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Socioeconomic Determinants of Childhood Obesity in India: An Empirical Study Using Nfhs-5

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Abstract

Introduction: Good health is considered the most important wealth a human can have. But nowadays, due to the transitional changes in the economy, changing job roles, and food habits, the majority of the world's population is leaning towards an idle, sedentary lifestyle. Obesity is a health condition characterized by excessive accumulation of fat, especially in the lower abdomen area, with respect to the specific age and gender of an individual. **Objective:** The current study aims to find socioeconomic correlates of childhood obesity in India. **Data:** This study uses data from the 5th cycle National Family Health Survey (2019-2021) conducted by the Ministry of Health and Family Welfare (MoHFW). For analysis, 'Children Recode File' (IAKR7EFL) is utilized in STATA format. After omitting the missing entries from every variable used in the model, a total of 582 children are considered for obesity analysis. **Methods:** Ordered Logit Regression is run, accounting for three categories of obesity: non-obese, mildly obese, and severely obese. Odds ratios are estimated to check the probability of the occurrence of childhood obesity. Marginal effects are then calculated to get the incidence of category-specific obesity. **Result and Discussion:** Haemoglobin level of mothers has a slightly unfavourable effect on obesity, the marginal effect of that variable is positive in the non-obese category but is negative in mild obesity and severe obesity. Both Hindu and Muslim households have unfavourable but significant effects on obesity. Receiving PNC turns out to be an unfavorable variable in occurring obesity. Moving from medium birth order to low birth order decreases the possibility of obesity. Both very low and medium birth intervals cause the incidence of childhood obesity. Proper and sufficient breastfeeding can cut down the probability of obesity in children. Lastly, low antenatal care accounts for a lower possibility of children being obese. Thus, the reasonable and permissible effort from the public authority for such controllable causes can be the way forward towards the reduction of obesity in the future generation of the country.

Keywords: Childhood Obesity, Sedentary Lifestyle, Severely Obese
JEL Classification: I12, J13, O15

1. INTRODUCTION

It is no dilemma that health is the greatest wealth. People across the world differ by region, religion and ethnicity, but will surely assemble to priorities a healthy and disease-free life on top of the list. But nowadays, due to transitional changes in the economy, changing job roles and food habits, the majority of the world population is leaning towards an idle, sedentary lifestyle. Lack of proper physical activities and

an increase in consumption of unhealthy food are making the young lives disease-prone and less immune. People from the older generation used to consume more nutritious food and engage in more physical activities, leading them to enjoy a simple but healthy life. But in recent times, people are better in terms of technology and availability of resources which, in return, are making them static.

Obesity is a health condition characterized by excessive accumulation of fat, especially in the lower abdomen area, with respect to the specific age and gender of an individual. This phenomenon, starting from being overweight, has several reasons from genetic inheritance to modern sedentary life-style and from frequent consumption of packaged food and fast food to not getting proper nutrition due to poverty. Inequality possesses low correlation with obesity as it is seen in almost every income group. In modern days, children from a very young age are becoming obese. According to the Centre for Disease Control and Prevention, child obesity occurs when body mass index (BMI) of a child of a particular age and sex exceeds 95th percentile based on the 2000 CDC growth chart. Occurrence of child obesity is estimated to be worldwide over 22 million under the age of 5 (**Kosti, et al., 2006**). Recent studies have raised concern on increasing rate of child obesity. A study in US through national surveys from 1960s to 1990s confirmed the increasing case of overweight children from 5 per cent to 11 per cent (**Ogden, et al., 1997**). Another study showed that in US from 1999 to 2002, among children aged 6, 31 per cent were overweight and 16 per cent were obese (**Hedley, et al., 2004**). Asian countries show no exception in this case. A study in China shows that children experienced a notable increase in obesity from 1997 to 2011 among both boys and girls (**Wang, et at., 2017)**. A similar study conducted in Kerala district in India from 2003 to 2005 showed an increasing time trend in prevalence of overweight (including obesity) from 4.94 per cent to 6.57 per cent. Also, incidence of being overweight is more among the children of 5-11 years than that of the children of 12-16 years in 2003 and 2005. Again, it was evident that private schools had more overweight children than that of government schools. In urban areas 4.5 per cent children are overweight while 1.4 per cent children are obese (**Raj, et at., 2007**).

Increasing cases of overweight and obesity among child and adolescents create a direct threat to productivity of labour in future India. A study in US explained factors like absenteeism and presenteeism in work place, disability and premature mortality to be directly and indirectly caused by overweight and obesity (**Hammond, et al., 2022**). All these factors affect labour productivity in workplaces. A study remarked that addition of physical and mental conditions further stimulates the effect of obesity on absenteeism (**Frone, 2007**). These conditions are partly caused by obesity where obesity results in psychological abnormalities, poor self-perception and depression among young adults (**Ackard, et al., 2003; Herva, et al., 2006**). A study in North American division of Shell Oil Company found that 3.73 additional days of work were lost per year of each obese employee compared to those who had normal weight (**Tsai, et al., 2008**). Another study stated that possibility of obesity were 1.23 times more likely to be in the 'higher absenteeism' group than those who were not (**Serxner, et al., 2001**). Researchers have found that obese workers were 134 per cent more likely to use paid time off than their non-obese counterparts (**Durben, et al., 2008**). A study listed estimates of nation-wide annual productivity losses ranging from $3.38 billion to $6.38 billion due to obesity related absenteeism (**Trogdon, et al., 2008**).

Obesity may also result in loss of productivity while being present in their workplaces. This can probably happen due to adverse physical and mental conditions caused by obesity (**Hammond, et al., 2022**). Addressing this problem, a study showed that obese workers are likely to lose more productive time than their non-obese colleagues (**Ricci, et al., 2005**). Another study found correlation between presenteeism due to obesity and interpersonal relationship with colleagues in workplace (**Pronk, et al., 1999**).

Another form of productivity loss occurs due to premature mortality and loss of quality-adjusted life years, which are found to have relations with obesity (**Trogdon, et al., 2008**; **Hammond, et al., 2022**). A recent study found that BMI has a relation with years of life lost (YLL) where YLL follows a J-shaped and U-shaped distribution across different BMI categories (**Fontaine, et al., 2010**). These factors are considered as severe economic impacts of obesity and can significantly decrease productivity (**Groessel, et al., 2004**). Another economic impact of obesity is the increasing annual medical cost. A study considered obesity to be effective for causing diseases like, hypertension, hypercholesterolemia, type 2 diabetes mellitus, CHD, and stroke. The result of this study showed that obese people had 36 per cent higher average annual health care costs than those of non-obese people, including 105 per cent higher prescription costs and 39 per cent higher primary health care costs (**Thompson, et al., 2001**). Another study in Minnesota, USA, compared total medical care charges over an 18-month period across BMI categories and concluded that a unit increase in BMI causes a 1.9 per cent increase in median medical spending during the study period (**Wolf, 2002; Pronk, et al., 1999**).

Reasons for Child Obesity

It is evident from earlier studies that an increase in obesity is strongly backed by changes in energy consumption patterns and imbalance of energy intake and energy expenditure, which is closely associated with sedentary lifestyle and daily diet (**Choudhury, et al., 2015**). However, there are studies showing a marginal effect of genetics in determining obesity within children. It is found that body mass index (BMI) is 25 per cent to 40 per cent heritable (**Anderson, et al., 2006**). But genetic factors often need to be associated with other environmental and behavioural factors as genetics might play a role in developing obesity in children, but not in sustaining (**CDC Report, 2010**). Parental gene accounts for less than 5 per cent of cases of childhood obesity (**Anderson, et al., 2006**).

Reviewing the literature has come up with the fact that recent behavioural factors like preferring unhealthy packaged food, very frequent intake of fast food and lack of energy expenditure are the major causes of the increasing incidence of obesity among children. And in this regard, parental obesity holds a strong correlation with that of children. Non-obese children aged 1-2 years with non-obese parents have 10 per cent chance of getting obese in adulthood, while children in the same age group with at least one obese parent have 28 per cent possibility of getting obese in adulthood. This figure worsens in case of children aged 3-5 years, whereas children with at least one obese parent have 62 per cent chance of being obese in comparison with 24 per cent chance of obesity in adulthood with children from non-obese parents (**Whitaker, et al., 1997**).

Obesity can be a cause of the absence of important micronutrients in children. A recent study has shown that deficiency of several micronutrients like, Iron, Folic acid, Vitamin B12 and Vitamin D from a very young age is strongly associated with the incidence of child obesity. These could be a result of poor nutritional intake (**Calcaterra, et al., 2023**). A drastic change in dietary intake from plant-based nutritious food to ready-made junk foods has set a trend of getting obese from a very young age while a sedentary lifestyle and lack of physical activity among young ones have contributed in sustaining their obesity through their adulthood. Studies in the US and Canada found some key factors causing excessive weight gain in adolescents and young adults, including shifting their food preference from vegetables, milk, and eggs to carbonated and artificially sweetened beverages, salty snacks, preserved foods and cheese (**Roblin, 2007**). In India, with economic development, several studies have recorded a prominent change in nutritional intake. Changes in eating habits like replacing white rice with brown rice, over-consuming refined/processed food, carbohydrate-rich diet and increasing use of vegetable oil have significantly pulled

down the overall level of nutrition (**Choudhary, et al., 2023**). Examining the dietary pattern in India, a study found that Indians, irrespective of urban and rural residents, take more than the prescribed amount of cereals and the intake of processed food does not depend on poverty level (**Sharma, et al., 2020**). Another study in India showed that megacities like Delhi are characterized by a larger number of fast-food outlets and full-service restaurants, which is elevating poor dietary intake, followed by increasing cases of overweight and obesity (**Patel, et al., 2018**). Another study using several studies has constructed a linkage between unbalanced food inflation and consumption of calorie-dense food and beverages. In and around 1980s, prices of high calorie foods have decreased relative to low-calorie foods. Another argument captured the food price inflation where from 1985 to 2000 prices of fresh fruit, vegetables, fishes, and dairy products have risen by 118 per cent, 77 per cent and 56 per cent respectively while that of sugar and sweets, fats and oils and carbonated beverages have risen at a lower rate – 46 per cent, 35 per cent and 20 per cent respectively. This indicated the betterment in technologies in processed food production that lowered the prices of calorie-dense foods, ultimately causing over-consumption of packaged and processed foods (**Finkelstein, et al., 2005**).

As discussed earlier, energy imbalance in children possesses great significance in determining childhood obesity, especially in recent times. Environmental changes associated with changing lifestyle can possibly be seen through factors like: the food market, the built environment, schools and day care and parental behaviour (**Anderson, et al., 2006**). The availability of packaged food and preserved snacks is increasing day by day. These types of food are very popular as well as cheap options to mitigate short-term cravings among children and young adults. An increasing number of fast-food joints and restaurants create easier and faster choices for consuming calorie-dense food (**Chou, et al., 2004**). Another possible reason of child obesity found by many researchers is the increasing rate of parental employment. Studies have suggested that children of working mothers consume less of home-cooked food and more of ready-made outside food (**Anderson, et al., 2003; Ruhm, 2003**). The rural population is also characterized by increasing obesity trends. Changes in job role and accordingly the lifestyle have raised the risk of getting overweight in working youths. With the time due to economic transition, a notable proportion of rural women have been withdrawn from the workforce, indicating physical inactivity among rural women. Increasing opportunities and shifting from agricultural labour to non-farm wage labour have led to a state of less physical activity and inclination towards processed foods, lacking nutritional level among rural women than men (**Kanter, et al., 2012**). The presence of urban centres has a strong relationship with obesity in rural people. Better accessibility to nearest town has contributed to increased availability of the processed food supply chain, resulting in nutrition transition (**Aiyar, et al., 2021**). Uncontrolled urban sprawl was also found to be correlated with obesity (**Ewing et al., 2003**). A recent study in India emphasizing physical activities has shown that 57 per cent of the Indian population is physically inactive or mildly active, and women are more physically inactive than men (**Podder, et al., 2020**). These changes in their lifestyle further affect the health of their children. It is found in a study that from 1970 to 1990, the participation of females in the workforce increased due to higher wage opportunities for females. This trend might have independently contributed to the increase in obesity rates (**Bluestone, et al., 1997**). Again, this rise in employment rates and higher wage opportunities might have partly explained the shift in consumption of food away from home from 18 per cent to 32 per cent of total calorie intake from the 1970s to 1990s. Also, the proportion of food away from home in total food expenditure increased from 32 per cent to 38 per cent (**Economic Research Survey, 2004**; **Guthrie, et al., 2002**).

In India, the wealth of a household is found to have effects on abdominal obesity (**Choudhary, et al.,**

2023). Many other studies have concluded that the prevalence of overweight and obesity is higher among those having a high standard of living based on wealth score (**Luhar, et al., 2018**). Wealthier section of society is more characterized by reduced physical activity and mechanized transport leading them to easier adoption of sedentary lifestyle. Overconsumption of fat-rich diet intensifies the possibility of getting obese in wealthier counterparts of the society (**Choudhary, et al., 2023**). Interesting results are found by many researchers where watching television plays a role in child obesity, as arguably children are exposed to 10 advertisements per watch hour promoting fast foods, sweets, and beverages. This, in return, increases demand for those food items among children, resulting in childhood obesity (**Ebbeling et, al., 2002**). Another study in India using multiple logistic regression models found a correlation between the prevalence of obesity and the upper socioeconomic group and hours of watching television, while physical activity held no significance. The incidence of obesity among children and adolescents is higher in wealthier groups of society than their less wealthy counterparts. Also, children watching TV for more than 2 hours a day showed a higher possibility of being overweight and obese as compared to the children watching TV occasionally (**Tharkar, et al., 2009**).

The focus of this current study is to investigate the factors possibly affecting childhood obesity, using the latest data from 5th cycle of National Family Health Survey (2019-2021). The remaining parts of this study are arranged as follows. Section 2 states the research gap. Section 3 highlights the objective of this study. Section 4 describes the variables used in this paper. Section 5 explains the descriptive and econometric methods of this paper in detail. Section 6 discusses the results. Section 7 concludes this study and provides a critical discussion.

2. RESEARCH GAP

Based on existing literature, it is evident that obesity causes several health complications and has a dampening impact on our economy. Factors affecting obesity are multidimensional. In modern days, the incidence of obesity occurs in early childhood due to various causes discussed above. Literature till date has focused more on documenting different causes and consequences of childhood and adulthood obesity. Over time, as medical sciences evolved, researchers have established more prominent causes, whether genetic or behavioural. But after developing a better understanding of social sciences and socioeconomic scenarios, researchers started delving deeper to examine the root causes and backgrounds of childhood obesity. Specific models are developed based on local ecologies and neighbourhoods to study the causes and effects of obesity in different regions all over the world. Studies have provided differentiated views on obesity, indicating distinguished Indian culture and societal conditions. But very few studies in India have been focused on examining the status of childhood obesity (anthropometric comparative measure Z-score (W/a) among Indian children and deriving the factors that can have a huge impact on childhood obesity using the latest 5th cycle National Family Health Survey (2019-2021) dataset. Also, there is an absence of research in India that used an econometric model to establish the relationship between obesity and different socioeconomic factors. A couple of researchers determined the effects of different socioeconomic variables on abdominal obesity among adults, keeping waist circumference as the dependent variable (**Choudhary, et al., 2023**). Another group of researchers used BMI Z-score for children as an outcome variable and compared the results with those of the NFHS-4 dataset. They used child-level, maternal-level and household-level variables in their model (**Manapurath, et al., 2024**). No studies so far has considered Weight-to-Age Standard Deviation as an outcome factor for child obesity. Also, not too many studies have used the NFHS-5 dataset to particularly examine childhood obesity in

India.

3. OBJECTIVE OF THIS STUDY

Reviewing existing literature and their methods, the current study aims to determine socioeconomic correlates of childhood obesity using the NFHS-5 dataset.

4. DATA AND VARIABLE DEFINITION

This section focuses on the data used in this study and defines all variables considered in the model.

Data:

This study uses data from the 5th cycle National Family Health Survey (2019-2021) conducted by the Ministry of Health and Family Welfare (MoHFW). For analysis, 'Children Recode File' (IAKR7EFL) is utilized in STATA format. After omitting the missing entries from every variable used in the model, a total of 582 children are considered for obesity analysis.

4.1 Variable Definition:

To test for child obesity, this study uses 'Weight for Age Standard Deviation' (w/a SD) as a latent variable. To apply the ordered logit regression model, this study creates a categorized outcome variable, W/A_cat, that considers only the values of 'Weight for Age SD' greater than 0. This consideration is made only to deal with overweight and obese individuals. Thus dependent variable, W/A_cat, includes three categories: non-obese (232 children), mildly obese (221 children) and severely obese (129 children).

Independent variables used in this analysis are divided into 3 categories: child level, maternal level and household and community level.

Child level variables include sex of the child, birth weight and birth interval and birth order of children. All these variables represent the inherent causes of malnourishment among children (**Hatkar, et al., 1999; Sarkar, et al., 2014**).

Within maternal level variables, a mother's highest year of education shows the depth of knowledge of a mother, which is very important in determining adverse nutrition consequences among children (**Smith, et al., 2003**). It is categorized into 3 groups: just literate, primary literacy and secondary literacy. Other maternal factors like 'haemoglobin level of mother', 'body mass index of mother', 'duration of breastfeeding (in months)', 'number of antenatal cares received' and 'whether post-natal care (PNC) received by mother' are used as maternal-level explanatory variables of childhood obesity.

Household and community level variables include residence (rural-urban dummy), number of household members, dummy for whether toilet facility shared by others, dummies of religion (Hindu, Muslim, Christian and others).

5 METHODOLOGY

This section extensively describes the econometric method used in this study. The latent variable, W/A_cat, used here represents childhood obesity and includes three categories (1 = not obese, 2 = mildly obese and 3 = severely obese). To analyze such ordered categorical variables, an appropriate tool is ordered logit/probit model (**Sarkar, et al., (2014); Amemiya, (1981); Cameron, et al., (1986); Greene, (1993); Gerdtham, et al., (1997); Wooldridge, (2002, 2009)**).

Independent variables are divided into 3 dimensions (described in the data section). Let, X_i denote the set of variables used in the model for ith observation. Then, the ordered logit regression model will be:

$$W/A\_cat_i = \sum_m \beta'_{mi} X^c_{mi} + \sum_n \beta'_{ni} X^m_{ni} + \sum_j \beta'_{ji} X^h_{ji} + \varepsilon_i;\ \varepsilon_i \sim N(0, \sigma^2)$$

Where,

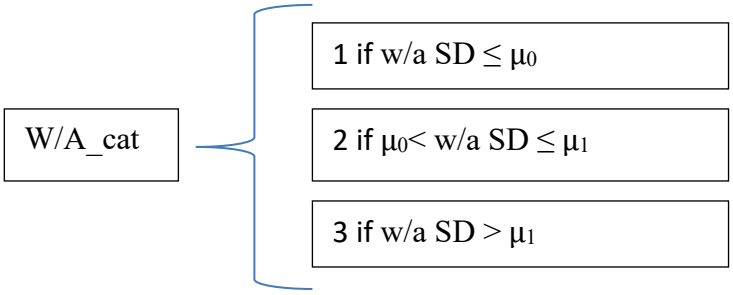
X^c_{mi} =Column vector consisting of m number of child-level independent variables for i[th] observation

X^m_{ni} = Column vector consisting of n number of maternal level independent variables for i[th] observation

X^h_{ji} = Column vector consisting of j number of household and community level independent variables for i[th] observation

ε_i = white noise for all i, which is normally distributed with mean 0 and variance σ^2

The essence of this model lies in determining β coefficients as well as unobserved thresholds (μ_i). Here, in this study outcome variable contains 3 categorical values (1, 2 and 3), so accordingly, there are two thresholds, μ_0&μ_1, such that



Where, $\mu_1 > \mu_0$; μ_0 and μ_1 are unobserved thresholds which are also called cut points. The main focus of this model is to determine the probabilities associated with the incidence of each category that follows the logistic distribution function, Λ. Probabilities are given by:

P [W/A_cat = 1] = Λ [$\mu_0 - \beta'X_i$]

P [W/A_cat = 2] = Λ [$\mu_1 - \beta'X_i$] - Λ [$\mu_0 - \beta'X_i$]

P [W/A_cat = 3] = 1 - Λ [$\mu_1 - \beta'X_i$]

The focus of this model is to find out the probabilities associated with the occurrence of different categorical values. To estimate the parameters, μ and β, this model develops a log-likelihood function:

$$\ell_i(\alpha, \beta) = \mathbf{1[W/A\_cat = 1]\ log\ [\Lambda\ (\mu_0 - \beta'X_i)] + 1[[W/A\_cat = 2]\ log\ [\Lambda\ (\mu_1 - \beta'X_i) - \Lambda\ (\mu_0 - \beta'X_i)] + 1[W/A\_cat = 3]\ log\ [1 - \Lambda\ (\mu_1 - \beta'X_i)]}$$

Positive estimates typically mean that one unit increase in a particular independent variable increases the probability of occurrence of the highest category, W/A_cat = 3, and simultaneously decreases the probability of occurrence of the lowest category, W/A_cat = 1 (i.e., childhood obesity will increase). On the other hand, negative estimates mean that if a particular variable is increased by 1 unit, it will shift the weight of occurrence from the highest category to the lowest category (i.e., childhood obesity will decrease).

Since the dependent variable in this model is an ordered categorical variable, the odds ratios of respective variables do not reflect the category-specific marginal effects. So, marginal effects are derived differently using the following formula:

$$\frac{\delta\ Prob(category\ j)}{\delta\ x_k} = \left[\theta(\mu_{j-1} - \beta' x_k) - \theta(\mu_j - \beta' x_k)\right] \times \beta$$

Here, θ (.) is the normal density function, μ_j is the threshold parameter, and x_k is the k[th] explanatory variable. (**Sarkar, et al., (2014)** and **Wooldridge, (2002, 2009)**)

6 RESULTS

This section elaborates on the results obtained from the analysis of descriptive statistics and the ordered logit regression model.

Table 1: Descriptive Statistics (Percentage Share of Variables)

Variables	Total Sample	Non-obese	Mildly Obese	Severely Obese	Variables	Total Sample	Non-obese	Mildly Obese	Severely Obese
Residence					**Birth Interval**				
Rural	65.6	69.0	61.1	67.4	Very Low	18.0	15.9	22.6	14.0
Urban	34.4	31.0	38.9	32.6	Medium	55.7	53.4	52.5	65.1
Literacy of Mother					High Birth	26.3	30.6	24.9	20.9
Just Literate	3.3	2.6	2.7	5.4	**Duration of Breastfeeding**				
Primary Literate	44.7	46.1	48.4	35.7	Abnormal	6.4	5.6	4.5	10.9
Secondary Literate	52.1	51.3	48.9	58.9	Normal	67.2	71.1	67.4	59.7
Household Type					Moderate	26.5	23.3	28.1	29.5
Nuclear	45.0	48.3	43.4	41.9	**Number of ANC Visit**				
Joint	55.0	51.7	56.6	58.1	Low	89.5	91.4	89.6	86.0
Sex of the Child					Normal	9.6	7.8	14.5	11.6
Male	47.6	43.1	49.3	52.7	Abnormal	0.9	0.9	0.0	2.3
Female	52.4	56.9	50.7	47.3	**PNC Received**				
Religion					Yes	90.2	90.9	90.5	88.4
Hindu	57.4	56.9	58.4	56.6	No	9.8	9.1	9.5	11.6
Muslim	19.6	22.0	19.0	16.3	**BMI of Mother (in kg/m^2)**				
Christian	14.3	15.1	12.7	15.5	< 18.5	6.9	8.2	7.7	3.1
Others	8.8	6.0	10.0	11.6	18.5 - 24.9	57.7	59.9	52.0	63.6
Anaemia in Mother (in gm./dl)					> 24.9	35.4	31.9	40.3	33.3
Severe	2.6	2.6	0.9	5.4	**Birth Weight (in kg)**				
Moderate	26.3	22.0	29.0	29.5	< 2.5	9.6	8.6	9.5	11.6
Mild	25.8	28.0	21.7	28.7	2.5 - 4.0	87.1	88.4	86.4	86.0
No	45.4	47.4	48.4	36.4	> 4.0	3.3	3.0	4.1	2.3
Birth Order					**Shared Toilet**				
Low	68.4	73.3	66.5	62.8	Yes	7.9	7.3	9.0	7.0
Medium	28.7	23.7	31.7	32.6	No	92.1	92.7	91.0	93.0
High	2.9	3.0	1.8	4.7					

Source: Author's calculation from NFHS-5 dataset.

Note: Mildly obese and severely obese are separately counted.

Above table (Table 1) shows sample statistics and description of variables used in the model. In this dataset, more than half of the households are Hindu and that of one-fifth are Muslim. 14 per cent are Christian and nearly 9 percent of all households belong to other religions. Low birth order is dominant with almost 70 per cent. Nearly 56 per cent of all children have a birth interval between 25 to 60 months. The majority of mothers continued breastfeeding up to 18 months, which is considered good for infants' health. More than 45 per cent of mothers show no sign of anaemia, while both mild and moderate anaemia is found to be 26 per cent of all mothers.

Hindu religion is dominant in all three categories of children, followed by Muslim, Christian and other religions respectively. Mostly mothers are non-anaemic with but the difference decreases in severely obese category as in this category more than 5 per cent of mothers are reported to be severely anemic. Birth order seems to have similar stats in all categories of childhood obesity, where low birth order gets the highest percentage of households. Birth interval holds a positive scenario with more than half of the children to be born in a medium birth interval ranging from 25 months to 60 months. Lastly, the table shows that the normal duration of breastfeeding is majorly practised throughout all categories.

The above table (Table 2) shows the results of ordered logit regression using various independent variables discussed above. The Mean VIF of the above model is 1.68. Here, the odds ratio relates to the effect of independent variables on the occurrence of childhood obesity.

Table 2: Ordered Logit Regression Result

Independent Variables	Odds Ratio	Z value	Marginal effects for non-obese	Marginal effects for mildly obese	Marginal effects for severely obese
Residence	0.82	-1.13	0.046	-0.013	-0.033
Shared Toilet	1.22	0.68	-0.046	0.012	0.035
BMI	1.00	0.54	0.000	0.000	0.000
Haemoglobin	0.99	-2.31	0.003**	-0.001**	-0.002**
Sex of the Child	0.80	-1.38	0.053	-0.016	-0.038
Birth Weight	1.00	0.08	0.000	0.000	0.000
PNC Received	0.72	-1.21	0.074	-0.016*	-0.058
Secondary Literacy	1.16	0.94	-0.035	0.011	0.025
Hindu	0.56	-2.06	0.136**	-0.037**	-0.099**
Muslim	0.39	-2.93	0.231***	-0.098**	-0.133***
Christian	0.60	-1.52	0.126	-0.049	-0.077*
Nuclear Household	0.77	-1.51	0.061	-0.019	-0.043
Low Birth Order	0.72	-1.88	0.078*	-0.021**	-0.058*
High Birth Order	0.90	-0.21	0.026	-0.008	-0.017
Very Low Birth Interval	1.39	1.38	-0.077	0.018*	0.059
Medium Birth Interval	1.53	2.24	-0.102**	0.032**	0.070**
Moderate Breastfeeding	0.75	-0.8	0.069	-0.023	-0.046
Normal Breastfeeding	0.52	-1.92	0.150**	-0.034**	-0.115*

Low Number of ANC	**0.69**	**-1.32**	**0.084**	**-0.018****	**-0.066**
Abnormal Number of ANC	**1.72**	**0.55**	**-0.120**	**0.015**	**0.104**

Source: Author's calculation from NFHS-5 using STATA software

Note: Z ≥ |1.69| implies significance at 10%; Z ≥ |1.96| implies significance at 5%; Z ≥ |2.54| implies significance at 1%

Note: "*" means 10% level of significance; "**" means 5% level of significance; "***" means 1% level of significance

An odds ratio greater than one signifies the favorable effect of any independent variable on obesity, while an odds ratio less than one implies unfavorable effects. In the above table (Table 2), it can be seen that the place of residence has an unfavorable effect on the incidence of obesity. It means that moving from urban to rural areas reduces the occurrence of childhood obesity. But the impact is insignificant, as shown by the Z value. The shared toilet facility has the value of odds ratio 1.22, implying that sharing toilet facilities with others increases the chance of childhood obesity, but this is insignificant. The Body Mass Index (BMI) of mother also favorably affect the obesity of the child but this is also insignificant. Hemoglobin of the mother shows a little bit different result where an increase in the level of hemoglobin in mother causes obesity to fall, and this effect is significant at 5% level. The effect of the sex of the child is also unfavourable and insignificant. Birth weight of the children and PNC received are both insignificant, but the former is favorable to obesity, and the latter is not. Here, the point to be noted is that other variables of the mother's literacy are omitted due to the presence of multicollinearity. Only secondary literacy can be added to the model, which is favorable but is insignificant. Religion, on the other hand, reports an interesting result. Keeping other religions as a reference group, both Hindu and Muslim show unfavorable but highly significant impact. It implies that if a household from other religions is replaced by a Hindu or a Muslim, the obesity of the children actually decreases in both categories. But Christians record unfavorable but insignificant results. Type of household is seen to affect childhood obesity unfavorably but in also insignificant. Only low birth order is significant, with an unfavorable impact on the occurrence of obesity. The other category of birth order is similar but insignificant. Categories of birth interval follow a similar pattern. Both categories of birth order have favorable effect, but the medium birth interval is significantly affected but very low birth interval is not. Further, it is recorded in the results that normal breastfeeding duration is significant in decreasing the probability of the occurrence of obesity among children. But moderate breastfeeding duration is insignificant in doing the same. Lastly, the two categories of ANC services impact oppositely on the incidence of childhood obesity, but both are insignificant.

The marginal effects of different independent variables have been depicted in the last three columns (Table 2), which illustrate the marginal effects for the different categories of childhood obesity. As it is seen earlier that the hemoglobin level of mothers has slightly unfavorable effect on obesity, the marginal effect of that variable is positive in the non-obese category but is negative in mild obesity and severe obesity. This may be due to the fact that an increase in hemoglobin level implies a lower occurrence of anemia among mothers. This further uplifts not only mothers' health but also children's health and nutrition. Also, this effect is significant. Both Hindu and Muslim households have unfavorable but significant effects on obesity. Thus, both the dummies have positive marginal effects in the first category and negative effects in the other two. This result may correlate with the increased population share of Hindus and Muslims. And also, it signifies a better standard of living and better health conditions of people belonging to these two religions. An interesting observation is that Christian households show similar marginal effects, but

the effect is significant only in severely obese category. Receiving PNC turns out to be an unfavorable variable in occurring obesity. So, accordingly marginal effect of the PNC variable is positive in non-obese category and is negative in the other two categories of obesity. However, this impact is significant only in mildly obese category. This shows the importance of PNC in improving child health. Another interesting story is being told by the marginal effects of birth order. Taking medium birth order as the reference group, it is evident from the result that moving from medium birth order to low birth order decreases the possibility of obesity. This result is significant as well. Probably, low birth order directly relates to giving proper nourishment to both the mother and her children, followed by having non-obese children. Similarly, higher birth order generally means less nutrition for both the mother and her child. Households with a higher number of children are bound to spend less money on the nourishment of the mother and children. This further leads to having non-obese children in future. Nevertheless, this result is statistically insignificant. Furthermore, different categories of birth interval provide favorable conditions when calculated with respect to children with a high birth interval. Both very low and medium birth intervals cause the incidence of childhood obesity. A shorter birth interval results in malnutrition and adverse health of both mother and children. High birth interval, on the other hand, means the birth of each child gets enough time and supplements to build better health. However, the effects of medium birth interval are significant in all three categories of childhood obesity, but a very low birth interval is significant only in the occurrence of mild obesity. Proper and sufficient breastfeeding can cut down the probability of obesity in children. This is what is seen in the results where both normal and moderate duration of breastfeeding with respect to abnormal breastfeeding cause childhood obesity to fall. Here, only the effects of normal breastfeeding are significant in all three categories of obesity. Lastly, low antenatal care accounts for a lower possibility of children being obese. This connection can probably be explained by the fact that low ANC leads to malnourishment and underweight of children. Nonetheless, this result is significant only for mildly obese children.

7 CONCLUSION

In modern-day economics, public health is considered one of the key driving forces for any economy to grow. Poor health condition negatively impacts productivity and ultimately output and low GDP. So, for a country to be developed, needed is improved health of the common people. Children are the stakeholders of future growth and will participate in the labour force. But if they are not healthy, they will not only lack good education but also lack good industrial and technical skills to shoulder their economy in future.

Childhood obesity is increasing day by day, creating a threat to the productivity of the future labour force. Several studies have shown numerous prospects like, loss of productivity, absenteeism, presenteeism, increased disease and related health expenditure, to be caused by overweight and obesity. This paper uses empirical analysis to find out the correlation between childhood obesity and different child levels, maternal level and socio-demographic factors. Variables like hemoglobin level of mother, religion, birth order, birth interval, duration of breastfeeding, number of antenatal care and shared toilet facility are the significant correlates of the occurrence of obesity among children. Hemoglobin level in mothers is a measurement of anemia in them. So, an increase in hemoglobin level stands for better health of both the mother and her children, which further relates with less occurrence of obesity. Receiving proper post-natal care helps bring children back from being mildly obese to non-obese ones. Religion tells us a completely different scenario. Being a Hindu or a Muslim reflects a lower incidence of obesity. This may be explained in a way that they are high in population and so in workforce, earning relatively higher income, receiving

relatively better education and other resources. Anyways, other factors like birth order, duration of breastfeeding and number of ANC received have been recorded unfavorable impact on obesity. Children with low birth order are seen to be non-obese as compared to others. This result coincides with the children having normal duration breastfeeding, i.e., from 19 months to 36 months. However, a low number of ANC causes obesity to fall probably due to lack of nutrition and children born with diseases. On the other hand, low and medium birth intervals of children make them prone to obesity, whether it be mild or moderate. So, to conclude, it must be said that any source of nutrition, supplement and nurture both before and after the birth of the child will boost their immunity, resulting in reduction of occurrence of childhood obesity in India.

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