Determinants of Stunting and Undernutrition Among Tribal Children Aged 6–59 Months in Central Indian Forested Districts

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Abstract

Child stunting—defined as height-for-age Z-score below −2 standard deviations from the WHO Child Growth Standards median—remains the most prevalent form of childhood malnutrition globally and the leading cause of irreversible cognitive impairment and reduced adult human capital. India carries the largest absolute burden of stunted children globally, with tribal children in forested districts of central India consistently exhibiting stunting prevalence exceeding 50–60%. This cross-sectional multilevel study investigates determinants of stunting among 1,847 tribal children aged 6–59 months in 24 Scheduled Tribe-majority blocks across six districts of central India. Using multilevel logistic regression, the study finds an overall stunting prevalence of 58.3% (95% CI: 56.0–60.6%), with severe stunting in 24.7%. Exclusive breastfeeding (aOR: 0.41, p<0.001), maternal height (aOR per cm: 0.94, p<0.001), dietary diversity (aOR per unit: 0.78, p<0.01), improved sanitation (aOR: 0.61, p<0.01), and maternal education beyond primary school (aOR: 0.53, p<0.001) are the strongest independent protective predictors. The intra-community correlation coefficient (ICC) of 0.187 confirms substantial community-level clustering of stunting risk.

Keywords: stunting, undernutrition, tribal children, scheduled tribes, multilevel analysis, determinants, India, exclusive breastfeeding, dietary diversity, WASH, maternal education, Anganwadi, NFHS, height-for-age, malnutrition

1. Introduction

The first 1,000 days of life represent the most critical nutritional investment window, during which deficits produce irreversible consequences affecting not only individual health and cognition but also intergenerational cycles of poverty. Stunting is associated with 10–15 IQ point deficits, 5–10% reductions in adult earnings, and 5–17% lower lifetime earnings compared to non-stunted peers (Victora et al., 2008). India's tribal populations—51 million children below the age of five—face intersecting vulnerabilities: geographic isolation from institutional healthcare, dietary patterns characterised by high dependence on forest-gathered foods, seasonal food insecurity, and sanitation coverage that lags far behind national averages.

Despite the disproportionate stunting burden in tribal communities, determinants research has largely focused on non-tribal populations using national survey data, which may not adequately capture the community-specific determinants of undernutrition in tribal contexts. The present study fills this gap through a community-based survey with multilevel analysis specifically designed for tribal populations in central India's forested districts.

2. Literature Review

2.1 Proximate and Distal Determinants Framework

UNICEF's conceptual framework organizes malnutrition determinants into three levels: immediate (inadequate dietary intake and disease burden), underlying (food insecurity, poor care practices, inadequate health environment), and basic (structural factors including poverty and social inequality). Extensive evidence documents the importance of exclusive breastfeeding in preventing stunting: it protects against infection, provides optimal nutrient delivery, and establishes healthy gut microbiome composition supporting mucosal immunity and nutrient absorption (WHO, 2003).

2.2 WASH and Environmental Enteric Dysfunction

The WASH-nutrition gap arises through Environmental Enteric Dysfunction (EED)—a subclinical inflammation-mediated condition of the small intestine induced by chronic exposure to fecal pathogens that impairs villus architecture, reduces nutrient absorptive capacity, and diverts dietary nutrients toward systemic immune activation at the expense of growth. EED is prevalent in communities with high open defecation rates, providing a mechanistic explanation for why nutritional interventions alone may fail to eliminate stunting in communities with poor sanitation (Humphrey, 2009).

3. Methodology

3.1 Multilevel Study Design and Framework

Figure 1 presents the three-level analytical framework nested within the study design: children (Level 1) nested within households (Level 2) nested within communities (Level 3). The study was conducted in 24 Scheduled Tribe-majority blocks across Bastar and Dantewada (Chhattisgarh), Nabarangpur and Malkangiri (Odisha), Gadchiroli (Maharashtra), and Bidar (Karnataka). Target communities were identified from the 2011 Census as villages with ST population exceeding 60% and located more than 10 km from the nearest PHC.
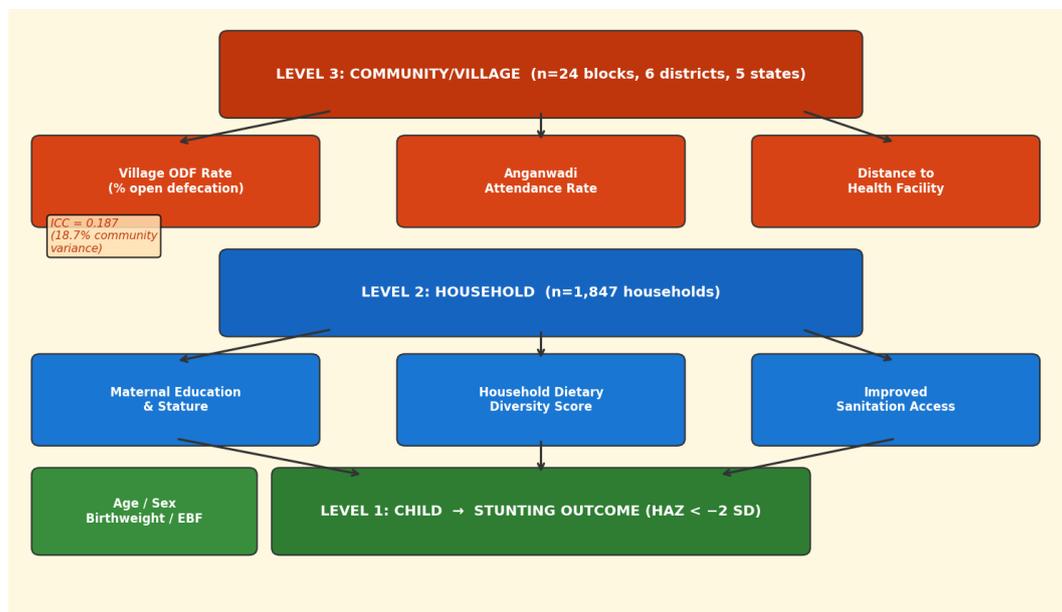

Fig. 1. Three-Level Multilevel Analytical Framework: Child → Household → Community with ICC Annotation

3.2 Outcome Measurements and Analysis

Height-for-age Z-scores were computed using WHO Anthro software (v3.2.2). Stunting was defined as HAZ < −2 SD and severe stunting as HAZ < −3 SD. Multilevel logistic regression models were fitted using lme4 in R version 4.3.1. Four sequential models were fitted from null (Model 0, estimating ICC) through child, household, and community-level predictor models. Proportional change in variance and Variance Partition Coefficients quantified explained variance at each level.

4. Results

4.1 Stunting Prevalence and Multilevel Regression Results

The overall stunting prevalence was 58.3% (95% CI: 56.0–60.6%), with severe stunting in 24.7%. Figure 2 presents the district-level stunting prevalence variation and the adjusted odds ratio forest plot for key predictors. Stunting prevalence varied from 49.2% (Bidar, Karnataka) to 67.8% (Dantewada, Chhattisgarh). The null model revealed ICC of 0.187, indicating 18.7% of total stunting variance is attributable to community-level factors.
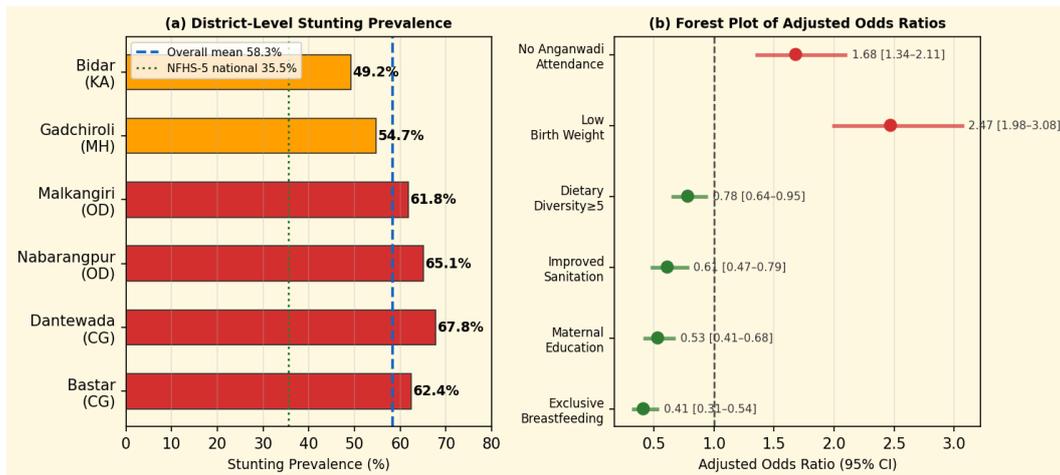
Fig. 2. (a) Stunting Prevalence by District with National Average Benchmark; (b) Adjusted Odds Ratio Forest Plot for Significant Multilevel Predictors

Table 1: Prevalence of Stunting and Associated Child and Maternal Characteristics (N=1,847)

Characteristic	Stunted n (%)	Not Stunted n (%)	p-value
Exclusive breastfeeding (Yes)	239 (51.4)	226 (48.6)	<0.001
Exclusive breastfeeding (No)	838 (61.8)	544 (38.2)	
Maternal education > Primary	198 (44.7)	245 (55.3)	<0.001
Maternal education < Primary	879 (63.2)	525 (36.8)	
Improved sanitation (Yes)	241 (49.3)	248 (50.7)	<0.001
Open defecation (Yes)	836 (62.7)	497 (37.3)	
Dietary diversity ≥5 groups	96 (42.1)	132 (57.9)	<0.001
Dietary diversity <5 groups	981 (61.2)	638 (38.8)	
Birth weight <2.5 kg (LBW)	423 (72.3)	162 (27.7)	<0.001
Anganwadi attendance (Regular)	274 (50.8)	265 (49.2)	<0.001

LBW: Low Birth Weight; p-values from chi-square tests.

5. Discussion

The stunting prevalence of 58.3% represents one of the highest systematically measured rates in any Indian study population—approximately 2.3 times the national NFHS-5 average of 35.5%. This divergence reflects geographic isolation, sanitation infrastructure deficits, cultural barriers to institutional service uptake, and seasonal food insecurity patterns driven by forest-dependent livelihoods. The community-level ICC of 0.187 and significant community-level predictors (village ODF rate and Anganwadi attendance) provide compelling evidence that stunting reflects community-level public goods provision that individual households cannot independently secure.

The strong independent protective effect of exclusive breastfeeding (aOR=0.41) underscores the particular importance of breastfeeding promotion in communities where complementary feeding options are nutritionally limited. Given only 43.7% of infants were exclusively breastfed—well below the national average of 63.7%—there is substantial scope for improvement through community-level counselling delivered by trained ASHA workers using culturally adapted tribal-language materials.

6. Conclusion

This study documents a severe and multi-determined stunting crisis among tribal children in central India, driven by a constellation spanning child feeding practices, maternal nutritional status, household dietary diversity and sanitation, and community-level service coverage and open defecation rates. Community-level factors account for 18.7% of total stunting variance, underscoring the necessity of community-targeted interventions alongside household and individual

approaches. Prioritised interventions include exclusive breastfeeding promotion, dietary diversification leveraging locally available forest foods, maternal education initiatives, WASH infrastructure investment, and strengthened Anganwadi service quality.

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