

Temporal Trends, Socio-Economic Inequalities in Obesity and Responses by Federal Government, Nepal: A Systematic Review of Observational Studies, Policies, Strategies and Plans, 2005-2019

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ABSTRACT

Introduction

Obesity has risen to epidemic proportions in low-income countries like Nepal, where maternal and child under-nutrition has reduced steadily. However, synthesised evidence on transition to obesity remains unavailable. We assessed trends and disparities in obesity occurrence, and examined central government's policies and programmes.

Methods

We searched PubMed and Google Scholar for articles published between January 1, 2005 and April 10, 2019, and websites of Demographic and Health Survey, Non-Communicable Diseases Risk Factor Survey, and Micronutrient Status Survey. We synthesised obesity and overweight prevalence data from the selected studies, narratively; and disaggregated latest proportions from nation-wide surveys by gender, geographical location and household wealth quintile. We charted obesity related actions from policies, strategies and plans; obtained through the websites of health ministry and government's planning commission.

Results

Twenty studies with data from 79,082 men and women aged 15 years or more and 11,866 children under five years, were included. Obesity or overweight among men and women increased from 20.0% in 2004 to 36.1% in 2016. Obesity alone rose from 5.3% to 7.5%. National average prevalence of childhood obesity or overweight remained very low. Overweight and obesity were more common among women, inhabitants of urban areas and central provinces, and the affluent. Governmental policies, strategies and plans on nutrition were primarily designed to control under-nutrition, with implications for preventing obesity.

Conclusion

Overweight and obesity increased substantially between 2005 and 2019, disproportionately affecting socio-economic and geographical groups. Governmental nutritional strategies should consider addressing obesogenic environments.

Keywords

Malnutrition; nutrition transition; obesity; obesity prevention; overweight

INTRODUCTION

Obesity has become a major public health challenge worldwide, with rapid increments in prevalence in numerous low-income countries.¹⁻⁵ Worldwide prevalence of adult overweight and obesity, defined as a body mass index (BMI) of 25 kg/m² or more, increased from 21-24% to nearly 40% between 1975 and 2016.⁶ Although excess body weight was predominantly affecting wealthy countries in the past, the epidemic has deeply entrenched all parts of the world. However the occurrence of obesity differs substantially across countries and regions. Most of the low- or middle- income nations have witnessed a steady rise, whereas several wealthier countries have observed a stabilisation or, at instances, reduction in the recent years.⁷⁻²³ Obesity is a known risk for chronic conditions such as cardiovascular diseases, type 2 diabetes, and some types of cancers.^{24, 25}

Although the decline in maternal and child under-nutrition is recorded; literature on the transition into coexisting obesity is rather scant, and a comprehensive synthesis of the trends is critically missing. Over the past several years, Nepal witnessed a steady reduction in maternal and child under-nutrition attributed to a range of improvements in socio- economic and health sectors.²⁶ However, this has come at the cost of increments in population obesity. Excess body weight accounts for 5% of mortality among Nepali people, which is much higher than proportion of deaths attributable to wasting (1.2%) or underweight (0.4%) among children.²⁷ A number of studies have been conducted to assess the magnitude of overweight and obesity among Nepali people,²⁸⁻³⁰ including a review published a decade ago.³¹ Yet, a synthesised body of evidence concerning Nepal's obesity epidemic remains unavailable.

We addressed this gap by assessing Nepal's trends in prevalence of overweight and obesity among children and adults over the past one and a half decade; examining disparities across gender, geographical locations and household wealth; and taking stock of governmental nutrition policies, strategies and plans for their significance in preventing and controlling obesity.

METHODS

Literature search and selection

We scoured seven bibliographic databases for locating research outputs and policy papers. Initially, we enumerated an exhaustive list of a) research articles by searching US National Library of Medicine (through PubMed) and Google Scholar, and b) reports of nationwide cross- sectional surveys, namely Demographic and Health Survey

(DHS), Non-communicable Diseases Risk Factor Survey (STEPS) and Nepal National Micronutrient Status Survey (NNMSS) searching manually on their official websites; published between January 1, 2005 and April 10, 2019. We retrieved obesity-related national policies, strategies and programmes from the websites of Ministry of Health and Population (which implements the government's health sector nutrition programmes) and the National Nutrition and Food Security Secretariat (which coordinates nutrition activities across half a dozen sectors and maintains a repository of nutrition and food security related policies, strategies and plans). Search terms used and results obtained from these databases are available online at International prospective register of systematic reviews (PROSPERO CRD42019132332) https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=132332.

We included studies if: 1) they were published in English between 1 January 2005 and 10 April, 2019; 2) reported prevalence of either obesity or overweight; 3) age of participants was either 0-5 years or 15 years and above.; and 4) were adequately powered using a sufficiently large sample size. We rendered the studies ineligible if they: 1) did not adopt cross-sectional and population based designs; 2) did not report prevalence of obesity or overweight; 3) they reported prevalence among older children, adolescents or elderly only; 4) were reviews of published articles; 5) were analyses of data from secondary sources; or 6) were conducted outside of Nepal (among diaspora Nepali) underpowered studies; and 7) those with any of the key characteristics (design, population, geographical coverage, sampling technique and size) missing were also excluded. However, we included all of the nutrition nutrition-specific policies, strategies and plans promulgated by the federal government in the health or closely related sectors.

AB developed the search combinations and discussed with DA through the revisions. AB performed literature search, repeated and updated by DA. AB performed initial screening, followed by DA, independently. First, an inter-rater disagreement of 17.8% was observed, which was eliminated after 2 rounds of re-screening and resolution through discussion.

Data extraction and synthesis

Study period (years and months, where available), geographical coverage, study population (gender, age), sampling procedures, sample size, cut-off points used to define overweight and obesity, and prevalences of overweight or obesity (combined), overweight and obesity were charted from the included papers, by AB and verified by DA. Owing to a variation among studies by age of participants, geographical and cultural settings and sampling procedures, we preferred to conduct narrative

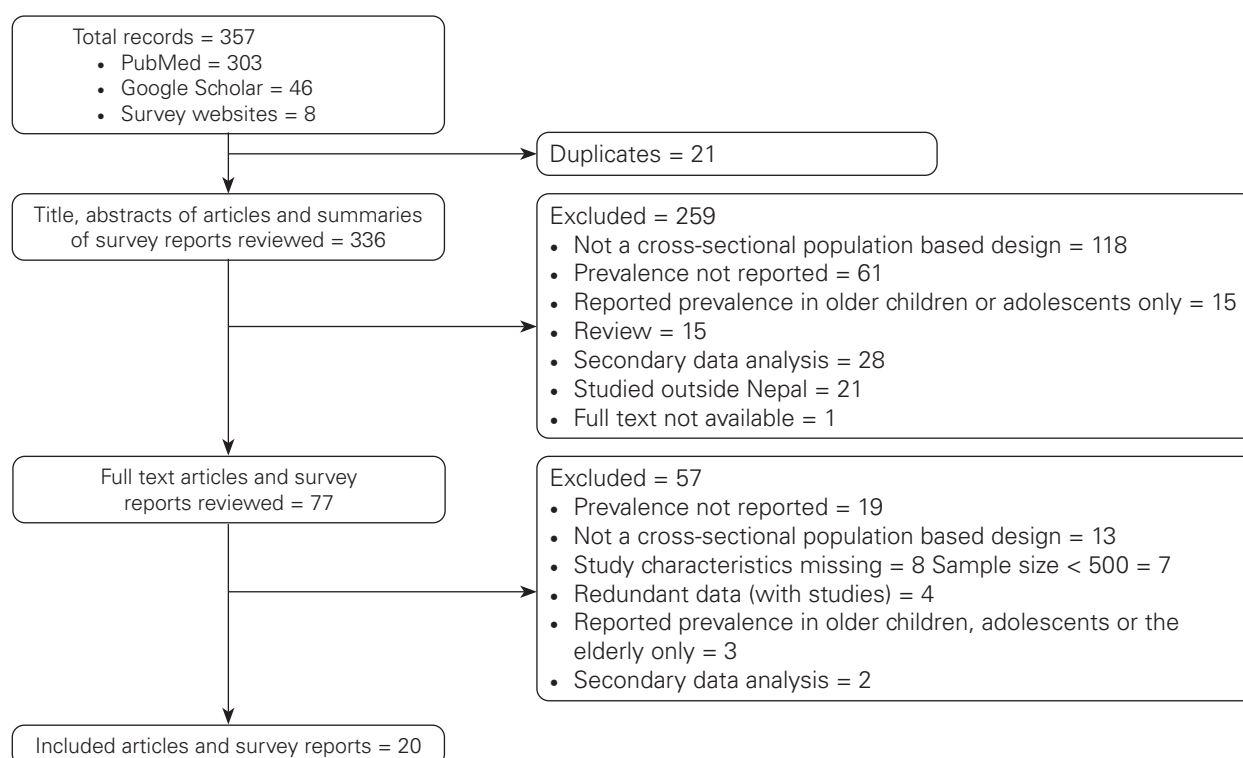


Figure 1. Literature search and selection strategy

tabular synthesis over an analysis of individual participant data, as is the recommended procedure. Point estimates (prevalence of overweight and obesity) and, where available, interval estimates (95% confidence intervals of the prevalence) were used for such synthesis. Using data from the latest available two reports from surveys conducted on a country-wide scale (DHS and NNMSS), we examined inequalities in overweight and obesity prevalence by gender, geographical locations and household wealth quintiles. Apart from urban and rural areas, we disaggregated prevalences across traditional divisions of eastern, central, western, mid-western and far-western regions; and the new structures of seven provinces. We also calculated urban-to-rural and richest-to-poorest ratios in prevalence of overweight and obesity among adults and children, based on data from the aforementioned two reports.

RESULTS

Description of the studies

We finally included 20 studies (13 peer reviewed articles and 7 survey reports) of the 357 records fetched, after removal of duplicates and screening titles, abstracts and full-text; with a total of 79,082 men and women aged 15 years or more, and 11,866 pre-school children participants, Figure 1.

Tables 1 and 2 illustrate diverse characteristics of the studies. First two of the three rounds of DHSs (2006 and 2011) and NNMSS (2016) incorporated

15-49 years old women and children under five years of age, whereas the latest round of DHSs (2016-17) included both men and women aged 15-49 years and the children. Participants in 11 of 13 articles were men and women aged 18 to 79 years, whereas men aged 35 years or more and women aged 15 to 49 years were included in one each of such research. Both urban and rural populations were considered in 10 of the 20 studies. All but one study adopted the World Health Organization's global anthropometric standards for adults, which defined overweight as $25 \text{ kg/m}^2 \leq \text{BMI} < 30 \text{ kg/m}^2$ and obesity as $\text{BMI} \geq 30 \text{ kg/m}^2$. The Organization's child growth standards 2006 formed the basis for determining overweight (2 standard deviation (SD) \leq weight-for-height z-score (WHZ) < 3 SD) and obesity (WHZ ≥ 3 SD).

Trends in prevalence of overweight and obesity

Overall, the occurrence of overweight as well as obesity increased steadily. Among people aged 15 years or above, the prevalence of overweight rose from 15.2% in 2004-15 to 18.5% in 2016. Obesity alone increased thrice from 1.7% in 2007 to 5.1% in 2016-17. The combined prevalence of overweight or obesity burgeoned more than twice from 8.9% in 2007 to 23.1 in 2016 as illustrated in Table 1. The combined prevalence of overweight or obesity among children remained fairly low, although it doubled from 0.6% in 2006 to 1.2% in 2017, Table 2.

Overweight and obesity were more common among women than men. The latest round of DHS (2016-17) showed that 17.1% of women and 14.6%

Table 1. Trends in prevalence of overweight and obesity among people aged 15 years and above in Nepal, 2003-2018

SN	Author, publish year	Data collection	Geographical location	Study population	Sampling procedures	Sample size	Overweight, obesity cut points	Prevalence % (95% CI)		
								Overweight or obesity	Overweight	Obesity
A. Survey reports										
1	Shrestha et al 2006 ⁴⁶	2004-05	Rural and urban, 19 villages and 2 cities, Ilam, Tanahun, Lalitpur districts	Men and women, 15-64	Random, multistage, probability proportionate to size	7720	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI≥30 kg/m ²	-	15.2 (14.0-16.0)	-
2	Ministry of Health and Population, 2007 ⁴⁷	Feb-Aug 2006	Rural and urban mixed, 13 domains from 3 ecological and 5 developmental regions	Men, 15-64	Random, multi-stage, systematic probability proportionate to size	3,645	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI≥30 kg/m ²	-	20.3 (19.0-21.6)	-
				Women, 15-64		4,075		-	10.7 (10.0-12.0)	-
3	Ministry of Health and Population, 2008	2007	Rural and urban, 15 cities and 75 villages, 15 districts in 5 developmental regions	Women, 15-49	Random, multistage, probability proportionate to size	1,582	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI≥30 kg/m ²	8.6	7.6	0.9
				Women, 15-49		8,422		6.3	5.9	0.4
								20.7	17.1	3.7
4	Ministry of Health and Population, 2012 ⁴⁹	Feb-Jun 2011	Rural and urban, 13 domains from 2 ecological and 5 developmental regions	Men and women, 15-64	Random, multi-stage, probability proportionate to size	4,280	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI≥30 kg/m ²	8.9	7.2 (4.8-9.5)	1.7 (0.9-2.5)
				Women, 15-64		2,391		9.5	7.1 (4.0-10.2)	2.4 (1.2-3.6)
				Men, 15-64		1,889		8.4	7.3 (4.9-9.6)	1.1 (0.2-2.0)
5	Aryal et al 2014 ⁵⁰	Jul 2012-Jun 2013	Rural and urban, 70 Ilakas from 3 ecological divisions	Men and women, 15-69	Random, multi-stage, probability proportionate to size	4,079	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI≥30 kg/m ²	13.5	11.2	2.2
6	Ministry of Health and Population, 2018 ⁵¹	Apr-Jun 2016	Rural and urban, 180 clusters from 3 ecological and 5 developmental regions	Women, 15-49	Random, multistage, probability proportionate to size	2,756	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI≥30 kg/m ²	21.7	17.7 (15.8-19.5)	4.0 (3.1-4.8)
				Men, 15-69		1,323		22.1	17.3 (15.4-19.2)	4.8 (3.7-5.9)
								21.1	18.0 (15.2-20.8)	3.1 (2.0-4.3)
7	Ministry of Health 2017 ⁴¹	Jun 2016-Jan 2017	Rural and urban, 14 strata from cities and villages from 3 ecological, 5 developmental regions and 7 provinces	Women, 15-49	Random, multistage, probability proportionate to size	2,139	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI≥30 kg/m ²	23.1	18.5 (16.4-20.8)	4.6 (3.7-5.7)
				Women, 15-49		295		21.8	17.4 (15.1-20.0)	4.4 (3.7-5.9)
				Women, 15-49		1844		30.9	25.0 (19.6-31.2)	5.9 (3.4-10.1)
7	Ministry of Health 2017 ⁴¹	Jun 2016-Jan 2017	Rural and urban, 14 strata from cities and villages from 3 ecological, 5 developmental regions and 7 provinces	Women, 15-49	Random, multistage, probability proportionate to size, systematic	6,069	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI≥30 kg/m ²	22.2	17.1	5.1
				Women, 15-49		2,234		15.4	13.4	2
				Women, 15-49		3,835		26.1	19.2	6.8

Table 1. Trends in prevalence of overweight and obesity among people aged 15 years and above in Nepal, 2003-2018 (contd ...)

SN	Author, publish year	Data collection	Geographical location	Study population	Sampling procedures	Sample size	Overweight, obesity cut points	Prevalence % (95% CI)		
								Overweight or obesity	Overweight	Obesity
B. Research articles										
8	Sharma et al, 2013 ⁵²	2003-2005	Urban, Dharan, Sunsari district	Men and women, ≥20	Census of purposively selected wards	3,218	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI ≥30 kg/m ²	25.3	20.0	5.3
9	Vaidya et al, 2006 ⁵³	2004-2005	Urban, Dharan, Sunsari district	Men, ≥35	Random, population proportionate to size	1,000	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI ≥30 kg/m ²	40.1	32.9	7.2
10	Mehta et al, 2011 ⁵⁴	Sep 2005-Jul 2006	Rural and urban, Dharan, Madhuban and Narsingh, Sunsari district	Men and women, >30	Non-random, convenience sample	2,006	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI ≥30 kg/m ²	34.0	25.1	8.9
11	Parajuli et al, 2014 ⁵⁵	May-Jun 2008	Rural and urban, Kuleshwar, Kathmandu; Khokana, Lalitpur; Birendranagar, Chitwan; Kanyam, Ilam; and Dhikurpokhari, Kaski districts	Men and women, ≥20	Non-random, convenience sample	594	Overweight: BMI 25-29.9 kg/m ²	-	21.7	-
12	Bhandari et al, 2016 ²⁸	Sep 2011-Aug 2012	Rural, 3-8 villages from Dolakha, Ilam, Kavrepalanchok, Kathmandu, Lamjung, Kaski, Sarlahi, Nawalparasi, Kailali districts	Women 15-49	Non-random, convenience sample	13,369	Overweight or obesity: BMI ≥25 kg/m ²	21.7	-	-
13	Vaidya et al, 2013 ⁵⁶	Sep-Nov 2011	Peri-urban, Jhaukhel and Duwakot, Bhaktapur district	Men and women, 25-59	Census of randomly selected wards	777	Overweight or obesity: BMI ≥25 kg/m ²	39.1	29.7	9.4
14	Koju et al, 2015 ⁵⁷	May-13	15 districts in 3 ecological and 5 developmental regions	Men and women, 18-65	Random, multistage, cluster, probability proportionate to size	2,100	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI ≥30 kg/m ²	-	20.1	-
15	Shrestha et al, 2016 ⁵⁸	Nov 2013-Feb 2015	Urban, Dhulikhel, Kavrepalanchok district	Men and women, ≥18 Women, ≥18 Men, ≥18	Random, stratified	1,073 627 446	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI ≥30 kg/m ²	37.1 39.1 34.3	29.4 29.7 28.9	7.7 9.4 5.4
16	Anil et al, 2018 ⁵⁹	2014	Urban, Bhaktapur, Lalitpur, Kathmandu districts	Men and women, 18-79 Women, ≥18 Men, ≥18	Non-random, convenience sample	5,530 2,232 3,298	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI ≥30kg/m ²	41.3 (40-42.6) 47.3 (45.2-49.4) 37.3 (35.6-38.9)	34.0 36.1 (34.1-38.1) 32.6 (31.0-34.2)	7.3 11.2 (10.0-12.6) 4.7 (4.0-5.4)
17	Maharjan, 2017 ⁶⁰	Dec 2015-Apr 2016	Urban, Kirtipur, Kathmandu district	Men and women, 20-59	Random, probability proportionate to size	580	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI ≥30 kg/m ²	55.2	47.9	7.5
18	Sainju et al, 2018 ⁶¹	2016	Rural, Namtaar, Makwanpur; Indrawati, Tripeni and Thokarpa, Sindhupalchok districts	Men and women, ≥18	Non-random, convenience sample	1,243	Overweight: BMI 25-29.9; Obesity: BMI ≥30	23.7	18.4	5.3
19	Khanal et al, 2017 ⁶²	Jan-Dec 2016	Urban, Birendranagar, Surkhet district	Men and women, ≥30 Women, ≥30 Men, ≥30	Multistage, cluster	1,159 824 335	Overweight: BMI 25-29.9 kg/m ² ; Obesity: BMI ≥30 kg/m ²	43.6 46.5 37.7	36.1 39 29	7.5 8.7 4.5
20	Gyawali et al, 2018 ⁶³	Oct 2016-Apr 2017	Urban, Lekhnath municipality, Kaski district	Men and women, 25-64	Random, systematic	2,310	Overweight: BMI ≥24 kg/m ²	62	-	-

Table 2. Trends in prevalence of overweight and obesity among children under five years of age in Nepal, 2006-17

SN	Reference	Study period	Geographic location	Sampling procedure	Sample size	Prevalence (%)		
						Overweight or obesity (WHZ \geq 2SD)	Overweight (2 SD \geq WHZ <3 SD)	Obesity (WHZ \geq 3 SD)
1	Ministry of Health and Population 2007 ⁴⁷	Feb-Aug 2006	Rural and urban, 13 domains of 3 ecological and 5 developmental regions	Random, multistage, systematic, probability proportionate to size	5,262	0.6	-	-
2	Ministry of Health and Population 2012 ⁴⁹	Feb-Jun 2011	Rural and urban, 13 domains of 2 ecological and 5 developmental regions	Random, multistage, probability proportionate to size	2,475	1.4	-	-
3	Ministry of Health and Population 2018 ⁵¹	Apr-Jun 2016	Rural and urban, 180 clusters from 15 eco-developmental regions	Random, multistage, probability proportionate to size, systematic	1,701	1.2	0.9	0.3
4	Ministry of Health and Population 2017 ⁴¹	Jun 2016-Jan 2017	Rural and urban, 14 strata from cities and villages of 7 provinces	Random, multistage, probability proportionate to size, systematic	2,428	1.2	-	-

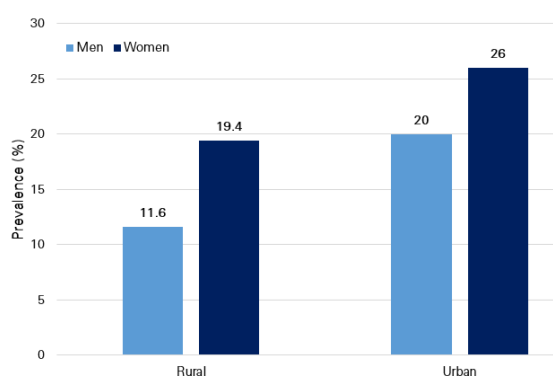
SD, standard deviation; WHZ, weight-for-height z-score

of men were overweight, respectively as shown in Table 3. Similarly, the pace of increment in obesity prevalence among women was much faster (more than five folds between 2006 and 2016) than that among men (slightly over twice between 2007 and 2017). Likewise, the rate of obesity was much higher among women than men (5.1% vs. 2.5%). The 2016 NNMSS reported overweight and

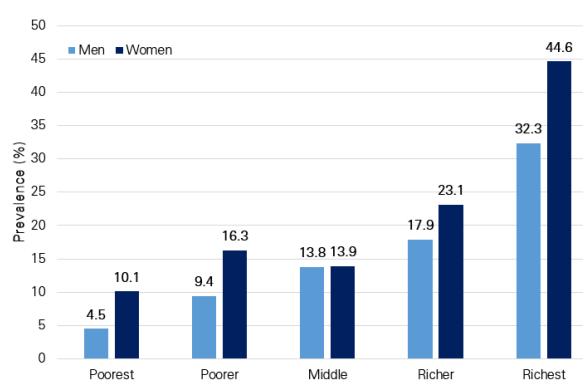
obesity rates of 18.5% and 4.6% among women, respectively, Table 2.

Inequalities across gender, geographical locations and household wealth

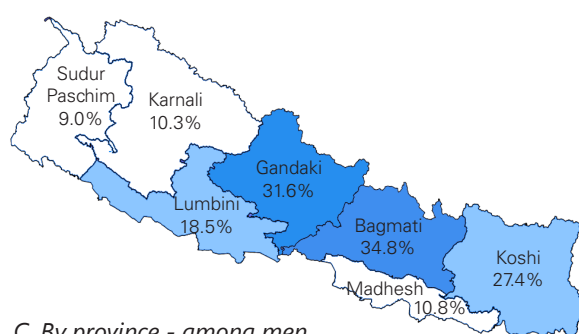
Overweight was twice as common among men as women one and a half decade ago. However, the difference has now reversed as depicted by most



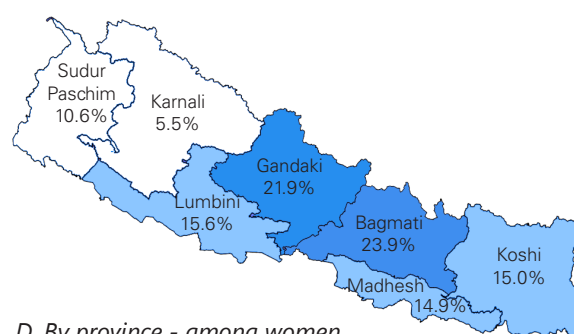
A. By residential location



B. By wealth quintiles



C. By province - among men



D. By province - among women

Figure 2. Disparities in prevalence (%) of adult overweight or obesity, based on Nepal Demographic and Health Survey 2016-17.

Table 3. Disparities in prevalence (%) of overweight and obesity across sex, geographic locations and wealth in Nepal based on national survey data from DHS 2016-7 and NNMSS 2016

Socio-demographic characteristics	Under-five children			Men		Women			
	Overweight %		Obesity %	Overweight %	Obesity %	Overweight %		Obesity %	
	DHS	NNMSS	NNMSS	DHS	DHS	DHS	NNMSS	DHS	NNMSS
All	1.2	0.9	0.3	14.6	2.5	17.1	18.5	5.1	4.6
Sex									
Boys	1.4	1.0	0.4						
Girls	1.0	0.9	0.3						
Geographical locations ^a	1.0								
Urban	1.5	0.8	0.0	17.1	2.9	19.2	25.0	6.8	5.9
Rural	0.9	1.0	0.4	9.8	1.8	13.4	17.4	2.0	4.4
Urban/rural ratio	1.7	0.8	0.0	1.7	1.6	1.4	1.4	3.4	1.3
Eastern region	0.5	0.7	0.4	12.6	2.5	18.5	18.0	4.2	2.1
Central region	0.8	1.5	0.3	18.1	2.4	18.8	21.4	7.2	7.9
Western region	2.8	0.2	0.0	15.7	3.7	20.7	21.8	6.0	5.0
Mid-western region	1.3	1.1	0.7	8.5	1.1	10.5	12.3	1.7	2.6
Far-western region	1.1	0.4	0.2	8.4	2.2	7.8	10.3	1.1	0.5
Koshi province	0.7	-	-	12.3	2.8	22.0	-	5.5	-
Madhesh province	0.0	-	-	13.4	1.5	9.2	-	1.6	-
Bagmati province	1.9	-	-	21.0	2.9	24.5	-	10.3	-
Gandaki province	3.7	-	-	17.0	4.8	24.0	-	7.6	-
Lumbini province	1.8	-	-	13.5	2.2	15.2	-	3.4	-
Karnali province	1.5	-	-	4.5	0.9	8.8	-	1.5	-
Sudur Paschim province	1.1	-	-	8.4	2.2	7.8	-	1.1	-
Wealth quintiles									
Richest	3.6	0.8	0.0	26.9	5.3	30.3	29.9	14.3	9.0
Richer	0.7	1.5	0.5	16.3	1.6	18.0	19.7	5.1	3.6
Middle	0.2	0.1	0.1	11.2	2.6	12.2	13.8	1.7	4.3
Poorer	1.1	0.3	0.0	8.1	1.3	13.4	14.2	2.1	3.5
Poorest	1.4	1.8	1.0	3.6	0.9	9.2	9.5	0.6	0.5
Richest/poorest ratio	2.6	0.4	0.0	7.5	5.9	3.3	3.1	23.8	18.0

BMI, body mass index; DHS, Demographic and Health Survey; NNMSS, Nepal National Micronutrient Status Survey; SD, standard deviation; WHZ, weight-for-height z-score.

^a Since September 2015, Nepal transitioned in to a federal system with new administrative divisions of seven provinces.

recent estimates. Prevalences of both overweight and obesity accelerated faster among women (2.43 and 5.66 times) compared to men (2.0 and 2.27 times) between 2006 and 2016-17, respectively (Table 1).

The latest round of DHS (2016-17) showed that overweight and obesity were more frequently occurring among women (17.1% and 5.1%) than men (14.6% and 2.5%). Such inequality was consistent across rural and urban areas and household wealth quintiles, except for the middle and poorest quintiles where proportion of men having obesity was slighter higher than women. According to the NNMSS (2016) 18.5% and 4.6% of women were having overweight and obesity, respectively.

Prevalence of obesity and overweight was much

higher in urban than rural areas. For example, 36.1% adults in Birendranagar municipality were having overweight or obesity compared to 18.4% in villages of Makwanpur and Sindhupalchok districts, in 2016. Risk of having obesity among urban women was as much as 3.4 times higher than their rural counterparts. However, the pace of increment for overweight and obesity was faster in villages compared to cities and towns.

Latest surveys indicated discernible differences across groups of people. Among the five developmental regions, eastern, central and western regions had much higher prevalence of adult overweight and obesity, relative to mid-western and far-western. Similarly, the rates of overweight and obesity were much pronounced in Koshi, Bagmati and Gandaki provinces than those in

Table 4. Nepal government's nutritional policies, strategies and programmes related to preventing or controlling obesity

	Policies, strategies and plans	Year publish	Intervention means	Primary objective	Pathway for impact on obesity	Target population
A. Direct interventions ^a						
1	Department of Education's directive	2011	Ban sale of highly processed foods in school premises	Limit consumption of processed foods	By reducing intake of excessive amounts of refined carbohydrates and fats	School children, teachers and administrative staff
2	Multi-sectoral action plan for the prevention and control of non-communicable diseases ⁶⁵	2014	Increase consumption of fruits and vegetables Reduce consumption of saturated fat and trans-fat Improve built environment and promoting physical activities Develop strategy to reduce harmful use of alcohol Legislate ban on food products having high amount of trans-fat	Reduce modifiable risk factors for non-communicable diseases and underlying social determinants through creation of health-promoting environments	By encouraging intake of fruits, vegetables and increasing physical activities, and discouraging consumption of alcohol and high-fat foods	General population
3	Food-based dietary guidelines ⁶⁶	2016	Encourage daily consumption of adequate amounts of fruits and vegetables	Promote healthy eating behaviours	By increasing consumption of fruits, vegetables and reducing consumption of sugars, fats	General population
4	Package of essential non-communicable disease interventions ^{67,68}	2016	Monitor body weight and related risk factors for selected non-communicable diseases	Reduce risk factors for selected non-communicable diseases	By reducing risk of gaining excess weight	General population
B. Indirect interventions ^b						
5	Mother's milk substitutes marketing control act and regulation ⁶⁹	1992	Restrictions on marketing of breastmilk substitutes	Promote exclusive (6 months) and continued (2 years) breastfeeding	By helping reduce risk of obesity later in adulthood	Children
6	National nutrition policy and strategy ⁷⁰	2004	Child growth monitoring and nutritional counseling Promote dietary diversification	Reduce prevalence of undernutrition among women and children Increase consumption of fruits, vegetables and whole grains	By helping reduce risk of obesity later in adulthood By increasing consumption of healthy foods	Children Women and children
7	Strategy for infant and young child feeding ⁷¹	2014	Promotion and protection of breastfeeding and complementary feeding Promote nutrient-dense and diverse foods	Improve nutritional status and ensure adequate growth and development	By helping reduce risk of obesity later in adulthood	Infants and young children
8	Multi-sector nutrition plan phase II ⁷²	2017	Educating mothers on preparing nutritious meals (porridge/whole grain gruels, vegetables) for children using local ingredients Increase production and promote consumption of fresh fruits, and green leafy vegetables	Improve nutritional status of mothers, adolescents and children	By helping reduce risk of obesity later in adulthood	Infants and young children General population

BMI, body mass index; DHS, Demographic and Health Survey; NNMSS, Nepal National Micronutrient Status Survey; SD, standard deviation; WHZ, weight-for-height z-score.

^aSince September 2015, Nepal adopted a new administrative division of seven provinces, which superseded the structures of fourteen zones and five development regions.

Madhesh, Lumbini and Sudur Paschim provinces, Figure 2. Prevalence of overweight among richest men was 7.5 times higher than that among the poorest. Among women, the richest were 18 to 23.8 times more likely to have obesity than the poorest. Contrasted with adults, geographical and wealth inequalities in childhood overweight was not consistent across the surveys. According to the 2016-17 DHS, prevalence of overweight was greater among boys than girls (1.4% vs 1.0%), 1.7 times higher in urban than in rural areas, and 2.6 times higher among children of the richest than those from the poorest families. However, the 2016 NMSS did not resonate similar patterns.

Governmental responses to the obesity epidemic

Policies, strategies and plans included in this study were originally designed to mitigate the perennial occurrence of maternal and child under-nutrition, assessed by periodic surveys (such as DHS) in terms of: thinness, anaemia and vitamin-A and iodine deficiency among women; and childhood stunting, underweight, thinness, anaemia, and inadequacy of dietary iodine and vitamin A. However, they also incorporated some interventions with implications for preventing obesity. We grouped these into direct and indirect preventive or intuitive actions, based on the specific pathways through which they would affect population obesity, Table 4.

Direct interventions included three approaches: a) increasing the consumption of healthy foods such as fruits and vegetables; b) creating environments and promoting physical activity; and c) discouraging the consumption of sugars, fats and super-processed foods. Indirect interventions included diversification of foods for children, child growth monitoring and nutritional counselling, treatment of child under-nutrition, preventing low birth-weight and controlling the use of breast-milk substitutes for infants and young children.

DISCUSSION

Prevalence of overweight and obesity among Nepali adults and under-five children increased substantially across the country and hugely in some groups of people. According to latest available data, large disparities existed across groups and regions. Large surveys conducted by the government on a country-wide scale assessed nutritional status (including under-nutrition, overweight and obesity) of children under five years of age and 15-45 year old women only until 2016-17 when men were also included for anthropometric measurements. Data concerning other groups of people such as older children, adolescents, and the elderly are missing, thus limiting ability to infer nationally representative status at the present or trends over the years. Forthcoming research activities should incorporate these groups too, to assist in gauging the transition

towards obesity as well as discerning the underlying determinants.

Much of the focus of existing nutrition policies, strategies and programs was the reduction of maternal and child under-nutrition. However, some also aimed directly on promoting healthy eating and physical activity, thus contributing to preventing obesity, indirectly. Others included interventions that have indirect implications for preventing obesity. Yet, the coverage and effectiveness of these interventions have not been evaluated. Research activities in the foreseeable future should endeavor to address this gap.

Rises in the occurrence of population obesity may have resulted from simultaneous changes in people's income, availability and consumption of foods, and transport. Between 2003-4 and 2015-16, Nepal witnessed a 2.8-fold increment in per capita gross domestic product.^{32,33} Annual household expenditure on food rose by 2.4 times between 2003-4 and 2015-16.^{34,35} The number of registered vehicles was 8.5 times more in 2015-16 than that in 2003-04.³⁶ Changing dietary habits with an increasing availability of highly-processed foods in cities as well as remote villages are also key factors accounting for the propagation of obesity epidemic in this country.^{37,38} Similar changes in environmental and socioeconomic factors associated with obesity were observed in many other low- and middle-income countries.¹⁶ Our finding of a higher prevalence of obesity among women is also analogous to findings from studies conducted in other South-Asian countries in such as Bangladesh.³⁹

The higher prevalence of overweight and obesity among urban men and women compared to their rural counterparts is consistent with the situation in most low-income nations, as attested by numerous studies in many countries. However, a highly influential recent analysis of trends based on data from nearly 200 countries concluded that much of the rises in BMI across countries was attributable to increases in villages rather than in cities.⁴⁰ However, our synthesis of observational studies from Nepal contradicts such finding, thus connoting that the country is in early phases of obesity's spread into rural and remote regions. Currently higher prevalence of obesity among city-dwelling Nepalis may be attributable to differences with their rural counterparts in terms of several societal and developmental parameters, and associated behaviours. For example, household wealth and food security statuses are higher in urban areas. Moreover, labour-intensive occupations in agricultural production are more common in villages than in the cities where most jobs are physically less demanding.⁴¹

Socio-economic inequalities were underlying the

manifest spatial variations in occurrence of obesity. Central and western regions, Bagmati and Gandaki provinces, with higher prevalence of overweight and obesity; were also more urbanised, had lower levels of poverty and achieved better indicators of societal development than the peripheral locations in Lumbini and Sudurpaschim province, for instance.^{42,43} This is also corroborated by our results that obesity occurrence was disproportionately affecting wealthier groups of people in all of the states or hitherto existing developmental regions within the country.

Although obesity's impact on mortality has already surpassed that of under-nutrition in Nepal²⁷, the gamut of governmental nutritional actions is vastly targeted against under-nutrition and is inadequate to contain the burgeoning obesity epidemic. In recent years, several effective strategies have been recommended and utilised elsewhere. These include front-of-pack food labeling; taxing unhealthy foods and subsidising healthier choices such as fresh and wholesome local produce; and improving the quality of food supply, for example by controlling ultra-processed foods and drinks, and increasing availability of natural foods at affordable prices.^{44,45} Nepal may need to consider a contextualised implementation of these strategies as integral part of its efforts to control the spread of obesity in the population. Simultaneously, it is also important to enhance the translation of existing policies, strategies and plans into practices so as to increase their coverage and effectiveness, for they have incorporated important actions which were either explicitly planned or carry the potential for affecting obesity through fortuitous pathways.

Our findings, however, should be interpreted with caution. We restricted our search databases to PubMed and Google Scholar, which included most of the published research. However, we could not illustrate the full spectrum of Nepal's obesity situation without the coverage of unpublished studies. Second, the included reports and articles were based on different sampling procedures, geographical settings and age groups, particularly for adults, thus restricting the calculation of a meaningful aggregate prevalence. Third, all of included studies except one used BMI cut-offs of 25 and 30 rather than the suggested lower limit for certain Asian populations, thereby possibly leading to an underestimation of overweight and obesity prevalences.⁷³ Seven of the eight policies, strategies and plans we selected were promulgated by the government's health sector (solely, or in partnership with a few other sectors) at the federal level. The programmes and interventions conducted by the health sector at provincial and municipal levels, and other sectors at any level were not adequately covered.

Nonetheless, our study has a couple of comparative advantages over previously published research in this field. It gives an updated description of obesity prevalence over the past one and a half decade. The last obesity-specific review from Nepal was published in 2010.⁷⁴ In addition, it is the first review of obesity related governmental policies, strategies and plans in the country.

CONCLUSION

The prevalence of overweight and obesity increased over the past one and a half decade, particularly, among women, residents of urban and central locations, and the wealthier. Although obesity continues to increase among all peoples, large disparities across socio-economic groups and geographical locations continue to exist. Federal government's nutrition policies and programmes aimed at reducing under-nutrition among women and children, with few actions that directly intervened to prevent the occurrence of obesity; yet none that addressed environmental, including economic, determinants; thus connoting to the need to steer policies and strategies towards this direction in the future.

AUTHOR CONTRIBUTIONS

Conceptualisation: AB; literature search and selection: AB, DA; drafting and revision: AB, DA. AB and DA have approved the final draft for submission here.

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CONFLICT OF INTEREST

The author(s) declare that they do not have any conflicts of interest with respect to the research, authorship, and/or publication of this article.

DATA AVAILABILITY

Data can be retrieved from supplementary material published with an earlier preprint. Bhurtyal A, Adhikari

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