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Double Burden of Malnutrition and Other Associated Factors among Reproductive Age Group Women in Assam, India

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Abstract

Objective: This study aims to assess the Double Burden of Malnutrition (DBM) and its associated factors among reproductive age group women in Assam, India. **Methods:** Based on a multistage sampling procedure, a total of 736 reproductive age group women from four districts of Assam were selected as the final sample unit. The sample units are grouped as rural (total 310 samples) and urban (total 426 samples) and data is collected from June to December 2022 based on a structured questionnaire. The classical measure of anthropometry is used to collect data on the height and weight of the respondents. The anthropometric rod to the nearest 0.1 cm is used to measure women's height and a portable weighing machine is used to measure their weights. The Body Mass Index (BMI) of sample women is calculated to assess the existing double burden of malnutrition. **Findings:** It is found that around 40 % of women in the study area are at risk of DBM. The risk of underweight is higher among rural women (29.4%). On the other hand, the severity of overweight is higher among urban women (20.2%) as compared to their rural counterparts (14.2%). The multinomial logistic regression analysis shows that women belonging to food-insecure households are at a 0.674 % higher risk of being underweight. Women's employment and availability of basic amenities reduce the risk of being underweight by 47.2% and 80.9% respectively. Women's dietary diversity, employment, and their age significantly affect their overweight status. **Novelty:** The socioeconomic and demographic factors considered in the study are based on household level as well as women's individual status and quantify the potential qualitative issues affecting women's DBM. This study will certainly provide a basis for further research on DBM in different settings and thereby to adopt strategic interventions.

Keywords: Underweight; Overweight; Body Mass Index; Reproductive women; Assam

1 Introduction

Double Burden of Malnutrition (DBM) is one of the greatest health challenges, especially for the low and middle-income countries of the world. The DBM among the global population exists in the form of undernutrition with the co-existence of overweight and obesity. Combating all forms of malnutrition is targeted in the UN's Decade of Action on Nutrition from 2016 to 2025. Globally 768 million people are in hunger during 2021 with 29.3 percent of the world's population facing the challenges of food insecurity, as per Global Nutrition Report, 2022. The report also states that obesity or overweight and non-communicable diseases (NCDs) have been rising due to a lack of adequate quality food consumption having low nutritional value.

The DBM in the form of underweight or micronutrient deficiencies, childhood stunting and wasting, etc., and overweight or obesity and diet-related non-communicable diseases have adverse health challenges for both men and women⁽¹⁾. The challenges become more severe among women in the reproductive age group (15-49 years) with varying demographic and socioeconomic factors⁽²⁾. The malnutrition among reproductive age group women negatively affects the physical and mental development of their children. The required neurological development of children depends on their mother's nutritional status during pregnancy. Undernutrition among pregnant women results in low birth weight babies and a higher infant mortality rate. Among the surviving children, who are born with low weight, growth retardation occurs throughout their life. Moreover, Obesity or overweight during pregnancy and childbirth creates greater health risks than pregnant women with normal BMI⁽³⁾.

The global analysis of nutritional status between men and women reflects gendered bias. Women and children are more vulnerable to the risk of obesity, anemia, and underweight⁽⁴⁾. According to the Global Nutrition Report, 2022 globally 40.8% of adult women and 40.4% of adult men are affected by the risk of being overweight or obese and at the same time 29.9% of reproductive age group women are affected by the evils of iron-deficiency anemia.

The simultaneous manifestation of underweight and obesity among reproductive age group women of low and middle-income countries has long-lasting impact on their growth and development process. The trend and prevalence of the DBM in India shows that although there is a slight decline in total underweight women from 22.9 % in NFHS-4 to 18.7 percent in NFHS-5, during this period the overweight or obesity among women increased from 20.6 % to 24.0 %⁽⁵⁾.

The available literature in the Indian setting has evidence of this DBM among adults and among the rural and urban populations⁽⁶⁾. The challenges of being underweight are higher among rural women while overweight or obesity is higher among urban women. According to NFHS-5, in Rural India the parentage of underweight and overweight women is 21.2% and 13.2% respectively while in urban India 19.7% of women are underweight and 33.2 % are overweight or obese. The production and consumption of nutrition-dense processed food, more sedentary lifestyles, etc. have been increasing the risk of obesity and non-communicable diseases. On the other hand, persisting poverty, food insecurity, lack of health facilities, etc. grave the Indian economy to the challenges of undernutrition. The state-level analysis of reproductive age group women's nutrition status indicates diverse causes of malnutrition with separate remedial measures for underweight and overweight⁽⁷⁾. The existing socioeconomic inequalities of the Indian economy also create disparities in the nutritional status of Indian women⁽⁸⁾.

Women, which constitutes 48.41% of the country's total population as per the Census, 2011, play an active role as productive agents for the present and future generations and necessitate proper interventions for their health and nutrition challenges. Studies that have addressed women's and children's malnutrition status, are limited to particular states like Delhi⁽⁹⁾, Kerala⁽¹⁰⁾, etc. The greatest health hazard of the reproductive age group Indian women has received limited attention from researchers^(2,11). Moreover, the strategic measures that must be adopted to reduce malnutrition among women need to be analyzed based on specific factors of local women. The present study makes an attempt to fulfill this research gap by analyzing –(i) the impact of demographic and socioeconomic factors on women's Body Mass Index (BMI) including household-level food insecurity and availability of basic amenities within household premises. (ii) The adequate amount of food consumption (quantity of diet) along with diverse nutritious food (quality of food) requirements for reproductive women are quantified in the study through Monthly Per Capita Consumption Expenditure on Food (MPCE_F) and Women's Dietary Diversity Score (WDDS) respectively with its impact on women's undernutrition and overweight or obesity.

2 Methodology

2.1 Sampling Procedure

Multistage random sampling is the most suitable sampling method to study the unknown population under consideration. Instead of using a standard sample size formula, therefore the sample size is determined based on the multistage random sampling procedure in the present study. In the first stage, four districts of the state were selected on the basis of Average Per Capita Income (APCI) as measured by the Assam Human Development Report, 2014. The study aims to examine the nutritional status of reproductive age group women at the individual level, validates APCI as a basis for selection of districts under study.

Four districts of Assam were selected based on the higher and lower APCI of the districts as compared to the average APCI of Assam. The APCI of Jorhat and Sivasagar district was above the state average while Tinsukia and Lakhimpur district had APCI below the state average. In the second stage, the sample districts are classified as rural and urban. For rural samples two blocks and for urban samples two towns from each district have been selected, one being the lowest Public Distribution System (PDS) coverage and another with the highest PDS coverage. The third stage randomly selects two villages and two wards from each block and town respectively. The final stage purposively selects 10 percent of households from each village and ward having reproductive age group women. A total of 736 reproductive age-group non-pregnant women were selected as the final sample for data collection out of which 310 were rural women and 426 urban women.

2.2 Data Collection

The sample women were interviewed based on a structured questionnaire. The classical measure of anthropometry was used to collect data on height and weight of the respondents. The anthropometric rod to the nearest 0.1 cm was used to measure women's height and a portable weighing machine was used to measure their weights, after verbal permission of the sample units.

2.3 Endogenous Variables

The DBM among women can be well assessed by their Body Mass Index (BMI). BMI of women is the ratio of the weight of women (in Kg) to the height of the women squared (m^2). It is a short-run measure of nutritional status which effectively captures both underweight and overweight or obesity. The BMI cutoffs as referred to by WHO are $BMI < 18.5 \text{ kg/m}^2$ (Underweight), $18.5 \leq BMI < 25 \text{ kg/m}^2$ (Normal weight), $25 \leq BMI < 30 \text{ kg/m}^2$ (Overweight) and $BMI \geq 30 \text{ kg/m}^2$ (Obese). In the present study, overweight and obesity are combined and considered as a single category.

2.4 Predictor Variables

The nutritional status of women is influenced by multiple factors which are interconnected and complex to determine. Based on the sample population and observation, the most powerful socioeconomic and demographic indicators are considered as predictors of the dependent variable.

(a) Residential Status: The women living in rural areas are more vulnerable to adequate food and nutritional facilities due to their low income, more children and other family burden, lack of education and nutrition knowledge, and due to their higher engagement in the agricultural field. Moreover, the development of nearby towns and cities, changing production behavior of farmers, etc. also reveals a health impact on rural households as well as on rural women. The literature review reveals the impact of urbanization, changing dietary behavior, sedentary lifestyle, and lack of physical activity on increasing the risk of being overweight or obese⁽¹²⁾, especially among women⁽¹³⁾. The study thus considers 'Residential Status' as a predictor variable to assess the DBM among the sample respondents.

(b) Household Food Insecurity: There is an association between Household Food Insecurity (HFI) and the DBM⁽¹⁴⁾. The women belonging to food-insecure households have a greater probability of being overweight or obese. There is also evidence in the literature that women in food-insecure households suffer the challenges of being underweight with low BMI⁽¹⁵⁾. The United States Agency for International Development (USAID)'s Food and Technical Assistance (FANTA) project developed a 9-item Household Food Insecurity Access Scale (HFIAS) to measure the severity of household food insecurity in a developing country setting. The USAID's HFIAS has four cut-offs: food secure, mildly food insecure, moderately food insecure, and severely food insecure. The present study adopts USAID's 'HFIAS' as an explanatory variable with two categories- Food Secure (includes both food secure and mildly food insecure) and Food Insecure (includes moderately and severely food insecure).

(c) Monthly Per Capita Consumption Expenditure on Food: The maintenance of BMI has a relation with adequate consumption of nutritious food. Households' accessibility to nutritious food depends on their ability to spend on food items. However, the absolute amount of food supply or accessibility could not reflect an individual's food sufficiency. It is the Monthly Per Capita Consumption Expenditure on Food ($MPCE_F$) that determines the per capita availability of food in the household. Thus, $MPCE_F$ has implications for determining women's underweight and overweight or obesity too. The study after estimating the average $MPCE_F$ of the sample population has categorized them into two groups-one above average $MPCE_F$ and another below average $MPCE_F$.

(d) Education of Women: The level of education of women has implications on their body weight. The available literature has evidence that the challenges of overweight or obesity are higher among women with low levels of education⁽¹⁶⁾. It is expected that with an increased level of education, the knowledge of nutrition increases which results in nutritious dietary intake. A nutritious diet help maintain the person's weight⁽¹⁷⁾. The present study recognized the education of women as one of the socioeconomic

predictors of women's BMI with three categories- women with no formal education, primary level, and secondary and above.

(e) Women's Employment: Women's employment may have positive and negative impacts on their health status and maintaining body weight. There is limited literature investigating the relationship between women's employment status and their underweight and overweight. With increased employment their income increases and consumption patterns change. The consumption of processed packaged food due to shortage of time, lack of physical activity, and work pressure adversely affect their health and results in overweight or obesity among employed women. The empirical research also has evidence that with increased employment, women's decision-making power increases and empowers them to think and work accordingly to maintain a healthy body weight⁽¹⁸⁾. In the present study, the sample women engaged in regular or casual, formal or informal sector employment along with self-employment are considered as employed women and others as unemployed.

(f) Basic Amenities Index: The availability of basic facilities, especially water quality, sanitation facilities, and cooking fuel are directly related to women's health and nutrition status. The Basic Amenities Index (BAI) is the average of the aggregate water quality index, sanitation facility, and cooking fuel and is considered as a predictor of women's BMI. BAI ranges between (0-1) where 1 for the best basic amenities and zero indicates the worst basic amenities.

(g) Women's Dietary Diversity Score: There is a negative association between women's dietary diversity and their underweight status. The Women's Dietary Diversity Score (WDDS) as developed by the USIAD FANTA project measures the adequacy of micronutrients in reproductive age group women's diet. The present study measures WDDS based on 9 local food groups' consumption as per individual dietary diversity guidelines of the Food and Agricultural Organization (FAO). Thus, three consumption categories are constructed for estimating the dietary diversity score of women: Low WDDS (LWDDS) if $WDDS \leq 3$, Medium WDDS (MWDDS) if WDDS is 4 and 5, and High WDDS (HWDDS) if $WDDS \geq 6$.

(h) Age: The age of women is one of the important determinants of the prevalence of underweight or overweight among them. In the young reproductive age group (15-24 years) women are more likely to be underweight whereas at higher reproductive ages (35-49 years), they are more likely to be overweight⁽¹⁹⁾. Based on the literature review and observation during data collection of the study population, the study has selected the age (in years)' of sample women as an explanatory variable of their BMI status. The age variable is categorized as 15-24 years, 25-34 years, and 35-49 years.

(i) Household Dependency Ratio: Household Dependency Ratio (HDR) is considered as another demographic variable in the study that has an impact on women's BMI. As the number of economically inactive persons or dependents in the family increases, the food and nutritional security of the household is likely to decrease. It is the women of the household who suffer most. The higher the dependency ratio, the larger the challenges for women to meet their nutrition requirements, and more likely to be underweight⁽²⁰⁾. The present study categorized HDR as: Low HDR (0-0.49), Medium HDR (0.5-0.79), and High HDR (0.8 and above).

Thus, the predictor variables used in this study are socioeconomic and demographic in nature. The socioeconomic variables are Residential Status (RS), Household Food Insecurity (HFI), Monthly Per Capita Consumption Expenditure on Food ($MPCE_F$), Women's Education (WEdu), Women's Employment (WEmp), Basic Amenities Index (BAI) and Women's Dietary Diversity Score (WDDS). Age and Household Dependency Ratio (HDR) are two demographic variables used in the study.

2.5 Statistical Analysis

BMI is the dependent variable used in the study to assess the DBM among reproductive age group women having three categories - normal weight, underweight, and overweight or obese. The odds of being underweight or overweight are measured in reference to normal weight. The Chi-square test statistic is used to assess the DBM status among the rural and urban women of the study area.

The given dataset is analyzed statistically using multinomial logistic regression. The association between dependent and independent variables is analyzed by the odd ratio (OR) at 99%, 95%, and 90% confidence intervals (CIs). The overall p-value for the multinomial logistic regression was $p=.103$ and the model is found as a good fit to evaluate the DBM among the study population of Assam.

3 Result and Discussion

The estimated results of multinomial logistic regression Table 2 have determined the socioeconomic and demographic factors that have significantly influenced women's underweight and overweight status. In total around 40% of women in the study area are at risk of the DBM Table 1. There is a co-existence of underweight and overweight women in the study area. However, the percentage of underweight women is higher in rural areas than in urban areas. In rural areas, 29.4 % of reproductive age group women suffer the risk of being underweight which is higher than the average underweight women (22.3%) in the state. On the other hand, the severity of overweight women was 20.2% in urban areas which is higher than average overweight women

(17.7%) in the state as estimated in the present study. It is also evident from the results of regression Table 2 that the chances of urban women being underweight are .634 times less as compared to the sample rural women. This result is consistent with earlier studies that showed that the risk of underweight is higher among rural women than urban women⁽²⁰⁾.

Table 1. Percentage Distribution of sample women as measured by BMI

Residential Status	Underweight (%)	Normal Weight (%)	Overweight or Obese (%)	Test Statistics
Rural	29.4	56.5	14.2	$\chi^2 = 16.83$ p=.000 d.f=2
Urban	17.2	62.7	20.2	
Total	22.30	60.1	17.7	

Source: Author’s calculation based on field survey

Table 2. Result of Multinomial Logistic Regression for DBM as measured by BMI

Variable	Underweight (BMI<18.5Kg/m ²)				Overweight (BMI 25.0 Kg/m ²)											
	Coefficient	S E	O R	Sig.	Coefficient	S E	O R	Sig.								
RS Rural ^{RC} Urban	-.456	.222	.634**	.040	-.212	.251	.809	.398								
HFI Food Secured ^{RC} Food Insecured	.515	.220	1.674**	.019	-.375	.243	.688	.122								
MPCE _F Below Average ^{RC} Average & above	-.463	.259	.630***	.074	.579	.257	1.785**	.024								
WDDSLWDDSR ^{RC} MWDDSHWDDSH	-.388	-.638	.247	.318	.678	.116	.033	.851	.973	.395	.424	2.343**	.031	.022		
WEdu No formal edu ^{RC} Primary level Secondary & above	-.370	-.600	.427	1.014	.691	.549	.387	.554	-.872	.327	.464	1.184	1.387	.418***	.060	.782
Age (Yr) 15-24 ^{RC} 25-34 35-49	-.236	-.492	.239	.357	.790	.611	.324	.168	.895	2.163	.332	.356	2.447*	8.695*	.007	.000
HDR Low ^{RC} Medium High	.241	-.140	.281	.276	1.272	.869	.391	.612	.093	-.209	.290	.275	1.098	.811	.748	.448
BAI Low ^{RC} High	-1.658	.265	.191*	.000	.708	.579	2.029	.221								
WEmp Unemployed ^{RC} Employed	-.638	.299	.528	.033	-.427	.248	.653***	.085								
Model Fitting	$\chi^2 = 231.43$, df=26, p=.000															
Goodness of Fit	$\chi^2 = 635.96$, df=592, p=.103 (P>.05, good fit)															
Pseudo R Square	Cox & Snell=.270, Nagelkerke =.317, McFadden =.165															

Source: Author’s calculation based on field survey

*, ** and *** represent significance at 1 percent,5 percent and 10 percent respectively

The literature on the challenges of DBM at national and sub-national level, reveals a wide variation in the prevalence of underweight and overweight. Socioeconomic inequalities and geographical location affect health and nutritional status in different ways. The existing literature has discussed the impact of household wealth status on the challenges of underweight and overweight and found diverse results in different settings. In low and middle-income countries, household wealth status and women’s underweight are found to be negatively associated while women’s risk of being overweight increases with increased household-level wealth⁽²¹⁾. However, household wealth is only a component of household food security and the health status of women depends more on household food security, which is unable to be reflected by the wealth status of the household. The scientific literature on the association between household food security and DBM is found to be limited, especially for the reproductive age group women. A recent study conducted in Malaysia has not found any association between household food insecurity and the weight status of reproductive age group women⁽²²⁾. The result of the present study reflects that HFI and women’s underweight are positively and significantly associated with each other. The women belonging to food-insecure households in the study population are at a .674% higher risk of underweight as compared to the women belonging to food-secured households.

The accessibility of an adequate quantity of quality food is important for a better nutritional status. The availability and accessibility of food to an individual can be measured by MPCE_F. There is a negative association between MPCE_F and

underweight status of reproductive age group women of the study area whereas $MPCE_F$ and the risk of overweight is positively associated. With increased $MPCE_F$ women's risk of underweight decreases. It is found that 37 % (OR=.630 at 90% Confidence Interval) underweight risk of sample women decreases when their $MPCE_F$ is at the average level or above it.

Empirical research on DBM through classical and Bayesian regression in Bangladesh shows that both the challenges of undernutrition and overweight are higher among employed women due to the impact of physical activity⁽²³⁾. The results of the present study show a negative association of women's employment with their underweight and overweight status. In contrast to the above study, the present study indicates that the risk of being underweight among employed women is 47.2% lower (OR=.528 at 95% Confidence Interval) as compared to unemployed women. It was observed that the knowledge of nutrition among employed women in the study area is higher than their unemployed counterparts. The results also reveal that as women's employment increases, the risk of women's overweight reduces by 34.7%.

Women's education and its results on women's health and nutrition are evident in the literature. A study conducted in South-East Asian countries reported a positive relationship between education and the risk of being overweight⁽²⁴⁾. The study shows that the risk of being overweight is higher among urban women having higher education. In the same line, the present study also found a higher risk of overweight or obesity among urban women. However, the present study reveals a negative association between women's education and women's being overweight at a 10 percent level of significance. The women having education up to primary level are 0.418 times less likely to be overweight as compared to the women having no formal education. The scope of enlarging knowledge on nutrition, the requirement of food as per their age, and thereby proper use of the household resources are higher among the educated women and considered as beneficial to control their weight gain.

The study also indicates a negative association between the Basic Amenities Index (BAI) (as explained above) and underweight at a 99% confidence interval. As the basic amenities are available in the household premises, the women of the households can save and use their time for income-earning activities, maintaining their own food and nutritional status along with the nutrition of their children and other family members. The women belonging to the household having higher BAI have 80.9% (OR=.191, 99% Confidence Interval) lesser risk of being underweight.

The diet quality of the households or individuals is examined in literature with a proxy variable called dietary diversity. The study conducted on Kenyan women shows that dietary diversity is associated with optimal BMI of women and helps them to maintain health and nutrition status without the danger of being underweight and overweight or obese. Addressing the DBM studies also indicates that poor-quality diet consumption is a major factor in rising the global disease burden⁽²⁵⁾. In line with these previous studies, the present study also reveals adequate consumption of diverse diets as a prerequisite for reducing micronutrient deficiency. Micronutrient inadequacy results in a higher risk of underweight among women. The present study shows that women with higher dietary diversity scores i.e. higher WDDS are .507 times less likely to be underweight as compared to the reference category women with low WDDS. However, the study established a significant positive association between WDDS and the risk of overweight. In the absence of quality components in food items, absence of physical labor, sedentary lifestyle, etc. only increasing the quantity of diverse diet may increase the risk of being overweight. It is evident from the estimated regression analysis that the medium WDDS category women are 2.343 times and High WDDS women are 2.646 times more likely to be overweight as compared to the reference category women of low WDDS.

The demographic factor 'Age' of women is found to be significantly associated with women's overweight status⁽⁷⁾. Consistent with earlier studies, the present study also reveals that women's risk of being overweight increases with their increasing age. As compared to the reference category women of 15-24 years age group, 25-34 age group women are 144.7% more likely to be overweight. The present study has not found any significant relationship between the age of women and their chances of being underweight like the study conducted in South-East Asian countries which shows that underweight is higher among women of the younger age group⁽²⁴⁾. Moreover, the probability of women's overweight increases with their increasing age. The aged women of developing countries are at higher risk of being overweight⁽²⁶⁾. The present study found that 25-34 age group women are 144.7 % and women aged 35-49 years are 765.9 % more likely to be overweight as compared to the reference category women in the 15-24 years age group.

The strength of the present study on reproductive women in the context of rural and urban Assam is that it is based on a large number of socioeconomic and demographic factors that are not yet studied for women of the state. The study also has some limitations such as –(i) the study is unable to incorporate important covariates like sedentary lifestyle, physical activity, and bio-medical test of anemia among women and (ii) among reproductive women, the nutrition requirement and other physical conditions for pregnant women and lactating mothers are quite different. The study fails to put special emphasis on this group of reproductive-age group women.

4 Conclusion

The challenges of being underweight and overweight in the nutrition continuum are not distinct conditions at opposite ends. Both the challenges of DBM may occur simultaneously among the reproductive age group women. The result of the study highlights both household level and individual factors affecting this twin burden of malnutrition. Household food insecurity and lack of basic amenities with lack of education and employment among rural women are increasingly affecting 29.4 % of rural women in the study area. The result of the study suggests that in the era of nutrition transition, increasing overweight or obesity is affecting both rural and urban women which is comparatively higher among urban women (20.2%) as compared to rural women (14.2%). The results of the study articulate the need for attention to the problem of DBM among reproductive age group women of the state of Assam. The co-existence of underweight and overweight among women in the state needs to be removed or minimized through proactive measures. The underweight among women, especially rural women necessitate strategic interventions like improvement of household food security and dietary diversity of rural women. The state government should emphasize on creating basic facilities of water, sanitation, and cooking fuel which indirectly help to improve the nutritional status of women by saving time and creating opportunities to maintain their health and nutrition status. The strategies for preventing both underweight and overweight women are complex and challenging to address. The problem of overweight women necessitates greater awareness of the consumption of quality diverse diets under the pressure of changing consumption patterns and nutrition transition. To combat the challenges of being underweight and overweight at a time more technical and specific programs and interventions need to be adopted. There is also a need for more integrated policies of the state and central government to face the challenges of DBM among women. In-depth research into this challenging health and nutritional issue of women is the need of the time to explore different related facts and issues and thereby implement strategic policies and interventions.

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References

- 1) Tanwi TS, Chakrabarty S, Hasanuzzaman S. Double burden of malnutrition among ever-married women in Bangladesh: a pooled analysis. *BMC Women's Health*. 2019;19(24):1–8. Available from: <https://doi.org/10.1186/s12905-019-0725-2>.
- 2) Ikoona EN, Toure MA, Njeng A, Namuleno L, Kaluya R, Kamar K, et al. Prevalence and factors associated with underweight among 15–49-year-old women in Sierra Leone: A secondary data analysis of Sierra Leone demographic health survey. *BMC Women's Health*. 2023;23:1–16. Available from: <https://doi.org/10.1186/s12905-023-02358-4>.
- 3) Melchor I, Burgos J, Campo AD, Aiartzagüena A, Gutiérrez J, Melchor JC. Effect of maternal obesity on pregnancy outcomes in women delivering singleton babies: a historical cohort study. *Journal of Perinatal Medicine*. 2019;47(6):625–630. Available from: <https://doi.org/10.1515/jpm-2019-0103>.
- 4) Cooper AJ, Gupta SR, Moustafa AF, Chao AM. Sex/Gender Differences in Obesity Prevalence, Comorbidities, and Treatment. *Current Obesity Report*. 2021;10:458–466. Available from: <https://doi.org/10.1007/s13679-021-00453-x>.
- 5) National Family Health Survey (NFHS-5). Available from: https://main.mohfw.gov.in/sites/default/files/NFHS-5_Phase-II_0.pdf.
- 6) Dutta M, Selvamani Y, Singh P, Prasad L. The double burden of malnutrition among adults in India: evidence from National Family Health Survey-4(2015–16). *Epidemiology and Health*. 2019;41:1–11. Available from: <https://doi.org/10.4178/epih.e2019050>.
- 7) Kavitha N. Double burden of malnutrition among women in the reproductive age group in India and factors influencing malnutrition. *International Journal of Advance Research and Innovative Ideas in Education*. 2022;8(4):2184–2190. Available from: http://ijariie.com/AdminUploadPdf/Double_Burden_of_Malnutrition_among_women_in_the_reproductive_age_group_in_India_and_Factors_influencing_Malnutrition_ijariie18056.pdf.
- 8) Singh S, Shri N, Singh A. Inequalities in the prevalence of double burden of malnutrition among mother child dyads in India. *Scientific Reports*. 2023;13:1–13. Available from: <https://doi.org/10.1038/s41598-023-43993-z>.
- 9) Malik R, Puri S, Tulsi A. Double burden of malnutrition among mother-child DYADS in urban poor settings in India. *Indian Journal of Community Health*. 2018;30(2):139–144. Available from: <https://doi.org/10.47203/IJCH.2018.v30i02.008>.
- 10) Jayalakshmi R, Kannan S. The double burden of malnutrition: An assessment of “stunted child and overweight/obese mother (SCOWT) pairs” in Kerala households. *Journal of Public Health Policy*. 2019;40(3):342–350. Available from: <https://doi.org/10.1057/s41271-019-00172-7>.
- 11) Melissa FY, Phuong N, Mai TL, Rasmi A, Purnima M. A Double Edged Sword? Improvements in Economic Conditions over a Decade in India Led to Declines in Undernutrition as Well as Increases in Overweight among Adolescents and Women. *Journal of Nutrition*. 2020;150(2):364–372. Available from: <https://doi.org/10.1093/jn/nxz251>.
- 12) Jayalakshmi R, Sewor C, Kannan S. Intraindividual double burden of malnutrition among women (15–49 years) in India, Myanmar, and Nepal: evidence from the recent Demographic and Health Surveys. *European Journal of Clinical Nutrition*. 2023;77(5):603–610. Available from: <https://dx.doi.org/10.1038/s41430-023-01269-9>.
- 13) Popkin BM, Ng SW. The nutrition transition to a stage of high obesity and non-communicable disease prevalence dominated by ultra-processed foods is not inevitable. *Obesity Reviews*. 2022;23(1):1–18. Available from: <https://doi.org/10.1111/obr.13366>.
- 14) Moshia D, Paulo HA, Mwanjika-Sando M, Mboya IB, Madzorera I, Leyna GH, et al. Risk factors for overweight and obesity among women of reproductive age in Dar es Salaam, Tanzania. *BMC Nutrition*. 2021;7(1):1–10. Available from: <https://doi.org/10.1186/s40795-021-00445-z>.
- 15) Harper A, Goudge J, Chirwa E, Rothberg A, Sambu W, Mall S. Dietary diversity, food insecurity and the double burden of malnutrition among children, adolescents and adults in South Africa: Findings from a national survey. *Frontiers of Public Health*. 2022;10:1–10. Available from: <https://doi.org/10.3389/fpubh.2022.891111>.

[//doi.org/10.3389/fpubh.2022.948090](https://doi.org/10.3389/fpubh.2022.948090).

- 16) Kroger H, Leopold L. Education differences in women's body weight trajectories: The role of motherhood. *PLoS ONE*. 2020;15(9):1–23. Available from: <https://doi.org/10.1371/journal.pone.0236487>.
- 17) Ahmed HM, Hameed AL. Association between women's level of education and family daily nutrient intake and obesity status in Iraq. *Medical Journal of Babylon*. 2021;18(2):95–101. Available from: https://doi.org/10.4103/MJBL.MJBL_102_20.
- 18) Wei W, Sarker T, Roy R, Sarkar A, Rabbany MG. Women's empowerment and their experience to food security in rural Bangladesh. *Sociology of Health and Illness*. 2021;43(4):971–994. Available from: <https://doi.org/10.1111/1467-9566.13273>.
- 19) Sisha TA. Household level food insecurity assessment: evidence from panel data, Ethiopia. *Scientific African*. 2020;7:1–9. Available from: <https://doi.org/10.1016/j.sciaf.2019.e00262>.
- 20) Biswas S, Pramanik KR, Sonowal CJ. Marginalized social groups differentials in nutritional status (BMI) among reproductive-aged women in West Bengal. *BMC Public Health*. 2023;23:1–18. Available from: <https://doi.org/10.1186/s12889-023-15635-6>.
- 21) Alem AZ, Yeshaw Y, Liyew AM, Tessema ZT, Worku MG, Tesema GA, et al. Double burden of malnutrition and its associated factors among women in low and middle-income countries: Findings from nationally representative data. *BMC Public Health*. 2023;23:1–16. Available from: <https://doi.org/10.1186/s12889-023-16045-4>.
- 22) Hamid SBA, Razali MFM, Suhaimi FA, Nor NM. Association of Food Insecurity and Weight Status of Women in Tuba Island, Malaysia. *Current Research in Nutrition and Food Science Journal*. 2021;9(2):441–449. Available from: <http://dx.doi.org/10.12944/CRNFJS.9.2.08>.
- 23) Hossain MI, Rahman A, Uddin MSG, Zinia FA, Rahman A. Double burden of malnutrition among women of reproductive age in Bangladesh- A comparative of classical and Bayesian logistic regression approach. *Food Science and Nutrition*. 2023;11(4):1785–1796. Available from: <https://doi.org/10.1002/fsn3.3209>.
- 24) Biswas T, Magalhaes RJS, Townsend N, Das SK, Mamun A. Double Burden of Underweight and Overweight among Women in South and Southeast Asia: A Systematic Review and Meta-analysis. *Advances in Nutrition*. 2020;11(1):128–143. Available from: <https://dx.doi.org/10.1093/advances/nmz078>.
- 25) Tyagi N, Chariar VM. Addressing the Dual Burden of Malnutrition: A Review of Double Duty Actions and Multifaceted Approaches. *Biomedical Journal of Scientific & Technical Research*. 2023;51(4):42870–42878. Available from: <https://biomedres.us/pdfs/BJSTR.MS.ID.008129.pdf>.
- 26) Chowdhury SR, Islam MN, Sheekha TA, Kader SB, Hossain A. Prevalence and determinants of non-communicable diseases risk factors among reproductive-aged women: Findings from a nationwide survey in Bangladesh. *PLOS ONE*. 2023;18(6):1–19. Available from: <https://doi.org/10.1371/journal.pone.0273128>.