Agricultural Economics Research Review
Vol. 30 (No.2) July-December 2017 pp 187-199
DOI: 10.5958/0974-0279.2017.00041.6

Inter-temporal and Spatial Changes in Nutritional Insecurity in India

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Abstract

Using household-level data from consumer expenditure surveys, this paper examines the dynamics of nutritional insecurity, for both rural and urban populations at all-India level and across states. In 1993-94, about 61 per cent of the rural and 54 per cent of the urban population was calorie deficient. In 2011-12, the prevalence of calorie deficient rural population increased by 5.2 percentage points, and urban population by about 1.5 percentage points. Across income classes, we observe incidence of calorie deficiency declining with an increase in income, but it also exists even among the rich households. Comparatively, the prevalence of protein deficiency is less severe. The spatial patterns of nutritional insecurity show a higher prevalence of calorie deficiency in states with lower incidence of poverty. Further, we find little, if any, evidence of a change in regional patterns of inequality in nutritional insecurity in the past two decades.

Key words: Nutritional insecurity; calorie; protein; FGT; rural, urban, India

JEL Classification: C31, C43, O12, O13, I30

Introduction

Even after four decades of the first World Food Conference in 1974, food and nutritional security continues to be one of the most tenacious problems across the world. Asia still has the largest number of undernourished people despite a modest progress in the reduction of its nutritional outcomes. However, this decline is not region-wide and remains uneven across countries. For instance, India with 191 million undernourished people (14.5 per cent of its total population) accounts for 37 per cent of the total undernourished population in Asia (SOFI, 2017). India's progress in improving nutritional security, despite rapid economic growth, has been dismal – almost two-thirds of Indians have been estimated to be calorie deprived (Chand and Jumrani, 2013).

Several studies have examined the determinants and impacts of food and nutritional insecurity on household welfare. Foodgrain deficiency and its determinants in India have been examined at national and sub-national levels (Bhattacharya *et al*., 2016). Using the Foster-Greer-Thorbecke (FGT) measures, Mishra and Mishra (2009) have measured undernourishment among Indian children using anthropometric outcomes. Foster *et al*. (2010) have undertaken a detailed review on the use and contribution of FGT measures across domains. However, a dimension that has not received much attention in empirical research is the one relating to the depth and severity of nutritional insecurity.

Now, there has been a renewed global commitment to achieve food security, end hunger and improve nutrition through promotion of efficient and sustainable agriculture by 2030 (https://sustainabledevelopment.un.org/sdg2). However, the attainment of these global goals is sensitive to the situation in India given its large population share and dependence on a few staple crops, which are highly sensitive to price fluctuations (Tandon and Landes, 2011).

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With this background, this paper examines the inter-temporal and spatial changes in the status of nutritional insecurity in India. The scale of nutritional insecurity is also evaluated both at the national and sub-national levels. The paper is organised as follows. Section 2 briefly discusses the data and methodology. Section 3 presents the results and discussion, and Section 4 concludes and suggests a few avenues for reducing the problem of nutritional insecurity.

Data and methodology

The calorie and protein deficiencies have been estimated using the unit-level data from 50th and 68th rounds of consumer expenditure surveys (CES) conducted in 1993-94 and 2011-12 covering 115354 and 101662 households, respectively by the National Sample Survey Office (GoI, 1996; GoI, 2014). In our analysis, the outliers i.e., 5-6% of the overall observations, have been excluded.

Nutrient intake of an individual has been computed using the quantity of each food item consumed and conversion factors from the nutrient charts. The nutrient intake by a household, so derived, may not be a true representative of the intake level, due to the expected concentration of donors (recipients) of free meals in upper (lower) expenditure range. This has been corrected for using the standard meal adjustment procedure (GoI, 2014).

In the 50th round, the monthly per capita expenditure (MPCE) used for the analysis is based on the uniform reference period (URP) wherein expenditure on all the items has been collected for the last 30 days prior to the date of surveying a household. However, for the 68th round, we have utilised the mixed reference period (MRP) wherein expenditure on items such as clothing and bedding, footwear, education and institutional medical care has been recorded for the last 365 days, and on all other items for the last 30 days. The entire sample has been divided into two subsets: poor and non-poor following the Tendulkar Committee's state-specific poverty lines as provided by the erstwhile Planning Commission. The above poverty line (APL) population has further been categorised into middle-income and high-income groups. This categorisation is based on MPCE decile classes, with the top two decile classes constituting the high-income group and the rest comprising the middle-income group.

The prevalence of undernutrition (PoU) has been estimated as:

$$\text{PoU}=\frac{1}{\text{N}}\sum_{h=1}^{n} I_h w_h$$

where, the indicator variable, I_h = 1 if $C_h < Z$, zero otherwise; h indexes households, C_h is per capita intake in the hth household, Z is pre-specified norm, n is number of sampled households, and $N=\Sigma_{h=1}^{n} w_h$ is estimated population with w_h as the sampling weight. In case of unit-level household data, w_h is the product of household-level multiplier and household size.

The calorie and protein deficiencies have been estimated on the basis of the recommended dietary allowances (RDAs) as provided by the Indian Council of Medical Research-National Institute of Nutrition (ICMR-NIN). The age and sex-adjusted norms for 1993-94 are constructed using the norms prescribed in the *Nutrient Requirements and Recommended Dietary Allowances for Indians* (ICMR, 1989). These norms were revised in 2010 (ICMR, 2010) and thus we use the revised norms for 2011-12. The revised norms, are on an average, on the lower side for a majority of the age-sex-activity status groups. To capture the demographic differentials across individuals, an alternative approach (Meenakshi and Viswanathan, 2006; Chand and Jumrani, 2013) has been used. In this approach, the demographic information provided in the surveys has been utilised. The household-specific norms (Z_h), instead of a pre-specified norm, have been computed first, and then the household level intakes (C_h) rather than the per capita intakes are compared with this norm. The sampling weight used here helps us in estimating the proportion of population living in households with insufficient nutrient intakes.

Nonetheless, this approach has a few caveats. The estimated thresholds serve as reasonable benchmarks but are not precise to capture individual needs, given the absence of nationally representative individual-level data. This approach cannot control for the intra-household inequalities in food consumption and it does not reflect the complete picture as individuals have diverse adaptation mechanisms. For simplification, we assume the recommended intakes for moderate activity for rural people, and ones relating to sedentary activity for urban people. This approach also does not capture the intra-household consumption distribution of individuals. Yet, it is undoubtedly a better approach compared to the uniform norm cut-off approach. It enables us to evaluate the sensitivity of the results to the changes in demographic and activity patterns of the population.

We also adopt an equity-focused approach to measuring nutritional insecurity. The scale of nutritional insecurity across economic classes is evaluated at sub-national levels. For this, FGT measures of poverty (Foster *et al.*, 1984) have been modified to estimate the nutritional insecurity levels. The FGT measure for a given population is:

$$FGT_{\alpha} = \frac{1}{N}\sum_{i=1}^{q}\left(\frac{z-y_i}{z}\right)^{\alpha}$$

where, α is a measure of sensitivity of the index to poverty, and $\alpha \geq 0$, N is the sample size, y_i is the variable of interest, and z is the poverty line. In our case, y_i is household i's nutrient intake and z is its estimated nutrient requirement. We estimate headcount index of nutritional deficiency (N0), nutritional deficiency gap index (N1) and squared nutritional deficiency gap index (N2) corresponding to α being equal to 0, 1 and 2, respectively. The headcount index, despite being easy to construct and simple to understand, is unable to capture the extent to which nutrient intakes fall below their desired norms. It does not provide the extent of deficiency among the people, and does not change even if the people consuming less than the required norms become worse off.

The prevalence of calorie and protein deficiencies simply represent the headcount index (N0), which assumes that the entire consumption is uniformly shared within the household. This weakness is overcome by the nutritional deficiency gap index (N1), which is the mean proportionate deficiency gap in the population. It can be considered as the cost of eliminating nutritional deficiency (relative to the required nutrient norms). However, it works on the assumption that there is perfect targeting, which is highly unlikely. The squared nutritional deficiency gap index (N2) captures the inequality amongst the deficient population by assigning larger weights to those observations that fall below the required norms. It is the most-widely used distribution-sensitive measure, but lacks intuitive appeal and thus used sparingly. The N1 and N2 measures provide complementary information on the incidence of nutritional insecurity, and it is therefore important that all these measures are used in tandem. Their synchronous application might assist the policymakers in designing appropriate and targeted interventions for various socio-economic classes.

The rationale for employing FGT measures to nutritional security is rooted in the biomedical literature that states that as nutritional shortfall increases, physiological risk increases at an increasing rate (Scrimshaw *et al.,* 1968; Pelletier *et al.,* 1994; Black *et al.,* 2008). Also, these measures have the advantage that these can be decomposed. In our case, we restrict our analysis to income (or expenditure) dimension but it can be extended to include social classes, gender, and other such parameters. Further, we also assess whether the rankings of states on different nutritional insecurity parameters have changed during the study period. For this, we estimate the Spearman's rank correlation coefficient (r_s) that summarises the strength and direction of the association between two variables. The closer the r_s is to zero, the weaker is the association.

Results and discussion

Nutritional status

We evaluate changes in the nutritional status, both at national and sub-national levels, by (i) comparing the per capita intakes of calorie and protein against their respective RDAs and, (ii) estimating the ratio of population that consumes lower than the RDAs. The first indicator reflects adequacy of a nutrient, while the second measures its deficiency. The summary statistics on the per capita daily nutrient intakes and their RDAs based on ICMR-NIN norms adjusted for age (A), sex (S) and activity status (AS) of the household members is provided in Table 1. The mean per capita per day dietary requirement for a typical rural household was 2217 Kcal against an intake of 2132 Kcal in 1993-94. The same increased to 2235 Kcal and 2077 Kcal, respectively in 2011-12. As expected, both the norms as well as intakes were lower for urban areas.

In both rural as well as urban populations, calorie deficit is present only amongst the poor households. In general, the rural population faces a larger calorie deficit than does the urban population. In 2011-12, the calorie deficit prevailed across all income classes, except for the high-income class. Between 1993-94 and 2011-12, the actual average calorie intakes reduced across locations as well as income categories. The middle-income households turned calorie deficient in 2011-12 from being calorie surplus in 1993-94. The urban households also experienced a similar transformation. Protein intakes portray a different picture than calorie adequacy. Except among the urban poor, all other classes exhibit protein intakes that are more than the required minimum intakes. And, just like calorie intakes, there are significant variations in protein intakes.

The nutritional status is better revealed in the prevalence rates of calorie and protein deficiencies. These provide estimates of the people living in households consuming less than their threshold levels. These prevalence rates are adjusted for A, S, AS[1] and are presented in Table 1. In 1993-94, about 61 per cent of the rural and 53.5 per cent of the urban population was calorie deficient. In 2011-12, for rural population the incidence of calorie deficiency increased by 5.2 percentage points and for urban population by 1.5 percentage points. Nonetheless, as expected, the prevalence of calorie deficiency seems to decline with an increase in household income. This relationship was starker in 1993-94 — 78.65 per cent of the rural and 77.8 urban poor consumed below their respective desired minimum level of calorie intakes. The corresponding figures for 2011-12 are 84.67 per cent and 82.37 per cent, respectively. A similar pattern of an increase in the prevalence rates of protein deficiency was also observed.

A sizable proportion of households in the middle-income class experience calorie deficiency. Calorie deficiency is also observed even among the rich households despite the fact that they have the incomes required to purchase the stipulated food consumption basket but do not consume either by choice or due to non-economic factors. Further, there has been a consistent increase in such deficiency across rural as well as urban populations. Protein deficiency is less severe than calorie deficiency (Table 1). Protein deficiency is more in urban population across all income classes, but has grown at a faster pace amongst the rich households.

Decline in calorie intakes despite rising incomes is a puzzle. And, alternative plausible explanations have been provided for this in the literature. Deaton and Drèze (2009) and Eli and Li (2013) attribute this to decreasing physical activity levels among the population and increasing mechanisation of economic activities. On the other hand, Gaiha *et al*. (2013), Patnaik (2013) and Basole and Basu (2015) consider relatively faster rise in food prices and the associated food budget squeeze responsible for such a phenomenon. Smith (2015) highlights the incompleteness of data on food consumed away from home, which is widespread and increasing, as a key argument explaining the decline. Recently, few studies (e.g., Duh and Spears, 2017; Siddiqui *et al*., 2017) have also associated calorie intakes with disease environments. Siddiqui *et al*. (2017) find that those living in healthier environments have lower calorie intakes as compared to those living in not so healthy environments. Prevalence of high levels of calorie deficiency among the non-poor households implies that the problem cannot be addressed through income measures alone, and requires identification of socio-cultural and biomedical factors responsible for this.

Spatial patterns in nutritional insecurity

Table 2 contains information on the adequacy of calorie and protein in Indian diets for the 17 major states[2]. In 1993-94, rural populations of Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Rajasthan and Uttar Pradesh had calorie intakes that were more than their respective norms. In 2011-12, such a situation prevailed only in Himachal Pradesh, Jammu & Kashmir and Rajasthan. In urban areas, barring about 4-6 states, all the states had calorie intakes higher than their respective specified norms in both the periods.

[1] As an academic exercise, calorie and protein deficiencies in 1993-94 were also computed using 2010 norms. Similarly, the prevalence of calorie and protein deficiencies in 2011-12 were computed using 1993-94 norms. The results are available on request.

[2] Andhra Pradesh (AP), Assam (Asm), Bihar (Bih), Gujarat (Guj), Haryana (Har), Himachal Pradesh (HP), Jammu & Kashmir (J&K), Karnataka (Kar), Kerala (Ker), Maharashtra (Mah), Madhya Pradesh (MP), Odisha (Odi), Punjab (Pun), Rajasthan (Raj), Tamil Nadu (TN), Uttar Pradesh (UP) and West Bengal (WB).

Table 1. Demographically and activity-wise adjusted norms and actual intakes, and prevalence of calorie and protein deficiencies across various income groups

	1993-94						2011-12					
	ICMR-NIN norm		Actual intake		Calorie deficiency (%)	Protein deficiency (%)	ICMR-NIN norm		Actual intake		Calorie deficiency (%)	Protein deficiency (%)
	Calorie/ person/ day (Kcal)	Protein/ person/ day (grams)	Calorie/ person/ day (Kcal)	Protein/ person/ day (grams)			Calorie/ person/ day (Kcal)	Protein/ person/ day (grams)	Calorie/ person/ day (Kcal)	Protein/ person/ day (grams)		
Rural												
Poor	2170	48.63	1845	51.22	78.65	45.97	2144	46.06	1743	45.90	84.67	51.44
Middle income	2265	51.29	2413	67.22	41.68	20.10	2249	49.15	2127	57.10	63.03	29.9
High income	2322	52.76	2841	79.71	21.63	9.71	2338	52.02	2452	67.12	45.33	17.47
All rural	2217	49.92	2132	59.31	60.67	33.75	2235	48.78	2077	55.71	65.93	33.58
Urban												
Poor	1984	49.45	1711	47.68	77.8	57.96	1976	47.41	1645	44.40	82.37	61.07
Middle income	2051	51.99	2164	59.73	43.56	33.36	2030	50.22	1996	53.93	55.71	41.17
High income	2102	53.38	2608	71.50	17.58	14.27	2087	53.11	2354	63.76	28.2	21.8
All urban	2031	51.18	2044	56.55	53.55	40.46	2031	50.30	2005	54.18	55	40.83
Rural + Urban	2171	50.23	2110	58.63	58.90	35.41	2177	49.22	2056	55.27	62.81	35.65

Note: ICMR-NIN norms are adjusted for age, sex and activity. *Source:* Author's own estimation using unit-level NSSO 1993-94 and 2011-12 CES data.

Table 2. Demographically and activity-wise adjusted norms, actual intakes and prevalence of calorie & protein deficiencies across major Indian states

	1993-94						2011-12						Poverty headcount ratio (%)	
	ICMR-NIN norm Calorie/person/day (Kcal)	Actual intake	Calorie deficiency (%)	ICMR-NIN norm Protein/person/day (grams)	Actual intake	Protein deficiency (%)	ICMR-NIN norm Calorie/person/day (Kcal)	Actual intake	Calorie deficiency (%)	ICMR-NIN norm Protein/person/day (grams)	Actual intake	Protein deficiency (%)	HCR (1993-94)	HCR (2011-12)
							Rural							
AP	2240	2056	69.11	50.38	51.01	53.01	2292	2167	63.92	50.84	53.07	46.91	51.68	10.96
Asm	2262	1990	77.57	51.31	49.71	58.78	2278	1991	78.01	49.69	48.85	56.71	62.21	33.89
Bih	2197	2103	61.33	49.16	59.87	26.19	2183	2037	63.48	46.90	56.70	22.72	68.08	34.36
Guj	2241	1984	72.37	50.62	55.34	41.45	2259	1905	80.42	49.53	50.72	49.93	52.42	21.54
Har	2182	2376	42.71	49.34	73.88	10.54	2277	2210	61.55	49.85	65.17	13.15	45.06	11.64
HP	2224	2284	50.91	50.76	69.01	11.97	2278	2446	37.22	50.36	69.33	4.35	43.99	8.48
J&K	2185	2488	28.25	49.71	74.77	5.04	2269	2313	51.09	49.75	62.23	15.97	37.08	11.54
Kar	2235	2081	65.54	50.51	55.49	43.00	2281	1969	76.57	50.45	49.57	57.14	62.05	24.53
Ker	2289	1946	75.72	52.08	50.13	59.04	2252	1932	76.91	50.09	52.80	47.99	38.51	9.19
Mah	2225	1914	76.74	50.09	54.04	42.87	2273	2086	69.68	50.10	55.60	33.75	64.47	24.22
MP	2208	2144	59.84	49.46	61.73	27.64	2220	2092	63.44	48.07	60.83	20.27	57.86	35.74
Odi	2236	2182	56.86	50.40	52.61	46.43	2276	2112	66.52	50.22	49.88	54.31	65.62	35.69
Pun	2239	2348	47.51	50.87	71.41	13.04	2279	2261	55.36	50.22	64.19	13.92	27.87	7.66
Raj	2182	2437	37.41	49.05	76.87	4.81	2219	2238	52.07	48.02	66.98	7.45	47.27	16.05
TN	2267	1883	79.63	51.20	46.71	66.49	2289	1898	81.58	50.97	48.09	61.01	55.92	15.83
UP	2174	2271	47.22	48.88	69.04	11.12	2173	2093	60.32	46.72	59.23	15.79	54.21	30.40
WB	2218	2191	57.12	49.94	54.58	41.36	2260	2071	70.02	49.67	51.18	47.77	47.66	22.52
India	2217	2132	60.67	49.92	59.31	33.75	2235	2077	65.93	48.78	55.71	33.58	55.28	25.38
							Urban							
AP	2023	2005	56.78	50.87	49.86	58.85	2049	2146	45.48	50.58	52.84	46.04	40.03	5.81
Asm	2070	2071	54.99	52.78	52.50	56.82	1744	1990	57.94	50.75	50.32	54.61	34.40	20.58
Bih	2027	2162	41.79	50.70	60.91	26.70	1975	2039	48.13	48.70	57.78	22.18	45.78	31.23
Guj	2033	1998	55.21	51.43	54.54	45.44	1833	1963	51.99	51.14	53.66	47.03	34.48	10.22
Har	2019	2142	45.53	50.62	63.57	24.97	1881	2173	43.67	49.75	59.14	20.09	28.22	10.28
HP	2055	2335	28.14	52.15	68.27	10.59	1633	2439	27.25	49.56	67.43	8.90	21.02	4.33
J&K	2024	2337	29.18	50.95	67.56	12.75	1883	2306	28.72	50.28	60.76	19.09	10.91	7.20
Kar	2033	2020	54.87	51.31	52.96	49.16	1962	1959	62.38	50.88	49.96	57.89	38.54	15.29
Ker	2051	1922	63.03	52.33	51.07	57.35	1955	1934	59.70	50.80	53.71	48.14	26.19	4.98
Mah	2042	1936	64.05	51.63	54.21	47.23	2048	2042	57.82	50.76	53.65	43.12	35.13	9.12
MP	2015	2063	49.63	50.52	59.67	29.17	2036	2069	57.39	49.97	57.30	31.21	36.89	21.00
Odi	2050	2252	38.58	51.90	57.21	39.86	1918	2103	51.54	50.69	52.00	48.15	36.21	17.29
Pun	2027	2059	54.55	50.97	60.98	26.20	1858	2210	43.58	50.07	60.45	20.21	30.29	9.24
Raj	2010	2177	40.97	50.26	66.20	16.11	2003	2207	44.79	48.91	61.33	12.93	36.21	10.69
TN	2043	1929	64.65	52.00	48.82	62.27	1989	1911	62.05	50.90	49.85	56.05	37.30	6.59
UP	2000	2101	46.95	50.01	62.92	21.87	1897	2060	58.37	48.64	55.38	32.39	42.26	26.17
WB	2071	2103	52.06	52.31	55.72	44.72	1933	2050	60.08	51.76	52.43	51.70	33.70	14.66
India	2031	2044	53.55	51.18	56.55	40.46	1903	2057	55.00	50.30	54.18	41.04	36.08	13.70

Note: ICMR-NIN norms are adjusted for age, sex and activity. *Source:* Author's own estimation using unit-level NSSO 1993-94 and 2011-12 CES data.

In terms of the protein adequacy, most states in both the sectors have had higher intakes than the desired norms. In 1993-94, only the rural populations residing in Assam, Kerala and Tamil Nadu consumed a protein diet that was below their respective specified norms. The protein gap in these states is also not that wide. In urban areas too, besides these three states Andhra Pradesh too had lower protein intakes than the desired thresholds. Over time, both the required dietary norms as well as the actual intakes have waned. Nevertheless, majority of the states have had higher intakes than their respective requirements in 2011-12 – only Assam, Karnataka and Tamil Nadu had marginally lower average intakes.

The wide variation in the spatial intakes of calorie and protein might be due to the variations around their mean values. We, therefore, evaluate the incidence of such insufficiencies, and these estimates are also presented in Table 2. The rural populace of Jammu & Kashmir and urban population living in Himachal Pradesh had the lowest rates of calorie deficiency in 1993-94. On the other hand, people living in both rural as well as urban areas of Tamil Nadu had the highest calorie deficiency incidence. In general, almost half of the states had calorie deficiency rates that were higher than the national average in both rural and urban areas. In 2011-12, rural as well as urban populations residing in Himachal Pradesh had the lowest calorie deficiency rates while rural Tamil Nadu was still the most deficient. Urban areas of Karnataka were the worst-performing calorie-consuming locations in 2011-12. Rural populations living in Bihar, Gujarat, Maharashtra, and Assam had calorie deficiency rates higher than the national average in 1993-94. Besides these, rural populace amongst the southern states of Karnataka, Andhra Pradesh, Kerala and Tamil Nadu faced a similar calorie deficiency. Note that, health outcomes for these states are better and the disconnect between food intakes and health outcomes requires further probing.

In the not-so-poor states of Punjab, Assam, Gujarat and Maharashtra and some of the southern states, the incidence rates in urban areas were higher than the national average. Over time, rural inhabitants of Maharashtra, Gujarat, West Bengal, Odisha, Assam, Karnataka, Kerala and Tamil Nadu have experienced calorie deficiencies that were greater than the prevailing national rate. In 1993-94, states with relatively low poverty headcount ratios (e.g., Kerala and Punjab) also witnessed reasonably high calorie deficiency rates. In 2011-12 too, almost half of the states recorded incidence rates that were greater than the urban national average. Here too, states faring well in poverty have not been doing so in terms of calorie deficiency. The prevalence of calorie deficiency highlights that over time there has been a deterioration in the situation, more so in rural areas. All the southern states along with Gujarat, Maharashtra and Assam are much more calorie deprived than Bihar, Madhya Pradesh, Odisha and Rajasthan. This finding also reiterates the fact that calorie and income poverty have not moved in tandem in India.

The incidence of protein deficiency portrays a different picture than calorie deficiency. Rural populace of Rajasthan and urban inhabitants of Himachal Pradesh have the lowest prevalence rates of protein deficiency while entire Tamil Nadu witnessed the highest incidence in 1993-94. Rural areas of Himachal Pradesh took over Rajasthan and attained the top spot in 2011-12 while rural Tamil Nadu was still at the bottom. Population residing in urban Tamil Nadu, however, has made some improvement. In 2011-12, rural areas of West Bengal, Gujarat, Odisha and Assam besides some southern states had incidence rates that were higher than the rural national average. Interestingly, the not-so-poor southern states also depict high protein deficiencies. Overall, protein deficiency has increased marginally at the national level.

To assess the incidence, depth and severity of nutritional insecurity, we estimate headcount index of nutritional deficiency (N0), nutritional deficiency gap index (N1) and squared nutritional deficiency gap index (N2). The results presented in Table 3 suggest that the population residing in poor households in both rural as well as urban areas is the most nutritionally insecure, followed by those in middle-income households.

Further, we look into the evolution of nutritional status across income classes and compare different measures of nutritional deficiency over time. For this, we compute changes in these measures that are arranged in ascending order of their magnitude and presented in Table 4. In terms of changes in depth and severity of calorie deficiency, rural middle-income households have performed the worst, followed by high-income and poor households. The nutritional

Table 3. Nutritional deficiency in India

	1993-94			2011-12		
			Calorie deficiency			
Rural	*N0 (α = 0)*	*N1 (α = 1)*	*N2 (α = 2)*	*N0 (α = 0)*	*N1 (α = 1)*	*N2 (α = 2)*
Poor	0.7865	0.1757	0.0556	0.8467	0.1942	0.0587
Middle income	0.4169	0.*0600*	*0.*0136	0.6303	0.1040	0.0244
High income	0.2163	0.0283	0.0061	0.4533	0.0615	0.0129
All	0.6067	0.1222	0.0365	0.6594	0.1208	0.0315
Urban	*N0 (α = 0)*	*N1 (α = 1)*	*N2 (α = 2)*	*N0 (α = 0)*	*N1 (α = 1)*	*N2 (α = 2)*
Poor	0.7780	0.1689	0.0519	0.8237	0.1812	0.0528
Middle income	0.4356	0.0609	0.0135	0.5571	0.0848	0.0188
High income	0.1758	0.0196	0.0035	0.2820	0.0314	0.0056
All	0.5355	0.0975	0.0271	0.5500	0.0900	0.0216
			Protein deficiency			
Rural	*N0 (α = 0)*	*N1 (α = 1)*	*N2 (α = 2)*	*N0 (α =0)*	*N1 (α = 1)*	*N2 (α = 2)*
Poor	0.4597	0.0918	0.0288	0.5144	0.09768	0.02666
Middle income	0.2011	0.0272	0.0060	0.2990	0.0413	0.0087
High income	0.0971	0.0121	0.0026	0.1747	0.0207	0.0040
All	0.3375	0.0622	0.0185	0.3358	0.0527	0.0126
Urban	*N0 (α = 0)*	*N1 (α = 1)*	*N2 (α = 2)*	*N0 (α = 0)*	*N1 (α = 1)*	*N2 (α = 2)*
Poor	0.5796	0.1253	0.0403	0.6107	0.1221	0.0351
Middle income	0.3336	0.0481	0.0112	0.4117	0.0601	0.0131
High income	0.1427	0.0173	0.0034	0.2180	0.0221	0.0035
All	0.4046	0.0740	0.0214	0.4083	0.0629	0.0148

Source: Author's own estimation using unit-level NSSO 1993-94 and 2011-12 CES data.

deficiency gap among the urban poor, however, has shown the least improvement. The changes in the depth and severity of calorie deficiency are less stark for the middle-income households. This again recapitulates that income enhancement alone might not always be a good predictor of food and nutritional insecurity. In addition, it reconciles the finding in Chand and Jumrani (2013) that income growth and elimination of poverty is a *necessary* but not a *sufficient* condition for reducing nutritional deficiencies.

The rural middle-income households have improved the least in the incidence and depth of protein deficiency while high-income households show reasonable progress. Interestingly, the rural poor have less severity of protein deficiency perhaps because of their greater consumption of relatively nutrient-rich coarse cereals. On the other hand, the high-income urban households did not show much improvement in protein deficiency, but also did not fare too badly in reduction of depth and severity measures.

The state-specific changes in the measures of nutritional deficiency are estimated and then arranged in ascending order of their magnitude. These changes in the context of calorie deficiencies are depicted in Maps 1-3 (Rural/Urban) while differences pertaining to protein deficiencies are presented in Table 5. Negative changes point towards deterioration while positive changes indicate improvement. The rural map [Map 1(R)] depicts that only Andhra Pradesh, Himachal Pradesh, and Maharashtra witnessed an improvement in the incidence of calorie deficiency. Rural areas of Jammu and Kashmir show the

Table 4. Changes in nutritional insecurity between 1993-94 and 2011-12

N0 (α = 0)		N1 (α = 1)		N2 (α = 2)	
		Calorie deficiency			
		Rural			
High income	-0.2369	Middle income	-0.0440	Middle income	-0.0108
Middle income	-0.2134	High income	-0.0332	High income	-0.0069
Poor	-0.0603	Poor	-0.0185	Poor	-0.0031
All	-0.0527	All	0.0014	All	0.0050
		Urban			
Middle income	-0.1215	Middle income	-0.0239	Middle income	-0.0053
High income	-0.1062	Poor	-0.0123	*High i*ncome	-0.0021
Poor	-0.0458	High income	-0.0117	Poor	-0.0008
All	-0.0145	All	0.0074	All	0.0055
		Protein deficiency			
		Rural			
Middle income	-0.0979	Middle income	-0.0141	Middle income	-0.0027
High income	-0.0776	High income	-0.0086	High income	-0.0015
Poor	-0.0547	Poor	-0.0059	Poor	0.0021
All	0.0017	All	0.0095	All	0.0059
		Urban			
High income	-0.0780	Middle income	-0.0120	Middle income	-0.0019
Middle income	-0.0753	High income	-0.0048	High income	0.0000
Poor	-0.0310	Poor	0.0032	Poor	0.0053
All	-0.0038	All	0.0111	All	0.0067

Source: Author's own estimation using unit-level NSSO 1993-94 and 2011-12 CES data.

largest deterioration in all the measures of caloric deficiency seeking special policy focus. In terms of calorie deficiency indicator N0, rural areas of Himachal Pradesh experienced the biggest improvement, while rural Maharashtra observed the same for N1 and N2. A higher number of states show an improvement in N0 in urban areas. Urban Andhra Pradesh exhibited the highest improvement in N0 and N1 while urban Tamil Nadu witnessed the highest improvement in N2. Urban Odisha in terms of N0 and Uttar Pradesh for N1 and N2 observed the biggest deterioration.

Almost half of the states show an improved performance in headcount index of protein deficiency in rural areas (Table 5). Rural locations of Kerala display the maximum improvement across all the measures, while rural Karnataka and West Bengal show the least improvement. A larger number of states have witnessed an improvement in urban areas than rural areas. Andhra Pradesh and Kerala are the best performing states while Odisha and Uttar Pradesh are the worst performers in terms of improving protein security in urban India.

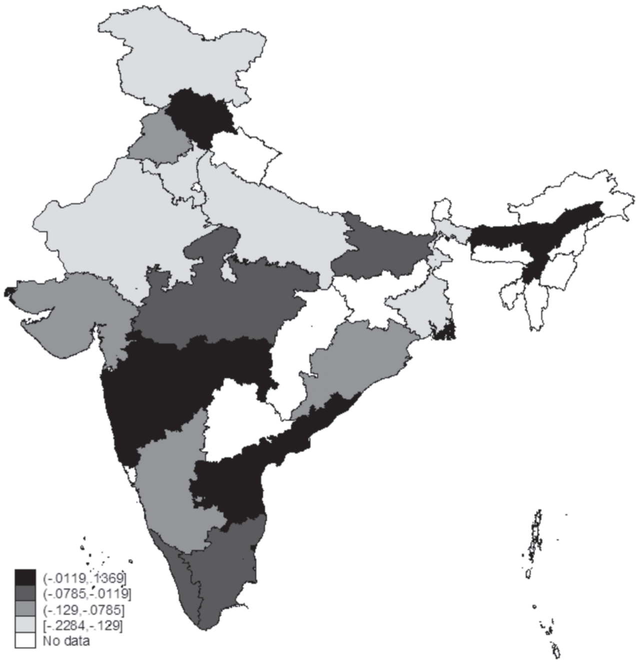
In order to know whether the ranks of different states by all measures of nutritional insecurity have differed significantly over time, we have computed the Spearman's rank correlations. For each of the measures for calorie and protein insecurity, the values are highly significant indicating that there is considerable stability in the rankings of states. It highlights the fact that spatial inequality persists and thus calls for urgent policy attention.

Table 5. Spatial changes in nutritional insecurity between 1993-94 and 2011-12

	Protein deficiency				
	N0 ($\alpha = 0$)		N1 ($\alpha = 1$)		N2 ($\alpha = 2$)
		Rural			
Kar	-0.1248	Kar	-0.0216	WB	-0.0036
J&K	-0.1147	WB	-0.0149	Kar	-0.0031
Guj	-0.0890	J&K	-0.0119	J&K	-0.0020
WB	-0.0739	Guj	-0.0051	UP	0.0009
Odi	-0.0673	Odi	-0.0037	Odi	0.0015
UP	-0.0544	UP	-0.0020	Raj	0.0015
Har	-0.0288	Raj	0.0004	HP	0.0024
Raj	-0.0273	Har	0.0032	Pun	0.0031
Pun	-0.0095	Asm	0.0046	Asm	0.0031
Asm	0.0083	Pun	0.0048	Har	0.0040
Bih	0.0257	HP	0.0111	Guj	0.0040
TN	0.0474	MP	0.0134	Bih	0.0072
AP	0.0664	Bih	0.0144	AP	0.0120
MP	0.0792	Mah	0.0284	MP	0.0134
HP	0.0816	AP	0.0287	Mah	0.0135
Mah	0.0963	TN	0.0422	TN	0.0229
Ker	0.1369	Ker	0.0598	Ker	0.0265
		Urban			
Odi	-0.1107	UP	-0.0122	UP	-0.0021
UP	-0.1020	WB	-0.0115	WB	-0.0008
Kar	-0.0816	J&K	-0.0056	Har	0.0001
J&K	-0.0734	Odi	-0.0023	J&K	0.0002
WB	-0.0676	Kar	0.0002	Asm	0.0006
MP	-0.0204	MP	0.0018	HP	0.0017
Guj	-0.0083	Har	0.0026	MP	0.0028
Asm	0.0180	Asm	0.0029	Guj	0.0033
HP	0.0232	HP	0.0063	Odi	0.0034
Raj	0.0282	Guj	0.0073	Kar	0.0047
Mah	0.0374	Raj	0.0078	Bih	0.0049
Bih	0.0395	Bih	0.0106	Raj	0.0051
Har	0.0514	Mah	0.0140	Mah	0.0058
Pun	0.0576	Pun	0.0185	Pun	0.0068
TN	0.0622	TN	0.0461	AP	0.0209
Ker	0.1148	AP	0.0500	TN	0.0227
AP	0.1483	Ker	0.0505	Ker	0.0234

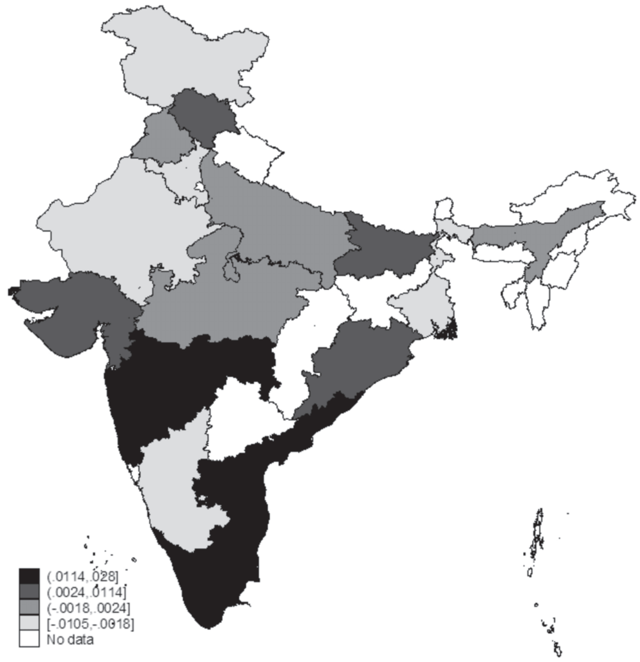
Source: Author's own estimation using unit-level NSSO 1993-94 and 2011-12 CES data.

Map 1(R): Spatial changes in rural headcount index of caloric insecurity (N0)



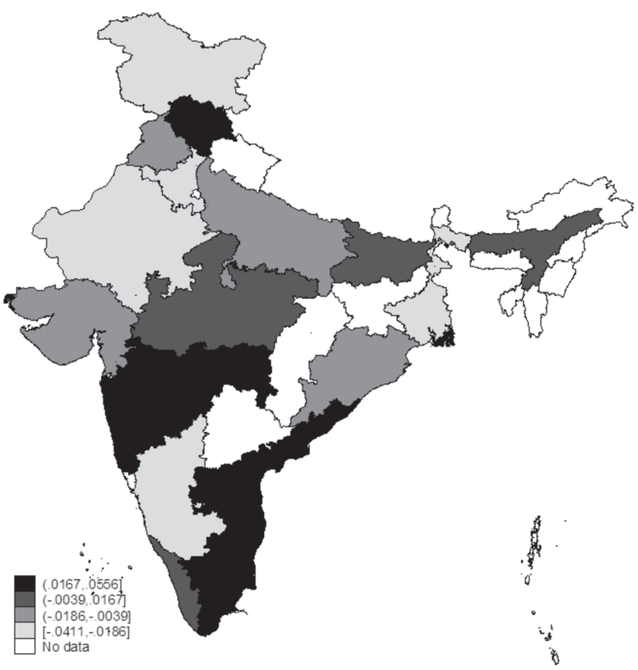
Source: Constructed using unit-level NSSO 1993-94 and 2011-12 CES data.

Map 3(R): Spatial changes in rural squared caloric deficiency gap index (N2)



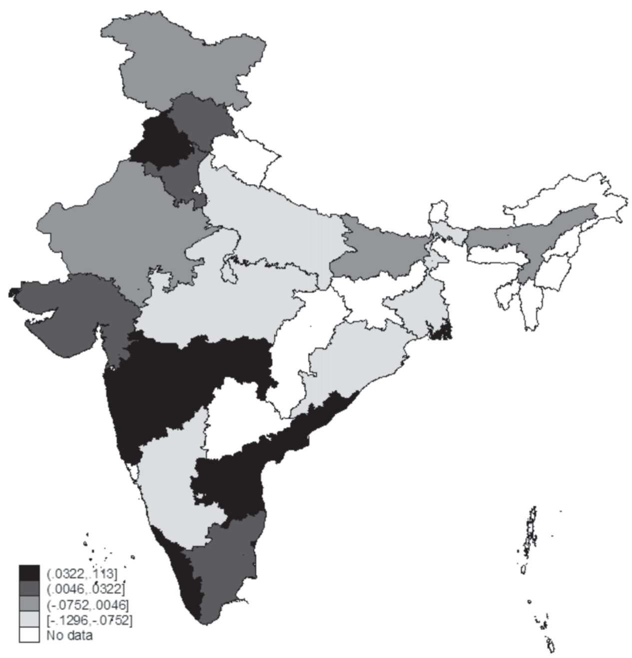
Source: Constructed using unit-level NSSO 1993-94 and 2011-12 CES data.

Map 2(R): Spatial changes in rural caloric deficiency gap index (N1)



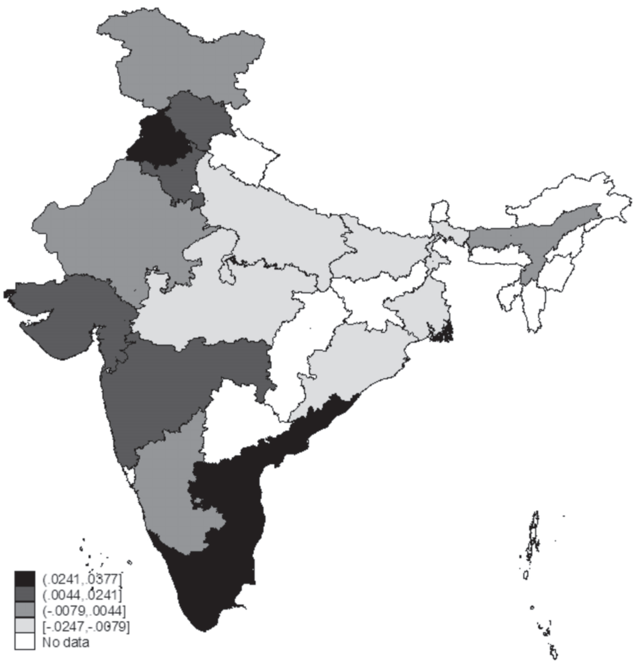
Source: Constructed using unit-level NSSO 1993-94 and 2011-12 CES data.

Map 1(U): Spatial changes in urban headcount index of caloric insecurity (N0)



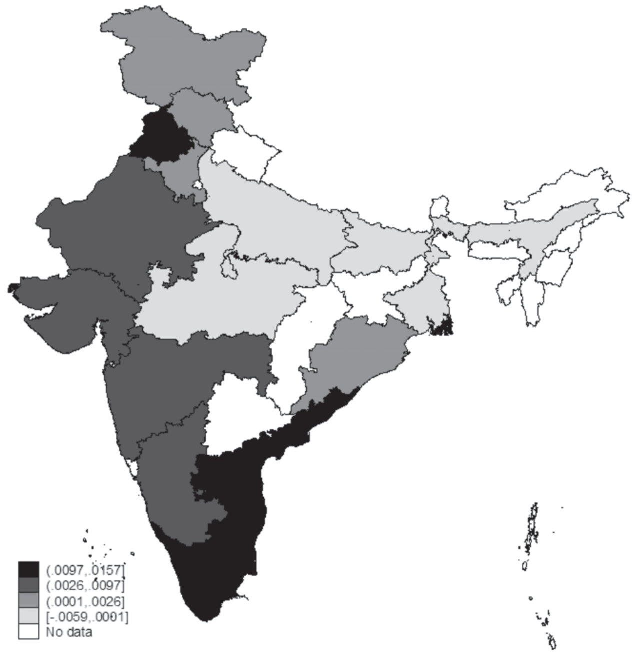
Source: Constructed using unit-level NSSO 1993-94 and 2011-12 CES data.

Map 2(U): Spatial changes in urban caloric deficiency gap index (N1)



Source: Constructed using unit-level NSSO 1993-94 and 2011-12 CES data.

Map 3(U): Spatial changes in urban squared caloric deficiency gap index (N2)



Source: Constructed using unit-level NSSO 1993-94 and 2011-12 CES data.

Concluding remarks

Sixty-six per cent of the rural population and 55 per cent of the urban population were calorie deficient in 2011-12. As anticipated, the caloric deficiency declined with an increase in income. A consistent increase is observed in the prevalence of calorie deficiency both in rural as well as urban India. Protein deficiency is less severe than calorie deficiency and is more prevalent among urban households across all income classes.

Almost half of the states have calorie deficiency rates higher than the national average. States with relatively low poverty also have high calorie deficiency rates. This finding reiterates the fact that calorie and income poverty have not been moving in tandem in India. Interestingly, the not-so-poor southern states also depict high rates of protein deficiency. The reduction in depth and severity of caloric insecurity had been slowest among the middle-income households, and then high-income and poor households in rural areas. The findings hint towards the fact that rising incomes alone are not a good predictor of food and nutritional insecurity. Further, there are inter-state differences in the incidence of nutritional insecurity across rural as well as urban areas, and the inequality in terms of rankings of different measures of nutritional insecurity has been persisting.

Just improving incomes is thus not a panacea for elevating upon the status of nutritional deprivation in India. In the wake of the triple burden of malnutrition, there is now a dire need to create awareness about adequate nutritive diets and bring in behavioural changes among the population. There is a vital need to ensure that greater knowledge and awareness is imparted through a variety of channels such as camps, media etc. It is now time to move towards aiming to attain both food and nutritional security simultaneously. With the existence of deficiencies even among the richer segments and persistence of spatial nutritional inequality, it has now become immutable that urgent policy attention is given to this aspect of developmental policy. Further, different measures (rather than relying on a single measure) should be adopted for obtaining an accurate representation of nutritional deprivation across time and across sub-populations. Their synchronous use might be able to assist the policymakers in designing appropriate targeted interventions for various socio-economic categories according to their specific needs.

Acknowledgement

This study was financially supported by ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi. Author expresses sincere gratitude to Prof Ramesh Chand for his feedback on this research.

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Received: October, 2017; Accepted: December, 2017