

Socio-Demographic and Socio-Economic Factors Associated With Undernutrition among Children Aged 6–24 Months Attending a Tertiary-Care Hospital in Delhi: A Cross-Sectional Study

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Abstract

Background: The period from 6 to 23 months is a critical window for complementary feeding and child growth. Socio-economic circumstances may influence access to adequate food, care and health services. This study examined the burden of undernutrition and its socio-demographic and socio-economic correlates among children attending a tertiary-care IYCF service in Delhi.

Methods: This hospital-based cross-sectional analysis included all 197 children eligible within a 6–24-month age window; observed ages were 6–23 months. Anthropometric measurements were interpreted using WHO Child Growth Standards. Underweight, stunting and wasting were defined as WAZ, HAZ and WHZ <−2 SD, respectively. Fourteen socio-demographic variables were examined using unadjusted odds ratios (ORs) and exploratory multivariable logistic regression models.

Results: Underweight affected 73/197 children (37.1%), stunting 54/197 (27.4%) and wasting 51/197 (25.9%). Severe underweight, stunting and wasting affected 12.2%, 11.7% and 4.1%, respectively. Lower SES was associated with wasting in unadjusted analysis (OR 2.54, 95% CI 1.21–5.34) and after adjustment (aOR 2.48, 95% CI 1.14–5.40). Illiterate/primary maternal education was associated with wasting after adjustment (aOR 3.19, 95% CI 1.07–9.45). Excluding six WHO-flagged records gave wasting aORs of 2.68 (1.20–5.98) for lower SES and 2.54 (0.83–7.73) for illiterate/primary maternal education.

Conclusion: Undernutrition was common in this tertiary-care IYCF cohort. The lower-SES wasting association persisted in the flag-exclusion analysis; evidence for maternal education was less consistent. Hospital-based sampling, cross-sectional design and limited outcome events restrict interpretation.

Keywords: Child undernutrition; stunting; wasting; underweight; socio-economic status; maternal educa-

tion; infant and young child feeding; Delhi; India

1. Introduction

Undernutrition during early childhood remains an important public health concern because inadequate growth during the first years of life is associated with increased morbidity, impaired development and adverse health consequences extending beyond childhood.[1, 2] The period from 6 to 23 months is particularly important within this broader window. At around six months, breast milk alone is no longer sufficient to meet the increasing energy and nutrient requirements of most infants, and complementary foods need to be introduced while breastfeeding continues.[3] The World Health Organization (WHO) identifies 6–23 months as a critical developmental period during which children are particularly vulnerable to growth faltering and nutrient deficiencies.[3] The transition from predominantly milk-based feeding to a more diverse family diet also introduces challenges related to food quantity, quality, dietary diversity, feeding frequency, food safety and responsive feeding.[3, 4]

Anthropometric assessment provides an objective approach to identifying different dimensions of nutritional vulnerability. The WHO Child Growth Standards allow weight-for-age, height-for-age and weight-for-height to be interpreted against an internationally derived standard population.[5] These indices describe different aspects of growth: weight-for-age identifies children who are underweight, height-for-age reflects linear growth and cumulative growth deficits, and weight-for-height identifies wasting, which is more closely related to acute nutritional deficit.[5] Because these outcomes capture related but distinct dimensions of undernutrition, examining them separately can provide a more informative picture than relying on a single nutritional indicator.

The burden of childhood undernutrition in India remains substantial despite improvements over time. Nationally representative data from the National Family Health Survey (NFHS) provide an important population-level benchmark. According to NFHS-6 (2023–24), 29.3% of children younger than five years in India were stunted, 31.8% were underweight and 19.0% were wasted.[6] In the National Capital Territory of Delhi, the corresponding estimates were 26.4% for stunting, 27.4% for underweight and 15.0% for wasting.[6] These figures indicate that undernutrition remains relevant even in an urban setting with comparatively greater access to health services and infrastructure. However, national and state-level survey estimates cannot necessarily be applied directly to children attending a tertiary-care nutritional or paediatric service. Differences in age distribution, referral patterns, clinical characteristics and sampling frame may substantially influence the observed prevalence in a hospital population.

The determinants of child undernutrition extend beyond immediate dietary intake. Household socio-economic conditions can influence the availability and affordability of nutritious foods, living conditions, access to healthcare, maternal time and resources, and the ability to respond to childhood illness.[7, 8] Socio-economic inequality has been documented across several anthropometric outcomes in India. Kumar and Paswan, using nationally representative NFHS data from India's Empowered Action Group states, found that household wealth, maternal education and maternal nutritional status contributed substantially to observed socio-economic inequalities in stunting and underweight.[8] Their findings illustrate that nutritional inequalities are not explained by household income alone but arise through interconnected social and household characteristics. Other Indian analyses have similarly demonstrated persistent differences in child nutritional status according to household wealth and social circumstances.[9]

Maternal education is another potentially important determinant because it may influence health knowledge, feeding decisions, healthcare utilisation and the ability to access or interpret health

information. Evidence from population-based studies suggests that higher maternal education is associated with more favourable child growth and nutritional outcomes, although the magnitude and consistency of associations vary across settings.[10] A systematic review and meta-analysis of population-based cohort studies found that maternal education was associated with child growth during the first two years of life, supporting the importance of education as a social determinant within the first 1,000 days.[10] Nevertheless, education should not be considered independently of household resources and other contextual factors because educational attainment, occupation, income and access to services frequently overlap.

The relationship between socio-economic circumstances and different forms of undernutrition may also vary according to the biological time scale represented by the anthropometric indicator. Wasting can reflect relatively recent nutritional or health disturbances, whereas stunting reflects cumulative impairment of linear growth over a longer period.[5] Underweight combines information related to body mass and age and can therefore reflect both acute and chronic influences. Consequently, the same socio-economic characteristic may not show identical associations with underweight, stunting and wasting. Examining these outcomes separately is therefore important when evaluating the nutritional profile of children attending clinical services.

The 6–23-month period is also characterised by rapid changes in feeding behaviour and nutritional requirements. WHO recommends that complementary foods introduced from approximately six months should progressively increase in amount, consistency and variety as the child grows, while breastfeeding continues.[3, 4] The quality of complementary feeding is influenced not only by caregiver knowledge but also by household food availability, affordability, cultural practices and social circumstances. Evidence from India has shown that infant and young child feeding practices are associated with child nutritional status, while socio-economic inequalities may influence both feeding practices and nutritional outcomes.[11, 9] Thus, assessment of socio-demographic factors alongside anthropometric status can help identify characteristics of children who may require closer nutritional assessment or follow-up within healthcare settings.

The present study was conducted in a tertiary-care hospital in Delhi among children aged 6–24 months attending an infant and young child feeding (IYCF) service. The study population is distinct from the general community because children attending a tertiary-care service may have different nutritional, clinical or referral characteristics. The present study therefore focuses specifically on the relationship between socio-demographic and socio-economic characteristics and three anthropometric outcomes: underweight, stunting and wasting.

The primary objective was to estimate the prevalence and severity of underweight, stunting and wasting among children aged 6–24 months attending the tertiary-care IYCF service. The secondary objective was to examine unadjusted and adjusted associations between these nutritional outcomes and selected socio-demographic characteristics, including maternal education, socio-economic status, child age, family type, number of children and other household characteristics. By examining these associations within a defined hospital-based cohort, the study aims to provide context-specific evidence on the social distribution of undernutrition among young children receiving nutritional and paediatric services in Delhi.

2. Materials and Methods

Study design and setting

This hospital-based cross-sectional study was conducted through the Infant and Young Child Feeding

(IYCF) service of the Department of Paediatrics at Hindu Rao Hospital, a 940-bed tertiary-care teaching hospital affiliated with North DMC Medical College, Delhi, India. The IYCF centre was located in the paediatric outpatient department and received referrals from the outpatient and immunisation services; caregivers also attended directly for anthropometry and counselling. Convenience sampling was used, with participants enrolled on a first-come, first-served basis. The study examined the relationship between selected socio-demographic and socio-economic characteristics and anthropometrically defined undernutrition among children aged 6–24 months. [AUTHOR CONFIRMATION REQUIRED: provide recruitment dates and how repeat visits were handled.]

The study was reported with reference to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations for cross-sectional studies, including description of the study setting, participant selection, measurement of exposures and outcomes, statistical methods, and reporting of effect estimates with measures of precision.[12]

Study population and participant selection

The analytical dataset comprised 197 children enrolled through the participating IYCF service. Eligibility for the present analysis was a recorded age of 6–24 months. All 197 records met this criterion; observed ages were 6–23 months, with no child aged 24 months. The parent infant-feeding study used Cochran's sample-size formula with $Z = 1.96$, an anticipated prevalence of 11% for adequate diet among breastfeeding children in Delhi, and an absolute precision of 5%. Its study protocol stated a 15% allowance for attrition and a recruitment target of 200 mothers or primary caregivers; data from 197 mother–child dyads were analysed. This target was based on a feeding indicator, rather than precision or power for the present anthropometric associations or multivariable models. The numbers approached, screened and excluded were not reported in the related study manuscript.

At enrolment, mothers or primary caregivers of eligible children attending the IYCF or immunisation outpatient services who agreed to participate were included. Very sick or critically ill children, immunocompromised children, and children with cleft lip or a disability affecting feeding, chewing or swallowing were excluded according to the parent study protocol. Mothers or primary caregivers who did not consent to participation were not enrolled.

Data collection

A pre-tested structured questionnaire was administered through face-to-face interviews by a single investigator to reduce variation between interviewers and improve completeness. Pilot testing preceded the main study, and pilot data were excluded from the final analysis. The questionnaire captured child and parental socio-demographic characteristics, family characteristics, socio-economic status, and feeding-related information. Questionnaire reliability reported for the parent feeding study included a Cronbach's alpha of 0.73 and a test–retest coefficient of 0.67 over a 20-day interval. These measures relate to the questionnaire and do not establish the reliability of anthropometric measurements or independently verify SES scoring.

The variables considered for the present analysis were child sex, child age, maternal age, paternal age, maternal education, paternal education, maternal occupation, number of children, family type, socio-economic status, religion, caste, monthly family income, and birth order. Child age was categorized into 6–11, 12–17, and 18–24 months for categorical analyses. Number of children was analysed in categories 1, 2 and ≥ 3 ; it was not assumed to establish obstetric parity.

Anthropometric assessment and nutritional-status definitions

Anthropometric measurements were performed following WHO recommendations and included body

weight, length/height, mid-upper arm circumference (MUAC), and head circumference for the parent study. Body weight was measured using the routinely available weighing scale in the hospital or clinic. Instrument model, measurement precision and calibration details were not documented in the available study records. Weight, length/height, and age were used to derive weight-for-age Z-scores (WAZ), height-for-age Z-scores (HAZ), and weight-for-height Z-scores (WHZ) according to the WHO Child Growth Standards.[5] Because all observed children were younger than 24 months, the recorded height field was analysed as recumbent length, consistent with WHO age-specific recommendations. Exact measurement dates were unavailable, so z-scores were calculated using recorded age in months and linear interpolation of sex-specific monthly age and 0.5-cm length LMS reference tables, rather than exact day-based WHO Anthro calculations.

The WHO Child Growth Standards were developed from the WHO Multicentre Growth Reference Study and are intended to provide a common standard for assessing growth among children under 5 years of age across populations.[5] The corresponding WHO growth-standard reference tables and software provide sex- and age-specific standards for weight-for-age and length/height-for-age, together with weight-for-length/height assessment.[5]

For the present study, underweight was defined as WAZ <-2 standard deviations (SD), stunting as HAZ <-2 SD, and wasting as WHZ <-2 SD. Values below -3 SD were classified as severe undernutrition for the corresponding indicator. These definitions follow standard WHO child-growth classification principles.[5]

The final anthropometric dataset was subjected to predefined data-quality checks before calculation and tabulation of nutritional-status outcomes. The corrected anthropometric measurements and WHO-based Z-scores were then used to generate the final prevalence estimates and outcome variables. The weight entry >6.30 kg was analysed as 6.30 kg following clarification. A length entry of 7102 was interpreted as 71.02 cm during data cleaning; this interpretation was not verified against the case sheet. Two MUAC entries were converted to centimetres, and two implausible head circumferences were set to missing. Six records flagged on at least one WHO anthropometric index were retained in the primary analysis; sensitivity analysis excluded these entire records. Original source values were preserved separately from derived data. A supplementary analysis excluded WHO-flagged values separately for each index, allowing the valid denominator to differ between outcomes. Nine potential age/date discrepancies were screening flags based on an assumed collection window, not confirmed age errors; source dates require review before final submission.

Socio-economic status assessment

Socio-economic status (SES) was assessed using the Revised Kuppuswamy Socioeconomic Scale, using the 2020 update.[13] The Kuppuswamy scale is a composite measure based on characteristics including education, occupation, and monthly family income. The 2020 revision was used for classification of the study population. Supplied SES classifications were retained without rescaling; original scoring sheets and the application of income thresholds were not independently checked. Monthly income groups in this analysis follow the supplied coding ($<₹10,000$, $₹10,000-29,972$ and $\geq ₹29,973$); they are not presented as an exact transcription of every income bracket in the cited scale.

For the primary SES comparison, households classified as upper or upper-middle were grouped together and compared with households classified as lower-middle, upper-lower, or lower. This categorisation was selected to provide a clinically and analytically interpretable comparison between relatively more

advantaged and less advantaged socio-economic groups. Grouping was used to limit sparse categories; it does not imply that all households within either group have equivalent resources.

Because monthly family income contributes to the calculation of the Kuppaswamy SES score, income was examined as an individual socio-demographic exposure in the unadjusted analyses but was not entered simultaneously with the composite SES variable in the primary multivariable models. This avoided treating two mathematically related measures as independent covariates in the same primary model. Secondary models replaced composite SES with monthly family income.

Study outcomes

Three anthropometric outcomes were evaluated separately:

Underweight: WAZ < -2 SD.

Stunting: HAZ < -2 SD.

Wasting: WHZ < -2 SD.

For descriptive reporting, each outcome was further classified into moderate and severe categories using the WHO threshold of -3 SD for severe undernutrition.[5]

The principal explanatory variables were socio-demographic and socio-economic characteristics, with particular attention to SES, maternal education, child age group, family type, and other household and parental characteristics.

Statistical analysis

All analyses were conducted using Python, with statistical processing performed using the pandas, NumPy, SciPy, and statsmodels libraries. Categorical variables were summarized using frequencies and percentages with the available denominator. Continuous variables were summarized using medians and interquartile ranges. Nutritional prevalence estimates were accompanied by Wilson 95% confidence intervals. [14]

For unadjusted analyses, each socio-demographic characteristic was cross-tabulated separately against underweight, stunting, and wasting. Odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were calculated for category-level comparisons using the stated reference categories. Category-specific P values were calculated using Wald tests; alternative chi-square or Fisher tests were reported where appropriate. Sparse larger tables used Fisher–Freeman–Halton Monte Carlo tests with 100,000 resamples. Category-specific tests and omnibus tests were distinguished. Because outcomes were common, odds ratios were not interpreted as risk ratios. [15]

The association between socio-demographic characteristics and each nutritional outcome was assessed separately for underweight, stunting, and wasting. The primary comparisons focused on the magnitude and precision of the observed associations rather than on statistical significance alone.

Binary logistic regression models were fitted separately for the three nutritional outcomes. The primary models included maternal age, maternal education, socio-economic status, number of children, family type, child sex, and child age group as explanatory variables. Adjusted odds ratios (aORs) with 95% CIs were reported to describe the association between the selected explanatory variables and each binary nutritional outcome after adjustment for the other covariates included in the corresponding model. All primary-model covariates were complete, so each primary model included 197 children. Models contained 12 non-intercept parameters; events per parameter were 6.1, 4.5 and 4.2 for underweight, stunting and wasting. All models converged, with variance inflation factors of 1.05–1.94, but these checks do not establish stable or unbiased estimates. Results were interpreted as exploratory because sparse-data bias remains possible. [16, 17] Covariates were included to account for child characteristics, maternal

characteristics and household composition; selection was not based on unadjusted P values. Maternal education and composite SES capture related but distinct constructs, and their coefficients represent conditional associations within the specified model rather than independent causal effects. No penalized estimation was performed; sensitivity analyses assessed changes under alternative data exclusions and replacement of SES by income.

For categorical predictors, reference categories were defined for estimation. Child age group was categorized as 6–11 months, 12–17 months, and 18–24 months, with 6–11 months serving as the reference group. For SES, upper/upper-middle was used as the reference category. Maternal education was categorized into four groups for analysis, with graduate or higher education serving as the reference category in the relevant comparisons.

A two-sided p-value <0.05 was considered the conventional threshold for statistical evidence of an association. Effect estimates were interpreted together with their 95% CIs. No formal adjustment for multiple comparisons was applied. P values were interpreted alongside effect size, uncertainty and study limitations rather than as a sharp distinction between presence and absence of an association. [18] The five contrasts in the main tables summarize SES, maternal education and child age, including nonsignificant results; all exposure categories are reported in the supplement. For multi-category predictors, a category-specific Wald comparison should not be read as an omnibus test of the entire predictor.

Ethical considerations

The study received ethical approval from the Institutional Ethical Committee of Hindu Rao Hospital (approval no. 5330/MS/HRH/2022) and the Ethical Committee of Sharda University (approval no. SU/SMSandR/76-A/2022/152). Before data collection, the study aims, methods, benefits and participants' rights were explained in Hindi, and written informed consent was obtained from mothers or primary caregivers. Participation was voluntary, and caregivers could withdraw without adverse implications. The study procedures were conducted in accordance with applicable institutional ethical requirements and the principles of the Declaration of Helsinki.

Confidentiality was maintained through anonymised identification codes and restricted access to study data by the research team. Direct personal identifiers were not included in the analytical variables, manuscript tables or figures. Source records containing identifiers were retained separately for the data audit.

3. Results

All 197 records in the updated workbook met the age eligibility criterion and were included in the final analytic cohort. The median age was 11.0 months (IQR 8.0–15.0), and observed ages ranged from 6 to 23 months. There were 109 boys (55.3%) and 88 girls (44.7%); 100 children (50.8%) were aged 6–11 months, 71 (36.0%) were aged 12–17 months, and 26 (13.2%) were in the 18–24-month band. No child was aged 24 months.

Hindu children comprised 146/196 with recorded religion (74.5%) and Muslim children 50/196 (25.5%). Family type was recorded as nuclear for 88 children (44.7%) and joint/three-generation for 109 (55.3%), with no missing observations. Seventy-one children (36.0%) belonged to the upper/upper-middle SES group and 126 (64.0%) to the lower-middle/upper-lower/lower group. Maternal education was illiterate/primary in 46 children (23.4%), middle in 66 (33.5%), secondary in 36 (18.3%), and graduate or higher in 49 (24.9%). Baseline characteristics are shown in Table 1.

3.1 Baseline characteristics

Table 1. Baseline characteristics of the 197-child cohort.

Characteristic	n (%) or median (IQR)
Final analytic cohort	197
Child age, months	11.0 (8.0–15.0)
Male sex	109 (55.3%)
Female sex	88 (44.7%)
Age 6–11 months	100 (50.8%)
Age 12–17 months	71 (36.0%)
Age 18–24 months	26 (13.2%)
Hindu religion	146 (74.5%)
Muslim religion	50 (25.5%)
Nuclear family	88 (44.7%)
Joint/three-generation family	109 (55.3%)
Upper/upper-middle SES	71 (36.0%)
Lower-middle/upper-lower/lower SES	126 (64.0%)
Monthly family income <₹10,000	43 (21.8%)
Monthly family income ₹10,000–29,972	131 (66.5%)
Monthly family income ≥₹29,973	23 (11.7%)
Maternal education: illiterate/primary	46 (23.4%)
Maternal education: middle	66 (33.5%)
Maternal education: secondary	36 (18.3%)
Maternal education: graduate or higher	49 (24.9%)
Weight, kg	7.70 (6.90–8.55)
Length/height, cm	71.00 (67.80–74.60)
MUAC, cm	13.00 (12.20–14.00)
Head circumference, cm	43.00 (41.50–44.30)
WAZ	−1.65 (−2.36 to −0.73)
HAZ	−1.19 (−2.17 to −0.22)
WHZ	−1.31 (−2.04 to −0.34)

Values are n (%) or median (IQR). Religion denominator: 196; head circumference: 195; other listed variables: 197. All observed ages were 6–23 months. Length was treated as recumbent length. SES uses supplied Kuppaswamy classifications.

3.2 Prevalence and severity of undernutrition

Underweight was present in 73/197 children (37.1%; 95% CI 30.6–44.0), stunting in 54/197 (27.4%; 95% CI 21.7–34.0), and wasting in 51/197 (25.9%; 95% CI 20.3–32.4). Severe underweight affected 24 children (12.2%; 95% CI 8.3–17.5), severe stunting 23 (11.7%; 95% CI 7.9–16.9), and severe wasting eight (4.1%; 95% CI 2.1–7.8). Moderate and severe forms are reported in Table 2; overall prevalence is shown in Figure 1.

Figure 1. Prevalence of underweight, stunting and wasting in the final analytic cohort (N=197). Error bars show Wilson 95% confidence intervals.

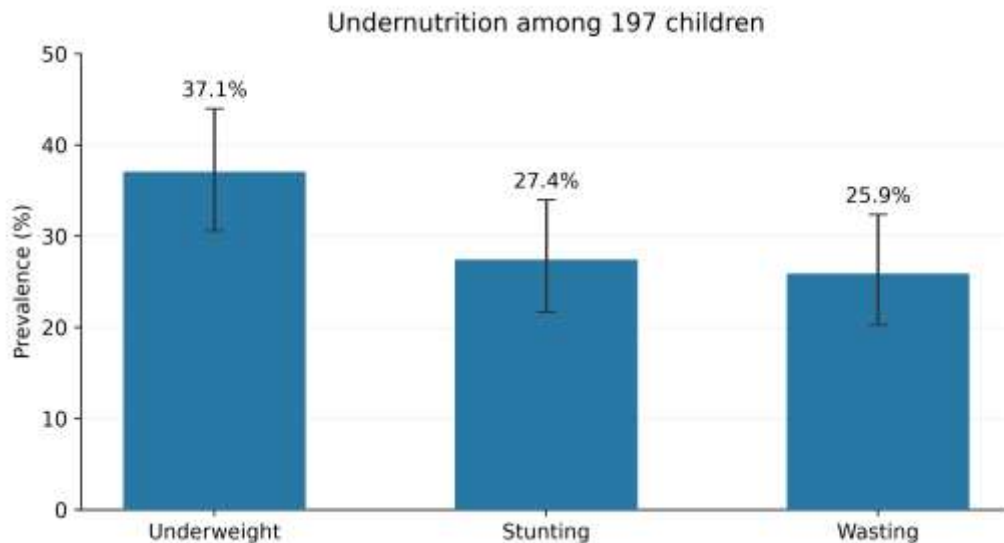


Table 2. Prevalence and severity of undernutrition (N=197).

Outcome	Moderate, n (%)	Severe, n (%)	Overall, n (%)	95% CI
Underweight	49 (24.9%)	24 (12.2%)	73 (37.1%)	30.6–44.0
Stunting	31 (15.7%)	23 (11.7%)	54 (27.4%)	21.7–34.0
Wasting	43 (21.8%)	8 (4.1%)	51 (25.9%)	20.3–32.4

Moderate: z-score ≥ -3 and < -2 ; severe: < -3 . Overall includes moderate and severe. Confidence intervals use the Wilson method; WHO-flagged records were retained.

3.3 Unadjusted associations

Lower-middle/upper-lower/lower SES was associated with higher odds of wasting (OR 2.54, 95% CI 1.21–5.34; $p=0.014$), while the underweight estimate was 1.67 (0.90–3.11; $p=0.104$). Compared with children aged 6–11 months, the stunting ORs were 1.80 (0.90–3.60; $p=0.095$) at 12–17 months and 2.35 (0.93–5.93; $p=0.070$) in the 18–24-month band. Children of mothers with illiterate/primary education had higher odds of wasting than those with graduate or higher education (OR 2.73, 1.04–7.21; $p=0.042$), although the overall maternal-education test had $p=0.128$. Paternal age 30–34 versus ≤ 29 years was associated with wasting (OR 2.47, 1.18–5.15; $p=0.016$). The lowest versus highest family-income category was associated with underweight by the Wald test (OR 3.26, 1.08–9.86; $p=0.036$), but the Yates-corrected comparison had $p=0.061$. Selected contrasts are reported in Table 3; the full unadjusted analyses are in the supplementary appendix.

Table 3. Selected unadjusted associations.

Outcome	Comparison	OR (95% CI)	p-value
Underweight	Lower-middle/upper-lower/lower SES vs upper/upper-middle	1.67 (0.90–3.11)	0.104

Stunting	Age 12–17 vs 6–11 months	1.80 (0.90–3.60)	0.095
Stunting	Age 18–24 vs 6–11 months	2.35 (0.93–5.93)	0.070
Wasting	Lower-middle/upper-lower/lower SES vs upper/upper-middle	2.54 (1.21–5.34)	0.014
Wasting	Maternal illiterate/primary vs graduate+	2.73 (1.04–7.21)	0.042

OR: odds ratio; CI: confidence interval. P values are category-specific Wald tests. Selected contrasts include nonsignificant estimates. All 14 unadjusted exposure analyses are supplied in the supplementary appendix.

3.4 Multivariable analysis

In the primary multivariable models, lower-middle/upper-lower/lower SES was associated with wasting (aOR 2.48, 95% CI 1.14–5.40; $p=0.022$), while its underweight estimate was 1.70 (0.89–3.25; $p=0.109$). For stunting, the age 12–17-month estimate was 1.78 (0.87–3.61; $p=0.114$), and the 18–24-month estimate was 2.37 (0.92–6.14; $p=0.075$), relative to 6–11 months. Illiterate/primary maternal education was associated with wasting (aOR 3.19, 1.07–9.45; $p=0.037$). Male sex had a wasting aOR of 2.05 (1.00–4.22; $p=0.051$); its rounded lower confidence limit of 1.00 did not make the comparison statistically significant. Each primary model included all 197 children with complete covariates. Selected estimates are shown in Table 4 and Figure 2. No primary-model category comparison for underweight or stunting had $p<0.05$. Excluding six WHO-flagged records left 191 children, with underweight, stunting and wasting prevalences of 36.1%, 26.7% and 25.1%; the corresponding wasting aORs were 2.68 (1.20–5.98; $p=0.016$) for lower SES and 2.54 (0.83–7.73; $p=0.101$) for illiterate/primary maternal education. Thus, the latter estimate remained elevated but became less precise, with its confidence interval including 1. Adjusted sensitivity comparisons are reported in supplementary Web Table 8; index-specific flag-exclusion prevalence is reported in Web Table 9.

Figure 2. Selected adjusted associations from the primary multivariable models (N=197). Points show adjusted odds ratios; horizontal lines show 95% confidence intervals. The dashed line marks 1. Comparisons match Table 4 and include nonsignificant estimates.

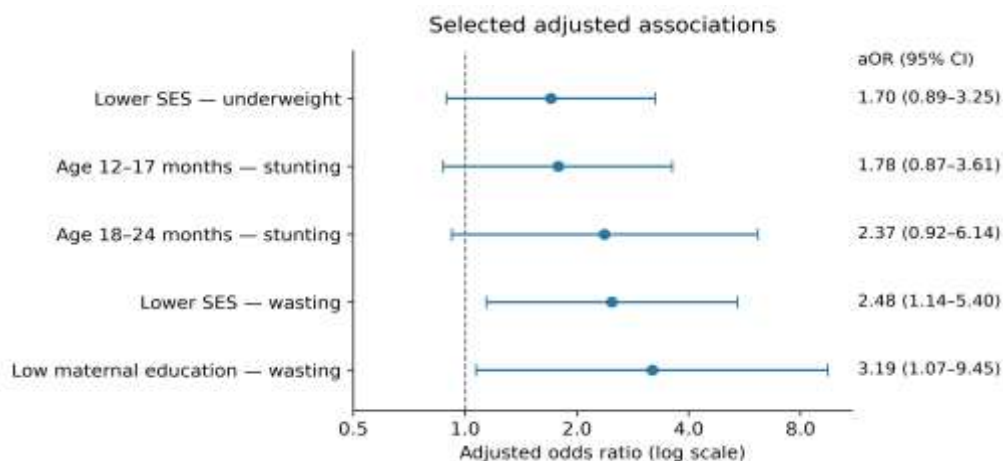


Table 4. Selected adjusted associations.

Outcome	Adjusted comparison	aOR (95% CI)	p-value
Underweight	Lower-middle/upper-lower/lower SES vs upper/upper-middle	1.70 (0.89–3.25)	0.109
Stunting	Age 12–17 vs 6–11 months	1.78 (0.87–3.61)	0.114
Stunting	Age 18–24 vs 6–11 months	2.37 (0.92–6.14)	0.075
Wasting	Lower-middle/upper-lower/lower SES vs upper/upper-middle	2.48 (1.14–5.40)	0.022
Wasting	Maternal illiterate/primary vs graduate+	3.19 (1.07–9.45)	0.037

aOR: adjusted odds ratio. All models N=197; adjusted for maternal age, maternal education, SES, number of children, family type, child sex and age group. Comparisons include nonsignificant estimates. Complete models and sensitivity results are in the supplementary appendix.

4. Discussion

The present hospital-based cross-sectional analysis examined socio-demographic and socio-economic factors associated with underweight, stunting, and wasting among children eligible within a 6–24-month window attending an IYCF service in a tertiary-care hospital in Delhi. All observed children were aged 6–23 months. In the final analytic cohort of 197 children, undernutrition was common: 37.1% were underweight, 27.4% were stunted, and 25.9% were wasted. The corresponding severe forms were observed in 12.2%, 11.7%, and 4.1%, respectively.

Lower SES was associated with higher adjusted odds of wasting in the primary and flag-exclusion analyses. The primary illiterate/primary maternal-education contrast was also elevated, but the flag-exclusion confidence interval included 1. The SES–underweight and age–stunting primary estimates were uncertain. These results support an exploratory description of associations in this clinical sample rather than a definitive hierarchy of independent determinants.

These prevalence estimates should not be interpreted as representative of children in Delhi because the study population comprised children attending a hospital-based IYCF service, where referral and care-seeking patterns may enrich the population for nutritional problems. Nevertheless, they demonstrate a considerable burden of anthropometric failure encountered in this clinical setting.

For underweight, children belonging to the lower-middle/upper-lower/lower SES group had an unadjusted OR of 1.67 (95% CI 0.90–3.11) compared with the upper/upper-middle group. The adjusted estimate was similar (aOR 1.70, 0.89–3.25), but both confidence intervals included 1. Indian evidence demonstrates socioeconomic inequalities in child nutritional status; the uncertain estimate in this hospital cohort does not exclude such differences. However, the magnitude should not be directly compared with nationally representative estimates because the present study used a relatively small hospital-based cohort and a different SES classification framework. [8, 9]

The association between SES and wasting was also notable. Children from the lower-middle/upper-lower/lower SES group had higher odds of wasting than those from the upper/upper-middle group (unadjusted OR 2.54, 95% CI 1.21–5.34; adjusted OR 2.48, 95% CI 1.14–5.40). This finding is compatible with evidence that household socioeconomic circumstances influence access to adequate food, healthcare, sanitation and other resources that may affect childhood nutritional status. At the same time, wasting can be influenced by acute infections, recent illness, feeding practices and other factors not comprehensively evaluated here. The observed SES–wasting association should therefore be interpreted as an epidemiological association rather than evidence of direct causation. [7, 19]

Maternal education showed an important pattern for wasting. In the unadjusted analysis, children of mothers with illiterate/primary education had higher odds of wasting than those whose mothers had graduate-level or higher education (OR 2.73, 95% CI 1.04–7.21). After adjustment, the estimate remained elevated and the confidence interval excluded 1 (aOR 3.19, 1.07–9.45). The interval was wide, and the overall unadjusted maternal-education test was not statistically significant. Maternal education may overlap with household circumstances and access to information, but education was not a direct measure of feeding knowledge or a tested intervention in this study. Associations vary across populations and over time. [10, 20] After excluding six WHO-flagged records, the education aOR was 2.54 (95% CI 0.83–7.73). The direction was unchanged, but the weaker precision and dependence of statistical evidence on data handling warrant caution. This contrast does not establish an overall maternal-education association across all categories.

Compared with children aged 6–11 months, children aged 12–17 months had a stunting aOR of 1.78 (95% CI 0.87–3.61), while the 18–24-month analysis band had an aOR of 2.37 (0.92–6.14). Both intervals included 1, so these primary models did not establish age-group associations with stunting. Elevated point estimates are compatible with the conceptual understanding of stunting as a cumulative process. However, because the present study is cross-sectional, age-group differences represent differences between children observed at different ages rather than longitudinal deterioration within the same children. [21]

Child growth may be influenced by household resources, maternal characteristics, feeding practices and environmental conditions. Indian research on water insecurity, dietary diversity and household food insecurity illustrates pathways through which social disadvantage may affect nutrition; these studies are cited for dietary and household context, rather than as direct evidence of linear-growth associations. The present analysis did not incorporate a comprehensive causal model of dietary intake, infection, birthweight, maternal anthropometry and environmental conditions. [19, 22, 23]

Urban residence does not necessarily eliminate nutritional disadvantage. Evidence from East Delhi has documented nutritional vulnerability among children aged 6–23 months living in an urban resettlement colony. The current findings suggest that within a tertiary-care IYCF population, socioeconomic disadvantage remains visible in anthropometric outcomes among children attending the Delhi service. [24] Strengths include the focus on the nutritionally sensitive 6–24-month eligibility age period, use of WHO Child Growth Standards, separate examination of underweight, stunting and wasting, and assessment of a broad set of socio-demographic and socioeconomic characteristics. Limitations include the cross-sectional design, hospital-based convenience sampling, the modest sample size and relatively wide confidence intervals for some estimates. The Kuppaswamy SES score also incorporates household-head education, occupation and household income, so these variables are conceptually interrelated. Several established determinants—including maternal height and BMI, birthweight, recent morbidity, sanitation, dietary diversity, meal frequency and detailed food intake—were not comprehensively evaluated. The low

numbers of events per model parameter create uncertainty despite model convergence. The six retained WHO-flagged records, unverified decimal correction of a length entry, recorded-month LMS interpolation and incomplete documentation of instrument specifications further limit anthropometric interpretation. Unmeasured clinical and household characteristics and selection through hospital attendance may also affect adjusted associations. Absence of statistical evidence is not proof of no association. [17, 16, 25, 26] Maternal-education evidence was sensitive to flag exclusion. Conventional logistic estimates were not supported by a penalized-model comparison, and the rationale for adjustment does not eliminate residual confounding. The supplied SES groups could not be verified against scoring sheets. Multiple exploratory comparisons, and overlap between social measures, further limit claims about individual determinants. For tertiary-care IYCF services, the findings suggest considering socioeconomic circumstances and maternal educational background alongside anthropometric assessment when identifying children who may require closer nutritional assessment and counselling. The results do not establish that changing a single socioeconomic characteristic would independently prevent undernutrition; child nutrition is shaped by interacting household, maternal, dietary, environmental and healthcare factors. This study did not test whether counselling targeted by SES or education improves nutritional outcomes.

5. Conclusion

Undernutrition was common among the 197 children attending this tertiary-care IYCF service in Delhi. Lower SES was associated with higher adjusted odds of wasting in the primary and flag-exclusion analyses. The primary illiterate/primary maternal-education estimate was elevated, but its confidence interval included 1 after flag exclusion. SES–underweight and age–stunting primary estimates also remained uncertain. These exploratory findings describe nutritional vulnerability within a hospital-based sample and do not establish causation or population-level prevalence. Measurement uncertainties and limited outcome events require cautious interpretation and further confirmation.

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