Decomposing the Hill–Valley Gap in Child Nutritional Status in Manipur: Evidence from National Family Health Survey (NFHS-5)

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Abstract

Childhood undernutrition in India exhibits marked spatial variation, yet the determinants of these disparities remain insufficiently understood. This study examines the hill–valley gap in child nutritional status in Manipur using data from the National Family Health Survey-5 (2019–21) for 2,987 children aged 0–59 months. Nutritional outcomes were assessed using height-for-age z-scores (HAZ) and stunting, and Blinder–Oaxaca decomposition was applied to quantify the contributions of compositional versus structural factors. While mean HAZ differed only marginally between hill (−1.03) and valley (−0.92) districts, stunting prevalence was significantly higher in hill districts (27.5% vs. 21.4%). Decomposition results showed that the entire hill–valley gap in both HAZ and stunting was driven by the unexplained component, indicating structural or contextual disadvantages rather than differences in household characteristics. Findings underscore the need for geographically targeted, supply-side interventions to address persistent nutritional inequities in Manipur's hill districts.

Keywords: Stunting, Manipur, Undernutrition, Childhood, Decomposition

Introduction

Childhood undernutrition remains a critical global health concern and is a leading contributor to child morbidity, mortality, impaired cognitive development, and reduced productivity in adulthood (Black et al., 2013). Childhood stunting is defined as height-

for-age (HAZ) more than two standard deviations below the median of the WHO Child Growth Standards and reflects chronic undernutrition during the most critical periods of growth and development. It results from prolonged inadequate dietary intake, repeated infections, and poor caregiving practices. Stunting is not merely a physical growth failure but a manifestation of long-term deprivation and adverse living conditions (UNICEF, WHO, & World Bank, 2021). Stunting, reflecting chronic growth failure, affects nearly one in four children globally and remains particularly high in South Asia (UNICEF, WHO, & World Bank, 2021). India alone accounts for a substantial share of the global stunted child population (Ministry of Health and Family Welfare, 2021).

Despite sustained economic growth and expanded nutrition programs, progress in reducing child undernutrition in India has been highly uneven across states and regions (Deaton & Drèze, 2009). Existing literature consistently identifies household wealth, maternal education, sanitation, maternal nutrition, and birth-related factors as primary determinants of child growth (Vollmer et al., 2014; Spears et al., 2013; Pandey & Lin, 2013; Smith & Haddad, 2000). However, a growing body of evidence suggests that geographic location itself may operate as an independent constraint on nutritional outcomes through infrastructure, health system reach, food market access, and ecological conditions (Mosley & Chen, 1984; Victora et al., 2008; Kim et al., 2018).

Manipur presents a unique geographic and developmental context. The state is divided into hill districts, characterized by rugged terrain, remoteness, weak transport connectivity, and limited market integration and the Imphal valley, which is comparatively urbanized and economically developed. These geographic contrasts are reflected in access to health services, nutrition programs, markets, and sanitation infrastructure. Yet, empirical evidence quantifying how much of the child nutrition gap between hill and valley districts is explained by household characteristics versus deeper structural factors remains scarce.

Blinder–Oaxaca decomposition provides a rigorous framework to decompose outcome gaps into explained (compositional) and unexplained (coefficient/structural) components (Oaxaca, 1973; Blinder, 1973; Powers, Yoshioka, & Yun, 2011). While widely used in labour economics and increasingly applied to health inequality research, its application to sub-state geographic nutrition inequality in Northeast India remains limited.

This study addresses this gap by applying Blinder–Oaxaca decomposition to disaggregate hill–valley differences in both continuous child growth (HAZ) and binary stunting outcomes using recent NFHS-5 data. The findings contribute new evidence on whether childhood undernutrition in Manipur is primarily driven by household-level disadvantage or deeper geographic and institutional constraints.

Methods

Data Source and Study Population

The study used unit-level data from NFHS-5 (2019–21), India's nationally representative household survey conducted under the Demographic and Health Survey (DHS) framework. The analysis was restricted to living children aged 0–59 months residing in Manipur. After excluding cases with missing anthropometric data, the final analytical sample comprised 2,987 children, of whom 1,820 resided in hill districts and 1,167 in valley districts.

Outcome Variables

Two outcome measures were analyzed in the study. Height-for-age z-score (HAZ) was used as a continuous standardized indicator of child linear growth, computed using the WHO Child Growth Standards. In addition, stunting was measured as a binary outcome, coded as 1 for children whose HAZ was below −2 standard deviations from the reference median and 0 otherwise.

Based on district codes, the study area was classified into two distinct geographical regions. The hill districts comprised Senapati, Tamenglong, Churachandpur, Ukhrul, and Chandel, while the valley districts included Bishnupur, Thoubal, Imphal West, and Imphal East. This classification allowed for a clear comparative assessment of child nutritional outcomes across contrasting topographical and socio-economic settings.

The covariates included in the analysis were selected on the basis of established literature (Vollmer et al., 2014; Spears et al., 2013; Pandey & Lin, 2013; Smith & Haddad, 2000; Mosley & Chen, 1984) and prior empirical evidence on child nutrition. These variables encompassed key child-, maternal-, household-, and environmental-level factors, namely child sex, child age in months, birth order, maternal education, maternal body mass index (BMI), household wealth quintile, access to improved drinking water, access to improved sanitation facilities, and place of residence (rural–urban).

Statistical Analysis

Survey weights and clustering at the primary sampling unit level were incorporated. Descriptive statistics were estimated using survey-adjusted means and proportions. Hill–valley differences were tested using survey-adjusted regressions. Blinder–Oaxaca decomposition was applied using a linear Oaxaca model for HAZ scores, and Logit-based Oaxaca model for stunting. The nutritional gap was decomposed into an explained component attributable to differences in characteristics, and an unexplained component arising due to differences in coefficients and unobserved structural factors.

Results

Descriptive Characteristics

The descriptive statistics is shown in Table 1. We found that the hill districts exhibit profound socioeconomic disadvantage. Children in the poorest wealth quintile constitute 37.2% of hill households compared to only 12.2% in valley districts ($p < 0.001$). Only 2.2% of hill children belong to the richest wealth group as against 9.6% in valley districts.

Maternal educational attainment is significantly lower in hill regions. Around 10.3% of mothers have no education compared to 6.1% in valley areas ($p = 0.003$). Secondary or higher education is substantially lower in hills than in the valley districts of Manipur (71.3% vs. 85.6%, $p < 0.001$). Mean maternal BMI is also lower in hill districts (23.16 vs. 24.11 kg/m², $p < 0.001$).

Access to improved sanitation is also markedly worse in hill areas (47.3%) than in valley districts (64.5%, $p < 0.001$). Hill districts are overwhelmingly rural (88.1%) compared to valley districts (57.0%, $p < 0.001$).

Despite these disadvantages, the mean HAZ difference (−0.11 SD) is statistically insignificant ($p = 0.191$). However, stunting prevalence is significantly higher in hill areas (27.5%) than in valley areas (21.4%) ($p = 0.002$).

Table 1. Descriptive characteristics of children under five by hill and valley districts, Manipur (NFHS-5)

HAZ (mean z-	-1.03	-0.92	0.000

score)			
HAZ (mean z-score)	-1.03	-0.92	0.191
Stunted (%)	27.5	21.4	0.002
Female child (%)	49.9	48.8	0.540
Age (months, mean)	30.71	31.42	0.302
Mother no education (%)	10.3	6.1	0.003
Mother secondary+ (%)	71.3	85.6	0.000
Maternal BMI (kg/m^2, mean)	23.16	24.11	0.000
Poorest wealth quintile (%)	37.2	12.2	0.000
Richest wealth quintile (%)	2.2	9.6	0.000
Improved drinking water (%)	15.9	20.7	0.090
Improved sanitation (%)	47.3	64.5	0.000
Rural residence (%)	88.1	57.0	0.000
Notes: Values are survey-weighted using NFHS-5 child sampling weights. Hill districts include Senapati, Tamenglong, Churachandpur, Ukhrul, and Chandel; valley districts include Bishnupur, Thoubal, Imphal West, and Imphal East. Stunting is defined as HAZ < −2 SD. p-values are from survey-adjusted linear regressions of each outcome on a hill–valley indicator (valley = 1).			

Oaxaca Decomposition of HAZ

Linear Oaxaca model for HAZ score is shown in Table 2. We found that the mean HAZ was −1.027 for hill districts and −0.920 for valley districts. The HAZ gap of −0.107 SD was entirely driven by the unexplained component, with zero contribution from observed endowments.

Oaxaca Decomposition of Stunting

Table 3 shows the logit-based Oaxaca model for stunting. The hill–valley stunting gap of 6.1 percentage points was statistically significant (p = 0.002). As with HAZ, 100% of the gap was attributable to the unexplained component, reflecting structural and contextual disadvantages.

Table 2: Blinder–Oaxaca Decomposition of HAZ					
Group	Mean HAZ	Difference	Explained	Unexplained	p-value
Hill	-1.027				
Valley	-0.920				
Gap (Hill – Valley)		-0.107 SD	0.000	-0.107 SD (100%)	0.211

Table 3: Blinder–Oaxaca Decomposition of Stunting					
Group	Stunting Prevalence (%)	Difference	Explained	Unexplained	p-value
Hill	27.48				
Valley	21.36				
Gap (Hill – Valley)		6.12 percentage points	0.000	6.12 pp (100%)	0.002

Notes:

1. Hill districts include Senapati, Tamenglong, Churachandpur, Ukhrul, and Chandel; Valley districts include Bishnupur, Thoubal, Imphal West, and Imphal East.

2. Height-for-age z-score (HAZ) is based on WHO Child Growth Standards.

3. Stunting is defined as HAZ < −2 standard deviations.

4. Blinder–Oaxaca decomposition was performed using the user-written 'oaxaca' command in Stata.

5. NFHS-5 child sampling weights were applied.

6. Robust standard errors were computed with clustering at the Primary Sampling Unit (PSU) level (v001).

7. Explained component reflects differences in observed characteristics, while

unexplained component captures differences in coefficients and unobserved structural factors.

Discussion

The most striking finding of this study is that despite large socioeconomic disadvantages in hill districts, none of the observed covariates statistically explain the hill–valley stunting gap. Both HAZ and stunting decompositions indicate complete dominance of the unexplained component. This implies that structural, institutional, and geographic barriers, not household poverty alone, are the primary drivers of nutritional inequality in Manipur.

These barriers likely include difficult terrain, weak road connectivity, limited health facility access, seasonal food insecurity, irregular functioning of Anganwadi centers, and poor market integration. While maternal education and wealth significantly differ between regions, their nutritional returns are weaker in hill settings.

The contrast between an insignificant HAZ gap and a significant stunting gap suggests clustering near the biological growth threshold in hill areas, making children especially vulnerable to chronic growth failure.

Policy Implications

The findings of this study highlight the urgent need to strengthen the last-mile delivery of Integrated Child Development Services (ICDS) and maternal–child health services, particularly in the hill districts where geographical barriers severely limit access. Improving service outreach in these remote areas is essential to ensure regular access to supplementary nutrition, growth monitoring, immunization, and antenatal and postnatal care. In addition, expanding road connectivity and strengthening food supply chains are critical to overcoming physical isolation, reducing food insecurity, and ensuring timely availability of essential commodities. Improving the coverage and functionality of Anganwadi centers through better infrastructure, staffing, and monitoring mechanisms can further enhance service utilization. The study also underscores the importance of introducing hill-specific nutrition delivery models that are integrated with transport and logistics planning, recognizing that conventional service delivery frameworks may not adequately address the unique challenges of mountainous and hard-to-reach regions.

Limitations

This study has certain limitations that should be acknowledged while interpreting the findings. The use of cross-sectional data restricts the ability to establish causal relationships between explanatory factors and nutritional outcomes. Moreover, the unexplained component in the decomposition analysis may capture the effects of omitted facility-level and community-level factors that could not be explicitly modeled. Key contextual variables such as food access, distance to health services, and quality of local governance could not be measured directly, which may have led to residual confounding. Despite these constraints, the study provides important insights into spatial disparities in child nutrition and offers valuable directions for targeted policy interventions.

Conclusions

Childhood stunting in Manipur is shaped far more by geographic and structural constraints than by household-level socioeconomic disadvantage. Without aggressive, place-based supply-side investments in hill districts, geographic nutritional inequality is likely to persist despite improvements in household living standards.

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