




RESEARCH ARTICLE

# Nationally representative surveys show gradual shifting of overweight and obesity towards poor and less-educated women of reproductive age in Nepal

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## Abstract

Overweight and obesity are considered major public health concerns all over the world. They have the potential to increase the risk of developing non-communicable diseases in reproductive age women, increasing their risk of pregnancy related complications and adverse birth outcome. This study was carried out to identify the trend of prevalence of overweight and obesity, along with their determinants, among reproductive age women (15–49 years) in Nepal. Data were taken from the nationally representative 2006, 2011 and 2016 Nepal Demographic and Health Surveys (NDHSs). Women were considered to be overweight or obese when their BMI was 23.0–27.5 kg/m<sup>2</sup> or  $\geq 27.5$  kg/m<sup>2</sup>, respectively. Univariate, bivariate and multivariate analyses were performed, with significance taken at  $p < 0.05$ . The prevalences of overweight and obesity both showed rising trends in women of reproductive age in Nepal from 2006 to 2016, particularly among those with no education, only primary education and poor women. The presence of overweight and obesity was found to be significantly associated with the sample women's age, educational status, wealth index, place of residence, ecological zone, developmental region, number of household members, marital status and ethnicity. In 2016 one in every three women of reproductive age in Nepal was either overweight or obese. As overweight and obesity have detrimental effects on women's health, the Government of Nepal, in collaboration with other government and non-government organizations, should take action to halt the rising trends in overweight and obesity in the country.

**Keywords:** Overweight and obesity; Women; Nepal

## Introduction

Overweight and obesity are emerging public health concerns all over the world because of their rising trend and adverse health impacts (Abarca-Gómez *et al.*, 2017). Globally, 857 million individuals were reported to be either overweight or obese in 1980, and the prevalence increased by 27.5% over subsequent decades, so that in 2013 around 2.1 billion people were estimated to be overweight or obese (Ng *et al.*, 2014). If this trend remains unchanged, more than half of the global adult population will be overweight (38%) or obese (20%) by 2030 (Kelly *et al.*, 2008).

Overweight and obesity disproportionately affect low- and middle-income countries (LMICs) (Popkin & Slining, 2013; Ford *et al.*, 2017). In 2013, around 671 million individuals were obese globally, of which nearly two-thirds (62%) were residents of developing countries (Ng *et al.*, 2014). In addition, of the ten countries with more than half of the total obese people in the world, eight are LMICs (Ford *et al.*, 2017). Between 1990 and 2015, the age-standardized BMI-related death rate also increased in LMICs although it showed a declining trend in high-income countries (GBD 2015 Obesity Collaborators, 2017). As an inevitable consequence of urbanization, economic development and demographic transition, overweight and obesity have become highly prevalent in South Asian countries, including India, Bangladesh, Pakistan, Sri Lanka, Bhutan and Maldives (Balarajan & Villamor, 2009; Mistry & Puthussery, 2015).

Both overweight and obesity are identified as well-established causes of global mortality and morbidity (Manson *et al.*, 1995; Abarca-Gómez *et al.*, 2017). In 2015, high Body Mass Index (BMI) was estimated to account for 4.0 million (7.1%) deaths and 120 million (4.9%) total Disability Adjusted Life Years globally (GBD 2015 Obesity Collaborators, 2017). Overweight and obesity are also thought to cause a wide range of non-communicable diseases such as hypertension, diabetes, cardiovascular disease, musculoskeletal disorder, and several kinds of cancers, e.g. oesophageal cancer, colon cancer, breast cancer and thyroid cancer (Lamon-Fava *et al.*, 1996; Klein *et al.*, 2002; Chen *et al.*, 2013; Arnold *et al.*, 2015; GBD 2015 Obesity Collaborators, 2017). High BMI is more detrimental for women because of its strong association with menstrual dysfunction and suppression of ovulation, which can lead to subfertility, infertility and miscarriage (Chong *et al.*, 1986; Hamilton-Fairley *et al.*, 1992; Zaadstra *et al.*, 1993). It is also well evident that overweight and obese mothers more frequently give birth to large-for-gestational-age (LGA) babies, who are at higher risk of developing metabolic syndrome and various NCDs later in life (Hanson *et al.*, 2002; Boney *et al.*, 2005; Morea *et al.*, 2013; Marchi *et al.*, 2015).

Like other countries in South Asia, Nepal is going through a demographic and epidemiological transition and thus facing a growing burden of overweight and obesity (Balarajan & Villamor, 2009; Stewart *et al.*, 2013; Koirala *et al.*, 2015). In 2008, only 8.9% of Nepalese adults were overweight or obese; this increased by more than two times over the next couple of years and in 2013 the prevalence was 21.0% (Aryal *et al.*, 2015). In Nepal, the prevalence of overweight and obesity has been found to vary by gender, socioeconomic status, ethnicity, area of residence and occupation (Vaidya *et al.*, 2010; Stewart *et al.*, 2013).

Although the prevalence of overweight and obesity among Nepalese adults has been documented in several studies, little information exists on women of reproductive age, and none for the trend of overweight and obesity among these women. Therefore, the present study aimed to identify the trend of the prevalence of overweight and obesity in women of reproductive age (15–49 years) in Nepal by analysing nationally representative data from the Nepal Demographic and Health Survey from 2006 to 2016. The study also investigated whether this prevalence changed over time and across the socio-demographic characteristics of women, and aimed to establish the determinants of overweight and obesity among these women.

## Methods

### *The Nepal Demographic and Health Survey*

Data obtained in this study were obtained from the 2006, 2011 and 2016 Nepal Demographic and Health Surveys (NDHSs). These surveys were funded by the Government of Nepal, supervised by the Ministry of Health and Population, Nepal, and carried out by the NEW ERA and the Macro International Inc.

The NDHS 2006 utilized the sampling frame of the 2001 population census conducted in Nepal. This was updated in 2011 for the Nepal National Population and Housing Census and,

therefore, NDHS 2011 and 2016 used this updated sampling frame. Both NDHS 2006 and 2011 used two-stage stratified (by area of residence: urban and rural) cluster sampling of households to select respondents. At the first stage, Primary Sampling Units (PSUs) were selected by Probability Proportional to Size (PPS) and using systematic random sampling. At the second stage, systematic sampling was used to select households from the PSUs. However, for NDHS 2016, two-stage and three-stage stratified cluster sampling techniques were used in rural and urban areas, respectively. In rural settings, PSUs were selected based on PPS at the first stage and households were selected by systematic random sampling during the second stage. However, in the case of urban settings, PSUs were selected based on PPS at the first stage followed by random selection of enumeration areas at the second stage. Later, households were selected from the enumeration areas by systematic random sampling during the third stage. The complete NDHS reports for 2006, 2011 and 2016 have been published previously (MOHP *et al.*, 2007, 2012, 2017).

### **Study participants**

Women of reproductive age (15–49 years) from the Nepalese surveys were considered as participants in the study. The total sample size for NDHS 2006, 2011 and 2016 combined was 23,375, but only 21,717 participants were analysed as those who were pregnant and who had given birth 2 months prior the survey were excluded from the study. The study participants were not the same for the three NDHS because the surveys were conducted cross-sectionally 5 years apart (MOHP *et al.*, 2007, 2012, 2017).

### **Outcome of interest**

The outcomes of interest were ‘overweight’ and ‘obesity’. The Asian cut-off values for these were used (Barba *et al.*, 2004). Women were considered to be overweight if their BMI was between 23.0 and  $<27.5 \text{ kg/m}^2$  and obese if their BMI was  $\geq 27.5 \text{ kg/m}^2$ .

### **Determinants**

The socio-demographic variables considered as possible determinants of overweight and obesity were: survey year (2006, 2011 and 2016); age in years (15–24, 25–34 and 35–49); educational status (no education, primary education, secondary education, higher education); economic status as given by the Wealth Index (poorest, poorer, middle, richer and richest); type of place of residence (urban and rural); ecological zone (Mountain, Hill and Terai); developmental region (Far-Western, Mid-Western, Western, Central and Eastern); number of household members (1–2, 3–4 and  $\geq 5$ ); working status (currently working and currently not working); marital status (currently married, formerly married and never married) and ethnicity (Brahman/Chhetri, Terai Middle Caste, Total Dalit, Newar, Hill Janajati, Terai Janajati, Muslim and Other). For the calculation of the Wealth Index, households were assigned scores based on the number and kinds of goods they owned, ranging from a television to a bicycle or car, and housing characteristics such as source of drinking water, toilet facilities and flooring material. These scores were derived using principal component analysis. Then, national wealth quintiles were calculated by assigning the household score to each usual household member, followed by ranking each person in the household population by their score then dividing the distribution into five equal categories, each comprising 20% of the population (MOHP *et al.*, 2017).

### **Statistical analysis**

Statistical analysis was performed using Stata Version 13.0. The women’s socio-demographic characteristics were analysed separately for each NDHS survey and presented as percentages

and frequencies. The Chi-squared test was performed to determine whether there was any significant relationship between the outcome variable (overweight and obesity) and each explanatory variable. Multiple logistic regression analysis was performed separately for overweight and obesity to identify their determinants. Associations between variables were considered statistically significant at  $p < 0.05$ . The survey set command (*svy*) was applied for the adjustment of sampling weight.

## Results

### *Socio-demographic information*

Table 1 shows the socio-demographic characteristics of the study participants. Around one-third of the participants in all three waves were aged between 15 and 24 years (2006, 39.6%; 2011, 39.2%; 2016, 36.5%). In 2006, more than half (53.0%) were uneducated, but this proportion gradually decreased over the next few years. The opposite trend was observed for the proportion of women attaining secondary and higher education. In each wave, about one-sixth of the participants received only primary-level education (2006, 17.4%; 2011, 17.7%; 2016, 16.3%). In 2006 and 2011, the majority of the participants were from rural areas (2006, 84.1%; 2011, 86.0%), but in 2016 nearly two-thirds lived in urban areas (63.2%). Among ecological zones, the Terai (2006, 50.3%; 2011, 53.6%; 2016, 49.5%) and among developmental regions, the Central region (2006, 32.6%; 2011, 32.8%; 2016, 36.0%), were the places where the majority of participants lived. In all three waves, the highest proportion of households had 5 or more members, followed by 3–4 members, with least proportion having 1–2 members. The proportion of households with 5 or more members gradually declined between 2006 and 2016 (2006, 69.0%; 2011, 60.4%; 2016, 57.2%), and there was an upward trend in households with 1–2 members (2006, 4.7%; 2011, 7.1%; 2016, 7.7%) and 3–4 members (2006, 26.2%; 2011, 32.5%; 2016, 35.1%). Higher proportions of women reported that they were working rather than not working in 2006 (72.2%), 2011 (62.0%) and 2016 (58.9%), but there was a declining trend over the period. Nearly three-quarters of the participants in all three waves were currently married (2006, 74.6%; 2011, 74.0%; 2016, 74.9%) and only a few stated that they were formerly married (2006, 3.8%; 2011, 3.1%; 2016, 2.9%). In all three waves, the majority of the participants were Brahman/Chhetri (2006, 34.2%; 2011, 35.7%; 2016, 31.9%) followed by Hill Janajati (2006, 22.4%; 2011, 25.0%; 2016, 22.0%).

### *BMI distribution*

The overall BMI distributions of Nepalese women for the three survey years are shown in Fig. 1. The mean (+SE) BMI increased from 20.60 (+0.04) in 2006 to 21.41 (+0.06) in 2011 and 22.19 (+0.07) in 2016. The BMI distribution showed a clear shift to the right, indicating a nutritional transition from underweight to overweight among reproductive age women in Nepal from 2006 to 2016. Similar findings were observed for the median and inter-quartile range (IQR) of BMI for the year 2006 (Median=20.12, IQR=22.12–18.54=3.58), 2011 (Median=20.90, IQR=23.27–19.09=4.18) and 2016 (Median=21.235, IQR=24.08–19.15=4.93).

### *Trends of prevalence of overweight and obesity*

Figure 2 shows the trend of the prevalence of overweight and obesity among the study women. The overall prevalence of overweight and obesity among women of reproductive age in Nepal increased over the 10-year period from 2006 to 2016. In 2006, 18.3% women were either overweight or obese, and this almost doubled over the following decade so that in 2016 more than one-third (35.2%) were either overweight or obese. In the case of overweight, the prevalence was 15.1% in 2006, and this increased steadily in following years so that in 2016 nearly a quarter of reproductive age women in Nepal were overweight (23.6%). The prevalence of obesity was only 3.2%

**Table 1.** Socio-demographic characteristics of reproductive age women in Nepal

Variable	2006 (N=9920)	2011 (N=5757)	2016 (N=6040)
	n (%)	n (%)	n (%)
<b>Age (years)</b>			
15–24	3973 (39.6)	2263 (39.2)	2262 (36.5)
25–34	2803 (28.4)	1675 (29.1)	1781 (30.4)
35–49	3144 (32.1)	1819 (31.8)	1997 (33.1)
<b>Educational status</b>			
No education	5198 (53.0)	2220 (39.3)	2094 (34.0)
Primary	1728 (17.4)	980 (17.7)	935 (16.3)
Secondary	2551 (25.6)	2083 (35.4)	2184 (35.5)
Higher	443 (4.0)	474 (7.6)	827 (14.3)
<b>Wealth index</b>			
Poorest	1979 (17.8)	1077 (16.3)	1276 (17.0)
Poorer	1830 (19.1)	1053 (18.9)	1227 (18.9)
Middle	1799 (20.4)	1066 (20.4)	1228 (20.2)
Richer	2100 (20.8)	1121 (21.4)	1252 (22.6)
Richest	2212 (21.9)	1440 (23.1)	1057 (21.2)
<b>Area of residence</b>			
Urban	2745 (15.9)	1644 (14.0)	3910 (63.2)
Rural	7175 (84.1)	4113 (86.0)	2130 (36.8)
<b>Ecological zone</b>			
Mountain	1365 (7.0)	925 (6.4)	430 (6.0)
Hill	3892 (42.7)	2247 (40.0)	2773 (44.6)
Terai	4663 (50.3)	2585 (53.6)	2837 (49.5)
<b>Developmental region</b>			
Eastern	2351 (22.4)	1354 (23.6)	1142 (22.6)
Central	2497 (32.6)	1341 (32.8)	1489 (36.0)
Western	1953 (19.3)	1082 (21.8)	1303 (20.1)
Mid-western	1547 (11.5)	1012 (11.4)	1250 (12.6)
Far-western	1572 (14.3)	968 (10.4)	856 (8.8)
<b>No. household members</b>			
1–2	452 (4.7)	398 (7.1)	455 (7.7)
3–4	2565 (26.2)	1850 (32.5)	2092 (35.1)
≥5	6903 (69.0)	3509 (60.4)	3493 (57.2)
<b>Working status</b>			
Currently not working	2667 (27.8)	2029 (38.0)	2408 (41.1)
Currently working	7253 (72.2)	3728 (62.0)	3632 (58.9)

*(Continued)*

Table 1. (Continued)

Variable	2006 (N=9920)	2011 (N=5757)	2016 (N=6040)
	n (%)	n (%)	n (%)
<b>Marital status</b>			
Never married	2141 (21.5)	1376 (23.0)	1323 (22.2)
Currently married	7389 (74.6)	4194 (74.0)	4542 (74.9)
Formerly married	390 (3.8)	187 (3.1)	175 (2.9)
<b>Ethnicity</b>			
Brahman/Chhetri	3873 (34.2)	2394 (35.7)	2163 (31.9)
Tarai Middle Caste	844 (9.4)	277 (6.9)	671 (14.2)
Total Dalit	1184 (11.3)	765 (14.1)	783 (12.2)
Newar	466 (4.3)	230 (4.0)	226 (5.1)
Hill Janajati	2165 (22.4)	1377 (25.0)	1266 (22.0)
Tarai Janajati	1023 (13.1)	583 (11.4)	652 (9.6)
Muslim	284 (3.3)	122 (2.8)	254 (4.7)
Other	81 (1.9)	9 (0.2)	25 (0.4)

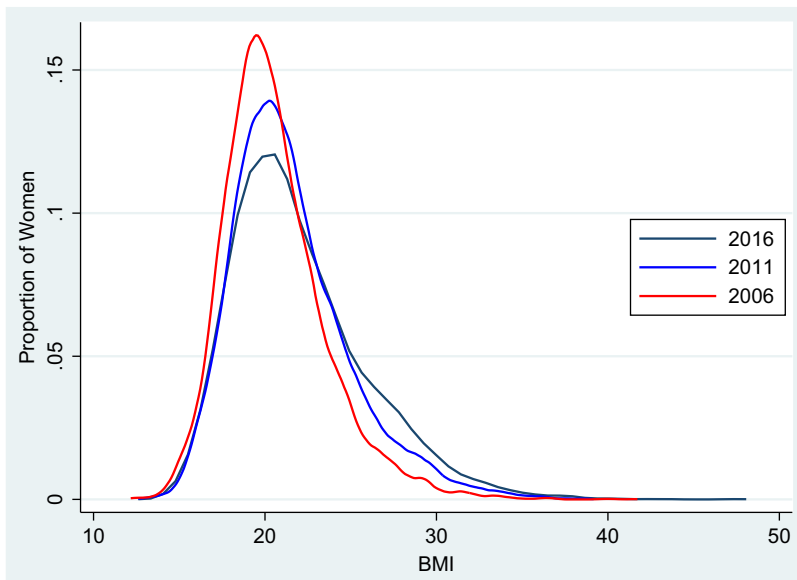
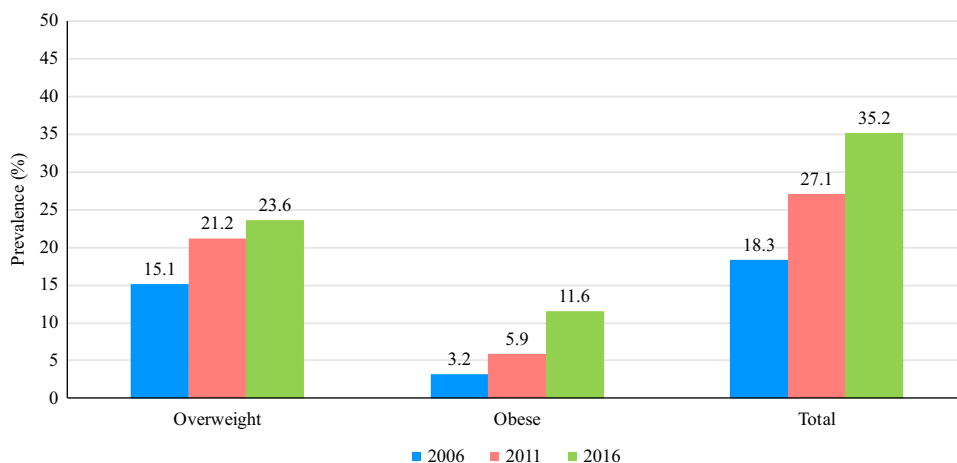


Figure 1. BMI distributions of reproductive age women in Nepal for the survey years 2006, 2011 and 2016.

among Nepalese women in 2006, but this almost doubled (5.9%) and quadrupled (11.6%) by the years 2011 and 2016 respectively.

**Trend of prevalence of overweight and obesity by socio-demographic variables**

Table 2 depicts the trends of prevalence of overweight and obesity among the study women by socio-demographic characteristics. In 2006, the highest prevalences of overweight and obesity



**Figure 2.** Trend of prevalence of overweight and obesity among reproductive age women in Nepal for the survey years 2006, 2011 and 2016.

were among women who received higher education (23.1%) and secondary education (4.6%), respectively. However, in 2016, the prevalences of both overweight and obesity were higher among women with only primary education (overweight, 27.6%; obesity, 14.7%). Obesity showed a rising trend from 2006 to 2016 in women from all categories, but for overweight a growing trend was observed only in the ‘no education’ and ‘primary education’ groups.

The prevalences of both overweight and obesity were highest among women in the richest wealth quintile in all three waves. Obesity showed a rising trend among women in all five wealth quintiles between 2006 and 2016. However, in the case of overweight, a rising trend was observed among participants belonging to the poorest, poorer, middle and richer quintiles. Among the richest women, the prevalence of overweight increased from 2006 (28.5%) to 2011 (34.2%) but then declined by 2016 (30.0%). The prevalences of overweight and obesity were highest among urban residents in all three waves. In rural settings, both overweight and obesity gradually increased from 2006 to 2016. In the case of urban women, the prevalence of overweight increased from 2006 (25.0%) to 2011 (28.6%) but then dropped by 2016 (24.9%). Interestingly, the urban–rural difference slowly decreased between 2006 and 2016 in terms of prevalence of overweight and obesity.

Among ecological zones, the highest prevalence of overweight and obesity was observed in the Hill area for all three waves. Obesity showed a rising trend among participants from all three ecological zones (Mountain, Hill and Terai) between 2006 and 2016, but overweight showed a similar trend in the Mountain and Hill regions only. In addition, the prevalence of overweight and obesity increased gradually in all developmental zones except for the Eastern region.

In the last two NDHS conducted in 2011 and 2016, the highest prevalences of overweight and obesity were observed among women with 1–2 family members. In large households (3 or more family members), the prevalence of both overweight and obesity steadily increased from 2006 to 2016. However, in small households (1–2 family members), a rising trend was observed in the case of obesity only. In the year 2006, overweight and obesity was highly prevalent among women who were not working, but in 2016, these prevalences were highest among working women. Among both working and non-working women, overweight and obesity showed a rising trend between 2006 and 2016. In all three waves, the prevalence of overweight was found to be highest among formerly married women. In the case of obesity, currently married women had the highest prevalence in 2006 and 2016, but in 2011, this prevalence was highest among formerly married women.

**Table 2.** Trend of prevalence of overweight and obesity among women of reproductive age group in Nepal by socio-demographic characteristics

Variable	2006		2011		2016	
	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity
<b>Educational status</b>						
No education	12.7 (11.6–13.9)	2.4 (1.9–3.0)	19.1 (17.2–21.1)	4.7 (3.7–5.8)	23.2 (21.2–25.4)	9.7 (8.2–11.5)
Primary	17.3 (15.1–19.6)	3.2 (2.2–4.6)	20.9 (18.0–24.2)	7.5 (5.7–9.7)	27.6 (24.4–31.1)	14.7 (12.2–17.6)
Secondary	17.0 (15.2–19.0)	4.6 (3.6–5.8)	22.7 (20.6–25.0)	6.1 (5.0–7.4)	21.5 (19.5–23.6)	11.3 (9.6–13.2)
Higher	23.1 (18.5–28.4)	3.8 (2.3–6.1)	26.4 (21.9–31.5)	7.6 (5.2–11.0)	25.5 (21.8–29.5)	13.8 (10.8–17.4)
<i>p</i> -value	<0.001	0.001	0.012	0.025	0.014	0.008
<b>Wealth index</b>						
Poorest	9.7 (8.2–11.4)	0.2 (0.06–.70)	11.4 (9.3–13.9)	0.8(.3–1.9)	20.5(18.1–23.1)	3.0(2.1–4.2)
Poorer	8.9 (7.4–10.6)	1.1 (.63–1.9)	14.3 (12.0–17.0)	2.1 (1.3–3.4)	22 (19.5–24.8)	6.4 (5.1–8.1)
Middle	10.5 (9.0–12.4)	1.4 (.77–2.4)	18.9 (16.2–22.0)	2.4 (1.6–3.8)	20.5 (18.0–23.2)	6.5 (5.2–8.1)
Richer	15.5 (13.7–17.5)	2.7 (2.0–3.6)	23.1 (20.2–26.2)	6.1 (4.6–7.9)	24.3 (21.4–27.4)	11.9 (9.7–14.5)
Richest	28.5 (26.1–31.0)	9.5 (8.0–11.3)	34.2 (31.2–37.3)	15.6 (13.4–18.0)	30.0 (26.8–33.3)	27.9 (24.6–31.5)
<i>p</i> -value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
<b>Area of residence</b>						
Urban	25.0 (22.8–27.5)	8.8 (7.3–10.5)	28.6 (26.1–31.3)	13.6 (11.8–15.7)	24.9 (23.2–26.7)	14.7 (13.3–16.3)
Rural	13.2 (12.2–14.1)	2.1 (1.7–2.6)	20.0 (18.7–21.5)	4.6 (3.9–5.5)	21.5 (19.7–23.4)	6.3 (5.3–7.5)
<i>p</i> -value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
<b>Ecological zone</b>						
Mountain	12.8 (10.8–15.1)	1.5 (.89–2.5)	15.8 (13.6–18.3)	3.3 (2.3–4.6)	25.7 (21.4–30.7)	9.3 (6.3–13.4)
Hill	19.0 (17.5–20.6)	4.2 (3.4–5.2)	22.6 (20.7–24.6)	6.2 (5.2–7.5)	26.5 (24.4–28.7)	14.8 (12.9–16.9)
Terai	12.0 (10.9–13.2)	2.5 (2.0–3.0)	20.9 (19.1–22.8)	6.0 (5.0–7.1)	20.8 (19.2–22.5)	9.1 (8.0–10.3)
<i>p</i> -value	<0.001	<0.001	0.014	0.078	<0.001	<0.001

(Continued)



Table 2. (Continued)

Variable	2006		2011		2016	
	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity
<b>Developmental region</b>						
Eastern	14.7 (13.1–16.4)	2.9 (2.2–3.8)	24.2 (21.5–27.2)	6.2 (4.7–8.0)	22.3 (19.9–24.9)	11.4 (9.6–13.4)
Central	17.0 (15.3–18.8)	4.5 (3.5–5.6)	21.4 (19.0–24.0)	8.0 (6.5–9.7)	24.3 (21.8–27.0)	15.1 (12.9–17.6)
Western	18.5 (16.6–20.6)	3.8 (2.9–4.9)	25.1 (22.3–28.0)	6.2 (4.9–7.8)	28.9 (26.4–31.5)	13.4 (11.6–15.5)
Mid-western	13.4 (11.3–15.8)	1.6 (.89–2.9)	15.0 (12.8–17.5)	3.1 (2.2–4.3)	21.2 (18.7–24.0)	5.1 (3.9–6.7)
Far-western	7.8 (5.9–10.2)	0.9 (.34–2.1)	12.9 (10.6–15.6)	1.3 (.74–2.2)	15.8 (13.4–18.6)	3.6 (2.4–5.4)
<i>p</i> -value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
<b>No. household members</b>						
1–2	24.1 (19.5–29.5)	3.2 (1.7–5.8)	30.9 (25.6–36.7)	7.9 (5.2–11.7)	29.9 (25.4–34.8)	19.3 (15.0–24.3)
3–4	17.1 (15.3–18.9)	4.5 (3.5–5.7)	24.3 (22.0–26.8)	7.5 (6.2–9.0)	26.4 (24.1–28.8)	14 (12.2–16.1)
≥5	13.7 (12.7–14.7)	2.6 (2.1–3.2)	18.5 (17.0–20.1)	4.8 (4.0–5.7)	21.1 (19.6–22.7)	9.2 (8.0–10.5)
<i>p</i> -value	<0.001	0.002	<0.001	0.002	<0.001	<0.001
<b>Working status</b>						
Currently not working	17.8 (16.0–19.7)	4.3 (3.5–5.4)	20.3 (18.3–22.5)	7.1 (5.9–8.5)	21.3 (19.4–23.2)	11.2 (9.7–12.9)
Currently working	14.0 (13.0–15.0)	2.7 (2.2–3.3)	21.8 (20.2–23.5)	5.2 (4.4–6.1)	25.3 (23.6–27.1)	12 (10.6–13.5)
<i>p</i> -value	<0.001	0.001	0.273	0.011	0.002	0.472
<b>Marital status</b>						
Never married	10.8 (9.2–12.5)	0.8 (.43–1.5)	11.3 (9.5–13.4)	2.0 (1.2–3.1)	12.6 (10.5–15.0)	2.2 (1.5–3.4)
Currently married	16.2 (15.1–17.2)	3.9 (3.3–4.5)	24.1 (22.5–25.7)	7.0 (6.2–8.0)	26.5 (25.0–28.0)	14.5 (13.2–15.9)
Formerly married	17.6 (13.2–23.0)	2.7 (1.5–4.7)	27.7 (20.3–36.4)	7.7 (4.2–13.7)	34.9 (26.3–44.7)	9.4 (5.2–16.3)
<i>p</i> -value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

(Continued)

**Table 2.** (Continued)

Variable	2006		2011		2016	
	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity
<b>Ethnicity</b>						
Brahman/Chhetri	15.5 (14.1–17.0)	3.2 (2.6–3.9)	22.3 (20.3–24.5)	6.7 (5.6–8.0)	23.6 (21.4–25.9)	13.3 (11.3–15.6)
Terai Middle Caste	8.7 (6.9–11.1)	1.1 (0.5–2.3)	15.8 (11.5–21.2)	4.0 (2.3–7.1)	15.5 (12.9–18.5)	5.3 (3.8–7.3)
Total Dalit	9.5 (7.7–11.8)	1.3 (0.6–2.4)	15.6 (12.6–19.1)	4.6 (3.0–7.1)	22.7 (19.0–26.8)	8.9 (6.9–11.6)
Newar	23.3 (18.6–28.9)	11.1 (7.4–16.3)	37.8 (30.8–45.3)	12.3 (8.1–18.3)	34.9 (27.7–42.9)	22.5 (16.2–30.4)
Hill Janajati	22.8 (20.8–25.0)	5.1 (4.0–6.5)	26.5 (23.8–29.3)	6.6 (5.3–8.3)	30.1 (27.4–33.1)	15.7 (13.4–18.2)
Terai Janajati	9.3 (7.0–12.1)	0.8 (0.3–2.5)	13.4 (10.5–17.0)	1.8 (0.8–3.9)	18.5 (15.4–22.1)	5.1 (3.5–7.4)
Muslim	8.3 (5.4–12.8)	2.2 (0.7–6.6)	11.2 (6.1–19.6)	7.5 (3.6–15.2)	16.0 (11.9–21.2)	9.0 (6.0–13.4)
Other	11.4 (5.4–22.6)	0.6 (0.001–4.3)	29.4 (8.7–64.8)	12.7 (1.8–54.1)	56.1 (33.6–76.4)	15.2 (5.5–35.7)
<i>p</i> -value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Association between the covariates and outcome were examined using the Chi-squared test and a *p*-value of 5% was taken as significant. Range given in parentheses beside each prevalence figure; 95% CI calculated based on exact binomial distribution for the prevalence.

The prevalence of overweight and obesity increased from 2006 to 2016 in all ethnic groups except for the Terai Middle Caste and Newar. Among the Terai Middle Caste and Newar, the prevalence of obesity increased over this period, but that of overweight slightly decreased from 2011 to 2016 after initial growth between 2006 and 2011.

### **Determinants of overweight and obesity**

Table 3 shows the determinants of overweight and obesity among the study women by socio-demographic characteristics. The risk of being overweight and obese increased significantly from 2006 to 2016 among these Nepalese women. Compared with those of the 2006 NDHS, women from the 2011 NDHS and 2016 NDHS were at 1.4 times ( $p<0.001$ ) and 1.7 times ( $p<0.001$ ) higher risk of being overweight, respectively. Similarly, women from the 2011 NDHS and 2016 NDHS were 1.8 times ( $p<0.001$ ) and 3.8 times ( $p<0.001$ ) more likely to be obese, respectively (Table 3). Developing overweight and obesity among Nepalese women were found to be associated with their age, educational status, wealth index, living place in terms of area of residence, ecological zone and developmental region, number of household members and marital status. Women aged 25–34 and 35–49 years were 1.7 times and 2.0 times more likely to be overweight, respectively, than their counterparts who were 15–24 years old. Likewise, women aged 25–34 years and 35–49 years were 4.0 times and 8.1 times, respectively, more likely to be obese than those who were 15–24 years old. In the case of both overweight and obesity, this association was found to be statistically significant ( $p<0.001$ ).

The risk of being overweight and obese increased with increasing level of education. Participants who received primary and secondary education were 1.3 times more likely to be overweight, and 1.6 times and 1.5 times more likely to be obese, than those who did not receive any education ( $p<0.001$ ). Interestingly, women attaining higher education were at greater risk of developing overweight, but not obesity.

The risk of being overweight and obese increased significantly with improving economic status. Compared with women in the lowest wealth quintile (poorest), those in the poorer and middle quintiles were 1.2 and 1.5 times more likely to be overweight, and 2.9 and 3.6 times more likely to be obese, respectively. Also, richer and richest women were at 1.9 times and 2.9 times higher risk of being overweight ( $p<0.001$ ) and 7.2 times and 17.6 times more likely to be obese ( $p<0.001$ ) than the poorest women.

The risk of obesity was found to be higher among urban women than their rural counterparts ( $p=0.006$ ), but this was not the case for overweight. Participants residing in the Hill and Mountain regions were 1.2 times and 1.3 times more likely to be overweight, and 1.3 times and 1.7 times more likely to be obese, respectively, than those living in the Terai region ( $p<0.001$ ). Women residing in the Mid-western, Western, Central and Eastern regions were at higher risk of being overweight and obese than those living in the Far-western region, and these associations were found to be statistically significant.

The risk of developing overweight and obesity showed a negative association with increasing family size. Participants with 3–4 family members were at 20% lower risk of being overweight and at 10% lower risk of being obese than those with 1–2 family members. Similarly, women with 5 or more family members were at 30% lower risk of being overweight and 20% lower risk of being obese than with 1–2 family members. The association was found statistically significant only in case of overweight.

The risk of being overweight 1.7 times and 1.9 times higher among currently married and formerly married women, respectively, compared with never-married women ( $p<0.001$ ). However, in comparison to never-married women, the risk of being obese was significantly higher only among currently married women ( $p<0.001$ ).

Respondents from the Terai Middle Caste were 32% and 47% less likely to be overweight and obese, respectively, whereas the Hill Janajatis were 68% and 82% more likely to be overweight and

**Table 3.** Determinants of overweight and obesity among reproductive age group women in Nepal

Variable	Overweight			Obesity		
	Odds Ratio	95% CI	p-value	Odds Ratio	95% CI	p-value
Survey year						
2006 (Ref.)						
2011	1.4	1.289–1.599	<0.001	1.8	1.488–2.274	<0.001
2016	1.7	1.487–1.877	<0.001	3.8	3.113–4.749	<0.001
Age (years)						
15–24 (Ref.)						
25–34	1.7	1.504–1.947	<0.001	4.0	2.945–5.467	<0.001
35–49	2.0	1.732–2.295	<0.001	8.1	5.848–11.203	<0.001
Educational status						
No education (Ref.)						
Primary	1.3	1.143–1.49	<0.001	1.5	1.227–1.934	<0.001
Secondary	1.3	1.128–1.49	<0.001	1.6	1.269–2.029	<0.001
Higher	1.3	1.053–1.581	0.014	1.1	0.832–1.587	0.397
Wealth index						
Poorest (Ref.)						
Poorer	1.2	1.015–1.384	0.032	2.9	1.92–4.294	<0.001
Middle	1.5	1.256–1.727	<0.001	3.6	2.353–5.382	<0.001
Richer	1.9	1.634–2.275	<0.001	7.2	4.873–10.682	<0.001
Richest	2.9	2.435–3.504	<0.001	17.6	11.742–26.322	<0.001
Area of residence						
Rural (Ref.)						
Urban	1.0	0.913–1.134	0.758	1.3	1.078–1.551	0.006
Ecological zone						
Terai (Ref.)						
Hill	1.2	1.034–1.289	0.011	1.3	1.081–1.554	0.005
Mountain	1.3	1.077–1.492	0.004	1.7	1.182–2.316	0.003
Developmental region						
Far-western (Ref.)						
Mid-western	1.4	1.133–1.634	0.001	1.6	1.005–2.506	0.048
Western	1.5	1.265–1.804	<0.001	1.9	1.257–2.882	0.002
Central	1.3	1.072–1.535	0.007	2.2	1.463–3.329	<0.001
Eastern	1.4	1.159–1.658	<0.001	2.2	1.424–3.314	<0.001
No. household members						
1–2 (Ref.)						
3–4	0.8	0.651–0.917	0.003	0.9	0.659–1.154	0.340
≥5	0.7	0.606–0.845	<0.001	0.8	0.605–1.044	0.099

(Continued)

Table 3. (Continued)

Variable	Overweight			Obesity		
	Odds Ratio	95% CI	<i>p</i> -value	Odds Ratio	95% CI	<i>p</i> -value
Working status						
Currently not working (Ref.)						
Currently working	1.0	0.874–1.074	0.551	0.9	0.744–1.043	0.141
Marital status						
Never married (Ref.)						
Currently married	1.7	1.49–2.016	<0.001	2.5	1.688–3.686	<0.001
Formerly married	1.9	1.415–2.451	<0.001	1.3	0.757–2.398	0.310
Ethnicity						
Brahman/Chhetri (Ref.)						
Terai Middle Caste	0.7	0.563–0.826	<0.001	0.5	0.377–0.753	<0.001
Total Dalit	1.0	0.841–1.164	0.899	1.4	1.015–1.826	0.040
Newar	1.4	1.133–1.733	0.002	1.3	0.943–1.803	0.108
Hill Janajati	1.7	1.495–1.885	<0.001	1.8	1.491–2.22	<0.001
Terai Janajati	0.9	0.746–1.086	0.270	0.6	0.414–0.964	0.033
Muslim	0.7	0.501–0.888	0.006	1.2	0.767–1.878	0.424
Other	1.1	0.595–1.882	0.848	0.4	0.135–1.207	0.104

obese compared with their counterparts from the Brahman/Chhetri caste. Of the other ethnic groups, Muslims and Terai Janajatis were at lower risk of being overweight and obese, but Newars and Dalits were at higher risk of being overweight and obese compared with respondents from the Brahman/Chhetri caste.

## Discussion

This study identified the trend of prevalence of overweight and obesity, and their determinants, among Nepalese women of reproductive age using nationally representative data obtained from the NDHS 2006, 2011 and 2016. A similar study was conducted in Nepal by Balarajan and Villamor (2009) using nationally representative data for between 1996 and 2006.

The study demonstrated that the prevalence of overweight and obesity increased among reproductive age Nepalese women over the 10-year period from 2006 to 2016, and that in 2016 more than one-third of women (35.2%) were either overweight (23.6%) or obese (11.6%). This result is in accordance with the finding of other studies, which have reported an increasing trend of overweight and obesity among women from different LMICs in South Asia and Africa. According to the National Family Health Survey Report, the prevalence of overweight and obesity increased from 13.0% in 2005–06 to 21.0% in 2015–16 among women of reproductive age in India (IIPS & ICF, 2017). Similarly, a recently published review article affirmed that the prevalence of overweight and obesity has increased among women of reproductive age in Bangladesh since 2000, and as of 2017, one out of every four adult women in Bangladesh are either overweight or obese (Hasan *et al.*, 2017). Another study reported that the proportion of overweight and obese women had increased significantly between 1993 and 2014 in several developing countries in

Africa, including Ghana (overweight: 17.9% to 30.4%; obesity: 7.7% to 22.0%), Kenya (overweight: 19.5% to 28.9%; obesity: 6.4% to 15.0%) and Burkina Faso (overweight: 14.0% to 16.5%; obesity: 3.8% to 9.5%) (Amugsi *et al.*, 2017).

The rising trend of weight gain among Nepalese women might be explained by the shifting dietary habits of Nepalese people towards significantly higher amounts of plant and animal fats, sugars and processed foods (Subedi *et al.*, 2015). Over the 30-year period from 1970 to 2010, the consumption of meat, plant oil and sugar increased three-fold (1970, 13 g/capita/day; 2010, 39 g/capita/day), seven-fold (1970, 10 g/capita/day; 2010, 65 g/capita/day) and ten-fold (1970, 4 g/capita/day; 2010, 57 g/capita/day), respectively, in Nepal (Subedi *et al.*, 2015). Nepalese people are also consuming energy-dense junk food and processed food more than ever before, possibly due to their easy availability in local markets and supermarkets (Subedi *et al.*, 2015). In addition, many people do not eat enough fruit and vegetables and do not perform regular physical activity as per WHO recommendations (MOHP *et al.*, 2014). Social networks of women with larger body sizes might also contribute to this trend, by portraying larger body size as the social norm (Christakis & Fowler, 2007; Lancki *et al.*, 2018). Nepalese people's attitude of considering being overweight as an indication of affluence might also play a role (Simkhada *et al.*, 2011).

The study showed that both overweight and obesity had a rising trend among less-educated women in Nepal (with only primary education), but the opposite trend was observed in the case of women who received secondary or higher education. A study conducted in Hong Kong reported that the prevalence of overweight and obesity decreased with increasing level of education and the highest prevalence was reported among women who attained only primary education (69.8%) (Woo *et al.*, 1999). This could have been due to differences in the dietary habits of women of different educational status, as reported in the study: primary-educated women consumed more carbohydrates and less fruit (carbohydrates: 137.9 g/1000 kcal/day; fruit: 1453 g/week) than their counterparts who received secondary (carbohydrates: 130.5 g/1000 kcal/day; fruit: 1572 g/week) or tertiary level education (carbohydrates: 130.3 g/1000 kcal/day; fruit: 1899 g/week) (Woo *et al.*, 1999). With the economic development of a country, the pattern of influence of education on dietary habits and high BMI levels changes over time, and in transitional societies better education acts as a protective factor for developing overweight and obesity, perhaps due to the adoption of healthy dietary habits by women with higher levels of education (Kain *et al.*, 2003). However, further research is required to draw conclusions about the changing pattern of influence of education on the prevalence of overweight and obesity among Nepalese women.

This study also revealed that the prevalence of overweight and obesity has shown a rising trend among the poorest and poorer quintile women in Nepal, although in the case of the richest quintile women, the prevalence declined from 2011 to 2016. If this trend continues, it is possible that in the future, a higher proportion of women of low socioeconomic status will be overweight or obese in comparison to their counterparts from well-off households. A previous study reported that in developing nations that are going through nutritional transition, affluent women less-frequently experience overweight and obesity (Kain *et al.*, 2003). This might be explained by the fact that educated women from well-off families have the opportunity to consume healthier diets, as well as to perform regular physical exercise, which help them keep their body weight within normal limits (Kain *et al.*, 2003). On the other hand, a rising trend of overweight and obesity among the poorer and poorest quintile women might be explained by the concept of adaptive genetic factors as proposed by Thrifty Genotype Hypothesis (Deutsch *et al.*, 1985). This states that people consuming inadequate food gradually develop an adaptive mechanism in their bodies that helps them to manage efficient use of energy and in fat deposition. These people, when starting regular food intake, become more prone to developing overweight or obesity (Deutsch *et al.*, 1985). Another reason for this trend might be that poor people cannot afford healthy food items such as fish, fruit and vegetables because of their high price and thus consume more energy-dense food (Subedi *et al.*, 2015). A lack of knowledge on healthy diets and physical activity might also be a factor

(Stunkard, 2000). A wide range of chronic diseases such as hypertension, diabetes mellitus, stroke, ischaemic heart disease and cancers, are attributable to overweight and obesity (Mokdad *et al.*, 2003). All these diseases are non-curable and need life-long treatment as well as regular follow-up for prevention of complications, premature death and disability. However, the health system of Nepal is not well equipped to provide high-quality, affordable health care for these diseases (Dhitali & Arjun, 2013; Misra *et al.*, 2017). Therefore, stakeholders should take immediate steps to curb the burden of overweight and obesity among poor women considering its adverse health and economic consequences.

Health, education, empowerment and nutritional outcomes among women vary across region, caste and ethnicity in Nepal (Pandey *et al.*, 2013; Hodge *et al.*, 2015). Studies have found that the Hill and Mountain regions perform better in comparison to the Terai region in these indicators (Hodge *et al.*, 2015; Subedi, 2016). Along with resource constraint and the lack of suitable policies in the Terai region, deep-rooted hierarchical caste/ethnic structures and restrictive gender relations might be responsible for its poor performance on these indicators (Bhandari, 2018). The findings of this study echo this pattern of regional variation in the case of high BMI prevalence among women. Women residing in the Hill and Mountain zones were more likely to develop overweight and obesity in comparison to their counterparts from the Terai zone. This might be because women from the Hill and Mountain regions had better food security (both quality and quantity), financial solvency and better education (MOHP *et al.*, 2017; Bhandari, 2018). Being more empowered in terms of having health care access, making major household purchases, making purchases for daily household needs by Hill and Mountain region women also might play role (Bennett *et al.*, 2008; Pandey *et al.*, 2013). In addition, the higher prevalences of early marriage and adolescent pregnancy prevailing in the Terai zone (Bennett *et al.*, 2008; Guragain *et al.*, 2017) might incidentally prevent women gaining excessive body weight. Nevertheless, further research adopting a longitudinal design is warranted to understand the exact reasons why Hill and Mountain region women are more prone to being overweight and obese.

The study found that the risk of being obese was positively associated with urban residence. This validates the results of previous studies conducted in Nepal and across the globe identifying urbanization as an important determinant of high body weight in women (Kain *et al.*, 2003; Adair, 2004; Mendez *et al.*, 2005; Kinnunen & Neupane, 2014). Urbanization has the potential to have a significant impact on the life-style of women. One study reported that people residing in urban areas are usually involved in sedentary work, which makes them physically inactive (Kain *et al.*, 2003). Urbanization also influences women to shift their dietary pattern to high-calorie and processed food (Popkin, 2001). This is exacerbated by the use of motor vehicles for travel and watching TV during leisure time (Kain *et al.*, 2003). Hence, policymakers and public health professionals in Nepal should prioritize urban women when designing programmes for the prevention of overweight and obesity in women.

The risk of being overweight and obese significantly increased with increasing age and improvement in socioeconomic status among the study participants. The proportions of elderly ( $\geq 25$  years) as well as richer and richest quintile women showed a rising trend. Therefore, it is inevitable that, in Nepal, the number of overweight and obese women will increase over the coming years. Excessive body weight is a well-established risk factor for several chronic non-communicable diseases such as diabetes mellitus, cardiovascular diseases, chronic kidney disease, non-alcoholic fatty liver disease, arthritis and some cancers (Manson *et al.*, 1995; Mokdad *et al.*, 2001; GBD 2015 Obesity Collaborators, 2017). Overweight and obesity need further attention if it affects reproductive age group women because such women become pregnant and both of these conditions have the potential to pose detrimental effect on maternal and child health (Sebire *et al.*, 2001; Hanson *et al.*, 2002). In a recently conducted systematic review, it was found that overweight and obese women were at greater risk of developing pregnancy-related complications like gestational diabetes, preeclampsia and eclampsia than

women of normal body weight (Athukorala *et al.*, 2010; Marchi *et al.*, 2015). Obese mothers are more likely to experience adverse birth outcomes such as preterm delivery, neonatal death and giving birth to babies with congenital anomalies (Leddy *et al.*, 2008). Children of obese mothers are at higher risk of developing cardiovascular diseases and diabetes in adulthood (Hanson *et al.*, 2002; Leddy *et al.*, 2008). Therefore, there is a timely need for pertinent stakeholders in Nepal to take the steps necessary to prevent and control overweight and obesity among women of reproductive age considering its long-term consequences.

The study has its strengths and limitations. It used nationally representative data, so its findings can be generalized to all reproductive age women in Nepal. Rigorous methodology, along with a large sample size, make the findings more credible in comparison to other single cross-sectional studies. In addition, the inclusion of data from the last three NDHS, including the NDHS 2016, helped to identify the changing pattern of overweight and obesity prevalence across socio-demographic variables over time. However, because data were obtained from repeated cross-sectional surveys, it was not possible to establish a causal relationship between overweight and obesity and its determinant factors. It was not possible to use the latest province-based administrative structure of Nepal to present this study results because only NDHS 2016 used this latest structure.

In order to curb the burden of overweight and obesity in women in Nepal, it is crucial to raise community awareness on the adverse health consequences of gaining excessive body weight and the harmful effects of an unhealthy diet and inadequate physical activity. As the body size norm has the potential to influence women's weight-related behaviour modification, health education campaigns need to be organized to raise awareness on healthy body weight. Both mass media (television, newspaper, billboard) and social media (Facebook, Twitter) can be used for this purpose. Incorporating these issues into the national school curriculum, and keeping physical activity as a component of student evaluation in girls' school, might play a pivotal role in this. Community-based volunteer group can be formed to arrange sessions with parents, teachers, local influential people and religious leaders to make them interested about the importance of maintaining a healthy body weight for women so that they can motivate and assist girls from an early age to keep a normal body weight. Doctors and other health care providers can guide pregnant women to maintain a normal body weight when they visit for antenatal and/or postnatal care. It is also imperative to create an enabling environment for women so that they can perform physical activities such as walking, cycling and swimming without any obstacles. The government, in collaboration with different non-government organizations, should develop and implement policies to control the production, purchase and advertisement of junk food, as well as to make healthy foods (fish, fruits and vegetables) accessible and affordable to people from the poorest families.

The prevalence of overweight and obesity have increased among reproductive age group women in Nepal throughout the last decade. This prevalence has shown a rising trend among women from the lowest wealth quintile and with less education, but has started to decline among well-off and educated women. Pertinent stakeholders of Nepal should take the necessary steps to halt the rising trend of this harmful health event across all socioeconomic groups considering its devastating effect on women's health, as well as on the health of the next generation.

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