

# Factors associated with double and triple burden of malnutrition among mothers and children in Nepal: evidence from 2016 Nepal demographic and health survey

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## Research article

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# Abstract

Background Double and triple burden of malnutrition is defined by the coexistence of overweight/obese mother and undernourished child and coexistence of overweight/obese mother and undernourished and anemic child at the same household level respectively. The aims of this study were to explore the coexistence of overweight/obesity among mothers and undernourished and anemia among children and associated factors among the mother-child pairs in the same household. Methods A total sample of 5018 mother-child pairs from the Nepal Demographic and Health Survey (NDHS) 2016 were included in the study. Anthropometric measurements, hemoglobin level of the children and their mothers were taken. The bivariate and multivariate logistic regression were performed to observe the factors associated with the double and triple burden of malnutrition. To assess the outcome, we created the categories such as the double and triple burden of malnutrition where the overweight/obese mother and undernourished (stunted or wasted or underweight) child and overweight/obese mother and undernourished (stunted or wasted or underweight) child and anemic child respectively. Results Prevalence of double burden of malnutrition (DBM) and triple burden of malnutrition (TBM) was 6.59(5.13-8.84)% and 7(5.42-8.99)% respectively at the same household. In the adjusted multivariate logistic regression, mothers with short stature (AOR=3.94, 95% CI: 1.94-8.00), from the richest wealth status (AOR=2.59, 95% CI= 1.27-5.28), age groups of 26-49 years (AOR=2.38, 95% CI: 1.18-4.77), attended at least a secondary level of education (AOR=1.93, 95% CI: 1.01-3.69) were more likely to have the double burden of malnutrition. Similarly, mothers who had short stature (AOR=4.48, 95% CI: 2.19-9.16), the richest wealth status (AOR=2.46, 95% CI= 1.19-5.08) and age groups of 26-49 years (AOR=2.27, 95% CI: 1.16-4.44) were more likely to suffer from the triple burden of malnutrition. Conclusions Our study concludes with the prevalence of double and triple burden of malnutrition existence among mothers and children in Nepal. Mothers having short stature and from the richest family are more prone to double and triple burden of malnutrition. Integration of maternal health promotion and nutrition education program would be a good strategy to prevent mother overweight/obesity and stunting among children under five years of age in Nepal.

## Introduction

The different forms of malnutrition and micronutrient deficiency anemia is an emerging public health problem in low and middle-income countries [1]. Multiple forms of malnutrition consist of double and triple burden of malnutrition during the lifetime at the country, household, and individual level. The double burden of malnutrition is defined as the coexistence of overweight/ obesity with undernourished such as stunting, wasting and underweight or with nutrition related problem, throughout the life course at the population, household and individuals level [2-5]. Similarly, the triple burden of malnutrition refers to the coexistence of overnutrition, undernourished and micronutrient deficiencies [6, 7]. Overnutrition, undernourished and micronutrient deficiencies equally increase the risk of various health problems [8]. Child undernourished is associated with an increased risk of childhood mortality and poor cognitive development [9]. On the other hand, overnutrition plays a significant role in causing various non-communicable diseases like high blood glucose, raised blood pressure, central obesity and high lipid profiles [10]. Overweight/obesity during pregnancy is positively linked with several adverse maternal and fetal consequences during pregnancy, delivery and postpartum period [11, 12].

Globally, the prevalence of undernourished (stunting, wasting and underweight) in children has declined as compared to early decades, whereas maternal overweight and obesity has increased [8]. The recent systematic review reported the prevalence of double burden of malnutrition at household level varied from 0.0 to 26.8% in different countries and year [13]. Similarly, a study was done in different low and middle-income countries in Africa, Asia, and Latin America showed the prevalence of overweight/obese mother and stunted child varied from 4-30.6% at the household's level [3]. Among the south and Southeast Asian countries, the prevalence of overweight and obesity was observed at 21.3% and 8.6% respectively [11]. In Nepal, the prevalence of stunting, wasting, and underweight have declined in the last decade [14], however, anemia among the children aged under five year has been stagnant. Overweight and obesity has increased in all women of all ages socio-demographic groups [15, 16].

The association between the double burden of malnutrition has been explored in several studies in different countries [17, 18]. The maternal overweight/obesity and child undernourished among the mother-child pairs is due to the interaction of changes related to socio-demographic and economic status, dietary habit and intensity of physical activity [5]. Moreover, various studies have indicated that double burden of malnutrition is associated with older aged mothers, mothers having short stature and a higher level of maternal education and wealth [17, 19, 20].

Undernourished and micronutrient deficiencies are highly prevalent particularly among Nepalese mothers and children under five years of age however adequate evidence on co-existence of such malnutrition are lacking in Nepalese context. The child undernourished has continued to decline however, maternal obesity during the same time period has been increasing. To our knowledge, overnutrition, undernourished and micronutrient deficiencies in mother-child pairs within the same household level have not been explored using nationally representative's data in Nepal so far. Based on the aforementioned consideration we intended to explore the factors associated with the double and triple burden of malnutrition among mother-child pairs in Nepal. Eventually, this study provides important information on the reality of nutritional status among mother-child pairs in the context of Nepal.

## Methods

### Dataset and study design

This study utilized secondary data from the Nepal Demographic and Health Survey (NDHS) 2016, a nationally representative cross-sectional survey, to explore the prevalence of double and triple burden of malnutrition and associated factors among mother-child pairs. This survey was carried out as part of the globally DHS program by New ERA under the guidance of the Ministry of Health, Government of Nepal and supported by ICF international and United States Agency for International Development (USAID). The aim of this survey was to provide nationally representatives updated estimates of the health, nutrition and demographic indicators.

The NDHS 2016 utilized a stratified, two-stage cluster sampling design to provide representatives estimates for seven provinces, three ecological zones, and urban and rural areas. The survey used enumeration areas (EAs) which is a primary sampling unit (PSU) and were selected from 383 wards in the both rural (n=199) and urban (n=184) areas with probability proportional to size methods. In the second stage, 30 households on average within EAs were selected using a systematic sampling technique. A more detailed methodology of the NDHS

have been published in most recent NDHS report [16]. Out of the 12,862 women aged 15-49 years in NDHS 2016, 5018 women with children aged 0-59 months were included in this study. Currently pregnant women (n=292) were excluded from the analysis. NDHS 2016 data were downloaded after provided electronic copy of permission to use the dataset in May 2019.

### **Study variables**

The detailed plan for data coding and description of the study variables is given in Table 1.

### **Outcome variables**

In this study, we used anthropometric and biochemical indices such as height-for-age, weight-for-height, and weight-for-age and hemoglobin level to evaluate the nutritional status of 0-59 month's child. The WHO Multicenter Growth Reference Study Group, 2006 was used to calculate the anthropometric indicators to evaluate the nutritional status of the child [21]. Stunting, wasting and underweight were defined as children with Z-scores below -2 standard deviation (more than 2 standard deviations below the reference median), for height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ) respectively. We categorized blood hemoglobin level as anemic (<11g/dl) and not anemic ( $\geq 11$ gm/dl) for the purpose of analysis. Similarly we used body mass index (BMI) classification according to WHO for mothers aged 15-49 years. The standard WHO cut-off value were used to determine the normal (18.5 to <24.99kg/m<sup>2</sup>) and overweight/obesity ( $\geq 25.0$  kg/m<sup>2</sup>) based on BMI measurement [22].

In order to analyze the outcome variables, we dichotomized all dependent variables. We created four different forms of malnutrition such as overweight/obese mother and stunted child (OM/SC), overweight/obese mother and wasted child (OM/WC), overweight/obese mother and underweight child (OM/UC), overweight/obese mother and anemic child (OM/AC) at the same household level. Further two categories were created: overweight/obesity mother and undernourished child (stunting or wasting or underweight) which was considered as double burden of malnutrition (DBM) and overweight/obesity mother and undernourished and anemic child (stunting or wasting or underweight or anemia) which was regarded as triple burden of malnutrition (TBM) [6, 7].

### **Independent variable**

In this study, we included maternal socio-demographic factors (mother's age, age at first birth, ethnicity, place of residence, province, education level, occupation, household wealth status, height, iron/folate intake, ante natal care (ANC) visits, parity, delivery by caesarean section), fathers occupation, education and child factors (age of child, child sex, vitamin A consumption, deworming tablet consumption, breastfeeding status, child weight at birth, and total number of children ever born from single mother) as independent variables.

### **Table 1 Plan for data coding and description of the study variables.**

Study variables (according to DHS coding)	Coding category for analysis
<b>Outcome variables</b>	
Stunting (HAZ)	0=normal HAZ/not stunted (HAZ -2SD and above) 1=stunted(HAZ<-2SD)
Wasting (WHZ)	0=normal WHZ/not wasted (WHZ-2SD to +2SD) 1=Wasted (WHZ <-2SD)
Underweight(WAZ)	0=Normal WAZ/not underweight (WHZ-2SD and above) 1=underweight (WAZ<-2SD)
Child anemia	0= normal/not anemic (hemoglobin level $\geq 11$ g/dl), 1=anemic (hemoglobin level <11g/dl)
Mothers BMI (Continuous, calculated using measured height and weight)	0 = Normal (18.5-24.9 kg/m <sup>2</sup> ) 1 = Overweight/Obese ( $\geq 25$ kg/m <sup>2</sup> )
Double burden of malnutrition (DBM):overweight/obese mothers was paired with her child having one form of undernourished(stunted or wasted or underweight)	0=normal or not overweight/obese mother and not undernourished child (stunted or wasted or underweight) 1=overweight/obese mother and undernourished child (stunted or wasted or underweight)
Triple burden of malnutrition (TBM):overweight/obese mothers was paired with her child having one form of undernourished(stunted or wasted or underweight) and anemic child	0=normal or not overweight/obese mother and not undernourished child (stunted or wasted or underweight) and not anemic child 1= overweight/obese mother and undernourished child (stunted or wasted or underweight) and anemic child
<b>Predictor variables:</b>	
<b>Maternal factors</b>	
Mothers age in years (continuous)	Coded as 1 =15-20, 2 =21-25, 3 =26-49
Age at 1 <sup>st</sup> birth (continuous)	Coded as 1=<19 years , 2=20-29 years , 3=Above 30 years
Residence (used same coding)	1=Rural , 2=Urban
Province (used same coding)	1=Province, 2=Province, 3=Province

	4=Province, 5=Province, 6=Province,7=Province
Education (used same coding)	0=No education, 1=Primary, 2=Secondary 4=higher
Ethnicity (1=hill Brahmin, 2=hill chhetri, 3=terai Brahmin/chhetri, 4=other terai caste, 5=hill dalit, 6=terai dalit, 7=newar, 8=hill janajati, 9=terai janajati, 10=muslim, 96=others)	1 & 2 as 1=Brahmin/chhetri 7, 8 & 9 as 2=Janajati 3, 4,5 ,6 10 & 96 as 3=Others caste
Currently working (used same coding)	0=Not working, 1=Working
Occupation (0=did not work, 1=professional/technical/managerial, 2=clerical, 3=sales/service, 4=agriculture, 8=skilled manual, 9=unskilled manual)	Codes as 0 & 9 as 0=No job, 1, 2,3 & 8 as 1=services  4 as 2=Agriculture
Wealth status (1=poorer, 2=poorest, 3=middle, 4=richer, 5=richest)	1 & 2 as 1=poor, 2 as 2=middle, 4 & 5 as 3=rich
Height (continuous)	1=Normal height ( $\geq 145$ cm), 2=Short stature (< 145cm)
Iron/folate intake(used same coding)	1=Yes, 0=No
ANC visits	1=Less than 5 times visit, 2=More than 6 times visits
Total children ever born(continuous)	1= $< 2$ children (1-2), 2= $> 3$ children ( $> 3 +$ )
Birth spacing (continuous)	1= $< 59$ months, 2= $\geq 60$ months
Delivery by CS (used same coding)	0=No, 1=Yes
<b>Child factors</b>	
Child's age in years (continuous)	0= $\leq 12$ months, 1=13-23 months, 2=24-35 months 3=36-47 months, 4=48-59 months
Child's sex (used same coding)	1=Male, 2=Female
Vitamin A (0=no, 1=yes, 8=don't know)	1=Yes, 0=No
Deworming (0=no, 1=yes, 8=don't know)	1=Yes, 0=No
Currently breastfeeding (used same coding)	1=Yes, 0=No
Birth weight (1=very large, 2=larger than average,	1=Average, 2=Large, 3=Small

3=average, 4=smaller than average, 5=very small,  
8=don't know)

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Birth order (continuous)	1=1-3 order, 2=4 <sup>th</sup> order or more
Initiation of breastfeeding (continuous)	1= $\leq$ 1 hour, 2= $>$ 1 hour

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## Data analysis

Data were analyzed using STATA/MP version 14.1 (StataCorp LP, College station, Texas). The 'svy' command was used to adjust for EAs and disproportionate sampling weight and non-response. The datasets for women and child file were merged. The prevalence of overweight/obese mother and stunted child (OM/SC), overweight/obese mother and wasted child (OM/WC), overweight/obese mother underweight child (OM/UC), overweight/obese mother and anemic child (OM/AC), double and triple burden of malnutrition were presented as weighted percentage and 95% confidence intervals. The bivariate and multivariate logistic regression model were performed to assess the factors associated with double and triple burden of malnutrition. Outcome variables were categorized as dichotomous variable such as overweight/obese mother and undernourished child or anemic child were categorized as '1' and normal mothers and child were coded to '0'. Normal mother and normal child was chosen as the comparison category. To prevent statistical bias in multivariate logistic regression model, we examined and reported any collinearity among the predictor variables using variation inflation factors. Bivariate analysis was performed to assess the association of socio-demographic factors with outcome variables. All variables with statistically significant associations ( $p < 0.05$ ) in bivariate analysis were included in multivariate regression model. Results were presented as crude odds ratio (COR) and adjusted odds ratio (AOR) with 95% confidence intervals (CI). P-value  $< 0.05$  was considered as statistically significant.

## Ethical considerations

This study was secondary analysis of the NDHS 2016 data thus no separate ethical approval was required. However, ethical clearance for the NDHS was obtained from the ethical review board of Nepal Health Research Council and the written informed consent was obtained from each of the participants as per the standard ethical guidelines of the DHS program. We registered and requested for access to data from DHS website (URL:<https://www.dhsprogram.com/data/available-datasets.cfm>) and received an approval to access and download DHS data file as per data obtaining procedure.

**Table 2 Bivariate and multivariate logistic regression models of double and triple burden of malnutrition among mother-child pairs and its associated factors (n=5018).**

Internal factors	Double burden of malnutrition (DBM)		Triple burden of malnutrition (TBM)	
	COR(95% CI)	AOR(95% CI)	COR(95% CI)	AOR(95% CI)
<b>Age group</b>				
15-20	1.18(0.38-3.61)	0.97(0.33-2.84)	1.21(0.39-3.75)	1.03(0.34-3.09)
21-25	1	1	1	1
26-49	2.09(1.10-3.98)*	2.38(1.18-4.77)*	2.19(1.13-4.26)*	2.27(1.16-4.44)*
<b>Age at 1<sup>st</sup> birth</b>				
<19 years	0.13(0.03-0.45)**	0.34(0.07-1.45)	0.16(0.04-0.62)	0.39(0.08-1.85)
20-29 years	0.12(0.03-0.44)**	1	0.16(0.03-0.64)*	0.22(0.04-1.13)
Above 30 years	1	1	1	1
<b>Residence</b>				
Rural	1	1	1	1
Urban	1.53(0.87-2.67)	1	1.57(0.88-2.79)	1
<b>Province</b>				
Province 1	0.89(0.40-2.00)	1.25(0.54-2.91)	0.89(0.38-2.03)	1.21(0.52-2.82)
Province 2	0.08(0.02-0.29)**	0.15(0.04-0.55)*	0.10(0.03-0.33)**	0.16(0.04-0.57)*
Province 3	1	1.11(0.40-3.05)	1	1
Province 4	0.73(0.31-1.71)	0.50(0.19-1.32)	0.71(0.29-1.70)	0.98(0.35-2.74)
Province 5	0.51(0.21-1.22)	0.36(0.11-1.13)	0.57(0.23-1.38)	0.55(0.22-1.39)
Province 6	0.24(0.07-0.75)*	0.27(0.07-1.03)	0.28(0.09-0.87)*	0.39(0.12-1.25)
Province 7	0.13(0.04-0.41)**	0.13(0.04-0.41)**	0.14(0.04-0.45)**	0.25(0.06-1.01)
<b>Education</b>				
No education	1	1	1	1
Primary	1.14(0.55-2.34)	0.95(0.41-2.18)	1.09(0.53-2.27)	0.92(0.60-2.16)
Secondary	2.43(1.24-4.76)*	1.93(1.01-3.69)*	2.09(1.05-4.16)*	1.73(0.89-3.38)
higher	1.83(0.81-4.10)	1.00(0.40-2.50)	1.57(0.67-3.71)	1.04(0.40-2.68)
<b>Ethnicity</b>				
Brahmin/chhetri	1.58(0.79-3.14)	1	1.52(0.76-3.04)	1
Janajati	1.97(0.95-4.07)	1	1.87(0.89-3.91)	1
Others caste	1	1	1	1
<b>Currently working</b>				
Not working	1	1	1	1
Working	1.21(0.70-2.08)	1	1.23(0.70-2.16)	1
<b>Occupation</b>				



Agriculture	1	1	1	1
No job	1.42(0.75-2.68)	1.23(0.66-2.30)	1.33(0.70-2.52)	1.14(0.60-2.16)
Services	2.82(1.37-5.81)	1.71(0.82-3.54)	2.60(1.26-5.36)*	1.44(0.69-2.99)
<b>Health status</b>				
Poor	1	1	1	1
Middle	1.15(0.48-2.75)	1.51(0.65-3.51)	0.98(0.38-2.49)	1.39(0.56-3.41)
Rich	2.89(1.50-5.54)**	2.59(1.27-5.28)*	2.61(1.36-5.02)*	2.46(1.19-5.08)*
<b>Height</b>				
Normal height	1	1	1	1
Short stature	3.19(1.59-6.40)**	3.94(1.94-8.00)**	4.38(2.17-8.86)**	4.48(2.19-9.16)**
<b>Iron/folate intake</b>				
Yes	1		1	
No	0.83(0.35-1.95)		0.89(0.38-2.08)	
<b>IC visits</b>				
Less than 5 times	1	1	1	1
More than 6 times	1.96(1.06-3.61)*	1.40(0.73-2.67)	1.90(1.01-3.55)*	1.49(0.78-2.83)
<b>Total children ever born</b>				
≤2 children	1		1	
>2 children	1(0.59-1.65)		1.10(0.65-1.84)	
<b>Birth spacing</b>				
<59 months	1		1	
≥60 months	1.83(0.98-3.44)		1.79(0.93-3.47)	
<b>Delivery by CS</b>				
No	1	1	1	
Yes	2.39(1.18-4.48)*	1.21(0.57-2.58)	1.95(0.90-4.25)	
<b>Father's occupation</b>				
No job	1		1	
Employed	0.75(0.28-1.98)		0.78(0.27-2.19)	
Agriculture	1.23(0.54-2.79)		1.26(0.53-3.00)	
<b>Father's education</b>				
No	1		1	
Education/Primary	1.04(0.58-1.87)		0.94(0.51-1.71)	
Secondary/Higher				
<b>Child factors</b>				
<b>Child's age</b>				
≤12 months	1	1	1	1
13-23 months	1.63(0.80-3.30)	0.91(0.34-2.41)	2.13(0.99-4.57)	1.28(0.47-3.50)
24-35 months	2.15(1.04-4.46)*	1.36(0.45-4.12)		
36-47 months	2.19(1.01-4.73)*	1.26(0.39-4.09)		

48-59 months	1.76(0.79-3.89)	1.36(0.32-5.79)	2.85(1.33-6.11)*	1.96(0.63-6.12)
			2.75(1.21-6.24)*	1.88(0.52-6.79)
			2.27(0.98-5.28)	2.15(0.45-10.24)
<b>Child's sex</b>				
Male	1		1	
Female	0.84(0.53-1.33)		0.78(0.49-1.26)	
<b>Maternal A</b>				
Yes	1	1	1	1
No	0.45(0.22-0.92)*	0.82(0.30-2.20)	0.40(0.19-0.86)*	0.97(0.35-2.64)
<b>Worming</b>				
Yes	1	1	1	1
No	0.54(0.31-0.91)*	0.74(0.34-1.60)	0.49(0.28-0.86)*	0.80(0.36-1.78)
<b>Currently breastfed</b>				
Yes	1	1	1	1
No	1.97(1.10-3.51)*	1.01(0.37-2.75)	1.93(1.07-3.47)*	0.93(0.32-2.71)
<b>Child weight</b>				
Average	1	1	1	
Large	1.93(1.13-3.29)*	1.37(0.71-2.62)	1.61(0.90-2.87)	
Small	1.43(0.78-2.60)	1.75(0.84-3.64)	1.53(0.84-2.81)	
<b>Birth order</b>				
1-3 order	1		1	
4 <sup>th</sup> order or more	1.03(0.52-2.03)		1.18(0.59-2.35)	
<b>Duration of breastfeeding</b>				
≤1 hour	1		1	
>1 hour	1.28(0.74-2.21)		1.27(0.72-2.23)	

DBM: Double burden of malnutrition (Overweight/obese mother and undernourished child at the same household)

TBM: Triple burden of malnutrition (Overweight/obese mother and undernourished and anemic child at the same household)

1: reference category

COR: crude odds ratio, AOR: adjusted odds ratio

\*p < 0.05, \*\*p < 0.001

# Results

A total of 5018 mother-child pairs were included in the study. Fig 1. Shows that the different forms of malnutrition existing among the mother-child pairs at the same household level in Nepal. The prevalence of overweight/obese mother and stunted child (OM/SC) was 8.30% (6.32-10.84) %, overweight/obese mother and wasted child (OM/WC) was 1.26(0.74-2.11) %, overweight/obese mother and underweight child (OM/UC) was 3.37(2.34-4.83) % and overweight/obese mother and anemic child (OM/AC) was 18.87(15.43-22.83) %. Likewise, the prevalence of the double burden of malnutrition (DBM) was 6.59(5.13-8.84) %. Similarly, the coexistence of the triple burden of malnutrition (TBM) has occurred in 7(5.42-8.99) % at the same household level.

## Different forms of malnutrition and its associated factors

Table 2. Depicts bivariate and multivariate logistic regression model for the different forms of malnutrition and its associated factors among the mother-child pairs. The following results are the interpretation of the different forms of malnutrition and associated factors.

### Double burden of malnutrition (Overweight/obese mother and undernourished child)

In bivariate logistic regression model, several maternal factors were significantly associated with the double burden of malnutrition: mother's short stature (COR=3.19, 95% CI: 1.59-6.40), mothers from the richest wealth status (COR=2.89, 95% CI: 1.50-5.54), mothers whose occupation was services (COR=2.82, 95% CI: 1.37-5.81), mother who had attended at least secondary level of education (COR=2.43, 95% CI: 1.24-4.76), mothers whose last delivery done through caesarean section (COR=2.39, 95% CI: 1.18-4.48) and mothers aged 26-49 years (COR=1.18, 95% CI: 0.38-3.61). In addition, child related factors that were positively associated with double burden of malnutrition were children who were 24-35 months (COR=2.15, 95 % CI: 1.04-4.46), with no history of current breastfeeding (COR=1.97, 95% CI: 1.10-3.51) and child's large size at birth (COR=1.93, 95% CI: 1.13-3.29). Mothers who were 20-29 years of age during first birth of their child (AOR=0.12, 95% CI=0.03-0.44), mothers living in province number 2 (AOR=0.09, 95% CI: 0.03-0.31), no history of vitamin A intake among children (COR=0.45, 95% CI: 0.22-0.92) and no history of deworming in children (COR=0.54, 95% CI: 0.31-0.91) were found to be protective against DBM. Multivariate logistic regression model indicated that mothers with short stature (AOR=3.94, 95% CI: 1.94-8.00), richest wealth status (AOR=2.59, 95% CI= 1.27-5.28), age groups of 26-49 years (AOR=2.38, 95% CI: 1.18-4.77), mothers with secondary level of education (AOR=1.93, 95% CI: 1.01-3.69) were positively associated with double burden of malnutrition. While mothers living in province number 2 (AOR=0.12, 95% CI: 0.03-0.40), mothers aged 20-29 years at first birth (AOR=0.18, 95% CI=0.04-0.81) were less likely to have the double burden of malnutrition (Table 2).

### Triple burden of malnutrition (Overweight/obese mother and undernourished and anemic child)

Bivariate logistic regression model (Table 2) indicated that the mother's height of short stature (COR=4.38, 95% CI: 2.17-8.86), had child's age group of 24-35 months (COR=2.85, 95 % CI: 1.33-6.11), had the richest wealth status (COR=2.61, 95% CI: 1.36-5.02), mothers from services occupation group (COR=2.60, 95% CI: 1.26-5.36), mother's age groups of 26-49 years (COR=2.19, 95% CI: 1.13-4.26), having at least secondary level of education (COR=2.09, 95% CI: 1.05-4.16), had no history of current breastfeeding (COR=1.93, 95% CI: 1.07-3.47) were more

likely to be risk of triple burden of malnutrition. Likewise, results in the multivariate logistic regression model showed mothers short stature (AOR=4.48, 95% CI: 2.19-9.16), mothers from the richest wealth status (AOR=2.46, 95% CI= 1.19-5.08), and mothers aged 26-49 years (AOR=2.27, 95% CI: 1.16-4.44) were found to had higher odds of triple burden of malnutrition. Furthermore, mothers living in province number 2 (AOR=0.13, 95% CI: 0.04-0.43), mothers aged 20-29 years during first birth of their child (COR=0.16, 95% CI=0.03-0.64), children with no history of vitamin A intake (COR=0.40, 95% CI: 0.19-0.86), and no history of deworming drug intake (COR=0.49, 95% CI: 0.28-0.86) were found to had protective effects against triple burden of malnutrition (Table 2).

## Discussion

The present study revealed the coexistence of double and triple burden of malnutrition under the same household level in Nepal. We found the prevalence of double and triple burden of malnutrition among mother-child pairs exist 6.59% and 7% respectively. Our study found the prevalence of overweight/obese mother and stunted child (OM/SC) was 8.30% under the same roof. These percentages were slightly higher as compared to the findings from other developing countries in Southeast Asia. The prevalence of overweight/obese mother and stunted child in Bangladesh and India were 4.7% and 3.7% respectively [3, 4]. However, the results from African and Latin American countries showed the prevalence of overweight/obese mother and stunted child varied from 1.8-23% [17, 23]. In 2006, a systematic review done by Kosaka et al., reported the prevalence of overweight/obese mother and the stunted child was only 0.9% in Nepal [13]. Surprisingly, overweight/obese and stunted mother-child pairs have been continuously increased since the last decades. The current study found the prevalence of Overweight/obese mother and wasted child (OM/WC) was 1.26 % and overweight/obese mother and underweight child (OM/UC) was 3.37% in Nepal. This findings is consistent with the study of Bangladesh, where the prevalence of overweight/obese mother and wasted child and overweight/obese mother and underweight children were 1.7% and 3.8% respectively [3]. The urbanization in developing countries has an influence on adoption of sedentary life style, consuming energy dense foods and less physical activity that put the individual's at greater risks of obesity and overweight [24, 25]. Likewise, this result is also similar with the findings from most of the low and middle-income countries where the prevalence of maternal overnutrition and child wasting was varied from 0.3-5.3% [3, 5, 19]. In the current study, the prevalence of overweight/obese mother and anemic child (OM/AC) was 18.87%. In Bangladesh, Mamun et al., [1] reported the prevalence of overweight mother's pairs with anemic children were 27% which is higher than our study. Likewise, Sarmiento et al., found that the coexistence of overweight/obesity with anemic children was varied from 8.1-27.5% in Colombia [26].

The present study observed the prevalence of DBM in Nepal was 6.59% which is higher than that of the neighboring country Bangladesh. Hauque et al., [4] study found the maternal over and child undernourished(MOCU) was 4.9% and Das et al., [3] reported the coexistence of overweight/obese mother and underweight or stunted or wasted child (OWOBM/USWC) was 6.3%. However, about 11% of the maternal-child pair's double burden of malnutrition were observed in Indonesia which is higher than most of the South Asian countries [3, 4, 27]. It has been noted that this DBM is associated with the nutrition transition that contributes to a positive energy balance that means the intake of higher energy dense food and less energy expenditure [28]. The increasing trend of overweight/obese mother and undernourished child has reckoned the consequences of maternal child nutrition transition in Nepal. Consequences of nutrition transition may due to household dietary

habit. Most of the people are had a tendency to consume calorie dense food with more saturated fat, trans fat and sedentary lifestyle which results in reproductive aged women gaining weight [13, 29]. On the other hand intakes of processed food with low nutrient content leads to child undernourished [3, 23]. Other study reported that the prevalence of overweight/obesity mother and child undernourished is more common in urban areas [20]. This result is consistent with our findings, mothers who lived in urban areas had higher odds of the double burden of malnutrition than urban areas. The reason being most of the people in the urban areas are compelled to buy low costs food as a result of high rises in the living expenses and food prices [30]. Also, most of the households in such a setting have difficulty meeting their basic need and adequate nutritious food [30]. It may benefit the adults however it ruins the child nutritional status [3, 17].

While the adjusted regression model, this study depicts the mother who had short stature was strongly associated with the risk of DBM. This result is consistent with that of Oddo et al., [19] who reported the maternal short stature and mother had older age had higher odds of DBM compared to those normal height and younger age groups. Similarly, this findings is also supported by Ferreira et al., who found the higher BMI was significantly with short stature mother which reflect the vicious cycle of malnutrition that is more prone to the risk of a stunted child [31]. Stunting is the intergenerational phenomenon which transfers from mother to child as well as contributing to small for gestational age that leads to malnourished mother and likely to giving low birth weight and stunted child in first 1000 days of life [5, 32]. Haque et al., and Mamun et al., reported the maternal over and child undernourished were significantly associated with higher income and wealthier family [1, 4] which is consistent with our findings. This result was also validated by other similar studies [5, 11, 33]. Similarly, the current study found that mothers who had wealth status were positively associated with DBM. This is because those in the wealthy family may have increased intake of energy dense food such as processed food trans-fat and sedentary lifestyle [19]. Moreover, our study also found that mothers from the lowest wealth status were likely to be protective against the maternal over and child undernourished. The findings are parallel to the results of the previous study conducted in Bangladesh and Indonesia [19]. Our result revealed that mothers who had an older age group (26- 49 years) were found to be a higher risk of double burden of malnutrition. This result is consistent with Haque et al., and Wong CY et al., who suggested that prevalence of overweight/obesity was higher in the older age groups compared to younger groups [4, 5]. Mothers who attended at least secondary level of education had a higher risk of having a double burden of malnutrition. This findings is supported by Rai A et al., [34] who revealed women had primary/secondary level of education were more likely to be risk of overweight/obesity. However, higher levels of education were protective against maternal child double burden of malnutrition in Indonesia [19]. Other studies suggest that the relationship between education and overweight/obesity is complex and vary from country to country [35]. In developing countries, this association could be partly due to the educational status of women, getting sedentary lifestyle jobs and being unaware of the health consciousness of having overweight/obesity [34]. In case of the mother having poor health and nutritional knowledge, it leads to women being less sensitive to child and her nutritional status in terms of food choices and barriers such as food cost, accessibility, availability, lack of cooking skills [5]. As we found that DBM was more prevalent in mother who attended a lower level of education, therefore, providing nutrition education during pregnancy could bridge this nutritional knowledge gap in Nepal [36].

This study found that only mothers from province number 2 compared with that of province 3 was less likely to be double burden of malnutrition. Al Kibria GM et al., found that mothers from province 2 were less likely to be

overweight/obesity. Moreover, the prevalence of overweight/obesity had higher in province number 3 which is Kathmandu, the largest city (and capital) of the country [37].

Further, we intended to examine the triple burden of malnutrition. Maternal overweight/obesity and undernourished child and its associated factors have been explored in most of the Latin American and South Asian countries like Guatemala, Colombia, Brazil, Malaysia, Indonesia, and Bangladesh. However, in mother-child pairs, the coexistence of three forms of malnutrition has not yet examined. Thus, to our knowledge, this study is the first to present in the coexistence of overnutrition mother if there is undernourished child and anemic child under the same household. Present study depicts the coexistence of the triple burden of malnutrition among mother-child pairs was 7% in Nepal. This proportion is slightly higher than the double burden of malnutrition. This could have happened because more than half (53%) of the children aged 6-59 months were still anemic in Nepal [16]. The overall prevalence of anemia among the less than 59 months of children is 54.2% in developing countries [1]. Despite declining undernourished in children, micronutrient deficiency anemia remains one of the most intractable public health problem in South Asia [38]. The plausible explanation for the phenomenon of TBM has not been examined clearly. However, a possible reason could be suggested by various studies that the overweight/obesity mother is more risk factor for being anemia in their offspring. They found impaired iron transfer to the fetus among obese mother and resulting in lower serum iron as well as transferrin saturation in cord blood as compared to normal weight mother thus overweight/obese during pregnancy was positively associated with poorer iron status in the child [39, 40]. It could be happened due to the upregulation of hepcidin under proinflammatory conditions in overweight/obese mothers that lead to impaired iron transfer to the placenta resulting iron deficiency in the newborn [39].

Our study had some limitations, first, the study design was cross-sectional in nature, which could not establish the causal pathway of the association between the predictors and explanatory variables. To find out the causal relationship between the risk factor and different forms of malnutrition, rigorous analytical research is needed. Second, dietary intake of mother and children were not assessed. Likewise, data on the outcome measure of maternal overweight/obesity were not available such as dietary intake, physical activity level, health, and nutrition status during pregnancy. Third, the nutritional status of the mother was assessed using BMI only. BMI method is less accurate than other methods to assess the type of overweight/obesity, such as waist-hip ratio, bioelectrical impedance technique, skinfold thickness, and DEXA methods. Although, these other methods are less feasible to use in study with a wider sample due to expensive. Finally, the operational definition and prior literature for the triple burden of malnutrition are lacking.

Despite these limitations, our study had some strength, we use of population-based nationally representative samples. So our sample size is considerably large which provided reliable results. This study provided information on overweight/obese mother and undernourished child as well as micronutrient deficiency anemia with associated risk factor among mother-child pairs in the same household. These findings can provide relevant information and foundation to establish national nutrition intervention program in Nepal.

## Conclusions

In conclusion, our study revealed the double and triple forms of malnutrition coexisting among the mother-child pairs in Nepal. Our results suggest that mothers having short stature, from the richest family and mothers who

had old age are more prone to double and triple burden of malnutrition. The results clearly indicate the necessity of pragmatic strategies for preventing both double and triple burden of malnutrition in Nepal. The targeted nutrition-sensitive and specific interventions need to be scaled up for the timely prevention of double and triple burden of malnutrition. Likewise, integration of maternal health promotion and nutrition education focused components in the existing national nutrition program would a good strategy to prevent mother overweight/obesity and stunting among children under five years of age in Nepal. Further research is needed to identify the causes and associated risk factors of the double and triple burden of malnutrition which helps to pave the way for suitable policy implication and recommendation in Nepal.

## Abbreviations

ANC: Antenatal care; AOR: Adjusted odds ratio; BMI: Body mass index; CI: Confidence interval; COR: Crude odds ratio; DBM: Double burden of malnutrition; DEXA: Dual energy X-ray absorptiometry; DHS: Demographic and Health Surveys; EAs: Enumeration areas; NDHS: Nepal Demographic and Health Survey; OM/AC: Overweight/obese mother anemic child; OM/SC: Overweight/obese mother stunted child; OM/UC: Overweight/obese mother underweight child; OM/WC: Overweight/obese mother wasted child; TBM: Triple burden of malnutrition; PSU: Primary sampling unit

## Declarations

### Ethical approval and consent to participants

This study was secondary analysis of the NDHS 2016 data thus no separate ethical approval was required. However, ethical clearance for the NDHS was obtained from the ethical review board of Nepal Health Research Council and the written informed consent was obtained from each of the participants as per the standard ethical guidelines of the DHS program.

### Consent for publication

Not applicable

### Availability of supporting data

Dataset used in this study is publicly available from DHS website (URL:<https://www.dhsprogram.com/data/available-datasets.cfm>). Dataset modified for use in this paper are available upon reasonable request to the corresponding author.

### Competing interest

The authors have declared that no competing interest exist.

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### Author's contributions

## **Dev Ram Sunuwar**

Roles: Research design, conceptualization idea, data extraction, data analysis, interpretation, software, writing original draft, writing review and editing.

## **Devendra Raj Singh**

Roles: Data analysis, interpretation, writing original draft, writing review and editing.

## **Pranil Man Singh Pradhan**

Roles: Supervision on writing original draft, reviewing and editing

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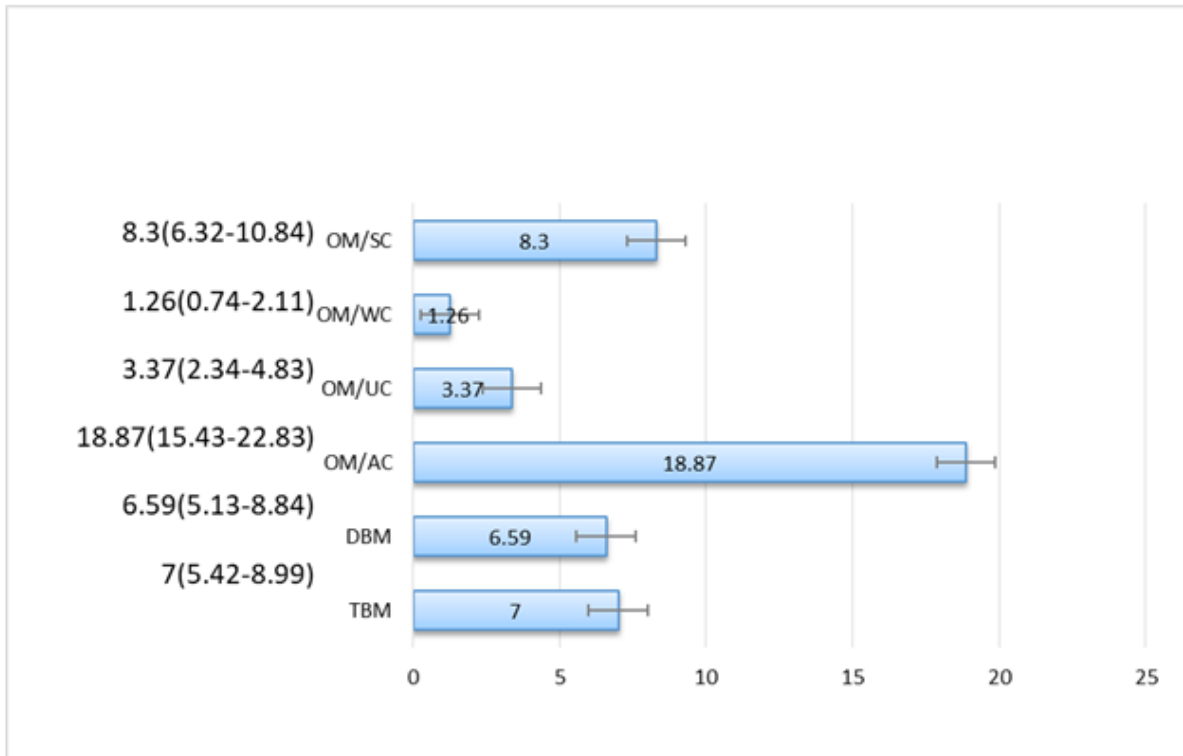


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## Figures



OM/SC: Overweight/obese mother and stunted child

OM/WC: Overweight/obese mother and wasted child

OM/UC: Overweight/obese mother and underweight child

OM/AC: Overweight/obese mother and anemic child

DBM: Double burden of malnutrition (Overweight/obese mother and undernourished child (stunted or wasted or underweight) at the same household)

TBM: Triple burden of malnutrition (Overweight/obese mother and undernourished and anemic child) at the same household)

## Figure 1

Prevalence (with 95% CI) of different forms of malnutrition among mother-child pairs (n=5018).

## Supplementary Files

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