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Changes in socio-economic patterns of energy consumption and insufficient energy intake across India from 1993–94 to 2011–12

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Abstract

Objective: To assess whether disparities in energy consumption and insufficient energy intake in India have changed over time across socio-economic status (SES).
Design: This cross-sectional, population-based survey study examines the relationship between several SES indicators (i.e. wealth, education, caste, occupation) and energy consumption in India at two time points almost 20 years apart. Household food intake in the last 30 d was assessed in 1993–94 and in 2011–12. Average dietary energy intake per person in the household (e.g. kilocalories) and whether the household consumed less than 80 % of the recommended energy intake (i.e. insufficient energy intake) were calculated. Linear and relative risk regression models were used to estimate the relationship between SES and average energy consumed per day per person and the relative risk of consuming an insufficient amount of energy.
Setting: Rural and urban areas across India.
Participants: A nationally representative sample of households.
Results: Among rural households, there was a positive association between SES and energy intake across all four SES indicators during both survey years. Similar results were seen for energy insufficiency vis-à-vis recommended energy intake levels. Among urban households, wealth was associated with energy intake and insufficiency at both time points, but there was no educational patterning of energy insufficiency in 2011–12.
Conclusions: Results suggest little overall change in the SES patterning of energy consumption and percentage of households with insufficient energy intake from 1993–94 to 2011–12 in India. Policies in India need to improve energy intake among low-SES households, particularly in rural areas.

Keywords
Undernutrition
Energy intake
Energy consumption
India
National Sample Survey
Diet
Nutrition

Rapid economic growth is expected to accelerate progress towards a hunger-free society and minimize socio-economic differences in consumption enough for all groups to meet their minimum stipulated dietary requirements. Indeed, absolute levels of energy consumption have increased over several decades in India(1) alongside gains in many development indicators at the national level(2,3). However, food insecurity, hunger and undernutrition remain as serious issues across India(4–6). To help address these concerns, the union and state governments in India

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have launched important poverty alleviation and food security programmes, including the Public Distribution System for low-income households, the Integrated Child Development Services for children and pregnant/lactating women, and the Mid-Day Meal Scheme for schoolchildren. Other programmes such as the National Rural Employment Guarantee Act and the National Rural Livelihood Mission also provide support. Yet, amidst competing growth and development priorities, it is important to highlight the continued nutritional need for these basic poverty alleviation programmes. Identifying sectors of the population which may be particularly vulnerable to nutritional deficits would be critical information for assessing policy targets.

Sufficient energy intake is a critical component of the human growth process. Therefore, average per capita energy consumption and the percentage of a population meeting a sufficient energy intake level can be helpful markers of undernutrition within and across populations even though they are unidimensional measures (i.e. they do not address dietary diversity, food quality or micronutrient intake). Researchers and practitioners can use these basic markers to capture inequalities in food consumption and changes in any gradients over time. In addition, assessing progress on energy indicators could assist understanding of progress towards achieving the second Sustainable Development Goal to 'end hunger, achieve food security and improved nutrition and promote sustainable agriculture'[7]. Thus, studying population-level energy deprivation is a critical component of nutrition discourse and research and would complement research on maternal and child nutrition outcomes.

Several studies have shown substantial socio-economic patterning of nutrition-related outcomes in India with the poor, the less educated, the rural and the lower social castes at greater risk for anthropometric failure and undernutrition[4,8–16]. And one study in India has found that the gap in energy consumption reduced between high and low expenditure classes from 1993–94 to 2011–12[17]. However, no studies have explicitly assessed gradient changes in energy consumption across different indicators of socio-economic status (SES) over time in India. Using multiple measures to identify resource-vulnerable populations in India can provide additional perspectives about trends in nutritional intake as household SES itself may be changing more rapidly on some indicators over time compared with other indicators[18]. Therefore, energy-based disparities may be greater per some indicators as compared with other markers, which would be helpful information when trying to allocate scarce resources to reduce undernutrition. In addition, no studies have assessed socio-economic patterning of meeting minimum energy intake thresholds over time. This easy-to-interpret marker of insufficient nutrition in India could be helpful for displaying progress in reaching national nutrition goals.

To address these gaps in the literature, the current study aims to assess the strength of associations between fundamental indicators of nutritional intake (i.e. per capita energy consumption as well as insufficient energy intake) and multiple indicators of SES (i.e. asset-based household wealth, completion of education levels, caste and occupation) at two time points 18 years apart across India. Using nationally representative data on household food consumption, the analysis highlights whether SES-based disparities in energy intake have changed over a period of time during which India experienced significant economic growth and development[19–21].

Furthermore, as energy consumption requirements in rural spaces are much greater in India than in urban spaces[1,22], the present study assesses evidence of these associations in rural and urban places, separately. The rural and urban occupational profiles are very different with the bulk of the rural workforce engaged in agriculture, casual labour and related sectors with intensive physical labour requirements, thus necessitating a greater energy intake. In addition, the higher fertility burden and paid and unpaid work burden among women in rural areas also require a higher energy norm[22,23].

Results from the present study will provide helpful information for policy makers, practitioners and researchers involved in addressing barriers to sufficient nutrition in India by assessing the social determinants of a basic nutritional building block for human growth. If disparities remain, then the future well-being of any identified sub-populations is also at greater risk for longer-term negative outcomes given associations between nutrition and longer-term health, economic status and intergenerational outcomes.

Methods

Data

The analyses are based on nationally representative data from the Household Consumer Expenditure Survey (HCES) conducted by the National Sample Survey Office (NSSO), Government of India, in 1993–94 (50th round) and 2011–12 (68th round)[24]. A key objective of the HCES was to obtain food consumption data in order to assess the level of nutritional intake across different regions and population groups. The HCES provides information on the total quantities consumed and rupee amounts spent by households to purchase a wide list of food and non-food items. Additionally, the survey also provides household-level information on demographics and access to services and utilities as well as individual-level data on age, sex, education and meals taken in a given month by all household members. The procedures followed in the present study were in accordance with the ethical standards of the 1964 Helsinki Declaration and the NSSO. Official approval for the study was obtained and all participants provided written consent. Data were de-identified.

Survey design

The HCES interviews are conducted with a representative sample of households randomly selected through a stratified multistage survey design covering India[1]. To start, a rural/urban stratification was created within clusters called state-regions, which comprise a contiguous group of districts within a State or Union Territory having similar characteristics. Within each district of a State/Union Territory, two strata were formed: the rural stratum comprising all rural areas in the district and the urban stratum comprising all urban areas in the district. Selection of first-stage units then occurred by applying probability-proportional-to-size circular systematic sampling to census-identified villages in the rural sector of each district and urban frame survey blocks in the urban sector of each district. Larger sample villages and blocks were divided into a suitable number of 'hamlet groups'/'sub-blocks' of roughly equal population content. Second-stage sampling constituted the households belonging to only two of these hamlet groups, selected circular systematically in case of sample villages, and one randomly selected sub-block in the case of sample blocks. Households within a village were then categorized into two strata based on affluence. From these strata, households were circular systematically sampled for the final sample. The total number of households sampled per village was ten in 1993–94 and eight in 2011–12. Households were sampled to be representative at the state-region level. Cross-sectional data collection for the 50th and 68th rounds occurred from July 1993 to June 1994 and from July 2011 to 2012, respectively.

Sample

In 1993–94, 69 491 rural and 46 254 urban households participated in the survey. In 2011–12, 59 695 rural and 41 967 urban households participated in the survey. After excluding households with missing data on any of the variables used in the analyses, the final analytical sample contained 67 413 rural and 45 490 urban households in 1993–94 and 59 670 rural and 41 945 urban households in 2011–12.

Outcomes

First, we calculated average intake of dietary energy (measured in kilocalories) per person in the household. To create this measure, information was collected on the quantity of food items consumed by a household in the last 30 d. Food items included cereals, pulses, milk and milk products, sugar, salt, edible oil, egg, fish and meat, vegetables, fruits, spices, beverages and processed foods, and pan, tobacco and intoxicants. Items included both market-purchased food items as well as home-grown produce. The amounts consumed were converted into the equivalent amounts of energy on the basis of a nutrition chart which gives the energy per unit of different foods in the Indian diet[1,25]. For some items having variable food content, average energy content per rupee was used instead of per unit of quantity[1].

Following the NSSO's approach[1,24], the distribution of energy intake over persons is derived by assigning to each person in a household the per capita energy intake of the household. The consumption of food cooked in a household is recorded in the preparing household, irrespective of who consumes the food. However, adjustments based on number of meals consumed by household members and non-members help to adjust the estimates of energy intake by the household. A similar approach is followed when cooked meals are purchased from the market (hotels, restaurants, canteens or catering agency, government or a non-government agency). In such situations, the purchasing household is considered to be the consuming household, regardless of who eats the food. Although the issue of intra-household variation in food intake exists, the estimated household per capita energy intake is expected to be a useful indicator to study the trends and patterns in nutritional intake in India[1].

Second, we created a variable indicating that a household had insufficient energy intake if individuals in the household, on average, consumed less than 80 % of the recommended minimum daily energy intake for India (which was 8786 kJ (2100 kcal) for urban areas and 10 042 kJ (2400 kcal) for rural areas)[23]. Thus, the thresholds were less than 8033 kJ (1920 kcal) for rural areas and less than 7029 kJ (1680 kcal) for urban areas. A challenging area for estimating undernourishment using consumption-derived energy is deciding the cut-off at which an individual is considered to be undernourished. In the present study, we have used 80 % of India's traditional recommended daily intake as the threshold[26]. This 80 % threshold level has previously been used by the official report from the NSSO to describe adequacy of nutritional intake[1]. The threshold ensures that prevalence estimates are in line with the substantial prevalence of low BMI in India. According to India's 2005–06 National Family Health Survey the prevalence of low BMI was 36 and 34 % among women and men, respectively[27], which closely aligns around our estimates of undernourishment for 2011–12 described in the present study. Moreover, the Rangarajan Committee (2014) on poverty measurement recommends the use of the lower cut-offs (as compared with the traditional energy thresholds) to account for a reduction in the proportion of the population in the occupational categories that require a relatively higher energy intake[28]. For further explanation about our choice of energy thresholds, see the online supplementary material (Supplemental File 1, Supplemental Fig. S1 and Supplemental Table S1).

Indicators of socio-economic status

We focused on four SES indicators: household wealth quartile, highest education obtained by the head of household, caste and occupation of the household head. The household wealth quartile was based on a household asset score, which was constructed using principal component analysis for data from rural/urban areas and survey rounds, separately. Household assets included bedsteads, chairs, radio, television, utensils, fan, stove, pressure cooker, sewing machine, washing machine, fridge, bicycle, motorcycle, car, clock, land owned, improved cooking fuel and improved light source. (Water purifier and mobile phone ownership were also included when using the 2011–12 data, but they were not available in the earlier round.) We then divided the asset score into quartiles of wealth.

Significant milestones of the Indian education system were followed to categorize the household head as illiterate (0 years), primary education or below (1–5 years), middle school education or below (6–10 years), secondary education (11–12 years) and higher education (graduate school and above). Caste was categorized as scheduled tribes (ST), scheduled castes (SC), other backward classes (OBC) and other castes. The SC and ST households have historically been economically, socially and geographically deprived groups in India whereas the 'other castes' households have, on average, relatively better SES compared with the SC and ST households[29]. OBC refers to those non-SC/ST social groups or castes who are identified by state and central governments to be socially and economically disadvantaged as well, as defined by the National Commission for Backward Classes Act 1993 in India. For occupation of the household head, we used dummy variables to represent self-employed in non-agriculture, self-employed in agriculture, agricultural labour, other labour, regular wage/salary and other occupations.

Other covariates

We included information on household location (urban *v.* rural), sex of the household head, household size (categorized as ≤4 members *v.* ≥5 members), total number of females in the household (continuous variable), religion (Hindu, Muslim, Christian or Other) and state of residence. We also captured total free meals provided by employers, total free meals at school as a part of a mid-day meal programme, total meals paid and taken outside the home, total other meals outside the house, total meals given to servants and total meals served to any non-household member. These variables capture energy from food items not purchased for personal consumption by the household as per NSSO methodology[1].

Statistical analyses

All of the main analyses were conducted separately by survey rounds and urban and rural strata. First, we display demographic statistics and the average per capita energy intake and percentage undernourished across sub-categories. We also provide descriptive statistics about the occurrence of eating meals outside the home to gauge the extent of possible energy underestimation. We then fit a series of linear and relative risk regression models. For the continuous outcome (energy intake per person per day), we fitted linear regression models with state-fixed effects to the data. We adjusted for sampling weights and also clustered SE at the regional level for which NSSO data are representative. By performing adjustments for state-fixed effects, we control for all time-invariant unobserved variables at the state level. Adjusting for sampling weights ensures that our estimates are representative at the national level. SE are clustered to ensure that statistical tests are robust for geographical correlation within a cluster of neighbouring districts. Choosing the National Sample Survey region as the clustering unit ensures that we have enough clusters and no bootstrapping is required[30]. We report β coefficients and SE for the fixed-effects linear regression models. For the binary outcome (undernourished household), we fit relative risk models with the same specification to the data and report adjusted and 95 % CI. For all models, we adjust for sex of household head, household size, total number of females in the household, religion, free meals at employer, free meals at school, total meals paid, total meals outside the house, number of meals to servants and number of meals to non-household members.

For robustness checks we ran additional analyses. First, we pooled the data across time and specified models where ordered SES variables (wealth and education) were interacted with a year dummy to observe changes in effects over time using pooled samples. Second, we constructed an alternative wealth index based on a set of assets common to both periods of time. Again using two samples separated by time, but still stratified by rural and urban areas, we fit regression models with this revised wealth index to observe the extent to which coefficients were sensitive to alternative constructions of wealth.

Results

Descriptive statistics of sample population

The distributions of the population in 1993–94 and in 2011–12 across socio-economic sub-categories are provided in Tables 1 and 2. Similar statistics about all other variables included in the present study are provided in the online supplementary material, Supplemental Table S2. This supplemental information includes data on meals consumed outside the home. Although the data show an increase in meals consumed outside the house (Supplemental Table S3), the increase appears greater in rural areas than urban areas. This change is largely due to the greater number of school-based meals consumed by school-going children in rural areas (Supplemental Table S2) brought about by the expansion of a mid-day meal scheme programme in the

Table 1 Description of a nationally representative sample population of adults in India in 1993–1994 and in 2011–2012

	Urban				Rural			
	1993–94		2011–12		1993–94		2011–12	
Socio-economic status	*n*†	%	*n*†	%	*n*†	%	*n*†	%
All households	46 254	100	41 967	100	69 491	100	59 695	100
Household wealth index								
Bottom wealth quartile	15 168	32·8	11 917	28·4	19 174	27·6	16 327	27·4
Quartile 2	8946	19·3	10 587	25·2	17 578	25·3	14 742	24·7
Quartile 3	11 266	24·4	9592	22·9	17 181	24·7	14 691	24·6
Top quartile	10 874	23·5	9871	23·5	15 558	22·4	13 953	23·4
Education of household head								
Illiterate	14 888	32·2	10 002	23·8	44 441	64·0	24 701	41·4
Primary and below (1–5 years)	5939	12·8	4359	10·4	8911	12·8	8094	13·6
Middle (6–10 years)	13 975	30·2	13 163	31·4	12 094	17·4	17 516	29·3
Secondary (11–12 years)	4016	8·7	4982	11·9	2035	2·9	4349	7·4
College and above (>12 years)	7428	16·1	9458	22·5	1998	2·9	5031	8·4
Household caste								
Scheduled tribes	3093	6·7	3628	8·6	10 403	15·0	10 001	16·8
Scheduled castes	5321	11·5	5503	13·1	13 052	18·9	10 194	17·1
Other backward classes‡	–	–	16 157	38·5	–	–	23 757	39·8
Other	37 814	81·8	16 674	39·7	45 991	66·2	15 734	26·4
Occupation of household head§								
Self-employed in non-agriculture	16 320	35·9	15 647	37·3	8386	12·4	15 295	25·6
Agricultural labour	–	–	–	–	16 834	25·0	4889	8·2
Other manual labour	5362	11·8	5385	12·8	5122	7·6	8758	14·7
Self-employed in agriculture	–	–	–	–	29 318	43·5	16 788	28·1
Other occupations	3954	8·7	4553	10·9	7789	11·6	13 953	23·4
Regular wage/salary‖	19 874	43·7	16 367	39·0	–	–	–	–

†The *n* size for each sub-category within a variable does not always add up to the total *N* size due to missing data.
‡Data on the other backward classes category was not available in the 1993–94 round because the category was implemented by the government post 1993 as per the National Commission for Backward Classes Act (Ministry of Law and Justice, 1993; http://www.ncbc.nic.in/Writereaddata/NCBC%20ACT,%20199363556495391749149l.pdf).
§Some employment categories such as agricultural labour and self-employed in agriculture are relevant only to rural households and therefore no urban households are classified in these categories.
‖There was no 'regular wage/salary' category in the 1993–94 round for rural households. Thus, people in this category in the 2011–12 round were combined into the closest other occupation category available in the earlier round for consistency.

country[31]. In addition, the increase in eating outside the home appears relatively small per the data in general. Further, SD of meals consumed outside are quite large so their impact may vary depending on context.

Average energy consumption in 1993–94 and 2011–12

The estimated average per capita household energy consumption was very similar across rural and urban households at both survey rounds: 9514 kJ (2274 kcal) in 1993–94 and 9213 kJ (2202 kcal) in 2011–12 for urban households, and 9540 kJ (2280 kcal) and 9247 kJ (2210 kcal), respectively, for rural households (Table 2). In addition, in urban households the estimated average per capita energy consumed was above 8786 kJ (2100 kcal; the minimum for sufficiency) in most subgroups in both 1993–94 and 2011–12. The exceptions at both time points include households whose head engaged in manual labour and, separately, illiterate households. Among rural households, the estimated average household per capita energy consumption was below 10 042 kJ (2400 kcal; the minimum for sufficiency) in most subgroups in 1993–94 and in all but one subgroup in 2011–12 (the exception being households with the highest level of education). In general, households in higher SES categories seemed to consume more energy on average, a trend which was more apparent in the 2011–12 round of data.

Prevalence of insufficient energy intake in 1993–94 and 2011–12

Overall, the percentage of households consuming an insufficient amount of energy per capita per household on average was 20·4 and 18·6 % among urban households in 1993–94 and 2011–12, respectively, and 33·7 and 32·4 % among rural households, respectively. The percentage of undernourished households did not appear to shift greatly in a particular pattern between the two survey periods for most socio-economic categories in both rural and urban households (Table 3). When comparing the distribution of insufficient energy intake within each survey year across household wealth status quintiles in 1993–94 and in 2011–2012, there was little absolute difference among the years and locations (Table 4). Results were similar for the relative differences.

Table 2 Average per capita energy consumed per day per household in 1993–1994 and in 2011–2012 among a nationally representative sample of households across India

	Energy consumption per capita per household (kcal†)							
	Urban				Rural			
	1993–94 (*n* 46 221)		2011–12 (*n* 41 957)		1993–94 (*n* 69 487)		2011–12 (*n* 59 651)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
All households	2274	947	2202	737	2280	904	2210	719
Household wealth index								
Bottom wealth quartile	2217	821	2158	727	2192	972	2111	583
Quartile 2	2225	966	2107	771	2227	764	2173	624
Quartile 3	2199	754	2196	668	2238	886	2208	624
Top quartile	2469	1211	2365	750	2495	949	2368	978
Education of household head								
Illiterate (0 years)	2085	712	2062	715	2212	834	2155	644
Primary and below (1–5 years)	2124	986	2098	726	2266	1098	2163	627
Middle (6–10 years)	2265	770	2164	726	2426	945	2232	721
Secondary (11–12 years)	2446	882	2274	679	2035	2572	2303	714
College and above (>12 years)	2693	1405	2415	811	1998	2677	2400	1074
Household caste								
Scheduled tribes	2314	778	2172	649	2112	731	2076	597
Scheduled castes	2064	692	2127	919	2132	714	2168	705
Other backward classes	–	–	2149	708	–	–	2198	631
Other	2300	986	2286	707	2360	975	2342	884
Occupation of household head								
Self-employed in non-agriculture	2224	1045	2120	617	2211	730	2156	576
Agricultural labour	–	–	–	–	2018	848	2069	531
Other manual labour	1960	641	2005	563	2042	803	2100	557
Self-employed in agriculture	–	–	–	–	2470	968	2296	875
Other occupations	2535	1007	2473	969	2386	837	2285	773
Regular wage/salary	2351	900	2271	788	–	–	–	–

†To convert to kJ, multiply kcal values by 4·184.

Socio-economic correlates of energy consumption and insufficient energy intake in urban and rural households in 1993–94 and 2011–12

Among urban households, regression estimates indicated that socio-economic indicators were positively associated with estimated average per capita per household energy consumption in 1993–94 (Table 5). This pattern still appeared in 2011–12 although the gradient was less strong. The estimated energy difference between the bottom and the top wealth quartiles in 2011 was 781 kJ (186·6 kcal) as compared with 1107 kJ (264·6 kcal) in 1993–94. Moreover, there was no statistically significant difference between households with illiterate heads and households where the head had any schooling up to 12 years in 2011–12. The full set of regression estimates is provided in the online supplementary material, Supplemental Table S4.

Insufficient energy intake among urban households was clearly patterned by wealth quartiles at both time periods, a pattern that was even stronger in the most recent data (Table 5). For example, urban households in 1993–94 in the bottom wealth quartile were 2·2 times (95 % CI 1·9, 2·5) at greater risk of undernourishment compared with urban households in the top wealth quartile; in 2011–12, such households were at 2·5 times greater risk (95 % CI 2·1, 3·1). In contrast, although lower education was associated with greater risk of undernourishment in 1993–94, that pattern did not appear in 2011–12. Moreover, there were no other SES patterns of undernourishment risk in 2011–12. The full set of relative risk estimates is provided in the online supplementary material, Supplemental Table S5.

Among rural households, there was clear socio-economic patterning of estimated energy intake across all four SES indicators during both survey years although the magnitude of the estimates appeared slightly reduced in the recent data (Table 6). Similar to the results from the urban data, rural households in the highest wealth quartile were estimated to consume 1230 (SE 84·9) kJ (294 (SE 20·3) kcal) more ($P < 0·001$) than the poorest rural households in 1993–94 whereas the richest were estimated to consume 724 (SE 82·8) kJ (173 (SE 19·8) kcal) more ($P < 0·001$) in 2011–12. A similar trend was seen with the education indicator in 2011–12. In addition, OBC and other castes were associated with consuming about 397 kJ (95 kcal) and 527 kJ (125·9 kcal) more, respectively, as compared with ST in the most recent data. See the online supplementary material, Supplemental Table S4 for further results.

Furthermore, relative risk regression results indicated a consistent socio-economic patterning of risk for insufficient energy intake at both time points among rural households

Table 3 The number and percentage of households with insufficient energy intake† in 1993–1994 and in 2011–2012 among a nationally representative sample of households across India

	Undernourished households							
	Urban				Rural			
	1993–94 (*n* 46 221)		2011–12 (*n* 41 957)		1993–94 (*n* 69 487)		2011–12 (*n* 59 651)	
	n	%	*n*	%	*n*	%	*n*	%
All households	9429	20·4	7804	18·6	23 417	33·7	19 327	32·4
Household wealth index								
Bottom wealth quartile	3641	24·0	2860	24·0	7358	38·4	6362	39·0
Quartile 2	2129	23·8	2482	23·4	6402	36·4	4939	33·5
Quartile 3	2516	22·3	1539	16·0	6135	35·7	4698	32·0
Top quartile	1143	10·5	923	9·4	3522	22·6	3328	23·9
Education of household head								
Illiterate (0 years)	4248	28·5	2549	25·5	16 562	37·3	8796	35·6
Primary and below (1–5 years)	1555	26·2	1013	23·2	3016	33·9	2855	35·3
Middle (6–10 years)	2601	18·6	2567	19·5	3156	26·1	5446	31·1
Secondary (11–12 years)	510	12·7	727	14·6	366	18·0	1119	25·7
College and above (>12 years)	513	6·9	949	10·0	314	15·7	1110	22·1
Household caste								
Scheduled tribes	512	16·6	716	19·7	4338	41·7	4112	41·1
Scheduled castes	1567	29·5	1237	22·5	5399	41·4	3529	34·6
Other backward classes	–	–	3337	20·7	–	–	7771	32·7
Other	3744	19·4	2513	15·1	13 660	29·7	3912	24·9
Occupation of household head								
Self-employed in non-agriculture	3415	20·9	3156	20·2	2981	35·6	5196	34·0
Agricultural labour	–	–	–	–	8164	48·5	2038	41·7
Other manual labour	1922	35·8	1544	28·7	2471	48·2	3413	39·0
Self-employed in agriculture	–	–	–	–	6933	23·7	4731	28·2
Other occupations	560	14·2	592	13·0	2081	26·7	3943	28·3
Regular wage/salary	3352	16·9	2508	15·0	–	–	–	–

†Insufficient energy intake (labelled as 'undernourished households') is indicated if a household consumed below 80 % of required energy norms, which was equivalent to less than 8033 kJ (1920 kcal) for rural areas and less than 7029 kJ (1680 kcal) for urban areas.

Table 4 The distribution of insufficient energy intake within each year across household wealth status quartiles in 1993–1994 and in 2011–2012 among a nationally representative sample of households across India

Year	Total *N*†	Households with insufficient energy intake in the lowest wealth quartile		Households with insufficient energy intake in the highest wealth quartile		Absolute difference between the lowest and highest wealth quartiles (Q1 – Q4) in prevalence of households with insufficient energy intake (%)	Relative difference between the lowest and highest wealth quartiles (Q1/Q4) in prevalence of households with insufficient energy intake (%)
		n	%	*n*	%		
1993–94 Rural	69 491	19 174	38·4	15 558	22·6	15·8	1·7
2011–12 Rural	59 695	16 327	39·0	13 953	23·9	15·1	1·6
1993–94 Urban	46 254	15 168	24·0	10 874	10·5	13·5	2·3
2011–12 Urban	41 967	11 917	24·0	9871	9·4	14·6	2·6

†Total *N* refers to the full sample size. *n* refers to the sub-sample size for each quartile out of which the percentage of the population with insufficient energy was calculated.

(Table 6). This gradient of association did not seem to change across wealth quartiles from one survey period to the next, nor across caste categories. In contrast, although there was a clear risk gradient across education in 1993–94, in 2011–12 rural households with less than 10 years of education were all 1·2 times more likely to be undernourished. Moreover, the occupation gradient appeared to reduce; rural households engaged in agricultural labour were no longer at increased risk of being undernourished as compared with households self-employed in non-agricultural work. See the online supplementary material, Supplemental Table S5 for further results.

Using pooled data, regression models for interaction trends by SES subgroup were specified to explicitly test whether the association between the ordered socio-economic categories varied by time (see online

Table 5 Linear and relative risk regression estimates of the relationship between per capita energy consumption per day per household and having insufficient energy intake, separately, and socio-economic indicators among a nationally representative sample of urban households across India

	Linear outcome: average energy consumed per capita per urban household						Binary outcome: having insufficient energy intake in an urban household					
	1993–94 (*n* 45 490)			2011–12 (*n* 41 945)			1993–94 (*n* 45 490)			2011–12 (*n* 41 945)		
	β		SE	β		SE	RR		95 % CI	RR		95 % CI
Household wealth index												
Bottom wealth quartile	Ref.		–	Ref.		–	2·2	***	1·9, 2·5	2·5	***	2·1, 3·1
Quartile 2	67·4	***	16·8	18·8		23·9	1·9	***	1·6, 2·1	2·0	***	1·7, 2·4
Quartile 3	85·9	***	21·1	88·2	**	28·6	1·7	***	1·5, 1·9	1·5	***	1·3, 1·7
Top quartile	264·6	***	25·7	186·6	***	33·0	Ref.		–	Ref.		–
Education of household head												
Illiterate	Ref.		–	Ref.		–	2·2	***	1·9, 2·4	1·2	***	1·0, 1·4
Primary and below (1–5 years)	14·9		14·9	–5·7		15·8	2·1	***	1·9, 2·4	1·2	*	1·0, 1·3
Middle (6–10 years)	63·7	***	13·7	4·7		17·5	1·9	***	1·7, 2·0	1·2	***	1·1, 1·4
Secondary (11–12 years)	126·2	***	23·6	36·6		23·2	1·6	***	1·4, 1·7	1·1		0·9, 1·2
College and above (>12 years)	291·1	***	22·5	111·8	***	22·2	Ref.		–	Ref.		–
Household caste												
Scheduled tribes	Ref.		–	Ref.		–	1·0		0·9, 1·1	1·0		0·8, 1·2
Scheduled castes	–65·1	**	23·4	–27·6		29·2	1·2	***	1·1, 1·3	1·1		1·0, 1·2
Other backward classes	NA		NA	6·4		27·7	NA		NA	1·2	***	1·0, 1·4
Other	21·9		23·5	45·6		36·9	Ref.		–	Ref.		–
Occupation of household head												
Self-employed in non-agriculture	Ref.		–	Ref.		–	Ref.		–	Ref.		–
Other manual labour	–160·2	***	14·3	–37·6	**	13·2	1·3	***	1·2, 1·4	1·1		1·0, 1·2
Other occupations	58·0	**	18·5	67·7	**	24·0	1·0		0·9, 1·1	1·1		0·9, 1·3
Regular wage salary	–26·3	*	11·5	10·2		15·5	1·0		1·0, 1·1	1·0		0·9, 1·1

RR, relative risk; ref., reference category; NA, not applicable.
Estimates are adjusted for sex of household head, household size, total number of females in the household, religion, free meals at employer, free meals at school, total meals paid, total meals outside the house, number of meals to servants, number of meals to non-household members, state dummy variables, sampling weights and SE clustered at the region level for which National Sample Survey data are representative.
*$P < 0·05$, **$P < 0·01$, ***$P < 0·001$.

supplementary material, Supplemental Tables S6–S9). Although there was little evidence of SES gradient convergence by wealth over time, disparities by education were significantly lower over time, especially for those with less than 10 years of education. Finally, we fit models using the alternative wealth index based on a common set of assets derived from a pooled sample. Descriptive statistics first showed that households were concentrated in the bottom two wealth quartiles in 1993–94, and then the concentration moved to the top two quartiles by 2011–12 in both rural and urban areas. This change signals an overall improvement in asset ownership over time (Supplemental Table S10). Estimates of the association between nutrition indicators and this index were qualitatively similar, however, to estimates from the main analyses (Supplemental Table S11). Thus, the original specifications of relative wealth status were robust to modifications using common assets over time.

Discussion

The present study describes the socio-economic patterning of estimated energy consumption and insufficient energy intake across India in 1993–94 and 2011–12 using multiple SES measures to identify sub-populations at nutritional risk. There were three key findings. First, absolute levels of average per capita energy consumption did not increase between 1993–94 and 2011–12 among samples of nationally representative households. Furthermore, the prevalence of insufficient energy intake among all sub-populations remained concerningly present and substantial with no reductions between the two time periods. In 2011–12, 24 % of people in the poorest urban households and 39 % of people in the poorest rural households still consumed less than the recommended amount of energy per day. At the same time, this marker of undernourishment was also present among the wealthiest households (9 and 24 % of richest urban and rural households, respectively). These population-level statistics are concerning given the number of persons they represent in India.

Second, detrimental disparities in energy consumption and insufficient intake remained clearly present. For example, the current study found evidence that a wealth-based gradient in these markers of nutrition did not change substantially from 1993–94 to 2011–12. This result is troubling in light of national programmatic efforts to relieve undernutrition concerns particularly among the poor. Despite overall economic development in India, it is important for policy makers to recognize that households with lower financial resources are still at a much higher risk for not meeting their energy needs in both rural and urban areas.

Table 6 Linear and relative risk regression estimates of the relationship between per capita energy consumption per day per household and having insufficient energy intake, separately, and socio-economic indicators among a nationally representative sample of rural households across India

	Linear outcome: average energy consumed per capita per rural household						Binary outcome: having insufficient energy intake in a rural household					
	1993–94 (*n* 67 413)			2011–12 (*n* 59 670)			1993–94 (*n* 67 413)			2011–12 (*n* 59 670)		
	β		SE	*β*		SE	RR		95 % CI	RR		95 % CI
Household wealth index												
Bottom wealth quartile	Ref.		–	Ref.		–	1·6	***	1·5, 1·8	1·7	***	1·5, 1·8
Quartile 2	85·6	***	14·1	73·7	***	10·9	1·4	***	1·3, 1·6	1·3	***	1·2, 1·4
Quartile 3	139·8	***	13·3	85·9	***	12·1	1·3	***	1·3, 1·4	1·3	***	1·2, 1·4
Top quartile	294·4	***	20·3	172·7	***	19·8	Ref.		–	Ref.		–
Education of household head												
Illiterate	Ref.		–	Ref.		–	1·7	***	1·5, 1·9	1·2	**	1·1, 1·4
Primary and below (1–5 years)	33·9	**	11·7	–10·5		9·6	1·6	***	1·4, 1·8	1·2	**	1·1, 1·4
Middle (6–10 years)	120·5	***	15·8	24·3	**	9·2	1·4	***	1·2, 1·5	1·2	***	1·1, 1·4
Secondary (11–12 years)	209·5	***	24·4	53·5	**	19·7	1·1		0·9, 1·3	1·1		0·9, 1·2
College and above (>12 years)	262·4	***	29·0	84·9	***	20·5	Ref.		–	Ref.		–
Household caste												
Scheduled tribes	Ref.		–	Ref.		–	1·3	***	1·2, 1·4	1·3	***	1·1, 1·4
Scheduled castes	31·7		22·4	40·2		23·1	1·2	***	1·2, 1·3	1·2	***	1·1, 1·3
Other backward classes	NA		NA	95·0	***	22·1	NA		NA	1·0		1·0, 1·1
Other	164·9	***	20·5	125·9	***	23·1	Ref.		–	Ref.		–
Occupation of household head												
Self-employed in non-agriculture	Ref.		–	Ref.		–	Ref.		–	Ref.		–
Agricultural labour	–93·9	***	15·9	5·6		13·9	1·1	***	1·1, 1·2	1·0		0·9, 1·0
Other manual labour	–94·2	***	22·9	–47·7	***	11·4	1·2	***	1·1, 1·3	1·1	**	1·0, 1·2
Self-employed in agriculture	265·0	***	21·6	132·4	***	12·4	0·6	***	0·6, 0·7	0·7	***	0·7, 0·8
Other occupations	69·4	***	16·8	38·9	**	14·2	0·9	***	0·8, 0·9	1·0		0·9, 1·0

RR, relative risk; ref., reference category; NA, not applicable.
Estimates are adjusted for sex of household head, household size, total number of females in the household, religion, free meals at employer, free meals at school, total meals paid, total meals outside the house, number of meals to servants, number of meals to non-household members, state dummy variables, sampling weights and SE clustered at the region level for which National Sample Survey data are representative.
*$P < 0·05$, **$P < 0·01$, ***$P < 0·001$.

The wealth-based gradient was similar to wealth-based nutritional patterns observed in other low- and middle-income countries[32–35]. It is important to note here that disparities in energy intake may remain or widen if no substantial changes in energy intake occur when energy needs among the urban rich decrease and energy needs among the rural poor stay the same. Apart from other causal mechanisms, energy intake disproportionate to physical energy requirements is an important determinant of obesity and diabetes. The SES-based patterns seen in the present study are similar to patterns of concentrated diabetes and obesity risk among richer households, particularly in urban areas[36]. In addition, assessing disparity trends in both average per capita energy consumed as well as whether households meet minimum energy intake requirements can offer different yet critically important pieces of evidence about nutritional status.

Finally, the current study provides evidence that there are fewer SES-based gradients of energy intake in 2011–12 as compared with 18 years earlier, particularly in urban areas. For example, in 2011–12, estimated energy consumption was not patterned by education category among urban households. In addition, the gradient was less steep by education among rural households. However, the risk of undernourishment was still greater in worse-off rural households in 2011–12 according to several other SES indicators. Thus, our study suggests that to address the challenge of undernutrition in India in an equitable manner, improved access to sufficient energy consumption among a range of under-resourced populations may be needed, particularly in rural areas. Providing access to sufficient quantities of food could be combined with other nutrition-focused interventions such as provision of specific micronutrients. Overall, these results detail the nutritional risk for different vulnerable populations and build upon a past study finding evidence that the gradient in energy intake by consumption expenditure still existed but had reduced from 1993–94 to 2011–12[17]. The present study reveals that significant work is needed in India to meet a basic nutritional need in a way that does not hide or further increase the greater nutritional burden among populations already marginalized by location, wealth, education, caste and occupation.

India's anthropometric indicators of nutrition are ranked among the lowest in the world despite rapid growth in gross domestic product. Moreover, undernutrition outcomes are even worse among the lowest-SES groups[4,8–15]. As part of meeting the Sustainable

Development Goal to end hunger and improve nutrition in India by 2030, vulnerable sub-populations must not be left behind (e.g. in terms of consuming minimum energy needed). Keeping track of trends in the energy-based nutrition indicators included in the present study by various SES markers is crucial. For example, agricultural labourers and other casual labourers were most vulnerable to energy deprivations according to our study. These groups may be at nutritional risk due to low utilization of nutritional support programmes for several reasons including cumbersome eligibility requirements and challenges with programme capture[37,38]. Moreover, the present study reveals hidden unmet energy needs among rural households with a relatively decent amount of education (up to 10 years), and among rural ST and SC.

Given the stagnant levels of energy consumption and overall insufficient energy intake evidenced in the present study, particularly among marginalized populations, a focus on institutional provisions and design innovations for improving delivery mechanisms through the Public Distribution System is desirable. However, prior studies have found that programme effects are often biased, with the non-poor sectors receiving greater benefits[37,38]. Use of various guidelines and processes for beneficiary enrolment is often affected by difficult procedures disproportionately affecting the poor at the receiving end[39,40]. Given the critical levels of undernourishment as found in our study, such programmes may need improvements in targeting, administration and monitoring to ensure greater utilization among the poor as defined by different criteria. Dietary diversity requirements is another critical aspect of nutrition that has received less attention in Indian policies and programmes such as the Public Distribution System. Although there are efforts to include dietary diversity in the Mid-Day Meal Scheme programme and within the Integrated Child Development Services programme, uptake of these services is rather poor and quality of supplies needs substantial improvement[41–44]. In addition, future research should assess whether SES patterns of micronutrient intake, specific forms of food intake and consumption of specific food groups have changed over time[45].

There are some issues for consideration when interpreting these findings. First, we cannot determine causal direction of associations given the nature of the data. However, this limitation would not impact results regarding disparity patterns. Second, HCES data may present a few limitations arising from difficulties assessing energy from meals consumed by household members outside the home[46]. Yet, information on foods that were obtained on payment was still included in consumption. Thus, this issue might affect only a very small proportion of the total sample and is not likely to influence the conclusions derived here. Separate, the problem regarding food consumed outside the home may be more about measurement error in relation to the energy conversion rather than capturing of data, in part because several categories of food consumed outside the home were captured. However, the widening food choices in the category of processed foods and snacks may be difficult to convert to energy estimates[47]. Thus, although we directly controlled for the number of meals taken outside the home, the possibility of biases arising from measurement errors remains.

Third, the outcomes used in the present study are based on estimated energy consumption and not actual energy consumption. Recall bias may be introduced as food consumption reports are based on orally given information and not observation nor immediate recording of food and beverage intake. In addition, even though 7 d recall data are available in 2011–12, we use the 30 d recall period as our base of energy estimation for comparability with 1993–94 data, which may introduce further recall bias. Fourth, there may be omitted variables that would change the relationship between SES and energy consumption if included. For example, age distribution within a household could ostensibly influence household-level energy needs and if the distribution changed between the data collection time points, then the trends might differ compared with the results presented here. However, in the current study, 75 % of the population was between the ages of 5 and 49 years at both time points, so there likely would be little impact of household age distribution. Finally, in the present study, consumption is measured at the household level and not at the individual level, although there may be important differences in intra-household allocation of food.

Conclusions

Little progress was made in reducing the prevalence of insufficient energy intake across India between 1993–94 and 2011–12. That is, many households still did not meet minimum energy intake thresholds in both rural and urban areas. In addition, SES-based disparities in average per capita energy consumption as well as in insufficient intake remained clearly present, with poor urban households at greater risk for lower intake as well as rural households with less education, less wealth, lower caste and in the agricultural/casual labour sector. Equitable improvements towards reaching zero hunger and improving nutrition across India will require concerted efforts over time to increase energy intake across households vulnerable to not meeting minimum consumption thresholds, in addition to focusing on providing access to food for selected age groups such as young children and pregnant women. Policies providing access to sufficient energy intake should continue to target low-SES households to reduce nutritional disparities, which did not change substantially between 1993–94 and 2011–12. Finally, when depicting the nutritional state of India using energy as a fundamental component, both a continuous energy measure as well as insufficient energy intake should be utilized to provide a more complete assessment, along with showing these outcomes across different forms of SES.

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Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.1017/S1368980019001484

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