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Case Study

District-Level Analysis of Inequality in Malnutrition Among Children: Evidence from Maharashtra, India

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Abstract: India currently faces the triple burden of malnutrition characterized by the coexistence of undernutrition and overnutrition along with micronutrient deficiencies. The unequal distribution of child health outcomes in the population may affect the goal of a 'malnutrition free world'. The nutritional status and its inequalities among post under-five age have rarely been assessed in the country. This study examines the degree and extent of asset-based household wealth inequalities in malnutrition among preschool and school children in the Maharashtra state of India. The study utilizes the fourth round of the District Level Health Survey 2012-2013 to provide district-level estimates of the inequalities in five malnutrition indicators-stunting, wasting, underweight, overweight, and anemia among children. Concentration curves, normalized concentration index, geographical maps and correlation matrix are used to analyze the data by districts, rural-urban residence and gender. The findings indicate that considerable proportion of children are malnourished in Maharashtra, even with its advanced economic status**.** Malnutrition levels among school going children are as high as those of children under six years of age. The results show that malnutrition inequalities manifest primarily among the weaker sections of society. However, children from affluent households are more likely to suffer from overweight and obesity issues. The prevalence of malnutrition is higher in rural areas, but inequality is significantly higher in urban regions. The nutritionally backward areas are concentrated in the tribal districts of the Marathwada division and a few others from Vidarbha and Amravati. Many districts of Maharashtra have multiple burdens of malnutrition and have high inequalities on more than one indicator. A negative correlation is observed between the prevalence of malnutrition and human development indicators. There is a need to capture broader age groups in the nutrition monitoring frameworks. The regional heterogeneity in the malnutrition prevalence and distribution calls for unique health intervention strategies specific to district targets.

***Keywords*:** anemia, child health, health inequality, overweight, school children, triple burden of malnutrition

JEL Code: I10, I12, I14, I15, I18, J13

1. Introduction

Over recent decades, the world has made remarkable headways in improving malnutrition and associated health burdens. Despite the improvements, malnutrition is still a large-scale universal problem. Lack of proper nutrition and micronutrients will have severe repercussions in their adulthood and further into succeeding generations. Nutritional

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deprivation makes the child susceptible to morbidity and mortality. Malnutrition is multidimensional. According to the World Health Organisation (WHO, 2020), malnutrition refers broadly to undernutrition or deficiencies in calorie intake and overnutrition or the issues of unbalanced diets. Undernutrition includes stunting, wasting, underweight and insufficiency in micronutrients. The other involves overweight, obesity, and diet-related problems such as diabetes, heart disease, stroke and cancer. Countries worldwide are currently undergoing a nutritional transition in the form of a shift in the population's dietary habits due to increased modernization, economic growth, and demographic change (Popkin, 2006; Misra & Khurana, 2008). The double burden of malnutrition characterized by the coexistence of undernutrition along with overweight poses a real threat to the social and economic development of the global population. Elimination of malnutrition in all its forms will improve health and economic outcomes. To emphasize the urgency of the matter United Nations (UN) has declared 2016 to 2025 as the UN Decade of Action on Malnutrition.

Despite making strides in economic growth, India has not succeeded in securing a better nutritional status for all its children. In the 2018 Global Hunger Index (GHI) [GHI scores are based on four indicators-undernourishment, child stunting, child wasting and child mortality], India ranks 103th out of 119 countries. India falls in the category of serious levels of hunger, and child malnutrition is one of the main reasons pushing the country to the worst performing region in South Asia (Von Grebmer et al., 2018). A global burden of disease study by Dandona et al. (2017) reports that 0.9 million children below five years of age died in India in 2016. This figure is the highest in the world. Along with nutritional deficiency, overweight and obesity are on the rise in India. A major demographic, epidemiological and nutritional transition is happening in the country, resulting in the unique problem of twin challenges spanning from malnutrition and underweight to overweight and obesity. India, with its 14.4 million children, is home to the second highest number of obese children in the world, reports a study published in The New England Journal of Medicine (GBD 2015 Obesity Collaborators, 2017). In addition, a recently published Harvard study by Ward et al. (2017) finds that excess weight in childhood is predictive of adult obesity. The study is particularly relevant to India, given its soaring levels of child obesity. These findings warn that child obesity is becoming a silent epidemic worldwide with adverse health impacts in adulthood. However, the magnitude of the problem of double and triple burden of malnutrition and its distribution among children and adolescents in India are vague due to the dearth of studies. Hence, the present study attempts to look beyond the conventional indicators of malnutrition and assess the prevalence of malnutrition in a multidimensional context.

2. Review of literature

To achieve the objective of a malnutrition free world, countries need to tackle the distributional aspects of malnutrition. The WHO also notes that average health status is an inadequate summary of the country's health performance and points out that the countries must also consider the distributional dimension of the health variable. Health inequalities are unjust and avoidable differences in health across the population and between specific population groups. Failure to tackle avoidable inequalities is considered to social injustice (Van de Poel et al., 2008). Many studies show that inequalities in malnutrition between poor and non-poor segments of the population are high even in countries with an overall low prevalence of malnutrition (Bredenkamp et al., 2014). Even though malnutrition prevalence has declined over the years, inequality levels persist. Van de Poel et al. (2008) argue that reducing the prevalence does not necessarily reduce inequality. Accordingly, the stress should also be on the distribution of nutrition across all socio-economic groups. Several empirical studies (Wagstaff & Watanabe, 2000; Van de Poel et al., 2008; Bredenkamp et al., 2014) document the socio-economic inequalities in childhood malnutrition that prevails throughout the developing world. Large cross-country variations in malnutrition inequalities are observed in these studies. In almost all countries, malnutrition rates are high among the poorest quintile. Furthermore, malnutrition inequalities are likely to accentuate income inequalities due to their far-reaching consequences on people's ability to earn.

The Indian scenario is no different. Socio-economic inequality in conventional indicators of malnutrition is studied extensively in India (Joe et al., 2008; Van de Poel & Speybroeck, 2009; Mazumdar, 2010; Subramanyam et al., 2010; Kumar et al., 2015; Singh et al., 2019; Kumar & Paswan, 2021). Prior studies observed a constant decline in the prevalence of undernutrition over the years; however, social disparities in childhood undernutrition widened or remained static (Subramanyam et al., 2010; Pathak & Singh, 2011; Kumar et al., 2015). More recently, a study by Kumar and Paswan (2021) on the Empowered Action Group states finds that stunting inequality has remained unchanged while the inequality in the underweight has decreased during the period 2005-2016. One of the foremost studies which presented a state-level analysis of income-related inequalities in child health is Joe et al. (2008). The study shows that inequalities in child health vary across different Indian states and are primarily concentrated among the poor. Children from low-income families are at a greater disadvantage in the case of under-five mortality, stunting, underweight and anemia. This general observation about the unequal nutritional deprivation among poor households is similar to that of other studies such as Van de Poel and Speybroeck (2009), Joe et al. (2009), Arokiasamy and Pradhan (2011).

Van de Poel and Speybroeck (2009) and Joe et al. (2009) emphasize the group disparities existing in child health. There appear to be no remarkable gender differentials in the child health indicators. Even for that matter, boys are more prone to being undernourished than girls. This has been confirmed by Mazumdar (2010) and many others. Subramanyam et al. (2010) find no significant evidence for differential rates of undernutrition based on caste, gender or rural residence. Many of these studies examine malnutrition inequalities at the household or state level. Given the severity and depth of malnutrition in the states, examining the relative distribution of malnutrition across districts is essential as recent interventions to reduce malnutrition and its disparities are likely to be implemented at the local decentralized level. A few recent studies by Singh et al. (2019) and Liou et al. (2020) confirm the existence of socio-economic inequality in child health at the district level in India. The studies find a higher burden of malnourished children in the least developed districts of India. Using NFHS-4 data, Khadse and Chaurasia (2020) estimate the nutritional status and inequalities among under-five children in different geographical regions of Maharashtra. Previous studies have consistently focused on the nutritional status and its distribution among children under five years of age. Only a handful of studies in the regional context of India have explored the burden of malnutrition among school going children (Srivastava et al., 2012; Pal et al., 2016; Ahmad et al., 2018; Bhattacharyya et al., 2021). Further, the socio-economic inequality in malnutrition among children aged 6-14 years is less explored among researchers widely. Against this backdrop, the study attempts to quantify inequalities in malnutrition among preschool children and school children in Maharashtra. Health inequality analysis focusing on the regional disparity of child nutrition appears to be fairly limited in the state.

We focus our study on Maharashtra, a state in the western region of India and the second most populous state in the country. The paradoxical nature of the state's achievements is behind this inquiry of malnutrition inequalities. Being one of the prosperous states in the country, it has not been able to improve the socio-economic and health status of all the population subgroups. Even though the state has made some advancements in health transition, the inequality rates in nutritional deficiencies, mortality and morbidity across regions and social groups are unacceptably high. Maharashtra figures are worse than the national averages in many health indicators such as mortality rates and sex ratio (National Health Policy, 2017). Estimates from the National Family Health Survey (2019-2021) show that in Maharashtra, 35% of the children under the age of five are stunted, 25.6% are wasted, 36% are underweight, and 69% are anaemic. In contrast, India's prevalence of stunting, wasting, underweight, and anemia reportedly are 35%, 19.3%, 32%, and 67%, respectively. The study contributes to the literature mainly in two ways. First, very few studies have analysed five child malnutrition indicators-stunting, wasting, underweight, overweight, anaemia and its severe forms together as outcome variables. Secondly, the study updates the evidence base on average malnutrition and wealth inequality in malnutrition among school-aged children in the state who are often neglected in the nutrition surveys and health surveillance. To the best of our knowledge, this is the first study to assess malnutrition rates and inequalities among school-aged children in Maharashtra.

2.1 *Data sources and variables*

For the empirical analysis, we use the fourth round of District Level Household and Facility Survey (DLHS-4) [It may be noted that the DLHS-4 does not cover entire India and provides data only on 26 states and union territories which are better performers than the omitted states in terms of economic and development indicators] conducted during 2012-2013 by the International Institute for Population Sciences (IIPS). The survey used multistage stratified random sampling with probability proportional to size. The nutritional status of school children aged 6-14 years remains excluded from the monitoring frameworks as they are rarely targeted in nutrition surveys. The DLHS-4 is the latest available data that contains information about older children, making it possible to analyse school-aged children (6-14 years) and preschool children (0-5 years). The final analysis consists of 17,044 observations for stunting, underweight and overweight indicators. The wasting and anemia analyses include 7,118 and 16,717 observations, respectively. The flagged observations with outliers and incomplete/missing information are excluded from the final analysis. The study considers the extent of malnutrition inequality at the multiple levels of the sector, gender and age groups.

2.2 *Malnutrition indicators*

We have created a binary outcome variable using the standardized z-scores based on the international reference population released by the World Health Organisation (WHO) in April 2006, indicating whether a child is malnourished or not (WHO Multicentre Growth Reference Study Group, 2006).

Stunting-Children whose height for age is below -2 standard deviation from the median of the reference population and below -3 standard deviations are regarded as severely stunted.

Wasting [Since WHO child growth reference data for a weight-for-height indicator of school-aged children (6-14 years) is unavailable, wasting outcome is only for preschool children]-Weight for the height of a child below -2 standard deviations from the median of the reference population. The weight-for-height indicator is for 0-5 years of age.

Underweight-A child with a z-score of less than -2 standard deviations from the median weight for age of the reference population. A z-score of less than -3 standard deviations categorizes severely undernourished children.

Overweight-Children whose BMI value is above +1 standard deviation from the median BMI of the reference population are considered overweight, and above +2 standard deviations are considered obese.

Anemia-Children of six months and above are classified as anaemic if the haemoglobin concentration is lower than 11.0 g/dl and severely anemic if the Hb levels are lower than 7.0 g/dl.

2.3 *Household wealth*

In the absence of data on income or household consumption expenditures in DLHS-4, we have generated an index of wealth that proxies for the household's long-run economic status. The wealth index is based on a set of 32 selected assets of the households and housing characteristics like land; the number of dwelling rooms; kind of toilet facility; type of cooking fuel; type of house structure; ownership status of the household; the main source of lighting; and whether the family owns a radio, television, computer with and without internet, telephone, mobile phone, washing machine, sewing machine, refrigerator, watch, bicycle, scooter, car/jeep/van, tractor, water pump/tube well, animal driven cart, cart driven by machine, other cart and cooler or air conditioner. The wealth index is then constructed using the principal component analysis proposed in Filmer and Pritchett (2001) and Vyas and Kumaranayake (2006). The interdistrict inequalities in the asset concentration range from -0.338 to 0.538 (Refer Table A1). Across districts, Parbhani, Osmanabad, Dhule, Nanded and Nandurbar are the bottom five districts with the lowest wealth scores. Mumbai, Pune, Raigarh and Nagpur have the highest wealth score.

3. Methodology

Concentration curves (CC) have been extensively used in the literature to measure socio-economic inequality in any health outcome (Wagstaff et al., 1991; Cuyler & Wagstaff, 1993; Kakwani et al., 1997). The concentration curve plots the cumulative proportions of malnourished children on the y-axis against the cumulative population shares ranked by wealth index on the x-axis. The Concentration Index (CI) [CI ranges from -1 to +1. CI = 0 if there is an equitable distribution of health across the population] measures the extent of malnutrition inequalities that are systematically associated with socio-economic status. It is defined as twice the area between the concentration curve and the egalitarian line (the 45-degree line). The concentration index is defined as positive when the concentration curve lies below the diagonal and malnutrition is concentrated in the hands of the higher socio-economic groups. Conversely, the concentration index is negative when the curve lies above the diagonal and malnutrition is concentrated amongst the most disadvantaged income groups. In the case of a dichotomous malnutrition indicator, Wagstaff (2005; 2011) has suggested normalizing the concentration index [The ranges of normalized CIs are ($\mu - 1$, $1 - \mu$), where μ is the mean of the health variables. The feasible interval of the CI shrinks as the mean increases. Thus, higher means indicate a narrower range of possible CI values but do not necessarily imply less inequality] by dividing it through either the reciprocal of the mean of the malnutrition variable or by its feasible bounds, rather than reporting the actual value. The CI and C_N can be computed by using the covariance result, which is given below.

$$C = \frac{2}{\mu}\text{cov}(y,\ r) \tag{1}$$

$$C_N = \frac{C}{1-\mu} \tag{2}$$

where C is the concentration index, C_N is the normalized concentration index, y is the health variable, μ is its mean and r is the relative fractional rank of the individual in the socio-economic distribution.

4. Results

4.1 *Inequality levels in malnutrition by region, age groups and gender*

In this section, we examine the degree and magnitude of wealth-related inequalities in malnutrition. With this motive, we have plotted the concentration curves and calculated the concentration indices across different districts of Maharashtra. Other than the overweight indicator, all the concentration curves lie above the line of equality (see Figure 1). This observation indicates a disproportionate burden of malnutrition among children from low-income families. At the same time, it may be observed that relatively wealthy children are more likely to be overweight. The concentration curves for anemia more or less coincide with the diagonal, implying a near equal distribution of anemia across children. The sign of the concentration indices also complements the graphical exploration of the inequality in child malnutrition prevalent among the poor.

Tables 1 and 2 shows the prevalence and normalized concentration indices (CI) for all the five selected malnutrition indicators amongst preschool and school children across stratifiers of the region, age categories and gender. All concentration indices for stunting, wasting, underweight, and anemia are negative, reflecting the higher malnutrition rates among poor children. The positive CI values of overweight and obesity imply that inequality is disfavoring the rich. The statistically significant CI values suggest that the tendency of a higher concentration of health casualties among poor children is not due to sampling variability. Inequality appears to be increasing in the case of severe stunting, wasting and underweight. We also analyzed whether there is any difference in inequality of malnutrition across different subgroups of the region, gender and age groups. The statistically significant differences between concentration indices are provided in Table A2 (Appendix).

Stunting-Around twenty percent and nine percent of the children in Maharashtra are stunted and severely stunted. Maharashtra's rural areas have more stunted children than its urban parts, but Maharashtra's urban region witnesses remarkably higher inequalities in stunting across all age groups. The prevalence of stunting is higher among school children than preschool kids. The risk of stunting is higher among boys than girls. Regarding inequalities across gender, higher inequality is observed among boys in preschool kids and schoolgirls in the higher age group., Stunting inequalities are more pronounced among boys in the lower age group and girls in the higher age category. The magnitude of inequality is higher among school children in overall Maharashtra and its rural parts, but there is no apparent difference between the age categories in the urban sector. None of the differences between concentration indexes across groups is statistically significant for stunting.

Wasting-Around thirty-three percent of the preschool children are wasted or too thin for their height, and sixteen percent are severely wasted. The respective values for concentration indices are -0.085 and -0.106. Greater inequalities are noticed in the case of severe criteria of wasting. The prevalence of wasting is higher among rural children than urban children across gender. Along the lines of prevalence, rural areas of Maharashtra experience higher inequality in wasting. Wasting is slightly higher among boys than the opposite gender. Child wasting is more unequally distributed among boys than the girls in Maharashtra, irrespective of residence. There is no significant distinction between concentration indexes across different stratifiers in the case of wasting.

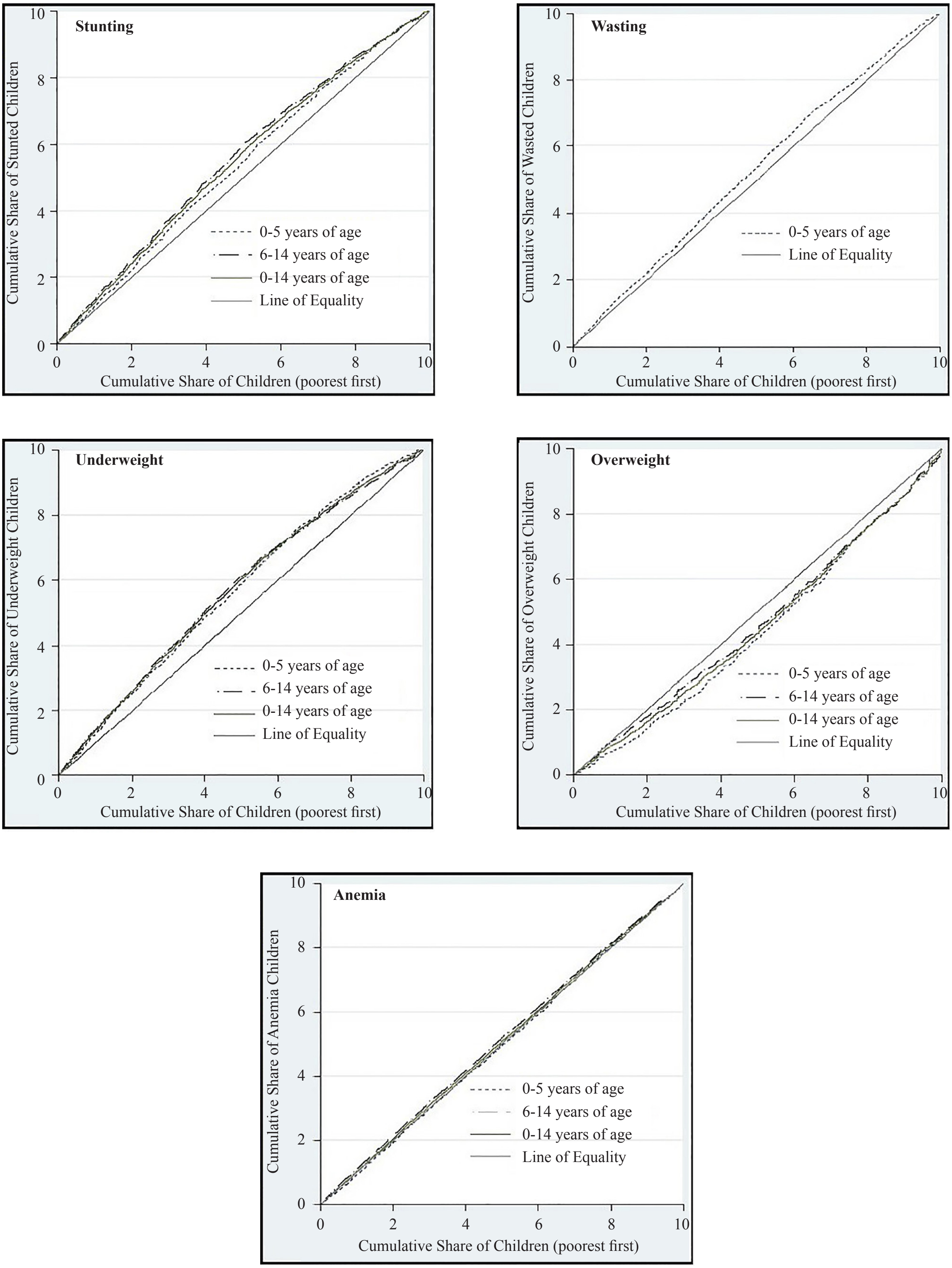


Figure 1. Concentration curves for malnutrition indicators by age-groups

Table 1. Normalised Concentration Indices for Inequalities in Malnutrition Indicators among pre-school children

Indicators	Rural			Urban			Total		
Sub-groups	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Stunting									
Incidence	22.83	19.53	21.27	20.71	17.23	19.08	21.93	18.57	20.35
CI	-0.130	-0.038	-0.092	-0.138	-0.128	-0.144	-0.129	-0.115	-0.118
Std. Error	(0.029)	(0.032)	(0.027)	(0.036)	(0.040)	(0.022)	(0.022)	(0.025)	(0.016)
Severe Stunting									
Incidence	9.93	8.79	9.39	7.83	8.43	8.11	9.05	8.64	8.85
CI	-0.122	-0.011	-0.073	-0.119	-0.179	-0.159	-0.135	-0.104	-0.117
Std. Error	(0.041)	(0.047)	(0.031)	(0.055)	(0.054)	(0.039)	(0.033)	(0.035)	(0.024)
Wasting									
Incidence	34.87	33.58	34.26	31.33	31.99	31.64	33.37	32.92	33.16
CI	-0.098	-0.082	-0.084	-0.055	-0.043	-0.053	-0.096	-0.116	-0.085
Std. Error	(0.025)	(0.027)	(0.018)	(0.031)	(0.033)	(0.030)	(0.019)	(0.027)	(0.014)
Severe Wasting									
Incidence	17.59	15.89	16.79	14.67	15.37	14.99	16.36	15.67	16.04
CI	-0.132	-0.120	-0.133	-0.039	-0.046	-0.053	-0.118	-0.116	-0.106
Std. Error	(0.032)	(0.035)	(0.024)	(0.040)	(0.044)	(0.030)	(0.025)	(0.027)	(0.018)
Underweight									
Incidence	31.31	30.63	30.99	22.85	26.49	24.55	27.34	28.9	28.28
CI	-0.189	-0.133	-0.165	-0.162	-0.249	-0.228	-0.206	-0.203	-0.211
Std. Error	(0.026)	(0.028)	(0.019)	(0.034)	(0.034)	(0.024)	(0.020)	(0.021)	(0.015)
Thinness									
Incidence	9.87	9.98	9.92	8.04	6.83	7.48	9.09	8.67	8.89
CI	-0.259	-0.177	-0.235	-0.188	-0.177	-0.205	-0.245	-0.207	-0.237
Std. Error	(0.041)	(0.044)	(0.030)	(0.054)	(0.060)	(0.040)	(0.032)	(0.035)	(0.024)
Overweight									
Incidence	11.18	9.55	10.41	12.15	11.46	11.83	11.59	10.35	11.01
CI	0.154	0.131	0.150	0.033	0.005	0.013	0.096	0.095	0.103
Std. Error	(0.040)	(0.045)	(0.030)	(0.043)	(0.047)	(0.032)	(0.029)	(0.032)	(0.021)
Obese									
Incidence	4.89	4.71	4.8	5.78	4.78	5.31	5.27	4.74	5.02
CI	0.053	0.149	0.092	0.066	0.012	-0.040	0.028	0.069	0.052
Std. Error	(0.057)	(0.064)	(0.042)	(0.062)	.070	(0.046)	(0.041)	(0.047)	(0.031)
Anemia									
Incidence	81.48	81.88	81.67	80.05	80.84	80.41	80.87	81.45	81.14
CI	-0.039	-0.107	-0.085	-0.046	-0.048	-0.057	-0.072	-0.101	-0.069
Std. Error	(0.032)	(0.033)	(0.023)	(0.035)	(0.039)	(0.026)	(0.023)	(0.025)	(0.017)
Severe Anemia									
Incidence	26.03	24.23	25.18	20.71	26.22	23.27	23.78	25.06	24.38
CI	-0.024	-0.028	-0.009	-0.047	0.011	-0.024	-0.082	-0.022	-0.024
Std. Error	(0.029)	(0.031)	(0.021)	(0.037)	(0.037)	(0.026)	(0.022)	(0.024)	(0.016)

Robust standard errors are in parentheses.
Note: CI-Concentration Index. Source: Estimated using data from DLHS-4 (2012-13).

Table 2. Normalised Concentration Indices for Inequalities in Malnutrition Indicators among school children

Indicators	Rural			Urban			Total		
Sub-groups	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Stunting									
Incidence	24.89	24.28	24.59	22.18	17.93	20.16	23.73	21.65	22.72
CI	-0.119	-0.074	-0.109	-0.118	-0.148	-0.145	-0.127	-0.143	-0.139
Std. Error	(0.024)	(0.025)	(0.021)	(0.029)	(0.033)	(0.017)	(0.018)	(0.020)	(0.013)
Severe Stunting									
Incidence	10.01	9.76	9.89	8.37	6.37	7.42	9.34	8.35	8.85
CI	-0.101	-0.104	-0.108	-0.104	-0.169	-0.140	-0.108	-0.157	-0.147
Std. Error	(0.034)	(0.037)	(0.025)	(0.042)	(0.050)	(0.032)	(0.027)	(0.029)	(0.020)
Underweight									
Incidence	39.44	40.22	39.82	27.3	28.22	27.74	34.23	35.24	34.72
CI	-0.131	-0.079	-0.123	-0.179	-0.167	-0.185	-0.213	-0.185	-0.191
Std. Error	(0.021)	(0.022)	(0.015)	(0.026)	(0.029)	(0.019)	(0.016)	(0.017)	(0.012)
Thinness									
Incidence	14.85	15.85	15.34	8.35	8.65	8.49	12.05	12.87	12.45
CI	-0.099	-0.036	-0.081	-0.203	-0.199	-0.210	-0.209	-0.192	-0.179
Std. Error	(0.030)	(0.030)	(0.021)	(0.041)	(0.046)	(0.030)	(0.024)	(0.025)	(0.017)
Overweight									
Incidence	10.59	8.59	9.61	15.03	11.39	13.31	12.5	9.75	11.17
CI	0.027	0.016	0.011	0.079	0.122	0.110	0.107	0.089	0.093
Std. Error	(0.033)	(0.038)	(0.025)	(0.033)	(0.040)	(0.025)	(0.023)	(0.027)	(0.017)
Obese									
Incidence	4.82	3.09	3.97	6.94	4.48	5.77	5.73	3.67	4.73
CI	0.093	0.039	0.051	0.137	0.102	0.139	0.137	0.055	0.128
Std. Error	(0.048)	(0.060)	(0.037)	(0.047)	(0.062)	(0.037)	(0.034)	(0.043)	(0.026)
Anemia									
Incidence	71.02	73.28	72.13	70.97	71.97	71.45	71.01	72.74	71.84
CI	-0.034	-0.044	-0.038	-0.038	-0.061	-0.059	-0.033	-0.054	-0.047
Std. Error	(0.023)	(0.024)	(0.016)	(0.026)	(0.029)	(0.019)	(0.017)	(0.018)	(0.012)
Severe Anemia									
Incidence	14.85	15.36	15.09	14.29	14.32	14.31	14.61	14.92	14.77
CI	-0.005	-0.025	-0.021	-0.009	-0.019	-0.018	-0.010	-0.069	-0.023
Std. Error	(0.030)	(0.030)	(0.021)	(0.035)	(0.039)	(0.026)	(0.022)	(0.024)	(0.016)

Robust standard errors are in parentheses.
Note: CI-Concentration Index. Source: Estimated using data from DLHS-4 (2012-13).

Underweight-Approximately 35% and 28% percent of the school and preschool children, respectively, are underweight in Maharashtra. Between the age categories, the underweight prevalence is higher among school kids, but the magnitude of inequality is higher in the case of preschool children across all divisions of Maharashtra. The child health inequality according to the underweight criterion is by far the largest when contrasted with the alternative criterion. There are some significant rural-urban and gender differentials in the case of underweight and thinness. The underweight and thinness inequality is more pronounced among children living in the urban parts of Maharashtra than in rural children, regardless of their age. The burden of underweight is slightly higher for girls than male children. The weight-for-age inequity gap between girls and boys are more among preschool children and even more in urban areas. Among the rural children, inequality in thinness is higher among male preschool children. The difference in inequalities between the two sexes is statistically significant.

Overweight-Around twelve percent of the children are overweight in Maharashtra, the proportion being substantially higher among urban male school children. All concentration indices of overweight and obesity measures are significantly positive, implying that children from affluent households suffer from the greater burden of overweight and obesity. The higher inequalities among school children are observed in the moderate and severe cases, i.e. overweight and obesity. The preschool kids in the rural areas of Maharashtra are disproportionally carrying the burden of being overweight than their urban peers. The urban region is at a disadvantageous position in the matters of inequality in overweight and obesity among school children. The risk of becoming overweight and obese is higher for boys than girls. The inequality indices are also disfavoring male children. Thirty-two percent of girls and thirty-one percent of boys are underweight in Maharashtra, and eleven percent of the girls and twelve percent of the boys are overweight. Over half of boys and girls are at a healthy weight for their height in Maharashtra.

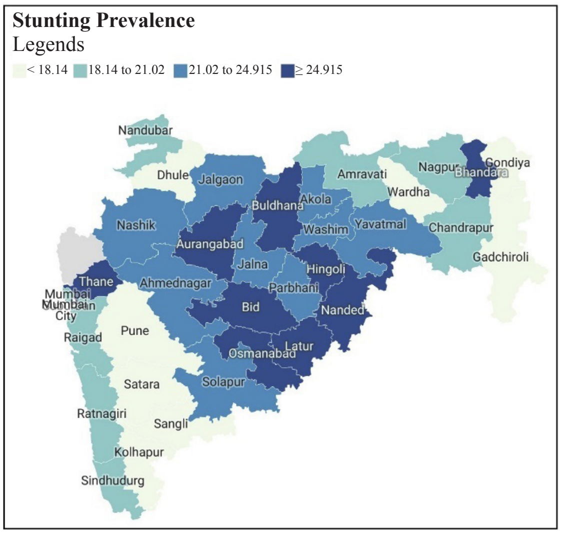
Anemia-A staggering percentage of approximately 82% and 72% of the preschool children and school children are found to be anemic, which is quite alarming. The concentration indices of anemia are observably much less negative than the CI indices of other child health indicators. This could be due to the widespread prevalence of anemia across the population. Nonetheless, the underprivileged sections are found to be in a risky situation. Rural-urban differentials are negligibly small for moderate and severe cases of anemia owing to its omnipresence. A closer look at the age group differences in anemia shows that the children aged six months to five years are most vulnerable irrespective of locality. Anemia inequality is also higher among preschool kids in overall Maharashtra and rural parts. Economic inequality concerning anemia is greater among girls.

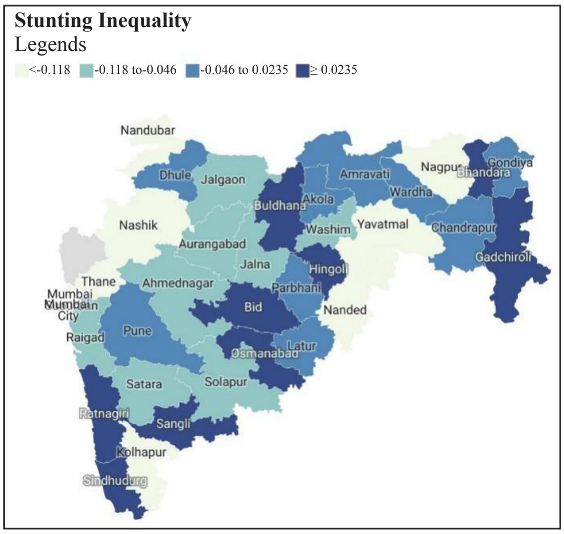
4.2 *District-level analysis of malnutrition inequality*

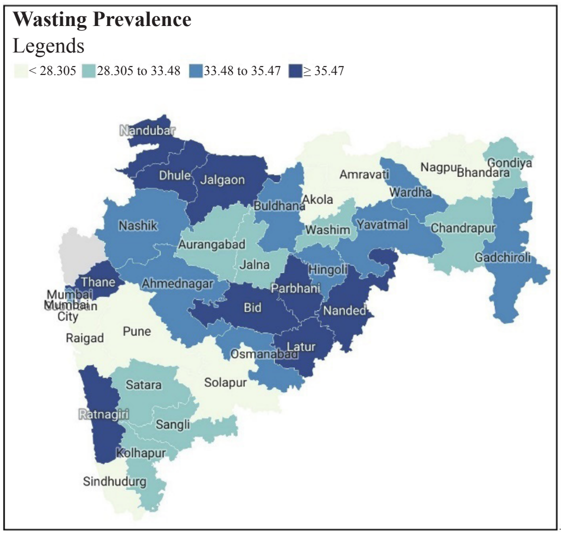
Choropleth maps for different age categories are constructed to inspect the economic inequality with respect to the prevalence of malnutrition indicators across thirty-five districts of Maharashtra [Maharashtra's 36th district Palghar was carved out of Thane in August 2014] (See Figure 2).

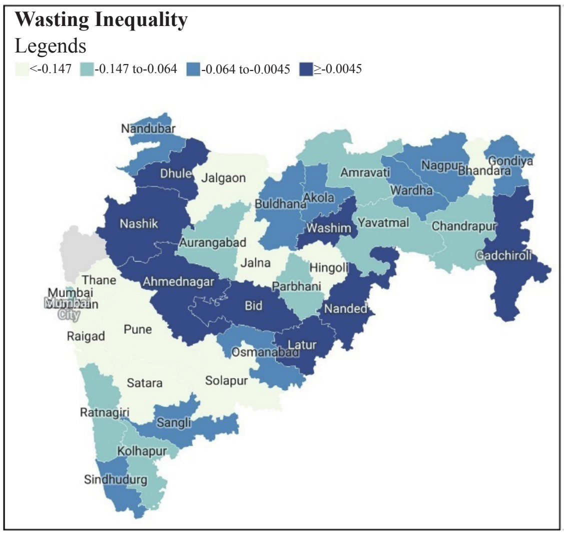
Different shades of blue represent four quantile classes of prevalence (%), with the highest quantile in the darkest shade and lowest in the cream shade. The darkest blue (pro-rich) and cream (pro-poor) colors indicate the magnitude of concentration indices with higher levels of malnutrition inequality. The light colour shades denote regions where children in the lower quintiles are more malnourished than wealthy households. Darker shades of blue signify the districts where the burden of that particular malnutrition indicator is greater among children of relatively wealthy households. The spatial pattern illustrates that districts with a relatively lower prevalence of malnutrition experience higher inequality than regions with a high prevalence of malnutrition. For instance, economically advanced districts in the north-western regions of Maharashtra are characterized by higher economic inequalities in relation to child undernutrition than their counterparts. We also found that the central areas of Maharashtra experience moderate levels of malnutrition prevalence and inequality. The emerging pattern is inconsistent in all the forms of undernutrition. These analyses facilitate identifying hot spots (low coverage-high need areas) and cold spots (high-coverage-low need areas) for child health indicators. The inspection of health disparities geographically aids in identifying the precise location where the allocation of resources lags behind neighboring areas, and critical interventions are requisite. Next, a detailed account of district-wide overall burden and inequality in malnutrition indicators among preschool and school children are given in Tables 3 and 4.

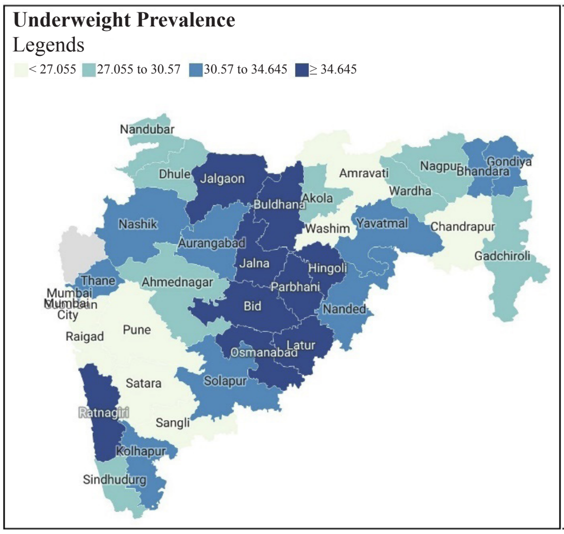
The prevalence of stunting among preschool children ranged from 14.29% in Gadchiroli to 34.41% in Bid. Around 25 percent of the children are stunted in the developed districts of Solapur, Ratnagiri and Thane. Among school children, stunting is the highest in Bhandara with 36.89% and lowest in Mumbai city with 9.02%, followed by Hingoli, Bid and Buldana. As far as inequality is concerned, the majority of the districts fare worse than the state average. Stunting has a remarkably high concentration among the children from poor socio-economic status in majority of the districts in Maharashtra. For stunting, inequality among preschool children is the highest in Yavatmal (-0.336), followed by Nashik (-0.265), Mumbai city (-0.257) and Thane (-0.254). Among school children, Yavatmal (-0.432), Mumbai city (-0.304) and Thane have the worst inequalities in stunting. Disparities in stunting are lower in the less developed districts (except Yavatmal and Nandurbar) and higher among the prosperous districts of Maharashtra.

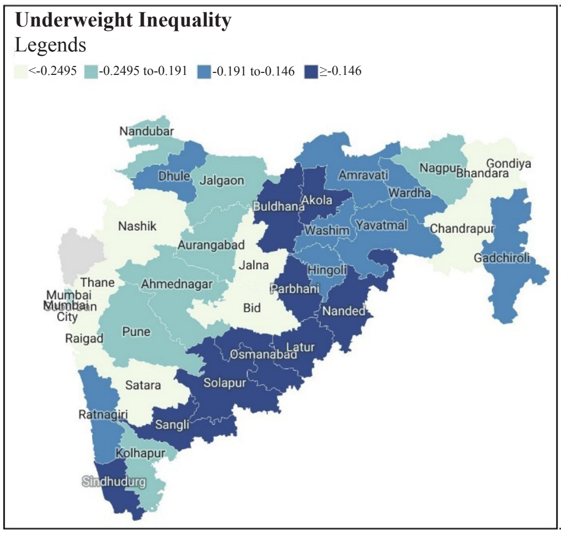

Stunting Prevalence
Legends
< 18.14
18.14 to 21.02
21.02 to 24.915
≥ 24.915
Nandubar
Dhule
Jalgaon
Amravati
Nagpur
Bhandara
Gondiya
Akola
Wardha
Buldhana
Nashik
Washim
Yavatmal
Chandrapur
Aurangabad
Gadchiroli
Jalna
Hingoli
Thane
Ahmednagar
Parbhani
Mumbai
Mumbai City
Bid
Nanded
Raigad
Pune
Latur
Osmanabad
Satara
Solapur
Ratnagiri
Sangli
Kolhapur
Sindhudurg


Stunting Inequality
Legends
<-0.118
-0.118 to-0.046
-0.046 to 0.0235
≥ 0.0235
Nandubar
Dhule
Jalgaon
Amravati
Nagpur
Bhandara
Gondiya
Akola
Wardha
Buldhana
Nashik
Washim
Yavatmal
Chandrapur
Aurangabad
Gadchiroli
Jalna
Hingoli
Thane
Ahmednagar
Parbhani
Mumbai
Mumbai City
Bid
Nanded
Raigad
Pune
Latur
Osmanabad
Satara
Solapur
Ratnagiri
Sangli
Kolhapur
Sindhudurg


Wasting Prevalence
Legends
< 28.305
28.305 to 33.48
33.48 to 35.47
≥ 35.47
Nandubar
Dhule
Jalgaon
Amravati
Nagpur
Bhandara
Gondiya
Wardha
Buldhana
Akola
Nashik
Washim
Yavatmal
Chandrapur
Aurangabad
Gadchiroli
Jalna
Hingoli
Thane
Ahmednagar
Parbhani
Mumbai
Mumbai City
Bid
Nanded
Raigad
Pune
Latur
Osmanabad
Satara
Solapur
Ratnagiri
Sangli
Kolhapur
Sindhudurg


Wasting Inequality
Legends
<-0.147
-0.147 to-0.064
-0.064 to-0.0045
≥-0.0045
Nandubar
Dhule
Jalgaon
Amravati
Nagpur
Bhandara
Gondiya
Wardha
Buldhana
Akola
Nashik
Washim
Yavatmal
Chandrapur
Aurangabad
Gadchiroli
Jalna
Hingoli
Thane
Ahmednagar
Parbhani
Mumbai
Mumbai City
Bid
Nanded
Raigad
Pune
Latur
Osmanabad
Satara
Solapur
Ratnagiri
Sangli
Kolhapur
Sindhudurg


Underweight Prevalence
Legends
< 27.055
27.055 to 30.57
30.57 to 34.645
≥ 34.645
Nandubar
Dhule
Jalgaon
Amravati
Nagpur
Bhandara
Gondiya
Wardha
Buldhana
Akola
Nashik
Washim
Yavatmal
Chandrapur
Aurangabad
Gadchiroli
Jalna
Hingoli
Thane
Ahmednagar
Parbhani
Mumbai
Mumbai City
Bid
Nanded
Raigad
Pune
Latur
Osmanabad
Satara
Solapur
Ratnagiri
Sangli
Kolhapur
Sindhudurg


Underweight Inequality
Legends
<-0.2495
-0.2495 to-0.191
-0.191 to-0.146
≥-0.146
Nandubar
Dhule
Jalgaon
Amravati
Nagpur
Bhandara
Gondiya
Akola
Wardha
Buldhana
Nashik
Washim
Yavatmal
Chandrapur
Aurangabad
Gadchiroli
Jalna
Hingoli
Thane
Ahmednagar
Parbhani
Mumbai
Mumbai City
Bid
Nanded
Raigad
Pune
Latur
Osmanabad
Satara
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Sangli
Kolhapur
Sindhudurg

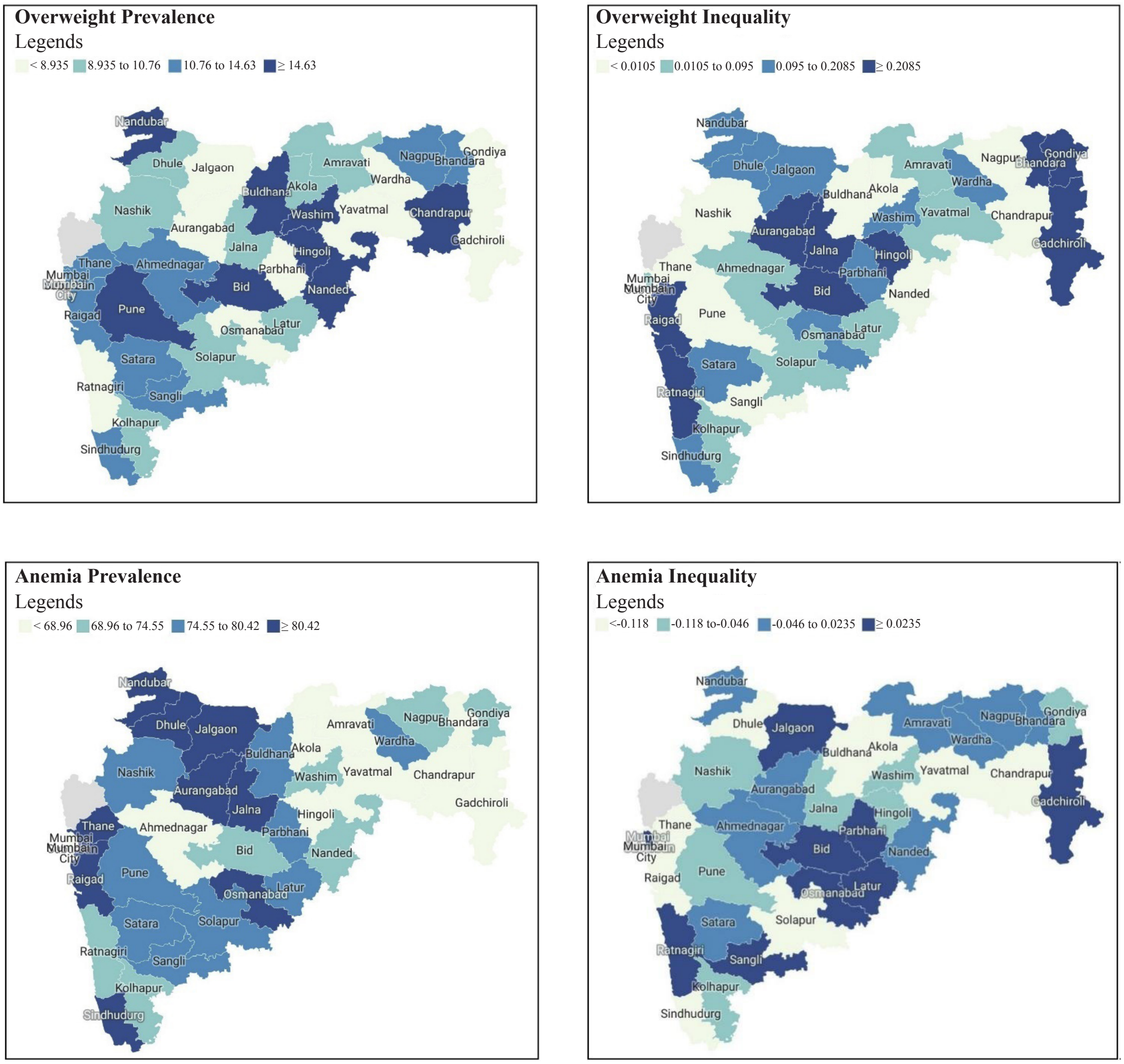


Figure 2. Districts-wide overall burden and inequality in malnutrition indicators among pre-school children in Maharashtra

The high prevalence of more than 40% under-five wasted children is observed in Nandurbar, Thane and Nanded. The prevalence of wasting is more than 33 percent in the bottom ten districts (by per capita income) of Maharashtra. The majority of the districts exhibit distributions disfavoring poor in wasting with few exceptions. The CI value for wasting depicts a wide range across different districts with a minimum of 0.005 in Latur and a maximum of -0.336 in Jalna. Among the other districts, Satara (-0.322), Jalgaon (-0.248) and Hingoli (-0.244) experience greater wealth-related inequalities in under-five wasting as against the districts of Bid (0.007), Mumbai (0.008) and Nagpur (-0.014), which display lower inequality levels.

Table 3. Prevalence of and inequalities in malnutrition indicators among pre-school children by districts in Maharashtra

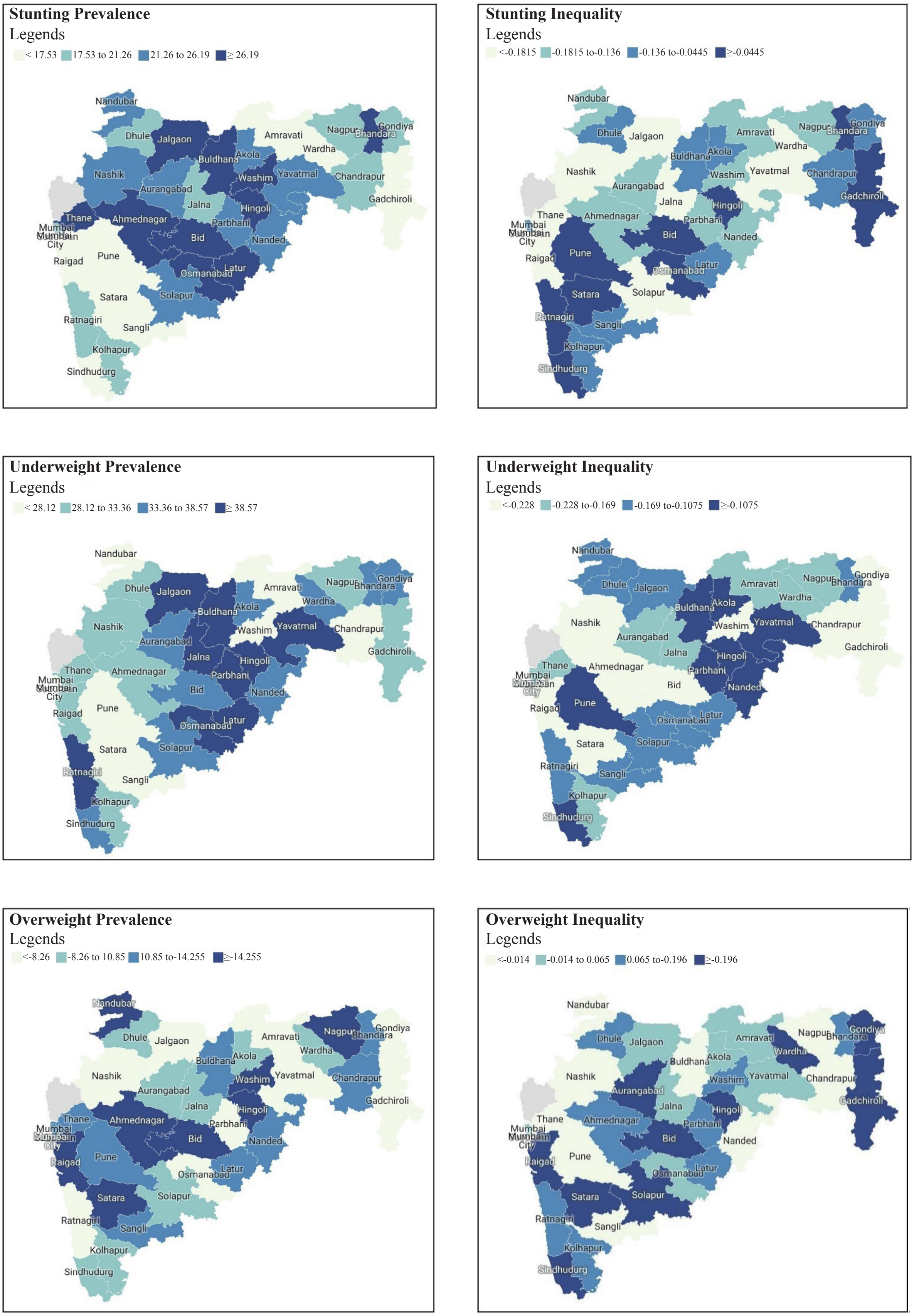
Districts	Stunting		Wasting		Underweight		Overweight		Anemia	
	%	CI	%	CI	%	CI	%	CI	%	CI
Hingoli (4)	28.77	0.024	34.68	-0.244	38.68	-0.151	15.33	0.225	65.01	-0.115
Nandurbar (1)	20.27	-0.227	46.38	-0.048	28.04	-0.244	16.72	0.098	81.65	0.009
Osmanabad (5)	25.44	-0.039	33.64	-0.064	40.7	-0.144	8.81	0.137	85.35	0.038
Bid (10)	34.41	0.096	35.58	0.007	35.00	-0.281	20.88	0.362	72.94	0.071
Buldana (12)	28.86	0.039	34.63	-0.048	36.69	-0.021	14.90	-0.002	79.89	-0.261
Gadchiroli (2)	14.29	-0.034	35.36	0.069	27.71	-0.148	8.87	0.265	59.96	0.126
Nanded (6)	27.03	-0.185	42.16	0.092	34.29	-0.048	15.60	-0.205	71.94	0.023
Jalna (7)	23.26	-0.124	33.24	-0.336	42.54	-0.298	9.20	0.439	84.92	-0.051
Parbhani (11)	23.94	-0.115	37.08	-0.074	45.83	-0.039	8.03	0.095	77.16	0.042
Yavatmal (13)	22.62	-0.336	33.97	-0.069	33.04	-0.175	7.98	0.014	60.77	-0.146
Gondiya (14)	17.60	-0.115	28.50	-0.018	32.40	-0.301	7.30	0.236	73.35	-0.055
Bhandara (16)	32.54	0.004	28.24	-0.189	31.86	-0.269	14.58	0.271	63.07	0.017
Latur (8)	27.99	-0.066	37.16	0.005	37.32	-0.123	9.51	0.020	75.58	0.033
Jalgaon (21)	24.02	-0.148	36.59	-0.248	36.24	-0.195	7.58	0.105	82.54	0.038
Amravati (15)	20.31	-0.113	18.64	-0.101	25.00	-0.169	10.07	0.066	57.69	-0.042
Akola (19)	22.66	-0.089	26.63	-0.025	28.72	-0.109	9.96	-0.057	68.81	-0.179
Dhule (9)	16.81	-0.056	38.82	0.082	27.54	-0.158	9.57	0.172	87.41	-0.125
Ahmadnagar (18)	21.75	-0.17	35.16	0.048	28.50	-0.235	13.83	0.075	65.98	-0.046
Washim (3)	21.02	-0.178	28.37	0.015	23.90	-0.191	15.59	0.095	71.58	-0.100
Wardha (20)	15.86	-0.123	35.34	-0.056	29.40	-0.153	8.70	0.154	74.55	-0.011
Solapur (23)	24.75	-0.134	26.35	-0.148	32.32	-0.135	10.61	0.084	77.69	-0.129
Ratnagiri (24)	18.39	0.027	36.84	-0.127	37.55	-0.153	7.28	0.218	72.31	0.196
Satara (25)	16.41	-0.153	29.93	-0.322	25.08	-0.307	13.93	0.195	76.01	-0.035
Chandrapur (17)	18.20	-0.072	32.88	-0.109	25.64	-0.262	14.68	0.007	61.52	-0.263
Sangli (26)	15.22	-0.007	31.41	-0.018	26.57	-0.101	12.08	-0.107	74.63	0.024
Sindhudurg (28)	20.77	0.101	22.73	-0.048	28.46	-0.063	11.92	0.199	87.69	-0.208
Aurangabad (22)	25.13	-0.163	30.86	-0.146	34.11	-0.196	7.16	0.255	80.95	-0.028
Nashik (27)	21.63	-0.265	33.48	0.038	31.49	-0.339	9.00	-0.039	78.51	-0.054
Kolhapur (30)	18.12	-0.187	29.11	-0.069	30.57	-0.249	10.26	0.016	69.11	-0.066
Nagpur (31)	20.33	-0.235	28.22	-0.014	27.75	-0.228	14.29	-0.028	71.67	-0.032
Raigarh (29)	18.16	-0.154	27.88	-0.201	26.55	-0.326	14.17	0.331	85.07	-0.121
Thane (32)	25.08	-0.254	43.65	-0.209	32.38	-0.25	11.11	-0.148	86.41	-0.129
Pune (33)	16.59	-0.082	26.70	-0.166	19.73	-0.197	14.80	-0.032	76.04	-0.098
Mumbai (34)	17.80	-0.222	26.92	-0.053	18.93	-0.219	16.21	0.006	71.27	0.074
Mumbai Suburban	19.69	-0.212	34.78	-0.066	22.57	-0.231	10.76	0.035	68.35	0.123
Mumbai City	15.92	-0.257	19.05	0.008	15.29	-0.159	21.66	0.078	74.19	-0.094
Maharashtra	20.35	-0.118	33.16	-0.085	28.28	-0.211	11.01	0.103	81.14	-0.069

Source: Estimated using data from DLHS-4 (2012-13).
Notes: Districts are arranged in the ascending order of PNDP 2012-13 at current prices. Relative Human Development ranks of districts in parenthesis.

Table 4. Prevalence of and inequalities in malnutrition indicators among school children by districts in Maharashtra

Districts	Stunting		Underweight		Overweigh		Anemia	
	%	CI	%	CI	%	CI	%	CI
Hingoli (4)	34.40	-0.026	39.97	-0.018	17.41	0.212	65.31	-0.107
Nandurbar (1)	21.81	-0.181	27.66	-0.156	17.93	-0.210	80.03	-0.097
Osmanabad (5)	28.87	0.038	44.67	-0.116	7.83	0.056	84.38	0.063
Bid (10)	33.89	0.044	38.49	-0.323	20.81	0.319	65.53	0.132
Buldana (12)	31.82	-0.055	42.06	-0.107	14.22	-0.019	74.82	-0.269
Gadchiroli (2)	15.44	0.023	29.19	-0.232	7.55	0.393	56.35	-0.133
Nanded (6)	25.30	-0.177	37.86	-0.028	11.83	-0.281	67.11	0.138
Jalna (7)	20.27	-0.215	43.47	-0.201	8.61	0.038	82.65	0.001
Parbhani (11)	25.34	-0.149	52.86	0.003	6.78	0.088	73.04	0.058
Yavatmal (13)	21.26	-0.432	38.65	-0.059	7.39	-0.009	48.41	-0.172
Gondiya (14)	18.08	-0.136	36.67	-0.352	7.22	0.196	73.27	0.071
Bhandara (16)	36.89	-0.024	36.89	-0.143	11.22	0.065	57.03	-0.035
Latur (8)	29.01	-0.059	39.81	-0.169	11.44	0.158	72.61	-0.001
Jalgaon (21)	26.19	-0.182	42.33	-0.108	7.63	0.05	80.15	0.031
Amravati (15)	16.06	-0.171	28.1	-0.194	6.05	0.047	51.31	-0.113
Akola (19)	23.19	-0.067	34.82	-0.072	8.46	0.045	66.57	-0.179
Dhule (9)	19.07	-0.115	31.93	-0.162	9.09	0.129	86.06	-0.13
Ahmadnagar (18)	27.75	-0.176	32.48	-0.281	14.86	0.116	56.41	-0.002
Washim (3)	26.19	-0.154	27.18	-0.246	16.86	0.102	71.51	-0.107
Wardha (20)	16.36	-0.191	33.87	-0.227	10.06	0.213	73.81	-0.044
Solapur (23)	26.07	-0.192	37.42	-0.151	10.21	0.229	76.14	-0.105
Ratnagiri (24)	17.78	0.032	40.18	-0.141	7.89	0.11	70.88	0.237
Satara (25)	15.04	-0.041	21.76	-0.339	14.29	0.412	69.35	-0.008
Chandrapur (17)	21.17	-0.111	26.62	-0.229	13.31	-0.029	59.12	-0.232
Sangli (26)	17.33	-0.048	25.98	-0.121	11.39	-0.123	72.27	0.007
Sindhudurg (28)	14.39	0.041	33.36	-0.105	9.93	0.196	84.71	-0.157
Aurangabad (22)	24.59	-0.177	35.14	-0.218	9.66	0.407	76.66	0.036
Nashik (27)	21.78	-0.215	32.41	-0.358	8.06	-0.069	73.4	-0.138
Kolhapur (30)	17.98	-0.136	29.33	-0.197	9.16	0.085	62.57	-0.168
Nagpur (31)	17.72	-0.156	28.14	-0.184	14.41	-0.081	63.09	0.053
Raigarh (29)	17.42	-0.205	32.45	-0.335	14.89	0.349	86.51	0.023
Thane (32)	31.25	-0.233	33.08	-0.225	13.17	-0.035	83.56	-0.239
Pune (33)	16.38	-0.003	22.02	-0.062	11.53	-0.029	70.98	-0.071
Mumbai (34)	15.51	-0.161	22.25	-0.200	14.55	0.071	64.28	0.027
Mumbai Suburban	17.64	-0.113	24.34	-0.209	10.85	0.059	63.21	0.009
Mumbai City	9.02	-0.304	15.85	-0.097	25.85	0.001	67.56	0.057
Maharashtra	22.72	-0.139	34.72	-0.191	11.17	0.095	71.84	-0.048

Source: Estimated using data from DLHS-4 (2012-13).
Notes: Districts are arranged in the ascending order of Per capita Net Domestic Product 2012-13 at current prices. Relative Human Development ranks of districts in parenthesis.


Stunting Prevalence
Legends
< 17.53 17.53 to 21.26 21.26 to 26.19 ≥ 26.19
Stunting Inequality
Legends
<-0.1815 -0.1815 to-0.136 -0.136 to-0.0445 ≥-0.0445
Underweight Prevalence
Legends
< 28.12 28.12 to 33.36 33.36 to 38.57 ≥ 38.57
Underweight Inequality
Legends
<-0.228 -0.228 to-0.169 -0.169 to-0.1075 ≥-0.1075
Overweight Prevalence
Legends
<-8.26 -8.26 to 10.85 10.85 to-14.255 ≥-14.255
Overweight Inequality
Legends
<-0.014 -0.014 to 0.065 0.065 to-0.196 ≥-0.196

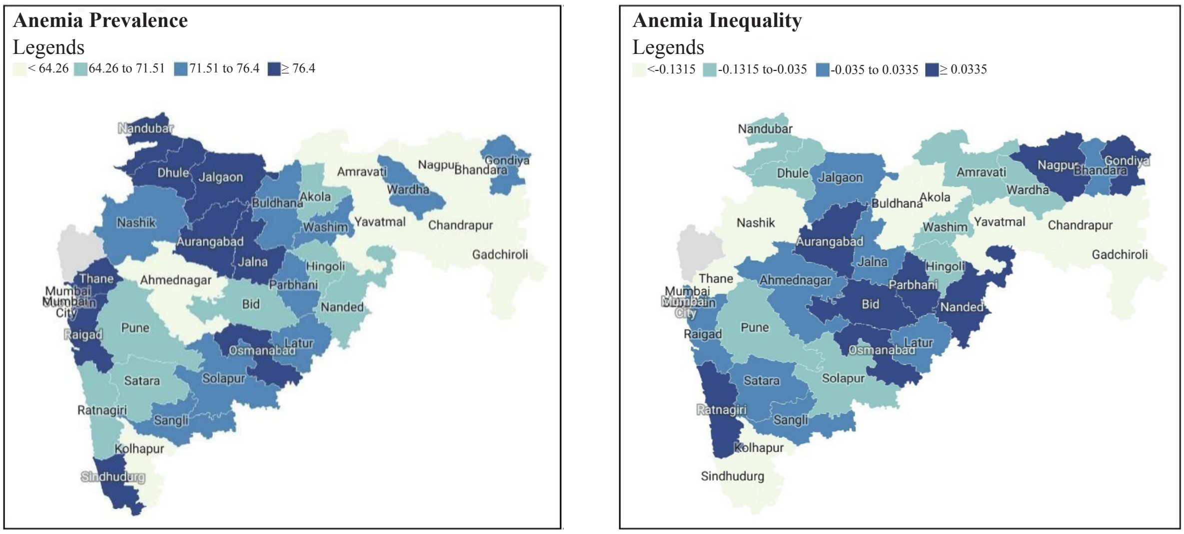


Figure 3. Districts-wide overall burden and inequality in malnutrition indicators among school children in Maharashtra

In terms of the prevalence of underweight, Parbhani (45.83% and 52.86%) performs the worst and Mumbai city (15.29% and 15.85%) delivers the best among the child population. More than 40% of children of both the age groups are underweight in Jalna and Osmanabad. Buldana, Jalgaon and Ratnagiri also have 40% of their school children with low weight-for-age. The regional divide between the least and most prevalent districts are 30 percentage points. Higher underweight prevalence is noticed in the less developed districts comprising the Marathwada region. The underweight outcome is pronounced among the lower sections of all the districts with a -0.201 CI index. Remarkably higher inequalities are observed in districts like Raigarh (-0.326), Satara (-0.307) and Gondiya (-0.301). On the other hand, lower levels of inequalities prevail in the districts of Buldana (-0.021), Parbhani (-0.039) and Nanded (-0.048). For school children, underweight inequality is largest in Nashik, Gondiya and Raigarh, with a CI value of -0.358, -0.352 and -0.335, respectively. Most of the moderately developed and high per capita income districts in the Western, Konkan and Nagpur divisions have a relatively low prevalence of underweight but with substantial inequalities.

Around twenty-two and twenty-six percent of preschool and school children respectively are overweight in Mumbai (city) district, which is the highest in the state. The problem of overweight and obesity is not only restricted to high-income districts like Mumbai, Pune, and Raigarh but also reported in low-income districts like Bid, Nandurbar and Nanded. The majority of the districts follow the general pattern of obese children being from affluent households. Overweight inequality levels are exceptionally high in Jalna (0.439), Satara (0.412) and Aurangabad (0.407).

Buldana, Chandrapur and Latur districts endured the lowest inequality in the overweight. Anemia is widely spread across the different income segments of the population in Maharashtra. More than three-fourths of children are anemic in districts like Sindhudurg, Dhule and Raigarh. When we look at the distribution, anemia is clustered around the deprived segments of society in most districts. The top three districts with the highest wealth inequality in anemia are Chandrapur (-0.263), Buldana (-0.261) and Sindhudurg (-0.208). Nevertheless, inequalities are comparatively less than all the indicators analyzed here due to the ubiquitous nature of the disease.

The prevalence of stunting, wasting, underweight, overweight, and anemia is highly variable across districts of Maharashtra. The nutritional situation in West Maharashtra (except Thane) is slightly better than in the other regions. The worst nutritional outcomes are mostly concentrated in the Aurangabad division. Nanded, Nandurbar, Hingoli, Bid, Parbhani, Jalna and Thane are ranked among the districts with an overall high prevalence of anthropometric failures. Yavatmal, Thane, Raigarh, Nashik, Mumbai suburban are the poor performing districts in terms of wealth inequality. The regional imbalances in the prevalence and inequality across districts can be viewed in the context of the state's varied socio-economic and demographic profile. There are marked inter-district variations in many of the human development parameters. Some districts in western Maharashtra and a few from the Konkan division are progressive, with HDI values higher than the state average. The remaining districts in the eastern and central parts of Maharashtra are doing worse than the state average with lower HDI values. In Maharashtra, about 19 percent of the population belongs to the scheduled castes and scheduled tribes. The majority of the tribal populace in the state is spread over the districts of Thane, Pune, Nashik, Nandurbar, Dhule, Jalgaon, Ahmednagar, Nanded, Amravati, Yavatmal, Gadchiroli and Chandrapur. Since tribal districts are deprived of necessary medical and infrastructure facilities, making them the worst performers on child nutrition indicators. The inter-district and inter-regional variations in malnutrition and its distribution cannot be dismissed among the state's relative prosperity. In the next section, we resort to the correlation matrix to explore another dimension of nutritional outcomes vis-à-vis macro-economic level variables.

4.3 *Correlation analysis*

Table 5 reveals more evidence of the association between malnutrition prevalence and malnutrition inequality measured by concentration index and select human development indicators.

Table 5. Correlation results of malnutrition indicators and its inequalities with select human development indicators

Variable	Stunting	Wasting	Underweight	Overweight	Anemia
Percapita NDDP[a]	-0.345**	-0.207	-0.541***	0.071	0.173
Male Literacy Rate[b]	-0.109	-0.649***	-0.263	-0.111	-0.165
Female Literacy Rate[b]	-0.279	-0.584***	-0.511***	-0.081	-0.153
HDI[c]	-0.257	-0.388**	-0.431**	-0.013	0.089
Variable	Stunting CI	Wasting CI	Underweight CI	Overweight CI	Anemia CI
Percapita NDDP[a]	-0.066	-0.358**	-0.044	-0.514***	-0.288*
Male Literacy Rate[b]	0.102	-0.239	0.034	-0.219	-0.298*
Female Literacy Rate[b]	0.027	-0.214	0.065	-0.435**	-0.352**
HDI[c]	-0.013	-0.404**	-0.057	-0.449***	-0.305*
Incidence	0.167	0.175	0.108	-0.095	-0.071

Significant at *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
NDDP-Net District Domestic Product 2012-13 at current prices in Rupees.
a: Economic survey of India, 2014-15.
b: Directorate of Census Operations Maharashtra, 2011.
c: Maharashtra State Human Development Report, 2012.

Stunting, wasting and underweight prevalence are negatively correlated with per capita Net District Domestic Product with correlation coefficients -0.345, -0.207 and -0.541, respectively. The association is opposite in the case of overweight and anemia, with correlation coefficients standing at 0.071 and 0.173. Overall, the underweight outcome has the highest negative correlation with per capita income. Estimates of HDIs and the prevalence of malnutrition indicators across districts showcase a negative association. Barring anemia, the rank correlation between malnutrition prevalence and HDIs are negative and significant in all the selected child health indicators. There is a significant negative correlation between inequality in wasting, overweight and anemia with district per capita income and HDI. Stunting and wasting CIs are also negatively correlated but statistically insignificant. The literacy rate is the sole variable analysed, showing a negative relationship across all the child health indicators. Both male and female literacy rates follow this trend. Wasting correlation coefficients are highest, with values at -0.644 and -0.571 for male and female literacy rates, respectively. This indicates that districts with higher female literacy rates are likely to have lower undernourished populations. The relations between educational variables and the child health indicators are inconsistent across indicators. Negative significant correlations are observed only for anemia CI and literacy rates. Overall, most human development indicators share an inverse association with the prevalence of malnutrition. Results propose that HDI and its related components can alter the prevalence of malnutrition and its unequal distribution. This exercise underscores the role of human development factors in alleviating the malnutrition situation.

5. Discussion

The current paper brings forth the gravity of malnutrition and micronutrient deficiencies in Maharashtra. This paper finds that anemia is the most prevalent malnutrition outcome in Maharashtra, followed by underweight, wasting, stunting, and overweight. In the comparison of inequalities across various indicators of malnutrition, inequalities are more pronounced in the case of underweight and stunting, followed by wasting and overweight and the least inequality for anemia. This study observes that malnutrition levels are high among school going children, just as in children below six years. The wealth inequalities in child malnutrition do not vary significantly between age groups. The results imply that it is necessary to include broader age groups in the nutrition monitoring frameworks. School feeding programs should improve in parallel to household feeding practices to meet the nutritional requirements of children up to 14 years of age and beyond. Hence, there is a need for a renewed commitment from governments and civil society to prioritize efforts on older children. It appears that at the state level, there are no gender disparities in terms of malnutrition outcomes. In fact, male children are at minor disadvantages to being malnourished. The higher prevalence of overweight and obesity among boys in this study might be due to the unhealthy eating practices of boys. Mukhopadhyay (2016) argues that the apparent non-significance of sex in the determination of the nutritional status of children might probably be due to the differential way in which gender bias operates in different social settings.

The distributive aspects of malnutrition indicate that the magnitude of wealth-based inequality concerning child malnutrition is higher and manifests primarily among weaker sections of society. Similar findings are reported in Joe et al. (2008), Pathak and Singh (2011), Kumar and Paswan (2021). Due to the high overall prevalence and relatively low wealth inequality, Liou et al. (2020) suggest the need for universal interventions to reduce anemia among the child population. Individuals from wealthy households disproportionately bear the odds of suffering from overweight and obesity. Our findings are also consistent with a study by Kelishadi et al. (2018). The higher prevalence of excess weight (overweight and obesity) in affluent families might be due to changing dietary habits, higher consumption of energy-dense foods, and sedentary lifestyles. The analysis indicates that children living in urban areas have a higher prevalence of overweight and obesity than rural subjects. The present findings align with some other studies that showed a higher risk of obesity in rural children than urban children (Zhang et al., 2016; Pathak et al., 2018). With India still fighting undernourishment, the emerging menace of childhood obesity serves as a double-edged sword. Since most public health programs are designed to mitigate undernutrition, priority should also be given in nutrition awareness action plans to attend to excessive weight problems early in life before they become life-threatening.

Huge rural-urban disparities in nutritional outcomes are also a very critical issue for Maharashtra to address. Across sectors, malnutrition has a vast rural presence in contrast to the urban region. The geographical spread of the economic growth of Maharashtra is highly skewed across rural-urban sectors and at the district level. Most public and private hospitals, nursing homes, and health personnel are concentrated in cities and towns. People living in remote villages face challenges reaching the health care facilities located in urban areas. Nonetheless, economic differentials in malnutrition are consistently higher among urban children. Maharashtra is the most highly industrialized and urbanized state in the country. The lion's share of the urban population lives in slum settlements in poor housing facilities and less hygienic sanitary conditions. On top of it, an influx of migrants into the substandard livelihood situation adds to the cities' woes, endangering children's proper growth. These findings imply the vulnerability of the urban poor and make a strong case for policies aimed at urban people. Nutrition strategies should consider the urban and equity dimensions in malnutrition. For instance, the Brazilian government has been successful in bringing down child malnutrition as well as reducing the poor-rich gap in the nutrition status of their children (Monteiro et al., 2010).

The present study confirms the simultaneous occurrence of under-and overnutrition in many districts of Maharashtra. The analysis also reveals a similar spatial pattern in the overall burden and inequalities in malnutrition outcomes between preschool and school children. Many districts of Maharashtra perform poorly on both accounts of the prevalence and inequalities in chronic malnutrition. The nutrionally backward areas are concerted in the tribal districts of the Marathwada division and a few from Vidarbha and Amaravati. Inequalities are reported to be lower in these districts. Ghosh and Varerkar (2019) identified the poverty-stricken background of the tribal population as the leading cause of undernutrition. Loss of dependence on biodiversity for livelihood, exclusion from the public distribution system, a shortage of nutrition entitlements aggravate the nutritional crisis among the tribal children. The sizeable tribal population spread across the state face various adversities in accessing healthcare facilities. The nutrition-specific interventions for pregnant and lactating mothers and home-based management of the severely malnourished are implemented in the tribal regions of the state. Aside from improving the livelihood condition of the tribal population, the state needs to strengthen all the existing programs like APJ Abdul Kalam Amrut Aahar Yojana and Village Child Development Centres (VCDCs). Maharashtra should also improve the quality and coverage of the Integrated Child Development Scheme (ICDS) and Public Distribution System (PDS). They can potentially bridge the gaps in nutrition outcomes and health among children, particularly in challenging terrains. At the other end of the scale are relatively well-off districts with higher inequalities, mainly from the Western and Konkan divisions. Many districts in Maharashtra have multiple burdens of undernourishment and have high inequalities on more than one indicator of malnutrition, while several others have low levels of inequalities in child health. We have seen that several districts have relatively higher inequality levels even at low levels of average malnutrition. This suggests that the decline in the average malnutrition rate does not necessarily lead to diminishing inequalities. We need to have policies to address both the prevalence and inequality issues separately.

Many of the governments' initiatives to tackle malnutrition are crippled by problems like lack of coordination, an insufficient workforce, scarce financial resources, fragmented efforts. However, the more recent attempt by the government, 'Transformation of Aspirational Districts Programme' with its real-time collection of socio-human data of 101 districts, is promising in its vision to measure the progress of underdeveloped regions of the country. Maharashtra is the first state in the country to launch a specific program to eradicate malnutrition by implementing Rajmata Jijau Mother-Child Health and Nutrition Mission (RJMCHNM) in 2005. The mission, fully funded by the UNICEF (United Nations International Children Education Funds), focuses on the first thousand days from conception has been successful in reducing undernutrition. However, the decline is primarily constricted to stunting among children below two to three years old, not wasting and underweight (Jose & Hari, 2015). Hence, the health schemes must be targeted better, and service coverage should be expanded in the long run to bridge the health inequality gap.

In summary, the malnutrition status of Maharashtra does not correspond with its superior economic ranking in the country. Therefore, the government should increase the budgetary allocations for the health sector from its current level of a mere 0.46% of the State Domestic Product (SDP). Besides, different districts of India require different policy approaches according to the nature of the disease burden and risk factors each district is facing. Since considerable inequalities are observed in many districts of Maharashtra, future programs should be formulated, considering the marginalized and excluded segments of society. Moreover, India has one of the youngest and largest working age population. To capitalize fully on this demographic dividend country needs to invest in the capabilities of its young citizens. Persistent child health inequalities are a formidable challenge to recently proposed Nutrition Free India. Equity-oriented policies and programs need to be executed to erase the nutritional deficit and overweight, starting at an early age, keeping in mind the goal of "Malnutrition Free India-2030".

6. Limitations of the study

There exist some limitations to this study. First, demographic Health Surveys do not collect household income or expenditure information traditionally used to measure wealth. Second, the asset-based wealth index, a primary variable in this analysis, is only a proxy indicator for household economic status and does not always produce accurate results. Third, cross-sectional studies are limited by their inability to make confident causal inferences. Finally, there may be variations within districts that need further investigations.

7. Ethical approval

This article does not contain any studies with human participants performed by any of the authors. The data used in this research is from an anonymous publicly available large-scale health data collected following all ethical procedures and approved by the Ministry of Health and Family Welfare, Government of India. Before data collection, formal written consent was obtained from all individual participants included in the study.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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APPENDIX

Table A1. Wealth Index in ascending order of the rank across districts in Maharashtra

Districts	Wealth Index
Parbhani	-0.338
Osmanabad	-0.317
Dhule	-0.268
Nanded	-0.266
Nandurbar	-0.261
Jalgaon	-0.238
Hingoli	-0.231
Ahmadnagar	-0.229
Jalna	-0.216
Gadchiroli	-0.216
Buldana	-0.212
Yavatmal	-0.205
Bid	-0.199
Latur	-0.191
Amrawati	-0.153
Chandrapur	-0.152
Gondiya	-0.142
Aurangabad	-0.137
Washim	-0.126
Akola	-0.086
Bhandara	-0.055
Nashik	-0.049
Wardha	-0.045
Solapur	-0.041
Sangli	-0.011
Thane	0.041
Kolhapur	0.067
Ratnagiri	0.108
Satara	0.163
Sindhudurg	0.186
Nagpur	0.206
Raigarh	0.235
Mumbai (Suburban)	0.384
Pune	0.508
Mumbai	0.538

Source: Estimated using DLHS-4

Table A2. Test of significant difference in concentration index between groups

Indicator	Population	Groups	Difference	Result
Underweight	National	Region	-0.056***	Higher inequality in urban region
	Pre-school children	Region	-0.061**	Higher inequality in urban region
	School Children	Region	-0.061**	Higher inequality in urban region
	Girls	Region	-0.095***	Higher inequality in urban region
Thinness	National	Regions	-0.053*	Higher inequality in urban region
	Rural	Gender	-0.067*	Inequality higher among boys
	Rural	Age-groups	0.112***	Inequality higher among pre-school kids
	School Children	Region	-0.106***	Higher inequality in urban region
Overweight	Rural	Age-groups	-0.090**	Inequality higher among pre-school kids
	School Children	Region	0.089**	Higher inequality in the urban area
Obesity	School Children	Region	0.107**	Higher inequality in the urban area
	Boys	Age-groups	0.108**	Higher inequality among school children
Anemia	Rural	Gender	0.049*	Higher inequality among girls
	Rural	Age-groups	0.063**	Higher inequality among pre-school kids
	Urban	Age-groups	0.043**	Higher inequality among pre-school kids
Anemia (Severe)	Pre-school Children	Gender	-0.060*	Higher inequality among girls
	School Children	Gender	0.058*	Higher inequality among girls
	Boys	Age-groups	0.072**	Higher inequality among pre-school kids

Authors' computation, Significant at *** p < 0.01, ** p < 0.05, * p < 0.1