Prevalence and 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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Abstract

Background: Malnutrition among mothers and children is a major public health challenge in developing countries like Nepal. Although undernutrition among children has been gradually decreasing, the coexistence of various forms of malnutrition among mothers and children has continued to rise globally. There is a gap in knowledge of the coexistence of such multiple burdens of malnutrition in the Nepalese context. The aims of this study were to explore the coexistence of various forms of malnutrition and associated factors among the mother-child pairs in the same household.

Methods: A total sample of 2,261 mother-child pairs from the Nepal Demographic and Health Survey (NDHS) 2016 were included in the study. Anthropometric measurements and hemoglobin levels of the children and anthropometric measurements of their mothers were taken. The bivariate and multivariable logistic regression were performed to assess the factors associated with the double burden of malnutrition (DBM) and the triple burden of malnutrition (TBM).

Results: Prevalence of DBM and TBM was 6.60(5.13-8.84) % and 7(5.42-8.99) % respectively in the same household. In the adjusted multivariable logistic regression, mothers with short stature compared to normal height (AOR=4.18, 95% CI: 2.04-8.52), from the richest wealth status compared to poor wealth status (AOR=2.46, 95% CI= 1.17-5.15), from age group of above 35 years compared to 15-24 years (AOR=3.08, 95% CI:1.20-7.86), and those who had attended at least a secondary level of education compared to no education (AOR=2.05, 95% CI: 1.03-4.07) were more likely to suffer from the DBM. Similarly, mothers with short stature compared to normal height (AOR=5.01, 95% CI:2.45-10.24), from the richest wealth status compared to poor wealth status (AOR=2.66, 95% CI=1.28-5.54), age groups of above 35 years compared to 15-24 years (AOR=3.41, 95% CI:1.26-9.17), and those who had attended at least a secondary level of education compared to no education (AOR=2.05, 95% CI: 1.00-4.18) were more likely to suffer from the TBM.

Conclusions: There is a low prevalence of double and triple burden of malnutrition among mother-child pairs in Nepal. Older mothers with short stature and from richer wealth status were more likely to suffer from double and triple burden of malnutrition.

Introduction

The various forms of malnutrition among children and mothers are major public health challenges in low and middle-income countries [1]. Various forms of malnutrition consist of double and triple burden of malnutrition. The double burden of malnutrition (DBM) is defined as the coexistence of maternal overweight and obesity along with child undernutrition within the same household level [2, 3]. Triple burden of malnutrition (TBM) refers to the coexistence of overnutrition, undernutrition and micronutrient deficiencies [4, 5]. Overnutrition, undernutrition, and micronutrient deficiencies equally increase the risk of various health problems [6]. Child undernutrition increases the risk of childhood mortality and poor cognitive development [7] and overnutrition causes various non-communicable diseases like high blood

glucose, raised blood pressure, central obesity and high lipid profiles [8]. Overweight/obesity during pregnancy is positively linked with several adverse maternal and fetal consequences during pregnancy, delivery and the postpartum period [9, 10].

Globally, the prevalence of undernutrition (stunting, wasting and underweight) in children has declined from an estimated 40% in 1990 to an estimated 26% in 2011 which was average annual rate of reduction of 2.1% per year, whereas maternal overweight has increased from an estimated 20% in 1990 to an estimated 30% in 2008 and obesity have increased from an estimated 5% in 1990 to an estimated 10% in 2008 respectively over the same time period [6]. Whereas the prevalence of overweight and obesity has been projected to increase by two-thirds in South and Southeast Asia by 2030 [11]. Among the South and Southeast Asian countries, the prevalence of overweight and obesity among women of reproductive age was observed at 21.3% and 8.6% respectively [9]. In Nepal, a systematic review based on nationally representative's report from 2001 to 2016 showed that the prevalence of stunting, wasting, and underweight among children has declined from 57.2% to 35.8%, 11.2% to 9.7%, and 42.7% to 27.0% respectively. However, overweight and obesity among women has increased from 6.5% to 22.1% over the same period of time [12]. The prevalence of stunting, wasting, and underweight has declined in the last decade in the context of Nepal [14], however, anemia among children aged under five years has been stagnant. Overweight and obesity have increased in all women of all socio-demographic groups [15, 16]. The nationally representative survey from different low and middle-income countries reported that overweight and obesity in mothers were found to coexist with stunting, wasting and underweight among children within the same households [17–19].

Association of socioeconomic status (SES) and the double burden of malnutrition has been explored in several studies [17, 20]. The maternal overweight/obesity and child undernutrition among the mother-child pairs was due to the interaction of changes related to socio-demographic and economic status, dietary habit and intensity of physical activity [19]. Popkin et al (2012) has highlighted that most of the low and middle-income countries are undergoing economic and nutrition transition [21]. In addition, various studies have also indicated that the double burden of malnutrition is associated with older aged mothers, mothers having short stature and a higher level of maternal education and wealth [17, 22, 23]. This might be due to the fact that educated women are more likely to engage in jobs that involves less physical activity, potential dietary difference and economic development. [24]. Undernutrition and micronutrient deficiencies are highly prevalent among Nepalese mothers and children under five years of age. According to the Nepal Demographic and Health Survey (NDHS), the 2016 report depicted that the prevalence of stunting, wasting, underweight, and anemia among <5 years of children was 35.8%, 9.7%, 27.0%, and 53% respectively.

The coexistence of various forms of malnutrition among mothers and children has continued to rise globally [25]. To our knowledge, overnutrition, undernutrition and micronutrient deficiencies in mother-child pairs within the same household has not been explored using nationally representative data in Nepal so far. This study aims to provide important information on the prevalence of double and triple burden of malnutrition and associated factors among mother-child pairs in the Nepalese context.

Methods

Study design and population

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 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 study population for this study was mother-child pairs from the Nepal Demographic and Health Survey 2016.

Sampling strategy

The NDHS 2016 utilized a stratified, two-stage cluster sampling design to provide representative 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 was selected from 383 wards in both rural (n=199) and urban (n=184) areas with probability proportional to size method. In the second stage, 30 households on average within EAs were selected using a systematic sampling technique. A more detailed methodology of the NDHS has been published in the most recent NDHS report [16]. The details of the sample size and exclusion criteria for the selection of the mother-child pairs are presented in Fig. 1.

Fig. 1 Flow chart for sample size selection

Data collection techniques

In this study, we used anthropometric and biochemical indices such as height-for-age, weight-for-height, and weight-for-age and hemoglobin levels to evaluate the nutritional status of each child aged 0-59 months. The WHO Multicenter Growth Reference Study Group, 2006 was used to calculate the anthropometric indicators to evaluate the nutritional status of the child [27]. Children suffering from 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 the blood hemoglobin level as anemic (<11g/dl) and not anemic (≥11gm/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 was used to determine the normal BMI (18.5 to <24.99kg/m^2) and overweight/obesity (≥25.0 kg/m^2) [28].

Study variables

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

Outcome variables

In order to simplify the analysis of the outcome variables, we dichotomized all dependent variables into presence (coded 1) versus absence (coded 0). We created four different categories 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. Four different categories were further combined to form two categories: overweight/obesity mother and undernourished child (stunting or wasting or underweight) which was considered as the double burden of malnutrition (DBM)[13] and the double burden of malnutrition plus anemic child (DBM + anemia) was regarded as the triple burden of malnutrition (TBM) [4, 5].

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, antenatal care (ANC) visits, parity, delivery by cesarean 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.

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 files 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 multivariable logistic regression model were performed to assess the factors associated with the double and triple burden of malnutrition. To prevent statistical bias in the multivariable logistic regression model, we examined and reported multicollinearity among the predictor variables using variation inflation factors (VIF). In this study, we used "10" as a cut-off value for the maximum level of VIF [29]. 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 the multivariable 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 a 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 participant as per the standard ethical guidelines of the DHS program. We registered and requested for access to data from the DHS website (URL: https://www.dhsprogram.com/data/available-datasets.cfm) and received an approval to access and download the DHS data file.

Results

Table 2 Socio-demographic characteristics of the study participants (N=2,261)

A total of 2,261 mother-child pairs were included in the study (Fig 1). Table 2 shows socio-demographic information of the participants and different forms of malnutrition existing among the mother-child pairs at the same household level in Nepal. The mean (±SD) age of the mothers and age of the child was 26.36(±5.64) years and 29.01(±17.37) months respectively. About one-half of the mothers (49.22%) were in the 25-34 years age groups and more than half of the mothers (52.77%) were below 19 years of age at their first birth. One-third of the mothers (33.68%) and only 15.12% of the fathers did not receive any formal education and approximately one-third of the mothers (32.36%) and more than one-third of the fathers (43.86%) attained secondary level education. The majority of the mothers (46.69%) and only 19.32% of the fathers were involved in agriculture. Slightly more mothers (25.89%) were living in province number 2, More mothers (42.04%) belonged to poor wealth status and the majority of the mothers (90%) had normal height. Slightly more children (22.53%) were below 12 months of age groups, more than half of children (52.71%) were male, slightly more than two-thirds of the child (74.52%) received a vitamin A capsule in the previous six months and more than half of the child (59.82%) were taking deworming. About two-thirds of the child (67.72%) were born with average birth weight.

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 1.25(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 18.89(15.43-22.83) %. The prevalence of the DBM was 6.60(5.13-8.84) % and TBM was 7(5.42-8.99) % at the household level.

Table 3. 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.

Prevalence and factors associated with the double burden of malnutrition

In the bivariate logistic regression model, several maternal factors were significantly associated with higher odds of the double burden of malnutrition: mother's short stature compared to normal height (COR=3.19, 95% CI: 1.59-6.40), mothers from the richest wealth status compared to poor wealth status (COR=2.89, 95% CI: 1.50-5.54), mothers whose occupation was services compared to agriculture

(COR=2.82, 95% CI: 1.37-5.81), mother who had attended at least secondary level of education compared to no education (COR=2.43, 95% CI: 1.24-4.76), mothers whose last delivery done through cesarean section compared to normal delivery (COR=2.39, 95% CI: 1.18-4.48) and mothers aged of above 35 years compared to 15-24 years (COR=1.18, 95% CI: 0.38-3.61). In addition, child-related factors that were more likely to increase odds of double burden of malnutrition were as follows: Children who were 36-47 months compared to below 12 months (COR=2.19, 95 % CI: 1.01-4.73), children with no history of current breastfeeding compared to children being currently breastfed (COR=1.97, 95% CI: 1.10-3.51) and child's large size at birth compared to average birth weight (COR=1.93, 95% CI: 1.13-3.29). Mothers who were 20-29 years of age during first birth of their child compared to above 30 years (AOR=0.12, 95% CI=0.03-0.44), mothers living in province number 2 compared to province number 3 (AOR=0.08, 95% CI: 0.03-0.47), no history of vitamin A intake compared to intake of vitamin A intake among children (COR=0.45, 95% CI: 0.22-0.92) and no history of deworming compared to deworming among children (COR=0.54, 95% CI: 0.31-0.91) were found to have lower odds of DBM. Multivariable logistic regression model indicated that mothers with short stature compared to normal height (AOR=4.18, 95% CI:2.04-8.52), mothers from richest wealth status compared to poor wealth status (AOR=2.46, 95% CI: 1.17-5.15), age groups of above 35 years compared to 15-24 years of age groups (AOR=3.08, 95% CI: 1.20-7.86-4.77), mothers with secondary level of education compared to no education (AOR=2.05, 95% CI: 1.03-4.07) were more likely to have higher odds of DBM. While mothers living in province number 2 compared to province number 3 (AOR=0.13, 95% CI: 0.03-0.47), were found to had lower odds of DBM (Table 3).

Prevalence and factors associated with the triple burden of malnutrition

Bivariate logistic regression model (Table 3) indicated that the mother's height of short stature compared to normal height (COR=4.38, 95% CI: 2.17-8.86), mother's age groups of above 35 compared to 15-24 years (COR=3.11.19, 95% CI: 1.34-7.22), had child's age group of 24-35 months compared to below 12 months (COR=2.85, 95 % CI: 1.33-6.11), had the richest wealth status compared to poor wealth status (COR=2.61, 95% CI: 1.36-5.02), mothers who worked in services compared to agriculture (COR=2.61, 95% CI: 1.36-5.02), having at least secondary level of education compared to no education (COR=2.09, 95% CI: 1.05-4.16), and mothers who had no history of current breastfeeding (COR=1.93, 95% CI: 1.07-3.47) were more likely to have higher odds of TBM. Likewise, results in the multivariable logistic regression model shows mothers short stature compared to normal height (AOR=5.01, 95% CI: 2.45-10.24), mothers age groups of above 35 years compared to 15-24 years (AOR=3.41, 95% CI: 1.26-9.17), mothers from the richest wealth status compared to poor wealth status (AOR=2.66, 95% CI= 1.28-5.54), and mothers who attended at least secondary level of education compared to no education (AOR=2.05, 95% CI: 1.00-4.18) were found to have higher odds of TBM. Furthermore, mothers living in province number 2 compared to province number 3 (AOR=0.11, 95% CI: 0.03-0.41), children with no history of vitamin A intake compared to 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 have lower odds of TBM (Table 3).

Table 3 Bivariate and multivariable analysis of double and triple burden of malnutrition among mother-child pairs and its associated factors (n=2,261).

Discussion

This study explored the coexistence of double and triple burden of malnutrition among mother-child pairs within the same household in Nepal. The prevalence of DBM was 6.60% which is higher than that of the neighboring country Bangladesh. A study by Emdadul S et al., [3] found that the maternal over and child undernourishment was 4.9% and Das et al., [13] reported that in Bangladesh the proportion of coexistence of overweight/obese mother and underweight or stunted or wasted child was 6.3%. The double burden of malnutrition was 11% in Indonesia which was higher than in most of the South Asian countries [3, 13, 30]. It has been noted that the overweight/obesity of mothers is associated with the nutrition transition situation that contributes to a positive energy balance which means higher intake of energy-dense food and less energy expenditure[31]. Tendency to consume calorie-dense food with more saturated fat, trans fat and a sedentary lifestyle results in reproductive-aged women gaining weight [21, 30]. In Nepal, The prevalence of overweight/obesity among such populations has been increased an estimated from 6.5% in 2001 to 22.1% in 2016 [14].

This study shows that short stature in mothers was strongly associated with the risk of DBM. This result is consistent with that of Oddo et al., [32] who reported that maternal short stature and older age had higher odds of DBM compared to those mothers of normal height and younger age groups. These possible phenomenon could be supported by the findings from Sichieri et al., and Ferreira et al., studies, who reported that BMI gain was significantly higher among short-statured women which reflects malnutrition in early life [33, 34]. This condition is likely to be associated with an increased risk of having cephalopelvic disproportion and stunted child resulting vicious cycle of malnutrition that is more prone to the risk of stunted children [33, 34]. Women with short stature were more likely to suffer from chronic degenerative diseases and consequently produced unhealthy children than women of normal stature [34]. Stunting is an intergenerational phenomenon that transfers from mother to child and contributes to small for gestational age (SGA) babies. Malnourished mother is likely to have a low birth weight baby in the first 1000 days of life which signifies the importance of exploring the double burden of malnutrition among mother-child pairs. [19, 35]. Our results revealed that mothers who were above 35 years were found to be at higher risk of double burden of malnutrition. This result is consistent with Emdadul et al., and Wong et al., who suggested that the prevalence of overweight/obesity was higher in the older age groups compared to younger groups [3, 36]. Mothers who attended at least a secondary level of education had a higher risk of having a double burden of malnutrition. This finding is supported by Rai et al., [38] who revealed that women who had primary/secondary levels of education were more likely to be at risk of overweight/obesity. In contrast, various studies have also reported that the double burden of malnutrition is associated with a higher level of maternal education and wealth status[17, 22, 23]. The possible reason could be due to the working environment where educated women are likely to be involved with less physical activity, consequently overweight and obese mothers [24]. Another study suggested that the relationship between education and overweight/obesity is complex and varies from country to country [39]. The explanation for this conflicting finding could be that mothers having a higher level of education may not necessarily be sufficient to adopt behavior change in a healthy lifestyle. In the 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 [19]. As we found that DBM was more prevalent in mothers who had a lower level of education, therefore, providing nutrition education during pregnancy could bridge this nutritional knowledge gap in Nepal [40].

This study found that mothers from province number 2 were less likely to have DBM compared with that of province 3. A possible reason could be mothers from province number 2 were belonging to poor socioeconomic status and consumed low diversified food groups (29%) [16] resulting less likely to be overweight and obesity (11%) [38, 41] According to the NDHS 2016 report, the prevalence of overweight/obesity was higher (35%) and highest proportion of consumed more diverse food groups (64%) in province number 3 which is Kathmandu, the largest city (and capital) of the country [41]. Overweight/obesity among mothers could be attributable to the shifting of the Nepalese diet away from locally available staple based foods to modern fast food and processed food [42] and sedentary lifestyle [38]. Nepal et al (2018) found that more than two thirds (76%) of participants consumed fast food and 39% had a sedentary lifestyle in Kathmandu valley [43] which contributes to the highest prevalence of overweight and obesity in province number 3.

Our study shows that the prevalence of TBM among mother-child pairs was 7% in Nepal. 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 [3, 32, 44–46]. However, in mother-child pairs, the coexistence of the triple burden of malnutrition has not yet been examined. Thus, to our knowledge, this study is the first to present the coexistence of overnutrition in mothers with undernutrition and anemia in child of the same household. A higher rate of TBM than DBM could have happened because more than half (53%) of the children aged 6-59 months were found to be anemic in Nepal as per NDHS [16]. Mamun et al (2019) also found the prevalence of overweight mothers with anemic children was 27% in Bangladesh. TBM prevalent is higher because this could have happened due to the higher prevalence of anemia among <59 months child in developing countries including Nepal. Despite declining undernutrition among children, micronutrient deficiency anemia remains one of the intractable public health problems in South Asia [47]. Despite limited evidence available so far on TBM, maternal overweight/obesity is a crucial factor in contributing to child anemia [1]. The plausible mechanism for the phenomenon of TBM has not been examined clearly. A possible reason could be that maternal overweight/obesity is a risk factor for anemia in their offspring. Maternal obesity and excessive gestational weight gain posed a higher risk of low neonatal iron status [48]. In obese mothers, impaired iron transfer to the fetus resulted in lower serum iron as well as transferrin saturation in cord blood as compared to normal-weight mothers [48, 49]. The upregulation of hepcidin under proinflammatory conditions in overweight/obese mothers leads to impaired iron transfer to the placenta resulting in iron deficiency in the newborn [48].

Our study had some limitations. First, the study could not establish the causal pathway of the association between the predictors and explanatory variables. Second, dietary intake of mothers and children were not assessed. Data on the outcome measure of maternal overweight/obesity such as

dietary intake, physical activity level, health, and nutrition status during pregnancy were not available. Third, the nutritional status of the mother was assessed using BMI only. BMI is less accurate than other methods such as waist-hip ratio, bioelectrical impedance technique, skinfold thickness, and DEXA methods to assess the type of overweight/obesity. Despite these limitations, the strengths of this study were the use of a population-based nationally representative sample. This study provided information on the combination of overweight/obese mother and undernourished child plus anemia with associated factors among mother-child pairs in the same household. These findings can provide relevant information to prioritize nutrition intervention programs in Nepal.

Conclusions

In conclusion, our study revealed a low prevalence of DBM and TBM in Nepal. Our results found that mothers having short stature, mothers from the richest family and older mothers are more prone to double and triple burden of malnutrition. Also, nation-wide effective implementation of maternal health promotion interventions and nutrition education program would be a good strategy to prevent overweight/obesity and stunting among children under five years of age in Nepal. Likewise, our study findings also indicate that wealthier families should not be neglected in the prevention strategies of double and triple burden of malnutrition. The nutrition-sensitive and specific interventions need to be scaled up throughout the country for the timely prevention of DBM and TBM among the Nepalese mothers and children. 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 sustainable prevention of the various forms of malnutrition 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; SGA: Small for gestational age, TBM: Triple burden of malnutrition; PSU: Primary sampling unit

Declarations

Ethical approval and consent to participants

This study was a 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 the DHS website (URL:https://www.dhsprogram.com/data/available-datasets.cfm). Dataset modified for use in this paper is available upon reasonable request to the corresponding author.

Competing interest

The authors have declared that no competing interest exists.

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Author's contributions

Dev Ram Sunuwar

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

Devendra Raj Singh

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

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Roles: Supervision on writing original draft, reviewing and editing

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Tables

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

Study variables	Coding category for analysis
Outcome variables	
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 ≥11g/dl), 1=anemic (hemoglobin level <11g/dl)
Mothers BMI (Continuous, calculated using measured height and weight)	0 = Normal (18.5–24.9 kg/m^2) 1 = Overweight/Obese (≥25 kg/m^2)
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) plus anemic child	0=normal or not overweight/obese mother and not undernourished child (stunted or wasted or underweight) plus not anemic child 1= overweight/obese mother and undernourished child (stunted or wasted or underweight) plus anemic child

Table 2 Socio-demographic characteristics of the study participants (N=2,261)

Variables		Mean±SD
Mother's age (years)		26.36±5.64
Child's age (months)		29.01±17.37
Mother's age at 1st birth (year)		19.83±3.34
Maternal factors	**characteristics**	**n(%)[a]**
Age groups (years)	15-24	951(41.14)
	25-34	1,104(49.22)
	≥35	206(9.64)
Age at 1st birth (years)	≤19	1,190(52.77)
	20-29	1,039(45.73)
	≥30	32(1.50)
Province	Province 1	305(16.27)
	Province 2	467(25.89)
	Province 3	227(15.61)
	Province 4	232(8.01)
	Province 5	382(18.93)
	Province 6	341(6.57)
	Province 7	307(8.71)
Education	No education	744(33.68)
	Primary	423(19.53)
	Secondary	744(32.36)
	higher	350(14.42)
Occupation	Agriculture	1,120(46.69)
	No job	855(40.35)
	Services	286(12.95)
Wealth status	Poor	1,052(42.04)
	Middle	476(22.02)
	Rich	733(35.94)
Height	Normal height	2,046(90)
	Short stature	215(10)
Delivery by CS	No	2071(90.2)
	Yes	190(9.8)
Father's occupation	Agriculture	422(19.32)
	No job	952(41.9)
	Services	869(38.78)
Father's education	No education	310(15.12)
	Primary	509(22.79)
	Secondary	1000(43.86)
	higher	422(18.24)
Child factors		
Child's age (months)	≤12 months	514(22.53)
	13-23 months	435(19.18)
	24-35 months	427(18.45)
	36-47 months	452(20.11)
	48-59 months	433(19.73)
Child's sex	Male	1193(52.71)
	Female	1068(47.29)
Vitamin A	Yes	1688(74.52)

	No	573(25.48)
Deworming	Yes	1399(59.82)
	No	862(40.18)
Currently breastfeeding	Yes	1824(78.8)
	No	437(21.2)
Birth weight	Average	1510(67.72)
	Large	350(15.72)
	Small	396(16.61)
OM/SC (n=1027)	Not stunted	949(91.7)
	Stunted	78(8.302)
OM/UC(n=1138)	Not underweight	1100(96.63)
	Underweight	38(3.37)
OM/WC(n=1350)	Not wasted	1335(98.75)
	Wasted	15(1.253)
OM/AC(n=751)	Not anemic	625(81.11)
	Anemic	126(18.89)
DBM(n=1529)	Normal	1437(93.4)
	OWOBM/UC	92(6.60)
TBM(n=1381)	Normal	1293(93)
	OWOBM/UC/AC	88(7)

[a] Frequency are unweighted; percentage are weighted

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

CS: Caesarean section

Table 3 Bivariate and multivariable analysis of double and triple burden of malnutrition among mother-child pairs and its associated factors (n=2,261).

ıternal factors	DBM		TBM	
	COR(95% CI)	AOR(95% CI)[b]	COR(95% CI)	AOR(95% CI)[c]
e group				
15-24	1	1	1	1
25-34	1.61(0.87-2.98)	1.59(0.83-3.03)	1.64(0.88-3.08)	1.96(1.04-3.71)*
≥35	2.59(1.13-5.94)**	3.08(1.20-7.86)**	3.11(1.34-7.22)**	3.41(1.26-9.17)**
e at 1st birth				
≤19 years	0.13(0.03-0.45)**		0.16(0.04-0.62)**	0.34(0.66-1.83)
20-29 years	0.12(0.03-0.44)**		0.16(0.03-0.64)**	0.18(0.03-1.06)
Above 30 years	1		1	1
ɔvince				
Province 1	0.89(0.40-2.00)	1.20(0.50-2.85)	0.89(0.38-2.03)	1.08(0.47-2.49)
Province 2	0.08(0.02-0.29)***	0.13(0.03-0.47)***	0.10(0.03-0.33)***	0.11(0.03-0.41)***
Province 3	1	1	1	1
Province 4	0.73(0.31-1.71)	0.97(0.36-2.61)	0.71(0.29-1.70)	0.85(0.31-2.32)
Province 5	0.51(0.21-1.22)	0.65(0.25-1.72)	0.57(0.23-1.38)	0.65(0.27-1.59)
Province 6	0.24(0.07-.75)*	0.47(0.14-1.58)	0.28(0.09-0.87)*	0.50(0.15-1.67)
Province 7	0.13(0.04-0.41)***	0.24(0.07-0.86)*	0.14(0.04-0.45)***	0.23(0.06-0.82)*
ucation				
No education	1	1	1	1
Primary	1.14(0.55-2.34)	1.04(0.49-2.22)	1.09(0.53-2.27)	1.06(0.46-2.41)
Secondary	2.43(1.24-4.76)*	2.05(1.03-4.07)*	2.09(1.05-4.16)*	2.05(1.00-4.18)*
higher	1.83(0.81-4.10)	1.04(0.43-2.49)	1.57(0.67-3.71)	1.43(0.53-3.84)
cupation				
Agriculture	1	1	1	1
No job	1.42(0.75-2.68)	1.19(0.58-2.42)	1.33(0.70-2.52)	1.10(0.53-2.26)
Services	2.82(1.37-5.81)*	1.34(0.63-2.86)	2.60(1.26-5.36)*	1.33(0.59-2.96)
ɜalth status				
Poor	1	1	1	1
Middle	1.15(0.48-2.75)	1.42(0.54-3.71)	0.98(0.38-2.49)	1.61(0.58-4.40)
Rich	2.89(1.50-5.54)***	2.46(1.17-5.15)**	2.61(1.36-5.02)***	2.66(1.28-5.54)***

ight				
Normal height	1	1	1	1
Short stature	3.19(1.59-6.39)***	4.18(2.04-8.52)***	4.38(2.17-8.86)***	5.01(2.45-10.24)***
livery by CS				
No	1	1	1	
Yes	2.39(1.18-4.84)*	1.44(0.68-3.04)	1.95(0.90-4.25)	
ther's occupation				
Agriculture				
No job	1		1	
Services	0.98(0.41-2.32)		1.01(0.40-2.52)	
	1.24(0.53-2.87)		1.27(0.52-3.07)	
ther's education				
No education	1		1	
Primary	1.81(0.58-5.75)		1.84(0.54-6.17)	
Secondary	1.49(0.54-4.10)		1.36(0.46-4.00)	
higher	1.64(0.56-4.80)		1.51(0.48-4.71)	
ild factors				
ild's age				
≤12 months	1	1	1	1
13-23 months	1.63(0.80-3.30)	0.85(0.33-2.20)	2.13(0.99-4.57)	1.24(0.47-3.34)
24-35 months	2.15(1.04-4.46)*	1.06(0.39-2.86)	2.85(1.33-6.11)*	1.60(0.56-4.57)
36-47 months	2.19(1.01-4.73)*	1.18(0.43-3.24)	2.75(1.21-6.24)*	1.71(0.58-5.02)
48-59 months	1.76(0.79-3.89)	0.77(0.26-2.26)	2.27(0.98-5.28)	1.17(0.36-3.75)
ild's sex				
Male	1		1	
Female	0.84(0.53-1.33)		0.78(0.49-1.26)	
amin A				
Yes	1	1	1	1
No	0.45(0.22-0.92)*	0.70(0.29-1.69)	0.40(0.19-0.86)*	0.85(0.34-2.14)
worming				
Yes	1	1	1	1
No	0.54(0.31-0.91)*	0.71(0.32-1.56)	0.49(0.28-0.86)*	0.79(0.35-1.74)
rrently				
eastfeeding	1	1	1	1
Yes				1.24(0.59-2.60)

No	1.97(1.10-3.51)*	1.34(0.64-2.79)	1.93(1.07-3.47)*
th weight			
Average	1	1	1
Large	1.93(1.13-3.29)*	1.57(0.85-2.92)	1.61(0.90-2.87)
Small	1.43(0.78-2.60)	1.46(0.77-2.75)	1.53(0.84-2.81)

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

*$p < 0.05$, **$p < 0.02$, ***$P<0.001$

[b] This model was adjusted for mother's age groups, province, education, occupation, wealth status, mother's height, delivery by CS, child's age, vitamin A intake in the last 6 months, deworming, currently breast feeding, and birth weight

[c] This model was adjusted for mother's age groups, mother's age at 1st birth, province, education, occupation, wealth status, mother's height, child's age, vitamin A intake in the last 6 months, deworming, and currently breast feeding

Figures

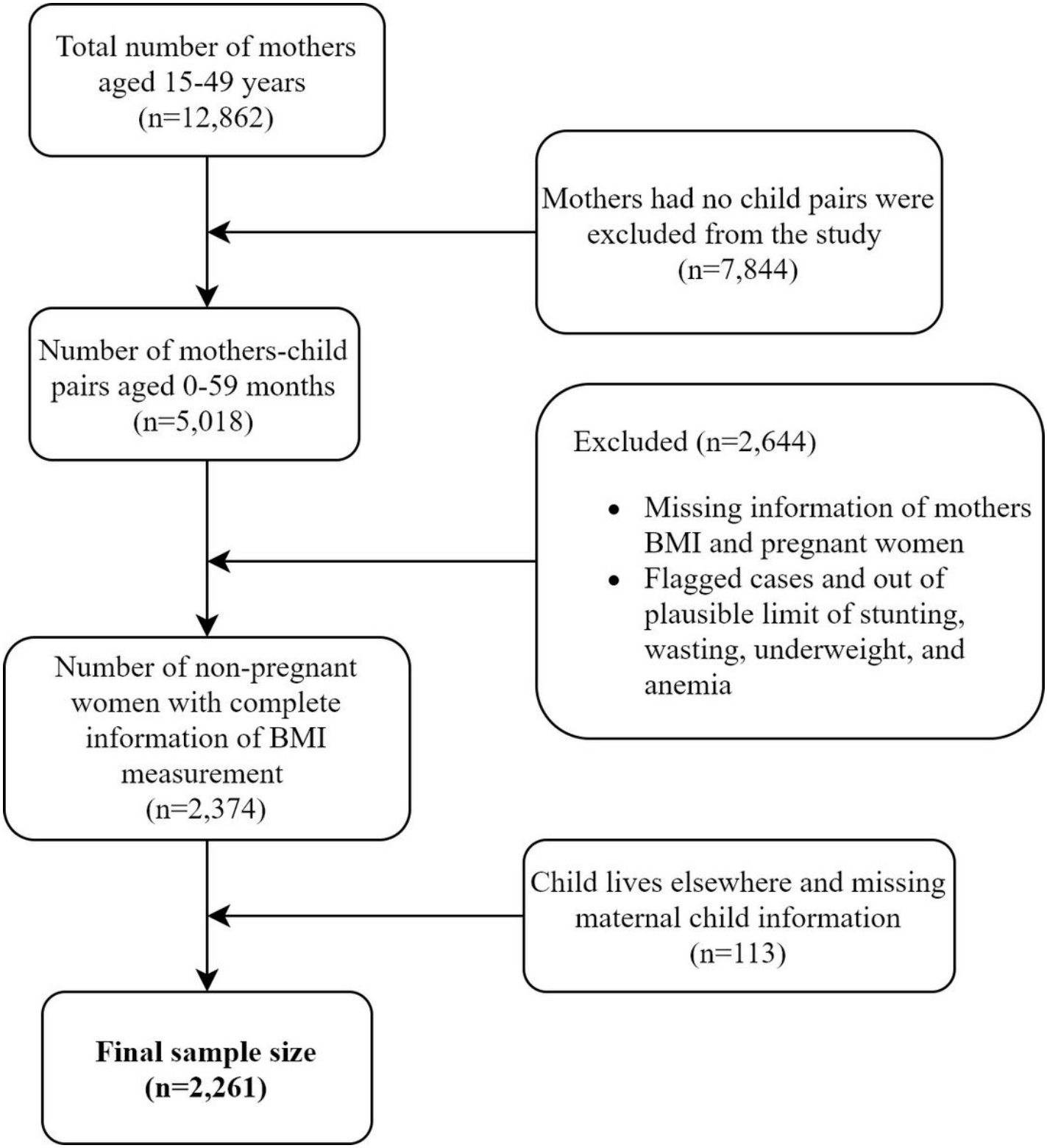

Figure 1

Flow chart for sample size selection

Supplementary Files

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- Dataset.dta