reported assessment of occupational sitting and physical activity among employees. *Adv Soc Sci Educ Humanit Res* 2021;438–44.
- 56 World Bank. Strong link between education and earnings. n.d. Available: <https://blogs.worldbank.org/en/education/strong-link-between-education-and-earnings>
- 57 Mou W. A Quantitative Analysis of the Relationship between Education Level and Income. *J Educ Humanit Soc Sci* 2023;12:160–6.
- 58 Aitsi-Selmi A, Bell R, Shipley MJ, *et al.* Education modifies the association of wealth with obesity in women in middle-income but not low-income countries: an interaction study using seven national datasets, 2005-2010. *PLoS One* 2014;9:e90403.
- 59 Dahly DL, Adair LS. Does lower birth order amplify the association between high socioeconomic status and central adiposity in young adult Filipino males? *Int J Obes* 2010;34:751–9.