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Association Between 23 Correlates and Anthropometric Failure Among Children: Analysis of 2016 and 2021 National Family Health Surveys in India

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A B S T R A C T

This study evaluates the associations among 23 factors related to child anthropometric outcomes in children aged 6 to 23 months, using data from the National Family Health Survey (NFHS) rounds 4 (2016) and 5 (2021). The factors examined include maternal characteristics such as body mass index (BMI), height, education level, and pregnancy details; household characteristics like type of residence, waste disposal, drinking water quality, air quality, and poverty status; and child characteristics including age, sex, vaccination status, dietary diversity, and treatments for diarrhea and cough. Anthropometric measures of stunting, wasting, and underweight were assessed using standard deviations for height-for-age, weight-for-age, and weight-for-height. Binary logistic regression was used to analyze the strength of associations for both years. The results indicate that maternal characteristics and household poverty are the strongest predictors of child anthropometric failures in 2021. In contrast, factors such as treatment access, vaccination, and sanitation showed weaker associations. The ranking of these factors was similar in both years; however, the association strength for maternal characteristics decreased from 2016 to 2021. Furthermore, there were differences in association strength based on the severity of anthropometric failure outcomes.

Key words: *children, maternal characteristics, household poverty, vaccination, sanitation, India , medical anthropology*

Introduction

Child anthropometry, which is commonly used as a population measure of child health, particularly nutrition, has seen disproportionately lower improvements in the past few decades of India, despite large investments to enhance child health and food consumption[1]. In India, almost 19% of children are wasted as of 2021, and a third are underweight or stunted. Severe wasting has risen alarmingly from 2.2% in 1996 to 7.7% in 2021[2–4]. This begs important questions regarding why the anthropometric outcomes of children have not significantly improved despite India's persistent policy efforts. It is yet unclear if the problem is with how these multisectoral policies are being implemented or if important variables affecting child nutrition were incorrectly identified, which could result in ineffective interventions.

Although the contribution of social determinants of health to better living conditions and better child anthropometric outcomes are widely acknowledged[5–7], nutrition-specific interventions–which center on activities such as breastfeeding, complementary feeding, and baby feeding practices–have frequently been given priority[8,9]. Evidence, however, points to a limited impact of these downstream determinants, which brings focus on discussions concerning the conceptual frameworks underlying nutrition policy. While the UNICEF framework[10] highlights the significance of proximal determinants, like vaccination and dietary diversity, new research indicates that upstream factors, like maternal height, body mass index (BMI), household poverty, and maternal education, have a stronger predictive ability in influencing child nutrition,

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†Mayanka Ambade passed away in January 2025. We are grateful for what we have learned from her through our joint work.

as represented by anthropometric outcomes[7,11,12]. This pattern has been noted not only in South Asia and other low- and middle-income nations, but also in India.

More recent data shows that these correlations' relative rankings and effect sizes vary over time and according to income levels[7,11,12]. In order to make sure that the frameworks driving child health policy are still applicable, there should be an annual review of the predictive ability of both proximal and distal factors. The most recent National Family Health Survey (NFHS-5) round, which was completed in 2019–21, offers a chance to revise estimates of these associations. Furthermore, this dataset provides an opportune moment to evaluate the influence of various policy innovations—including Mission Indradhanush, POSHAN Abhiyaan, and the Pradhan Mantri Matru Vandana Yojana—as well as state-level interventions, which were put into effect between 2016 and 2021[13].

Thus, the purpose of this study is to perform a thorough evaluation of the relative significance of 23 correlates of anthropometric failures of stunting, wasting, and underweight in Indian children between the ages of 6 and 23 months for 2016, and 2021. In order to investigate shifts in the relative significance of these correlates, the study will also distinguish between them based on the degree of severity.

Materials and Methods

Data source and study population

The current study uses unit level data from the fourth and fifth rounds of the National Family Health Survey conducted in 2014–15 (NFHS-4) and 2019–21 (NFHS 5), respectively[2,3]. The NFHS-4 and NFHS-5 surveys employed a stratified two-stage sampling design to produce district-level estimates. The 2011 Census served as the sampling frame, with Primary Sampling Units (PSUs) defined as villages in rural areas and Census Enumeration Blocks (CEBs) in urban areas. PSUs with fewer than 40 households were merged with nearby PSUs. In rural areas, villages were selected using probability proportional to size (PPS) within each stratum, which were further divided based on household numbers and the percentage of Scheduled Caste/Scheduled Tribe (SC/ST) populations. In urban areas, CEBs were sorted by SC/ST population, and sample CEBs were chosen using PPS sampling. Further details are found elsewhere. The study was reviewed by the Institutional Review Board of the Harvard T.H. Chan School of Public Health and was deemed exempt from full review, as it utilized an anonymous public-use dataset without any identifiable information about the study participants.

The current study utilizes unit level information of all children aged 6 to 23 months. The children in this age groups have been chosen because most of the information on correlates in the data was available for this age group

Outcome variables

The NFHS collects anthropometric information about children from trained health investigators using digital solar-powered scales, accompanied by adjustable Shorr measuring boards to ensure precision. For children aged 24 months and older, standing height was recorded, while for those under 24 months, recumbent length was measured[2,3]. Based on these height and weight assessments, three key anthropometric failure outcomes were constructed- stunting, wasting, and underweight.

Stunting, which signifies chronic undernutrition and impaired skeletal growth due to prolonged deprivation, was defined as a height-for-age z-score falling below –2 standard deviations (SD) from the WHO child growth reference standards. Severe stunting, marked by a z-score below –3 SD, reflects more intense and long-term nutritional deficits, often leading to lasting impacts on physical and cognitive development. Moderate stunting was marked by a z-score between –2 and –3 SD.

Underweight was defined as a weight-for-age z-score of less than –2 SD, capturing both chronic and acute forms of undernutrition. Severe underweight, with a z-score below –3 SD, indicates heightened vulnerability to illness, delayed development, and higher mortality risk. Moderate underweight was marked by a z-score between –2 and –3 SD.

Wasting, a marker of acute malnutrition was defined as a weight-for-height z-score below –2 SD, with severe wasting identified when the z-score falls below –3 SD. Severe wasting represents a critical health risk, often associated with life-threatening malnutrition that requires immediate intervention. Moderate wasting was marked by a z-score between –2 and –3 SD.

Correlates

The data for NFHS-4 and NFHS-5 primarily relied on self-reported information, with the exception of anthropometric measurements for both mothers and fathers. Variables at the household level included indicators such as the wealth index, access to improved drinking water and sanitation facilities, air quality, proper disposal of child stools, and the use of iodized salt. An "improved" drinking water source referred to water piped directly into the home, yard, or plot, or provided through public taps, boreholes, tube wells, protected wells, protected springs, or rainwater collection. Sanitation systems were classified as improved if they included flush toilets connected to sewer systems, septic tanks, pit latrines, ventilated improved pit latrines, pit latrines with slabs, or composting toilets. Household air quality was evaluated based on the fuel used for cooking, where non-solid fuels were considered better, while solid fuels used in non-separate kitchens indicated poor air quality. Binary variables were created to assess whether child stools were disposed of safely (yes/no) and whether iodized salt was used in the household (yes/no).

Maternal indicators covered aspects such as education, height, body mass index (BMI), and age at marriage. Maternal education was categorized into five distinct groups: no formal education, primary education, secondary education, higher secondary education, and college or above. For maternal height, women were divided into the following groups: below 145 cm, 145–149.9 cm, 150–154.9 cm, 155–159.9 cm, and 160 cm and above. BMI was computed by dividing weight in kilograms by the square of height in meters, and classified into categories: less than 18.5, 18.5–24.9, and 25+ kg/m². Another binary variable focused on whether the mother was married before the age of 18, with those married at 18 or older serving as the reference group.

Several variables related to maternal and child health were also analyzed. Dietary diversity was measured through a 24-hour food recall survey, assigning a point for the intake of various food groups, including milk and dairy, legumes, nuts, starchy staples (such as grains and tubers), vitamin A-rich fruits and vegetables, other fruits and vegetables, oils, fats, and butter. Higher dietary diversity scores indicated a broader range of food consumed. It's important to note that using a 24-hour food recall has limitations, as it may not accurately reflect longer-term dietary patterns. Other binary variables included early breastfeeding initiation (within one hour of birth or later), recent experiences of child illness (such as fever, diarrhea, or coughing), whether the child needed medical attention in the past two weeks, and whether the child received vitamin A supplementation (yes/no).

Family planning needs were measured with a binary variable, identifying whether or not a family's contraceptive needs were unmet. Antenatal care (ANC) visits were also evaluated, with adherence to the World Health Organization's recommendation of at least four ANC visits during pregnancy serving as the standard. Finally, anemia in children was assessed based on their hemoglobin levels, with a binary variable indicating whether the child was anemic (yes/no).

Statistical analysis

A set of comprehensive statistical analysis were conducted to assess the factors associated with anthropometric failures. Logistic regression models were used as the primary method of analysis due to the binary nature of the outcome variables, which are the indicators of anthropometric failure (e.g., stunting, wasting, underweight). Each of the nine anthropometric failures (coded as 1 for "failure" and 0 for "no failure") were treated as a dependent variable in separate regression models. Each correlate (such as maternal education, wealth index, access to sanitation, etc.) was first analyzed separately to evaluate its independent effect on the anthropometric outcomes. In these models, only the child's age and sex were adjusted. Odds ratios with 95% confidence intervals for all the selected indicators were plotted for both NFHS-4 and NFHS-5 to compare all nine indicators.

Results

Sample distribution

The study sample consisted of 83,461 observations in 2016 and 78,767 observations in 2021 of children aged 6 to 23 months for the analysis of stunting outcome. (Table 1). For the analysis of wasting outcome there were 21,325 observations in 2016 and 17,137 in 2021 (Table 2). Similarly, there were 83,461 observations in 2016 and 81,946 in 2021 for the analysis of underweight outcome (Table 3). The distribution of the study sample across correlates for all anthropometric outcomes remained comparable between the two rounds of the NFHS (Tables 1–7). The sample predominantly comprised children aged 12 to 23 months, of sixth or higher birth order, rural residents, children from the poorest wealth quintile, children of illiterate mothers, and children whose mothers were under 145 cm in height, underweight, or married below the age of 18.

Stunting

In 2021, the full model for stunting (Figure 1) showed that among children aged 6 to 23 months, stunting was most strongly associated with maternal stunting (height <145 cm) (OR: 3.48; 95% CI: 3.17–3.81), followed by the child's age being above 12 months (OR: 2.03; 95% CI: 1.86–2.21), maternal BMI less than 18.5 kg/m² (OR: 1.53; 95% CI: 1.43–1.64), living in a poor household (OR: 1.45; 95% CI: 1.31–1.60), high birth order (sixth or higher) (OR: 1.39; 95% CI: 1.22–1.58), maternal education (no education vs. others) (OR: 1.32; 95% CI: 1.21–1.43), and being male (OR: 1.30; 95% CI: 1.25–1.35).

The factors with the least influence on stunting, in increasing order of effect size, were lack of safe drinking water (OR: 0.94; 95% CI: 0.88–1.00), lack of care-seeking for cough (OR: 0.96; 95% CI: 0.88–1.06), no vitamin A supplementation (OR: 0.96; 95% CI: 0.92–1.01), fewer than four antenatal care visits (OR: 0.96; 95% CI: 0.92–1.01), and incomplete vaccination (OR: 0.97; 95% CI: 0.93–1.01).

For moderate and severe stunting (Figures 2–3), maternal height, child age, poverty status, and maternal BMI remained the most critical determinants, though the effect sizes were smaller. For example, children of stunted mothers (height <145 cm) were 2.72 times more likely to be severely stunted and 1.82 times more likely to be moderately stunted. In moderate stunting, additional factors such as late breastfeeding initiation, infectious diseases, and type of residence had smaller impacts.

Wasting

In 2021, the fully adjusted model for wasting (Figure 4) showed that maternal BMI (less than 18.5 kg/m²) was the most significant predictor (OR: 1.78; 95% CI: 1.64–1.93), followed by maternal height (less than 145 cm) (OR: 1.44; 95% CI: 1.29–1.60), household poverty (OR: 1.42; 95% CI: 1.27–1.60), a dietary diversity score of zero (OR: 1.29; 95% CI: 0.99–1.67), and maternal illiteracy (OR: 1.17; 95% CI: 1.06–1.29).

TABLE 1

DISTRIBUTION OF STUNTING BY SELECTED CORRELATES AMONG CHILDREN AGED 6–23 MONTHS, INDIA NFHS 2016–2021

Characteristics	N (2016)	Stunting %	N (2021)	Stunting %
Total	83461	32.7	78676	32.2
Age in Months				
6–11 months	39745	21.6	39076	24.5
12–23 months	43716	42.7	39600	39.8
Sex of child				
male	43235	34.7	40472	34.4
female	40226	30.5	38204	29.8
Birth Order				
1	31946	29.3	31186	30.0
2–3	40436	32.9	38685	32.4
4–5	8550	40.4	7179	38.2
6 & above	2530	45.6	1625	42.2
Place of Residence				
urban	22405	28.3	19806	28.7
rural	61057	34.3	58870	33.4
Wealth Index				
poorest	20532	42.1	18924	39.6
poorer	18605	36.1	17189	35.7
middle	17018	31.1	15804	31.2
richer	15241	26.6	14693	27.1
richest	12065	21.0	12066	23.0
Maternal Education				
illiterate	22568	42.2	14706	39.9
primary	11310	37.2	8854	36.4
secondary	39833	29.0	41436	31.3
higher	9750	20.1	13680	23.7
Maternal Height				
0–145 cm	10228	47.5	9933	45.8
145–149.9 cm	22524	37.2	20394	36.9
150–154.9 cm	28010	30.9	26363	30.4
155–159.9 cm	16403	24.9	15191	24.5
160+ cm	6140	20.1	6779	22.2
Maternal BMI				
< 18.5 kg/m^2	21495	37.9	16241	38.1
18.5–24.9 kg/m^2	46522	30.7	45505	30.8
25.0 + kg/m^2	9650	22.9	12221	25.2
Age at Marriage				
less than 18	41212	35.8	35177	35.1
greater than 18	41645	29.5	43402	29.8
Dietary Diversity Score				
0	33687	27.3	33872	29.0
1	17847	34.6	13818	32.5
2	13797	38.9	11940	35.6
3	8762	37.4	8805	35.3
4	4622	35.8	4905	35.8
5	2513	35.2	2724	35.4
6	2233	31.8	2613	35.9

TABLE 1
Continued

Infectious Disease				
no	59649	32.8	57553	32.1
yes	23812	32.3	21122	32.5
Initiation of Breastfeeding				
> 1 hour of birth	34969	32.2	32971	32.5
=<1 hour of birth	48492	33.0	45704	32.0
Drinking Water				
not improved	14346	29.4	12191	29.3
improved	69115	33.3	56318	32.8
Stool Disposal				
safe	22783	27.4	29608	29.7
unsafe	59887	34.6	47067	33.6
Sanitary Facility				
improved	39993	27.6	51098	30.1
unimproved	36584	39.3	21520	38.1
Household Air Quality				
solid fuels in non – separate kitchen	13420	35.4	12217	35.7
solid fuels in separate kitchen	37085	37.6	24429	36.0
solid Fuels	26149	25.8	36106	29.1
Households with Iodized Salt				
not used	5687	35.4	4859	35.0
used	77476	32.5	73589	32.0
Full Vaccination				
no	49455	29.2	28718	29.7
yes	33332	37.7	29844	37.2
Vitamin A Supplementation				
no	38632	31.0	32632	30.3
yes	43993	34.1	45401	33.5
Family Planning Needs Met				
no	54200	33.2	59107	32.1
yes	26409	31.8	17483	32.4
Skilled Birth Attendance at the Delivery				
no	13754	39.9	7415	37.5
yes	69707	31.2	71261	31.6
Antenatal Care Visits				
less than four	39358	36.7	30805	33.5
at least four	40787	27.9	44290	30.6

TABLE 2

DISTRIBUTION OF WASTING BY SELECTED CORRELATES AMONG CHILDREN AGED 6–23 MONTHS, INDIA NFHS 2016–2021

Characteristics	N (2016)	Wasting %	N (2021)	Wasting %
Total	21325	25.6	17137	22.2
Age in Months				
6–11 months	11728	29.5	9424	25
12–23 months	9598	22.0	7713	19.6
Sex of Child				
male	11415	26.4	9188	23.2
female	9910	24.6	7948	21.2
Birth Order				
1	7985	25	6544	21.4
2–3	10071	24.9	8424	22.3
4–5	2424	28.3	1745	24.8
6 & above	846	33.4	424	26.2
Place of Residence				
urban	5402	24.1	3954	20.4
rural	15923	26.1	13183	22.9
Wealth Index				
poorest	6315	30.8	5008	27.0
poorer	4904	26.4	3853	23.0
middle	4072	23.9	3262	21.1
richer	3494	22.9	2912	20.2
richest	2540	21.1	2102	17.8
Maternal Education				
illiterate	6484	28.7	3807	26.5
primary	2945	26	1965	22.8
secondary	9743	24.5	8870	21.8
higher	2154	22.1	2495	18.6
Maternal Height				
0–145 cm	2921	28.6	2433	24.8
145–149.9 cm	6120	27.2	4856	24.4
150–154.9 cm	7067	25.2	5696	22.1
155–159.9 cm	3880	23.7	2930	19.6
160+ cm	1300	21.2	1220	18.3
Maternal BMI				
< 18.5 kg/m^2	6567	30.5	4302	26.9
18.5–24.9 kg/m^2	11488	24.7	9926	22.4
25.0 + kg/m^2	1879	19.5	1921	16.0
Age at Marriage				
less than 18	10729	26.0	8176	23.7
greater than 18	10429	25.0	8945	21.1
Dietary Diversity Score				
0	9839	29.2	8008	24.5
1	4501	25.2	2964	21.6
2	3117	22.6	2397	20.3
3	1973	22.5	1749	20.1
4	913	19.7	996	20.4
5	533	21.2	504	18.8
6	450	20.1	519	20

TABLE 2

Continued

Infectious Disease				
no	15174	25.4	12388	22.1
yes	6152	25.8	4749	22.7
Initiation of Breastfeeding				
> 1 hour of birth	8875	25.4	7086	21.9
=<1 hour of birth	12451	25.7	10051	22.5
Drinking Water				
not improved	3814	26.6	2625	22.1
improved	17511	25.3	12389	22.5
Stool Disposal				
safe	5210	22.9	5831	20.1
unsafe	15899	26.5	10834	23.5
Sanitary Facility				
improved	8931	22.3	10462	20.9
unimproved	10533	28.8	5352	25.4
Household Air Quality				
solid fuels in non – separate kitchen	3474	25.9	2775	23.1
solid fuels in separate kitchen	10104	27.2	5971	25.0
solid fuels	5914	22.6	7118	20.1
Households with Iodized Salt				
not used	1557	27.4	1131	23.7
used	19703	25.4	15966	22.2
Full Vaccination				
no	13747	27.8	6973	25.3
yes	7399	22.2	5820	19.6
Vitamin A Supplementation				
no	10507	27.2	7379	23.3
yes	10585	24.1	9577	21.4
Family Planning Needs Met				
no	13093	24.2	12566	21.6
yes	7505	28.4	4117	24.3
Skilled Birth Attendance at the Delivery				
no	3891	28.3	1818	24.9
yes	17434	25.0	15319	22.0
Antenatal Care Visits				
less than four	10773	27.4	7203	23.9
at least four	9875	24.2	9275	21.4
Oral Rehydration Therapy for Children Diarrhea				
no	1721	28.2	864	25.1
yes	1513	27.0	1091	23.5
Paternal Education				
illiterate	709	29.7	420	25.5
primary	530	27.2	303	20.5
secondary	1977	24.5	1465	22.8
higher	458	21.6	366	17.4

TABLE 3

DISTRIBUTION OF UNDERWEIGHT BY SELECTED CORRELATES AMONG CHILDREN AGED 6–23 MONTHS, INDIA NFHS 2016–2021

Characteristics	N (2016)	Underweight %	N (2021)	Underweight %
Total	83461	31.6	81946	29.2
Age in Months				
6–11 months	39745	27.8	41197	27.4
12–23 months	43716	35.1	40749	31.0
Sex of Child				
male	43235	33.6	42264	31.5
female	40226	29.4	39682	26.8
Birth Order				
1	31946	28.8	32597	27.1
2–3	40436	30.9	40176	29.2
4–5	8550	40.7	7472	36.4
6 & above	2530	48.7	1699	38.9
Place of Residence				
urban	22405	26	20767	25.4
rural	61057	33.7	61179	30.5
Wealth Index				
poorest	20532	44.9	19703	39.5
poorer	18605	35	17861	32.3
middle	17018	28.7	16447	27.1
richer	15241	23.9	15253	22.9
richest	12065	17.6	12681	19.2
Maternal Education				
illiterate	22568	42.9	15272	38.4
primary	11310	35.4	9172	34.3
secondary	39833	27.7	43211	27.8
higher	9750	17.1	14291	20.3
Maternal Height				
0–145 cm	10228	47.0	10379	41.9
145–149.9 cm	22524	37.5	21161	33.1
150–154.9 cm	28010	29.2	27352	27.8
155–159.9 cm	16403	23.1	15851	22.1
160+ cm	6140	17.9	7188	20.5
Maternal BMI				
< 18.5 kg/m^2	21495	42.0	16846	38.8
18.5–24.9 kg/m^2	46522	28.7	47494	28.1
25.0 + kg/m^2	9650	17.4	12730	18.7
Age at Marriage				
less than 18	41212	34.8	36577	32.4
greater than 18	41645	28.3	45265	26.7
Dietary Diversity Score				
0	33687	31	35710	29.3
1	17847	33.3	14291	29.0
2	13797	34.3	12281	29.4
3	8762	31.2	9086	29.1
4	4622	27.6	5051	30.1
5	2513	28.2	2807	27.1
6	2233	24.7	2719	29.5

TABLE 3

Continued

Infectious Disease				
no	59649	31.1	59960	28.7
yes	23812	32.9	21986	30.7
Initiation of Breastfeeding				
> 1 hour of birth	34969	30.8	34318	28.8
=<1 hour of birth	48492	32.2	47627	29.5
Drinking Water				
not improved	14346	30.5	12782	27.9
improved	69115	31.8	58574	29.6
Stool Disposal				
safe	22783	24.3	30862	25.3
unsafe	59887	34.4	48981	31.5
Sanitary Facility				
improved	39993	24.4	53193	26.3
unimproved	36584	39.9	22353	36.7
Household Air Quality				
solid fuels in non – separate kitchen	13420	34.0	12666	32.4
solid fuels in separate kitchen	37085	37.6	25332	34.7
solid fuels	26149	22.4	37681	24.9
Households with Iodized Salt				
not used	5687	35.6	5055	32.8
used	77476	31.3	76654	29.0
Full Vaccination				
no	49455	31.1	30418	30.6
yes	33332	32.3	30679	29.5
Vitamin A Supplementation				
no	38632	31.7	34114	29.2
yes	43993	31.5	47149	29.1
Family Planning Needs Met				
no	54200	30.9	61353	28.7
yes	26409	32.9	18412	30.8
Skilled Birth Attendance at the Delivery				
no	13754	40.6	7739	34.8
yes	69707	29.8	74207	28.6
Antenatal Care Visits				
less than four	39358	36.9	31978	32.0
at least four	40787	26.3	46249	27.1
Oral Rehydration Therapy for Children Diarrhea				
no	6099	34.4	3613	32.7
yes	5595	36.1	4835	32.0
Paternal Education				
illiterate	2389	44.4	1770	37.7
primary	1948	36.8	1568	33.4
secondary	8078	28.5	6837	28.9
higher	2122	20.9	2250	20.2

TABLE 4

DISTRIBUTION OF MODERATE STUNTING BY SELECTED CORRELATES AMONG CHILDREN AGED 6–23 MONTHS, INDIA NFHS 2016–2021

Characteristics	N (2016)	Moderate Stunting %	N (2021)	Moderate Stunting %
Total	14755	17.7	12688	16.1
Age in Months				
6–11 months	4621	11.6	4466	11.4
12–23 months	10134	23.2	8222	20.8
Sex of child				
male	7671	17.7	6822	16.9
female	7085	17.6	5866	15.4
Birth Order				
1	5228	16.4	4727	15.2
2–3	7261	18.0	6360	16.4
4–5	1721	20.1	1301	18.1
6 & above	545	21.5	300	18.5
Place of Residence				
urban	3555	15.9	2767	14.0
rural	11200	18.3	9921	16.9
wealth index				
poorest	4226	20.6	3437	18.2
poorer	3706	19.9	3156	18.4
middle	3054	17.9	2540	16.1
richer	2317	15.2	2137	14.5
richest	1452	12.0	1418	11.8
Maternal Education				
illiterate	4703	20.8	2683	18.2
primary	2359	20.9	1549	17.5
secondary	6587	16.5	6758	16.3
higher	1107	11.4	1697	12.4
Maternal Height				
0–145 cm	2401	23.5	1997	20.1
145–149.9 cm	4448	19.7	3739	18.3
150–154.9 cm	4845	17.3	4237	16.1
155–159.9 cm	2339	14.3	1988	13.1
160+ cm	689	11.2	722	10.6
Maternal BMI				
< 18.5 kg/m^2	4320	20.1	3146	19.4
18.5–24.9 kg/m^2	7731	16.6	6814	15.0
25.0 + kg/m^2	1303	13.5	1661	13.6
Age at Marriage				
less than 18	7920	19.2	6158	17.5
greater than 18	6718	16.1	6509	15.0
Dietary Diversity Score				
0	4778	14.2	4665	13.8
1	3386	19.0	2299	16.6
2	2884	20.9	2204	18.5
3	1818	20.7	1588	18.0
4	964	20.9	910	18.6
5	543	21.6	516	18.9
6	383	17.1	506	19.4

TABLE 4

Continued

Infectious Disease				
no	10527	17.6	9154	15.9
yes	4228	17.8	3534	16.7
Initiation of Breastfeeding				
> 1 hour of birth	6114	17.5	5390	16.3
=<1 hour of birth	8641	17.8	7298	16.0
Drinking Water				
not improved	2326	16.2	1817	14.9
improved	12429	18.0	9214	16.4
Stool Disposal				
safe	3505	15.4	4408	14.9
unsafe	11108	18.5	7933	16.9
Sanitary Facility				
improved	6298	15.7	7812	15.3
unimproved	7391	20.2	3977	18.5
Household Air Quality				
solid fuels in non – separate kitchen	2541	18.9	2171	17.8
solid fuels in separate kitchen	7313	19.7	4318	17.7
solid fuels	3853	14.7	5338	14.8
Households with Iodized Salt				
not used	1068	18.8	840	17.3
used	13637	17.6	11796	16.0
Full Vaccination				
no	7561	15.3	3972	13.8
yes	7089	21.3	5847	19.6
Vitamin A Supplementation				
no	6482	16.8	4866	14.9
yes	8124	18.5	7709	17.0
Family Planning Needs Met				
no	9956	18.4	9496	16.1
yes	4326	16.4	2882	16.5
Skilled Birth Attendance at the Delivery				
no	2759	20.1	1300	17.5
yes	11996	17.2	11388	16.0
Antenatal Care Visits				
less than four	7649	19.4	5028	16.3
at least four	6392	15.7	6926	15.6
Oral Rehydration Therapy for Children Diarrhea				
no	1045	17.1	609	17.5
yes	1032	18.4	809	17.4
Paternal Education				
illiterate	509	21.3	301	17.8
primary	377	19.4	259	17.2
secondary	1369	16.9	1124	17.1
higher	262	12.4	269	12.5

TABLE 5

DISTRIBUTION OF MODERATE UNDERWEIGHT BY SELECTED CORRELATES AMONG CHILDREN AGED 6–23 MONTHS, INDIA NFHS 2016–2021

Characteristics	N (2016)	Moderate Underweight %	N (2021)	Moderate Underweight %
Total	17709	21.2	14954	18.2
Age in Months				
6–11 months	7366	18.5	6817	16.5
12–23 months	10343	23.7	8137	20.0
Sex of Child				
male	9562	22.1	8072	19.1
female	8147	20.3	6882	17.3
Birth Order				
1	6309	19.7	5529	17.0
2–3	8513	21.1	7414	18.5
4–5	2195	25.7	1652	22.1
6 & Above	692	27.3	359	21.2
Place of Residence				
urban	4002	17.9	3289	15.8
rural	13706	22.4	11666	19.1
Wealth Index				
poorest	5728	27.9	4647	23.6
poorer	4343	23.3	3672	20.6
middle	3495	20.5	2831	17.2
richer	2635	17.3	2312	15.2
richest	1509	12.5	1492	11.8
Maternal Education				
illiterate	6010	26.6	3424	22.4
primary	2771	24.5	1969	21.5
secondary	7720	19.4	7697	17.8
higher	1209	12.4	1865	13.1
Maternal Height				
0–145 cm	2953	28.9	2658	25.6
145–149.9 cm	5526	24.5	4281	20.2
150–154.9 cm	5735	20.5	4908	17.9
155–159.9 cm	2648	16.1	2223	14.0
160+ cm	812	13.2	881	12.3
Maternal BMI				
< 18.5 kg/m^2	5901	27.5	4166	24.7
18.5–24.9 kg/m^2	9022	19.4	8141	17.1
25.0 + kg/m^2	1228	12.7	1544	12.1
Age at Marriage				
less than 18	9681	23.5	7393	20.2
greater than 18	7887	18.9	7534	16.6
Dietary Diversity Score				
0	6738	20.0	6283	17.6
1	4081	22.9	2623	18.4
2	3270	23.7	2315	18.9
3	1846	21.1	1687	18.6
4	890	19.3	1007	19.9
5	488	19.4	506	18.0
6	396	17.7	533	19.6

TABLE 5

Continued

Infectious Disease				
no	12447	20.9	10672	17.8
yes	5262	22.1	4282	19.5
Initiation of Breastfeeding				
> 1 hour of birth	7294	20.9	6347	18.5
=<1 hour of birth	10415	21.5	8607	18.1
Drinking Water				
not improved	2976	20.7	2223	17.4
improved	14733	21.3	10809	18.5
Stool Disposal				
safe	3832	16.8	4957	16.1
unsafe	13682	22.8	9582	19.6
Sanitary Facility				
improved	6806	17.0	8851	16.6
unimproved	9527	26.0	4974	22.3
Household Air Quality				
solid fuels in non – separate kitchen	3052	22.7	2595	20.5
solid fuels in separate kitchen	9119	24.6	5303	20.9
solid fuels	4175	16.0	5964	15.8
Households with Iodized Salt				
not used	1381	24.3	1017	20.1
used	16280	21.0	13894	18.1
Full Vaccination				
no	10082	20.4	5591	18.4
yes	7455	22.4	5876	19.2
Vitamin A Supplementation				
no	8098	21.0	6183	18.1
yes	9450	21.5	8630	18.3
Family Planning Needs Met				
no	11405	21.0	11133	18.1
yes	5670	21.5	3430	18.6
Skilled Birth Attendance at the Delivery				
no	3592	26.1	1630	21.1
yes	14117	20.3	13324	18.0
Antenatal Care Visits				
less than four	9521	24.2	6318	19.8
at least four	7475	18.3	7898	17.1
Oral Rehydration Therapy for Children Diarrhea				
no	1369	22.4	780	21.6
yes	1352	24.2	961	19.9
Paternal Education				
illiterate	698	29.2	371	21.0
primary	485	24.9	343	21.9
secondary	1533	19.0	1222	17.9
higher	338	15.9	298	13.2

TABLE 6

DISTRIBUTION OF MODERATE WASTING BY SELECTED CORRELATES AMONG CHILDREN AGED 6–23 MONTHS, INDIA NFHS 2016–2021

Characteristics	N (2016)	Moderate Wasting %	N (2021)	Moderate Wasting %
Total	13014	15.6	9717	12.6
Age in months				
6–11 months	6721	16.9	5212	13.8
12–23 months	6293	14.4	4505	11.4
Sex of Child				
male	6880	15.9	5150	13.0
female	6134	15.2	4567	12.2
Birth Order				
1	4929	15.4	3704	12.1
2–3	6128	15.2	4765	12.6
4–5	1462	17.1	1010	14.3
6 & above	495	19.6	240	14.8
Place of Residence				
urban	3250	14.5	2154	11.1
rural	9764	16.0	7563	13.1
Wealth Index				
poorest	3813	18.6	2918	15.8
poorer	3002	16.1	2248	13.4
middle	2473	14.5	1816	11.7
richer	2163	14.2	1647	11.4
richest	1563	13.0	1089	9.2
Maternal Education				
illiterate	3913	17.3	2111	14.7
primary	1806	16.0	1169	13.6
secondary	5972	15.0	5068	12.5
higher	1323	13.6	1370	10.2
Maternal Height				
0–145 cm	1715	16.8	1417	14.5
145–149.9 cm	3696	16.4	2782	14.0
150–154.9 cm	4352	15.5	3241	12.6
155–159.9 cm	2400	14.6	1625	10.9
160+ cm	828	13.5	651	9.8
Maternal BMI				
< 18.5 kg/m^2	3995	18.6	2581	16.2
18.5–24.9 kg/m^2	6915	14.9	5443	12.3
25.0 + kg/m^2	1160	12.0	1112	9.3
Age at Marriage				
less than 18	6638	16.1	4724	13.7
greater than 18	6287	15.1	4983	11.7
Dietary Diversity Score				
0	5645	16.8	4336	13.3
1	2795	15.7	1752	12.8
2	2038	14.8	1409	11.9
3	1291	14.7	1044	12.0
4	587	12.7	579	11.9
5	349	13.9	291	10.9
6	308	13.8	305	11.7

TABLE 6

Continued

Infectious Disease				
no	9098	15.3	6894	12.3
yes	3916	16.4	2824	13.5
Initiation of Breastfeeding				
> 1 hour of birth	5378	15.4	3990	12.3
=<1 hour of birth	7636	15.7	5727	12.8
Drinking Water				
not improved	2288	16.0	1408	11.8
improved	10725	15.5	7064	12.8
Stool Disposal				
safe	3216	14.1	3251	11.2
unsafe	9666	16.1	6189	13.4
Sanitary Facility				
improved	5574	13.9	5937	11.9
unimproved	6353	17.4	3082	14.6
Household Air Quality				
solid fuels in non – separate kitchen	2158	16.1	1624	13.5
solid fuels in separate kitchen	6147	16.6	3468	14.5
solid fuels	3645	13.9	3956	11.2
Households with Iodized Salt				
not used	943	16.6	653	13.7
used	12039	15.5	9041	12.5
Full Vaccination				
no	8068	16.3	3732	13.6
yes	4837	14.5	3450	11.6
Vitamin A Supplementation				
no	6290	16.3	4161	13.1
yes	6584	15.0	5457	12.2
Family Planning Needs Met				
no	8130	15.0	7237	12.5
yes	4479	17.0	2216	13.1
Skilled Birth Attendance at the Delivery				
no	2367	17.2	1026	14.1
yes	10647	15.3	8691	12.5
Antenatal Care Visits				
less than four	6584	16.7	4114	13.6
at least four	5973	14.6	5247	12.1
Oral Rehydration Therapy for Children Diarrhea				
no	1096	18.0	539	15.7
yes	964	17.2	666	14.4
Paternal Education				
illiterate	429	18.0	236	14.3
primary	321	16.5	169	11.4
secondary	1159	14.3	839	13.0
higher	280	13.2	198	9.4

TABLE 7

DISTRIBUTION OF SEVERE STUNTING BY SELECTED CORRELATES AMONG CHILDREN AGED 6–23 MONTHS, INDIA NFHS 2016–2021

Characteristics	N (2016)	Severe Stunting %	N (2021)	Severe Stunting %
Total	12393	14.8	12532	15.9
Age in Months				
6–11 months	3951	9.9	5072	13.0
12–23 months	8441	19.3	7460	18.8
Sex of Child				
male	7254	16.8	7052	17.4
female	5139	12.8	5480	14.3
Birth Order				
1	4099	12.8	4600	14.8
2–3	5975	14.8	6118	15.8
4–5	1715	20.1	1432	20.0
6 & above	604	23.9	382	23.5
Place of Residence				
urban	2741	12.2	2894	14.6
rural	9652	15.8	9638	16.4
Wealth Index				
poorest	4397	21.4	4022	21.3
poorer	2993	16.1	2952	17.2
middle	2205	13.0	2382	15.1
richer	1723	11.3	1826	12.4
richest	1075	8.9	1350	11.2
Maternal Education				
illiterate	4785	21.2	3165	21.5
primary	1834	16.2	1656	18.7
secondary	4934	12.4	6175	14.9
higher	840	8.6	1536	11.2
Maternal Height				
0–145 cm	2438	23.8	2532	25.5
145–149.9 cm	3895	17.3	3749	18.4
150–154.9 cm	3767	13.4	3744	14.2
155–159.9 cm	1729	10.5	1724	11.3
160+ cm	545	8.9	781	11.5
Maternal BMI				
< 18.5 kg/m^2	3793	17.6	3022	18.6
18.5–24.9 kg/m^2	6482	13.9	7142	15.7
25.0 + kg/m^2	898	9.3	1405	11.5
Age at Marriage				
less than 18	6763	16.4	6133	17.4
greater than 18	5529	13.3	6387	14.7
Dietary Diversity Score				
0	4386	13.0	5115	15.1
1	2745	15.4	2176	15.7
2	2464	17.9	2027	17.0
3	1447	16.5	1509	17.1
4	685	14.8	831	16.9
5	340	13.5	446	16.4
6	326	14.6	427	16.4

TABLE 7

Continued

Infectious Disease				
no	8972	15.0	9224	16.0
yes	3421	14.4	3308	15.7
Initiation of Breastfeeding				
> 1 hour of birth	5109	14.6	5270	16.0
=<1 hour of birth	7283	15.0	7262	15.9
Drinking Water				
not improved	1873	13.1	1734	14.2
improved	10520	15.2	9194	16.3
Stool Disposal				
safe	2723	12.0	4349	14.7
unsafe	9552	15.9	7828	16.6
Sanitary Facility				
improved	4683	11.7	7500	14.7
unimproved	6924	18.9	4187	19.5
Household Air Quality				
solid fuels in non – separate kitchen	2192	16.3	2161	17.7
solid fuels in separate kitchen	6561	17.7	4437	18.2
solid fuels	2851	10.9	5116	14.2
Households with Iodized Salt				
not used	937	16.5	853	17.6
used	11403	14.7	11649	15.8
Full Vaccination				
no	6823	13.8	4541	15.8
yes	5448	16.3	5206	17.4
Vitamin A Supplementation				
no	5426	14.0	4979	15.3
yes	6833	15.5	7452	16.4
Family Planning Needs Met				
no	7955	14.7	9398	15.9
yes	4029	15.3	2768	15.8
Skilled Birth Attendance at the Delivery				
no	2704	19.7	1474	19.9
yes	9688	13.9	11058	15.5
Antenatal Care Visits				
less than four	6761	17.2	5241	17.0
at least four	4948	12.1	6580	14.9
Oral Rehydration Therapy for Children Diarrhea				
no	889	14.6	521	15.0
yes	878	15.7	757	16.3
Paternal Education				
illiterate	499	20.9	386	22.8
primary	317	16.3	283	18.8
secondary	1127	14.0	981	14.9
higher	187	8.8	262	12.2

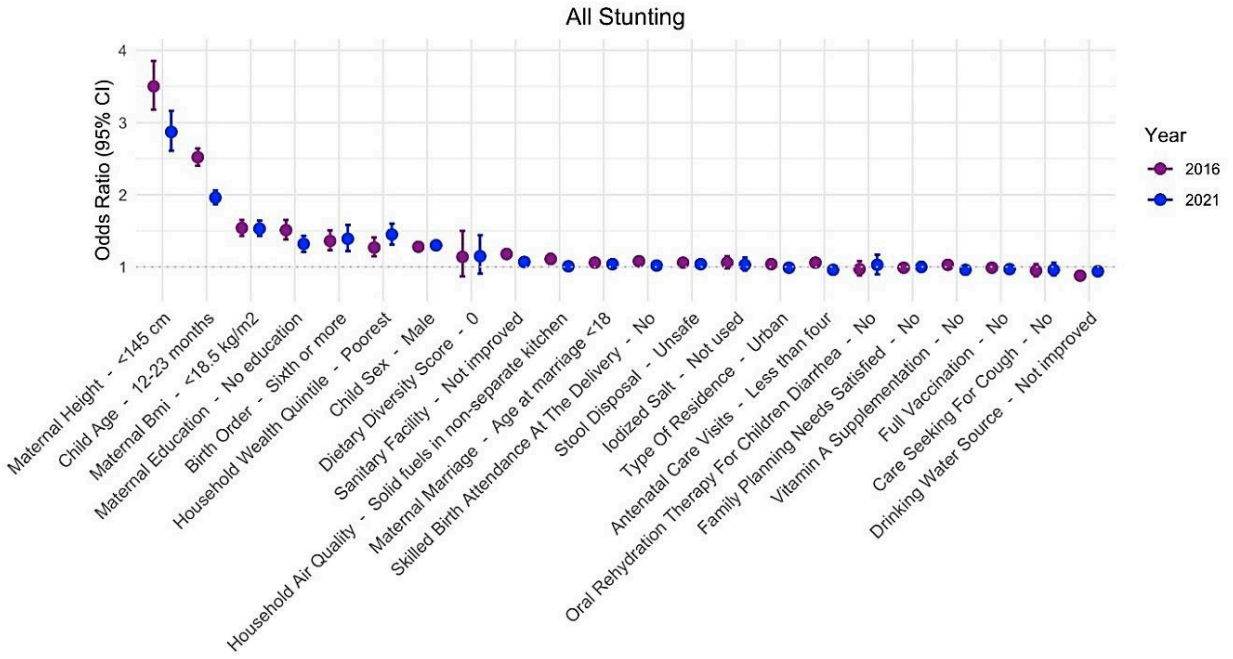

Fig. 1. Odds ratio and 95% CI of Stunting by selected correlates among child aged 6–23 months, NFHS-4 and NFHS-5.

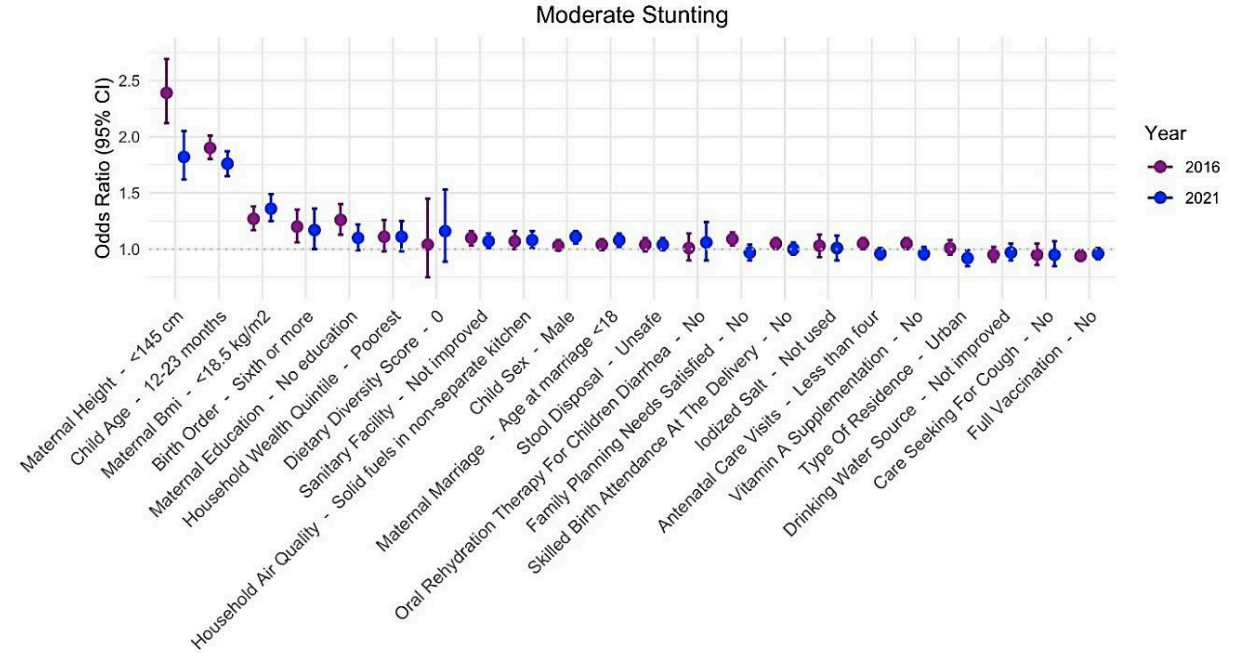

Fig. 2. Odds ratio and 95% CI of Moderate Stunting by selected correlates among child aged 6–23 months, NFHS-4 and NFHS-5.

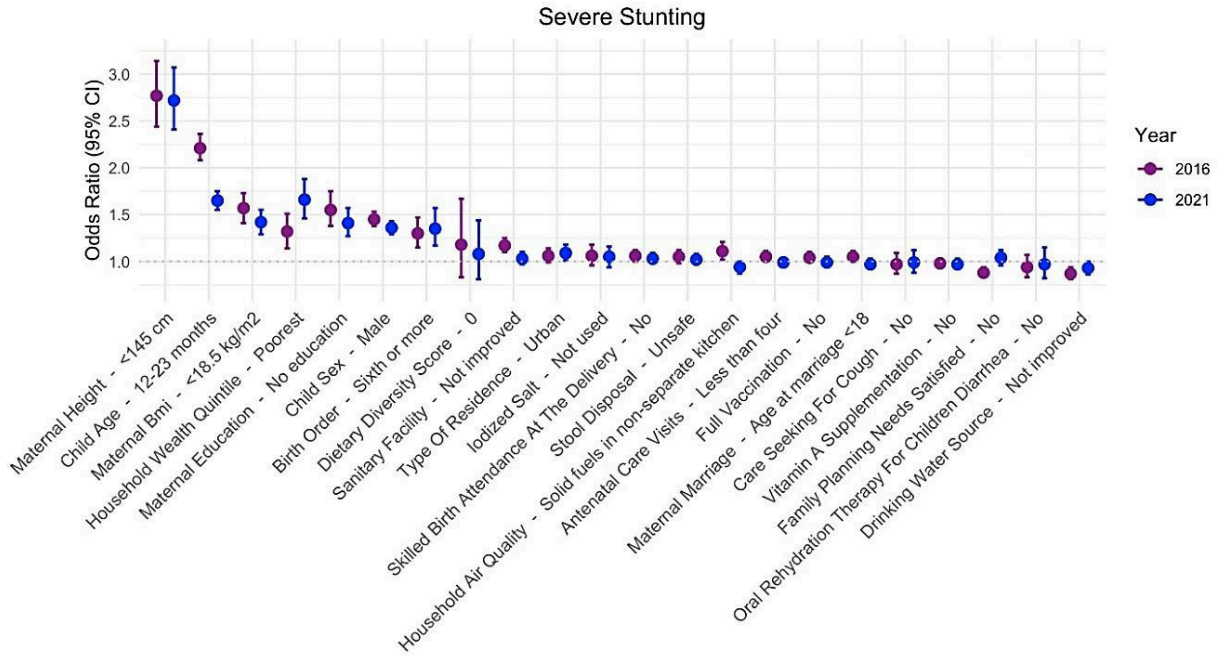

Fig. 3. Odds ratio and 95% CI of Severe Stunting by selected correlates among child aged 6–23 months, NFHS-4 and NFHS-5.

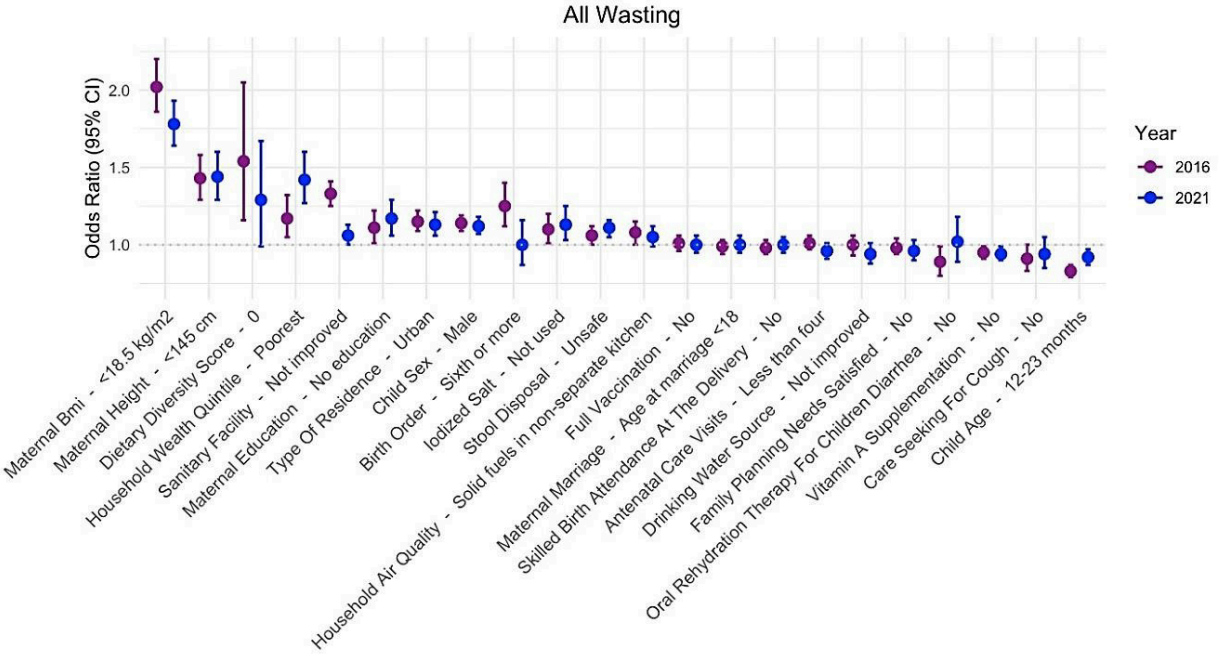

Fig. 4. Odds ratio and 95% CI of Wasting by selected correlates among child aged 6–23 months, NFHS-4 and NFHS-5.

TABLE 8

DISTRIBUTION OF SEVERE WASTING BY SELECTED CORRELATES AMONG CHILDREN AGED 6–23 MONTHS, INDIA NFHS 2016–2021

Characteristics	N (2016)	Severe Wasting %	N (2021)	Severe Wasting %
Total	8231	9.9	7371	9.6
Age in Months				
6–11 months	4967	12.5	4191	11.1
12–23 months	3264	7.5	3180	8.1
Sex of child				
male	4491	10.4	4011	10.1
female	3740	9.3	3360	9.0
Birth Order				
1	3021	9.5	2814	9.2
2–3	3902	9.6	3640	9.6
4–5	957	11.2	735	10.4
6 & above	351	13.9	182	11.3
Place of Residence				
urban	2139	9.5	1778	9.2
rural	6092	10.0	5593	9.7
Wealth Index				
poorest	2486	12.1	2075	11.2
poorer	1883	10.1	1600	9.5
middle	1578	9.3	1442	9.3
richer	1316	8.6	1252	8.7
richest	967	8.0	1003	8.5
Maternal Education				
illiterate	2550	11.3	1688	11.8
primary	1128	10.0	789	9.2
secondary	3730	9.4	3777	9.3
higher	822	8.4	1117	8.3
Maternal Height				
0–145 cm	1198	11.7	1010	10.3
145–149.9 cm	2407	10.7	2062	10.4
150–154.9 cm	2685	9.6	2433	9.5
155–159.9 cm	1458	8.9	1298	8.7
160+ cm	467	7.6	568	8.5
Maternal BMI				
< 18.5 kg/m^2	2532	11.8	1700	10.6
18.5–24.9 kg/m^2	4544	9.8	4458	10.0
25.0 + kg/m^2	711	7.4	807	6.7
Age at Marriage				
less than 18	4048	9.8	3431	9.9
greater than 18	4104	9.9	3936	9.3
Dietary Diversity Score				
0	4155	12.3	3651	11.2
1	1690	9.5	1204	8.8
2	1069	7.7	978	8.3
3	675	7.7	698	8.0
4	323	7.0	414	8.5
5	184	7.3	212	7.9
6	135	6.1	214	8.2

TABLE 8

Continued

Infectious Disease				
no	6021	10.1	5463	9.7
yes	2210	9.3	1908	9.1
Initiation of Breastfeeding				
> 1 hour of birth	3467	9.9	3079	9.5
=<1 hour of birth	4764	9.8	4292	9.6
Drinking Water				
not improved	1502	10.5	1213	10.2
improved	6728	9.7	5283	9.6
Stool Disposal				
safe	1980	8.7	2557	8.8
unsafe	6167	10.3	4620	10.0
Sanitary Facility				
improved	3321	8.3	4495	9.0
unimproved	4146	11.3	2255	10.7
Household Air Quality				
solid fuels in non – separate kitchen	1303	9.7	1147	9.5
solid fuels in separate kitchen	3919	10.6	2491	10.4
solid fuels	2250	8.6	3134	8.9
Households with Iodized Salt				
not used	611	10.7	476	10.0
used	7586	9.8	6878	9.5
Full Vaccination				
no	5627	11.4	3234	11.7
yes	2534	7.6	2349	7.9
Vitamin A Supplementation				
no	4179	10.8	3205	10.1
yes	3958	9.0	4085	9.1
Family Planning Needs Met				
no	4911	9.1	5292	9.1
yes	3000	11.4	1891	11.2
Skilled Birth Attendance at the Delivery				
no	1515	11.0	791	10.8
yes	6716	9.6	6581	9.4
Antenatal Care Visits				
less than four	4158	10.6	3068	10.2
at least four	3855	9.5	4001	9.2
Oral Rehydration Therapy for Children Diarrhea				
no	618	10.1	320	9.3
yes	542	9.7	423	9.1
Paternal Education				
illiterate	277	11.6	184	11.2
primary	208	10.7	133	9.0
secondary	811	10.0	613	9.5
higher	174	8.2	167	7.9

TABLE 9

DISTRIBUTION OF SEVERE UNDERWEIGHT BY SELECTED CORRELATES AMONG CHILDREN AGED 6–23 MONTHS, INDIA NFHS 2016–2021

Characteristics	N (2016)	Severe Underweight %	N (2021)	Severe Underweight %
Total	8559	10.3	8915	10.9
Age in Months				
6–11 months	3628	9.1	4442	10.8
12–23 months	4932	11.3	4473	11.0
Sex of Child				
male	4922	11.4	5188	12.3
female	3637	9.0	3727	9.4
Birth Order				
1	2846	8.9	3269	10.0
2–3	3905	9.7	4289	10.7
4–5	1270	14.9	1059	14.2
6 & above	538	21.3	297	17.5
Place of Residence				
urban	1813	8.1	1978	9.5
rural	6746	11.0	6936	11.3
Wealth Index				
poorest	3444	16.8	3111	15.8
poorer	2146	11.5	2079	11.6
middle	1359	8.0	1622	9.9
richer	998	6.5	1165	7.6
richest	612	5.1	936	7.4
Maternal Education				
illiterate	3606	16.0	2421	15.9
primary	1220	10.8	1165	12.7
secondary	3283	8.2	4300	10.0
higher	450	4.6	1029	7.2
Maternal Height				
0–145 cm	1835	17.9	1672	16.1
145–149.9 cm	2864	12.7	2703	12.8
150–154.9 cm	2426	8.7	2682	9.8
155–159.9 cm	1136	6.9	1266	8.0
160+ cm	281	4.6	592	8.2
Maternal BMI				
< 18.5 kg/m^2	3098	14.4	2347	13.9
18.5–24.9 kg/m^2	4258	9.2	5160	10.9
25.0 + kg/m^2	452	4.7	831	6.5
Age at Marriage				
less than 18	4625	11.2	4416	12.1
greater than 18	3849	9.2	4489	9.9
Dietary Diversity Score				
0	3646	10.8	4156	11.6
1	1847	10.3	1498	10.5
2	1436	10.4	1280	10.4
3	877	10.0	948	10.4
4	377	8.1	512	10.1
5	222	8.8	251	8.9
6	155	6.9	269	9.9

TABLE 9

Continued

Infectious Disease				
no	6028	10.1	6466	10.8
yes	2531	10.6	2449	11.1
Initiation of Breastfeeding				
> 1 hour of birth	3437	9.8	3495	10.2
=<1 hour of birth	5123	10.6	5420	11.4
Drinking Water				
not improved	1384	9.6	1330	10.4
improved	7176	10.4	6479	11.1
Stool Disposal				
safe	1680	7.4	2841	9.2
unsafe	6801	11.4	5795	11.8
Sanitary Facility				
improved	2907	7.3	5120	9.6
unimproved	5016	13.7	3187	14.3
Household Air Quality				
solid fuels in non – separate kitchen	1497	11.2	1487	11.7
solid fuels in separate kitchen	4748	12.8	3444	13.6
solid fuels	1679	6.4	3400	9.0
Households with Iodized Salt				
not used	642	11.3	638	12.6
used	7883	10.2	8260	10.8
Full Vaccination				
no	5216	10.5	3679	12.1
yes	3278	9.8	3153	10.3
Vitamin A Supplementation				
no	4111	10.6	3762	11.0
yes	4348	9.9	5042	10.7
Family Planning Needs Met				
no	5280	9.7	6427	10.5
yes	2979	11.3	2225	12.1
Skilled Birth Attendance at the Delivery				
no	1967	14.3	1052	13.6
yes	6592	9.5	7863	10.6
Antenatal Care Visits				
less than four	4938	12.5	3879	12.1
at least four	3201	7.8	4624	10.0
Oral Rehydration Therapy for Children Diarrhea				
no	726	11.9	396	11.0
yes	664	11.9	578	12.0
Paternal Education				
illiterate	358	15.0	295	16.7
primary	230	11.8	179	11.4
secondary	765	9.5	747	10.9
higher	104	4.9	157	7.0

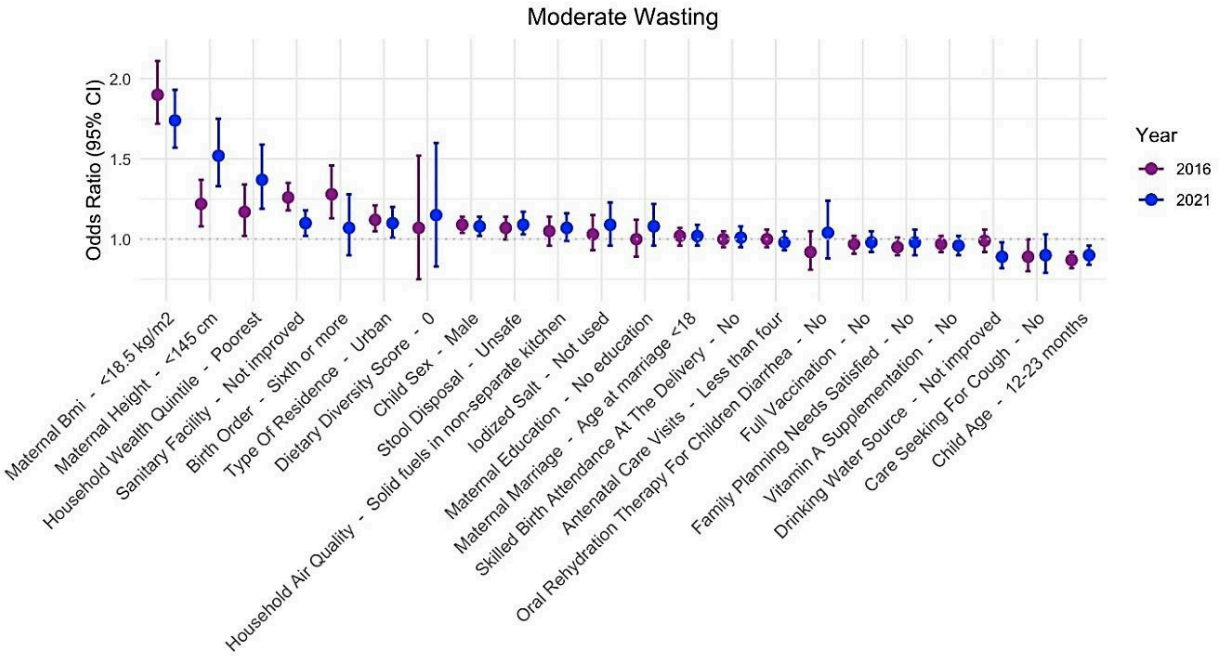

Fig. 5. Odds ratio and 95% CI of Moderate Wasting by selected correlates among child aged 6–23 months, NFHS-4 and NFHS-5.

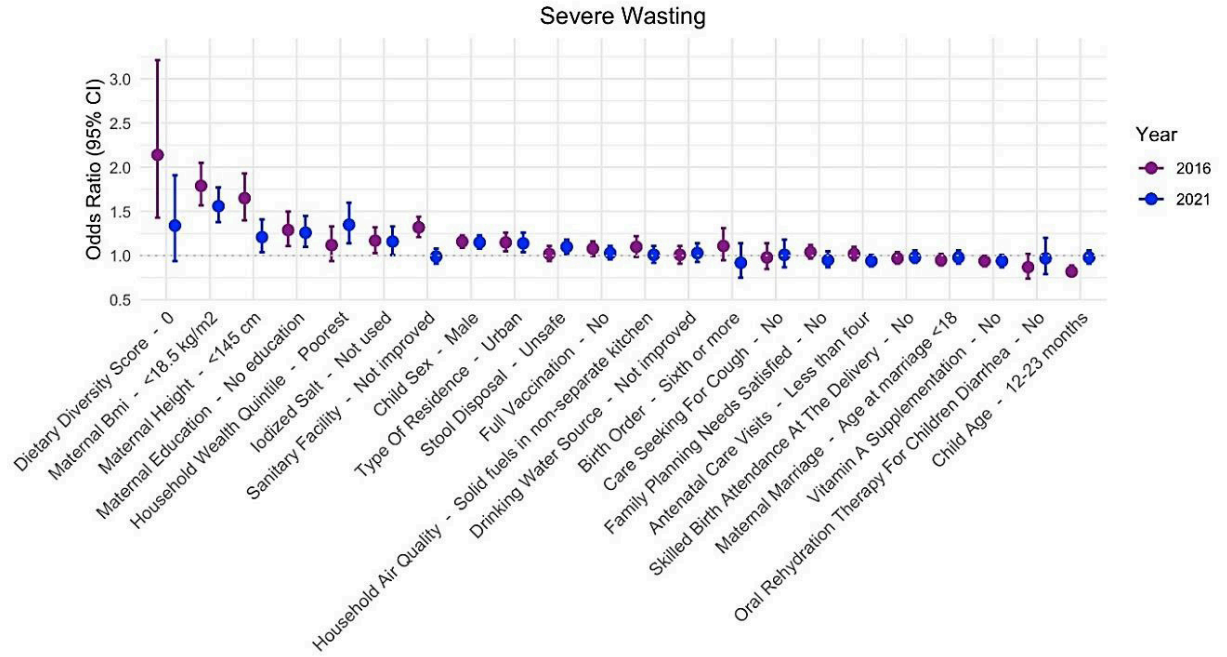

Fig. 6. Odds ratio and 95% CI of Severe Wasting by selected correlates among child aged 6–23 months, NFHS-4 and NFHS-5.

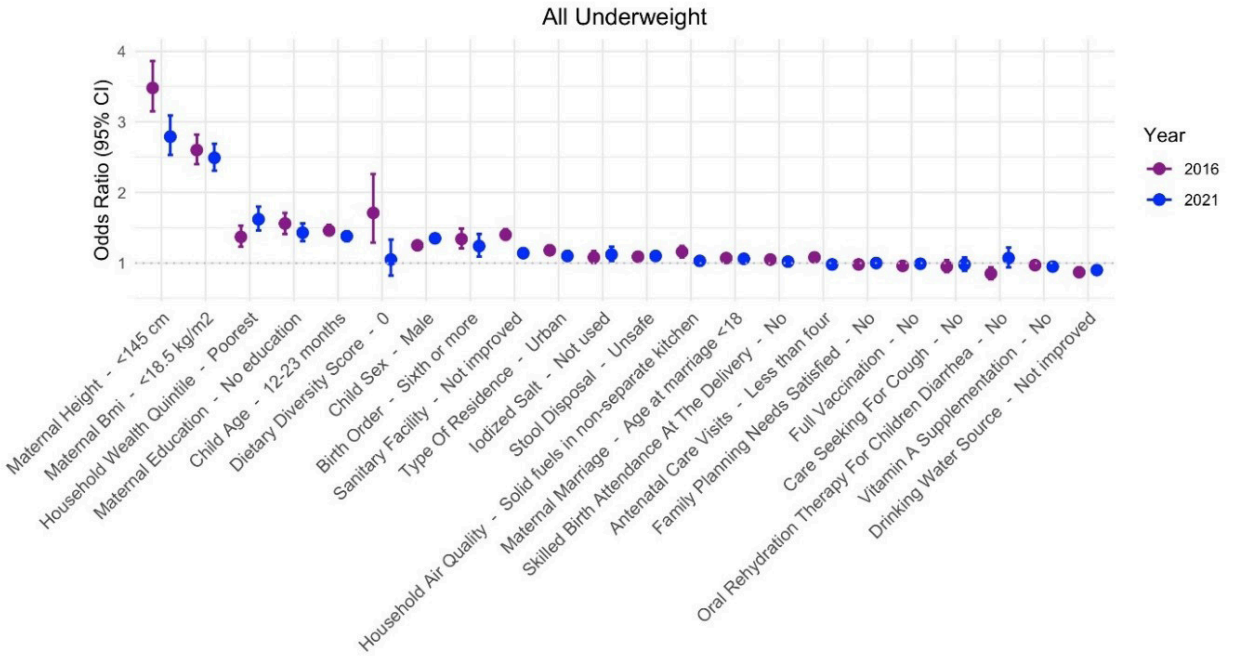

Fig. 7. Odds ratio and 95% CI of Underweight by selected correlates among child aged 6–23 months, NFHS-4 and NFHS-5.

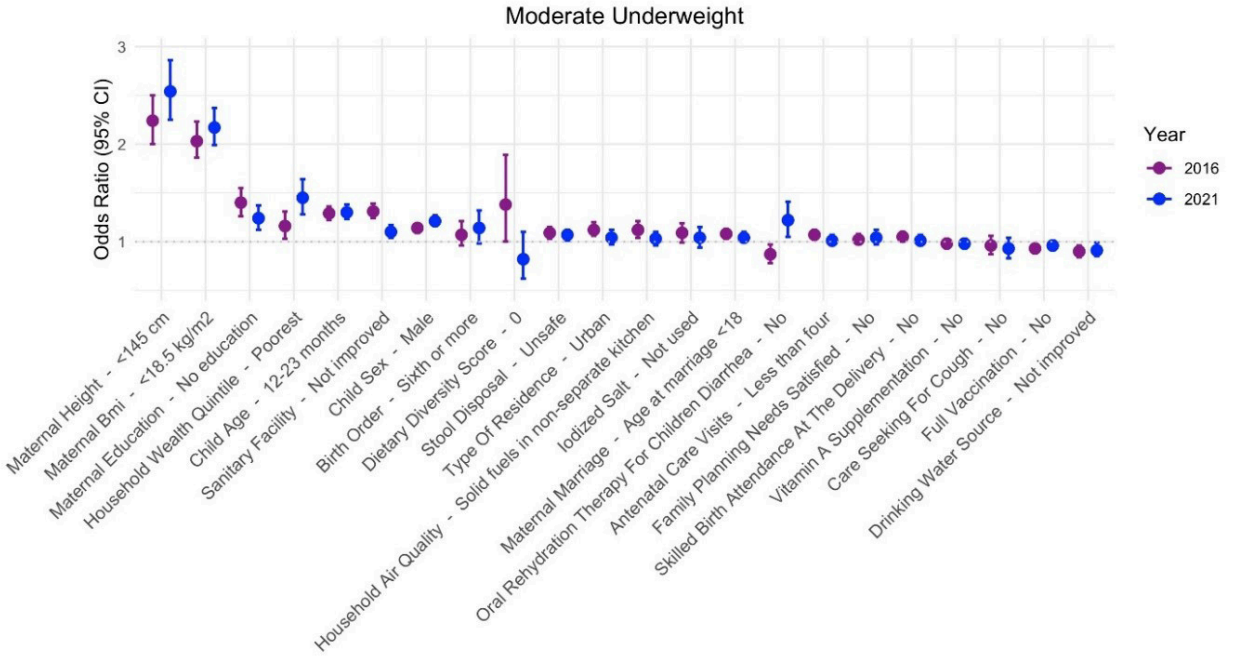

Fig. 8. Odds ratio and 95% CI of Moderate Underweight by selected correlates among child aged 6–23 months, NFHS-4 and NFHS-5.

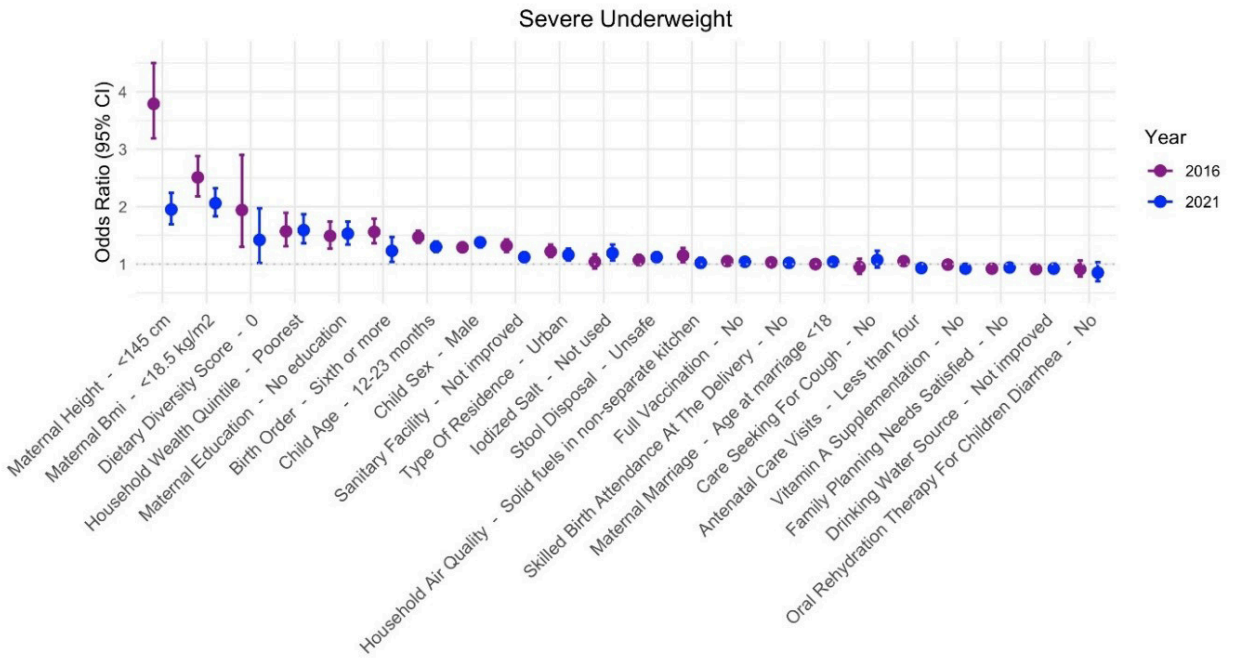

Fig. 9. Odds ratio and 95% CI of Severe Underweight by selected correlates among child aged 6–23 months, NFHS-4 and NFHS-5.

Lower odds of wasting were observed for lack of care-seeking for cough (OR: 0.85; 95% CI: 0.76–0.94), lack of ORS therapy for diarrhea (OR: 0.88; 95% CI: 0.79–0.98), and child age 12 to 23 months (OR: 0.92; 95% CI: 0.87–0.97).

For moderate and severe wasting (Figure 5–6), the top predictors were maternal BMI (for moderate: OR: 0.74; 95% CI: 0.57–0.93; for severe: OR: 1.56; 95% CI: 1.38–1.77), followed by household poverty and dietary diversity score of zero. The effect sizes for these predictors were lower compared to overall wasting. For instance, the odds of severe wasting in children from poor households were 1.37, compared to 1.42 for any level of wasting.

Underweight

In 2021, the fully controlled model for underweight (Figure 7) revealed that maternal height (less than 145 cm) was the strongest predictor (OR: 2.79; 95% CI: 2.53–3.09), followed by maternal BMI (less than 18.5 kg/m²) (OR: 2.49; 95% CI: 2.31–2.69), household poverty (OR: 1.88; 95% CI: 1.72–2.06), maternal illiteracy (OR: 1.43; 95% CI: 1.31–1.56), and child age over 12 months (OR: 1.38; 95% CI: 1.31–1.45).

Negative predictors of underweight included a dietary diversity score of seven (OR: 0.89; 95% CI: 0.76–1.04), lack of improved drinking water source (OR: 0.90; 95% CI: 0.84–0.96), lack of ORS therapy for diarrhea (OR: 0.93; 95% CI: 0.84–1.03), and lack of care-seeking for cough (OR: 0.93; 95% CI: 0.85–1.02). The effect sizes for most predictors of underweight ranged between odds of 1.0 to 1.5.

For moderate underweight (Figure 8), the strongest predictors were maternal height (less than 145 cm) (OR: 2.54; 95% CI: 2.25–2.86), maternal BMI (less than 18.5 kg/m²) (OR: 2.17; 95% CI: 1.99–2.37), and household poverty (OR: 1.45; 95% CI: 1.28–1.64). However, the effect sizes were smaller compared to overall underweight. For instance, the odds for underweight mothers were 2.49 in overall underweight, but only 1.7 in moderate underweight.

In severe underweight cases (Figure 9), the largest predictors were maternal BMI (less than 18 kg/m²) (OR: 2.06; 95% CI: 1.83–2.32), maternal height (OR: 1.95; 95% CI: 1.69–2.24), and household poverty (OR: 1.59; 95% CI: 1.36–1.87). Lack of ORS therapy (OR: 0.85; 95% CI: 0.70–1.03) and lack of safe drinking water (OR: 0.80; 95% CI: 0.81–0.98) were associated with lower odds of severe underweight.

Changes in predictors between 2016 and 2021

Between 2016 and 2021 (Figures 1–9), the effect sizes of key predictors—such as maternal underweight, stunted mothers, household poverty, maternal illiteracy, and zero dietary diversity—declined. For example, the odds of overall wasting for children of underweight mothers declined from 2.02 in 2016 to 1.77 in 2021. However, the odds of children being wasted due to household poverty increased in 2021 (OR: 1.42) compared to 2016 (OR: 1.17). Such reductions are more prominent in certain cases such as severe stunting where its odds with respect to maternal stunting have reduced from 3.79 in 2016 to 2.06 in 2021.

Discussion

This study presents four key findings. First, upstream factors such as maternal factors—specifically height, body mass index (BMI), and education—along with household poverty status and child age (above 12 months), exhibited the most consistent and strongest associations with an increased risk of anthropometric failures. Second, weaker and less consistent associations were observed for correlates such as vitamin A supplementation, lack of oral rehydration therapy (ORT), treatment for cough, unimproved drinking water sources, and vaccination, suggesting the relatively low impact of nutrition-specific interventions or downstream factors. Third, the ranking of predictors by effect size did not change substantially with the severity of anthropometric failures. However, for the primary predictors, such as maternal characteristics, the effect sizes were relatively larger in cases of overall anthropometric failures than in moderate or severe conditions. Fourth, between 2016 and 2021, the relative predictive strength of maternal characteristics—such as BMI, height, and education—decreased across all three anthropometric outcomes (moderate, severe, and overall). In contrast, the effect size of household poverty increased between the two rounds. Furthermore, we observed a slight increase in the effect sizes for nutrition intervention-related predictors, such as treatment for diarrhea, vitamin A supplementation, vaccination, and care-seeking for cough, across all three categories of anthropometric failures.

Our findings reveal significant similarities with previous studies that have examined related issues within India and other low- and middle-income countries (LMICs). For instance, earlier studies in India[7,12] found that maternal height, BMI, and education were the strongest predictors of child anthropometric failures. Across LMICs, as demonstrated in previous study[11], maternal factors, and household poverty remain the most significant predictors of all three anthropometric measures. However, the effect size in our study for 2021 is lower compared to earlier research. For example, previous study[12] using data from the third round of the National Family Health Survey (NFHS-3), reported an odds ratio of 4.2 for childhood stunting among mothers who were stunted. In contrast, our study, using data from 2021, computed an odds ratio of 3.5 for the same correlation. This decline is also apparent when comparing data between 2016 and 2021, as demonstrated in our study and supported by previous findings[7]. When comparing across countries, those with a lower developmental trajectory than India, the relative strength of maternal characteristics appears to be higher in these contexts compared to India for 2016 and 2021. There were notable differences in the ranking of predictors across countries[11]. In countries such as Cameroon, Gambia, Lesotho, and Mali, household poverty played the most crucial role, whereas maternal characteristics were the strongest predictors in other settings.

In light of the findings from our study, along with insights from previous studies in India that have addressed similar issues, as well as research that provides frameworks for improving child anthropometry through nutritional interventions, we were able to assess two key aspects. First, since across 25 years, maternal characteristics and household poverty continue to be the main predictors of child anthropometric failures, existing nutritional frameworks need to reassess the role of social determinants of health concerning child anthropometry. Ideally, these frameworks should be designed to consider children's nutritional status as a direct result of adequate nutrition, proper feeding practices, and illness management. For example, the UNICEF child and maternal nutrition framework[10] continues to emphasize that the immediate causes of a child's nutritional status are primarily diet and caregiving, with underlying factors including age-appropriate feeding, hygiene practices, and the availability of services such as social protection, a healthy living environment, and opportunities for physical activity for children.

Simultaneously, it is also essential to explore whether other pathways exist through which children's nutritional status may be affected. Previous studies have suggested that parental characteristics, such as stature, reflect economic status and quality of life, with body mass index (BMI) serving as an indicator of living standards[14]. If these are indeed the primary pathways through which child nutrition is impacted, then dietary measures and other factors related to living standards, such as healthcare access and food consumption, should emerge as stronger predictors of child undernutrition. However, since this has not been observed over time and again across populations, it becomes imperative to question if we are missing out on any intermediary factors that can act as pathways for upstream predictors.

Furthermore, two unique observations from this study warrant further exploration: (A) Why do the effect sizes of maternal stature decrease in cases of severe anthropometric failure compared to less severe malnutrition outcomes? and (B) Are the effect sizes of socioeconomic status (SES) factors and maternal characteristics generally diminishing over time, or with higher levels of economic development? These observations are particularly significant because economic development is expected to improve dietary allocation, vaccination coverage, childcare, sanitation, and other related factors. In this context, one might anticipate an increasing relevance of intergenerational factors. However, since this is not observed, it raises the question of whether development leads to a decline in intergenerational health transfers and a greater reliance on immediate causes. If this is the case, then prioritizing investments in immediate nutritional interventions may yield substantial benefits in terms of nutritional gains. Further investigation in this direction will be necessary to answer these questions with greater degree of reliability.

The findings of this study need to be considered in light of certain data related considerations. First, the cross sectional nature of the study did not allow for any causal inferences. Second, the use of multiple factors in the study may have correlation with each other resulting in multicollinearity. Third, the self-reported nature of some of the data such as vaccination, dietary diversity, care seeking, etc. are prone to potential reporting errors.

Conclusion

This systematic analysis of the relative significance of direct and indirect factors contributing to child anthropometric failures underscores the critical need for enhancing maternal nutritional status and improving household socioeconomic conditions. Simultaneously, it is essential to further investigate why the predictive power of maternal characteristics and socioeconomic status is diminishing, in order to better inform evidence-based nutritional interventions.

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POVEZANOST 23 KORELATA ANTROPOMETRIJSKOG PODBAČAJA DJECE U INDIJI

SAŽETAK

Ova studija procjenjuje povezanost između 23 čimbenika povezana s antropometrijskim ishodima djece u dobi od 6. do 23. mjeseca, koristeći podatke iz 4. kruga (2016.) i 5. kruga (2021.) Nacionalne ankete o zdravlju obitelji (NFHS) u Indiji. Čimbenici koji se ispituju uključuju karakteristike majke kao što su indeks tjelesne mase (BMI), visina, razina obrazovanja i detalji o trudnoći; karakteristike kućanstva poput vrste prebivališta, odlaganja otpada, kvalitete pitke vode, kvalitete zraka i statusa siromaštva; karakteristike djeteta uključuju dob, spol, status cijepljenja, raznolikost prehrane i tretmane za proljev i kašalj. Antropometrijske mjere zaostajanja u rastu, gubitka težine i pothranjenosti procijenjene su korištenjem standardnih devijacija za visinu u odnosu na dob, težinu u odnosu na dob i težinu u odnosu na visinu. Za analizu jačine povezanosti za obje godine korištena je binarna logistička regresija. Rezultati pokazuju da su karakteristike majke i siromaštvo kućanstva najjači prediktori antropometrijskih podbačaja djeteta u 2021. Nasuprot tome, čimbenici kao što su pristup liječenju, cijepljenje i sanitarni uvjeti pokazali su slabiju povezanost. Poredak ovih čimbenika bio je sličan u obje godine; međutim, snaga povezanosti za karakteristike majke smanjila se od 2016. do 2021. Nadalje, postojale su razlike u jačini povezanosti na temelju težine poremećaja.