

# The Coexistence of Dual Malnutrition At Household Level in India: Evidence From The Comprehensive National Nutrition Study 2016–18

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## Research Article

**Keywords:** Child undernutrition, maternal overnutrition, double burden of malnutrition, CNNS, India

**Posted Date:** October 26th, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-997252/v1>

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# Abstract

## Objective

To examine the prevalence of DBM at national, state, regional level and its proximate determinants in households with a mother and child under 5 years of age.

## Methods

The present study includes data on 38,060 children under 5 years of age and their biological mothers, drawn from the nationally representative Comprehensive National Nutrition Survey (CNNS) of children and adolescents aged 0–19 years in India. The outcome variable for this study was the double burden of malnutrition at the household level. A child was classified as stunted if the height was at least -2SD below the mean for their age. A mother with a body mass index (BMI) of more than or equal to 25kg/m<sup>2</sup> (BMI  $\geq$  25 kg/m<sup>2</sup>) was considered as overweight. A binary variable with coexistence of both conditions was created and categorized as 1 (existence of stunted child and overweight mother), and 0 otherwise. Multivariate regression analysis was used to examine the association between DBM and covariates at maternal, child and household level.

## Results

3.4% of households were found to be with DBM, with higher prevalence in urban areas (6.2%) as compared to rural areas (2.5%). Inter-state and regional variations were present in the prevalence of DBM. The proportion of DBM was higher in households with mothers aged 30 years or more, mothers not working and those who had cesarean births. Prevalence of DBM was found to be higher in urban area and rich households.

## Conclusion

This study shows the prevalence of DBM and its proximate determinants. These findings highlight the need for a comprehensive nutrition programme that targets both undernutrition and overnutrition. While formulating standalone policies for both forms of malnutrition is relatively easier, customized policies and programmes are needed to combat the conflicting situation of dietary excess and deprivation at the household level.

## Background

Malnutrition in form of over- or undernutrition is a global public health concern [1]. While undernutrition remains a public health concern in developing countries, recent studies show that overnutrition too is becoming a point of concern in these countries [2]. In general, undernutrition and overnutrition have

different casual pathways [3–5]. While undernutrition is a result of deficient nutrient consumption[1], overnutrition in form of excess nutrient consumption is a result of change in diet and physical activity patterns due to urbanisation and globalisation. Pokin et.al states in his lancet series that increase in overweight population in LMIC is mainly due to rapid changes in the food system, particularly the availability of cheap ultra-processed food and beverages, and major reductions in physical activity at work, transportation, home and even leisure due to introductions of activity-saving technologies [6].

Both over- and undernutrition have severe and long-lasting adverse effects [7–12]. Child undernutrition is associated with multiple co-morbidities and increases the risk of developing obesity and other non-communicable diseases (NCDs) in later stages of life [9–12]. Undernutrition hampers the optimal cognitive growth and development of the child and further negatively impacts human capital [12]. Overnutrition on the other hand is linked with many NCDs and other cardio-metabolic risk factors [13–15].

Previous studies reported the co-existence of these two forms of malnutrition within the same country [16–18], among same household members [5, 19, 20], among mother-child pairs [3, 4, 21, 22] or within same individual [23, 24]. However, the co-existence of these two forms of malnutrition within the same household is not usually considered in the design and implementation of nutrition interventions. Interventions designed to reduce undernutrition contradicts the obesity prevention programme and vice versa. Supplying food to reduce undernutrition and recommending reduced fat diet to prevent obesity in household will have adverse effects on overweight and underweight members of the same household [19]. To address both forms of malnutrition, nutritious food and a healthy lifestyle is essential, as both over- and undernutrition have equally devastating effects on the future health of individuals as well as society [9, 10].

In India, malnutrition is found to be one of the major contributors to the disease burden among children under 5 years of age. Of the 1.04 million deaths of children under 5 years of age in India in 2017, 68.2% could be attributed to malnutrition [25]. The proportion of deaths attributable to malnutrition in India has been persistently high and changed only slightly from 70.8% to 68.2 % during 1990-2017 [25]. While child malnutrition continues to be high in India, adult overweight and obesity have also shown an increasing trend over the past few decades [26], possibly because of a rise in sedentary lifestyles and more energy dense, fat and animal based dietary habits [19]. Recent studies document a 21% overall prevalence of overweight and obesity among women [27]. With persistent child undernutrition and growing adult overweight and obesity, India is now facing a complex situation—that of the double burden of malnutrition. At the household level, the double burden of malnutrition (DBM) can be defined as the coexistence of a stunted child along with an overweight mother within the same household [3]. Previously, a study conducted across 131 developing countries reported that DBM at the household level ranged from 1.8 % to 15.9% [28]. Recent studies in bordering countries like Nepal and Bangladesh reported prevalence of DBM at the household level as 2-4% [29, 30]. In India, several studies have documented DBM at the household level but are limited to certain geographies [21, 31]. A study, using the National Family Health Survey (NFHS) 2015-16 data, highlights prevalence of DBM at the household level, but no state or region-specific variations were documented [32]. The present study aimed to fill this

gap in literature by documenting prevalence of DBM at the household level among mother-child pairs for at the country, state and regional level and further examined the factors associated with it.

With the aim to meet the UN Sustainable Development Goal (SDG) of eliminating malnutrition by 2030 [33], in 2017, the Indian government released the National Nutrition Strategy with measures to address malnutrition across the lifecycle[34]. In 2018, the Indian government launched the *Poshan Abhiyaan* programme with an overarching goal of reducing child and maternal malnutrition [35]. The findings of this study can play an important role in understanding the factors associated with DBM and the variations in the prevalence of DBM across the country. These findings can further help device a comprehensive nutrition policy focusing on both forms of malnutrition.

## Methods

### Dataset and sample covered

This study used nationally representative data from the CNNS that was conducted under the aegis of the Ministry of Health and Family Welfare (MoHFW) in collaboration with UNICEF and the Population Council, India with approval from the National Statistical Commission. CNNS was designed to provide nationally representative and comprehensive nutritional profiling of preschoolers (0–4 years), school-age children (5–9 years) and adolescents (10–19 years). Anthropometric measurements were taken from 38,060 children 0–4 years of age, 38,355 children 5–9 years of age and 35,830 adolescents from 2,035 primary sampling units (PSUs) across the country between February 24, 2016, and October 26, 2018. This study specifically focused on children aged 0–4 years and their biological mothers.

### Study sampling and Participants

CNNS used a multi-stage stratified sampling design to obtain a nationally representative sample of households and individuals aged 0–19 years across 29 states and the capital Delhi. In each state, the sample was selected in two stages. In the first stage, PSUs were selected using probability proportional to size (PPS) sampling. The second stage involved a systematic random selection of households within each PSU. In large PSUs, the sampling design involved three stages, with the addition of a segmentation procedure to reduce enumeration areas to manageable sizes. Children who had a chronic illness, physical deformity, mental illness, cognitive disability, or an ongoing current illness (high fever, infection) were not included in the study. The overall study design and methods have been described elsewhere [36]. For children 0–4 years, caregivers (mostly the mother) were interviewed, and anthropometric measurements of eligible children and biological mothers were recorded. Weight was recorded in kilograms and height in centimetres using a digital SECA scale and a three-piece wooden height/length board, respectively. Before each measurement, the instrument was set up on a portable wooden square and spirit-level was used to ensure even measurement surface. Recumbent length was measured in children who were either less than 2 years of age or 85 cm in height and for the rest, standing height was measured [26]. The present study included data from 38,060 children aged 0–4 years and their 35,452-biological mothers. The procedure of arriving at final the analytical sample size is described in Table 1.

Table 1  
Selection of analytical sample for households with children aged 0–59 months and their biological mothers in India, CNNS 2016–18

Criteria	N
Total interviewed Households	38,060
Biological mother was not interviewed	2,608
Flagged/missing cases of maternal BMI	3,387
Flagged/missing cases of stunted child	1,922
Flagged/missing cases of maternal BMI or stunted child	4,072
Missing information regarding covariates	46
<b>Final analytical sample</b>	<b>31,334</b>

## Outcome measures for nutritional status of children and their mothers

According to the World health organization (WHO), the double burden of malnutrition is the coexistence of undernutrition along with overweight, obesity or diet related non -communicable diseases, within individuals, households and populations and across the life-course [37]. The outcome variable of this study—double burden of malnutrition at household level—is defined as mother-child pair, with mother as overweight or obese and child as stunted. The WHO Anthro-Plus software was used to calculate Z-scores (standard deviation scores) for height-for-age of the child. A child was classified as stunted if the height was at least two standard deviation ( $< 2SD$ ) below the mean for their age. A mother was considered as overweight if her BMI was more than or equal to  $25\text{kg}/\text{m}^2$  ( $BMI \geq 25\text{ kg}/\text{m}^2$ ). A binary variable with coexistence of both the conditions was created and categorized as 1 (existence of stunted child and overweight mother), and 0 otherwise.

## Covariates

Based on UNICEF’s conceptual framework of factors associated with malnutrition[38] and other relevant literature on overweight mothers and stunted children [3, 19, 21, 28, 29], a variety of socio-demographic characteristics at child, mother and household level were included in the analysis. Child covariates included age categorized as less than 24 months and 24 months to 59 months. Sex of child as dichotomous variable was categorized as male or female. Birth order of child was classified as 1st to 3rd order and 4th or more. Breastfeeding status denoted that the child was ever breastfed and was categorized as yes, or no. Morbidity was classified as yes if the child suffered from diarrhea, acute respiratory infection, or fever in the 2 weeks prior to the survey.

Maternal covariates included age categorized as less than 20 years, 20-24 years, 25- 29 years, and 30 or more years. Maternal education was categorized as no education, completed primary schooling,

completed secondary schooling, above secondary schooling. Working status was classified as working or not working. Type of delivery of the index child was categorized as normal or cesarean.

Finally, household level characteristics included wealth index, place of residence (urban or rural), caste, and exposure to mass media. Wealth index was computed using data on household's ownership of selected assets. The detailed description of methodology for wealth index calculation has been documented elsewhere [36]. Caste was classified as Scheduled Caste or Scheduled Tribe and Others including Other Backward Castes.

## Statistical analysis

Descriptive statistics were used to describe the study variables. The association of DBM at the household level with socioeconomic and demographic characteristics was verified by the Pearson's  $\chi^2$  test. Multivariate logistic regression models were used to assess the association between the DBM and covariates. Adjusted odds ratios with 95% confidence interval (CI) were estimated to assess the strength of the association of DBM with predictors and covariates. In view of the complexity of the survey design, sampling weights were used and accounted for stratification and clustering in the sample design to estimate the proportion and 95% CIs for estimates. All the analyses were performed using the Stata software version 16.0 (STATA Corp LP, College Station, USA).

## Results

Table 1 presents the analytical sample for this study. A total of 38,060 households with children aged 0–4 years were interviewed. Out of these households, in 38,454 households' biological mothers were interviewed. Considering the exclusion of implausible values and missing cases, the final analytical sample for this study was 31,334. Figure 1 shows the percentage of households with stunted children, overweight mothers and DBM at the household level. Overall, 33.9% of children and 15.3% mothers were found stunted and overweight, respectively. The prevalence of stunting was found to be higher in rural areas (36.3% vs. 26.5%); whereas prevalence for both overweight mothers and DBM was higher in urban areas. Of the total number of households, 3.4% were found having DBM.

Table 2 shows the maternal, child and socio-demographic characteristics of the study population among households with one mother-child pair. More than 30% of the mothers were less than 25 years of age and the same proportion had no formal education. About one-fourth of the mothers were working and 60% reported exposure to mass media. Of the total, 61% of the children were in the age group of 24–59 months and 4% were never breastfed. Half of the children were reported having morbidity in the two weeks prior to the survey. More than three-fourths of the households were in rural areas and more than one third of the households belonged to Scheduled Caste or Scheduled Tribe.

Table 2  
 Basic socio-demographic characteristics of  
 households with mother-child pair, India, CNNS  
 2016–18

<b>Basic Characteristics</b>	<b>N</b>	<b>%#</b>
<b>Maternal Characteristics</b>		
<b>Mother's Age</b>		
Less than 20	859	2.8
20–24	7,769	30.4
25–29	11,620	38.6
30 and above	11,086	28.3
<b>Mother's Education</b>		
No education	5,787	30.4
Primary school	3,747	14.0
Secondary school	12,111	34.2
> Secondary school	9,689	21.4
<b>Mother's Working Status</b>		
No	23,897	76.0
Yes	7,437	24.0
<b>Type of Delivery of Index Child</b>		
Normal	23,553	83.0
Caesarean	7,781	17.0
<b>Mother's Mass Media Exposure</b>		
No	7,202	39.7
Yes	24,132	60.3
<b>Child Characteristics</b>		
<b>Age in Months</b>		
0–23 months	12,167	39.1

N: Number of observations

#: Percentage are weighted

<b>Basic Characteristics</b>	<b>N</b>	<b>%#</b>
24–59 months	19,167	60.9
<b>Sex</b>		
Male	16,549	52.2
Female	14,785	47.8
<b>Birth order</b>		
1–3	28,456	87.3
4+	2,878	12.7
<b>Breastfed ever</b>		
No	1,490	3.9
Yes	29,844	96.1
<b>Morbidity in Past 2 Weeks</b>		
No	17,936	50.9
Yes	13,398	49.1
<b>Household Characteristics</b>		
<b>Family Size</b>		
2–3	4,118	7.4
>=4	27,216	92.6
<b>Wealth Index</b>		
Poorest	2,423	19.6
Poor	3,716	20.0
Middle	5,928	20.0
Rich	8,147	20.0
Richest	11,120	20.4
<b>Region</b>		
North	7,247	13.8
Central	3,617	30.2
N: Number of observations		
#: Percentage are weighted		

<b>Basic Characteristics</b>	<b>N</b>	<b>%#</b>
East	4,718	24.5
West	3,432	12.3
South	5,071	16.1
North-East	7,249	3.2
<b>Place of Residence</b>		
Rural	16,991	76.4
Urban	14,343	23.6
<b>Caste</b>		
Scheduled Caste/Tribe	11,707	35.6
Others/OBC	19,627	64.4
N: Number of observations		
#: Percentage are weighted		

Table3 presents the association of DBM with selected socio-demographic characteristics. The proportion of DBM was higher in households with mothers aged 30 years or more, those who were not working and those who had cesarean births. Female children were less likely to belong to households with DBM as compared to households with male children (AOR: 0.86, 95% CI: 0.77-0.96). Children with morbidity and in the birth order 4 or more were more likely to belong to households with DBM (AOR: 1.14, 95% CI: 1.02-1.28) and (AOR: 1.48, 95% CI: 1.21-1.80), respectively. Breastfed children were less likely to belong to DBM households as compared to never breastfed children (AOR:0.77, 95% CI: 0.59-1.02). Prevalence of DBM was found to be higher in urban area and rich households.

Table 3

Bivariate association (percentage) and adjusted associations (odd ratio) between different socio-demographic determinants and DBM at household level, India, CNNS 2016–18

Determinants	% <sup>a</sup> (n)	p-value	UOR (95%CI)	AOR (95%CI)
<b>Mother's Age</b>		<0.001		
Less than 20	1.6 (19)		1(Ref)	1(Ref)
20–24	2.2 (230)		1.35(0.84-2.17)	1.13(0.7-1.82)
25–29	3.5 (491)		1.95(1.23-3.1) ***	1.43(0.89-2.29)
30 and above	4.7 (602)		2.54(1.6-4.03) ***	1.7(1.06-2.72) **
<b>Mother's Education</b>		<0.001		
No education	2.3 (190)		1(Ref)	1(Ref)
Primary school	3.0 (148)		1.21(0.97-1.51) *	1(0.8-1.26)
Secondary school	4.1 (588)		1.5(1.27-1.78) ***	1.02(0.84-1.23)
> Secondary school	4.0 (416)		1.32(1.11-1.57) ***	0.71(0.58-0.88) ***
<b>Mother's Working Status</b>		0.014		
No	3.6 (1061)		1.18(1.03-1.35) **	1.13(0.99-1.3) *
Yes	2.6 (281)		1(Ref)	1(Ref)
<b>Caesarean Delivery</b>		<0.001		
No	3.0 (896)		1(Ref)	1(Ref)
Yes	5.0 (446)		1.54(1.37-1.73) ***	1.34(1.18-1.51) ***
<b>Mother's Mass Media Exposure</b>		<0.001		
No	2.0 (176)		1(Ref)	1(Ref)
Yes	4.3 (1166)		2.03(1.73-2.38) ***	1.19(0.98-1.44) *
<b>Age in Months</b>		<0.001		
0–23 months	2.6 (387)		1(Ref)	1(Ref)
24–59 months	3.9 (955)		1.6(1.42-1.8) ***	1.5(1.32-1.7) ***
<b>Child Sex</b>		0.003		

Ref., reference; UOR, unadjusted odds ratio; AOR, adjusted odds ratio

n, total observation; P-value ( $\chi^2$ ), P-value obtained from chi-square estimation

<sup>a</sup> Prevalence of DBM; Level of significance \*\*\*p<0.01, \*\*p<0.05, \*p<0.1

Determinants	% <sup>a</sup> (n)	p-value	UOR (95%CI)	AOR (95%CI)
Male	3.8 (762)		1(Ref)	1(Ref)
Female	2.9 (580)		0.85(0.76-0.94) ***	0.86(0.77-0.97) **
<b>Birth order</b>		0.022		
1–3	3.3 (1195)		1(Ref)	1(Ref)
4+	3.9 (147)		1.23(1.03-1.46) **	1.48(1.21-1.8) ***
<b>Breastfed ever</b>		0.306		
No	3.7 (56)		0.87(0.66-1.14)	0.77(0.59-1.02) *
Yes	3.4 (1286)		1(Ref)	1(Ref)
<b>Morbidity in Past 2 Weeks</b>		0.191		
Yes	3.2 (597)		1.08(0.96-1.20)	1.14(1.02-1.28) **
No	3.5 (745)		1(Ref)	1(Ref)
<b>Family Size</b>		0.024		
2–3	3.8 (149)		1(Ref)	1(Ref)
>=4	3.3 (1193)		1.22(1.03-1.45) **	1.13(0.95-1.35)
<b>Wealth Index</b>		<0.001		
Poorest	1.4 (39)		1(Ref)	1(Ref)
Poor	1.8 (68)		1.14(0.77-1.69)	1.16(0.77-1.74)
Middle	3.0 (188)		2.00(1.41-2.84) ***	1.91(1.31-2.78) ***
Rich	4.6 (436)		3.46(2.48-4.81) ***	3.08(2.1-4.51) ***
Richest	5.9 (611)		3.55(2.56-4.93) ***	3.17(2.12-4.74) ***
<b>Place of Residence</b>		<0.001		
Rural	2.5 (546)		0.57(0.51-0.63) ***	0.75(0.67-0.85) ***
Urban	6.2 (796)		1(Ref)	1(Ref)
<b>Caste</b>		0.054		

Ref., reference; UOR, unadjusted odds ratio; AOR, adjusted odds ratio

n, total observation; P-value ( $\chi^2$ ), P-value obtained from chi-square estimation

<sup>a</sup> Prevalence of DBM; Level of significance \*\*\*p<0.01, \*\*p<0.05, \*p<0.1

Determinants	% <sup>a</sup> (n)	p-value	UOR (95%CI)	AOR (95%CI)
Scheduled Caste/Tribe	2.7 (468)		0.89(0.8-1.0) *	1.07(0.95-1.2)
Others/OBC	3.8 (874)		1(Ref)	1(Ref)
Ref., reference; UOR, unadjusted odds ratio; AOR, adjusted odds ratio				
n, total observation; P-value ( $\chi^2$ ), P-value obtained from chi-square estimation				
<sup>a</sup> Prevalence of DBM; Level of significance ***p<0.01, **p<0.05, *p<0.1				

Table 4 presents the prevalence of DBM at the regional and state level. Out of 6 regions, three regions had a higher prevalence of DBM than the national average. These three regions were west, north and north-east, with DBM prevalence of 5.3%, 4.6% and 4.3%, respectively. Of all the states, Kerala, Himanchal Pradesh, Delhi, Punjab, Tamil Nadu, Sikkim, and Haryana had the highest DBM, with prevalence of 10.4%, 10.0%, 9.0%, 7.9%, 7.5%, 5.9% and 5.8%, respectively. Whereas, Jharkhand (0.5%), Bihar (0.7%), Assam (0.9%), Rajasthan (1.5%), Madhya Pradesh (1.5%), Telangana (2.0%), Nagaland (2.1%) and Tripura (2.3%) had the lowest prevalence of DBM.

Table 4  
Regional and state level prevalence of  
DBM at household level, India, CNNS  
2016–18

	<b>Sample</b>	<b>%</b>
<b>India</b>	<b>31,334</b>	<b>3.4</b>
<b>North</b>	<b>7,247</b>	<b>4.6</b>
Delhi	1,394	9.0
Haryana	915	5.8
Himachal Pradesh	1,044	10.0
Jammu & Kashmir	998	3.6
Punjab	908	7.9
Rajasthan	995	1.5
Uttarakhand	993	4.1
<b>Central</b>	<b>3,617</b>	<b>3.0</b>
Chhattisgarh	1,008	3.1
Madhya Pradesh	960	1.5
Uttar Pradesh	1,649	3.7
<b>East</b>	<b>4,718</b>	<b>1.7</b>
Bihar	1,182	0.7
Jharkhand	1,059	0.5
Odisha	1,179	2.4
West Bengal	1,298	4.0
<b>Northeast</b>	<b>3,432</b>	<b>4.2</b>
Arunachal Pradesh	1,041	3.5
Assam	1,219	0.9
Manipur	1,000	4.7
Meghalaya	735	5.1
Mizoram	706	3.8
Nagaland	762	2.1

	Sample	%
Sikkim	895	5.9
Tripura	891	2.3
<b>West</b>	<b>5,071</b>	<b>5.3</b>
Goa	876	4.8
Gujarat	926	4.5
Maharashtra	1,630	4.0
<b>South</b>	<b>7,249</b>	<b>1.7</b>
Andhra Pradesh	1,051	3.9
Karnataka	791	4.6
Kerala	760	10.4
Tamil Nadu	1,532	7.5
Telangana	937	2.0

## Discussion

This study attempted to document the prevalence and factors associated with DBM at the national, regional, and state levels using a nationally representative dataset. DBM at the household level was reported as 3.4%, which is similar to previous studies conducted in India and other south Asian countries. A study conducted using NFHS 2015–16 data reported 4% households with overweight mothers and stunted child [32]. Further, a study conducted in 42 countries based on the demographic health survey (DHS) reported the prevalence of DBM as 1%, 1.2% and 1.5% in Bangladesh, India and Nepal utilizing data collected in 2000, 1998 and 2001 respectively [21]. Recently, a study reported the prevalence of DBM as 4.2%, 1.5%, 3.9% and 5.5% in Bangladesh, Nepal, Pakistan and Myanmar, respectively [29]. Another study reported that 11% and 4% of households in rural Indonesia (2000-03) and Bangladesh (2003-06), respectively, were double burdened [39]. These results indicate that the prevalence of DBM is increasing over time, highlighted the urgency for targeted interventions and attention of policy makers. This present study further showcased the prevalence of DBM at the state and regional level. The prevalence of DBM varied from 0.5% in Jharkhand to 10.4% in Kerala. A previous study conducted in Kerala reported a similar prevalence of DBM at the household level as 10.7% [31].

This study found that the prevalence of stunting among children less than 5 years of age was 33.9%. NFHS has reported 38% of stunted children across India ranging from 20% in Kerala to 48% in Bihar [40]. A study conducted in high burden pockets (districts) of India reported stunting as 37.9% in Madhya Pradesh to 70.7% in Jharkhand [41]. This shows a huge variation in the prevalence of stunting in India at

the state and district level. The prevalence of stunting was higher in rural areas (36.3%) than in urban areas (26.3%) and these findings corroborated with the findings from NFHS 2015–2016 [40]. This study also revealed that 15.3% of mothers were overweight or obese, whereas, NFHS 2015–2016 reported 21% of women as overweight or obese. This may be due the fact that the mothers of young children practice breastfeeding and therefore lose pregnancy weight [42].

This study further examined the maternal, child and household factors that are associated with DBM. Maternal characteristics, including mothers' age, education, working status, caesarean delivery and mass media exposure were found to be associated with DBM. It was found that households with older mothers were at an increased risk of DBM as compared to those with younger mothers. This finding is in line with other studies [29, 39] and a possible explanation can be that with increasing age, chances of obesity increase due to a sedentary lifestyle and reduced metabolic rates. Another study also reported that maternal weight has been negatively associated with breastfeeding [42, 43]. Mothers' education level was negatively associated with the prevalence of DBM at the household level. The finding corroborated with previous studies conducted in Pakistan [29] and Indonesia [39]. However, few studies documented that the risk of obesity among educated mothers was higher and can be attributed to a sedentary lifestyle [44]. Study households with mothers who had c-section deliveries were found to be at a higher risk of DBM. Studies suggest that obese mothers have a higher cesarean delivery rate[45]. In addition, children born via c-section delivery are less likely to have timely initiation of breastfeeding [46, 47].

Child characteristics, including age, sex, birth order and morbidity were examined and were found to be associated with DBM. Household with older children in age group of 24–59 months were at higher risk of DBM. These finding were similar to the studies conducted in Pakistan, Myanmar, Indonesia, and Bangladesh [29, 39]. One of the probable reasons can be that decreased breastfeeding and improper complementary feeding results in stunting among children age 24–59 [48]. Further, households with higher birth order of child were at increased risk of DBM. As the birth order increased so did the chances of a child being stunted, due to a preference for an older male child [49]. Further, with an increase in the number of live births, chances of maternal obesity increased by 7% per live birth [50].

The results of this study suggested that DBM was positively associated with higher wealth index of household and urban residence. Other studies in the South Asian region also reported the association of higher wealth index with DBM [19, 29, 39]and urban residence [29]. This is contradictory to the studies conducted in Latin American countries that report DBM association with lower wealth quintile and rural areas [51]. This contrast can be because of dietary habits. For instance, households in the higher wealth index had a higher consumption of energy dense food and aerated drinks. As the prevalence of obesity among women was high in urban areas [52], it contributed to the prevalence of DBM among urban households.

This study has several limitations. As this study used cross-sectional data, it limits the ability to draw causal inferences. Further, few important variables due to non-availability were not included in this study, such as physical activity and time use pattern of mothers to understand their lifestyles. In addition,

genetic factors, which might have influenced both mother and child nutritional statuses, have not been assessed in this study.

DBM at the household level indicated the dual nutrition challenge facing India [37]. Addressing this complex issue is a crucial step towards achieving SDG-2. With unprecedented investment and focus on nutrition through the *Poshan Abhiyaan* programme, customized intervention, programme and policy can help overcome DBM and eventually smoothen the way to achieve SDG-2. The nutrition policies should focus not only on the diet of children but also on that of the mothers. Most of the child health programs focus on weight gain; therefore, stunting continues to remain a problem. Focus needs to be put on recommending a nutritious diet to overcome stunting along with other forms of malnutrition which co-exist in children. Mothers should also be recommended to have a nutritious diet and reduce energy-dense foods which lack nutrients. This will help reduce overweight and obesity and will also help in reducing other forms of malnutrition (micronutrient deficiency).

## **Conclusion**

The study computed the prevalence of DBM at the household level and the determinants associated with it. The findings of this study pose a challenge for policy makers and programmers in a rapidly developing and urbanizing country like India. While policy formulation for these two problems as standalone is relatively easier, however, in this case it cannot be assumed that households with malnourished children need more food. Issues of dietary quality, changes in individual dietary patterns and feeding behaviors need to be addressed. Customized policies and programmes are needed to combat the conflicting situation of dietary excess and deprivation at the household level.

## **Declarations**

### **Funding**

This study was funded by UNICEF

### **Conflicts of interest/Competing interests**

On behalf of all authors, the corresponding author states that there is no conflict of interest.

### **Ethics approval**

The CNNS received ethical clearance from the Ethical Review Board of the Post Graduate Institute for Medical Education and Research (PGIMER) and the Institutional Review Board of the Population Council in New York.

### **Consent to participate**

All aspects of the survey were informed to participants, following which written consent was obtained from caregivers of children aged 0–4 years.

### Consent for publication

Not Applicable

### Availability of data and material

Reasonable request for data used in this article may be made to the corresponding author.

### Code availability (software application or custom code)

Reasonable request for code used in this article may be made to the corresponding author.

### Authors' contributions

AP, RA, PKA and SA conceptualized the manuscript. PKA designed the survey, NK conducted data quality control and computed sampling weights. AP led the statistical analyses and SA contributed to analyses. AS and RA guided the analysis and AP, RA and AS interpreted the results. AP led the writing of the manuscript with inputs from RA and SA. RA, AS, SR, NK, RJ and PKA reviewed the manuscript.

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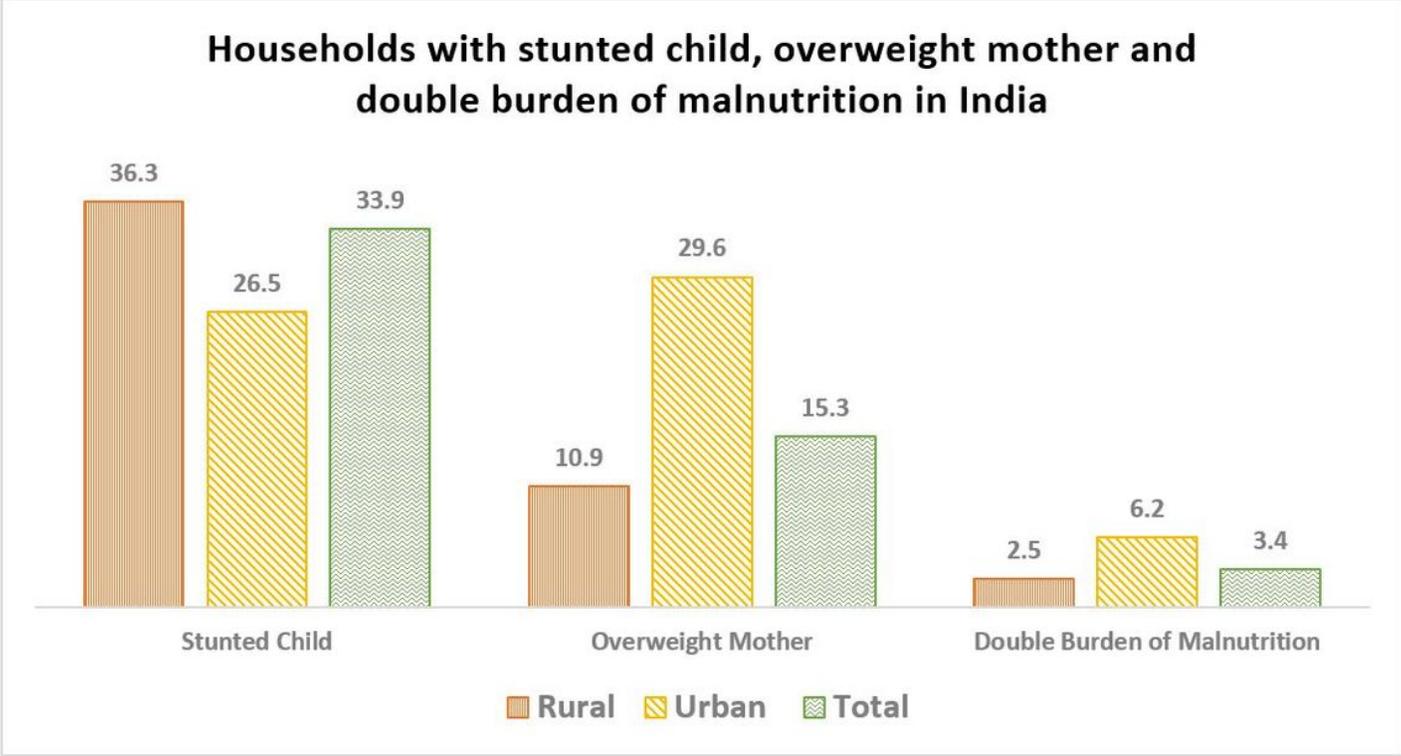
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## Figures



**Figure 1**

Prevalence of stunted child, overweight mother and DBM at household level, India, CNNS 2016–18