Heliyon 10 (2024) e37794

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Prevalence and socio-demographic factors associated with double and triple burden of malnutrition among mother-child pairs in India: Findings from a nationally representative survey (NFHS-5)

Premkumar Ramasubramani [a], Yuvaraj Krishnamoorthy [b,*], Sathish Rajaa [c]

[a] Department of Community Medicine, Mahatma Gandhi Medical College and Research Institute, Puducherry, India
[b] Evidence Synthesis Unit, Partnerships for Research, Opportunities, Planning, Upskilling, Leadership (PROPUL) Evidence, Chennai, India
[c] Department of Community Medicine, ESIC Medical College and PGIMSR, K.K. Nagar, Chennai, India

ARTICLE INFO

Keywords:
Malnutrition
Double burden
Triple burden
Mother-child pair
Household

ABSTRACT

Introduction: Improper consumption of food leads to various forms of malnutrition such as undernutrition, overnutrition and micronutrient deficiency. The coexistence of various malnutrition forms in the same household is a public health concern in developing countries. Very little research has been done on exploring the burden and risk factors associated with double (DBM) and triple burden of malnutrition (TBM).

Methods: Secondary analysis was done using data from India's National Family Health Survey-5 (NFHS-5), 2019-21. Mothers and under-five children were paired at the household level as a unit of analysis. DBM and TBM were interpreted from children's height-for-age, weight-for-height, weight-for-age and anaemia status and mothers' body-mass-index. Stratification and clustering in the sample design were accounted for during the analysis in STATA v14.2. DBM and TBM were summarized as weighted proportions with 95 % confidence interval (CI) and the risk factors associated were reported as adjusted odds ratio (aOR) with 95%CI using mixed effects logistic regression.

Results: We included 167,380 mother-child pairs for analysis. In India, the prevalence of DBM was 7.7 % (95 % CI: 7.5–7.9 %) and TBM was 5.1 % (5.0–5.3 %) at the household level among mother-child dyads. Mothers' age, age at first birth, educational levels, current breastfeeding habits, mode of delivery, child's age, gender, twin birth, birth weight, geographical region, residence, caste and religion, and wealth index were associated with both DBM and TBM.

Conclusion: Both DBM and TBM are public health concerns in India. Thus, scaling-up of health intervention, effective implementation of nutritional programmes and life-course approach are needed to control malnutrition.

1. Introduction

Access to a variety of food groups in both quantity and quality is important for ensuring a calorie- and micronutrient-sufficient diet [1]. Improper calorie, protein or other essential-nutrient consumption leads to malnutrition, encompassing undernutrition,

* Corresponding author.
E-mail addresses: prem8015r@gmail.com (P. Ramasubramani), yuvi.1130@gmail.com, yuvaraj@propulevidence.org (Y. Krishnamoorthy), psrajaa2410@gmail.com (S. Rajaa).

https://doi.org/10.1016/j.heliyon.2024.e37794
Received 8 March 2023; Received in revised form 4 September 2024; Accepted 10 September 2024
Available online 11 September 2024

micronutrient deficiency or overnutrition. Undernutrition, the most common form of malnutrition, includes stunting, underweight, and wasting. World Health Organization has reported that nearly 148 million under-five children suffer from stunting and 49 million children suffer from wasting [2]. The major contributor to undernutrition is low- and middle-income countries (LMIC), especially India [3]. Undernutrition leads to poor development or child mortality [4,5]. Similarly, overweight/obesity amongst mothers is associated with serious maternal and foetal consequences [6,7].

Despite various forms of malnutrition, it is being addressed separately. Less concern is provided in developing countries regarding occurrence of undernutrition and overnutrition simultaneously [8]. Hence, for the policy directives and public health programs solutions to work, action should be taken to address more than one dimension of malnutrition. Understanding the concepts of "double-burden of malnutrition" (DBM) and "triple-burden of malnutrition" (TBM) might be crucial to initiate actions and achieving complete eradication of malnutrition amongst under-five children.

The term DBM refers to presence of coexisting undernutrition & overnutrition in the same nation, community, or family [9,10]. Co-existence of undernourished children with an overweight/obese mother in the same household is an important issue [11,12]. This seems paradoxical. However, possible explanations are available. With limited access to food resources, household members tend to consume low-cost, unhealthy, energy-dense food items. Such food choices might lead to overweight/obesity and undernutrition in the same household [1].

Few studies started exploring the presence of micronutrient deficiency along with DBM [3,8]. This coexistence of DBM with micronutrient deficiency is referred to as TBM [3,8]. Micronutrient deficiency is referred to as inadequate consumption of vitamins and minerals. Micronutrient deficiency extensively studied in India is anaemia among children [13]. About 58 % under-five children in India have anaemia and it is a significant public health concern [13]. TBM is considered a relatively newer issue on the scope of a healthy debate and has been less explored amongst researchers around the world.

Previous studies based on nationally representative surveys have shown that India does have the problem of DBM and TBM in the same household [3,8,14]. Though India has made great strides in tackling individual forms of malnutrition, public health interventions addressing only one form of malnutrition may not be sufficient to tackle DBM or TBM. Though this problem has been studied using the previous nationally representative survey from India, understanding the trend in burden and determinants is important to find out whether the public health efforts over the past five years have helped to reverse the trend of this coexistence of problems [3,8,14]. If not, it will inform the policymakers, program managers and various levels of implementers to take the necessary course of action and design public health interventions addressing multiple forms of malnutrition. National Family Health Survey-5 (NFHS-5) conducted between 2019-21 provides an opportunity to assess recent estimates to study the pattern of DBM and TBM [15]. Hence, the current study was done to determine the prevalence and socio-demographic factors associated with DBM and TBM amongst mother-child pairs in India based on NFHS-5 (2019-21).

2. Methods

2.1. Study design and data source

We conducted a secondary data analysis of the nationally representative survey (NFHS-5 data) in India. South-Asian country, India is the second most populous country in the world (nearly 1.3 billion). The country has 28 states and eight union territories with 773 districts. The NFHS-5 data provides information for 707 districts across all 28 states and eight union territories.

The NFHS-5 dataset was retrieved through the data distribution system of the Demographic Health Survey (DHS). The study proposal was submitted to the DHS Program to obtain a de-identified dataset with authorization to use. Informed consent was obtained during the primary survey for all the participants. Mother-child (under-five years) pairs were taken as study participants for the study analysis.

2.1.1. Sampling design

NFHS surveys followed a uniform sampling design, a representative at national, state/union territory and district levels. NFHS-5 survey followed a stratified two-stage sampling process. Census 2011 was utilized as sampling frame for primary sampling unit (PSU) selection. Each district was first stratified into rural and urban areas. Each rural stratum was sub-stratified into six smaller substrata by crossing three substrata, each created by considering the population of the village and with two substrates, each created by considering the percentage of population belonging to scheduled castes (SC) and tribes (ST). Within each of the explicit rural sampling strata, villages were selected as the PSUs with the probability proportional to size (PPS) technique. PSUs having lesser than 40 households were linked to the nearest PSU. Before PSU selection, they were sorted based on the literacy rate of women aged more than 6 years. Within each of the explicit urban sampling stratum, a sample of census enumeration blocks (CEBs) were selected as the PSUs with the PPS technique. Before PSU selection, they were sorted based on the percentage of SC/ST population. In second stage of selection process, a fixed number of households (22 per cluster) was selected with equal probability by a systematic selection process from a newly created household list in selected PSUs. In every selected, rural and urban PSU, complete household mapping & listing operation was conducted before household selection. Of 30,456 PSUs selected from 707 districts, fieldwork was completed in 30,198 PSUs. In total, NFHS-5 has gathered information from 636,699 households (response rate 98 %), 724,115 women aged 15–49 years (response rate 97 %), and 101,839 men aged 15–54 years (response rate 92 %) [15]. Amongst the 724,115 women, 232,920 had an under-five child and amongst them, 167,380 had all the information necessary for the study and included for analysis (Fig. 1).

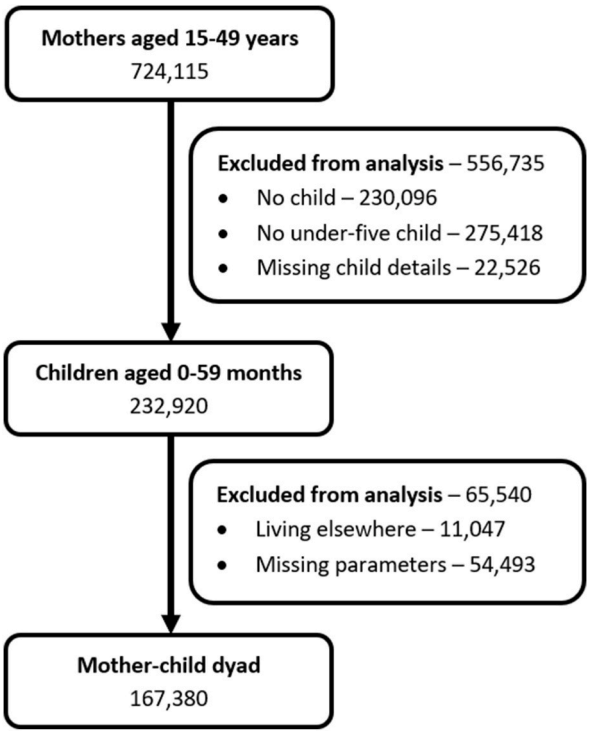

Fig. 1. Flowchart showing the selection of participants in the study analysis.

2.2. Data variables and data sources

Independent variables in the model consisted of socio-demographic characteristics of mother, child, and household. Characteristics of the mother were age, age at first childbirth, educational qualification, breastfeeding status and mode of delivery (normal vaginal delivery/Caesarean section). Child characteristics were age, gender, single or twin/multi gestation, size at birth and recent illness (diarrhoea/fever/cough) in the past two weeks preceding the survey. Household characteristics were geographical region (North/Central/West/East/South/North-East), place of residence (urban/rural), caste (SC/ST/other backward class (OBC)/others), religion (Hindu/Christian/Muslim/Others) and wealth index (in quintiles). Two separate models were run with these characteristics. The dependent variable in each of these models was DBM and TBM.

DBM: Defined as the presence of both *undernourishment in the child* (underweight [<2SD weight-for-age], stunted [<2SD height-for-age] or wasted [<2SD weight-for-height), and *maternal overnutrition* (overweight/obese [body mass index ≥25 kg/m^2) [14].

TBM: Defined as the presence of *undernourishment in the child*, *maternal overnutrition* and *child micronutrient deficiency* (anaemia with haemoglobin value < 11 g/dl) [3].

2.3. Statistical analysis

Analysis was performed using the software STATA v14.2 (StataCorp, College Station, TX, USA). First step in the analysis was to declare the dataset as survey data by adjusting for the sampling weights and clustering in the sample design using "*svyset*" command. Descriptives were summarized as mean with standard deviation (SD) for continuous variables and proportions for categorical variables. Prevalence of DBM and TBM was reported with 95 % confidence interval (CI). Mixed effects logistic regression was utilized to account for clustering at the primary sampling unit (PSU) and household levels, providing more precise estimates by considering the hierarchical structure of the data. This approach was chosen over standard logistic regression to address potential intra-cluster correlation that could bias the results. Odds ratios (ORs) were calculated to assess the factors associated with DBM and TBM outcomes, with variables showing a p-value less than 0.2 in the univariable analysis being included in the multivariable model. The final associations were expressed as both unadjusted and adjusted ORs with 95 % confidence intervals, with statistical significance set at a p-value less than 0.05.

Table 1
Sociodemographic characteristics of mother-child pair and household characteristics covered in NFHS-5 in India, N = 167,380.

Variable	Frequency, n (Unweighted proportion, %)		Weighted proportion (95 % CI)	
Characteristics of the mothers				
Age of women (in years)				
≤19	3009	(1.8)	2.1	(1.9–2.2)
20–34	149,246	(89.2)	90.3	(90.1–90.5)
≥35	15,125	(9.0)	7.6	(7.4–7.8)
Age at first birth (in years)				
< =19	54,338	(32.5)	34.2	(33.8–34.7)
20–34	112,135	(67.0)	65.3	(64.8–65.8)
≥35	907	(0.5)	0.5	(0.4–0.5)
Educational level				
No education	35,235	(21.0)	20.5	(20.1–21.0)
Primary	21,555	(12.9)	12.3	(12.0–12.6)
Secondary	87,746	(52.4)	51.8	(51.3–52.3)
Higher	22,844	(13.7)	15.4	(15.0–15.8)
Currently breastfeeding				
No	62,568	(37.4)	38.1	(37.7–38.6)
Yes	104,812	(62.6)	61.9	(61.4–62.3)
Caesarean section delivery				
No	135,123	(80.7)	78.4	(78.1–78.9)
Yes	32,257	(19.3)	21.5	(21.1–21.9)
Characteristics of the child				
Age of children (in years)				
< =12	17,276	(10.3)	10.6	(10.4–10.8)
13–23	36,215	(21.6)	21.7	(21.4–22.0)
24–35	37,389	(22.3)	22.3	(22.1–22.6)
36–47	37,736	(22.6)	22.5	(22.2–22.7)
48–59	38,764	(23.2)	23.0	(22.7–23.2)
Sex of the child				
Male	86,247	(51.5)	51.7	(51.4–52.0)
Female	81,133	(48.5)	48.3	(48.0–48.6)
Twin or multiple gestation				
Single birth	165,153	(98.7)	98.6	(98.5–98.7)
Twin or multi	2227	(1.3)	1.4	(1.3–1.5)
Size at birth*				
Very large	15,388	(6.7)	7.1	(6.9–7.4)
Larger than average	26,566	(11.6)	11.9	(11.6–12.2)
Average	163,929	(71.5)	70.6	(70.2–71.1)
Smaller than average	18,090	(7.9)	8.0	(7.8–8.3)
Very small	5402	(2.4)	2.3	(2.2–2.5)
Recent illness diarrhoea/fever/cough in 2 weeks*				
Absent	130,218	(77.9)	76.8	(76.5–77.2)
Present	36,888	(22.1)	23.2	(22.8–23.6)
Characteristics of the household				
Geographical region				
North	28,767	(17.2)	12.8	(12.3–13.3)
South	21,224	(12.7)	16.7	(16.1–17.4)
East	32,676	(19.5)	26.6	(25.7–27.4)
West	15,224	(9.1)	12.7	(12.0–13.5)
Central	44,566	(26.6)	27.4	(26.6–28.1)
Northeast	24,923	(14.9)	3.8	(3.6–4.0)
Place of residence				
Urban	34,179	(20.4)	26.5	(25.7–27.4)
Rural	133,201	(79.6)	73.5	(72.6–74.3)
Caste*				
Schedule case	34,301	(21.5)	24.6	(24.1–25.1)
Schedule tribe	33,460	(21.0)	10.4	(10.0–10.7)
Other backward class	63,854	(40.1)	45.5	(44.9–46.1)
Others	27,749	(17.4)	19.6	(19.0–20.1)
Religion				
Hinduism	123,794	(74.0)	80.1	(79.4–80.7)
Islam	23,402	(14.0)	15.6	(15.0–16.2)
Christianity	13,420	(8.0)	2.1	(2.0–2.3)
Others	6764	(4.0)	2.3	(2.1–2.4)
Wealth index				
Poorest	44,158	(26.4)	23.8	(23.3–24.4)
Poor	39,230	(23.4)	21.8	(21.5–22.2)
Middle	32,988	(19.7)	19.9	(19.5–20.3)

(*continued on next page*)

Table 1 (*continued*)

Variable	Frequency, n (Unweighted proportion, %)		Weighted proportion (95 % CI)	
Characteristics of the mothers				
Rich	28,613	(17.1)	18.8	(18.4–19.2)
Richest	22,391	(13.4)	15.7	(15.2–16.2)

Table 2
Status of various forms of malnutrition among the mother-child pair covered in NFHS-5 in India, N = 167,380.

Variable	Frequency, n (Unweighted proportion, %)		Weighted proportion (95 % CI)	
Children with stunting	62,193	(37.2)	37.3	(36.9–37.7)
Children with underweight	50,375	(30.1)	31.4	(31.0–31.8)
Children with wasting	30,246	(18.1)	18.7	(18.3–19.0)
Children with anemia	112,234	(67.1)	67.8	(67.4–68.2)
Maternal Overweight/Obesity	30,527	(18.2)	19.5	(19.1–19.9)
Overweight/Obesity mother + Stunted child	8599	(5.1)	5.6	(5.4–5.7)
Overweight/Obesity mother + Underweight child	5779	(3.5)	3.9	(3.8–4.1)
Overweight/Obesity mother + Wasted child	3768	(2.3)	2.4	(2.3–2.5)
Overweight/Obesity mother + Anemic child	18,875	(11.3)	12.1	(11.8–12.3)
Double burden of malnutrition	12,018	(7.2)	7.7	(7.5–7.9)
Triple burden of malnutrition	8019	(4.8)	5.1	(5.0–5.3)

3. Results

3.1. Characteristics of study participants

Our study included 167,380 mother-child (under-five) dyads across India. The weighted mean age of the children was 32.8 (95 % CI: 32.7–32.9) months and the mother was 27.0 (26.9–27.0) years.

Majority (90.3 %) of the mothers were in 20–34 years age group. Nearly 32.5 % mothers had their first pregnancy ≤19 years of age. About 20.5 % mothers did not have any formal education. Currently, 61.9 % mothers were breastfeeding. And 21.5 % mothers had caesarean section delivery (**Table 1**).

The children less than one year were 10.6 % and between second to fifth year, children were equally distributed (21.7–22.9 %). Gender distribution was equal. About 1.4 % were twin- or multiple-born children. About 8.0 % were smaller than the average size at birth and 2.3 % were very small. And 23.2 % of children had a recent illness (diarrhoea/fever/cough) in the past 2 weeks of the survey.

Maximum participants were from the central (27.4 %) and eastern (26.6 %) regions of India. Majority (73.5 %) were from rural parts of India. Highest representation was from OBC (45.5 %) followed by SC (24.6 %). Majority (80.1 %) were following Hinduism. Participants were almost equally distributed across all five wealth index quantiles.

3.2. Malnutrition status among study participants

The weighted prevalence of children and their mothers' malnutrition indicators were summarized in Table 2. The burden of anaemia was maximum, prevalent among 67.8 % children. About 37.3 %, 31.4 % and 18.7 % children were stunted, underweight and wasted, respectively. Maternal overweight/obesity was among 19.5 % mothers.

It was found that 12.1 %, 5.6 %, 3.9 % and 2.4 % mother-child dyads were combination of overweight/obese mothers with anaemic children, stunted children, underweight children and wasted children, respectively. Additionally, 7.7 % mother-child dyads were suffering from DBM and 5.1 % were suffering from TBM. The state-wise burden of DBM and TBM is provided in Figs. 2 and 3.

3.3. Determinants of DBM

The mixed-effects logistic regression model identified several significant predictors of DBM (Table 3). Mothers aged 20 to 34 (aOR = 1.92, 95%CI: 1.47–2.50, $p < 0.001$), and those aged 35 or older (aOR = 3.03, 95%CI: 2.30–4.00, $p < 0.001$) had significantly higher odds of DBM compared to mothers of 19 years and less. Similarly, mothers of age 20–34 years at first birth (aOR = 1.09, 95%CI: 1.03–1.15, $p = 0.01$) had higher odds of DBM compared to those aged 19 years and less at first birth. Education level was not significant predictor, with mothers having secondary education showing higher odds (aOR = 1.06, 95%CI: 0.97–1.16, $p = 0.07$) compared to those with no education. Mothers currently breastfeeding (aOR = 0.89, 95%CI: 0.84–0.93, $p < 0.001$) had 11 % lesser odds of DBM than those who are not breastfeeding their child. Household with mothers who underwent C-section delivery (aOR = 1.57, 95%CI: 1.48–1.65, $p < 0.001$) had a higher odd of DBM than those who underwent normal delivery.

Households with children aged 13–23 months (aOR = 1.31, 95%CI: 1.20–1.43, $p < 0.001$), 24–35 months (aOR = 1.52, 95%CI: 1.39–1.66, $p < 0.001$), 36–47 months (aOR = 1.50, 95%CI: 1.37–1.64, $p < 0.001$) and 48–59 months (aOR = 1.43, 95%CI: 1.30–1.56, $p < 0.001$) had a higher odds of DBM than those aged less than one year. Female child (aOR = 0.93, 95%CI: 0.89–0.97, $p < 0.001$) had

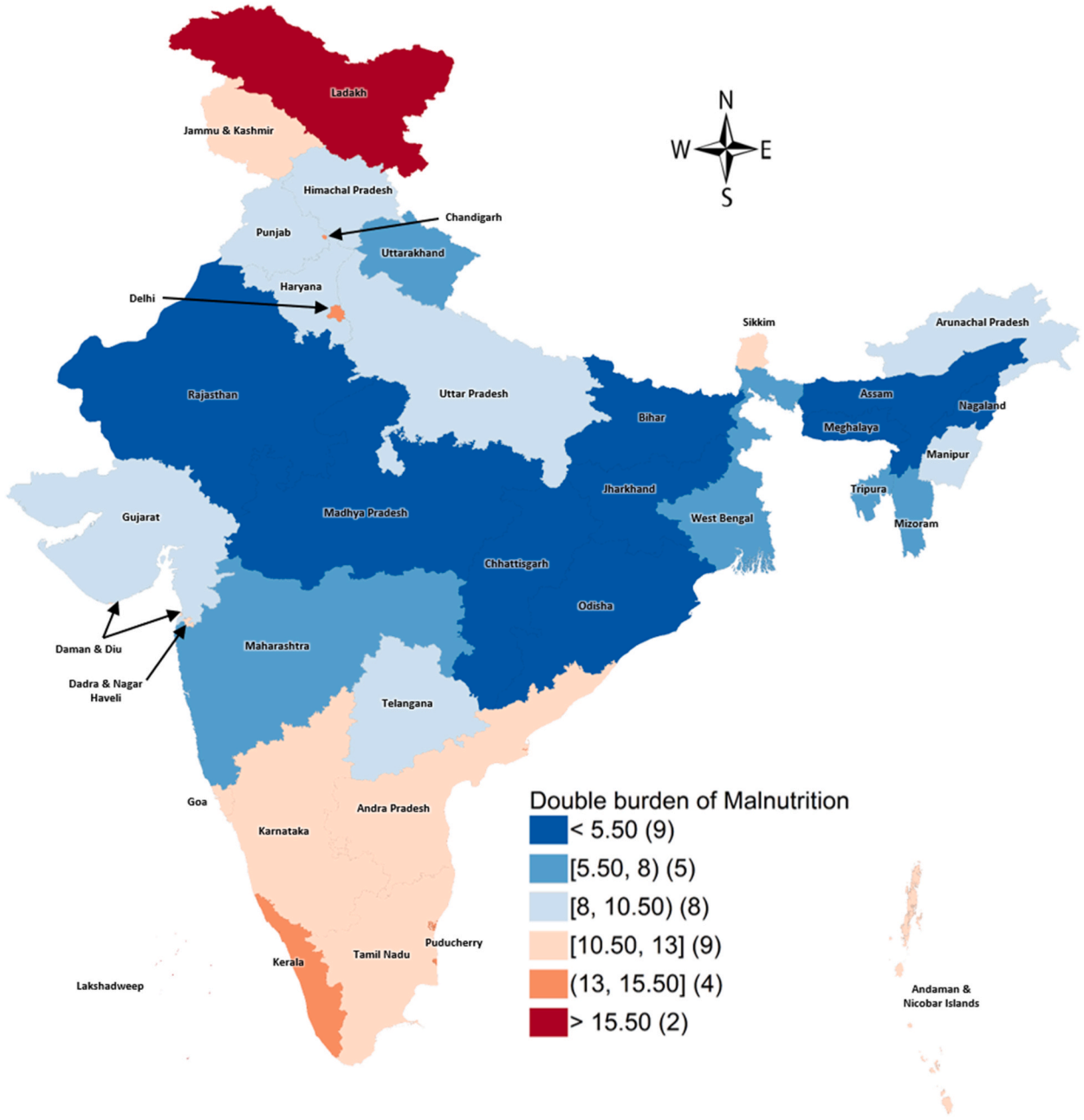

Fig. 2. State wise prevalence of double burden of malnutrition amongst mother-under five child pairs in India (NFHS-5, 2019–2021).

significantly lesser odds of DBM compared to the male child. Twin- or multiple-born (aOR = 1.21, 95%CI: 0.99–1.47, $p < 0.001$)) had higher odds of DBM than single-born. Children with smaller than average (aOR = 1.11, 95%CI: 1.02–1.21, $p = 0.01$) and very small birth sizes (aOR = 1.45, 95%CI: 1.26–1.67, $p < 0.001$) had a higher odds of DBM than children with average birth sizes. Recent illness had no significant relation to the prevalence of DBM.

Households present in South (aOR = 1.52, 95%CI: 1.39–1.66, $p < 0.001$), West (aOR = 1.19, 95%CI: 1.08–1.31, $p < 0.001$) and Northeast (aOR = 1.13, 95%CI: 1.02–1.27, $p < 0.001$) had a higher odds of DBM and East (aOR = 0.88, 95%CI: 0.80–0.97, $p < 0.001$) had less odds of DBM than households in the North region of India. Residences in rural parts of India (aOR = 0.79, 95%CI: 0.74–0.84, $p < 0.001$) had 21 % lesser odds of DBM than urban residence. Households of SC (aOR = 0.79, 95%CI: 0.72–0.86, $p < 0.001$) and OBC (aOR = 0.91, 95%CI: 0.85–0.97, $p < 0.001$) had 21 % and 9 % lesser odds of DBM than those of SC. Households of religion Islam (aOR = 1.65, 95%CI: 1.54–1.78, $p < 0.001$) and Christianity (aOR = 1.33, 95%CI: 1.19–1.49, $p < 0.001$) had higher odds of DBM than Hinduism. Richest quantile household (aOR = 1.97, 95%CI: 1.76–2.20, $p < 0.001$), rich quantile household (aOR = 1.93, 95%CI:

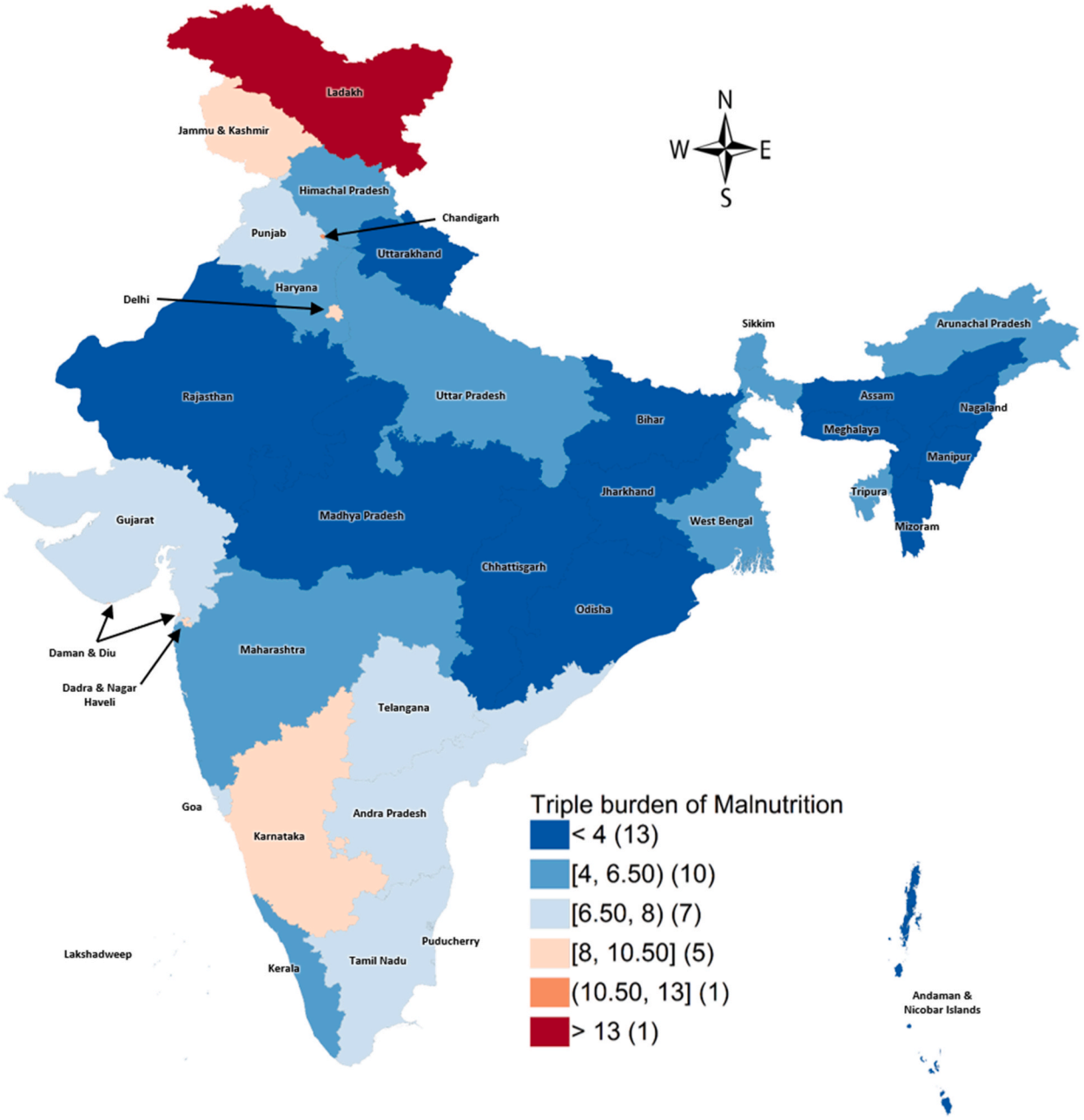

Fig. 3. State wise prevalence of triple burden of malnutrition amongst mother-under five child pairs in India (NFHS-5, 2019–2021).

1.75–2.13, $p < 0.001$), middle quantile household (aOR = 1.73, 95%CI: 1.58–1.90, $p < 0.001$) and poor quantile household (aOR = 1.41, 95%CI: 1.29–1.54, $p < 0.001$) had significantly higher odds of DBM compared to those in poorest quantile.

Regarding random effects, the variance of the random intercept at the PSU level was 0.20 (95 % CI = 0.03–1.25), indicating substantial variability in DBM across different clusters. Additionally, further variability was observed within the nested structure, with a variance of 0.58 (95 % CI = 0.31–1.11).

3.4. Determinants of TBM

Households with mothers aged 20–34 years (aOR = 1.74, 95%CI: 1.29–2.34, $p < 0.001$) and, 35 and more years (aOR = 2.68, 95% CI: 1.96–3.67, $p < 0.001$) had higher odds of TBM compared to mothers aged 19 and lesser years. Similarly, mothers with age at first birth as 20–34 years (aOR = 1.11, 95%CI: 1.04–1.19, $p = 0.01$) had higher odds of TBM compared to those with 19 and lesser years of

Table 3
Determinants of double burden of malnutrition among mother-child pair covered in NFHS-5 in India, N = 167,380.

Variable	Double burden of malnutrition, n (%)		Crude odds ratio, OR (95 % CI)		Adjusted odds ratio, aOR (95 % CI)		P value
Characteristics of the mothers							
Age of women (in years)							
≤19	84	(2.8)	Ref		Ref		
20–34	10,298	(6.9)	2.45	(1.92–3.12)	1.92	(1.47–2.50)	**<0.001**
≥35	1636	(10.8)	4.16	(3.24–5.33)	3.03	(2.30–4.00)	**<0.001**
Age at first birth (in years)							
< =19	3150	(5.8)	Ref		Ref		
20–34	8755	(7.8)	1.34	(1.27–1.41)	1.09	(1.03–1.15)	**0.01**
≥35	113	(12.5)	2.26	(1.78–2.88)	1.03	(0.79–1.34)	0.84
Educational level							
No education	1959	(5.6)	Ref		Ref		
Primary	1326	(6.2)	1.14	(1.04–1.24)	1.06	(0.97–1.16)	0.22
Secondary	6683	(7.6)	1.38	(1.29–1.47)	1.07	(0.99–1.16)	0.07
Higher	2050	(9.0)	1.60	(1.48–1.73)	0.94	(0.85–1.03)	0.18
Currently breastfeeding							
No	5525	(8.8)	Ref		Ref		
Yes	6493	(6.2)	0.69	(0.66–0.72)	0.89	(0.84–0.93)	**<0.001**
Caesarean section delivery							
No	8330	(6.3)	Ref		Ref		
Yes	3688	(11.4)	1.96	(1.87–2.07)	1.57	(1.48–1.65)	**<0.001**
Characteristics of the child							
Age of children (in months)							
< =12	872	(5.1)	Ref		Ref		
13–23	2377	(6.6)	1.34	(1.22–1.46)	1.31	(1.20–1.43)	**<0.001**
24–35	2870	(7.7)	1.60	(1.47–1.74)	1.52	(1.39–1.66)	**<0.001**
36–47	2939	(7.8)	1.61	(1.48–1.75)	1.50	(1.37–1.64)	**<0.001**
48–59	2960	(7.6)	1.57	(1.45–1.71)	1.43	(1.30–1.56)	**<0.001**
Sex of the child							
Male	6402	(7.4)	Ref		Ref		
Female	5616	(6.9)	0.92	(0.88–0.96)	0.93	(0.89–0.97)	**<0.001**
Twin or multiple gestation							
Single birth	11,788	(7.1)	Ref		Ref		
Twin or multi	230	(10.3)	1.58	(1.30–1.91)	1.21	(0.99–1.47)	0.07
Size at birth							
Very large	806	(7.3)	1.03	(0.95–1.13)	0.97	(0.89–1.06)	0.53
Larger than average	1394	(7.3)	1.02	(0.95–1.09)	0.96	(0.89–1.03)	0.22
Average	8446	(7.1)	Ref		Ref		
Smaller than average	955	(7.5)	1.08	(1.00–1.16)	1.11	(1.02–1.21)	**0.01**
Very small	304	(8.9)	1.31	(1.15–1.51)	1.45	(1.26–1.67)	**<0.001**
Recent illness diarrhoea/fever/cough in 2 weeks							
Absent	9364	(7.2)	Ref		Ref		
Present	2620	(7.1)	0.99	(0.94–1.04)	1.00	(0.95–1.06)	0.96
Characteristics of the household							
Geographical region							
North	2280	(7.9)	Ref		Ref		
South	2454	(11.6)	1.53	(1.41–1.65)	1.52	(1.39–1.66)	**<0.001**
East	1594	(4.9)	0.56	(0.51–0.61)	0.88	(0.80–1.03)	**<0.001**
West	1300	(8.5)	1.06	(0.67–1.17)	1.19	(1.08–1.21)	**<0.001**
Central	2852	(6.4)	0.75	(0.69–0.81)	1.06	(0.98–1.67)	0.12
Northeast	1538	(6.2)	0.71	(0.65–0.78)	1.13	(1.02–1.29)	**0.03**
Place of residence							
Urban	3672	(10.7)	Ref		Ref		
Rural	8346	(6.3)	0.52	(0.49–0.55)	0.79	(0.74–0.84)	<**0.001**
Caste*							
Schedule case	2424	(7.1)	Ref		Ref		
Schedule tribe	1785	(5.3)	0.70	(0.65–0.76)	0.79	(0.72–0.86)	**<0.001**
Other backward class	4790	(7.5)	1.08	(1.01–1.15)	0.91	(0.85–0.97)	**<0.001**
Others	2402	(8.7)	1.24	(1.15–1.33)	0.93	(0.86–1.01)	0.08
Religion							
Hinduism	8136	(6.6)	Ref		Ref		
Islam	2385	(10.2)	1.65	(1.54–1.76)	1.65	(1.54–1.78)	**<0.001**
Christianity	889	(6.6)	0.96	(0.87–1.06)	1.08	(0.96–1.23)	0.19
Others	608	(9.0)	1.41	(1.27–1.57)	1.33	(1.19–1.49)	**<0.001**
Wealth index							
Poorest	1698	(3.9)	Ref		Ref		
Poor	2393	(6.1)	1.61	(1.49–1.75)	1.41	(1.29–1.54)	**<0.001**
Middle	2699	(8.2)	2.24	(2.07–2.43)	1.73	(1.58–1.90)	**<0.001**

(*continued on next page*)

Table 3 (*continued*)

Variable	Double burden of malnutrition, n (%)		Crude odds ratio, OR (95 % CI)		Adjusted odds ratio, aOR (95 % CI)		P value
Characteristics of the mothers							
Rich	2830	(9.9)	2.79	(2.58–3.02)	1.93	(1.75–2.13)	**<0.001**
Richest	2398	(10.7)	3.07	(2.83–3.33)	1.97	(1.76–2.20)	**<0.001**

age at first birth. Mothers with higher education levels (aOR = 0.83, 95%CI: 0.74–0.92, p < 0.001) had 17 % lesser odds of TBM than mothers with no formal education. Mothers currently breastfeeding (aOR = 0.90, 95%CI: 0.84–0.96, p < 0.001) had 10 % lesser odds of DBM than those who did not breastfeed. Household with mothers who underwent C-section delivery (aOR = 1.56, 95%CI: 1.46–1.66, p < 0.001) has a higher odds of TBM than those who underwent normal delivery (Table 4).

Households with children aged 13–23 months (aOR = 1.35, 95%CI: 1.22–1.49, p < 0.001), 24–35 months (aOR = 1.43, 95%CI: 1.29–1.58, p < 0.001) and 36–47 months (aOR = 1.24, 95%CI: 1.12–1.37, p < 0.001) had a higher odds of TBM than those aged less than one year. Households with female children (aOR = 0.90, 95%CI: 0.85–0.94, p < 0.001) had 10 % less odds of TBM than male children. Twin- or multiple-born (aOR = 1.35, 95%CI: 1.08–1.68, p = 0.01) had higher odds of TBM than single-born. Children with very small birth size (aOR = 1.42, 95%CI: 1.20–1.68, p < 0.001) had a higher odds of TBM than children with average birth size. Recent illness had no significant relation with TBM.

Households present in South (aOR = 1.30, 95%CI: 1.18–1.44, p < 0.001) and West (aOR = 1.25, 95%CI: 1.12–1.39, p < 0.001) had higher odds and, East (aOR = 0.78, 95%CI: 0.70–0.88, p < 0.001) had a lesser odds of TBM than households in the North region of India. Residences at rural parts of India (aOR = 0.81, 95%CI: 0.75–0.86, p < 0.001) had 19 % lesser odds of TBM than urban residences. Households of SC (aOR = 0.80, 95%CI: 0.72–0.89, p < 0.001) and OBC (aOR = 0.86, 95%CI: 0.80–0.93, p < 0.001) had 16 % and 20 % lesser odds of TBM than those of SC. Households of religion Islam (aOR = 1.67, 95%CI: 1.53–1.81, p < 0.001) had higher odds and Christianity (aOR = 0.80, 95%CI: 0.69–0.94, p < 0.001) had lesser odds of TBM than Hinduism. Richest quantile household (aOR = 1.99, 95%CI: 1.75–2.26, p < 0.001), rich quantile household (aOR = 1.93, 95%CI: 1.72–2.16, p < 0.001), middle quantile household (aOR = 1.79, 95%CI: 1.61–1.99, p < 0.001) and poor quantile household (aOR = 1.47, 95%CI: 1.33–1.63, p < 0.001) had more chance of TBM compared to those in poorest quantile.

Regarding random effects, the variance of the random intercept at the PSU level was 0.06, indicating substantial variability in TBM across different clusters. Additionally, further variability was observed within the nested structure, with a variance of 0.76.

4. Discussion

We estimated the burden of DBM and TBM among mother-child pairs in India to be 7.7 % and 5.1 % respectively. Malnutrition was significantly associated with increasing mothers' age and age at first birth, higher educational levels, current breastfeeding habits, caesarean mode of delivery, increasing child's age, gender, twin birth, smaller birth weight, geographical region, urban residence, caste and religion, and increasing wealth index.

DBM and TBM were predominantly higher in LMICs. Compared with LMICs like sub-Saharan African countries, the burden of DBM and TBM was lesser in India [16]. In South and Southeast Asian region, the DBM was 12 %, much higher than our study findings [17]. But within the Southeast Asian region, malnutrition was higher in India than our neighbouring countries, Bangladesh, Myanmar, Nepal and Pakistan [18–20]. Compared to the previous national-level survey results, there was an increase in DBM from 6 % to 7.7 % and a decrease in TBM from 5.7 % to 5.1 % [3,14].

Coexistence of undernutrition and overnutrition was persistent in the vulnerable lower-socioeconomic groups in India [21]. Among the mother-child dyad, the combinations of malnutrition, overweight mother & stunted child (4.2 %–5.5 %), overweight mother & underweight child (3.3 %–3.9 %), overweight mother & wasted child (2 %–2.4 %) and overweight mother & anaemic child (7.8 %–12.1 %) has shown an increasing trend comparing to previous NFHS survey [3]. Individual malnutrition indicators showed a reduction in the burden of childhood stunting (38.4 %–30.1 %), underweight (35.8 %–27.3 %) and wasting (21 %–18.5 %). In contrast, anaemia caused by the micronutrient deficiency of iron has increased (58.6 %–64.2 %). Maternal overweight/obesity has also increased from 20.6 % to 33.2 % [15]. These results clearly show that mother's nutritional status was associated with their children's nutritional status [16].

Women with increasing age become sedentary with physiological decrease in metabolic rate and eventually become overweight [22]. Maternal age can be correlated with increasing parity leading to undernourished children [23,24]. Both of these led to DBM and TBM at household level leading to higher risk among mothers aged ≥35years [3,14,19,25,26]. With increasing mothers' age at first birth, prevalence of malnutrition reduces as their nutritional knowledge increases [27,28]. Households with mothers who were not currently breastfeeding had higher risk of malnutrition similar to previous studies [3,14]. This showed that the lack of adequate knowledge, attitude and practices on breastfeeding led to the risk of malnutrition. Caesarean section delivered child suffered from malnutrition can be attributed to difficulty in breastfeeding with reduction in secretion and poor attachment leading to insufficient breastfeeding and early cessation of breastfeeding habit [29–32].

Place of residence was an important determinant of DBM and TBM because of the unplanned urbanization and influence of westernization [33,34]. Sedentary lifestyle and unhealthy dietary habits led to obesity in urban settlements [23,35]. Therefore urban residence has a higher prevalence of the DBM and TBM similar to other studies [36,37]. Economic inequalities played a major role in childhood malnutrition, thus poorest wealth-quantile households have higher odds of DBM [18,38]. In affluent families, sedentary

Table 4
Determinants of triple burden of malnutrition among mother-child pair covered in NFHS-5 in India, N = 167,380.

Variable	Triple burden of malnutrition, n (%)		Crude odds ratio, OR (95 % CI)		Adjusted odds ratio, aOR (95 % CI)		P value
Characteristics of the mothers							
Age of women (in years)							
≤19	64	(2.1)	Ref		Ref		
20–34	6897	(4.6)	2.14	(1.63–2.81)	1.74	(1.29–2.34)	**<0.001**
≥35	1058	(7.0)	3.41	(2.57–4.53)	2.68	(1.96–3.67)	**<0.001**
Age at first birth (in years)							
< =19	2092	(3.9)	Ref		Ref		
20–34	5848	(5.22)	1.35	(1.27–1.44)	1.11	(1.04–1.19)	**0.01**
≥35	79	(8.7)	2.41	(1.83–3.16)	1.12	(0.83–1.51)	0.47
Educational level							
No education	1399	(4.0)	Ref		Ref		
Primary	900	(4.2)	1.07	(0.97–1.19)	1.01	(0.91–1.13)	0.85
Secondary	4410	(5.0)	1.28	(1.18–1.38)	0.98	(0.90–1.07)	0.65
Higher	1310	(5.7)	1.44	(1.31–1.58)	0.83	(0.74–0.92)	**<0.001**
Currently breastfeeding							
No	3503	(5.6)	Ref		Ref		
Yes	4516	(4.3)	0.78	(0.74–0.82)	0.90	(0.84–0.96)	**<0.001**
Caesarean section delivery							
No	5539	(4.1)	Ref		Ref		
Yes	2480	(7.7)	1.96	(1.85–2.08)	1.56	(1.46–1.66)	**<0.001**
Characteristics of the child							
Age of children (in years)							
< =12	645	(3.7)	Ref		Ref		
13–23	1819	(5.0)	1.37	(1.24–1.51)	1.35	(1.22–1.49)	**<0.001**
24–35	2036	(5.5)	1.49	(1.36–1.65)	1.43	(1.29–1.58)	**<0.001**
36–47	1847	(4.9)	1.32	(1.20–1.46)	1.24	(1.12–1.37)	**<0.001**
48–59	1672	(4.3)	1.14	(1.04–1.26)	1.04	(0.94–1.16)	0.47
Sex of the child							
Male	4311	(5.0)	Ref		Ref		
Female	3708	(4.6)	0.89	(0.85–0.94)	0.90	(0.85–0.94)	**<0.001**
Twin or multiple gestation							
Single birth	7846	(4.8)	Ref		Ref		
Twin or multi	173	(7.8)	1.75	(1.42–2.16)	1.35	(1.08–1.68)	**0.01**
Size at birth							
Very large	553	(5.0)	1.04	(0.94–1.16)	0.98	(0.88–1.09)	0.73
Larger than average	948	(4.9)	1.04	(0.96–1.13)	1.00	(0.92–1.09)	0.94
Average	5617	(4.7)	Ref		Ref		
Smaller than average	618	(4.8)	1.06	(0.96–1.16)	1.08	(0.98–1.20)	0.11
Very small	205	(6.0)	1.33	(1.13–1.57)	1.42	(1.20–1.68)	**<0.001**
Recent illness diarrhoea/fever/cough in 2 weeks							
Absent	6218	(4.8)	Ref		Ref		
Present	1775	(4.8)	1.01	(0.95–1.08)	1.01	(0.95–1.08)	0.71
Characteristics of the household							
Geographical region							
North	1657	(5.8)	Ref		Ref		
South	1537	(7.2)	1.25	(1.14–1.37)	1.30	(1.18–1.44)	**<0.001**
East	1051	(3.2)	0.51	(0.46–0.56)	0.78	(0.70–0.88)	**<0.001**
West	967	(6.4)	1.10	(0.99–1.22)	1.25	(1.12–1.39)	**<0.001**
Central	1938	(4.4)	0.70	(0.64–0.76)	0.98	(0.90–1.08)	0.72
Northeast	869	(3.5)	0.55	(0.50–0.61)	0.95	(0.84–1.09)	0.47
Place of residence							
Urban	2412	(7.1)	Ref		Ref		
Rural	5607	(4.2)	0.55	(0.52–0.58)	0.81	(0.75–0.86)	<**0.001**
Caste							
Schedule case	1704	(5.0)	Ref		Ref		
Schedule tribe	1116	(3.3)	0.64	(0.58–0.70)	0.80	(0.72–0.89)	**<0.001**
Other backward class	3181	(5.0)	1.01	(0.94–1.09)	0.86	(0.80–0.93)	**<0.001**
Others	1600	(5.8)	1.17	(1.08–1.28)	0.88	(0.80–0.96)	**0.01**
Religion							
Hinduism	5526	(4.5)	Ref		Ref		
Islam	1623	(6.9)	1.63	(1.51–1.76)	1.67	(1.53–1.81)	**<0.001**
Christianity	433	(3.2)	0.67	(0.59–0.76)	0.80	(0.69–0.94)	**0.01**
Others	437	(6.5)	1.47	(1.31–1.66)	1.33	(1.17–1.51)	**<0.001**
Wealth index							
Poorest	1127	(2.6)	Ref		Ref		
Poor	1618	(4.1)	1.65	(1.50–1.81)	1.47	(1.33–1.63)	**<0.001**
Middle	1802	(5.5)	2.25	(2.05–2.47)	1.79	(1.61–1.99)	**<0.001**

(*continued on next page*)

Table 4 (*continued*)

Variable	Triple burden of malnutrition, n (%)		Crude odds ratio, OR (95 % CI)		Adjusted odds ratio, aOR (95 % CI)		P value
Characteristics of the mothers							
Rich	1879	(6.6)	2.75	(2.51–3.02)	1.93	(1.72–2.16)	**<0.001**
Richest	1593	(7.1)	3.02	(2.75–3.32)	1.99	(1.75–2.26)	**<0.001**

lifestyle and less labour-intensive work led to maternal obesity [39–41]. Further, children from wealthier families were used to consumption of processed junk food leading to malnutrition [42–44]. On the contrary, lower socioeconomic status families would have a limit on food with labour intense work led to malnutrition [45].

4.1. Strengths and limitations

The study has potential strengths. The source data was from a national-level representative survey with large number of participants recruited using a complex sampling technique. Further, the response rate is high enough to generalize the study findings and increase the power of the study. The anthropometric measures were measured using standardized tools by trained field investigators. Also, we have excluded the mother-child pairs with even a missing parameter used for assessment of the study objective. And to account for mother-child pairs in the same household we excluded children living elsewhere also.

Looking at the limitations, the results show only the association because of the cross-sectional nature of the survey and therefore causal relationship cannot be established. DBM and TBM have multidimensional aetiology, but study findings were limited to only the sociodemographic determinants, other drivers like biological, environmental or behavioural determinants were beyond the scope of this study. The nutritional status of the mother was assessed using BMI only. Methods like waist-hip ratio or skinfold thickness are more accurate for assessment of overweight/obesity.

4.2. Implications

The burden of DBM and TBM was high in India compared to other Southeast-Asian countries. Our study found that mothers' age, age at first birth, educational levels, current breastfeeding habits, mode of delivery, child's age, gender, twin birth, birth weight, geographical region, residence, caste and religion, and wealth index were associated with the malnutrition status at the household level. Nutritional intervention should be scaled-up across the country. Effective implementation of health promotion activity on nutritious natural food, supplementary nutrition programme with Anganwadi monitoring of health status. Awareness is to be created on specific protection against unhealthy food habits. Rather than an isolated focus on undernourishment, programmes should also emphasis on overnutrition because obesity, prevalent in affluent families, is also a public health problem in our country. Life-course approach should be used for the management of malnutrition, translated through concrete policy action. Further research is needed to explore sustained solutions addressing various forms of malnutrition in India.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors for publication of this study.

Compliance with ethics guidelines

Since the study utilized publicly available datasets, ethical approval was not required. Appropriate permissions were obtained before utilizing the data for the study.

Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Premkumar Ramasubramani: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Formal analysis, Data curation, Conceptualization. **Yuvaraj Krishnamoorthy:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Sathish Rajaa:** Writing – review & editing, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] S. Maxwell, M. Smith, Household food security: a conceptual review. Househ, Food Secur. Concepts Indic. Meas. 1 (1992) 1–72.
[2] Malnutrition [Internet]. [cited 2022 Jul 12];Available from: https://www.who.int/health-topics/malnutrition#tab=tab_2.
[3] P. Kumar, S. Chauhan, R. Patel, S. Srivastava, D.W. Bansod, Prevalence and factors associated with triple burden of malnutrition among mother-child pairs in India: a study based on National Family Health Survey 2015–16, BMC Publ. Health 21 (2021) 391, https://doi.org/10.1186/s12889-021-10411-w.
[4] Z.A. Bhutta, J.A. Berkley, R.H. Bandsma, M. Kerac, I. Trehan, A. Briend, Severe childhood malnutrition, Nat. Rev. Dis. Primer [Internet] 3 (2017) 1–18, https://doi.org/10.1038/nrdp.2017.67.
[5] P. De, N. Chattopadhyay, Effects of malnutrition on child development: evidence from a backward district of India, Clin. Epidemiol. Glob. Health 7 (2019) 439–445, https://doi.org/10.1016/j.cegh.2019.01.014.
[6] J. Stubert, F. Reister, S. Hartmann, W. Janni, The risks associated with obesity in pregnancy, Dtsch. Ärztebl. Int. [Internet] 115 (2018) 276, https://doi.org/10.3238/arztebl.2018.0276.
[7] T. Biswas, N. Townsend, R.S. Magalhaes, M.S. Islam, M.M. Hasan, A. Mamun, Current progress and future directions in the double burden of malnutrition among women in South and Southeast Asian countries, Curr. Dev. Nutr. [Internet] 3 (2019) nzz026, https://doi.org/10.1093/cdn/nzz026.
[8] B.T. Tarekegn, N.T. Assimamaw, K.A. Atalell, S.F. Kassa, A.B. Muhye, M.A. Techane, et al., Prevalence and associated factors of double and triple burden of malnutrition among child-mother pairs in Ethiopia: spatial and survey regression analysis, BMC Nutr 8 (2022) 34, https://doi.org/10.1186/s40795-022-00528-5 [Internet].
[9] World Health Organization, Double-duty Actions for Nutrition: Policy Brief [Internet], World Health Organization, 2017. https://www.who.int/publications/i/item/WHO-NMH-NHD-17.2.
[10] World Health Organization. Double Burden of Malnutrition [Internet]. World Health Organization; [cited 2023 Mar 8]. Available from: http://www.who.int/nutrition/double-burden-malnutrition/en/.
[11] C. Roemling, M. Qaim, Dual burden households and intra-household nutritional inequality in Indonesia, Econ. Hum. Biol. [Internet] 11 (2013) 563–573, https://doi.org/10.1016/j.ehb.2013.07.001.
[12] S. Dieffenbach, A.D. Stein, Stunted child/overweight mother pairs represent a statistical artifact, not a distinct entity, J. Nutr. [Internet] 142 (2012) 771–773, https://doi.org/10.3945/jn.111.153387.
[13] H. Sharma, S.K. Singh, S. Srivastava, Socio-economic inequality and spatial heterogeneity in anaemia among children in India: evidence from NFHS-4 (2015–16), Clin. Epidemiol. Glob. Health 8 (2020) 1158–1171, https://doi.org/10.1016/j.cegh.2020.04.009.
[14] R. Patel, S. Srivastava, P. Kumar, S. Chauhan, Factors associated with double burden of malnutrition among mother-child pairs in India: a study based on National Family Health Survey 2015–16, Child. Youth Serv. Rev. [Internet] 116 (2020) 105256, https://doi.org/10.1016/j.childyouth.2020.105256.
[15] International Institute for Population Sciences (IIPS) and ICF, National Family Health Survey (NFHS-5), 2019-21: India, 2021. Mumbai: IIPS.
[16] A.K. Christian, F.A. Dake, Profiling household double and triple burden of malnutrition in sub-Saharan Africa: prevalence and influencing household factors, Public Health Nutr 25 (2022) 1563–1576, https://doi.org/10.1017/s1368980021001750 [Internet].
[17] T. Biswas, N. Townsend, R.J. Magalhaes, M. Hasan, A. Mamun, Patterns and determinants of the double burden of malnutrition at the household level in South and Southeast Asia, Eur. J. Clin. Nutr. [Internet] 75 (2021) 385–391, https://doi.org/10.1038/s41430-020-00726-z.
[18] S. Das, S.M. Fahim, M.S. Islam, T. Biswas, M. Mahfuz, T. Ahmed, Prevalence and sociodemographic determinants of household-level double burden of malnutrition in Bangladesh, Public Health Nutr 22 (2019) 1425–1432, https://doi.org/10.1017/s1368980018003580 [Internet].
[19] D.R. Sunuwar, D.R. Singh, P.M.S. Pradhan, 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, BMC Publ. Health 20 (2020) 1–11, https://doi.org/10.1186/s12889-020-8356-y [Internet].
[20] A.I. Anik, M.M. Rahman, M.M. Rahman, M.I. Tareque, M.N. Khan, M.M. Alam, Double Burden of Malnutrition at Household Level: A Comparative Study Among Bangladesh, Nepal, Pakistan, and Myanmar, vol. 14, PloS One [Internet], 2019 e0221274, https://doi.org/10.1371/journal.pone.0221274.
[21] P. Paul, S. Chakrabarty, Double burden of malnutrition in the form of undernutrition among children-overweight/obesity among mothers within households in India: a systematic review, JOCAS 80 (2021).
[22] J. Gouda, R.K. Prusty, Overweight and obesity among women by economic stratum in urban India, J. Health Popul. Nutr. 32 (2014) 79.
[23] D. Chaurasiya, A. Gupta, S. Chauhan, R. Patel, V. Chaurasia, Age, period and birth cohort effects on prevalence of obesity among reproductive-age women in India, SSM-Popul. Health 9 (2019), https://doi.org/10.1016/j.ssmph.2019.100507 [Internet].
[24] W. Li, Y. Wang, L. Shen, L. Song, H. Li, B. Liu, et al., Association between parity and obesity patterns in a middle-aged and older Chinese population: a cross-sectional analysis in the Tongji-Dongfeng cohort study, Nutr. Metab. [Internet] 13 (2016) 1–8, https://doi.org/10.1186/s12986-016-0133-7.
[25] V.M. Oddo, J.H. Rah, R.D. Semba, K. Sun, N. Akhter, M. Sari, et al., Predictors of maternal and child double burden of malnutrition in rural Indonesia and Bangladesh, Am. J. Clin. Nutr. [Internet] 95 (2012) 951–958, https://doi.org/10.3945/ajcn.111.026070.
[26] S.E. Hauqe, K. Sakisaka, M. Rahman, Examining the relationship between socioeconomic status and the double burden of maternal over and child under-nutrition in Bangladesh, Eur. J. Clin. Nutr. [Internet] 73 (2019) 531–540, https://doi.org/10.1038/s41430-018-0162-6.
[27] L.Y. Appoh, S. Krekling, Maternal nutritional knowledge and child nutritional status in the Volta region of Ghana, Matern. Child. Nutr. [Internet] 1 (2005) 100–110, https://doi.org/10.1111/j.1740-8709.2005.00016.x.
[28] N. Choudhury, C.S. Jalal, Maternal nutritional knowledge and child nutritional status, 2008, pp. 116–127. Vol - XL.
[29] A. Belachew, Timely initiation of breastfeeding and associated factors among mothers of infants age 0–6 months old in Bahir Dar City, Northwest, Ethiopia, 2017: a community based cross-sectional study, Int. Breastfeed. J. [Internet] 14 (2019) 1–6, https://doi.org/10.1186/s13006-018-0196-3.
[30] M. Saaka, A.Y. Hammond, Caesarean section delivery and risk of poor childhood growth, J. Nutr. Metab 2020 (2020) 6432754, https://doi.org/10.1155/2020/6432754 [Internet].
[31] R. Chehab, L. Nasreddine, R. Zgheib, M. Forman, C-section delivery is a barrier to and demographic-maternal-child factors have mixed effects on the length of exclusive breastfeeding under nutrition transition in Lebanon (P11-058-19), Curr. Dev. Nutr. [Internet] 3 (2019) nzz048, https://doi.org/10.1093/cdn/nzz048.P11-058-19. P11.
[32] A.J. Hobbs, C.A. Mannion, S.W. McDonald, M. Brockway, S.C. Tough, The impact of caesarean section on breastfeeding initiation, duration and difficulties in the first four months postpartum, BMC Pregnancy Childbirth 16 (2016), https://doi.org/10.1186/s12884-016-0876-1.
[33] A. Nagarkar, S. Kulkarni, Obesity and its effects on health in middle-aged women from slums of Pune, J. -Life Health [Internet] 9 (2018) 79. http://www.jmidlifehealth.org/text.asp?2018/9/2/79/234387.
[34] B. Ghose, Frequency of TV viewing and prevalence of overweight and obesity among adult women in Bangladesh: a cross-sectional study, BMJ Open 7 (2017) e014399, https://doi.org/10.1136/bmjopen-2016-014399.
[35] B. Mehboob, N.F. Safdar, S. Zaheer, Socio-economic, environmental and demographic determinants of rise in obesity among Pakistani women: a systematic review, J Pak Med Assoc 66 (2016) 1165–1172.
[36] J.G.J. Laput, G.L. Go, Disentangling the effects of maternal employment on child stunting in the Philippines. http://hdl.handle.net/11540/14825, 2022.
[37] A. Dang, J.V. Meenakshi, The Nutrition Transition and the Intra-household Double Burden of Malnutrition in India [Internet], Asian Development Bank, 2017 [cited 2022 Jul 11], https://www.adb.org/publications/nutrition-transition-household-malnutrition-india.

[38] P. Seferidi, T. Hone, A.C. Duran, A. Bernabe-Ortiz, C. Millett, Global inequalities in the double burden of malnutrition and associations with globalisation: a multilevel analysis of Demographic and Health Surveys from 55 low-income and middle-income countries, 1992–2018, Lancet Glob. Health [Internet] 10 (2022), https://doi.org/10.1016/S2214-109X(21)00594-5 e482–90.
[39] T. Bhurosy, R. Jeewon, Overweight and obesity epidemic in developing countries: a problem with diet, physical activity, or socioeconomic status? Sci. World J. [Internet] 2014 (2014) https://doi.org/10.1155/2014/964236.
[40] S. Singh, S. Srivastava, A.K. Upadhyay, Socio-economic inequality in malnutrition among children in India: an analysis of 640 districts from National Family Health Survey (2015–16), Int. J. Equity Health 18 (2019) 1–9, https://doi.org/10.1186/s12939-019-1093-0. Internet.
[41] S. Neupane, P. Kc, D.T. Doku, Overweight and obesity among women: analysis of demographic and health survey data from 32 Sub-Saharan African Countries, BMC Publ. Health 16 (2015) 1–9, https://doi.org/10.1186/s12889-016-2698-5. Internet.
[42] R. Ahirwar, P.R. Mondal, Prevalence of obesity in India: a systematic review, Diabetes Metab. Syndr. Clin. Res. Rev. [Internet] 13 (2019) 318–321, https://doi.org/10.1016/j.dsx.2018.08.032.
[43] S. Pengpid, K. Peltzer, Prevalence and correlates of underweight and overweight/obesity among women in India: results from the National Family Health Survey 2015–2016, Diabetes Metab. Syndr. Obes. Targets Ther. [Internet] 12 (2019) 647, https://doi.org/10.2147/DMSO.S206855.
[44] S. Girdhar, S. Sharma, A. Chaudhary, P. Bansal, M. Satija, An epidemiological study of overweight and obesity among women in an urban area of North India, Indian J. Community Med. Off. Publ. Indian Assoc. Prev. Soc. Med. [Internet] 41 (2016) 154, https://doi.org/10.4103/0970-0218.173492.
[45] M. Little, S. Humphries, K. Patel, C. Dewey, Factors associated with BMI, underweight, overweight, and obesity among adults in a population of rural south India: a cross-sectional study, BMC Obes 3 (2016) 1–13, https://doi.org/10.1186/s40608-016-0091-7. Internet.