ABSTRACT

Background: The National Family Health Survey (NFHS) 2015–16, finds that every second child in India suffers from at least one form of nutrition failure. Dichotomised indicators of underweight and wasting based on z-score cut-off does not provide any information regarding those children who are clustered around the threshold and are at an elevated risk of undernutrition through any minor weight-loss. This paper aims to estimate the effect of bodyweight shocks on net increments in the prevalence of child underweight and wasting among the poorest households in India.

Methods: We used cross-sectional information from NFHS 2015–16 to estimate possible increase in the prevalence of child underweight and wasting as a result of reduction in their bodyweight. The shocks are presumed to range from a minimum of 0.5% to a maximum 5% reduction in the bodyweight for every child from the poorest 20% households. Various raw weight measures scenarios were developed and transformed into age-specific z-scores using World Health Organization child growth standards.

Results: Nutritional status of children is sensitive to smallest of the shocks to bodyweight. In fact, a reduction of 0.5 and 1 percent in weight can lead to substantial increase in underweight and wasting prevalence. Under a scenario of bodyweight shock of 0.5 percent, the prevalence of underweight and wasting will increase by 1.42 and 1.36 percentage points, respectively. These estimates get translated into 410,413 and 392,886 additional cases of underweight and wasting, respectively.

Conclusion: With such high concentration of children around the undernutrition threshold, any minor shock to nutritional health of the children can have major implications. In the current scenario of national lockdown and restrictions due to coronavirus disease 2019 pandemic, it is critical to ensure an uninterrupted supply of nutritious meals and food supplements to the poor children while arresting the infection spread.

Keywords: Underweight; Wasting; Undernutrition; India; Lockdown; COVID-19
INTRODUCTION

The National Family Health Survey (NFHS) 2015–16, finds that every second child in India suffers from at least one form of nutrition failure (i.e., stunting, underweight, or wasting). Given the large child population base (about 140 million in 2016), these figures translate into huge numbers of about 77 million undernourished children in India. Recent studies based on NFHS 2015–16 have observed a clear socioeconomic gradient in the prevalence as well as risk of nutritional failures with significantly higher burden among children from poor households. In fact, about half of the children from the poorest households (bottom 20% of the wealth quintile) in India are stunted and/or underweight whereas every fourth child suffers from wasting—an indicator of recent and severe weight loss. A higher likelihood of experiencing nutritional failure by poor children in India not only depicts the intrinsic but also the instrumental relevance of socioeconomic well-being—via better dietary intake, access to improved hygiene and sanitation facilities, better access to healthcare—in determining child’s nutritional status.

From a metric standpoint, nutritional failures among children pertaining to their bodyweight are widely measured as anthropometric indicators of underweight (weight-for-age) and wasting (weight-for-height). It is worthwhile to briefly describe this aspect of anthropometric measurement. To elaborate, a child’s underweight (low weight-for-age) and wasting (low weight-for-height) status is a measure of nutritional failure, relative to a healthy reference standard based on children of same sex and age. These height and weight standards were developed by World Health Organization (WHO) by studying healthy children across the world—including Indian children—and are widely accepted by researchers and experts across disciplines to measure undernutrition. A child’s weight-for-age is measured using reference standard z-scores estimated based on the difference between weight of the observed child and the average weight of the children in the reference population, divided by the standard deviation of child weight in the reference population. Therefore, a child with a weight-for-age z-score (WAZ) of zero will have same body weight as the median child in the reference group. Similarly, a child with a negative WAZ will reflect lesser weight than average weight of the reference population. A child is said to be underweight (or wasted) if its WAZ (or weight-for-height z-score [WHZ]) is below −2 standard deviation (SD) of the reference group. Ratio-based prevalence, calculated as the number of underweight cases relative to the total child population is by far the most widely used metric in nutrition-related policies worldwide, including India.

However, such dichotomised classification of undernutrition based on a z-score cut-off does not provide any information regarding those children who are clustered around the threshold and are at an elevated risk of undernutrition through any minor shock to their bodyweights. This is problematic because of 2 reasons. First, given the association between hunger and undernutrition, a higher concentration of children around such cut-off will depict greater vulnerability of undernutrition prevalence toward any dietary shocks. Second, the influence of any transitional nutritional shock on the nutritional status can be more adverse for those children who are at greater risk of longer exposure to such shocks. Understanding the clustering of children around the undernutrition threshold is therefore assumes salience for nutrition policies in India. These intricacies are almost completely lost to analysis when a thoroughgoing binary classification of nutritional status is adopted for assessments and policymaking. Such concerns of clustering of individuals and households around a specific threshold has received considerable attention in other domains of development whereas no attempts have been made to quantify the magnitude of such impact on nutritional status.
of children. For instance, the problem under consideration is akin to the use of poverty-line thresholds to estimate “poverty rates” which according to economists, fails to depict a complex problem of distribution of food-deprivation.

In India, most of the nutrition-related interventions under development programmes such as POSHAN Abhiyaan, and Integrated Child Development Services (ICDS) are designed, strategized and budgeted on the basis of prevalence of concerned nutritional failures. For instance, POSHAN Abhiyaan in India aims to reduce the prevalence of child stunting and underweight by 2 percentage points per annum. Since binary anthropometric outcome are unable to capture the risk of undernutrition around from the z-score cut-off, this metric can fail to offer complete insights on at risk population. Given the current policy momentum to improve nutritional status of children in India at all administrative and political levels, an understanding of border-line malnourished children can offer valuable insights.

The issues assume greater relevance because of the ongoing coronavirus disease 2019 (COVID-19) pandemic that has caused widespread disruptions to economic activities and health systems with catastrophic implications for the poor and the vulnerable. For example, with the outbreak of COVID-19 pandemic, Government of India as an immediate policy response announced a mandatory nationwide lockdown for 68 days (from on 25th March to 31st May 2020) thereby halting almost all economic activities at one go. Amidst elevated risks to lives and livelihood, such nationwide lockdown in India has also exposed the families from poorest strata—a population that even in normal times barely survives on daily wages—to an immediate threat of hunger and food deprivation. Among poor children the ability to withstand such unexpected restriction will be determined by the current nutritional status and vulnerability to an imminent shock of reduced dietary intake and diversity. More specifically, the concentration of children around the z-score cut-off will determine the quantum of impact on the prevalence measures. Notably, the magnitude of such concentration is not mere a statistical artefact, but an interplay of individual, contextual and macro-level affairs. For instance, recent studies found that more than 78 percent of children (below 5 years) in India do not have adequate daily calorie intake as per recommended dietary allowances suggested by Indian Council for Medical Research expert committee (ICMR). Further, about 90 percent of children in India (aged 6–23 months) do not receive minimum acceptable diet and only 22 percent of children were reported to have minimum dietary diversity. Besides, a clear socioeconomic gradient is observed in dietary pattern with high level of inadequacies in dietary intake and diversity among the poorest households. Analytical insights on such risks and additional undernutrition burden can be effective for planning and responding to such challenges in India and elsewhere.

With this motivation, this paper aims to estimate the effect of bodyweight shocks on net increments in the prevalence of child underweight and wasting among the poorest households in India. Specifically, we estimated by how much the prevalence of underweight and wasting among the poorest children will increase under alternative weight-loss scenarios, i.e., from a scenario of weight reduction 0.5% to a weight-loss scenario of 5%. It is worth noting that a scenario of 0.5% would imply a weight loss of about 50 g for a child with weight of 10 kg. The impact of such weight loss on anthropometric status is then re-estimated based on the WHO standard reference z-scores to provide estimates on the clustering of children around the z-score reference threshold −2SD. We also estimate the state-wise burden of the additional cases of underweight and wasting (also, severe underweight and wasting) cases for regional analysis and inferences.
The study contributes to the existing literature for the following 2 reasons. First, no previous study has assessed the magnitude of clustering associated with dietary shocks and its impact on the prevalence of anthropometric failures. Given the already higher burden of malnutrition among poor children in India, it is critical to be informed of such sensitivities associated with any nutrition-related shock. The study thus offers important empirical insights on the impact of weight loss on increase in the prevalence of underweight and wasting among poor children in India. Second, globally, researchers and policymakers are grappling to understand the potential impact of COVID-19 on various spheres of development including health and nutrition. Studies have also attempted to provide estimates regarding maternal and child deaths associated with COVID-19 pandemic disruptions in low-income and middle-income countries. Such quantifiable evidence is crucial to reflect on the magnitude of problem in order to prioritize policy response for restoring nutritional health of poor children in times of pandemic like COVID-19. In fact, it may well be the case that policy response of national lockdown to arrest COVID-19 spread have undone all the recent gains and achievements pertaining to child nutrition in India. Therefore, a quantitative understanding of the potential magnitude of the problem from a metric standpoint can offer valuable insights regarding alternative strategies to safeguard children from present and future nutritional shocks. The findings can highlight how such shocks are inimical to the United Nations Convention on the Rights of the Child ratified by India in 1989.

**METHODS**

**Data and survey design**
We used cross-sectional information from fourth round of NFHS 2015–16 to estimate possible increase in the prevalence of child underweight and wasting. The survey design allows for estimation of growth faltering among children for each of the states and union territories and by rural and urban areas separately. The NFHS 2016 provides data on 259,627 children aged 0–59 months. Since middle and upper economic class is anticipated to survive on their past savings, the immediate economic shock of national lockdown (and restrictions) is likely to be concentrated among the poor, therefore we maintain a conservative approach and focus only on the sub-sample of children from the lowest (bottom 20 percent) wealth quintile. After excluding the observations for those on missing age and sex information, flagged cases, a final analytic sample of 58,330 children (aged 0–59 months) from bottom 20 percent wealth quintile was used for estimations.

**Primary outcomes**
Based on the WHO child growth reference standards, binary outcome variable for child underweight and wasting was constructed. We also considered severe underweight and severe wasting as outcome indicators. The NFHS provides standard information on child’s weight. The raw weight measures were transformed into age-specific z-scores for boys and girls using “zscore06” package in Stata (StataCorp, College Station, TX, USA). Underweight was defined as WAZ and wasting was defined as WHZ less than −2SD. Similarly, the cut-off of −3SD from the reference standard is used to categorize severe underweight and severe wasting cases. At household level, wealth index was taken as the proxy indicator for household’s income. The wealth quintiles provided by survey data are based on principal component analyses on household assets and wealth characteristics. The NFHS provides self-reported binary information on an exhaustive list of the possession of 32 assets and based on that, wealth scores are obtained via principal component analysis.
Scenarios of bodyweight shocks

We estimated possible increase in the prevalence of child underweight and wasting under different scenarios of bodyweight shocks, i.e., percentage reduction in bodyweight of every sample child from the lowest wealth quintile. More specifically, the shocks are presumed to range from a minimum of 0.5% of the bodyweight to a maximum 5% reduction in the bodyweight for every child from the poorest 20% households. For example, the estimated average weight of children from poorest quintile (aged 0-11 months) was 6.02 kg, so a reduction of 0.5% in the weight of these children will result in an average weight-loss of about 30 g \((\text{Table 1})\). Similarly, after assuming a weight-loss by 2.5% among children below 12 months, the average weight of children was reduced from 6.02 kg to 5.87 kg. When assuming an impact scenario where we reduced the children’s (0-11 months) weight by 5%, the average weight was reduced from 6.02 kg to 5.72 kg. We also present average weight-loss for those children with one-month preceding or succeeding their birthday. For example, average weight loss among those aged 11-13 months was about 38 g in a scenario of 0.5% weight loss (\(\text{Table 1}\)). Using such reduced weights under 10 different scenarios of bodyweight shocks with 0.5% intervals (from 0.5% to 5%), we estimate 10 corresponding WAZ and WHZ distribution.

Further we also translate this increase in absolute numbers of underweight and wasted children based on the size of the under-5 population based on the population projections report of the National Commission on Population. \(^{22}\) In addition to this, we estimated state-wise distribution of additional underweight and wasting cases under different assumed scenarios. All the analyses were performed using Stata 15.0 (StataCorp). \(^{23}\)

**RESULTS**

\(\text{Table 1}\) shows that reduction in average weight of children under different scenarios for reduction in respective bodyweight of children by age groups. The average weight of children aged 0–59 months was estimated to be 9,980 g (\(\text{Table 1}\)). A reduction in respective bodyweight of children by only 0.5 percent will reduce the average weight by 50 g. Similarly, weight-loss by 2.5% and 5% will result in reduction in average weight by 240 g and 490 g, respectively. Among children below one-year age, a reduction by 0.5% and 5% of their respective bodyweight will reduce the average weight by 30 g and 300 g, respectively. Among children between 48–59 months, weight-loss by 0.5% and 5% in respective bodyweight will result decline in average weight by 70 and 660 g respectively. Weights of children can be sensitive to their age in months.

| Reduction in average weight (g) | 0–11 | 12–23 | 24–35 | 36–47 | 48–59 | 0–59 | 0–2 | 11–13 | 23–25 | 35–37 | 47–49 | 57–59 |
|----------------------------------|------|-------|-------|-------|-------|------|-----|-------|-------|-------|-------|-------|
| Average weight NFHS 2016         | 6,020| 8,380 | 10,180| 11,730| 13,240| 9,980| 4,040| 7,593 | 9,390 | 11,114| 12,602| 13,596|
| Weight-loss scenarios            |      |       |       |       |       |      |      |       |       |       |       |       |
| 0.5% reduction                   | 30   | 40    | 50    | 60    | 70    | 50   | 20  | 38    | 47    | 56    | 63    | 68    |
| 1.0% reduction                   | 60   | 80    | 100   | 120   | 130   | 90   | 40  | 76    | 94    | 111   | 126   | 136   |
| 1.5% reduction                   | 90   | 120   | 160   | 180   | 200   | 140  | 60  | 114   | 141   | 167   | 189   | 204   |
| 2.0% reduction                   | 120  | 160   | 210   | 240   | 270   | 190  | 80  | 152   | 188   | 222   | 252   | 272   |
| 2.5% reduction                   | 150  | 210   | 260   | 300   | 330   | 240  | 100 | 190   | 235   | 278   | 315   | 340   |
| 3.0% reduction                   | 180  | 250   | 310   | 360   | 400   | 290  | 120 | 228   | 282   | 333   | 378   | 408   |
| 3.5% reduction                   | 210  | 290   | 360   | 420   | 470   | 340  | 140 | 266   | 329   | 389   | 441   | 476   |
| 4.0% reduction                   | 240  | 330   | 410   | 470   | 530   | 390  | 160 | 304   | 376   | 445   | 504   | 544   |
| 4.5% reduction                   | 270  | 370   | 460   | 530   | 600   | 440  | 180 | 342   | 423   | 500   | 567   | 612   |
| 5.0% reduction                   | 300  | 420   | 510   | 590   | 660   | 490  | 200 | 380   | 469   | 556   | 630   | 680   |

NFHS = National Family Health Survey.

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5/13
Accordingly, Table 1 also present estimates of weight-reduction scenarios based on clubbing of nearby age group. Among children between 11–13 months, a 0.5% reduction in respective bodyweight will lead to an average reduction of 38 g. Further, among those aged 57–59 months, similar reduction will reduce the average weight by 68 g.

In 2015–16, the mean WAZ and WHZ for children from the poorest 20 percent household was −1.95 and −1.18, respectively. (Table 2). With a 0.5% shock to bodyweight, the mean WAZ and WHZ scores were estimated to be −1.99 and −1.19, respectively. An 1% reduction in the weight of the children would correspond to mean z-score of −2.03 and −1.25 for underweight and wasting, respectively. The estimated shifts in the distribution of z-scores across scenarios are depicted in Figs. 1 and 2 for underweight and wasting. The bell curve based on the z-score distribution for India is on the left side of the standard normal curve indicating how far behind India is from the reference distribution. More importantly, the distribution among the poor is even further apart from the reference standard as well as from the overall country-level distribution. The 5% hypothetical shock to bodyweight produces a virtually detectable shift which has severe consequences when translated into change in prevalence and burden.

Under a scenario of bodyweight shock of 0.5 percent, the prevalence of underweight and wasting is likely to increase by 1.42 and 1.36 percentage points, respectively (Table 3). The

![Graph showing weight-for-age z-score distribution for children (0–59 months) from bottom 20% wealth quintile, India, NFHS 2015–16. NFHS = National Family Health Survey; SD = standard deviation.](https://doi.org/10.35500/jghs.2020.2.e19)
The prevalence of severe underweight and severe wasting is also likely to worsen by 1.36 and 0.57 percentage points, respectively. Given the under-5 population of India, these estimates get translated into 410,413 and 392,886 additional cases of underweight and wasting, respectively. Number of severe underweight and wasted children is expected to increase by 268,767 and 166,342, respectively. In case of weight reduction by 1%, underweight prevalence among poorest children could rise by 3.03 percentage points translating into 879,243 new underweight children. Whereas, the scenario of 3% shock shows that underweight and wasting prevalence can increase by 9.04 and 9.92 percentage points, respectively with a substantial net increase of 2,620,040 underweight and 2,873,921 wasting cases. In a scenario of 5% weight-loss, India will experience a staggering increase of about 4,393,178 and

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**Table 3.** Estimated increase in the prevalence of underweight and wasting among children from bottom 20% wealth quintile by weight-loss scenarios, India, NFHS 2016

| Weight-loss scenarios | Underweight | Wasting |
|----------------------|-------------|---------|
|                      | Any | Severe | Any | Severe |
| Prevalence (% points) |     |        |     |        |
| 0.5%                 | 1.42 | 0.93   | 1.36 | 0.57   |
| 1.0%                 | 3.03 | 1.86   | 2.89 | 1.18   |
| 1.5%                 | 4.45 | 2.71   | 4.57 | 1.81   |
| 2.0%                 | 6.19 | 3.74   | 6.27 | 2.44   |
| 2.5%                 | 7.64 | 4.96   | 8.16 | 3.14   |
| 3.0%                 | 9.04 | 6.26   | 9.92 | 3.89   |
| 3.5%                 | 10.67 | 7.30  | 11.88 | 4.67   |
| 4.0%                 | 12.21 | 8.26  | 13.79 | 5.53   |
| 4.5%                 | 13.53 | 9.59  | 15.72 | 6.38   |
| 5.0%                 | 15.16 | 11.06 | 17.74 | 7.35   |

**Absolute numbers**

| Prevalence (% points) | Any | Severe | Any | Severe |
|----------------------|-----|--------|-----|--------|
| 0.5%                 | 410,413 | 268,767 | 392,886 | 166,342 |
| 1.0%                 | 879,243 | 539,154 | 836,539 | 341,390 |
| 1.5%                 | 1,288,653 | 784,808 | 1,323,336 | 525,404 |
| 2.0%                 | 1,792,488 | 1,083,470 | 1,817,868 | 706,302 |
| 2.5%                 | 2,214,443 | 1,437,214 | 2,365,113 | 910,361 |
| 3.0%                 | 2,620,040 | 1,813,173 | 2,873,921 | 1,127,670 |
| 3.5%                 | 3,091,780 | 2,115,954 | 3,442,254 | 1,352,562 |
| 4.0%                 | 3,537,400 | 2,383,589 | 3,996,968 | 1,620,498 |
| 4.5%                 | 3,920,036 | 2,778,071 | 4,555,095 | 1,850,148 |
| 5.0%                 | 4,393,178 | 3,205,057 | 5,140,936 | 2,129,522 |

NFHS = National Family Health Survey.
5,140,396 additional cases of underweight and severe wasting, respectively. The estimates are substantially high for severe underweight and wasting as well.

Across states, Bihar, Uttar Pradesh and Madhya Pradesh will account for highest share in estimated child additional underweight and wasting cases among poorest households (Table 4). For example, assuming reduction in weight by 0.5%, Bihar and Uttar Pradesh will have about 85,940 and 78,635 additional underweight cases respectively. Similarly, about 67,702 new severe underweight cases will be added if poorest children in Bihar will experience a weight-loss of only 0.5%. It may also be noted that under the scenario of 1% weight reduction, states like Uttar Pradesh, Jharkhand, Madhya Pradesh and Chhattisgarh will experience a notable increase in number of severely underweight children. However, in worst scenario, if children from poor households were exposed to prolonged hunger with possible weight reduction of about 5%, then 94,670 and 713,766 new underweight and severe underweight children will be added.

Table 4. Distribution of additional cases of underweight and severe underweight (numbers) among children from bottom 20% wealth quintile by weight-loss scenarios across states, India, NFHS 2015–16

| State/weight reduction | Underweight | Severe underweight |
|------------------------|-------------|--------------------|
|                         | 0.5%        | 2.5%               | 5.0%               | 0.5%        | 2.5%               | 5.0%               |
| All India               | 410,413     | 2,214,443          | 4,393,178          | 268,767     | 1,437,214          | 3,205,057          |
| Bihar                  | 85,940      | 482,527            | 946,730            | 67,702      | 319,780            | 713,766            |
| Uttar Pradesh          | 78,635      | 448,203            | 867,653            | 52,275      | 262,723            | 607,038            |
| Madhya Pradesh        | 60,413      | 272,155            | 530,696            | 37,224      | 202,935            | 449,990            |
| Jharkhand              | 33,326      | 173,391            | 357,165            | 23,786      | 162,549            | 353,838            |
| Odisha                 | 33,859      | 173,391            | 324,656            | 15,508      | 101,611            | 223,392            |
| Chhattisgarh           | 19,289      | 120,687            | 237,232            | 14,997      | 73,442             | 170,509            |
| Rajasthan              | 20,849      | 125,780            | 252,168            | 14,460      | 73,442             | 170,509            |
| Assam                  | 16,129      | 96,328             | 207,979            | 9,299       | 55,333             | 116,664            |
| West Bengal            | 9,357       | 54,254             | 110,708            | 4,139       | 30,181             | 68,909             |
| Gujarat                | 11,451      | 39,639             | 69,412             | 6,209       | 26,157             | 58,332             |
| Maharashtra            | 4,679       | 27,459             | 65,898             | 3,628       | 6,740              | 52,242             |
| Meghalaya              | 3,119       | 19,266             | 39,539             | 2,070       | 14,660             | 33,333             |
| Karnataka              | 3,653       | 14,172             | 30,752             | 2,070       | 13,654             | 25,640             |
| Arunachal Pradesh      | 5,746       | 26,352             | 52,718             | 2,070       | 16,997             | 24,679             |
| Jammu and Kashmir      | 5,212       | 25,809             | 54,475             | 2,070       | 10,060             | 21,794             |
| Manipur                | 2,586       | 21,702             | 50,082             | 1,021       | 6,611              | 20,192             |
| Nagaland               | 3,653       | 20,594             | 46,568             | 1,021       | 7,424              | 16,025             |
| Uttarakhand            | 2,093       | 11,072             | 21,087             | 1,021       | 9,054              | 14,102             |
| Haryana                | 1,026       | 7,529              | 16,255             | 511         | 6,036              | 12,179             |
| Tripura                | 3,119       | 10,629             | 21,966             | 511         | 3,018              | 11,218             |
| Telangana              | 1,026       | 3,986              | 10,983             | 1,021       | 2,587              | 10,577             |
| Tamil Nadu             | 2,093       | 9,079              | 22,405             | 1,021       | 5,605              | 9,393              |
| Mizoram                | 2,093       | 16,165             | 29,434             | 1,021       | 3,018              | 9,615              |
| Andhra Pradesh         | -           | 3,100              | 6,590              | 2,580       | 5,030              | 7,692              |
| Punjab                 | 534         | 1,993              | 3,954              | 511         | 2,012              | 5,128              |
| Dadra and Nagar haveli | -           | 3,543              | 7,908              | -           | 1,581              | 4,167              |
| Andaman and Nicobar Islands | 534 | 1,550 | 1,318 | - | 1,006 | 2,564 |
| Himachal Pradesh       | -           | 2,436              | 3,954              | -           | 575                | 641                |
| Kerala                 | -           | 1,107              | 2,197              | -           | 575                | 641                |
| Lakshadweep            | -           | -                  | -                  | -           | -                  | -                  |
| Delhi                  | -           | -                  | 439                | 511         | 575                | 641                |
| Puducherry             | -           | -                  | -                  | 511         | 575                | 641                |
| Sikkim                 | -           | -                  | -                  | -           | -                  | -                  |
| Goa                    | -           | 443                | 439                | -           | -                  | -                  |

NFHS = National Family Health Survey.
Table 5 presents state-wise distribution of additional cases of child wasting and severe wasting in different scenarios of weight-loss across states, India, NFHS 2015–16

| State/weight reduction | Wasting | Severe wasting |
|------------------------|---------|----------------|
|                        | 0.5%    | 2.5%           | 5.0% | 0.5% | 2.5% | 5.0% |
| All India              | 392,886 | 2,365,113      | 5,140,936 | 166,342 | 910,361 | 2,129,522 |
| Bihar                  | 89,735  | 492,180        | 1,132,034 | 23,820 | 175,427 | 416,322 |
| Madhya Pradesh        | 61,330  | 345,306        | 714,590 | 28,328 | 136,099 | 335,613 |
| Uttar Pradesh          | 60,819  | 397,339        | 892,466 | 25,633 | 136,099 | 317,938 |
| Jharkhand              | 38,385  | 249,756        | 531,059 | 22,024 | 102,143 | 242,553 |
| Rajasthan              | 22,945  | 143,799        | 287,378 | 13,041 | 69,187 | 154,177 |
| Chhattisgarh           | 23,416  | 139,778        | 287,892 | 12,143 | 61,449 | 141,187 |
| Assam                  | 17,955  | 88,692         | 199,468 | 8,084 | 34,776 | 75,811 |
| West Bengal            | 8,997   | 65,750         | 140,348 | 3,593 | 21,211 | 52,386 |
| Gujarat                | 4,479   | 44,937         | 88,938 | 3,144 | 21,940 | 49,192 |
| Maharashtra            | 8,486   | 41,863         | 89,966 | 2,695 | 19,482 | 43,229 |
| Arunachal Pradesh      | 2,986   | 19,867         | 45,240 | 1,347 | 8,557 | 22,573 |
| Karnataka              | 2,986   | 18,448         | 38,557 | 2,246 | 6,737 | 19,379 |
| Nagaland               | 2,986   | 13,481         | 35,987 | 1,796 | 9,468 | 18,101 |
| Jammu and Kashmir      | 1,493   | 19,867         | 44,726 | 2,695 | 10,378 | 17,036 |
| Uttarakhand            | 982     | 9,224          | 15,937 | 898 | 5,007 | 10,435 |
| Meghalaya              | 2,004   | 16,792         | 38,557 | 466 | 4,552 | 8,944 |
| Tripura                | 2,004   | 10,170         | 17,479 | 1,347 | 4,097 | 8,158 |
| Tamil Nadu             | 2,004   | 10,170         | 24,162 | 449 | 3,186 | 8,092 |
| Mizoram                | 2,004   | 10,170         | 24,162 | 449 | 3,186 | 8,092 |
| Manipur                | 1,493   | 12,772         | 30,332 | 898 | 2,731 | 7,666 |
| Andhra Pradesh         | 1,493   | 6,622          | 14,909 | - | 2,731 | 6,389 |
| Haryana                | 1,493   | 4,494          | 14,909 | - | 2,276 | 6,389 |
| Telangana              | 982     | 6,622          | 14,909 | - | 1,821 | 5,324 |
| Dadra and Nagar haveli | 511     | 2,602          | 5,141 | 449 | 910 | 3,620 |
| Andaman and Nicobar Islands | 511 | 2,129 | 4,627 | - | 455 | 2,342 |
| Punjab                 | 511     | 2,129          | 3,599 | - | 910 | 2,342 |
| Himachal Pradesh       | -       | 946            | 2,570 | - | - | 1,278 |
| Goa                    | -       | -              | - | - | - | 426 |
| Lakshadweep            | -       | -              | - | - | - | 426 |
| Puducherry             | -       | -              | - | - | - | 426 |
| Kerala                 | -       | 473            | 2,056 | - | 455 | 426 |
| Chandigarh             | -       | -              | 514 | - | - | - |
| Delhi                  | -       | 473            | 514 | - | - | - |
| Sikkim                 | -       | 473            | 514 | - | - | - |

NFHS = National Family Health Survey.

Table 5 presents state-wise distribution of additional cases of child wasting and severe wasting cases in different scenarios of weight-loss. Here also, populous and low-income states like Uttar Pradesh, Bihar, Jharkhand and Madhya Pradesh will be most affected in case of a possible weight-loss. For example, about 89,735 new cases of wasting was estimated for Bihar assuming only 0.5% weight-loss among poorest children. In the same scenario, Uttar Pradesh and Madhya Pradesh will have 60,819 and 61,330 new wasting cases. In case a 5% reduction in weight is experienced, 1,132,034 and 892,466 new children will be wasted in Bihar and Uttar Pradesh respectively. An 1% loss in weight can increase about 61,792 cases of severe wasting in Bihar and 54,008 cases in Madhya Pradesh.

DISCUSSION

This is first study to present empirical findings regarding impact of shocks to bodyweight on prevalence of underweight and wasting among poor households in India. Two salient findings...
Sensitivity of child undernutrition to bodyweight shocks

from this study are: first, nutritional status of children is very sensitive to smallest of the shocks to bodyweight. In fact, a reduction of 0.5 and 1 percent in weight can lead to substantial increase in underweight and wasting prevalence at the national level. The magnitude of the problem intensifies manifold if we consider the net increase in burden attributable to a large population base of the country. Populous states like Bihar, Uttar Pradesh, and Madhya Pradesh will account for the highest increase in the number of underweight and wasted (severe) children across all assumed scenarios. These states also account for more than 40 percent of the additional cases attributable to such shocks. Secondly, the findings suggest that the estimated increase in prevalence of underweight and wasting because of such shocks is equivalent (or higher) to the cumulative reductions in undernutrition prevalence that India has witnessed in the last 3 years. This has important implication because the COVID-19 disruptions are almost likely to undo the progress achieved since the launch of the National Nutrition Mission (POSHAN Abhiyaan) of India in 2018.

Our results depict a relatively much higher impact on nutritional status of children from low-income and populous states like Uttar Pradesh and Bihar. In this regard, it is worth mentioning that with COVID-19 related national lockdown, these states are now experiencing a bulge in in-migration of informal sector workers and families from metropolitan cities and industrial hubs. In the absence of any immediate remedy to the problem of such high magnitude of job-losses and livelihoods, mass in-migration of families and children of these workers will further add-up to the already high burden of child undernutrition—especially in rural areas—in these states. The problem intensifies further when considered along with the poor coverage (less than 50 percent) and service uptake among children under public schemes like ICDS in Bihar and Uttar Pradesh. In a nutshell, an increase in the burden of undernourished children along with in-migration of poor families and a very low coverage of government supplementation programmes will make it very difficult for these states to cope up with the situation if the COVID-19 pandemic and related disruptions persist for long.

With such high concentration of children in the vicinity of the undernutrition threshold, any minor shock to nutritional health of the children can have major implications. In fact, India runs the risk of reverting to the old trajectory of slow improvements in undernutrition that, until recently, was a key feature of undernutrition in India. With the launch of the National Nutrition Mission (the POSHAN Abhiyaan) India has witnessed much needed boost and socio-political support to nutrition and nutrition-sensitive issues at all levels of administration and governance. It is disconcerting to note that much of the benefits through such major institutional headways such as the inter-sectoral convergence forums and large-scale community-based events will be compromised with this spell of COVID-19 pandemic which is yet to show any signs of slowdown in India. Meanwhile, the hardships posed by the pandemic-induced nationwide lockdown is lingering on and is expected to be further aggravated because of bleak economic outlook for the next few quarters. While India has considerable buffers to meet any untoward food-security shocks, but it needs to firmly address the issue of distribution of food not only from a hunger perspective but also from a view of promoting all-around nutritional health. Uninterrupted functioning of the ICDS scheme is also instrumental to ensure supplementary nutrition support to all children and women from low-income households. Clearly, an equitable and poor-centric approach is necessary to ensure that India remains on track to realize the national and international goals in nutritional health and well-being. Furthermore, full restoration of basic maternal and child health care services is equally important to mitigate impacts of illness or health damage due to non-receipt of key services.
The findings are expected to draw attention toward a highly sensitive child undernutrition scenario among the poor which is vulnerable to minor shocks arising because of direct and indirect effects of COVID-19 pandemic and ensuing policy response. Lockdown-related restrictions and sudden declines in economic activity imply that children from subsisting households may have to compromise the most with both the quantity as well as quality of the dietary intake. This will particularly affect the nutritional requirements of millions of children relying on school meals and other public programmes. For instance, with the abrupt closing of Anganwadi Centres, primary schools, and diversion of frontline health workers (towards COVID-related activities), it is plausible to assert that children from poorest households will succumb to loss in dietary intake and dietary diversity. The potential vulnerability could be higher in rural areas, as more than half of children from poor households rely on food supplementation from such government schemes such as ICDS, and Mid-day Meal programme. Given that Anganwadi Workers (AWWs) being diverted towards COVID-19 related tasks, disruptions in their usual activities (like food supplementation under ICDS via Hot Cooked Meals [HCMs] and Take Home Ration [THR]) are likely to have an adverse impact on dietary intake of children. It may be noted that the HCMs as well as THR facilities provided under such government initiatives are aimed at ensuring adequate quantity as well as quality of dietary intake among children.

In the same vein, recently released Global Nutrition Report 2020, has taken explicit cognizance of grave economic crisis due to COVID-19 in developing countries like India. The report while addressing stark inequalities in accessing food and healthcare in India, clearly emphasize on underlying importance of maintaining food supply and healthcare systems for poor during policy response towards COVID-19 outbreak. Further, a report while assessing impact of COVID-19 lockdown on nutrition interventions in Madhya Pradesh have observed an abrupt decline in deliverables related to food-supplementation by AWWs and a complete halt to HCMs during COVID-19 lockdown. For instance, the study finds that about schools in 80 percent of villages in Madhya Pradesh have completely stopped providing Mid-day Meals.

Importantly, the lockdown induced disruptions in services and interventions for pregnant and lactating mothers,—such as food and nutrition supplementation, Vitamin-A and Iron and Folic Acid supplementation, and antenatal care, ICDS benefits at the time of breastfeeding—is also likely to affect the nutritional outcomes of children within first 1,000 days. More importantly, given the utmost importance of these intervention in first 1,000 days of child, such disruptions will severely compromise their future physical and cognitive development which many studies claim to be irreversible after first 2 years. The impact will be again disproportionately borne by Bihar which not only has a high proportion of new-born but also the highest share of poorest households in the country.

Our findings clearly indicate a stark increase in the prevalence of child underweight and wasting among poorest children in India as a result of shocks to weight and nutritional status. These figures are even higher when the magnitude is translated in absolute numbers. Therefore, at the policy front, it is crucial at the moment to navigate the policy priority towards the poorest section who are currently at the most vulnerable position. Particularly in current scenario of COVID-19 pandemic, it is critical to ensure an uninterrupted supply of nutritious meals and food supplements to poor children while arresting the infection spread. Alternative means such as direct cash benefits/transfers can be conceived to reach out to the needy households and those from the lowest economic strata. We also find that increase in burden will be substantially larger among states like Uttar Pradesh and Bihar. It is also critical...
to enable ground-level functionaries (such as Accredited Social Health activist, AWWs) to maintain their active participation in preserving ongoing nutrition efforts such as THR, and vitamin and iron supplementation.

In concluding, it is worth reiterating that the magnitude of shocks assumed under different scenarios—ranging from a minimum average reduction in bodyweight of 30 g (0.5%) to a maximum average reduction of 660 g (5%)—is relatively much conservative compared to estimated weight-loss associated with loss in calories intake.34–38 From a metric standpoint, previous studies have found that loss in caloric intake by 7 kcal. leads to a weight-loss by 7 g.34–38 Yet, such minor shocks can lead to large and devastating effects on nutritional health of India.

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