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Prevalence and determinants of undernutrition in the urban slums of Belagavi: a cross-sectional study among young children

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Introduction: Rapid urbanization in low- and middle-income countries has led to the expansion of slums, where children face a heightened risk of undernutrition. This study aimed to determine the prevalence of undernutrition and its determinants among children residing in the urban slums of Belagavi, Karnataka.

Methods: The anthropometric measurements, clinical signs, demographic information, and dietary history of children aged 9–36 months from urban slums were assessed. The chi-square test, bivariate analysis, and multivariable logistic regression were used to identify the risk factors at the child, maternal, and household levels for undernutrition.

Results: The prevalence of stunting, wasting, and underweight among children aged 9–36 months was 44%, 11%, and 25%, respectively. Common predictors of stunting and underweight included low birth weight, short maternal stature, lack of maternal exposure to print media, and maternal consumption of iron–folic acid during pregnancy. A lack of maternal exposure to print media was also associated with wasting. In addition, stunting was linked to male sex and low maternal education, while underweight was associated with children from non-Hindu and non-Muslim religious backgrounds, and maternal lack of autonomy or control over household finances. Wasting, however, was associated with the 24–36 months age group and maternal gestational diabetes.

Conclusion: A high level of undernutrition was observed in the urban slums of Belagavi, with the prevalence of stunting exceeding the national and state averages. Undernutrition was linked to maternal, child, and household factors, including low birth weight, maternal stature, education, and autonomy.

KEYWORDS

undernutrition, urban slums, determinants, young children, undernutrition in India, stunting, wasting, maternal factors

Introduction

Malnutrition continues to threaten children's ability to thrive and survive, representing one of the greatest social challenges globally (1, 2). The World Health Assembly and Sustainable Development Goals target ending all forms of malnutrition by 2030, yet the progress remains uneven (3, 4). Undernutrition is particularly alarming in urban India, where 30.1% of children under 5 years are stunted, 18.5% are wasted, and 27.3% are

underweight (5). Malnourished children face the highest risk of mortality and morbidity, along with some far-reaching consequences, affecting not only individuals but also societal and economic outcomes (6, 7).

In India, the extent of malnutrition is disproportionately high in urban slums, where children are more vulnerable than their counterparts in non-slum urban areas (8, 9). Low- and middle-income countries (LMICs) have experienced a significant growth in urbanization over the past few decades, leading to the development of slums characterized by overcrowding, unhygienic living conditions, and inadequate access to healthcare (9). Migrants to urban slums are particularly at risk, as they transition from a food-secure environment to precarious urban settings. Specific factors that contribute to poor nutritional status in children include a lack of immunization, early weaning, and dependence on street food, exacerbating undernutrition in this population and highlighting the urgent need for nutrition surveillance in these areas (9, 10).

Despite national efforts to address malnutrition, data from urban slums remains limited. Interventions related to malnutrition have historically focused on rural areas, leaving the unique vulnerabilities of urban slums unexplored. Karnataka, one of India's rapidly urbanizing states, exhibits substantial variation in health outcomes, but the nutritional status and its determinants among children in urban slums remain poorly understood. This study aims to assess the nutritional status and determinants of undernutrition among children aged 9–36 months in the urban slums of Belagavi, Karnataka.

Methods

Study context

The analysis presented in this study of the prevalence and determinants is from the data of the parent randomized controlled trial (RCT) conducted in the urban slums of Belagavi (CTRI Reg no: CTRI/2022/06/043002). The protocol for the RCT was approved by the Ethical Committee (Human) for Ph.D. Research, KAHER, Belagavi. Permission was obtained from the District Health Office, Taluka Health Office, and medical officers of the respective slum areas of Belagavi to conduct the study. Informed written consent was obtained from all the mothers as per the guidelines given by the Indian Council of Medical Research (ICMR), India.

Data collection time frame and eligibility screening for the RCT

The data for the current analysis were collected from March to July 2023. After obtaining a list of slums from the Taluka Health Office, it was determined that the slums in Belagavi fell under six primary health centers (PHCs). Permission to conduct the study was then secured from the respective medical officers of these PHCs. Data collected from all eligible and ineligible children

aged 9–36 months at the screening time for the registered RCT were included in the present analysis.

Sample size estimation

The sample size of the randomized controlled trial was $n = 360$, calculated using a 95% confidence interval and 90% power, considering an attrition of 1.05 and design effect of 1.2. The following formula was used:

$$n = \frac{(Z_{1-(\alpha/2)} + Z_{1-\beta})^2 \times (SD_1^2 + SD_2^2)}{(\bar{x}_1 - \bar{x}_2)^2} \times \text{Attrition} \times \text{Design Effect}$$

The previous randomized controlled trial showed a mean difference in height of the participants pre- and post-intervention of 14.7 ± 2.1 and 13.8 ± 1.7 cm, in the experimental and control groups, respectively (11, 12).

$$\begin{aligned} n &= \frac{(1.96 + 1.29)^2 \times (2.1^2 + 1.7^2)}{(14.7 - 13.8)^2} \times 1.05 \times 1.2 \\ &= 120 \text{ in each group} \\ &= 360 \end{aligned}$$

Data collection and nutritional assessment methods for RCT screening

Data were collected by a trained researcher at the time of the screening of the children for the randomized controlled trial. Mothers/caregivers were interviewed to collect data on correlates such as child, maternal, and household-level characteristics.

Anthropometric data were collected using standardized procedures. For the final measurement, an average of triplicate measurements was utilized. Weight was measured using an electronic scale with a digital screen to the nearest 0.01 kg (child and parent). Height was measured using an infantometer and a stadiometer (child and parents) to the nearest 0.1 cm. A non-flexible tape was used to measure mid-upper arm circumference and head and chest circumference to the nearest 0.1 cm.

Children were screened for signs of nutritional deficiencies. A child was considered to have signs of anemia if they presented with any one of the following: pale skin, pale eyes, pale tongue, or pale or spoon-shaped nails. Signs of a vitamin A deficiency included whether the child exhibited Bitot's spot, dry eyes, or scarring. A vitamin D deficiency was indicated by knock-knees, bowed legs, a widening of the wrist, Harrison's sulcus, or frontal bossing.

Variable description

Table 1 describes the independent variables considered for this study.

TABLE 1 Independent variables for analysis.

Variable level	Variable description	Categorization
Child level	Age (months)	9–11, 12–23, or 24–36
	Gender	Male or female
	Birth order	First, second, or equal to or more than three
	Birth weight (g)	Low birth weight (<2,500) or normal or above average (≥2,500)
	Child's status at birth	Preterm (defined as birth before 37 weeks of gestation) or full term
	DI in the previous 3 months	Yes or no
	RTI in the previous 3 months	Yes or no
	Signs of vitamin D deficiency	Yes or no
	Signs of anemia	Yes or no
	Exclusive breastfeeding (months)	<6, 6, or >6
	Dietary preferences	Vegetarian, non-vegetarian, or ovo-vegetarian
	Protein intake	Adequate or inadequate (defined using the acceptable macro-nutrient distribution range) (13)
	Calcium intake	Adequate or inadequate (categorized using RDA) (13)
	Zinc intake	Adequate or inadequate (categorized using EAR) (13)
Maternal level	Age (years)	≤20 or more than 20
	Education	Illiterate, primary education, secondary education, or higher education (5)
	Height (cm)	<155 or ≥155 (14)
	BMI (kg/m ²)	Normal (18.5–22.9), underweight (<18.5), or overweight (≥23) (15)
	Birth interval	First child, <24 months, or ≥24 months
	Place of delivery	Public, private, or home delivery
	Mode of delivery	Normal or cesarean
	Occupation	Housewife or working
	Exposure to print media	Yes or no
	Exposure to electronic media	Yes or no
	Maternal Hb (g/dl)	Anemia (<11) or normal (≥11)
	Gestational diabetes mellitus	Yes or no (collected using the mother/child health card)
	Pre-eclampsia	Yes or no (collected using the mother/child health card)
	Iron-folic acid consumption	Yes or no
	ANC visits	More than or equal to four or less than four (collected using the mother/child health card).
	Autonomy	Yes or no
	Control of money	Yes or no
Household level	Religion	Hindu, Muslim, or other religion
	Type of family	Nuclear family (defined as parents residing with their unmarried children) or joint family

DI, diarrheal infection; RTI, respiratory tract infection; RDA, recommended dietary allowance; EAR, estimated average requirement; BMI, body mass index; Hb, haemoglobin; ANC, ante-natal checkup.

The outcome variables included the prevalence of stunting, wasting, and underweight among children. Stunting, wasting, and underweight were defined as height-for-age Z score (HAZ), weight-for-height Z score (WHZ), and weight-for-age Z score (WAZ), respectively, more than 2 standard deviations (SD) below

the median of the WHO growth standards (16). These outcomes were assessed using the WHO Anthro software (17).

Statistical analysis

Categorical data were reported as frequencies and percentages, while continuous variables were summarized using means and SD. The chi-square test was used to assess the significant differences between undernutrition and explanatory variables or covariates. In addition, simple or crude logistic regression was used to examine the association between each covariate and the outcome variable. Eventually, multiple or multivariable logistic regression was used to examine the independent effect of each covariate on child malnutrition. We applied three models for the analysis: Model 1 was adjusted for individual child-level characteristics, Model 2 accounted for both child and maternal-level characteristics, and Model 3 incorporated adjustments for child, maternal, and household-level characteristics. Further, the equation for the multivariable logistic regression model is expressed as

$$\log(\pi/1 - \pi) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_m X_m$$

where π is the probability of the occurrence of the event (stunting, wasting, or underweight), β_i is the regression coefficient associated with the reference group, and X_i is the explanatory variables. Stata 16 software was used for all the statistical analyses.

Results

A total of 420 children living in the urban slums of Belagavi were screened for the main study, with complete data available for 362 children in the present analysis.

Descriptive analysis

As shown in Figure 1, the prevalence among children aged 9–36 months was 44.2% for stunting, 11.05% for wasting, and 25.14% for underweight. Descriptive statistics of the child, maternal, and household-level characteristics are presented in Table 2. The majority of the children were aged 12–36 months (79.5%) and more than half were female (54.1%). Most of the children were first in birth order (44.6%), had normal or above-average birth weight (79.6%), and were full term (80.6%). Diarrhea and respiratory tract infection (RTI) were reported at least once in the previous 3 months in 60.9% and 48.2% of the individuals, respectively. No signs of vitamin A deficiency were observed, while 11.6% showed signs of a vitamin D deficiency and 28.8% exhibited signs of anemia. Nearly all the children had an inadequate intake of calcium (96.7%) and zinc (97.8%) in their diet. The majority of mothers had completed their secondary education (74.6%), were housewives (92.3%), had exposure to

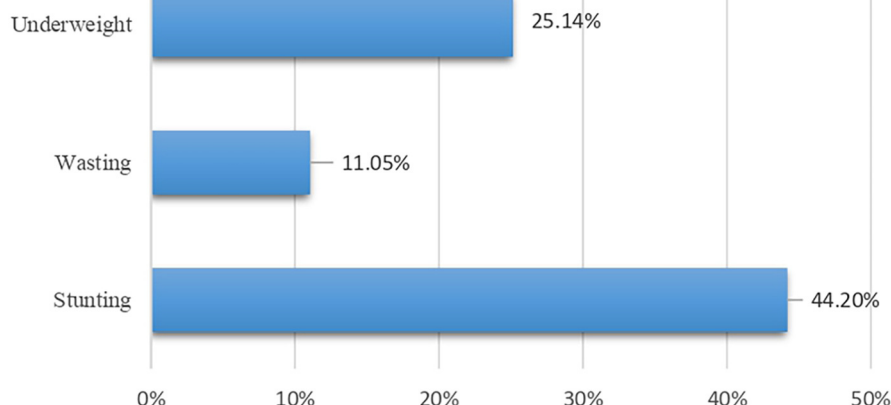


FIGURE 1

Prevalence of undernutrition in the urban slums of Belagavi among children aged 9–36 months.

electronic media (91.4%), and 74% had no exposure to print media. Most households belonged to the Hindu religion (64.4%) and reported living in a joint family (61.5%).

Table 3 presents the results of the chi-square tests examining the association between various child, maternal, and household characteristics with different forms of undernutrition (stunting, wasting, and underweight). Stunting was significantly associated with low birth weight, low maternal education, and short maternal height. Wasting was significantly associated with child age. Characteristics including child age, low birth weight, short maternal height, and iron–folic acid (IFA) consumption were significantly associated with underweight.

Association between child, maternal, and household characteristics and undernutrition: crude and multivariable analyses

Stunting

Table 4 presents the unadjusted crude and adjusted odds ratios (AORs) for the association between stunting and various child, maternal, and household-level characteristics.

Unadjusted estimates showed that children aged 12–23 months had a significantly higher risk of stunting (crude OR: 1.81, 95% CI: 1.01–3.23), but this association lost its significance after adjusting for other factors. Interestingly, sex was not significantly associated with stunting in the bivariate analysis, but in the adjusted model, being female was associated with a lower risk of stunting (AOR: 0.60, 95% CI: 0.36–0.99).

Children with normal or above-average birth weight consistently had a lower risk of stunting, as shown by both the crude (crude OR: 0.45, 95% CI: 0.27–0.76) and adjusted odds ratios (model 3—AOR: 0.34, 95% CI: 0.19–0.66). Regarding maternal characteristics, children of mothers with higher or secondary education were significantly less likely to be stunted

(AOR: 0.06–0.07, 95% CI: 0.01–0.74), compared to mothers who were illiterate. Similarly, children of mothers with normal height were less likely to be stunted (AOR: 0.53, 95% CI: 0.31–0.88) compared to those with shorter mothers. Children delivered in private hospitals had a 45% lower risk of being stunted. A unique finding was the influence of maternal exposure to print media: in the adjusted models, children of mothers who lacked such exposure were more likely to be stunted (AOR: 1.85, 95% CI: 1.03–3.30), though this was not observed in the crude estimates. In addition, children of mothers who did not consume IFA tablets during pregnancy paradoxically showed a lower risk of stunting (AOR: 0.38, 95% CI: 0.16–0.88). This was a result that only became significant in the adjusted analyses, warranting further exploration.

Wasting

Table 5 highlights the factors associated with wasting. Children aged 24–36 months had a significantly higher risk of wasting in all the models, with an AOR of 4.04 (95% CI: 1.19–13.64). Among maternal characteristics, a lack of exposure to print media was associated with an increased risk of wasting in children (AOR: 3.18, 95% CI: 1.05–9.59). In addition, children of mothers without gestational diabetes had a lower risk of being wasted (AOR: 0.06, 95% CI: 0.01–0.52). Furthermore, the adjusted model indicates that children of mothers lacking autonomy had a decreased risk of being wasted (AOR: 0.1, 95% CI: 0.02–0.50).

Underweight

Table 6 shows the results for the factors associated with underweight. Estimates obtained from the final model (model 4) show that the children aged 12–23 and 24–36 months had a significantly higher risk of being underweight (95% CI: 1.82–12.39). Children with normal or above-average birth weight had a lower risk of being underweight (AOR: 0.43, 95% CI: 0.22–0.86) compared to those with low birth weight. Maternal

TABLE 2 Individual, maternal, and household-level characteristics of children.

Variable	Number (%) or mean (standard deviation)
Individual level	
Age (months)	
9–11	74 (20.4)
12–23	146 (40.3)
24–36	142 (39.2)
Sex	
Male	166 (45.9)
Female	196 (54.1)
Birth order	
First	161 (44.6)
Second	138 (38.2)
≥3	62 (17.2)
Birth weight (g)	
Low birth weight (<2,500)	74 (20.4)
Normal or above average (≥2,500)	288 (79.6)
Anthropometric measurements (mean ± SD)	
Height (cm)	78.4 ± 7.99
Weight (kg)	9.73 ± 1.85
Mid-upper arm circumference (cm)	14 ± 1.09
Chest circumference (cm)	45.86 ± 2.64
Head circumference (cm)	45.57 ± 2.02
Child's status at birth	
Full term	290 (80.6)
Preterm	70 (19.4)
Diarrheal infection	
Yes	220 (60.9)
No	141 (39.1)
Respiratory tract infection	
Yes	174 (48.2)
No	187 (51.8)
Signs of vitamin A deficiency	
No	361 (100)
Signs of vitamin D deficiency	
Yes	42 (11.6)
No	319 (88.4)
Signs of anemia	
Yes	104 (28.8)
No	257 (71.2)
Exclusive breastfeeding (months)	
<6	85 (23.6)
6	207 (57.3)
>6	69 (19.1)
Dietary preference	
Vegetarian	63 (17.5)
Non-vegetarian	269 (74.5)
Ovo-vegetarian	29 (8)
Dietary history (mean ± SD)	
Calorie intake	535.2 ± 175.2
Protein intake (g)	14.3 ± 5.4
Calcium intake (mg)	156.1 ± 112.2
Zinc intake (mg)	1.1 ± 0.52
Protein intake	
Adequate	198 (54.6)
Inadequate	165 (45.4)

(Continued)

TABLE 2 Continued

Variable	Number (%) or mean (standard deviation)
Calcium intake by RDA	
Adequate	12 (3.3)
Inadequate	351 (96.7)
Zinc intake	
Adequate	8 (2.2)
Inadequate	355 (97.8)
Maternal level	
Age (years)	
≤20	8 (2.2)
>20	353 (97.8)
Education	
Illiterate	10 (2.8)
Primary education	10 (2.8)
Secondary education	270 (74.6)
Higher education	72 (19.9)
Height (cm)	
<155	170 (47.09)
≥155	191 (52.91)
BMI	
Normal (18.5–22.9)	156 (43.2)
Underweight (<18.5)	71 (19.7)
Overweight (≥23)	134 (37.1)
Birth interval	
First child	160 (44.3)
<24 months	26 (7.2)
≥24 months	175 (48.5)
Place of delivery	
Public	169 (46.7)
Private	191 (52.8)
Home	2 (0.6)
Mode of delivery	
Normal	171 (47.4)
Cesarean	190 (52.6)
Occupation	
Housewife	334 (92.3)
Working	28 (7.7)
Exposure to print media	
Yes	94 (26)
No	267 (74)
Exposure to electronic media	
Yes	330 (91.4)
No	31 (8.6)
Maternal history during pregnancy	
Hemoglobin level	
<11 g/dl (anemia)	137 (38.2)
≥11 g/dl (normal)	222 (61.8)
Gestational DM	
Yes	6 (1.7)
No	355 (98.3)
Pre-eclampsia	
Yes	28 (7.8)
No	333 (92.2)
Iron–folic acid consumption	
Yes	319 (88.4)
No	42 (11.6)

(Continued)

TABLE 2 Continued

Variable	Number (%) or mean (standard deviation)
ANC	
≥4	237 (65.8)
<4	123 (34.2)
Autonomy	
Yes	265 (73.4)
No	96 (26.6)
Control of money	
Yes	256 (70.9)
No	105 (29.1)
Household level	
Religion	
Hindu	233 (64.4)
Muslim	123 (34)
Other	6 (1.6)
Type of family	
Nuclear	139 (38.5)
Joint	222 (61.5)

LBW, low birth weight; MUAC, mid-upper arm circumference.

characteristics of normal height and exposure to print media were protective against underweight (AOR: 0.35, 95% CI: 0.19–0.66; and AOR: 2.16, 95% CI: 1.07–4.38, respectively). Children of mothers who did not consume iron–folic acid tablets during pregnancy had a lower risk of being underweight (AOR: 0.29, 95% CI: 0.09–0.94). However, mother’s autonomy was associated with an increased risk of the child being underweight (AOR: 0.20, 95% CI: 0.06–0.66), whereas a maternal lack of control over money led to a fourfold increased risk for the child to be underweight (AOR: 4.05, 95% CI: 1.34–12.25). Interestingly, children from non-Hindu and non-Muslim religious backgrounds had a dramatically increased risk of underweight (AOR: 10.79, 95% CI: 1.23–94.74), though this association was not apparent in the unadjusted analyses.

Discussion

The article aimed to determine the prevalence of stunting, wasting, and underweight among an understudied population of children aged 9–36 months residing in the urban slums of Belagavi, Karnataka, and examined the key determinants of undernutrition (18–21). The findings revealed a high prevalence of stunting compared to the national estimates and state averages of Karnataka, while the prevalence of wasting and underweight was lower (5). These disparities may reflect an increased availability and accessibility of calorie-dense foods to prevent underweight and wasting, but the overall quality of foods remains poor, leading to stunting (22, 23). Previous studies in the literature report similar findings in urban slums, reflecting the unique environmental and economic conditions present in slums (24–29).

Table 7 summarizes all statistically significant determinants of undernutrition after adjusting for child, maternal, and household-level characteristics, along with their corresponding odds ratios.

Key risk factors of stunting identified in the study included being male, aged 12–23 months, low birth weight, having an illiterate mother, shorter maternal stature, and maternal IFA consumption, while delivery in the private health sector emerged as a protective factor. The association with male children aligns with previous studies in the literature (29–32). This could be attributed to male children’s higher metabolic requirements and increased susceptibility to infections, leading to increased nutrient deficits that manifest as stunting. Moreover, children aged 12–23 months are at a critical stage of growth and development, having started weaning with increased physical activity, which places them at an increased risk of stunting, with established findings on growth faltering during this phase (33–35). Low birth weight emerged as a significant risk factor for stunting, emphasizing the importance of interventions targeting maternal health during the early phase of pregnancy (36, 37). The strong association between maternal education and stunting is consistent with a substantial body of literature (29, 38, 39). Maternal education is linked with improved health-seeking behavior, better child-caring practices, and utilization of healthcare services. Educated girls marry at an older age, bear a child later in life, have fewer children, and are better equipped with knowledge and resources to prevent malnutrition (29). Maternal stature was also identified as a key risk factor for stunting and is in line with available literature. Short maternal stature reflects suboptimal nutrition intake during their own childhood and adolescent phase and is linked with a higher risk of intra-uterine growth restriction, further adding to the intragenerational cycle of malnutrition (25, 40–42). Although our findings suggest that delivery in private facilities is associated with lower risk of stunting, this likely reflects underlying socioeconomic advantages rather than differences in care quality. Families choosing private care often have better access to resources, improving postnatal nutrition and childcare. Public facilities cater to more vulnerable populations and may be constrained by high patient loads. Additionally, the observed difference may be influenced by the relatively small sample size, which could limit the generalizability of the results. These findings highlight the need to strengthen postnatal support in the public sector.

In terms of wasting, a marker of the current nutritional status of the child (39), this study found that children aged 24–36 months were at increased risk of wasting, which is in contrast with previous studies that suggest an increased risk at an earlier age (43, 44). This observation of increased risk at an older age could reflect the effect of inadequate nutrition or repeated infections during this crucial phase, leading to wasting.

A history of gestational diabetes was associated with an increased risk of wasting, supporting the concept of “fetal programming,” wherein early exposure to certain adverse conditions can influence a child’s growth and lead to poor health outcomes later in life (45–47). Exposure to print media was

TABLE 3 Chi-square test results of the association between child, maternal, and household characteristics and undernutrition.

Variable	Stunting		Wasting		Underweight	
	No	Yes	No	Yes	No	Yes
Child level						
Age (months)	$p = 0.127$		$p = 0.006^*$		$p = 0.007^*$	
9–11	49 (66.2)	25 (33.8)	69 (93.2)	5 (6.8)	65 (87.8)	9 (12.2)
12–23	76 (52.1)	70 (47.9)	136 (93.2)	10 (6.9)	109 (74.7)	37 (25.3)
24–36	78 (54.9)	64 (45.1)	117 (82.4)	25 (17.6)	97 (68.3)	45 (31.7)
Gender	$p = 0.053$		$p = 0.577$		$p = 0.948$	
Male	84 (50.6)	82 (49.4)	146 (87.9)	20 (12.1)	124 (74.7)	42 (25.3)
Female	119 (60.7)	77 (39.3)	176 (89.8)	20 (10.2)	147 (75.0)	49 (25)
Birth order	$p = 0.371$		$p = 0.922$		$p = 0.208$	
First	88 (54.7)	73 (45.3)	143 (88.8)	18 (11.2)	114 (70.8)	47 (29.2)
Second	83 (60.1)	55 (39.9)	122 (88.4)	16 (11.6)	110 (79.7)	28 (20.3)
≥3	31 (50.0)	31 (50.0)	56 (90.3)	6 (9.7)	46 (74.2)	16 (25.8)
Birth weight	$p = 0.003^*$		$p = 0.732$		$p = 0.012^*$	
LBW	30 (40.5)	44 (59.5)	65 (87.8)	9 (12.2)	47 (63.5)	27 (36.5)
Normal or above average	173 (60.0)	115 (40)	257 (89.2)	31 (10.8)	224 (77.8)	64 (22.2)
Child's status at birth	$p = 0.644$		$p = 0.109$		$p = 0.878$	
Full term	161 (55.5)	129 (44.5)	254 (87.6)	36 (12.4)	217 (74.8)	73 (25.2)
Preterm	41 (58.6)	29 (41.4)	66 (94.3)	4 (5.7)	53 (75.7)	17 (24.3)
Diarrheal infection	$p = 0.982$		$p = 0.414$		$p = 0.542$	
Yes	123 (55.9)	97 (44.1)	198 (90.0)	22 (10)	167 (75.9)	53 (24.1)
No	79 (56.0)	62 (44.0)	123 (87.2)	18 (12.8)	103 (73.1)	38 (26.9)
Respiratory tract infection	$p = 0.892$		$p = 0.925$		$p = 0.213$	
Yes	98 (56.3)	76 (43.7)	155 (89.1)	19 (10.9)	125 (71.8)	49 (28.2)
No	104 (55.6)	83 (44.4)	166 (88.8)	21 (11.2)	145 (77.5)	42 (22.5)
Signs of vitamin D deficiency	$p = 0.620$		$p = 0.387$		$p = 0.876$	
Yes	22 (52.4)	20 (47.6)	39 (98.9)	3 (7.1)	31 (73.8)	11 (26.2)
No	180 (56.4)	139 (43.6)	282 (88.4)	37 (11.6)	239 (74.9)	80 (28.1)
Signs of anemia	$p = 0.326$		$p = 0.585$		$p = 0.834$	
Yes	54 (51.9)	50 (48.1)	91 (87.5)	13 (12.5)	77 (74.0)	27 (26.0)
No	148 (57.6)	109 (42.4)	230 (89.5)	27 (10.5)	193 (75.1)	64 (24.9)
Exclusive breastfeeding (months)	$p = 0.690$		$p = 0.066$		$p = 0.885$	
<6	51 (60.0)	34 (40.0)	76 (89.4)	9 (10.6)	64 (75.3)	21 (24.7)
6	113 (54.5)	94 (45.4)	189 (91.3)	18 (8.7)	156 (75.4)	51 (24.6)
>6	38 (55.1)	31 (44.9)	56 (81.2)	13 (18.8)	50 (72.5)	19 (27.5)
Dietary preference	$p = 0.745$		$p = 0.886$		$p = 0.270$	
Vegetarian	38 (60.3)	25 (39.7)	56 (88.9)	7 (11.1)	51 (80.9)	12 (19.1)
Non-vegetarian	148 (55.0)	121 (45.0)	240 (89.2)	29 (10.8)	200 (74.3)	69 (25.7)
Ovo-vegetarian	16 (55.2)	13 (44.8)	25 (86.2)	4 (13.8)	19 (65.5)	10 (34.5)
Protein intake	$p = 0.676$		$p = 0.706$		$p = 0.358$	
Adequate	113 (57.1)	85 (43.9)	175 (88.4)	23 (11.6)	152 (76.8)	46 (23.2)
Inadequate	90 (54.9)	74 (45.1)	147 (89.6)	17 (10.4)	119 (72.6)	45 (27.4)
Calcium intake	$p = 0.873$		$p = 0.214$		$p = 0.172$	
Adequate	7 (58.3)	5 (41.7)	12 (100.0)	0 (0.0)	11 (91.7)	1 (8.3)
Inadequate	196 (56.0)	154 (44.0)	310 (88.6)	40 (11.4)	260 (74.3)	90 (25.7)
Zinc intake	$p = 0.726$		$p = 0.313$		$p = 0.415$	
Adequate	4 (50.0)	4 (50.0)	8 (100.0)	0 (0.0)	5 (62.5)	3 (37.5)
Inadequate	199 (56.21)	155 (43.8)	314 (88.7)	40 (11.3)	266 (75.1)	88 (24.9)
Maternal level						
Age (years)	$p = 0.706$		$p = 0.313$		$p = 0.989$	
≤20	5 (62.5)	3 (37.5)	8 (100.0)	0 (0.0)	6 (75.0)	2 (25.0)
>20	197 (55.8)	156 (44.2)	313 (88.7)	40 (11.3)	264 (74.8)	89 (25.2)

(Continued)

TABLE 3 Continued

Variable	Stunting		Wasting		Underweight	
	No	Yes	No	Yes	No	Yes
Education	$p = 0.022^*$		$p = 0.538$		$p = 0.761$	
Illiterate	1 (10.0)	9 (90.0)	10 (100.0)	0 (0.0)	7 (70.0)	3 (30.0)
Primary education	7 (70.0)	3 (30.0)	9 (90.0)	1 (10.0)	8 (80.0)	2 (20.0)
Secondary education	153 (56.7)	117 (43.3)	237 (87.8)	33 (12.2)	199 (73.7)	71 (26.3)
Higher education	42 (58.3)	30 (41.7)	66 (91.7)	6 (8.3)	57 (79.2)	15 (20.8)
Height (cm)	$p = 0.018^*$		$p = 0.288$		$p = 0.003^*$	
<155	84 (49.4)	86 (50.6)	148 (87.1)	22 (12.9)	115 (67.6)	55 (32.4)
≥155	118 (61.8)	73 (38.2)	173 (90.6)	18 (9.4)	155 (81.2)	36 (18.8)
BMI	$p = 0.467$		$p = 0.633$		$p = 0.942$	
Underweight	83 (53.2)	73 (46.8)	139 (89.1)	17 (10.9)	118 (75.6)	38 (24.4)
Normal	44 (62.0)	27 (38.0)	61 (85.9)	10 (14.1)	53 (74.6)	18 (25.4)
Overweight	75 (56.0)	59 (44.0)	121 (90.3)	13 (9.7)	99 (73.9)	35 (26.1)
Birth interval	$p = 0.721$		$p = 0.991$		$p = 0.252$	
First child	88 (55.0)	72 (45.0)	142 (88.7)	18 (11.3)	113 (70.6)	47 (29.4)
<24 months	13 (50.0)	13 (50.0)	23 (88.5)	3 (11.5)	21 (80.8)	5 (19.2)
≥24 months	101 (57.7)	74 (42.3)	156 (89.1)	19 (10.9)	136 (77.7)	39 (22.3)
Place of delivery	$p = 0.059$		$p = 0.937$		$p = 0.724$	
Public	84 (49.7)	85 (50.3)	150 (88.8)	19 (11.2)	124 (73.4)	45 (26.6)
Private	117 (61.3)	74 (38.7)	170 (89.0)	21 (11)	145 (75.9)	46 (24.1)
Home	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)
Mode of delivery	$p = 0.0781$		$p = 0.513$		$p = 0.646$	
Normal	97 (56.7)	74 (43.3)	154 (90.1)	17 (9.9)	126 (73.7)	45 (26.3)
Cesarean	105 (55.3)	85 (44.7)	167 (87.9)	23 (12.1)	144 (75.8)	46 (24.2)
Occupation	$p = 0.781$		$p = 0.570$		$p = 0.986$	
Housewife	188 (56.3)	146 (43.7)	298 (89.2)	36 (10.8)	250 (74.9)	84 (25.1)
Working	15 (53.6)	13 (46.4)	24 (85.7)	4 (14.3)	21 (75)	7 (25)
Exposure to print media	$p = 0.074$		$p = 0.192$		$p = 0.116$	
Yes	60 (63.8)	34 (36.2)	87 (92.5)	7 (7.5)	76 (80.9)	18 (19.1)
No	142 (53.2)	125 (46.8)	234 (87.6)	33 (12.4)	194 (72.7)	73 (27.3)
Exposure to electronic media	$p = 0.610$		$p = 0.795$		$p = 0.432$	
Yes	186 (56.4)	144 (43.6)	293 (88.8)	37 (11.2)	245 (74.2)	85 (25.8)
No	16 (51.6)	15 (48.4)	28 (90.3)	3 (9.7)	25 (80.6)	6 (19.4)
Autonomy	$p = 0.584$		$p = 0.078$		$p = 0.546$	
Yes	146 (55.1)	119 (44.9)	231 (87.2)	34 (12.8)	196 (74)	69 (26)
No	56 (58.3)	40 (41.7)	90 (93.7)	6 (6.3)	74 (77.1)	22 (22.9)
Control of money	$p = 0.771$		$p = 0.546$		$p = 0.346$	
Yes	142 (55.5)	114 (44.5)	226 (88.3)	30 (11.7)	195 (76.2)	61 (23.8)
No	60 (57.1)	45 (42.9)	95 (90.5)	10 (9.5)	75 (71.4)	30 (28.6)
Maternal history during pregnancy						
Hb (g/dl)	$p = 0.471$		$p = 0.8$		$p = 0.36$	
<11	80 (58.4)	57 (41.6)	121 (88.3)	16 (11.7)	99 (72.3)	38 (27.7)
≥11	121 (54.5)	101 (45.5)	198 (89.2)	24 (10.8)	170 (76.6)	52 (23.4)
Gestational diabetes mellitus	$p = 0.260$		$p = 0.080$		$p = 0.644$	
Yes	2 (33.3)	4 (66.7)	4 (66.7)	2 (33.3)	4 (66.7)	2 (33.3)
No	200 (56.3)	155 (43.7)	317 (89.3)	38 (10.7)	266 (74.9)	89 (25.1)
Pre-eclampsia	$p = 0.597$		$p = 0.489$		$p = 0.351$	
Yes	17 (60.7)	11 (39.3)	26 (98.9)	2 (7.1)	23 (82.1)	5 (17.9)
No	185 (55.6)	148 (44.4)	295 (88.6)	38 (11.4)	247 (74.2)	86 (25.8)
Iron-folic acid consumption	$p = 0.069$		$p = 0.387$		$p = 0.013^*$	
Yes	173 (54.2)	146 (45.8)	282 (88.4)	37 (11.6)	232 (72.7)	87 (27.3)
No	29 (69.0)	13 (31)	39 (98.9)	3 (7.1)	38 (90.4)	4 (9.5)
ANC visits	$p = 0.997$		$p = 0.409$		$p = 0.780$	
≥4	133 (56.1)	104 (43.9)	213 (89.9)	24 (10.1)	176 (74.3)	61 (25.7)
<4	69 (56.1)	54 (43.9)	107 (87.0)	16 (13.0)	93 (75.6)	30 (24.4)

(Continued)

TABLE 3 Continued

Variable	Stunting		Wasting		Underweight	
	No	Yes	No	Yes	No	Yes
Household level						
Religion	$p = 0.063$		$p = 0.891$		$p = 0.055$	
Hindu	138 (59.2)	95 (40.8)	208 (89.3)	25 (10.7)	183 (78.5)	50 (21.5)
Muslim	64 (52.0)	59 (48.0)	109 (88.6)	14 (11.4)	85 (69.1)	38 (30.9)
Other	1 (16.7)	5 (83.3)	5 (83.3)	1 (16.7)	3 (50.0)	3 (50.0)
Type of family	$p = 0.140$		$p = 0.408$		$p = 0.992$	
Nuclear	71 (51.1)	68 (48.9)	126 (90.6)	13 (9.4)	104 (74.8)	35 (25.2)
Joint	131 (59.0)	91 (40.1)	195 (87.8)	27 (12.2)	166 (74.8)	56 (25.2)

*Significant at the level $p < 0.05$.

TABLE 4 Determinants of stunting among children in the urban slums.

Independent variable	Crude OR	95% CI	Model I		Model II		Model III	
			AOR	95%	AOR	95%	AOR	95%
Age (months)								
9–11 (reference)								
12–23	1.81*	1.01–3.23	1.75	0.95–3.24	1.75	0.89–3.41	1.75	0.89–3.48
24–36	1.61	0.90–2.88	1.48	0.78–2.80	1.72	0.86–3.47	1.81	0.89–3.67
Sex								
Male (reference)								
Female	0.66	0.44–1.01	0.63*	0.40–0.99	0.6*	0.36–0.99	0.61	0.37–1.01
Birth order								
First (reference)								
Second	0.8	0.50–1.27	0.88	0.54–1.43	1.04	0.07–15.80	1.49	0.11–21.01
≥3	1.21	0.67–2.17	1.28	0.69–2.37	1.43	0.09–22.63	1.64	0.11–23.74
Birth weight								
LBW (reference)								
Normal or above average	0.45**	0.27–0.76	0.44**	0.25–0.75	0.37**	0.20–0.69	0.34***	0.19–0.66
Child’s status at birth								
Full term (reference)								
Preterm	0.88	0.52–1.50	0.75	0.42–1.33	0.79	0.42–1.50	0.75	0.39–1.45
Diarrheal infection								
Yes (reference)								
No	0.99	0.65–1.52	1.06	0.68–1.66	0.98	0.58–1.63	0.95	0.57–1.61
Respiratory tract infection								
Yes (reference)								
No	1.03	0.68–1.56	1.08	0.69–1.69	1.19	0.71–1.98	1.23	0.73–2.09
Signs of vitamin D deficiency								
Yes (reference)								
No	0.85	0.45–1.62	0.93	0.46–1.84	1.01	0.47–2.17	1	0.46–2.17
Signs of anemia								
Yes (reference)								
No	0.8	0.50–1.26	0.82	0.50–1.32	0.94	0.55–1.61	0.97	0.56–1.66
Exclusive breastfeeding (months)								
<6 (reference)								
6	1.25	0.75–2.08	1.28	0.73–2.24	1.25	0.67–2.32	1.31	0.69–2.50
>6	1.22	0.64–2.33	1.13	0.56–2.26	1.09	0.51–2.33	1.11	0.51–2.39
Dietary preferences								
Vegetarian (reference)								
Non-vegetarian	1.24	0.71–2.17	1.04	0.57–1.90	0.94	0.49–1.80	0.88	0.46–1.71
Ovo-vegetarian	1.24	0.51–3.00	1.08	0.42–2.80	0.73	0.26–2.05	0.57	0.20–1.67

(Continued)

TABLE 4 Continued

Independent variable	Crude OR	95% CI	Model I		Model II		Model III	
			AOR	95%	AOR	95%	AOR	95%
Protein intake								
Adequate (reference)								
Inadequate	1.09	0.72–1.66	1.02	0.65–1.59	0.91	0.55–1.48	0.84	0.51–1.40
Calcium intake								
Adequate (reference)								
Inadequate	1.1	0.34–3.53	0.63	0.17–2.34	0.43	0.10–1.95	0.42	0.09–1.94
Zinc intake								
Adequate (reference)								
Inadequate	0.78	0.19–3.16	0.67	0.13–3.44	0.42	0.07–2.42	0.38	0.06–2.32
Maternal level								
Age (years)								
≤20 (reference)								
>20	1.32	0.31–5.61			2.8	0.39–20.18	2.72	0.36–20.80
Education								
Illiterate (reference)								
Primary education	0.05*	0.00–0.56			0.05*	0.00–0.65	0.03*	0.00–0.48
Secondary education	0.08*	0.01–0.68			0.06*	0.01–0.58	0.06*	0.01–0.57
Higher eduction	0.08*	0.01–0.66			0.07*	0.01–0.69	0.07*	0.01–0.74
Height (cm)								
Short (<155) (reference)								
Normal (≥155)	0.60*	0.40–0.92			0.56*	0.34–0.92	0.53*	0.31–0.88
Birth interval								
First child (reference)								
<24 months	1.22	0.53–2.80			1.34	0.08–24.03	0.81	0.05–13.56
≥24 months	0.9	0.58–1.38			0.78	0.05–11.78	0.54	0.04–7.65
BMI								
Normal (reference)								
Underweight	0.7	0.39–1.24			0.67	0.34–1.34	0.63	0.32–1.27
Overweight	0.89	0.56–1.42			0.85	0.49–1.46	0.77	0.44–1.35
Place of delivery								
Public (reference)								
Private	0.625*	0.41–0.95			0.56*	0.34–0.93	0.55*	0.33–0.92
Home								
Mode of delivery								
Normal (reference)								
Cesarean	1.06	0.70–1.61			1.13	0.69–1.87	1.11	0.67–1.84
Occupation								
Housewife (reference)								
Working	1.12	0.51–2.42			0.92	0.38–2.25	1.05	0.42–2.64
Exposure to print media								
Yes (reference)								
No	1.55	0.96–2.52			1.85*	1.03–3.30	1.77	0.97–3.25
Exposure to electronic media								
Yes (reference)								
No	1.21	0.58–2.53			1.04	0.44–2.48	0.92	0.37–2.26
Autonomy								
Yes (reference)								
No	0.88	0.55–1.41			0.73	0.28–1.91	0.69	0.25–1.87
Control of money								
Yes (reference)								
No	0.93	0.59–1.48			1.09	0.43–2.72	1.11	0.42–2.91

(Continued)

TABLE 4 Continued

Independent variable	Crude OR	95% CI	Model I		Model II		Model III	
			AOR	95%	AOR	95%	AOR	95%
Maternal history during pregnancy								
Hb								
<11 (reference)								
≥11	1.17	0.76–1.80			1.04	0.63–1.73	1.02	0.61–1.72
Gestational diabetes mellitus								
Yes (reference)								
No	0.39	0.07–2.14			0.32	0.05–1.98	0.31	0.05–1.93
Pre-eclampsia								
Yes (reference)								
No	1.24	0.56–2.72			1.03	0.39–2.70	0.99	0.38–2.61
Iron–folic acid consumption								
Yes (reference)								
No	0.53	0.27–1.06			0.34*	0.15–0.79	0.38*	0.16–0.88
ANC visits								
≥4 (reference)								
<4	1	0.65–1.55			1.06	0.62–1.84	1.14	0.65–2.00
Household level								
Religion								
Hindu (reference)								
Muslim	1.34	0.86–2.08					1.42	0.79–2.56
Other	7.26	0.84–63.16					11.62	1.00–134.80
Type of family								
Nuclear (reference)								
Joint	0.73	0.47–1.11					0.7	0.42–1.18

* $p < 0.05$ (statistically significant).** $p < 0.01$ (highly significant).*** $p < 0.001$ (very highly significant).

TABLE 5 Determinants of wasting among children in urban slums.

Independent variable	Crude OR	95% CI	Model I		Model II		Model III	
			AOR	95%	AOR	95%	AOR	95%
Age (months)								
9–11 (reference)								
12–23	1.01	0.33–3.08	1.08	0.34–3.43	1.13	0.33–3.91	0.95	0.26–3.41
24–36	2.95*	1.08–8.06	3.07*	1.04–9.11	4.12*	1.25–13.56	4.04*	1.19–13.64
Sex								
Male (reference)								
Female	0.83	0.43–1.60	0.85	0.43–1.71	0.71	0.31–1.60	0.7	0.31–1.61
Birth order								
First (reference)								
Second	1.04	0.51–2.13	1.16	0.55–2.46	3.3	0.02–590.38	2.82	0.03–260.59
≥3	0.85	0.32–2.25	1.01	0.36–2.83	3.44	0.02–654.46	2.75	0.03–264.51
Birth weight								
LBW (reference)								
Normal or above average	0.87	0.40–1.92	0.72	0.31–1.69	0.72	0.28–1.85	0.63	0.24–1.68
Child's status at birth								
Full term (reference)								
Preterm	0.43	0.15–1.24	0.43	0.14–1.32	0.55	0.16–1.88	0.49	0.14–1.76
Diarrheal infection								
Yes (reference)								
No	1.32	0.68–2.55	1.35	0.67–2.71	1.49	0.66–3.37	1.64	0.71–3.76

(Continued)

TABLE 5 Continued

Independent variable	Crude OR	95% CI	Model I		Model II		Model III	
			AOR	95%	AOR	95%	AOR	95%
Respiratory tract infection								
Yes (reference)								
No	1.03	0.53–1.99	0.96	0.47–1.96	1.19	0.51–2.73	1.53	0.63–3.75
Signs of vitamin D deficiency								
Yes (reference)								
No	1.71	0.50–5.80	1.7	0.47–6.16	1.92	0.46–8.12	1.69	0.40–7.21
Signs of anemia								
Yes (reference)								
No	0.82	0.41–1.66	0.92	0.44–1.95	0.92	0.40–2.14	0.91	0.39–2.12
Exclusive breastfeeding (months)								
<6 (reference)								
6	0.8	0.35–1.87	0.68	0.28–1.67	0.8	0.29–2.22	0.7	0.25–1.99
>6	1.96	0.78–4.91	1.32	0.49–3.56	1.81	0.59–5.57	1.74	0.57–5.30
Dietary preferences								
Vegetarian (reference)								
Non-vegetarian	0.97	0.40–2.32	0.63	0.24–1.64	0.57	0.20–1.58	0.47	0.16–1.36
Ovo-vegetarian	1.28	0.34–4.77	1.07	0.26–4.36	0.72	0.14–3.66	0.55	0.10–3.01
Protein intake								
Adequate (reference)								
Inadequate	0.88	0.45–1.71	0.92	0.46–1.87	0.55	0.24–1.24	0.5	0.21–1.17
Calcium intake								
Adequate (reference)								
Inadequate			—	—	—	—	—	—
Zinc intake			—	—	—	—	—	—
Adequate (reference)								
Inadequate								
Maternal level								
Literacy status								
Illiterate (reference)								
Primary education	1.22	0.13–11.35			1.89	0.13–27.41	1.6	0.11–23.53
Secondary education	1.53	0.62–3.81			1.85	0.60–5.75	1.66	0.51–5.36
Higher education								
Height (cm)								
<155 (reference)								
≥155	0.7	0.36–1.35			0.57	0.25–1.33	0.53	0.22–1.26
Birth interval								
First child (reference)								
<24 months	1.03	0.28–3.77			0.32	0.00–73.13	0.31	0.00–38.57
≥24 months	0.96	0.49–1.90			0.28	0.00–50.15	0.36	0.00–33.16
BMI								
Normal (reference)								
Underweight	1.34	0.58–3.10			1.76	0.64–4.84	1.84	0.66–5.13
Overweight	0.88	0.41–1.88			0.72	0.30–1.76	0.65	0.26–1.62
Place of delivery								
Public (reference)								
Private	0.97	0.50–1.88			0.86	0.40–1.85	0.82	0.37–1.80
Home								
Mode of delivery								
Normal (reference)								
Cesarean	1.25	0.64–2.42			1.26	0.58–2.75	1.28	0.58–2.83
Occupation								
Housewife (reference)								
Working	1.38	0.45–4.20			0.77	0.19–3.10	0.81	0.20–3.35

(Continued)

TABLE 5 Continued

Independent variable	Crude OR	95% CI	Model I		Model II		Model III	
			AOR	95%	AOR	95%	AOR	95%
Exposure to print media								
Yes (reference)								
No	1.38	0.45–4.20			3.04*	1.05–8.84	3.18*	1.05–9.59
Exposure to electronic media								
Yes (reference)								
No	0.85	0.25–2.93			0.74	0.16–3.37	0.8	0.16–3.93
Autonomy								
Yes (reference)								
No	0.45	0.18–1.12			0.11**	0.02–0.57	0.1**	0.02–0.50
Control of money								
Yes (reference)								
No	0.79	0.37–1.69			2.59	0.67–10.08	2.28	0.59–8.82
Maternal history during pregnancy								
Maternal Hb								
<11 (reference)								
≥11	0.86	0.44–1.69			0.95	0.43–2.11	0.92	0.41–2.07
Gestational diabetes mellitus								
Yes (reference)								
No	0.24	0.04–1.35			0.09*	0.01–0.71	0.06*	0.01–0.52
Pre-eclampsia								
Yes (reference)								
No	1.67	0.38–7.34			1.75	0.30–10.39	1.63	0.27–9.86
Iron–folic acid consumption								
Yes (reference)								
No	0.59	0.17–1.99			0.52	0.12–2.32	0.6	0.14–2.70
ANC								
≥4 (reference)								
<4	1.33	0.68–2.60			1.83	0.75–4.46	1.95	0.78–4.87
Household level								
Religion								
Hindu (reference)								
Muslim	1.07	0.53–2.14					1.9	0.70–5.09
Other	1.66	0.19–14.82					5.78	0.33–102.48
Type of family								
Nuclear (reference)								
Joint	1.34	0.67–2.70					1.66	0.69–3.98

* $p < 0.05$ (statistically significant).** $p < 0.01$ (highly significant).*** $p < 0.001$ (very highly significant).

TABLE 6 Determinants of underweight among children in the urban slums.

Independent variable	Crude OR	95% CI	Model I		Model II		Model III	
			AOR	95%	AOR	95%	AOR	95%
Age (months)								
9–11 (reference)								
12–23	2.45*	1.11–5.40	2.33*	1.02–5.35	2.7*	1.08–6.69	2.7*	1.05–6.92
24–36	3.35**	1.53–7.32	3.21**	1.38–7.46	4.37**	1.73–11.09	4.75**	1.82–12.39
Sex								
Male (reference)								
Female	0.98	0.61–1.58	1.07	0.64–1.79	0.98	0.55–1.74	1.02	0.57–1.84

(Continued)

TABLE 6 Continued

Independent variable	Crude OR	95% CI	Model I		Model II		Model III	
			AOR	95%	AOR	95%	AOR	95%
Birth order								
First (reference)								
Second	0.62	0.36–1.06	0.69	0.39–1.22	1.97	0.08–50.95	2.02	0.10–42.34
≥3	0.84	0.43–1.64	0.89	0.44–1.80	3.07	0.11–83.37	2.37	0.11–51.86
Birth weight								
LBW (reference)								
Normal or above average	0.5*	0.29–0.86	0.49*	0.27–0.88	0.48*	0.25–0.94	0.43*	0.22–0.86
Child's status at birth								
Full term (reference)								
Preterm	0.95	0.52–1.75	0.9	0.46–1.74	1.07	0.51–2.24	1	0.47–2.11
Diarrheal infection								
Yes (reference)								
No	1.16	0.72–1.89	1.17	0.70–1.95	0.99	0.55–1.77	0.96	0.53–1.73
Respiratory tract infection								
Yes (reference)								
No	0.74	0.46–1.19	0.64	0.38–1.08	0.65	0.36–1.16	0.71	0.38–1.30
Signs of vitamin D deficiency								
Yes (reference)								
No	0.94	0.45–1.96	0.99	0.45–2.20	1.23	0.48–3.11	1.18	0.46–3.03
Signs of anemia								
Yes (reference)								
No	0.95	0.56–1.59	0.94	0.54–1.65	0.95	0.51–1.77	0.95	0.51–1.78
Exclusive breastfeeding (months)								
<6 (reference)								
6	1	0.55–1.79	0.89	0.47–1.69	1.15	0.56–2.34	1.11	0.53–2.33
>6	1.16	0.56–2.39	0.93	0.42–2.04	1.14	0.48–2.68	1.09	0.46–2.61
Dietary preference								
Vegetarian (reference)								
Non-vegetarian	1.47	0.74–2.91	1.05	0.50–2.19	0.99	0.44–2.22	0.85	0.37–1.95
Ovo-vegetarian	2.24	0.83–6.02	2.14	0.74–6.19	1.2	0.36–3.97	0.85	0.25–2.95
Protein intake								
Adequate (reference)								
Inadequate	1.25	0.78–2.01	1.2	0.73–2.00	0.98	0.56–1.72	0.89	0.50–1.60
Calcium intake								
Adequate (reference)								
Inadequate	3.81	0.48–29.91	3.23	0.37–28.02	3.63	0.34–38.64	3.73	0.34–41.51
Zinc intake								
Adequate (reference)								
Inadequate	0.55	0.13–2.35	0.62	0.12–3.21	0.43	0.07–2.87	0.38	0.06–2.64
Maternal level								
Age (years)								
≤20 (reference)								
>20	1.01	0.20–5.10			0.55	0.07–4.24	0.61	0.08–4.89
Education								
Illiterate (reference)								
Primary education	0.58	0.07–4.56			0.78	0.08–7.57	0.58	0.05–6.30
Secondary education	0.83	0.21–3.31			0.92	0.19–4.44	0.89	0.18–4.37
Higher education	0.61	0.14–2.66			0.78	0.14–4.44	0.89	0.15–5.19
Height (cm)								
<155 (reference)								
≥155	0.49**	0.30–0.79			0.39**	0.22–0.72	0.35**	0.19–0.66
Birth interval								
First child (reference)								
<24 months	0.57	0.20–1.61			0.26	0.01–8.52	0.18	0.01–5.10
≥24 months	0.69	0.42–1.13			0.32	0.01–8.24	0.31	0.01–6.64

(Continued)

TABLE 6 Continued

Independent variable	Crude OR	95% CI	Model I		Model II		Model III	
			AOR	95%	AOR	95%	AOR	95%
BMI								
Normal (reference)								
Underweight	1.05	0.55–2.02			1.47	0.68–3.18	1.45	0.66–3.19
Overweight	1.1	0.65–1.87			1.19	0.64–2.24	1.07	0.57–2.04
Place of delivery								
Public (reference)								
Private	0.87	0.54–1.41			0.79	0.45–1.38	0.73	0.41–1.30
Home								
Mode of delivery								
Normal (reference)								
Caesarian	0.89	0.56–1.44			0.86	0.49–1.53	0.83	0.47–1.49
Occupation								
Housewife (reference)								
Working	0.99	0.41–2.42			0.76	0.28–2.06	0.86	0.31–2.38
Exposure to print media								
Yes (reference)								
No	1.59	0.89–2.84			2.16*	1.07–4.38	2.04	0.97–4.29
Exposure to electronic media								
Yes (reference)								
No	0.69	0.27–1.74			0.6	0.20–1.76	0.54	0.17–1.69
Autonomy								
Yes (reference)								
No	0.84	0.49–1.46			0.22*	0.07–0.70	0.2**	0.06–0.66
Control of money								
Yes (reference)								
No	1.28	0.77–2.13			3.94*	1.32–11.74	4.05*	1.34–12.25
Maternal history during pregnancy								
Hb								
<11 (reference)								
≥11	0.8	0.49–1.30			0.8	0.45–1.43	0.76	0.42–1.37
Gestational diabetes mellitus								
Yes (reference)								
No	0.67	0.12–3.72			0.46	0.07–3.21	0.37	0.06–2.56
Pre-eclampsia								
Yes (reference)								
No	1.6	0.59–4.34			1.25	0.38–4.09	1.21	0.36–4.10
Iron–folic acid consumption								
Yes (reference)								
No	0.28*	0.10–0.81			0.26*	0.08–0.84	0.29*	0.09–0.94
ANC								
≥4 (reference)								
<4	0.93	0.56–1.54			0.94	0.50–1.79	1.05	0.54–2.04
Household level								
Religion								
Hindu (reference)								
Muslim	1.64	1.00–2.68					1.98	0.99–3.99
Other	3.66	0.72–18.69					10.79*	1.23–94.74
Type of family								
Nuclear (reference)								
Joint	1	0.62–1.63					0.86	0.47–1.57

* $p < 0.05$ (statistically significant).** $p < 0.01$ (highly significant).*** $p < 0.001$ (very highly significant).

TABLE 7 Determinants of undernutrition after adjusting for child, maternal, and household-level characteristics.

Variable	Adjusted odds ratio (Model III)	
	AOR	95% CI
Stunting		
Birth weight		
LBW (reference)		
Normal or above average	0.34***	0.19–0.66
Education		
Illiterate (reference)		
Primary education	0.03*	0.00–0.48
Secondary education	0.06*	0.01–0.57
Higher education	0.07*	0.01–0.74
Height (cm)		
Short (<155) (reference)		
Normal (≥155)	0.53*	0.31–0.88
Place of delivery		
Public (reference)		
Private	0.55*	0.33–0.92
Home		
Iron–folic acid consumption		
Yes (reference)		
No	0.38*	0.16–0.88
Wasting		
Age (months)		
9–11 (reference)		
12–23	0.95	0.26–3.41
24–36	4.04*	1.19–13.64
Exposure to print media		
Yes (reference)		
No	3.18*	1.05–9.59
Autonomy		
Yes (reference)		
No	0.1**	0.02–0.50
Gestational diabetes mellitus		
Yes (reference)		
No	0.06*	0.01–0.52
Underweight		
Age (months)		
9–11 (reference)		
12–23	2.7*	1.05–6.92
24–36	4.75**	1.82–12.39
Birth weight		
LBW (reference)		
Normal or above average	0.43*	0.22–0.86
Maternal height (cm)		
<155 (reference)		
≥155	0.35**	0.19–0.66
Autonomy		
Yes (reference)		
No	0.2**	0.06–0.66
Control of money		
Yes (reference)		
No	4.05*	1.34–12.25

(Continued)

TABLE 7 Continued

Variable	Adjusted odds ratio (Model III)	
	AOR	95% CI
Iron–folic acid consumption		
Yes (reference)		
No	0.29*	0.09–0.94
Religion		
Hindu (reference)		
Muslim	1.98	0.99–3.99
Other	10.79*	1.23–94.74

* $p < 0.05$ (statistically significant).
** $p < 0.01$ (highly significant).
*** $p < 0.001$ (very highly significant).

TABLE 8 Determinants of undernutrition in the urban slums of Belagavi among children aged 9–36 months

Undernutrition	Determinants
Stunting	Birth weight, maternal education, maternal height, place of delivery, and maternal IFA consumption
Wasting	Child’s age, mother’s exposure to print media, maternal autonomy, and gestational diabetes mellitus
Underweight	Child’s age, birth weight, maternal height, maternal autonomy, maternal control of money, maternal IFA consumption, and religion

found to be a protective factor, consistent with previous research showing that mothers with media exposure are better informed, and this can encourage adequate child-caring practices (47–49).

Underweight was significantly associated with low birth weight and older age, which is well documented in the literature (47, 50, 51). Among maternal risk factors were short maternal stature, IFA consumption, and maternal autonomy. Short maternal stature has been linked with increased risk of underweight in children in previous studies (52). In addition, this study revealed that children from non-Hindu and non-Muslim religions had an increased risk of being underweight, which is in contrast with findings from National Family Health Survey-4 (NFHS-4) data, where Hindu children had a higher risk of being underweight (53).

Protective factors against the child being underweight included maternal exposure to print media and control of money. Maternal exposure to media has been associated with a decreased risk of the child being underweight (19). Maternal control of money is one of the important dimensions of maternal autonomy and has been previously reported to be associated with better nutritional outcomes in children (54).

Contrary to expectation, maternal autonomy did not emerge as a protective factor for wasting or underweight. It is possible that the current study’s definition of autonomy was not sufficiently elaborative to understand maternal autonomy (20, 54, 55). The association between IFA consumption and underweight, as with stunting, might reflect low adherence to IFA consumption, misreporting, or some confounding variables (56).

Table 8 presents the key determinants of undernutrition among young children residing in the urban slums of Belagavi city.

Strengths and limitations

The limitations of the present study include issues related to measurements of independent variables, such as maternal autonomy, which could have been captured with more detailed questions. The study's sample included children aged 9–36 months, whereas collecting data on all children under 5 years, along with a detailed history of past illnesses, would have increased the study's comprehensiveness. In addition, maternal self-reporting on iron-folic acid use may have introduced recall bias. Moreover, including more household/environmental level characteristics could have provided deeper insights into the correlates of malnutrition.

Conclusion

The study underscores the persistent burden of undernutrition, particularly stunting, among young children in the urban slums of Belagavi, Karnataka. Key risk factors include individual-level characteristics such as male sex, low birth weight, and critical growth phases, such as at 12–23 months; maternal factors such as shorter stature, low education levels, and limited autonomy; and belonging to a non-Hindu or non-Muslim religion, a household-level determinant. Protective factors, including delivery in private health facilities and maternal exposure to print media, highlight actionable areas for interventions. Empowering mothers through education and increased autonomy is crucial for improving the nutritional status of children and reducing the prevalence of malnutrition.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Ethical Committee (Human) for Ph.D. Research, KAHAR, Belagavi. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

DO: Conceptualization, Data curation, Methodology, Formal analysis, Writing – original draft. MA: Conceptualization, Project

administration, Data curation, Methodology, Investigation, Writing – review & editing. NM: Conceptualization, Methodology, Supervision, Writing – review & editing. MS: Formal analysis, Writing – original draft. SH: Data curation, Writing – original draft. MG: Conceptualization, Methodology, Investigation, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that Generative AI was used in the creation of this manuscript. Generative AI, Chat GPT, was used to assist in language editing and enhancing clarity.

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