Double Burden of Malnutrition in the form of Undernutrition among children - Overweight/Obesity among mothers within Households in India: A Systematic Review

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Background: At present, the double burden of malnutrition (DBM) in child undernutrition-overweight/obesity of mothers within households is an emerging issue, specifically in low and middle-income countries, including India. This new form of the adverse nutritional condition is considered the significant berries for achieving Sustainable Development Goals (SDGs) 2 and 3 within 2030.

Objectives: This study attempts to do a systematic review of literature on the prevalence of the double burden of child undernutrition-overweight/obesity of mothers and its associated factors in Indian households.

Materials & Methods: 398 articles were identified through the electronic search engine like PubMed, Science Direct, Google scholar, etc., and 389 articles were excluded for not fulfilling the inclusion criteria. Therefore, the present study reviewed nine papers indicating the double burden of malnutrition at the household level and meeting the selection criteria. The selected articles were published between the years 2008 and 2021 in the Indian context. We considered the PRISMA guideline in the systematic review process.

Results: The coexistence of the child undernutrition and mother overweight/obesity in the same household was noted in India. Studies also mentioned that the mother's age, educational status, household's wealth status, place of residence, and size of the baby at the time of birth had an essential association with the DBM among mother-child pairs in India. The DBM had a higher probability among mother-child pairs, which belonged to wealthy households than poor households. It also showed that children with low birth weight, maternal short stature, and mothers who have negligence of breastfeeding practice were more likely to suffer from DBM.

Conclusion: Maternal nutrition education and lifestyle modification were the key components to reduce the problem of DBM in India.

Keywords: *Double burden of malnutrition, undernutrition, overweight, Mother-child pair, India, PRISMA Guideline*

Introduction

With the increasing risk of obesity, we observe multiple forms of malnutrition; the Double Burden of Malnutrition (DBM) is the emerging one. WHO refers to DBM as characterized by the co-occurrence of undernutrition with overweight and obesity and diet-related non-communicable diseases (NCDs) within the frame of populations, households, and individuals' level of the situation across the life cycle (WHO, 2014). The world statistics show that worldwide, 1.9 billion adults are overweight, 462 million are underweight, and more than 600 million are obese. It is fascinating to observe that the number of adults obese is more than that of the undernourished population. In the case of children, 41 million children under the age of five suffered from overweight or obesity, 155 million and 50 million suffered from stunting (low height-for-age) and wasting (low weight-for-height), respectively. WHO expressed their strategies to reduce the double burden of Malnutrition within 2025 and encouraged the researcher to conduct more formative research on the DBM within the community and household levels (WHO, 2017).

The current double burden of Malnutrition mainly occurs in developing countries where the rapid economic transition is present (Kennedy, 2006). As a developing country, India is still grappling with poverty, undernutrition, and communicable diseases for the rapid socio-economic, demographic, nutritional, and health transition (IFPRI, 2017). Besides this, it faces additional challenges related to the dual form of Malnutrition, especially in the urban area, as for the massive nutritional transition in food consumption patterns and change of physical activity over time. This twin problem of Malnutrition and the growing rate of obesity may have a common cause of the high proportion of low-birth-weight children in India (Bhattacharya, 2017). In double burden households, distinct household typologies exist which consider that at least one member is underweight, and one member is overweight/obese like child undernutrition- overweight/obese mother. The global nutrition report 2017 highlighted India's need to tackle the double burden of Malnutrition as a part of India's national nutrition strategy and achieve Sustainable Development Goals (SDGs) 2 and 3 by the year 2030. This report also said that nutrition helps end poverty, fight diseases, raise educational standards, and tackle climatic change (Development Initiatives, 2017). Therefore it is essential to understand the current position of DBM in the form of child undernutrition- overweight/obese mothers within the household and to find out the associated factors. Hence, this study attempts to do a systematic review of literature on the prevalence of the double burden of child undernutrition-overweight/obesity of mothers and its associated factors in the Indian households.

Materials and Methods

We organized the methods of this systematic review according to the following stages:

Search Strategy

The selected articles were identified using the electronic databases PubMed, Science Direct, Google scholar, and different e-newspapers related to this topic. The random combination of keywords that were used for searching relevant articles were: "nutrition", "malnutrition", "burden", "double burden", "double burden of malnutrition", "DBM", "nutritional transition", "nutritional deficiency", "undernutrition", "micronutrient deficiency", "underweight", "overweight", "obesity", "prevalence", "risk factor", "India". To identify more potential reports or articles related to DBM (Double Burden of Malnutrition) in India, the selected articles or reports' bibliography was manually searched.

Inclusion and Exclusion Criteria

All the articles or papers were selected based on some inclusion and exclusion criteria.

The inclusion criteria were

- Primary research and/or research containing national data
- Reported prevalence and risk factor of the double burden of malnutrition/undernutrition/ underweight/ overweight and obesity/ micronutrient deficiency among the Indian related study only

• The study or published report must be recent and not before 2008

• Articles or papers published in English language only and quantitative nature.

• Report on national representative data that were obtained through nationwide survey/ surveillance.

The exclusion criteria were

• Qualitative study

• Research out of India

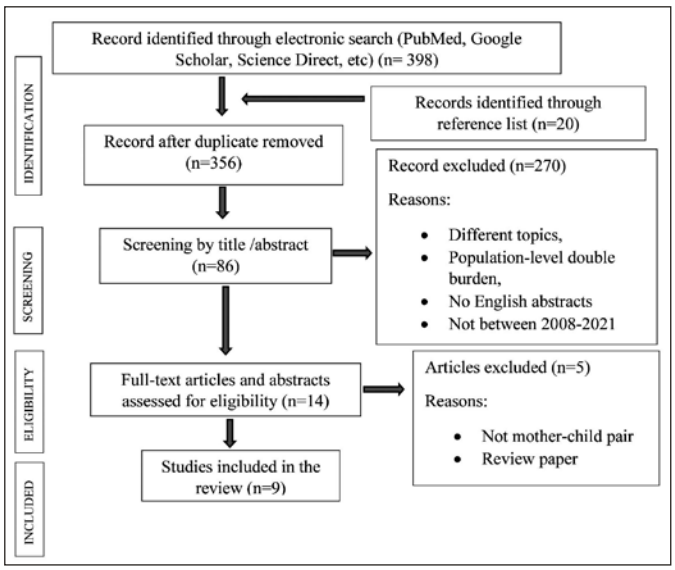
• Review papers

• Only abstracts available study

Search Result

At first, 398 studies were identified from the different databases for possible eligibility and cross-references. Then 86 studies were screened by title/abstract based on exclusion criteria (reasons described in figure 1). Later 356 studies were screened for the title and removing the duplication. Finally, after removing some studies, nine studies were selected and included for synthesis. The PRISMA flow chart displayed the overall selection process using the Preferred Reporting Items for Systematic Review process.

Figure 1. Flow diagram of studies that were identified using the search terms and strategy, articles screened for eligibility, included/excluded with reasons, following PRISMA guidelines



Data Extraction and Analysis

All the information was extracted from the selected studies using a data extraction form. The extracted data were arranged with Microsoft excel, 2010 format. Below are the articles or reports included in the data extraction form:

• Publication information: title of the journal, year of publication, author's name, volume, and page number of the paper.

• Data: country, data source, data type, year of data collection, characteristics of the subjects (e.g., slum dwellers, urban), and the number of subjects analyzed.

• Methods: focus combination of an overnourished, undernourished, and normal person (e.g., overweight mother and underweight child, normal mother and overweight child, overweight mother normal child), the age range of the subjects, analysis method, nutritional indicators that used to identify dietary levels and objectives of the study.

• Results: prevalence and associate factors of the double burden of malnutrition at the household level.

Finally, we analyze the data under two broad themes: prevalence of the double burden of malnutrition and associated risk factors of the double burden of malnutrition at the household level (overweight mother – stunted child)

Quality Appraisal

To evaluate the quality of selected studies, we used a quality assessment checklist that comprised of the following points:

• Mentioned study objectives.

• Clearly stated study design.

• Containing adequate sample size.

• Used a random sampling technique.

• Clearly defined statistical analysis.

These criteria were developed based on previous studies of published research. Those studies fulfilled all the requirements considered high-quality studies, and those that fulfilled less than three criteria were deemed low-quality studies.

Results

Study Characteristics

The features of the selected studies are summarised in Table 1. The majority of the studies were published within the last five years, from 2017 to 2021 (Danget al., 2017; Malik et al., 2018; Mittal and Vollmer, 2020; Swaminathan et al., 2019; Patel et al., 2020; Kumar et al., 2021) and the exception of two studies published in 2008 and 2013 (VanderKloet, 2008; Garg and Jindal, 2013). Within the nine selected studies, most of the articles were based on primary data of the nationally-representative household survey in India, except three articles that used secondary data analysis of National Family Health Survey (NFHS-IV, 2015-16) and one from India Human Development Surveys (IHDS) data. The studied population of the articles included both urban and rural settings. The study population varied among studies. The analytical methods of different studies also changed significantly. Inside the fourteen studies that fulfil the eligibility for full-text articles and abstract assessments, nine studies focused on the pairs of undernourished children and overweight mothers. The age range of the children and mothers varied among different studies.

In most cases, the child age group was under five years, and the mothers' age group varied from 15 to 49 years. For nutritional status, Body Mass Index (BMI) was the primary indicator for mothers and the child's height for age z score (HAZ), weight for height z score (WHZ), weight for age z score (WAZ), and mid-upper arm circumference (MUAC) were the primary indicator for children. Anthropometric indicators of undernutrition were commonly defined as stunting or wasting (length or height-for-age, weight-for-length or BMI Z score < −2 based on the WHO Child Growth Standards) among children, and as BMI <18.5 kg/m2 in adults (WHO, 2006). The overweight and obesity are defined as BMI ≥ 25 and 30 kg/m2 in adults. The equivalents childhood BMI was established using the International Obesity Task Force (IOTF) or WHO reference (Cole et al., 2000). Other indicators using biomarkers for measuring undernutrition that reflects on micronutrient status. This indicator demonstrates nutritional history. For example, long-time stunting was an indicator of chronic undernutrition, and wasting was regarded as poor nutrition.

Based on nutritional assessment, all child and mother pairs were classified into four categories (Lee et al., 2006) as follows:

- Stunted child and overweight mother (SCOM)
- Stunted child and normal-weight mother (SCNM)
- Normal child and overweight mother (NCOM)
- Normal child and normal-weight mother (NCNM).

These four reference groups were used for comparison with the double burden household. The associate factors differed among different reference groups. All nine selected studies reported prevalence values, but they would not specify the actual numbers of household pairs identified as suffering a double burden of malnutrition. All studies also reported factors associated with the double burden of malnutrition within households. Frequently considered factors included maternal age, urban or rural residence, family income, maternal or household head educational status, household size, etc. Two studies explored child breastfeeding history, birth weight, cesarean section delivery, and nutritional adequacy. Another study examined physical activity levels and short maternal stature as risk factors for double burden. A study in Kerala showed that religion or caste was not associated with the double burden of malnutrition (Jayalakshmi and Kannan, 2019). But another two studies showed a positive relation with religion or caste (Patel et al., 2020; Kumar et al., 2021).

Patterns and trends of household-level double burden of Malnutrition in India

As per the National Family Health Survey (NFHS-IV), 35.7 per cent of children under the age of five suffer from underweight (low weight for age) that reduced from 42.5 per cent in NFHS-III. The prevalence of underweight children was higher in rural areas as compared to urban. The percentage of the underweight child was more elevated in Jharkhand

and lower in Manipur. NFHS -IV also showed that 15.7 per cent of newborn babies had low birth weight, i.e., less than 2.5 kg. and overweight children were 2.4 per cent. In adults, 16.0 per cent of males and 22.0 per cent of women suffered from being overweight. Childhood stunting was highest in Uttar Pradesh and lowest in Kerala. The wasting percentage was higher in Arunachal Pradesh and reduced in Sikkim. 27.1 per cent of stunted children have an overweight mother. The prevalence of overweight/obese women was more than 40 per cent in Chandigarh and Lakshadweep. The proportion of overweight children was higher in highly urban areas (Jeemon et al., 2009; Sharma et al., 2007; Mondal et al., 2015). The prevalence of stunted children was higher in rural areas (Barquera et al., 2007). Overweight and obesity were mainly found among the middle class in the urban population, and the boys had a greater risk of overweight and obesity than girls (Sharma et al., 2007; Mondal et al., 2015). The National Family Health Survey-IV also showed that one-third of the under-five children in India were under-nourished, and one-fifth of the adult women were overweight or obese. Mothers' nutritional status was associated with their offspring (WHO, 2014). A large proportion of overweight and obese mothers had stunted, wasted or underweight children. The BMI of mothers with overweight/obese children was comparatively higher than normal-child normal mothers and underweight child-underweight mother pairs (Malik et al., 2018).

A study of the double burden of malnutrition among mother-child dyads in poor urban settings in Delhi showed that 52.9 per cent of underweight mothers had stunted children and 11.3 per cent had overweight/obese children. About 30 per cent of normal-weight mothers had an underweight child within the same household. Garg and Jindal (2013) studied Karnataka and showed that there was 30 per cent mother-child normal pair, 23.3 per cent overweight mother-underweight child pair, 10 per cent normal mother-underweight child pair, and 10 per cent overweight mother normal child pair existed. Patel et al. (2020) mentioned that 6 per cent of mother-child pairs in the same household suffered from DBM. This phenomenon showed the parallel existence of under and over-nutrition in the household/community level with different forms of malnutrition (Malik et al., 2018).

Table 1. Studies Characteristic in Chronological Order of Publication

	Year of Publication	Country	Data	Analysis	Year of Data Source	No. of HHs/pair	Adult		Child		Objectives	Findings	Notes	References
							Age Range	Indicator	Age Range	Indicator				
1	2008	India	P	CS	2002 and 2006	50	24-41	BMI	7.5-8.5	BAZ,HAZ	To identify independent predictors of child over and underweight in two categories of dual burden households: UC/OM households and OC/OM households, To examine associations between child, parents, and household-level indicators and household nutrition status.	Both UC/OM and OC/OM double burden households are present. 75% less likely to be in UC/OM households were present among post-pubertal children of both sexes than pre-pubertal children.	Poor households in Andhra Pradesh	VanderKloet, M. 2008

2	2013	India	P	CS	Aug- Dec 2011	30	20-45	BMI	1-3	HT,WT,MUAC	To identify the dual form of malnutrition existing in a household i.e., the coexistence of both undernutrition and overnutrition together To determining the adequacy of their food consumption.	MAR of nutrients between the mother and child has a positive correlation between the two values as p=0.001<0.05. 30% were normal pair, 23.3% were overweight mother-underweight child pair, 10% were normal mother with underweight child pair and 10% were overweight mothers with normal child pair. BMI of the mother influences on the BMI of the child	Manipal, Karnataka	Garg, M., & Jindal, S. (2013)
3	2017	India	S	CS	2004-2005 & 2011-2012	-	-	BMI	<5	WAZ	Correlates of households with an underweight child and an overweight mother (UC-OM)	UC/OM increased from 4% to 5% in rural areas and 6% to 8% in the urban area. Maternal occupation, education, and stature correlate with DBM.	India Human Development Surveys (IHDS)	Dang et al.2017
4	2018	India	P	CS	September 2014	225	>18	HT, WT, WC, HC, WHR, BMI	3-5	MAUC,HAZ,WHZ,WAZ,MUACZ	Explored the coexistence of under and over-nutrition among mother-child dyads in an urban poor setting in India	33 percent and 30 percent overweight and obese mothers had stunted, wasted or underweight children. 52.9 percent of underweight mothers had stunted children while 11.3 percent had overweight/obese children. Almost 30 percent of normal-weight mothers had an underweight child within the same household and overweight/obese mothers had overweight/obese children also found.	urban poor of Delhi	Malik et al. 2018

P – primary, S- secondary, CS- cross-sectional, UC/OM- underweight child/overweight mother, OC/OM- overweight child/overweight mother, NC/OM- normal weight child/overweight mother, SC/OM-stunted child/ overweight mother, WC/OM- wasted child/ overweight mother, HT- Height; WT- Weight, WC- waist circumference, HC- Hip circumference, BMI- Body Mass Index, BAZ-BMI-for-age z-scores, HAZ – height-for-age z-score, MUAC- Mid – upper arm circumference, WHR- Waist – hip ratio, MAR- Mean Adequacy Ratio, HAZ- Height-for-age, WHZ- weight-for-height, WAZ-weight-for-age, MUACZ-MUAC-for-age, DBM-Double burden of malnutrition, NFHS- National Family Health Survey

5	2018	India	P	CS	-	-	-	-	0-6 &7-18	-	To identify the factors responsible for DBM and predict future of DBM in India.	Socioeconomic and settlement differences and mother education effects on DBM.	City of Bangalore	Mittal, N.&Vollmer, S.,2020
6	2019	India	S	CS	1990-2017	-	15-49	BMI, Haemoglobin level	<5	HAZ, WH, WAZ, Haemoglobin level	Prevalence of malnutrition indicators up to 2020	If the trends estimated up to 2017continue in India there would be9·6 percent excess prevalence of stunting, 4·8 percent for underweight in 2020.	GlobalBurden of Diseases, Injuries, and Risk Factors Study (GBD) 2017	Swaminathan et al. 2019
7	2019	India	S	CS	2004-2005 & 2011-2012	344	-	BMI	<5	HAZ	Prevalence of stunted child and overweight/ obese mother (SCOWT) pairs in Kerala households.	The prevalence of stunted child and overweight mother pairs in the state of Kerala was found to be 10.7% (37). Residence, religion or caste is not associated with the household DBM.	India Human Development Surveys (IHDS)	Jayalakshmi, R., & Kannan, S. (2019)
8	2020	India	S	CS	NFHS 2015-2016	184680	15-49	BMI	<5	HAZ, WHZ, WAZ	Explore the coexistence of DBM and associates' factors	4.1 percent SC/OM, 3.3 percent UC/OM, and 2.1 percent WC/OM present in the same household. 6.0 percent mother-child pair suffering from DBM. mother's education, wealth status correlates with DBM.	NFHS-IV	Patel et al. 2020
9	2021	India	S	CS	NFHS 2015-2016	168784	15-49	BMI	<5	HAZ, WHZ, WAZ, Haemoglobin level	Prevalence and factors associated with the triple burden of malnutrition (TBM) among mother-child pairs	TBM prevalence was 5.7% among mother-child pairs. mother's age, education, residence, household size, wealth status, caesarean section delivery, birth size of the baby correlates with TBM	NFHS-IV	Kumar et al. 2021

Factors associated with the double burden of malnutrition within households

The double burden of malnutrition within the households is commonly associated with three factors: Urban/rural residence, income, and maternal/household-head education level. The exploring factors contributing to the dual burden are considered latency and sensitive windows for developing the different types of malnutrition. However, it is difficult to identify any specific factors to predict the risk of maternal overnutrition or child undernutrition.

Urban/Rural Residence: Both urban and rural populations were associated with the double burden of malnutrition in the socio-economic context (Lee et al., 2006; Dang et al., 2017). The double-burden households were higher in the urban areas (Patel et al., 2020) because urban environments offer a greater variety of food choices, including fast-food items and jobs with lower physical activity levels. (Roemling and Qaim, 2013). In contrast, a study in Kerala showed that residence was not associated with a household level double burden as the penetration of the developmental change in lifestyle and the dietary pattern is even found in the remote area of Kerala (Jayalakshmi and Kannan, 2019).

Income: There is a relationship between household income and nutritional status (Jayalakshmi and Kannan, 2019). The double-burden households tended to have a higher income than the undernourished households (Patel et al., 2020). Due to the economic development, the increase of income of the people had raised the household food availability that might be adequate to meet the hunger need of the people, especially those who belonged to the lower socio-economic strata, but insufficient to meet the nutritional need. People want to buy more inexpensive energy-rich food items rather than nutritionally rich items. In this way, families consumed more energy-dense food, and children were deprived of nutrient-rich food required for their growth and development. This factor may increase the prevalence of overweight/obese adults and undernourished children. (Pérez-Escamilla, 2017). A study revealed that wealthier households tended to follow a sedentary lifestyle, engaged in less labour-intensive work, and consumed more energy due to greater purchasing power that leads to higher rates of obesity among them. On the other hand, a low socio-economic group might be associated with limited food consumption and high manual labour, leading to negative energy intake (Kumar et al., 2021).

Maternal/Household-head Education Level: Mother's education has always been considered a determinant of household food security and nutrition. If mothers are educated, they have adequate knowledge about dietary choices, household income, and expenditure. Although a study exhibited that the mother's education was not associated with stunted child and overweight/obese mother (SCOWT) pairs in households (Gittinger,1990), the father's education had an association (Jayalakshmi and Kannan, 2019). The possible reason might be that increasing education can get more salaried jobs and start to spend more non-food expenditure, energy-rich food, and junk foods (Government of Kerala, 2012). Lee et al. (2006) also revealed in their studies that the proportion of the high level of maternal education was a less possibility of the stunted child and overweight mother pair than in normal child and normal mother pair. Shortly it can be said that maternal education is inversely related to the risk of child stunting. But Patel et al. (2020) presented a direct relation between mother education and DBM (double burden of malnutrition). She mentioned that the prevalence of DBM was higher among mothers with higher education than uneducated mothers as educated mothers were more likely to focus on work and, hence, less focused on physical activities; consequently, they developed obesity. Another study showed that mothers who were educated up to secondary level were 15% more suffer from TBM (Triple Burden of Malnutrition) than non-educated mothers (Kumar et al., 2021).

Others several factors which were significantly associated with mother-child pairs, including:

Nutritional Adequacy: A highly positive correlation

has been found in compression of the mean adequacy ratio of mother and child nutrient intake. This indicates that the mother's and child's nutritional status goes parallel, and if the mother's nutritional status is good, the child will follow a similar trend and vice-versa (Garg and Jindal, 2013; Patel et al., 2020). In India, Micronutrient deficiency is a severe public health problem, and low birth size is associated with it (Kumar et al., 2021). Most child deaths were caused by malnutrition, mainly by the lack of vitamin A, iron, iodine, zinc, and folic acid (Kotecha, 2008). The main factors associated with micronutrient deficiency were the poor diet due to poverty, ignorance, low agricultural productivity, and cultural factors. Besides these, inadequate access to safe drinking water, a disease-free environment, and healthcare practices are associated with child nutrition (Indian National Science Academy, 2011). The prevalence of vitamin A deficiency, vitamin B deficiency, and anaemia was significantly higher in the child of illiterate parents. (Chajhlana, 2007). VanderKloet (2008) stated that the nutritional transition in low- and middle-income countries' economic development and urbanization had forced a shift towards westernized lifestyle and diet patterns. This transition influence to reduce undernutrition but increase the prevalence of overweight, obesity, and non-communicable diseases.

Child's breastfeeding history: The demand for lactation can be high as the child's weight gained against mother weight loss (Tracer, 1991). In developing nations, breastfeeding becomes difficult or impossible, and the average duration of breastfeeding diminishes for women who have taken a job outside the home. It deprived the nutritional benefit that reduces the risk of malnutrition of the child (Shao et al., 2004). The breastfed child grew faster than the child not breastfed and is protected against childhood obesity (Chomtho, 2014). The mother's knowledge influences the practice of breastfeeding, attitude towards breastfeeding, and encouragement of the social environment (Vijayalakshmi et al., 2015). A study among the underage five in Tamil Nadu exposed that the child who received breast milk for less than 12 months was more malnourished (Stalin et al., 2013). The mothers who had negligence of breastfeeding had a higher prevalence of DBM (Patel et al., 2020; Kumar et al., 2021).

Maternal age: The risk of being overweight among the mother depends on both age and parity (number of children) (Oddo et al., 2012). The double burden of malnutrition among mothers aged 35 or above was higher than that of other age groups (Patel et al., 2020; Kumar et al., 2021). A study on the household level also revealed that older mothers and mothers who spend more time watching television were more likely to be overweight and have an underweight child than others (Dang et al., 2017).

Maternal short stature: The short maternal stature was significantly associated with stunted children and overweight mothers, found in a study of Guatemala (Lee et al., 2006), and it is also found in the semi-arid region Alagoas, Brazil (Ferreira et al., 2008). Another study on Mexican children was 3.6 times more likely to be stunted whose mother height was below 150.0 cm than those whose mother height was more than 150.0 cm (Varela-Silva et al., 2009). Dang et al. (2017) showed that short maternal stature was an indicator of malnutrition in early life, and it had been associated with increased Body Mass Index (BMI).

Child's Birth Weight and Size: Children with low birth weight are more likely to suffer from DBM than average birth weight children (Patel et al., 2020; Kumar et al., 2021), and it increases the risk of chronic disease in the future (Swaminathan et al., 2019). The birth weight of a child has a positive correlation with the current BMI of the child, and the children with more than 3kg birth weight have a higher BMI (Sharma et al., 2007). On the other side children whose birth size was greater than average also had a higher prevalence of TBM (Triple Burden of Malnutrition) in children, i.e., the coexistence of undernutrition, micro nutrition deficiency, and obesity (Kumar et al., 2021). Children with age group 48-59 months suffered more from DBM than children aged 12 months or less, and birth size also affects child growth. Children with smaller

birth sizes are more suffering from diarrheal infections, weakness, anaemia, loss of appetite, and jaundice; they are more susceptible to being underweight (Patel et al., 2020). Besides these, Childbirth with the C-section method had a higher prevalence of DBM and male children have a higher risk of DBM than females (Patel et al., 2020; Kumar et al. 2021)

Number of Siblings in the household: The number of children in the household directly impacts household food availability (Oddo et al., 2012). DBM was positively correlated with the number of family members (Pal, 2017; Dang et al., 2017). The adequate food and the lack of drinking water, sanitation, and hygiene practice that leads to diarrhoea like life-threatening diseases are also responsible for undernutrition and stunting.

Discussion

This study was a systematic review of the published literature, focusing on the prevalence and associate factors of the double burden of malnutrition within households. During the thirteen years from 2008 to 2021, nine published studies were entitled to inclusion in this literature review. Most were published within the last five years, indicating that this topic has had a special academic interest in recent years. The age classification varied significantly among the studies; for example, some included 15-year-old adults (Kumar et al., 2021; Patel et al., 2020; Swaminathan et al., 2019), whereas others included 18-year-old individuals as children (Mittal and Vollmer, 2020). Regarding indicators, some studies used HAZ as an indicator of undernutrition, while others used WHZ. HAZ reflects chronic malnutrition better, so it is preferable to WAZ and WHZ for children in studies of the double burden of malnutrition within households. Heterogeneity was found in the sample size and the sampling method because these factors affect the strength of evidence. Especially, a small sample size and without a clear explanation of the sampling method should be acknowledged as weak evidence. However, trends of the double burden on household-level can be explored, although this depends on a small number of studies and some of the studies calculating prevalence figures using secondary data. The study indicates that the prevalence of underweight and stunting reduce but overweight and obesity is increasing rapidly, though the rate of obesity in India is low in the world (Vora, 2017). Besides this, the micronutrient deficiency remained unchanged, and it is found to be higher in the child of illiterate parents (Chajhlana, 2007; Pal and Singh, 2007). The higher prevalence of nutritional deficiency of Indian peoples is due to the lack of knowledge of dietary consumption, dietary diversification, cultural practice (Mondal et al., 2015), lack of support from the family members (husband, mother-in-law), gender role, and adequate health care facility and the massive disruption of food system due to intake of a large amount of rice and wheat, not enough fruit, vegetable or even milk. It leads to food insecurity and undernutrition even obesity-related diseases (The Telegraph, 2018). The researcher showed that overweight and underweight children were found in the same communities where the health facility and the food availability were the same. This evidence was found in some slum areas of Mumbai (Vora, 2017).

The coexistence of underweight and overweight is found in the low socio-economic group (Patel et al., 2020). Due to the nutritional, epidemiological, and demographic transition. The underweight burden remains the same that expresses the double burden (Monteiro, 2004). A child's birth size, C-section delivery, the mother's health, the mother's stature, lifestyle, and household expenditure significantly show the probability that a household has an underweight child and an overweight mother. (Meenakshi and Jindal, 2013). With this systematic review, we can clearly emphasize that residence (urban/ rural), income, and education may have played an essential role in the prevalence and predictors of the double burden of malnutrition. Still, the part of physical activities and dietary habits remain unclear. Numerous macro-level studies were conducted on this issue. Therefore, there is a severe need to perform micro-level research on the household level. However, this study is limited only to the selected database source and English language publications only.

Conclusion

The household-level double burden of malnutrition is a public health phenomenon that depends on common macro-level social, environmental, and economic factors. This paper highlights the need to focus on the double form of malnutrition and the few critical risk factors of DBM among mother-child pairs in India. Although the percentage of mother-child pairs who suffered from DBM was even lower, an increasing trend was expected. The distribution of DBM will demonstrate the potential risk in the future and trickle-down effect on the population. So, it requires the awareness of the coexistence of malnutrition status among the people, nutrition education, and lifestyle modification that may reduce the problem. Nutrition intervention programs at the people and household level are required to manage the dual burden of malnutrition effectively.

References

Barquera, S., Peterson, K. E., Must, A., Rogers, B. L., Flores, M., Houser, R.,& Rivera-Dommarco, J. A. (2007). Coexistence of maternal central adiposity and child stunting in Mexico. *International Journal of Obesity*, *31*(4), 601-607. doi: 10.1038/sj.ijo.0803529

Chajhlana, S. P., Mahabhasyam, R. N., &Varaprasada, M. S. (2017). Nutritional deficiencies among school children in urban areas of Hyderabad, Telangana, India. *International Journal of Community Medicine And Public Health*, *4*(2), 607. doi:10.18203/2394-6040.ijcmph20170299

Chomtho, S. (2014). BREASTFEEDING TO PREVENT DOUBLE BURDEN OF MALNUTRITION. *Department of Pediatrics, Chulalongkorn University, Bangkok, Thailand*, *45*(1), 132-136. Retrieved from https://www.tm.mahidol.ac.th/seameo/2014-45-1-suppl/c8-04p132-136.pdf

Cole, T. J. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *BMJ*, *320*(7244), 1240-1240. doi:10.1136/bmj.320.7244.1240

Dang, A., & Meenakshi, J. V. (2017). Asian development bank. Retrieved from https://www.adb.org/publications/nutrition-transition-householdmalnutrition-india

Development Initiatives, 2017. Global Nutrition Report 2017: Nourishing the SDGs. Bristol, UK: Development Initiatives. Retrieved from https://globalnutritionreport.org/reports/2017-global-nutrition-report/

Doak, C. M., Adair, L. S., Bentley, M., Monteiro, C., & Popkin, B. M. (2004). The dual burden household and the nutrition transition paradox. *International Journal of Obesity*, *29*(1), 129-136. doi: 10.1038/sj.ijo.0802824

Express News Service. (2018, February 8). Every fourth child has stunted growth in India's 10 most-populous cities: Report. Retrieved from https://indianexpress.com/article/lifestyle/health/every-fourth-child-has-stunted-growth-in-indias-10-most-populous-cities-report-5055377/

Ferreira, H. S., Moura, F. A., Cabral Júnior, C. R., Florêncio, T. M., Vieira, R. C., & De Assunção, M. L. (2008). Short stature of mothers from an area endemic for undernutrition is associated with obesity, hypertension and stunted children: A population-based study in the semi-arid region of Alagoas, Northeast Brazil. *British Journal of Nutrition*, *101*(8), 1239-1245. doi:10.1017/s0007114508059357

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. (2006). The double burden of malnutrition case studies from six developing countries. Retrieved from https://www.fao.org/3/a0442e/a0442e00.htm

Garg, M., & Jindal, S. (2013). Dual burden of malnutrition in mother-child pairs of the same household: Effect of nutrition transition. *The Indian Association for Parenteral and Enteral Nutrition*, *1*(1), 1-7. Retrieved from https://www.jnutres.com/2018/09/dual-burden-of-malnutrition-in-mother.html

Garrett, J. L., & Ruel, M. T. (2005). Stunted child–overweight mother pairs: Prevalence and association with economic development and urbanization. *Food and Nutrition Bulletin*, *26*(2), 209-221. doi:10.1177/156482650502600205

Gittinger, J. P., Chernick, S., Horenstein, N. R., & Saito, K. (1990). Household Food Security and the Role of Women. Retrieved from http://documents1.worldbank.org/curated/en/857971468768019465/pdf/multi-page.pdf

Government of Kerala. (2008). NSS Socio-Economic Survey. Retrieved from http://www.ecostat.kerala.gov.in/images/pdf/publications/NSS/data/nss64_hous_con_exp.pdf

Indian National Science Academy. (2011). MICRO-NUTRIENT SECURITY FOR INDIA– PRIORITIES FOR RESEARCH AND ACTION. Retrieved from insaindia.res.in/download%20form/Micronutrient_final_with_cover.pdf

Jayalakshmi, R., & Kannan, S. (2019). The double burden of malnutrition: An assessment of 'stunted child and overweight/obese mother (SCOWT) pairs' in Kerala households. *Journal of Public Health Policy*, *40*(3), 342-350. doi:10.1057/s41271-019-00172-7

Jeemon, P., Prabhakaran, D., Mohan, V., Thankappan, K. R., Joshi, P. P., Ahmed, F.,& Chaturvedi. (2009). Double burden of

underweight and overweight among children (10-19 years of age) of employees working in Indian industrial units. *The National Medical Journal of India*, *22*(4), 172-6. Retrieved from https://pubmed.ncbi.nlm.nih.gov/20131480/

Kennedy, G., Nantel, G., & Shetty, P. (2006). The double burden of malnutrition case studies from six developing countries. Retrieved from https://www.fao.org/3/a0442e/a0442e03.htm

Kotecha, P. (2008). Micronutrient malnutrition in India: Let us say "no" to it now. *Indian Journal of Community Medicine*, *33*(1), 9. doi:10.4103/0970-0218.39235

Kumar, P., Chauhan, S., Patel, R., Srivastava, S., &Bansod, D. W. (2021). 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 Public Health*, *21*(1). doi:10.1186/s12889-021-10411-w

Lee, J., Houser, R. F., Must, A., De Fulladolsa, P. P., & Bermudez, O. I. (2010). Disentangling nutritional factors and household characteristics related to child stunting and maternal overweight in Guatemala. *Economics & Human Biology*, *8*(2), 188-196. doi: 10.1016/j.ehb.2010.05.014

Malik, R., Puri, S., & Adhikari, T. (2018). Double Burden of Malnutrition Among Mother-Child Dyads in Urban Poor Settings in India Corresponding Author Citation Article Cycle. *Indian Journal of Community Health*, *30*(2), 139-144. Retrieved from https://www.researchgate.net/publication/327273046_Double_Burden_of_Malnutrition_Among_Mother-Child_Dyads_in_Urban_Poor_Settings_In_India_Corresponding_Author_Citation_Article_Cycle

Mittal, N., & Vollmer, S. (2020). The double burden of malnutrition in Bangalore, India. *World Review of Nutrition and Dietetics*, 138-148. doi:10.1159/000507521

Mondal, N., Basumatary, B., Kropi, J., & Bose, K. (2015). Prevalence of double burden of malnutrition among urban school going Bodo children aged 5-11 years of Assam, Northeast India. *Epidemiology Biostatistics and Public Heal*, *12*, 4. Retrieved from DOI: 10.2427/11497

Monteiro, C. A., Moura, E. C., Conde, W. L., & Popkin, B. M. (2004). Socioeconomic status and obesity in adult populations of developing countries: a review. *Bulletin of the World Health Organization*, *82*(12), 940-6. Retrieved from https://pubmed.ncbi.nlm.nih.gov/15654409/

National Family Health Survey. (2016). Retrieved from https://rchiips.org/nfhs/

Oddo, V. M., Rah, J. H., Semba, R. D., Sun, K., Akhter, N., Sari, M., … Kraemer, K. (2012). Predictors of maternal and child double burden of malnutrition in rural Indonesia and Bangladesh. *The American Journal of Clinical Nutrition*, *95*(4), 951-958. doi:10.3945/ajcn.111.026070

Onis, M. (2007). WHO child growth standards based on length/height, weight and age. *Acta Paediatrica*, *95*, 76-85. doi:10.1111/j.1651-2227. 2006.tb02378.x

Stalin, P., Bazroy, J., Dimri, D., & Singh, Z. (2013). Prevalence of underweight and its risk factors among under five children in a rural area of Kancheepuram district in Tamil Nadu, India. *IOSR Journal of Dental and Medical Sciences*, *3*(6), 71-74. doi:10.9790/0853-0367174

Pal, A., Pari, A. K., Sinha, A., &Dhara, P. C. (2017). Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India. *International Journal of Pediatrics and Adolescent Medicine*, *4*(1), 9-18. doi: 10.1016/j.ijpam.2016.08.009

Partnerships and Opportunities to Strengthen and Harmonize Actions for Nutrition in India. (2017, November 14). Double-burden of malnutrition in India: A growing threat. Retrieved from https://poshan.ifpri.info/2017/11/14/double-burden-of-malnutrition-in-india-a-growing-threat/

Patel, R., Srivastava, S., Kumar, P., & Chauhan, S. (2020). Factors associated with double burden of malnutrition among mother-child pairs in India: A study based on national family health survey 2015–16. *Children and Youth Services Review*, *116*, 105256. doi: 10.1016/j.childyouth.2020.105256

Pérez-Escamilla, R. (2017). Food security and the 2015–2030 sustainable development goals: From human to planetary health. *Current Developments in Nutrition*, *1*(7), e000513. doi:10.3945/cdn.117.000513

Roemling, C., & Qaim, M. (2013). Dual burden households and intra-household nutritional inequality in Indonesia. *Economics & Human Biology*, *11*(4), 563-573. doi: 10.1016/j.ehb.2013.07.001

S. S., A., Jayasree, A. K., &Antherjanam S., D. (2017). Prevalence of underweight among preschool children attending anganwadi in Kannur district, Kerala, India. *International Journal of Community Medicine and Public Health*, *4*(7), 2361. doi:10.18203/2394-6040.ijcmph20172824

Shao Mlay, R., Keddy, B., &Noerager Stern, P. (2004). Demands out of context: Tanzanian women combining exclusive breastfeeding with employment. *Health Care for Women International*, *25*(3), 242-254. doi:10.1080/07399330490272741

Sharma, A., Sharma, K., & Mathur, K. (2007). Growth pattern and prevalence of obesity in affluent schoolchildren of Delhi. *Public Health Nutrition*, *10*(5), 485-491. doi:10.1017/s1368980007223894

Subramanian, S., Perkins, J. M., & Khan, K. T. (2009). Do burdens of underweight and overweight coexist among lower socioeconomic groups in India? *The American Journal of Clinical Nutrition*, *90*(2), 369-376. doi:10.3945/ajcn.2009.27487

Swaminathan, S., Hemalatha, R., Pandey, A., Kassebaum, N. J., Laxmaiah, A., Longvah, T., &Dandona, L. (2019). The burden of child and maternal malnutrition and trends in its indicators in the states of India: The global burden of disease study 1990–2017. *The Lancet Child & Adolescent Health*, *3*(12), 855-870. doi:10.1016/s2352-4642(19)30273-1

Telegraph India. (2018, March 31). Stunting-obesity double burden rises. Retrieved from https://www.telegraphindia.com/india/stunting-obesity-double-burden-rises/cid/1340289

Tracer, D. P. (1991). Fertility-related changes in maternal body composition among the AU of Papua New Guinea. *American Journal of Physical Anthropology*, *85*(4), 393-405. doi:10.1002/ajpa.1330850404

VanderKloet, M. (2008). Dual Burden of Malnutrition in Andhra Pradesh, India: Identification of Independent Predictors for Underweight and Overweight in Adolescents with Overweight Mothers. *YOUNG LIVES STUDENT PAPER*. Retrieved from https://assets.publishing.service.gov.uk/media/57a08b8be5274a31e0000bf6/YL_VanderKloet_08.pdf

Varela-Silva, M. I., Azcorra, H., Dickinson, F., Bogin, B., &Frisancho, A. R. (2009). Influence of maternal stature, pregnancy age, and infant birth weight on growth during childhood in Yucatan, Mexico: A test of the intergenerational effects hypothesis. *American Journal of Human Biology*, *21*(5), 657-663. doi:10.1002/ajhb.20883

Vijayalakshmi, P., &Susheela,D., M. (2015). Knowledge, attitudes and breast-feeding practices of postnatal mothers: A cross sectional survey. *International Journal of Health Sciences*, *9*(4), 363-372. doi:10.12816/0031226

Vora, P. (2017, October 12). What India's obesity problem has to do with its malnourished pregnant women. Retrieved from https://scroll.in/pulse/853774/what-india-s-obesity-problem-has-to-do-with-its-malnourished-pregnant-women

WHO | World Health Organization. (1995). Physical status: The use and interpretation of anthropometry. Retrieved from https://www.who.int/childgrowth/publications/physical_status/en/

Wojcicki, J. M. (2014). The double burden household in sub-Saharan Africa: Maternal overweight and obesity and childhood undernutrition from the year 2000: results from World Health Organization data (WHO) and demographic health surveys (DHS). *BMC Public Health*, *14*(1). doi:10.1186/1471-2458-14-1124

The World Bank. (2011, September). World Bank group - International development, poverty, & sustainability. Retrieved from https://www.worldbank.org/en/home

World Health Organization. (2014). Double Burden of Malnutrition. Retrieved from https://www.who.int/nutrition/double-burden-malnutrition/en/