Bihar's Burden of Child Stunting
A District-wise Analysis

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The prevalence of child stunting in Bihar is as high as 48%. This study of the immediate and underlying causes of stunting reveals that only 15 of Bihar's 38 districts are on course to reach the global target of 40% reduction in child stunting by 2025, with some districts likely to take over 25 years to reach the target. The data disaggregation at the district level presented here can help district managers use publicly available data to design and strengthen nutrition-specific and nutrition-sensitive programmes to lower the incidence of stunting.

In Bihar, the burden of stunting among children under five years of age is high, with serious and lifelong consequences, involving irreversible adverse changes to children's physical, cognitive and productive capacity. As state averages mask disparities at lower administrative levels, a disaggregated analysis of the causes of child stunting is important for strategising specific interventions to address child stunting.

Bihar is the third most populous state in India, with an estimated 100 million people and 12.7 million children under five years of age (Registrar General and Census Commissioner [RGCC] 2011). Despite a fast-growing economy, the state has the highest rural poverty concentration at 2,160 poor people per square kilometre (Shah 2016) and high prevalence of child stunting at 48% (International Institute for Population Sciences [IIPS] 2016). Estimates suggest that 6.1 million children under five years of age are stunted or short for their age in Bihar (RGCC 2011; IIPS 2016). While the proportion of stunted children has declined over the last 10 years, from 56% in 2005–06 to 48% in 2015–16, the rate of decline has been slow, at less than 1.5% per year (IIPS 2016, 2007). Stunting or linear growth failure begins early in life, from conception until two years of age, and is largely irreversible, affecting the child's survival, health, development, learning capacity, school performance and productivity in adulthood (Black et al 2008; Victora et al 2008; Dewey and Begum 2011; Martorell and Zongrone 2012).

Several interrelated factors cause stunting, including poor nutrition during pre-pregnancy and in pregnancy, non-optimal feeding and care to support rapid growth and development in infancy and early childhood, household food insecurity, frequent infections due to unhealthy environments, poor access to essential health services, and a poor sociopolitical and governance framework (Stewart et al 2013). Child undernutrition indices for India have been developed to capture the above causes and identify the main correlates of stunting at the national and state levels (Aguayo et al 2014). However, it is evident that state averages mask district-level disparities. Therefore, enhancing knowledge and understanding of the potential correlates of stunting by district is imperative. This article attempts to identify the district-wise burden and correlates of child stunting in Bihar using data available in the public domain. It uses simple analysis to enable district administrators to take decisions that address the problem. It also estimates the time frame for reducing stunting by 40% across districts of Bihar against the World Health Assembly (WHA) target of 2025 (World Health Organization [WHO] 2014).

Methods

This study used district-level data drawn from the following publicly available sources: National Family Health Survey 4 (NFHS–4) (IIPS 2016), the Annual Health Survey (AHS) (RGCC 2013), Clinical Anthropometric and Biochemical (CAB) survey, Census of India 2011 (RGCC 2011) and National Sample Survey Office (NSSO 68th round 2011–12).

The proportion of stunting is defined as the percentage of children aged 0–59 months old with a height-for-age below minus two standard deviations of the median height-for-age of the reference population (WHO 2006). The number of children stunted is calculated as the proportion of stunted children in a district as per NFHS–4, divided by the total Census 2011 population aged 0–59 months in that district.

The 1990 United Nations Children's Fund (UNICEF) conceptual framework for causes of stunting was adapted and used to determine the correlates of stunting and to select the relevant indicators (Figure 1, p 17). The indicators were then organised into seven domains, first for the individual level across the life cycle—such as pre-pregnancy, pregnancy, infancy and young childhood—and second, for household-level environmental health, food insecurity, and gender and

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Figure 1: Conceptual Framework of Intergenerational Stunting

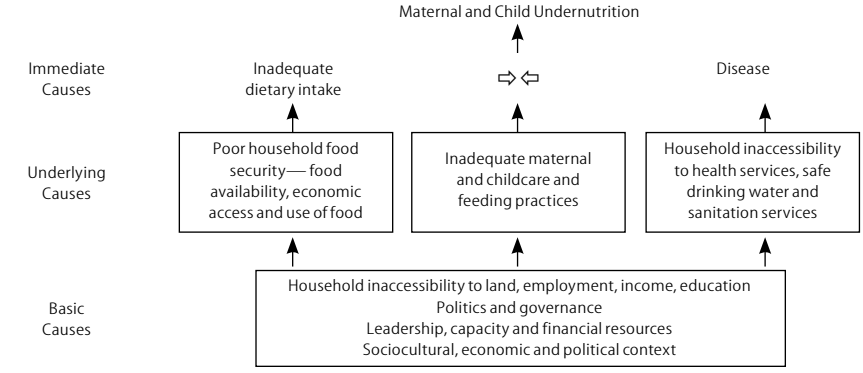


Table 1: Indicators Used to Determine Correlates of Stunting for All Districts of Bihar

Domains	Indicator/s	Source
1 Pre-pregnancy		
1	Non-pregnant women aged 15–49 years who are anaemic	NFHS 4
2	Women aged 20–24 years married before 18 years of age	NFHS 4
3	Women aged 15–19 years who were already mothers or pregnant at the time of survey	NFHS 4
4	Currently married women aged 15–49 years using any modern contraceptive	NFHS 4
5	Women whose body mass index is below normal (BMI < 18.5 kg/m^2)	NFHS 4
2 Pregnancy		
6	Mothers who had antenatal check-up in first trimester	NFHS 4
7	Mothers who had at least four antenatal care visits	NFHS 4
8	Mothers who consumed iron/folic acid for 100 days or more when they were pregnant	NFHS 4
9	Institutional births	NFHS 4
3 Infant and young child feeding and care		
10	Children under three years breastfed within one hour of birth	NFHS 4
11	Children under six months exclusively breastfed	NFHS 4
12	Children 6–8 months old receiving solids/semi-solids in addition to breastmilk	NFHS 4
13	Children 6–23 months receiving an adequate diet (breastfed and non-breastfed)	NFHS 4
14	Children (9–59 months) who received one dose Vitamin A in last six months	NFHS 4
4 Infant and young child healthcare		
15	Children (12–13 months) fully immunised (BCG, measles, and three doses each of polio and DPT)	NFHS 4
16	Children (under-5) with diarrhoea in the last two weeks who received oral rehydration salts (ORS)	NFHS 4
17	Children (under-5) with fever or respiratory illness in the previous two weeks and taken to health facility	NFHS 4
5 Environmental health		
18	Household with improved drinking water source	NFHS 4
19	Household improved sanitation facility	NFHS 4
6 Food insecurity		
20	Household using iodised salt	NFHS 4
21	Household expenditure on food to total household expenditure	NSS 68 2011–12
7 Socio-economic, gender context		
22	Household with none of the specified census assets	Census 2011
23	Landless rural household	Census 2011
24	Scheduled Caste population	Census 2011
25	Female literacy	Census 2011
26	Child sex ratio	Census 2011

socio-economic context. Accordingly, 26 indicators were used to investigate the correlates of stunting (Table 1).

A database of estimates for the 26 indicators across 38 districts was constructed using MS Excel 2010. Bivariate correlations were undertaken using MS Excel for each of the estimates with prevalence of child stunting (Table 2).

The annual rate of reduction (ARR) of stunting was used to calculate the number of years required for each district to achieve the WHA target of reducing child stunting by 40%. The district estimates of prevalence of child stunting were obtained from AHS (2012–13) and NFHS–4 (2015–16) to calculate ARR using the following formula:

(1-(Prevalence of stunting 2015–2016/ Prevalence of stunting 2012–2013) ^(1/3))*100

Table 2: Cut-offs for Correlation Coefficient (r)

0–0.29	No to weak correlation
0.30–0.59	Moderate correlation
0.6-1	Strong to perfect correlation

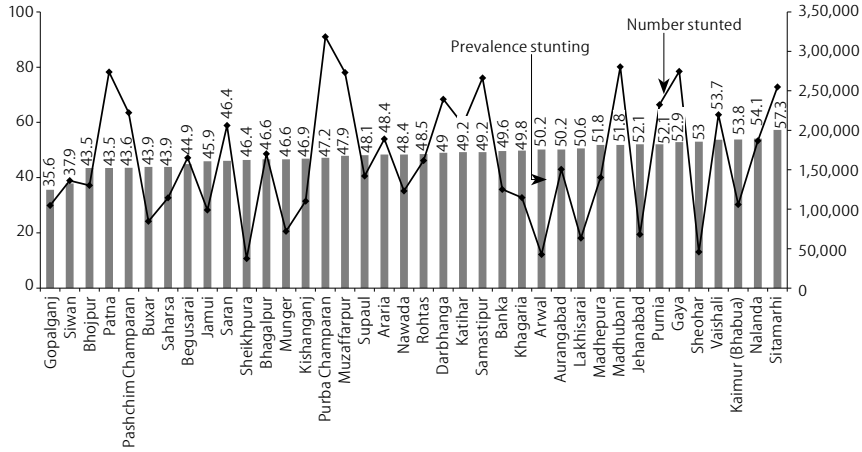
Results

Burden of child stunting in Bihar by district: The prevalence of child stunting is high across all districts, ranging from 36% in Gopalganj to 57% in Sitamarhi. Seven of 38 districts—Gaya, Madhubani, Muzaffarpur, Patna, Purba Champaran, Samastipur and Sitamarhi—account for 31% of the 6.1 million stunted children. Each of these seven districts has over 2,50,000 stunted children, with the highest number in Purba Champaran (3,18,471) (Figure 2, p 18).

Situation Analysis

Pre-pregnancy factors: In Bihar, the prevalence of anaemia in non-pregnant women ranges from 51.5% in Buxar to 68.6% in Supaul. In half the districts, over 60% of non-pregnant women are anaemic (Indicator 1), which is a serious concern. Early marriage and teenage pregnancy are also relatively widespread, and constitute key drivers of child stunting. There is a wide variation across districts in the proportion of women married before the legal age of marriage, from 27% (Saran) to 60% (Supaul), with a median of 39% (Indicator 2). Almost 20% of women have their first child when they are 15 to 19 years of age in Madhepura, Pashchim Champaran and Samastipur (Indicator 3). The use of modern contraceptive methods is low, ranging from 3.9% (Pashchim Champaran) to 42.4% (Rohtas), with usage below 27% in 19 of 38 districts (Indicator 4). Finally, the proportion of chronically undernourished women (body mass index [BMI] <18.5 kg/m^2) ranges from about 24% (Bhojpur, Patna, Saran, Siwan) to 39% (Purnia, Supaul) (Indicator 5).

Figure 2: District-wise Prevalence and Estimated Number of Stunted Children under Five



Pregnancy factors: In 19 of 38 districts, only 36% of pregnant women come under the ambit of public outreach services in the first trimester. Antenatal check-up within the first trimester ranges from 23% (Purba and Pashchim Champaran) to 52% (Patna) (Indicator 6). Only 8% (Begusarai) to 24% (Munger) of pregnant women receive at least four antenatal check-ups. In half of Bihar's districts, less than 14% of pregnant women receive at least four antenatal check-ups (Indicator 7). Iron-folic acid (IFA) compliance in pregnancy is also abysmal, ranging from 3% (Madhepura and Sheohar) to 21% (Patna). IFA compliance is below 9% in 19 of 38 districts (Indicator 8). Use of institutional delivery services is relatively high, but there is wide variation by district, from 37% (Sitamarhi) to 86% (Patna) (Indicator 9).

Infant and young child feeding and care: Timely initiation of breastfeeding has improved in India overall, including Bihar, but is still low, ranging from 20% (Rohtas) to 50% (Jehanabad), with half the districts having less than 35% of babies breastfed within one hour of birth (Indicator 10). Exclusive breastfeeding among infants less than six months ranges from 33% in Lakhisarai and Nawada to 74% in Muzaffarpur (the latter estimate is based on unweighted cases) (Indicator 11). Timely introduction of complementary feeding is relatively low, ranging from 15% (Saharsa) to 48% (Aurangabad) (Indicator 12). Adequate diet at 6 to 23 months of age is even lower, with only 8% of children receiving the recommended variety and frequency of feeding along with breastmilk or top milk in half the districts (Indicator 13). Vitamin A supplementation coverage varies from 45% (Purba Champaran) to 76% (Vaishali) (Indicator 14).

Basic child healthcare: Complete immunisation coverage among children aged 12 to 23 months ranges from 29% (Pashchim Champaran) to 78% (Saharsa) (Indicator 15). Diarrhoea-affected children receiving oral rehydration salts (ORS) ranges from a low of 30% (Muzaffarpur) to 66% (Munger); less than 45% of diarrhoea-affected children receive ORS in 19 of 38 districts. Similarly, the percentage of children with fever or respiratory illness taken to a health facility ranges from 33% (Bhojpur) to 75% (Munger) (Indicators 16 and 17).

Household environment: Household access to drinking water is almost universal,

Table 3: Indicator-wise Median, Range and Strength of Correlation with Child Stunting

	Indicator	Median (%)	Range (%)	Correlation Coefficient (r)
1	Non-pregnant women aged 15–49 years who are anaemic	60.4	51.5–68.6	0.06
2	Women aged 20–24 years married before 18 years of age	39.5	26.9–56.9	0.47
3	Women aged 15–19 years who were already mothers or pregnant at time of survey	11.9	5.5–19.9	0.34
4	Currently married women aged 15–49 years using any modern contraceptive	27.2	3.9–42.4	0.34
5	Women whose BMI < 18.5 kg/m^2	30.9	24.0–39.0	0.43
6	Pregnant women who had antenatal check-up in first trimester	36.1	22.1–51.9	−0.23
7	Pregnant women who had ≥ 4 antenatal checks	13.5	7.9–24.4	−0.38
8	Pregnant women who consumed ≥100 IFA tablets (syrup or equivalent)	8.5	2.6–21.1	−0.51
9	Institutional delivery	68.6	37.3–86.4	−0.28
10	Children under three years breastfed within one hour of birth	34.7	20.4–50.0	0.32
11	Children under six months exclusively breastfed*	55.0	32.7–73.8	−0.16
12	Children 6–8 months receiving solids/semi-solids in addition to breastmilk*	32.6	14.9–48.3	−0.21
13	Children 6–23 months receiving an adequate diet (breastfed and non-breastfed)	7.9	0.6–16.9	0.06
14	Children (9–59 months) receiving one dose of vitamin A in last six months	61.1	46.1–76.1	−0.22
15	Children (12–13 months) fully immunised (BCG, measles, and three doses each of polio and DPT)	64.1	29.4–78.0	0.07
16	Children (under five) with diarrhoea in the previous two weeks who received ORS*	45.2	29.9–66.1	0.22
17	Children (under five) with fever or respiratory illness in the previous two weeks taken to health facility*	59.7	33.0–74.9	0.04
18	Households with improved drinking water source	99.1	78.6–100	0.07
19	Households using improved sanitation facility	25.7	12.5–49.9	−0.17
20	Households using iodised salt	95.5	80.0–99.2	0.09
21	Household expenditure on food out of total expense	50.2	37.7–58.6	0.30
22	Households with none of the specified census assets	19.5	7.0–29.0	0.38
23	Landless rural households	66.7	34.082.0	0.33
24	Scheduled Caste population	15.4	9.0–30.0	0.34
25	Female literacy	52.9	42.063.0	−0.26
26	Child sex ratio	933	904–971	−0.11

*Calculations based on small, unweighted samples for some districts.
BMI = body mass index; IFA = iron-folic acid; ORS = oral rehydration salts.

with over 90% coverage across all districts, with the exception of Jamui (79%) (Indicator 18). However, lack of sanitation facilities remains a major challenge, the highest coverage of improved toilet facilities being just 50% in Patna, and below 25% in half the districts of the state (Indicator 19).

Household food insecurity: In most of the districts, household use of iodised salt is over 90%, the lowest coverage being 80% in Madhubani and Saran (Indicator 20). Household monthly expenditure on food out of total household expenditure (Indicator 21) ranges from 38% (Siwan) to 59% (Lakhisarai).

Socio-economic and gender context: Households with no census assets range from 7% (Patna) to 29% (Madhepura), and rural landlessness ranges from 34% (Gopalganj) to 82% (Patna) (Indicators 22 and 23). Though Bihar has a low tribal population, Scheduled Caste population ranges from 9% (Katihar) to 30% (Gaya) (Indicator 24). In 19 of 38 districts, nearly 50% of women are illiterate; female literacy ranges from a low of 42% (Madhepura, Purnia, Saharsa and Sitamarhi) to 63% (Rohtas) (Indicator 25). Child sex ratio is a concern in all districts with the worst scenario in Vaishali (904 girls for 1,000 boys) (Indicator 26) (Table 3, p 18).

Correlation of Stunting

Of the five indicators in domain 1 (pre-pregnancy), four are moderately correlated with child stunting. Childhood stunting increases with increasing proportion of girls married before legal age ($r = 0.47$), with increasing proportion of girls in the age-group 15–19 years pregnant or already mothers ($r = 0.34$), and increasing proportion of chronically undernourished women ($r = 0.43$). There is a counter-intuitive correlation between contraceptive coverage and prevalence of child stunting in this domain ($r = 0.34$). Of the four indicators in domain 2 (pregnancy phase), two are moderately correlated with child stunting—the proportion of pregnant women that received at least four antenatal check-ups ($r = -0.38$) and consumed the recommended IFA supplements (100+ tablets, syrup, or equivalent) ($r = -0.51$). Only one of the five indicators under domain 3 (infant and young child nutritional care) is moderately correlated with stunting; timely initiation of breastfeeding among newborns has a counter-intuitive correlation with stunting ($r = 0.35$). None of the indicators pertinent to domain 4 (infant and young child healthcare) and, surprisingly, domain 5 (household environmental factors) are correlated with stunting. Under domain 6 (household food insecurity), as household expenses on food as a proportion of total expenses increases, prevalence of stunting is also likely to increase ($r = 0.30$). Three of the five indicators under domain 7 (socio-economic and gender factors) are moderately correlated with stunting. As the proportion of households with no census assets, rural landlessness and Scheduled Caste population increases, prevalence of childhood stunting increases ($r = 0.38$, 0.33, 0.34). None of the indicators are strongly correlated with stunting (Table 3).

Time Required to Reduce Stunting

Of the 38 districts of Bihar, in 13 districts there has been an increase in prevalence of stunting or no change between 2012 and 2015. Of the remaining 25 districts that have reduced stunting, 10—Bhojpur, Gopalganj, Purba Champaran, Shekhpura,

Table 4: District-wise Estimated Years to Reduce Stunting by 40%

District	Children Stunted in 2015–16 (%)	Children Stunted in 2012–13 (%)	ARR	Target (After 40% Reduction)	Additional Years to Achieving Target (with Current ARR)	Calendar Year for Achieving Target
Jamui	46	63.1	10.1	27.5	4	2019
Patna	44	59.4	9.9	26.1	4	2019
Buxar	44	59.2	9.5	26.3	4	2019
Munger	47	61.4	8.8	28.0	5	2020
Siwan	38	49.3	8.4	22.7	5	2020
Begusarai	45	57.8	8.1	26.9	5	2020
Arwal	50	64.6	8.1	30.1	5	2020
Saharsa	44	55.2	7.4	26.3	5	2020
Jehanabad	52	64.6	6.9	31.3	6	2021
Araria	48	57.4	5.5	29.0	7	2022
Rohtas	49	57.3	5.4	29.1	7	2022
Muzaffarpur	48	55.8	5.0	28.7	8	2023
Khagaria	50	58	5.0	29.9	8	2023
Darbhanga	49	56.5	4.6	29.4	9	2024
Pashchim Champaran	44	50.1	4.5	26.2	9	2024
Bhojpur	44	48.7	3.7	26.1	11	2026
Gopalganj	36	39.6	3.5	21.4	11	2026
Purba Champaran	47	52.2	3.3	28.3	12	2027
Sheikhpura	46	50.5	2.8	27.8	14	2029
Kishanganj	47	50.9	2.7	28.1	15	2030
Supaul	48	51.4	2.2	28.9	18	2033
Bhagalpur	47	48.9	1.6	28.0	25	2040
Lakhisarai	51	52.8	1.4	30.4	28	2043
Samastipur	49	51	1.2	29.5	34	2049
Aurangabad	50	52.1	1.2	30.1	33	2048
Kaimur (Bhabua)	54	53.8	0.0	32.3	NA	NA
Madhepura	52	52.1	0.0	31.1	NA	NA
Katihar	49	48.7	−0.3	29.5	NA	NA
Vaishali	54	52.9	−0.5	32.2	NA	NA
Gaya	53	51.6	−0.8	31.7	NA	NA
Nalanda	54	52.4	−1.1	32.5	NA	NA
Banka	50	47.2	−1.7	29.8	NA	NA
Saran	46	42.8	−2.5	27.7	NA	NA
Sitamarhi	57	52.4	−3.0	34.4	NA	NA
Nawada	48	40.6	−6.0	29.0	NA	NA
Purnia	52	43.7	−6.0	31.3	NA	NA
Madhubani	52	39.7	−9.3	31.1	NA	NA
Sheohar	53	35.2	−14.6	31.8	NA	NA

Kishanganj, Supaul, Bhagalpur, Lakhisarai, Samastipur and Aurangabad—will not achieve the WHA target of reducing stunting by 40% by 2025 at the current reduction rate (Table 4, p 19). Thus, only 15 of the 38 districts will achieve the WHA target.

Discussion

The burden of child stunting is unequally distributed across the districts of Bihar, with 23 districts unlikely to achieve the WHA target of 40% reduction in child stunting by 2025. This is explained partly by the variable reach of nutrition-specific and nutrition-sensitive interventions across these districts. Pre-pregnancy anaemia can lead to impaired physical and brain development in the foetus, leading to low birth weight babies with low iron stores. Prevalence of anaemia among non-pregnant women is consistently high across districts and the variability in prevalence is limited. Districts with higher proportion of child stunting are more likely to have chronically undernourished women ($r = 0.43$), women married before legal age of marriage (0.47) and teenage pregnancies (0.34). The counter-intuitive correlation between child stunting and use of modern contraceptives ($r = 0.34$) can be explained by the fact that over 80% of modern contraceptive coverage in Bihar is due to sterilisation. As both male and female sterilisation is incentivised in India, it is more likely that poorer couples, with larger families and low usage of spacing methods, account for most of modern contraceptive usage.

During pregnancy, unless the mother has access to essential health and nutrition services, her risk of a poor pregnancy outcome increases. As such, timely care and early inclusion in nutrition safety nets in pregnancy is critical to optimal foetal growth and development (WHO 2002). Pregnancy factors such as early registration, complete antenatal check-up and compliance with IFA are inversely correlated with child stunting. The first two years of the child's life are crucial for optimum health, brain and physical growth and development. However, the correlations between child stunting and infant and young child feeding indicators are either counter-intuitive, as for timely initiation of breastfeeding ($r = 0.32$), or weak due to small sample size (exclusive breastfeeding under six months) and very low proportion of practitioners (infants receiving adequate complementary feeding with or without breastfeeding). Basic child healthcare services like complete immunisation are also weakly correlated with child stunting as the reach of these services is better in districts with a higher proportion of poor households.

There are 10 essential nutrition interventions that have the potential to reduce the current total of deaths in children under five by 15% and stunting by 20% if populations can access these at 90% coverage (Bhutta et al 2013). These include: (i) initiation of breastfeeding within an hour of birth, (ii) exclusive breastfeeding for the first six months, (iii) timely introduction of complementary feeding, (iv) age-appropriate complementary feeding, (v) adequate complementary feeding in terms of quality, quantity and frequency for children aged 6–24 months, (vi) safe handling of complementary foods and hygienic complementary feeding practices, (vii) adequate feeding during and after illness, (viii) immunisation and micronutrient supplementation (vitamin A, iron and zinc), (ix) adequate feeding for the severely undernourished, and (x) adequate nutrition for adolescent girls and women of reproductive age. Of these, district disaggregated data is available for five indicators, all of which have low coverage in the state and weak or counter-intuitive correlations with child stunting for the reasons explained earlier. These evidence-based interventions that have low coverage across almost all districts need to be included in the stunting reduction strategy despite variable correlations with child stunting.

In addition, nutrition-sensitive interventions, such as marriage after attaining legal age, female literacy, access to health and nutrition security schemes and environmental hygiene, have low coverage across most districts. Access to improved sanitation facilities is another area that needs to be addressed on priority, considering that the state has been able to provide drinking water to over 90% of households. Socially excluded groups such as Scheduled Castes and Scheduled Tribes are among the most economically and nutritionally deprived in India (UNICEF 2014). In eight of the 38 districts of Bihar, over 20% of the population belongs to socially excluded groups.

As none of the indicators are strongly correlated with child stunting, but 11 of 26 are moderately correlated, the findings indicate that a multipronged approach is required to address child stunting in Bihar, with an emphasis on pre-pregnancy and pregnancy care as well as poverty alleviation and social inclusion.

Limitations

This analysis is based on the most recent district-level data available through NFHS–4 (2015–16). However, as the raw data set for this survey is currently unavailable, our analysis is based on pooled estimates for each district. This limited the findings to bivariate correlations, which further limited identification of confounding variables and interactions. Consequently, a cause-and-effect relationship between child stunting and the selected 26 indicators could not be established.

The ARR for child stunting is calculated for a three-year time frame and using estimates from two surveys with different sampling techniques—NFHS–4 and AHS 2012–13. While both surveys provide population estimates, the AHS is a district-level survey with a much larger sample size of over 4 million households, compared to approximately 5,80,000 households in NFHS–4 (Registrar General and Census Commissioner 2013; IIPS 2014).

Conclusions

The findings point to a multipronged approach with the priority on pre-pregnancy and pregnancy phases coupled with poverty alleviation and social inclusion. At the same time, continued progress is needed to scale up all 10 essential interventions, though some are not correlated with child stunting partly because of small sample size or limited variation in their coverage. The disaggregation of estimates on the 26 indicators presented in this article can serve as a tool for district managers to

investigate and prioritise interventions that are likely to be most effective in reducing child stunting in their district. Collecting real-time data at the district level on all 26 indicators is critical for the preparation of district action plans to reduce child stunting.

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