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Impact of Maternal Conditions on The Nutritional Health of Children in India

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ABSTRACT

Background: The 2020 Global Nutrition Report by UNICEF highlights the high rate of deaths among children under five years of age, with India being one of the top five countries. Studies suggest that more than half of these early child deaths are attributable to malnutrition and its associated diseases, particularly in the case of countries with extreme poverty, scarcity of essential resources, lack of appropriate education, and wide disparities of wealth.

Objective: While several studies highlight the general nutritional determinants, literature lacks empirical investigation on details of the influencing factors. In this paper we address this gap and specifically explore the variables of wealth and maternal influences.

Methods: Using the Demographic and Health Survey (DHS) data set of 1,40,471 observations of children 2-5 years old, we employ Dietary Diversity Score (DDS) and Multiple Linear Regression (MLR) analysis to investigate the association between various influencing factors.

Result: The findings suggest that the wealth index of the household does not directly impact the DDS of children. Rather, in high wealth index households, the DDS of a female child tend to be lower than that of a male child. However, this difference tends to narrow with mothers' higher levels of education. Further, we found maternal health to be a key determinant of the nutritional status of children.

Conclusion: These findings together bring out the fact that the wealth index of households does not contribute to the nutritional status of children unless the mothers have formal education and awareness to leverage the available wealth to provide adequate and diverse food to the children irrespective of their gender. Besides, maternal education would result in enhancing maternal health which would in turn influence a child's nutritional status positively. Lastly, we conclude that facilitation of various health care facilities to women, indirectly and eventually leads to better nutritional intake for the child. These contributions are all the more significant in the current context of COVID-19 as poor countries face worsening of food security for underprivileged children.

Introduction

Children malnutrition, like many other health outcomes, forms a multifaceted problem appear in triple burden namely undernutrition, micronutrient deficiencies, and overweight or obesity [1]. Malnutrition in its all forms primarily occurs due to the lack of nutritional adequacy in terms of limited or absence of consumption of diverse nutrients on a regular basis, characterized as imbalanced or bulky diet [2-4]. Malnutrition or lacking nutritional diet impairs the activity of immune cells and antibodies (HARVARD, 2021). This in turn reduce a child's immunological outcomes to

tackle infectious diseases such as acute respiratory infections and diarrheal diseases, alongside with weight loss, mucosal damage, invasion by pathogens and further cause reduced dietary intake which could hamper a child's growth and overall development [5,6]. Furthermore, the prevalence of malnutrition in a child might result in mental illness including eating disorders such as anorexia nervosa (AN) and bulimia nervosa (BN) [7-9], and malabsorption and maldigestion of the food consumed [10,11]. Consequently, malnutrition in a child, if not addressed appropriately, could lead to severe damage to a child's health and even mortality. Hence, malnutrition gets regarded as one of the major impediments to child well-being affecting all areas of a child's physical and mental health, body immunity, growth, and development [12,13].

The adverse consequences of malnutrition on health status of children compel us to understand the influencing factors of malnutrition in children. Existing literature demonstrates malnutrition and its associated diseases to occur due to factors like maternal health, faulty childcare, less access to health care facilities, lack of sanitation, and hygienic facilities and large economic disparities [14-17]. In this paper we investigate the maternal factors that influence the dietary adequacy and further, nutritional status of children. Evidence shows that maternal adverse physical health associated diseases such as anemia during pregnancy are strongly associated with a child's poor nutritional status and developmental outcomes [18,19]. Maternal malnutrition poses serious health effects on fetus or intrauterine growth retardation and increase the risk of poor pregnancy outcomes such as premature or low-birthweight babies and impairs the innate host defense mechanism, and further, diminishing the immune system of the body. This in turn leads to increasing susceptibility to infections associated with decreasing appetite, and consequently, causing child's poor dietary intake which aggravate the risk of malnutrition in a [20-23]. Moreover, a child's dietary pattern, particularly at the young age, is primarily similar to the maternal dietary intake in a household [24]. Hence, due to this similarity in dietary patterns consumption, a malnourished mother with restricted nutritious or poor-quality dietary pattern strongly increases the risk of poor nutritional dietary consumption of a child and further increase the risk of malnutrition and its associated diseases in every phase of the childhood life [25,26]. Studies also emphasize the importance of maternal education as an essential intervention in promotion of a child's optimal health outcomes and nutritional status [27].

While several studies highlight the general determinants in maternal characteristics for children, existing literature lacks an empirical investigation on details of the maternal influencing factors including inequalities in terms of maternal health, healthcare activities, and maternal knowledge. This study attempts to address this gap and specifically explore the influence of inequalities in maternal characteristics in association with factors such as gender, wealth index, and child's anthropometric measurements on the nutritional status of a child, in the context of India.

Materials and Methods

Data from the Demographic and Health Survey (DHS) were utilized. The data set includes key information for 2.5 lakhs children in India, including each child's household and maternal characteristics, among others. 1340 variables were investigated, and 219 variables included as relevant for the study. Missing values in the data set are included using predictive mean matching which replaces the missing values according to the distribution of each datapoint. In the final analysis 1,40,471 data points were taken, which consisted of children in the age range of 2-5 years.

Dietary Diversity Score (DDS) forms the indicator for nutritional adequacy status. Dietary Diversity is defined as the number of different foods or food groups consumed in the previous day [28]. DDS was calculated by summing the number of times a unique food group was consumed during the last 24 hours. Food groups considered were cereals/roots, vegetables, fruits, legumes/lentils, high protein food, and milk/dairy products. DDS takes into account the quantity of any food group eaten that day. In other words, DDS gets calculated by considering the number of times a food group is eaten that day and not considers a minimum intake for that food group. The DDS ranges from 0 to 6. As an effective indicator of nutritional status, DDS forms the dependent variable in our study. The independent variables in the study have been presented in Table 1.

Statistical Analysis

Multiple Linear Regression (MLR) analysis investigates the association between the DDS and the independent variables presented in Table 1. The assumptions of normality, linearity and homoscedasticity were checked in order to ensure the validity of all the regression models. Further, as the number of variables is high, Akaike Information Criteria (AIC) was used to narrow down to a set of uncorrelated variables, thereby avoiding the issue of multicollinearity. Backward and forward stepwise regression analysis on all the variables with DDS as the dependent variable gave 78 variables as uncorrelated and has some influence on DDS. To address the research objective of the present study we adopted the variables presented in Table 1, among the 78 independent variables. Moreover, to ensure that the stepwise regression extracted variables were uncorrelated, bivariate correlation analysis was run as well. The correlation analysis suggested no significant correlation between any pair.

Result

Three regression models were constructed to understand the interaction of the variables (Table 1) with DDS. We probe the association in two ways, first in the presence of all the variables

represented by an overall model and second, through the interaction of independent variables with various sub-groups of children through DDS. These sub-groups include gender and anthropometric measurements (height for age, weight for height, weight for age). The independent variables are regressed with DDS of 1,40,471 children.

Table 1: Independent variables used in the regression model.

Independent Variables			Nature of Variables	Literature
Socioeconomics		Wealth index	Categorical	Hong & Mishra (2006) [29]
Child's physical health		Anthropometric measurements	Categorical	Ahmadi et al. (2018) [30]
		Child's Anaemia level	Categorical	Abu-Ouf & Jan (2015) [31]
Child's biological characteristic		Gender	Categorical	Jackson & Jackson, (2017); Ratsavong et al. (2020) [32,33]
Maternal conditions	Maternal physical health	Maternal Anaemia level	Categorical	Allen (2000) [34]
		Anthropometric measurements	Numerical	Doak et al. (2016); Li et al. (2020) [35,36]
	Maternal mental health	Current marital status	Categorical	Blankenship et al. (2020) [37]
	Maternal healthcare activities	Healthcare activities	Categorical	Kearns et al. (2016) [38]
	Education level	Education level	Categorical	Fadare et al. (2019) [39]

Table 2 shows the association between DSS and the maternal physical health in terms of anemia level and anthropometric measurements. Variables are regressed for an overall analysis and specific interaction of maternal physical heath factors with various sub-groups of children, including gender, wealth index and anthropometric measurements (height for age, weight for height, weight for age). Table 3 shows that the association between the maternal mental health in terms of marital status, and the DDS of children. An overall model and a model for interaction of maternal mental health factors with various sub-groups of children is developed. These sub-groups include gender, wealth index, and anthropometric measurements (height for age, weight for height, weight for age). Table 4 shows that the association between the maternal healthcare activities in terms of pregnancy duration, number of antenatal visits during pregnancy, baby's postnatal check-up within 2 months, during pregnancy given or bought iron tablets syrup, and maternal knowledge in terms of highest educational level (primary, secondary, or higher) and the DDS of children. An overall model and another model to see the interaction of maternal healthcare activities and knowledge factors with various sub-groups of children is developed. These sub-groups include gender, wealth index, and anthropometric measurements (height for age, weight for height, weight for age).

Table 2: Regression Analysis for maternal physical health factors.

DDS	Maternal Physical Health Factors						
	Anaemia Level				Anthropometric Measurements		
	Maternal Anaemia level- 2 (Moderate)Base Variable: Severe		Maternal Anaemia level- 3 (Mild)Base Variable: Severe	Maternal Anaemia level- 4 (Not Anaemic) Base Variable: Severe	Maternal Height (cm)	Maternal Weight (kg)	Arm Circumference
Overall	0.008		-0.046	-0.039	0.001**	< 0.01***	0.017**
Gender	Male	0.029	-0.02	-0.017	0.001**	< 0.01*	0.019**
	Female	-0.013	-0.073	-0.062	0.001**	< 0.01**	0.014**
Wealth index	High	0.001	-0.084	-0.066	0.001***	< 0.01**	0.017**
	Low	0.044	-0.004	0.002	0.001**	< 0.01	0.016**
Height for age	Stunted	-0.034	-0.084	-0.057	0.001**	< 0.01**	0.023**
	Normal	0.043	-0.018	-0.023	0.001**	< 0.01	0.013**
Weight for height	Wasted	0.022	-0.056	-0.071	0.001**	0	0.019**
	Overweight	0.338**	0.156	0.18	0.001**	< 0.01	0.008
	Normal	-0.021	-0.061	-0.05	0.001**	< 0.01	0.017**
Weight for age	Underweight	-0.009	-0.069	-0.057	0.001**	0.000***	0.022**
	Overweight	0.211	0.07	0.077	0.001***	< 0.01	0.009
	Normal	0.004	-0.038	-0.034	0.001**	< 0.01	0.015**

Table 3: Regression analysis for maternal mental health factors.

DDS		Maternal Mental Health			
		Marital Status			
		Current Marital Status- 1 (Never married nor lived in a consensual union) Base Variable: Legally or formally married	Current Marital Status- 3 (Not legally or formally married but living with a man/woman in a consensual union) Base Variable: Legally or formally married	Current Marital Status- 4 (Widowed from a marriage or consensual union and not remarried or not in a consensual union) Base Variable: Legally or formally married	Current Marital Status- 5 (Divorced from a legal or formal marriage and not remarried or in a consensual union) Base Variable: Legally or formally married
Overall		0.220*	0.191	0.064	0.134
Gender	Male	0.271	0.261	0.159	0.149
	Female	0.183	0.13	-0.017	0.125
Wealth index	High	0.099	0.041	-0.058	0.128
	Low	0.065	0.028	-0.047	0.001
Height for age	Stunted	0.235	0.125	0.044	0.045
	Normal	0.221	0.25	0.078	0.204
Weight for height	Wasted	0.530*	0.515	0.348	0.414
	Overweight	0.49	0.623	0.77	0.189
	Normal	0.136	0.085	-0.038	0.078
Weight for age	Underweight	0.226	0.157	0.061	0.064
	Overweight	0.401	0.481	0.371	0.087
	Normal	0.193	0.173	0.029	0.182

Table 4: Regression analysis for maternal mental health factors.

DDS		Maternal Healthcare and Knowledge						
		Health Care Activities				Education level		
		Pregnancy duration	Number of antenatal visits during pregnancy- 1 (Yes)Base Variable: No	Baby's postnatal check-up within 2 months- 1 (Yes)Base Variable: No	During pregnancy given or bought iron tablets syrup- 1 (Yes)Base Variable: No	Highest educational level- 1 (Primary) Base Variable: No education	Highest educational level- 2 (Secondary) Base Variable: No education	Highest educational level- 3 (Higher)Base Variable: No education
Overall		0.019**	0.008**	0.027***	0.006	0.042***	0.128**	0.226**
Gender	Male	0.022***	0.008**	0.015	0.002	0.046**	0.144**	0.249**
	Female	0.012	0.008**	0.036***	0.01	0.037*	0.112**	0.200**
	No	0.018**	0.009***	0.022**	0.004	0.051***	0.124**	0.215**
Wealth index	High	0.032*	0.009**	0.040**	0.48	0.031	0.147**	0.234**
	Low	0.003	0.009**	0.016	-0.005	0.036*	0.109**	0.201**
Height for age	Stunted	0.051***	0.009***	0.017	0.021	0.055**	0.118**	0.229**
	Normal	-0.006	0.008***	0.030**	-0.005	0.034*	0.136**	0.225**
Weight for height	Wasted	0.013	0.006**	0.016	0.043	0.015	0.130**	0.200**
	Overweight	-0.059*	0.008**	0.037	0	0.068	0.170**	0.394**
	Normal	0.026**	0.008**	0.026**	-0.002	0.047*	0.125**	0.215**
Weight for age	Underweight	0.053***	0.007***	0.014	0.025	0.041*	0.121**	0.188**
	Overweight	-0.057	0.007*	0.032	0.011	0.118**	0.178**	0.394**
	Normal	0.003	0.009***	0.031**	-0.006	0.034*	0.129**	0.230**

Discussion

An overall significant relationship exists between a maternal physical health in terms of mother's anthropometric measurements including height, weight, and arm circumference, and the child's nutritional diversity. While the mother's level of anemia (long term health status) does not significantly impact the child height and weight, but the maternal anthropometric measurements are significantly related to indicators of her nutritional status which in turn exclusively indicates a child's nutritional status. Maternal weight and DDS of children belonging to high wealth index households have a positive significant association. High wealth index contributes to better diet quality due to affordability of varied diverse food. Thus, inclusion of diverse nutritional food in a mother's diet, significantly increases the likelihood of a child consuming these nutrients, which would eventually lead to a better DDS [40,41]. However, in case of low wealth index households, even when the mother demonstrates good health, food insecurity and low affordability persists, depriving a child of necessary nutrients, influencing their DDS negatively. With regard to a child's postnatal check-up, we see a positive influence on the DDS of children belonging to high wealth index households. Higher wealth index provides better accessibility and availability to health care services, contributing to beneficial health outcome for children. On the other hand, low wealth index households have difficulty in affording quality health care and thus, post-natal health care access does not significantly contribute to better nutritional outcomes in terms of DDS.

Moreover, the results indicates that the baby's postnatal check-up positively effect on the DDS of children with normal anthropometric measurement (height for age, weight for height, weight for age). The postnatal check-up helps to ensure the child's optimal health status through measuring and record of weight, height, growth and development progress and other important health information. Hence, the health check-up used to monitor a child growing process and in the certain conditions of a child's illness help to prevent and treat health complications including maternity services support related to breastfeeding and childcare practices [42,43]. Consequently, this can contribute to maintain and improve a child's health status as well as nutritional status and thus, leading to better DDS, rooted in proper dietary intake of healthy children.

As compared to married marital status, an unmarried mother is more likely to positively influence a child's DDS. This corroborates the findings of some studies [44] that unmarried mothers spend equivalent amounts of time on childcare activities including feeding, healthcare and rearing and less time on housework compared to married mothers. Number of antenatal visits during pregnancy are important in improving the DDS of children. The WHO recommends at least eight antenatal visits during pregnancy to treat problems and for immunization. The antenatal visits ensure health of a mother and in turn promote the nutritional status of a baby. Further, the baby's postnatal check-up and DDS have a positive association. Postnatal care ensures a baby's optimal care as well as the health practices like vaccination. This contributes to improving a child's health with positive long-term consequences.

Maternal education is significantly positively associated with a child's DDS. Maternal education influences a positive attitude towards health-seeking behaviour including awareness of child's immunization, causes of illness, and essential awareness of prevention, and treatment of diseases. Therefore, maternal knowledge regarding nutritious diet also significantly helps to maintain a child's heath.

Conclusion and Implications

The findings together clearly bring out the fact that the wealth index of households does not contribute to the nutritional status of children unless the mothers have formal education and awareness to leverage the available wealth to provide adequate and diverse food to the children irrespective of their gender. Moreover, the findings affirm the significance of maternal health on a child's nutritional status. Thus, combined together, these finding asserts the importance of welfare of mothers in terms of facilitation of proper health care and quality education for better nutritional status of children. Hence, an urgent call for policies promoting the health and education of women across the country gets highlighted. The benefits of such policies would be two folds including promotion of health and well-being of mothers which would ultimately result in them providing better health care to the children thereby improving their nutritional status.

Lastly, the results contends that a mother's accessibility to healthcare facilities have a considerable impact on a child's DDS as it helps in tackling various health issues that might lead to poor nutritional intake and hence poor DDS. Thus, health policies nationwide must lay an exclusive focus on providing better accessibility to healthcare facilities for women in order to improve the nutritional intake of a child. Hence, in the essence our study contributes to the health policy by implying the importance of maternal health and education, proper environmental condition, and better accessibility to health care facilities in ensuring better nutritional intake of children and thus, tackling the alarming situation of malnutrition in India.

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Disclosure of Interest

The authors report no conflicts of interest.

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