British Journal of Nutrition (2023), 129, 2054–2066 doi:10.1017/S0007114522002847

Transition in dietary quality: evidence from India

Sourabh Paul[1]* and Sohini Paul[2]

[1]*Indian Institute of Technology Delhi, Hauz Khas, New Delhi 110016, India*
[2]*Population Council, India Habitat Centre, Zone 5A, Ground Floor, Lodi Road, New Delhi 110003, India*

(Submitted 27 November 2021 – Final revision received 28 July 2022 – Accepted 30 August 2022 – First published online 7 September 2022)

Abstract

Despite significant economic growth over the past decades, poor nutritional status in India is a serious concern. The social transformation led by growth in income influences both the composition of food and the quality of diet consumed. Against this backdrop of changing lifestyles and the rise in obesity and non-communicable diseases, in this study, we examined changes in diet quality and the critical socio-economic correlates of this quality from 1983 to 2012 using three rounds of nationally representative surveys providing information on food consumption for more than 100 000 households in each round. We constructed diet quality indices at the household level using deficient and excess intake of macro and micronutrients compared with the recommended daily allowances (RDA) for different age-sex groups of the Indian population. We found that in relation to the RDA, fat consumption increased over time while protein and energy consumption decreased. The average diet quality index improved in the rural sector while it deteriorated in the urban sector. Caste and religion are significant correlates of the diet quality index. The deficiency index of nutrients decreased for poor households as they get richer; however, it increased with affluence level for the non-poor. It is suggested that the Indian Government may play a more proactive role in implementing coherent national policies in trade, food and agriculture to protect public health by promoting the demand for a healthy diet.

Key words: Diet quality: Dietary transition: Nutrition: India

India has experienced rapid economic growth and structural transformation[1] during the past decades. These changes in transitional economies often appear to coincide with social changes. Economic growth has also prompted the urban Indian population to adopt a globalised culture befitting the status of an emerging economy. However, despite these socio-economic changes in the country, the population's health status remains disappointing[2]. Various waves of National Family Health Surveys in India reveal that malnutrition continues to be a significant problem for all age groups in India[2]. Moreover, Indians suffer from the dual burden of poor nutrition[1]: approximately 23 % of the women and 20 % of the men are underweight[2]. On the other extreme, around 21 % of the women and 19 % of the men are obese, as revealed by the fourth round of the National Family Health Survey[2]. Obesity is a significant risk factor for several chronic illnesses, including diabetes, heart diseases and cancer[3]. Until recently, obesity was a problem only in high-income countries. However, this phenomenon is rising dramatically in low-income and middle-income countries, especially in urban areas[4]. Worldwide, obesity has nearly tripled since 1975[5].

As the economy develops, the share of expenditure on food falls, and that on non-essential commodities rises, a concept popularly known as Engel's law[6]. Nonetheless, growth in income fosters many social changes, such as a rise in social status and changes in associated perceptions of diet patterns[7,8]. These social transformations have led to changes in tastes and living standards, which significantly influence the composition of food demand and diet quality. Further, consumption patterns are also affected by aggressive marketing and communication strategies, rapid urbanisation and the irresistible demonstration effect[2][7,8]. India is no exception to these trends.

The extant literature describes the dietary transition in India from 1980 to the 2000s in terms of energy/calorie consumption[3,7,9–12]. It has been observed that there has been a decline in cereal consumption while the intake of energy has been compensated by an increase in the consumption of fruits, vegetables and animal fat. Hence, the intake of

[1]Double/dual burden refers to the co-existence of underweight and obesity.

[2]The demonstration effect indicates the consumption habit of people to imitate consumption trends followed by other people.

Abbreviations: DI, deficiency index; EAR, estimated average requirement; EI, excess index; MPCE, monthly per capita consumption expenditure; NSS, National Sample Survey; RDA, recommended daily allowance; SC, scheduled caste; ST, scheduled tribe; TUL, tolerable upper limit.

* **Corresponding author:** Sourabh Paul, email sbikas@gmail.com

energy content has decreased, but protein and fat have increased[8].

The structural shift of food consumption away from cereals and towards a more fat-intensive diet, known as the nutrition transition[3], has been observed in many developing countries[13]. In contemporary China, the per capita energy consumption declined in the 1980s and 1990s[14] points out modern China has witnessed several nutritional transition periods. Following the reforms in 1979, China experienced rapid economic growth. Since 1985, total energy intake had decreased mainly due to a decline in cereal consumption. While the proportion of protein sources in the total energy consumption has not changed, that of fat sources has increased by almost 100 %[15] find a similar historical episode of stagnation or even decline in food consumption despite increased real wages in Britain from 1775 to 1850.

The negative relationship between energy consumption and income in India depicted through the Engel curve is the 'Indian calorie puzzle'[16–19]. A plausible explanation for the falling energy intake is the rise in income over time, which, in turn, leads to changes in food habits and the declining need for energy content due to lower levels of physical activities or improvement in the health environment[16,20]. However, these changes may not imply the absence of an energy deficit among the Indian population, as pointed out by the authors.

Existing literature across the globe showed that diet quality varies across age, sex, race/ethnicity, income and education level, implying an association between diet quality and socio-economic characteristics of the individuals[21–23]. The pattern and quality of diet vary widely across different regions of India. However, not much variation is observed across sex[24]. The traditional cereal-based diets are predominant in rural areas, particularly among agricultural households with low income and land endowments. A dairy diet including low cereal consumption and a high intake of dairy products is popular among the high-income households in rural areas. Another finding is the typical consumption of a diet dominated by processed food among high- and middle-income households in rural and urban India[11]. Although there is no clarity on the relation between diet and disease in the Indian context due to data limitations and methodological shortcomings, it can be said with certainty that consumers of a fat-intensive diet are more likely to have a higher BMI[24]. In contrast, a diet rich in sweets and snacks is associated with a greater risk of diabetes than a traditional diet dominated by rice and pulses[24].

The existing literature documents the dynamics of transition in diet quality in the Indian context, based mainly on the content of macronutrients in the food intake, which underscores the peculiar trend in aggregate energy consumption. However, micronutrients also play a crucial role in preventing diseases and ensuring the maintenance of a proper metabolism and tissue function[25]. According to the guidelines published by[26], 'micronutrient malnutrition contributes substantially to the global burden of disease . . . In addition to the more obvious clinical manifestations, micronutrient malnutrition is responsible for a wide range of non-specific physiological impairments, leading to reduced resistance to infections, metabolic disorders, and delayed or impaired physical and psychomotor development'.

To the best of our knowledge, none of the related studies has examined how the above-mentioned dietary transition has taken place if we account for a change in the consumption of micronutrients and macronutrients. To address the research gap, in this article, we studied changes in diet quality from 1983 to 2004–2005 using diet quality indices incorporating macro and micronutrients. We also identified socio-demographic factors associated with the changes.

Methods

Data

We used the unit-level record of the consumption schedule of National Sample Surveys (NSS) at the household level for analysis. NSS data were used widely to study food consumption and diet quality-related research questions, including the pioneering work on food consumption by[16] and[27].

The National Sample Survey Organisation, set up by the Government of India, conducted various rounds of sample surveys to collect socio-economic data. Each round was earmarked for covering a particular subject. We selected three specific 'thick' rounds, viz., the 38th, 61st and 68th rounds, conducted in 1983, 2004–2005 and 2011–2012, respectively, to reflect any changes in the long run, spanning the period before and after the economic reforms undertaken in 1991. NSS collected samples from all the geographical parts of India except some remote pockets of Jammu and Kashmir, the Andaman and Nicobar Islands and the northeastern States. After cleaning the outliers[3], we were left with 103 210, 124 643 and 101 637 households in the 38th, 61st and 68th rounds.

The NSS followed multi-stage stratified sampling, with rural and urban areas being the first-stage strata in each State. Almost 71 % of the households in our working sample were from rural areas in 1983, which fell to 64 % and 59 % in 2004–2005 and 2011–2012, respectively. The consumption schedule collected information on several household-level demographic and economic characteristics. It also collected data on the age, sex, marital status and education of the household members, among other things. The respondents were asked to recall their consumption expenditure in rupees and the physical quantity, whenever appropriate, on more than 300 items. Among these, more than 145 were food items for a recall window of 30 d and 365 d, depending upon the spending frequency. The total consumption spending on each item included consumption from the market and consumption from home-grown production valued appropriately at locally prevailed prices. The lists of items were very similar in all the rounds, which helped maintain consistency over time reasonably well. The field survey was conducted in four sub-rounds throughout the year, which helped to minimise any seasonality in consumption spending. A list of items and their broader grouping was provided in the Appendix. The

[3]We have removed outliers by inspecting calculated household monthly per capita consumption expenditure (MPCE). We avoided any statistical formula to truncate from above as it is hard to distinguish whether these households are truly rich or there are some measurement/reporting errors in the survey. We dropped two households in 1983, one household in 2004–2005 and 17 households in 2011–2012 with MPCE extremely high compared to the rest of the households in the top percentile.

surveys did not collect data on household income since it was believed that any such attempt would introduce a response error. Therefore, we followed the standard practice in the literature of relying on total consumption spending or outlay instead of total income[28,29].

Consumption spending on food did not necessarily reflect the actual consumption. Households bought food both for their own consumption and for guests and other non-members. Similarly, household members took meals from outside. Therefore, we adjusted the actual nutritional intake using conversion factors derived from the number of meals served to guests and the number of meals procured from outside. Details of this methodology are discussed in the methodology sub-section of the 'Methods' section. The NSS collected information on a number of ceremonies during the recall period, and the number of guest meals served during ceremonies and on any other day. NSS data also contained information on the number of outside meals consumed by each household member. We used poverty lines in terms of the monthly per capita expenditure in rupees, published by the Planning Commission (NITI Aayog) of India, as a deflator to convert nominal quantity to real quantity.[4] The poverty line of rural Maharashtra in 1983 was used as a base, and nominal quantities were converted to real quantities based on the information for rural Maharashtra in 1983.

Methodology

The nutrient values of food items consumed by households were calculated by applying the conversion factors, as reported in[30], for each disaggregated food item[30] gave the amount of macro and micronutrients contained per 100 g of different food items predominantly consumed in South Asian countries. The food items covered in this source are near universal. For example, 100 g of a green gram or *Moong Dal* (a type of pulse) contains 25 g of protein, 1 g of fat and fibre each, 60 g of carbohydrate, 75 mg Ca, 405 mg P, 4 mg Fe, 49 sigma g carotene, 0·47 mg thiamine, 0·21 mg riboflavin and 2·4 mg niacin. We followed the following steps to arrive at the total nutrient intake at the household level. First, we converted the quantities of nutrients per 100 g of food items to the compatible units in the NSS survey data. For example, if 100 g of *Moong Dal* contains 25 g of protein, we converted it to per kilogram unit, that is, 240 g of protein per kg of *Moong Dal*, because the NSS survey recorded pulses consumption in kilogram.

There are some food items for which the value of consumption (in rupee) is available instead of quantity. For these items, the conversion factor is derived using an inflation-adjusted rupee unit, that is, nutrients are given per rupee value worth of the food item consumed. We use general consumer price indices for rural and urban areas to adjust for inflation. Second, we multiplied the quantity/value of consumption of each food item by the corresponding conversion factor for the nutrients separately. Finally, we added nutrient values from all food items consumed by a household. This is repeated for each nutrient separately. Thus, we arrive at the intake of twelve nutrients at the household level.

[4]We use the mixed reference period poverty line for the 61st and 68th rounds and the uniform reference period poverty line for the 38th round.

The estimates of total energy content and nutrients of different food groups were thus derived by aggregating the overall food items in that food group. Some food items were reported in value (Rs.) only, and some had ambiguous quantity units. The nutrient conversion for these items had been done based on the nutrient per constant rupee unit, as suggested in[31]. It is important to note that the nutrient consumption thus derived might not reflect the accurate estimate of nutrient intake.

The total quantity of food reported as consumed by a household may be divided into three components: (1) number of meals served to household members (M_h), (2) number of meals served to guests (M_g) and (3) the number of meals served to employees (M_e). The number of free meals taken by household members from outside as guests or employees (M_f) was not reflected in the reported quantity. All this information had been collected for the recall period. Following[32], the adjusted nutrient intake was given by

$$N_a = N\frac{M_h + M_f}{M_h + M_g + M_e}$$

where N_a is the adjusted nutrient intake, and N is the nutrient intake calculated based on the reported quantity. The nutrient requirement is not the same for all individuals. Therefore, relying on a single value for such a requirement is misleading. Two important features of the distribution of the requirement of nutrients are used in the literature to define the deficiency of a nutrient. First, the median of the distribution is called the estimated average requirement (EAR). This value is useful to evaluate the nutrient intake of a population. However, it should be noted that 50 % of the population may have the requirement more than the EAR. Second, the 97·5th percentile of the distribution is called recommended daily allowance (RDA). The RDA value is useful to prescribe nutrient requirements for healthy individuals in different age-sex groups and ensures a very small probability that an individual requires a higher nutrient intake than the RDA value. In essence, diet planning for a population should be based on the EAR, whereas diet planning for an individual should rely on RDA. As we analyse the nutrient intake at the household level and find the structural correlates of dietary quality, we use RDA values to calculate the index. We calculated the household-level RDA of nutrients using the RDA of nutrients and energy by age and sex groups published by[33]. The aggregate RDA at the household level had been derived using a number of household members in the twelve age/sex groups and their corresponding RDA.

A balanced diet consists of four significant sources of energy – carbohydrates, proteins, fat and fibre – and different vitamins, minerals and salts. Using[23], we calculated the diet quality index of households. Twelve essential nutrients were used to calculate the deficiency index (DI). The deficiency score for each nutrient was given by

$$d_i = 100 \times \min\left(1, \frac{x_i}{RDA_i}\right)$$

where x_i is the amount of nutrient i consumed and RDA_i is the recommended daily allowance of nutrient i. This score was bounded between 0 and 100 (the perfect score). A higher score implies that the daily allowance was closer to the recommendation. As mentioned earlier, we considered the following macro and micronutrients – carbohydrates, proteins, fat, fibre, Ca, P, Fe, carotene, thiamine, riboflavin, niacin and vitamin C. The household-level DI had been derived by summing up the deficiency score, d_i, comprising twelve nutrients overall. Therefore, the DI took a value between 0 and 1200, and a higher score implied better diet quality.

Several nutrients are harmful if taken excessively. Tolerable upper limit (TUL) is the highest average daily nutrient intake that is likely to pose no risk of adverse health effects for the population. Therefore, EAR < RDA < TUL. An appropriate approach to calculating the TUL should consider age-sex wise subpopulation. The scientific evidence of establishing TUL for different nutrients is at the early stage for the Indian population. In the latest ICMR – National Institute of Nutrition study[34], the expert group published the EAR and TUL values for the first time, in addition to updating the RDA values. Ref. (23) defined a similar index, called the excess index (EI), for these nutrients using the RDA values. The TUL values were approximately between 2 and 3 times the RDA values. Following[23], we used a simplistic approach to calculate the EI in our analysis. If the nutrient intake was twice the RDA value, we categorised it as risk posing[5]. We calculated the EI of fat[6] using their methodology. The excess score was defined as

$$e_i = 100 - 100 \times \left(\max\left(1, \min\left(2, \frac{x_i}{RDA_i}\right)\right) - 1\right).$$

Therefore, e_i was bounded between 0 and 100. Households with fat intake below the RDA got a perfect score of 100, and households with more than the double RDA got a minimum score of 0. Since we had considered only fat for calculating the EI, the EI also took a value between 0 and 100. It was worth noting that a higher index (both EI and DI) implied better diet quality. We used χ^2 test to verify whether percentage change in diet quality index over time is statistically significant.

We regressed diet quality indices on household-level socioeconomic characateristics such as social groups (scheduled caste (SC)/scheduled tribes (ST)/other castes), religion, rural/urban residence and monthly per capita consumption expenditure (MPCE). By construction, DI is bounded between 0 and 1200 and EI is bounded between 0 and 100. Therefore, we used Tobit model which is appropriate in such censored regression specification[35].

Let y^* be the latent diet quality index of households and

$$\begin{aligned} y^* = {} & \beta_0 + \beta_1 log(realMPE) + \beta_2 (log(realMPCE))^2 + \beta_3 children + \beta_4 adult\_male \\ & + \beta_5 adult\_female + \beta_6 muslim + \beta_7 SCST + \beta_8 head\_female + \beta_9 head\_age \\ & + \beta_{10} urban + \textstyle\sum_{i=2}^{4} \gamma_i head\_edu_i + \sum_{i=2}^{31} \delta_i state_i + \sum_{i=2}^{4} \theta_i sub\_round_i + u \end{aligned}$$

where $SCST$ is a dummy for SC and ST and $head\_edu_i$ is the education dummy for the education of the household head. We defined the following five education categories: illiterate, below primary level, primary level, middle school and secondary level or above. Education and demographic composition of households are potential confounders because some religious and social groups are less educated, and education could influence the diet choice. Similarly, the composition of household members may influence the diet quality, and these variables could be correlated with some of the included regressors. Children were defined as household members aged below 15 years. We also controlled the geographical effect using State dummies and the seasonal effect using sub-round dummies. Muslim dummies and SC/ST dummies were used to assess whether social or religious affinity affected diet patterns. Therefore, the inclusion of these factors is warranted to maintain the exogeneity assumption[36]. We also note that despite all these controls, we still cannot rule out potential omitted variable bias due to a lack of information on some important factors.

A normal error structure had been assumed. The observed diet quality index (calculated index) y was censored by the upper (ul) and lower (ll) bounds, that is,

$$y = \begin{cases} y^* \;\&\; if \;\&\; ll \le y^* \le ul \\ ll \;\&\; if \;\&\; y^* < ll \\ ul \;\&\; if \;\&\; y^* > ul. \end{cases}$$

We estimated the above equation using Tobit regression for the DI and EI in 1983, 2004–2005 and 2011–2012 separately.

Results

Before presenting the main regression results, we discuss some interesting summary statistics about nutritional intake. Table 2 reports the proportion of households meeting the recommended allowances for energy content, protein and fat intake. Only 46 % of the rural households met the recommended energy demand per day in 1983, dropping to 31 and 22 % in 2004–2005 and 2011–2012, respectively. The corresponding figures for the urban sector were 30, 20 and 12 %, respectively. This drop in the proportion of households meeting the RDA of energy content is driven mainly by a drop in carbohydrate and protein intake. During this period, the distributions of the ratios of the actual nutrient intake to the RDA have shifted left except in the case of fat (Fig. 1). The proportion of households meeting the RDA in fat intake increased annually by 0·02 % points in rural areas and by 0·01 % points in urban areas from 2004–2005 to 2011–2012 as compared with corresponding figures of 0·07 % points and 0·04 % points between 1983 and 2004–2005. Almost 69 and 74 % of the urban households met the recommended daily fat intake in 2004–2005 and 2011–2012, respectively. However, 52 and 40 % of them met the protein intake in 2004–2005 and 2011–2012, respectively. This disproportionate increase in fat intake is evident in Fig. 1. Households are closer to consuming their recommended daily protein and carbohydrate allowances in 2011–2012 compared with 1983. While the absolute numbers of households that do not meet the RDA in energy and fat intake (Table 2) show a disappointing nutrition status in India, changes in the distribution of protein/RDA and carbohydrate/RDA clearly signal a positive message.

[5]Changing the limit to 3*RDA does not change the main conclusion.

[6]We also estimated the excess index by including protein, carbohydrate, fat, Ca and Fe, in addition to fat. The detailed result is presented in Appendix Table A4 and found that the result is robust.

https://doi.org/10.1017/S0007114522002847 Published online by Cambridge University Press

Table 1. Per capita per diet intake

	1972–1973	1983	1993–1994	1999–2000	2004–2005	2011–2012
Energy (kcal)						
Rural	2266	2221	2153	2149	2047	2099
Urban	2107	2089	2071	2156	2020	2058
Protein (g)						
Rural	62	62	60	59	57	57
Urban	56	57	57	59	57	56
Fat (g)						
Rural	24	27	31	36	36	42
Urban	36	37	42	50	48	53

Source: NSSO Report 2007 except for 2011–2012, which has been calculated by the authors using unit-level data.

Table 2. Percentage of households meeting the recommended daily allowances

1983				2004–2005			2011–2012		
Nutrient	Mean	Poorest quartile	Richest quartile	Mean	Poorest quartile	Richest quartile	Mean	Poorest quartile	Richest quartile
Rural									
Energy	46·39	16·63	80·05	30·69	13·12	57·94	21·80	10·04	40·13
Protein	67·90	49·29	87·95	59·65	44·12	81·55	50·41	34·53	69·25
Fat	26·46	5·55	62·14	44·38	17·69	83·92	54·07	30·93	81·90
Urban									
Energy	30·22	10·19	62·73	20·14	7·21	40·24	12·34	4·94	22·95
Protein	58·36	39·99	82·62	51·77	37·27	71·27	39·87	25·73	55·65
Fat	48·88	15·91	93·97	69·32	31·40	97·41	74·10	49·39	90·43

Source: Authors' calculation. Note: the poorest and richest quartiles are based on the monthly per capita household expenditure.

The thicker positive 'tail' of fat/RDA distribution can possibly explain the higher incidence of obesity, specifically in urban India.

Table 3 reported how diet quality indices behaved during the same period. The DI improved annually in rural and urban areas by the same magnitude (0·004 % points) during 1983 to 2004–2005. However, it worsened by 0·002 % points and 0·004 % points per year during 2005–2012. The EI increased by 0·01% points annually during 1983 to 2004–2005 in both rural and urban areas, while it decreased by 0·01 % points per year and by 0·004 % points per year in the rural and urban sectors, respectively, during 2004–2005 and 2011–2012.

We now present the result of the censored regression in Table 4. More educated households (measured by the education of the household head) chose to consume a poor-quality diet in terms of both the deficiencies of healthy nutrients and an excess of unhealthy nutrients (the summary statistics of DI are presented in the Appendix). Poorer households (proxied by consumption expenditure) tend to consume a diet that is lacking in important nutrients, whereas richer households consume a poor-quality diet in terms of the EI. However, this relationship is non-monotonic as depicted by significant quadratic terms of log(MPCE). Households belonging to the Muslim community have a significantly low DI and a high EI compared with the households belonging to other religious groups. The same is true for the SC and ST. There is a statistical difference between the rural and urban households' diet quality. As expected, urban households choose diets with an excess of unhealthy nutrients.

These correlates of the diet quality also change over time as depicted in columns 1983, 2004–2005 and 2011–2012 in Table 4. Though the urban households had better DI in earlier decades (1983–2005), evidence shows that DI for urban households is significantly lower in 2011–2012 compared with the rural households. We find that the number of children is positively associated with diet quality, whereas adult males and females have a contrary association (except for the year 1983). It should be noted that these associations are significant after controlling for the affluence level [log(realMPCE)], the household head's education level, geographical effects (State dummies) and seasonal effects (sub-round dummies)[7].

As we observe in Table 4 that the coefficients of the quadratic terms of log(MPCE) are statistically significant, and the non-monotonic relationship between the diet quality indices and affluence level of the household is derived in Fig. 2. A few interesting observations are as follows:

(1) The DI is non-linearly associated (inverted U-shaped) with the income status of the household (proxied by the MPCE). The diet quality of poor households improves as they get richer, but the relationship between income and diet quality becomes negatively sloped once they escape the poverty trap.

[7]To check the robustness of the results, we re-ran the regression analysis for diet quality index by dropping the food items where only rupee values are reported, and quantities are not available. The results are reported in the Appendix (ref: Table A2). We found that the results are robust throughout.

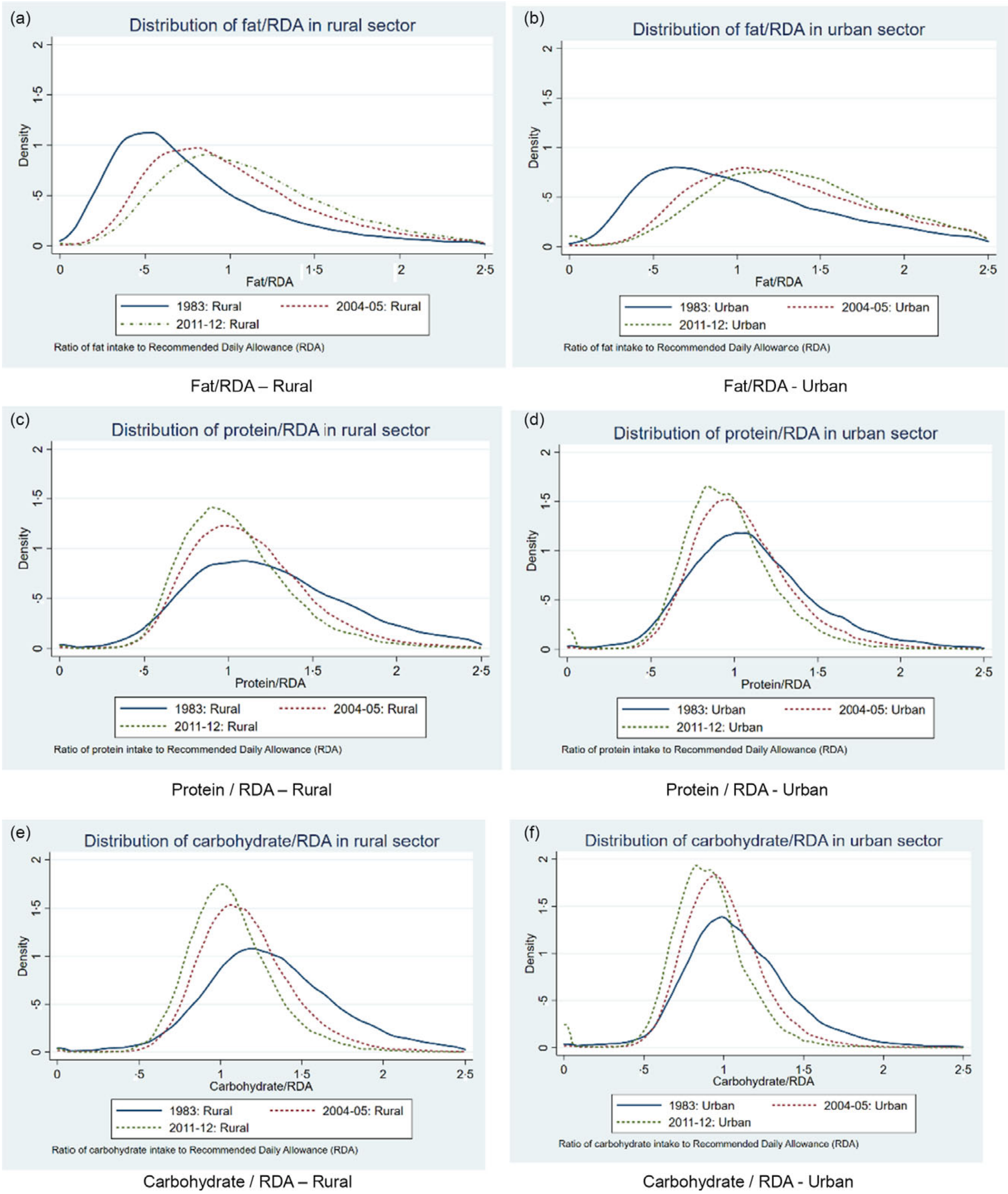


Fig. 1. Distribution of households by the ratio of intake of nutrients to the recommended daily allowance (RDA).

(2) In 1983, the EI was monotonically negatively associated with the affluence level, that is, the diet quality in terms of the EI deteriorated as households became richer. However, the relationship was no longer negative for the non-poor households in 2004–2005 and 2011–2012.

(3) The DI has deteriorated, and the EI has improved over time for the non-poor households.

(4) Diet quality in terms of an EI for households below the poverty line is marginally lower now than it was 20 years ago. This is driven by the fact that even the poorer sections of

British Journal of Nutrition

Table 3. Average diet quality index and its change over the time (Mean values and standard deviations)

	1983		2004–2005		2011–2012		Change (%)*			
	Mean	SD	Mean	SD	Mean	SD	1983–2004–05		2004–2005 – 2011–2012	
Rural										
DI	873·89	149·52	911·92	117·65	892·94	118·19	4·35	0·00	−2·08	0·00
EI	87·91	26·76	80·45	31·05	75·46	32·90	−8·49	0·00	−6·20	0·00
Urban										
DI	897·21	156·28	933·72	118·13	891·97	158·80	4·07	0·00	−4·47	0·00
EI	72·81	37·33	61·19	38·80	58·67	37·78	−15·97	0·00	−4·12	0·00

DI, deficiency index; EI, excess index.
Source: Authors' calculation.
* *P*-value of χ^2 for the statistical significance of the change is reported.

Table 4. Censored (Tobit) regression model of diet quality index

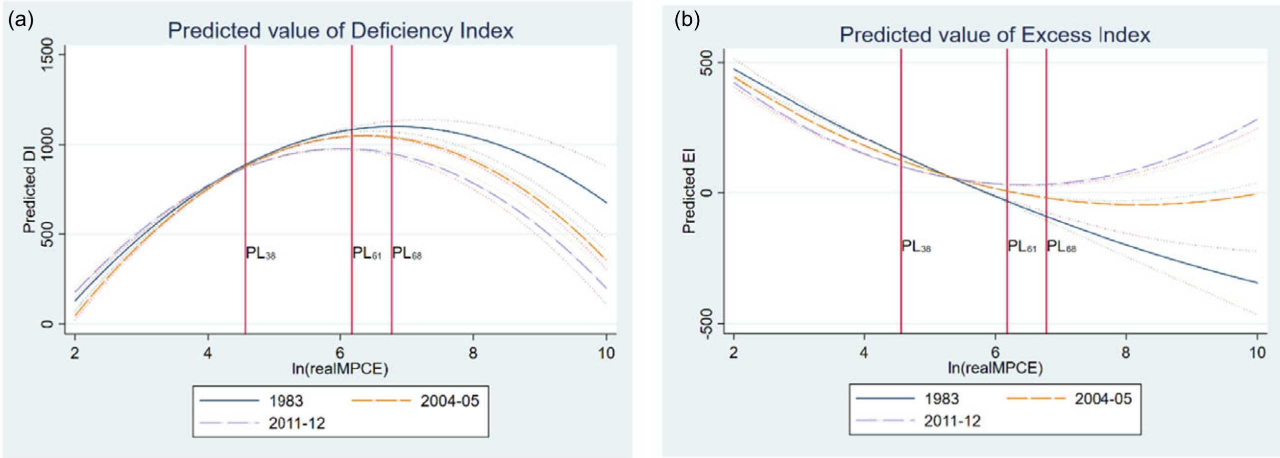
	DI			EI		
	1983	2004–2005	2011–2012	1983	2004–2005	2011–2012
Log (MPCE)	571·4***	670·2***	595·1***	−162·5***	−210·3***	−241·0***
	(36·62)	(12·28)	(19·17)	(22·51)	(9·67)	(7·22)
Log (MPCE)^2	−41·91***	−52·63***	−49·37***	5·00**	12·84***	18·44***
	(3·89)	(1·164)	(1·950)	(2·29)	(0·94)	(0·69)
No. of children	1·93***	3·68***	4·26***	2·19***	2·94***	4·26***
	(0·28)	(0·27)	(0·51)	(0·20)	(0·17)	(0·26)
No. of adult male	−7·63***	−6·95***	−12·78***	2·79***	2·82***	5·29***
	(0·52)	(0·46)	(0·76)	(0·33)	(0·26)	(0·34)
No. of adult female	−1·53**	0·60	4·34***	−2·57***	−1·71***	−1·54***
	(0·61)	(0·50)	(0·86)	(0·38)	(0·29)	(0·38)
Muslim (base: other religion)	−7·37***	−5·29***	−8·43***	6·44***	3·37***	1·74**
	(1·36)	(1·35)	(1·75)	(0·95)	(0·75)	(0·86)
Schedule caste/schedule tribe (base: other caste)	−8·58***	−9·43***	−10·25***	9·28***	7·93***	6·60***
	(1·15)	(0·96)	(1·43)	(0·86)	(0·54)	(0·69)
Female headed household	−9·03***	−4·11***	−13·30***	−1·53	−2·92***	−1·07
	(1·69)	(1·50)	(2·43)	(1·05)	(0·79)	(1·05)
Age of household head	−0·22***	−0·02	0·92***	0·062**	−0·04**	−0·25***
	(0·03)	(0·03)	(0·07)	(0·02)	(0·02)	(0·03)
Urban (base: rural)	14·17***	14·25***	−21·82***	−25·81***	−18·49***	−2·35***
	(1·09)	(1·02)	(1·40)	(0·68)	(0·55)	(0·59)
Education of the head: below primary (base: illiterate)	−13·04***	−1·45	−2·13	1·33	−1·91***	−1·35
	(1·34)	(0·97)	(2·05)	(0·90)	(0·55)	(1·02)
Education of the head: primary level	−12·72***	−2·22	−2·17	−0·62	−3·90***	−0·97
	(1·32)	(1·55)	(1·98)	(0·86)	(0·83)	(1·03)
Education of the head: secondary level	−8·73***	−5·80***	0·11	−4·59***	−3·95***	−3·12***
	(1·55)	(1·86)	(2·04)	(0·96)	(1·04)	(0·93)
Education of the head: secondary level and above	−10·75***	−6·52***	0·29	−8·29***	−4·49***	−5·54***
	(1·84)	(1·74)	(1·75)	(0·98)	(1·03)	(0·85)
N (sample size)	103 050	124 641	101 637	103 050	124 641	101 637
Pseudo R^2	0·06	0·05	0·03	0·18	0·15	0·11
F(43, N-47)	1147·18	1064·12	538·59	529·66	728·77	422·89

DI, deficiency index; EI, excess index; MPCE, monthly per capita consumer expenditure.
Source: Authors' calculation. Note: Robust standard errors are in parentheses.
* $P<0$, **$P<0{\cdot}05$, ***$P<0{\cdot}01$.

society change their preferences from low-cost nutrient-rich foods to oily and fatty products.

The finding of better diet quality in the urban sector in 1983 and 2004–2005 is seemingly contradictory to the result depicted in Table 1. In Table 1, the rural sector has a higher per capita energy and protein intake. However, it should be noted that the diet quality index is an unweighted[8] sum of all the twelve nutrients, not just the significant sources of energy. Therefore, the rural sector may have a higher energy intake, but at the same time, the urban sector may enjoy a better diet quality as the average urban diet is rich in other nutrients. The reversal pattern of diet quality in urban India in 2011–2012 indicates a declining consumption of micronutrients compared with rural areas. It is interesting to note that the higher education level of the head of household does not help improve the diet quality.

[8]To check the robustness of the result, we assigned weights to the twelve macro and micronutrients following the priority matrix for micronutrients developed by Cavelaars et al. (2010)[42] and re-ran the censored Tobit regressions for weighted deficiency index. The results remain the same. The detailed regression table is reported in the Appendix (ref: Tables A3 and A4).



Deficiency Index Excess Index

Note: Predicted over 50 specified values of ln (real MPCE) at mean values of other covariates. Dotted lines are twice the standard error confidence band using bootstrapping. The vertical lines correspond to the poverty lines in different years (NSSO rounds).

Fig. 2. Monthly Per Capita Consumer Expenditure (MPCE) and diet quality index.

Discussion

Against the backdrop of the dual burden of poor nutrition in India, we study the changes in diet quality and the critical socio-economic correlates of this quality from 1983 to 2012. This period also coincides with rapid socio-economic transformation influencing the composition of food and diet quality. Instead of focusing only on the significant macronutrients, we constructed more holistic indices of inadequate intake of essential nutrients and excessive fat intake. The links between income (proxied by expenditure), social identities and nutrition in India are explored through a regression model. We find that fat consumption in comparison with RDA increased over time while protein and energy consumption decreased as compared with RDA, which is similar to the findings of relevant literature.

Interestingly, fat consumption among the wealthiest Indians decreased during the period 2004–2005 to 2011–2012. The average diet quality index, inclusive of macro and micronutrients, improved in the rural sector while it deteriorated in the urban sector from 1983 to 2004–2005. It has been observed that the diet quality in 2011–2012 was worse in urban India than in rural India after controlling for MPCE. Urban households consume more fat-based energy content instead of other cheap and healthy food sources. The diet quality of Muslims and SC/ST is significantly lower (Tobit regression coefficient varies between −5·3 and −10·3) compared with other religions and castes in terms of DI. In contrast, these marginalised groups fared better in the EI, with the regression coefficient varying between 1·7 and 9·3. However, the education level of the household head is not found to be significant in determining the diet quality over time.

We derived two interesting conclusions on the relationship between affluence level and diet quality from (1) comparing the cross-section of households at a particular time and (2) comparing the same income group over time. When we analyse the cross-section of households at a particular time, there is a non-monotonic relationship between the diet quality indices and the affluence level of households. The poor households overcome the deficiency of essential nutrients as they get richer. However, the relationship becomes negative once they escape the poverty trap. That means, for the non-poor segment of the society, deficiency is higher as they get richer. This revelation requires further research to identify the causes of such a non-monotonic relationship. On the other hand, as families get richer, they tend to consume food with excess fat. However, this relationship changed in recent times as observed comparing the same income groups over time.

We get another interesting conclusion when we compare the relationship between diet quality and affluence level over time. A popular conjecture is that poor households might have improved their diet quality significantly in terms of deficiency, and wealthy families might have deteriorated diet quality in terms of excess intake of fat over time. However, the results of our analysis show a different trend between 1983 and 2011–2012. The deficiency and EI had not changed much for poor households. In contrast, the DI had deteriorated, and the EI had improved for non-poor families in 2011–2012 compared with 1983.

Our study has the following limitations. (i) An ideal dataset for analysing transition in diet quality over time is the individual-level food consumption recall data. However, we used the household food consumption data since nationally representative individual-level data do not exist for India. (ii) The latest available dataset used in our analysis is 2011–2012 since no other recent nationally representative household consumption survey data are available. Though NSS conducted a household consumption survey in 2017–2018, the data were not released because of quality concerns raised by the government of India. (iii) We had dropped some food items, categorised as 'other beverages', 'other processed foods' and 'other fresh fruits', from our analysis due to the ambiguous measurement unit and nutrient conversion factors. These dropped items had a minimal expenditure share. However, it appeared that these items were consumed mainly by the rich. Therefore, if this omission introduced some error, it would lead to an underestimation of the nutritional intake only for the rich. Since we were interested in examining changes in nutritional intake, these biases should not affect our result as we apply the same procedure for all the rounds.

Changes in diet quality reflect the interaction of demand and supply factors. The demand factors include rapid income growth and urbanisation, which have created new dietary needs and, more importantly, growing affluence and changes in lifestyle. Demand is triggered by the expansion of the middle class, high female participation in intra-household decision-making on food consumption, the emergence of nuclear two-income families and a sharp generational divide in food preferences, with the younger cohort more inclined to consume new food that is attractively advertised in the media. Exposure to global 'urban' eating preferences also increases with growth in incomes[8]. Evidence also suggests greater reliance of small and poor households on street foods. Food outlets in urban slums often mimic the branded products offered by fast-food outlets[37]. On the supply side, the critical determinants associated with the availability of food include the closer integration of global economies, local crop diversification and availability of food, liberalisation of foreign direct investment and the sharp reduction in freight and transportation costs[37] argue that there is no close link between income and energy consumption[16]. The health implication of a dietary transition, though not very clear, undoubtedly leads to the growing risk of NCD[38]. India has, in recent years, experienced a rapid epidemiological transition with a shift in the disease burden to NCD. Nearly 5·8 million people in the country die from NCD, that is, heart and lung diseases, stroke, cancer and diabetes, every year[39]. In other words, one in four Indians faces a risk of dying from an NCD before reaching the age of 70 years[40]. Dietary imbalance and rise in the incidence of chronic diseases and under-nutrition impose a heavy health burden on national budgets and institutions. Both the Government and individuals face the significant challenge of dealing with malnutrition in any form.

In order to combat NCD, the Ministry of Health and Family Welfare of the Government of India has implemented the National Programme for the Prevention and Control of Cancer, Diabetes, Cardiovascular Disease and Stroke to increase awareness about the risk factors, to set up infrastructure and to carry out opportunistic screening at the primary health care levels. However, to reduce the risk of NCD, it is simultaneously crucial to promote a healthy lifestyle characterised by proper nutritional intake and measures to address all forms of under-nutrition[41].

The Indian Government could play a key role in creating a positive food environment that empowers people to adopt and maintain healthy dietary practices. As recommended by[26], the viable actions of the Government may focus on creating coherence in national trade, food and agricultural policies and the investment plan. There may be incentives for producers and retailers to grow, use and sell fresh fruit and vegetables. The implementation of taxes on saturated fat, salt, sugar and sweetened beverages and offering subsidies on fruits and vegetables could be viable options for promoting the consumption of a healthy diet to curb the growing burden of obesity and NCD. Modifications could be undertaken in the Public Distribution System provisions to promote balanced diets across rural and urban sectors and different social groups. The demand for healthy foods and meals among consumers may be encouraged by promoting awareness about a healthy diet among consumers, by developing school policies and programmes that encourage children to adopt and maintain a healthy diet and by providing nutrition and offering dietary counselling regularly in primary care facilities. Government policies also need to promote and enforce appropriate infant and young child feeding practices.

Acknowledgements

We are thankful to Ashok Kotwal, Amartya Lahiri, Patrick Francois and anonymous referees for their insightful comments.

Authorship: Sourabh Paul: Conceptualization, Methodology, Validation, Formal analysis, Resources, Writing – original draft, Writing – review & editing Sohini Paul: Conceptualization, Methodology, Validation, Formal analysis, Resources, Writing – original draft, Writing – review & editing.

There are no conflicts of interest.

References

1. Erumban AA, Das DK, Aggarwal S, *et al.* (2019) Structural change and economic growth in India. *Struct Change Econ Dyn* **51**, 186–202.
2. IIPS (2016) National family health survey (NFHS-4), 2015–2016, India Fact Sheet. Mumbai: International Institute for Population Sciences (IIPS) and Macro International. http://rchiips.org/nfhs/factsheet_NFHS-4.shtml (accessed September 2021).
3. Law C, Green R & Kadiyala S (2019) Purchase trends of processed food ands and beverages in urban India. *Glob Food Sec* **23**, 191–124.
4. World Health Organization (2021) Obesity and Overweight. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight (accessed September 2021).
5. World Health Organization (2016) World Health Statistics 2016: Monitoring Health for the SDGs, Sustainable Development Goals. World Health Organization. https://apps.who.int/iris/handle/10665/206498 (accessed September 2021).
6. Mankiw NG (2016) Principles of Microeconomics, 8th ed. Boston, MA: CENGAGE Learning Custom Publishing.
7. Gaiha R, Jha R & Kulkarni V (2013). Demand for nutrients in India: 1993 to 2004. *Appl Econ* **45**, 1869–1886.
8. Gaiha R, Kaicker N, Katsushi I, *et al.* (2014) Dietary shift and diet quality in India: an analysis based on 50th, 61st and 66th rounds of NSS. In *Handbook of Food 8*, pp. 177–203 [R Jha, R Gaiha & AB Deolalikar, editors]. United Kingdom: Edward Elgar Publishing.
9. Shetty P (2002). Nutrition transition in India. *Public Health Nutr* **5**, 175–182.
10. Kumar P & Mruthyunjaya MMD (2007) Long-term changes in Indian food basket and nutrition. *Econ Polit Weekly*, **42**:3567–3572.
11. Tak M, Shankar B & Kadiyala S (2019) Dietary Transition in India: temporal and regional trends, 1993–2012. *Food Nutr Bull* **40**, 254–270.

12. Siddiqui MZ, Donato R & Jumrani J (2019) Looking past the Indian calorie debate: what is happening to nutrition transition in India. *J Dev Stud* **55**, 2440–2459.
13. Drewnowski A & Popkin BM (1997) The nutrition transition: new trends in the global diet. *Nutr Rev* **55**, 31–43.
14. Du S, Lu B, Zhai F, *et al.* (2002) A new stage of the nutrition transition in China. *Public Health Nutr* **5**, 169–174.
15. Clark G, Huberman M & Lindert PH (1995) A British Food Puzzle, 1770–1850. Econ Hist Rev 48, 215–237.
16. Deaton A & Drèze J (2009) Food and nutrition in India: facts and interpretations. *Econ Polit Wkly* **XLIV**, 42–65.
17. Basole A & Basu D (2015) Fuelling calorie intake decline: household-level evidence from rural India. *World Dev* **68**, 82–95.
18. Smith L (2015) The Great Indian calorie debate: explaining rising under-nourishment during India's rapid economic growth. *Food Policy* **50**, 53–67.
19. Hazarika G & Paul SB (2021) India's calorie consumption puzzle: insights from the stochastic cost frontier analysis of calorie purchases. *Empirical Econ* **60**, 2993–3010.
20. Eli S & Li N (2012) Can Caloric needs Explain Three Food Consumption Puzzle? Evidence from India. https://www.dartmouth.edu/neudc2012/docs/paper_263.pdf (accessed October 2021).
21. Hiza HAB, Casavale KO, Guenther PM, *et al.* (2013) Diet quality of Americans differ by age, sex, race/ethnicity, income and education level. *J Acad Nutr Diet* **113**, 297–306.
22. Rodrigues SSP, Caraher M, Trichopoulou A, *et al.* (2008) Portuguese household's diet quality (adherence to Mediterranean food pattern and compliance with WHO population dietary goals): trends, regional disparities and socioeconomic determinants. *Eur J Clin Nutr* **62**, 1263–1272.
23. Thiele S, Mensink GB & Beitz R (2004) Determinants of diet quality. *Public Health Nutr* **7**, 29–37.
24. Green R, Milner J, Joy EJM, *et al.* (2016) Dietary patterns in India: a systematic review. *Br J Nutr* **116**, 142–148.
25. Shenkin A (2006) The key role of micronutrients. *Clin Nutr* **25**, 1–13.
26. World Health Organization (2006) *Guidelines on Food Fortification with Micronutrients*. Geneva: World Health Organization and Food and Agricultural Association of the United Nations.
27. Subramanian S & Deaton A (1996) The demand for food and calories. *J Polit Econ* **104**, 133–162.
28. Deaton A (2019) The Analysis of Household Surveys: A Microeconometric Approach to Development Policy. Washington, DC: World Bank. License: CC BY 3.0 IGO. https://openknowledge.worldbank.org/handle/10986/30394 (accessed September 2021).
29. Srivastava A & Mohanty S (2010) Economic proxies, household consumption and health estimates. *Econ Polit Wkly* **45**, 55–63.
30. Gopalan C, Sastri BR & Balasubramanian S (1974) *Nutritive Value of Indian Foods*. Hyderabad: National Institute of Nutrition, Indian Council of Medical Research.
31. National Sample Survey Office (NSSO) (2007) *Nutritional Intake in India, 2004–2005. NSS 61st Round, Report No. 513(61/1.0/6)*. New Delhi: Ministry of Statistics and Programme Implementation, Government of India.
32. Minhas BS (1991) On estimating the inadequacy of energy intakes: revealed food consumption behaviour *v.* nutritional norms (Nutritional Status of Indian people in 1983). *J Dev Stud* **28**, 1–38.
33. Indian Council of Medical Research (ICMR) (2010) *Nutrient Requirements and Recommended Dietary Allowances for Indians. A Report of the Expert Group of the Indian Council of Medical Research*. Hyderabad: National Institute of Nutrition, Indian Council of Medical Research.
34. ICMR-NIN (2020) *Short Report of Nutrient Requirements for Indians. A Report of the Expert Group 2020*. India: Indian Council of Medical Research and National Institute of Nutrition.
35. Cameron CA & Trivedi PK (2005) *Microeconometrics: Methods and Applications*. New York: Cambridge University Press.
36. Wooldridge JM (2012) *Introductory Econometrics: a Modern Approach*. Mason, OH: South-Western Cengage Learning.
37. Pingali P (2006) Westernisation of Asian diets and the transformation of food systems: implications for research and policy. *Food Policy* **32**, 281–298.
38. Bloom D & Cafiero ET (2016) Not in the Pink of Health, The Hindustan Times, October 10. https://www.hindustantimes.com/comment-newspaper/not-in-the-pink-of-health/story-pxqctE5V7RqH5q4iKVgw7H.html (accessed 15 October 2021).
39. World Health Organization (2015) *World Health Statistics 2015*. Geneva: World Health Organization and Food and Agricultural Association of the United Nations.
40. Ministry of Health and Family Welfare (MOHFW) (2019) Non-Communicable Diseases. https://www.nhp.gov.in/healthlyliving/ncd2019 (accessed September 2021).
41. Kennedy E, Webb P, Walker P, *et al.* (2011) The evolving food and nutrition agenda: policy and research priorities for the coming decade. *Food Nutr Policy* **32**, 60–68.
42. Cavelaars, AEJM, Doets, EL, and Dhonukshe-Rutten, RAM *et al* (2010). "Prioritizing micronutrients for the purpose of reviewing their requirements: a protocol developed by EURRECA". *European Journal of Clinical Nutrition*, **64**, S19–S30.

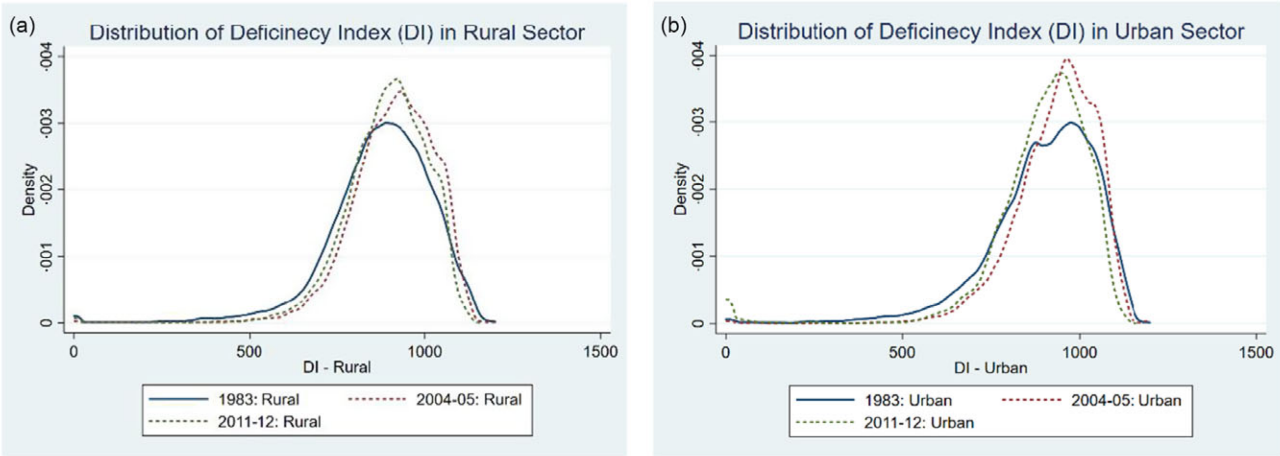
British Journal of Nutrition

Appendix

Table A1 Summary statistics of dietary deficiency index across different education levels of the household head.

Level of education: household head	1983	2004–2005	2011–2012
Illiterate	865·38	893·03	881·32
Below primary	863·06	914·33	874·28
Primary	873·95	952·85	883·13
Secondary	905·97	963	892·57
Secondary and above	950·91	993·42	919·62

Note: Average DI is presented. Source: Authors' calculation



Distribution of DI in Rural Sector   Distribution of DI in Urban Sector

Fig. A1. Distribution of Dietary Deficiency Index. (a) Distribution of DI in Rural Sector. (b) Distribution of DI in Urban Sector. Source: Author's calculation.

https://doi.org/10.1017/S0007114522002847 Published online by Cambridge University Press
British Journal of Nutrition

Table A2: Censored (Tobit) regression model of diet quality index (after dropping the items where only rupee values are reported, and quantities are not available)

	DI			EI		
	1983	2004–05	2011–12	1983	2004–05	2011–12
Lmpce*	603·0***	670·0***	595·1***	–189·0***	–209·9***	–241·0***
	(39·09)	(12·30)	(19·17)	(22·24)	(9·442)	(7·22)
lmpce2	–45·04***	–52·51***	–49·37***	7·314***	12·98***	18·44***
	(4·15)	(1·17)	(1·95)	(2·27)	(0·91)	(0·69)
Children	2·58***	3·72***	4·26***	1·84***	3·11***	4·26***
	(0·28)	(0·27)	(0·51)	(0·20)	(0·18)	(0·26)
adult_male	–7·25***	–6·74***	–12·78***	2·71***	2·85***	5·28***
	(0·52)	(0·47)	(0·76)	(0·34)	(0·27)	(0·34)
adult_female	–0·99	0·66	4·34***	–2·93***	–1·66***	–1·54***
	(0·61)	(0·51)	(0·86)	(0·39)	(0·30)	(0·38)
Muslim	–6·74***	–4·78***	–8·43***	7·61***	3·21***	1·74**
	(1·40)	(1·36)	(1·75)	(0·95)	(0·76)	(0·86)
Scst	–10·67***	–9·56***	–10·25***	11·51***	8·16***	6·60***
	(1·181)	(0·967)	(1·429)	(0·855)	(0·551)	(0·686)
head_female	–9·20***	–4·44***	–13·30***	–0·41	–2·99***	–1·07
	(1·71)	(1·52)	(2·43)	(1·08)	(0·80)	(1·05)
head_age	–0·20***	–0·02	0·92***	0·04*	–0·05**	–0·25***
	(0·03)	(0·04)	(0·07)	(0·02)	(0·02)	(0·03)
urban (base: urban)	16·16***	15·54***	–21·82***	–26·27***	–17·68***	–2·35***
	(1·10)	(1·03)	(1·40)	(0·70)	(0·55)	(0·59)
head_edu_below primary (base: illiterate)	–12·15***	–1·38	–2·13	1·51*	–1·80***	–1·35
	(1·38)	(0·98)	(2·05)	(0·91)	(0·56)	(1·02)
head_edu_primary	–10·84***	–2·08	–2·166	–0·59	–3·59***	–0·97
	(1·35)	(1·57)	(1·98)	(0·87)	(0·85)	(1·03)
head_edu_secondary	–5·49***	–5·51***	0·10	–5·43***	–3·80***	–3·12***
	(1·57)	(1·89)	(2·04)	(1·02)	(1·06)	(0·93)
head_edu_secondary and above	–6·06***	–6·62***	0·29	–9·99***	–3·69***	–5·54***
	(1·86)	(1·77)	(1·75)	(1·00)	(1·04)	(0·85)
N (sample size)	103,050	124,641	101,637	103,050	124,641	101,637
Pseudo R^2	0·06	0·05	0·03	0·18	0·14	0·11
F (43, N-47)	1193·34	10·74·08	538·61	535·63	696·66	422·91

Source: Authors' calculation.
*** $p < 0·01$, ** $p < 0·05$, * $p < 0·01$.
† Monthly per capita consumer expenditure. *Note*: Robust standard errors are in parentheses.

Table A3. Censored (Tobit) regression model of diet quality index (using weighted deficiency index)

	DI		
	1983	2004–2005	2011–2012
Lmpce†	50·98***	61·38***	52·19***
	(3·31)	(1·04)	(1·62)
lmpce2	–3·76***	–4·93***	–4·38***
	(0·35)	(0·10)	(0·16)
Children	0·14***	0·29***	0·34***
	(0·02)	(0·02)	(0·04)
adult_male	–0·61***	–0·55***	–1·07***
	(0·04)	(0·04)	(0·06)
adult_female	–0·14***	0·022	0·32***
	(0·05)	(0·04)	(0·07)
Muslim	–0·74***	–0·36***	–0·61***
	(0·11)	(0·11)	(0·15)
Scst	–0·79***	–0·70***	–0·75***
	(0·10)	(0·08)	(0·12)
head_female	–0·68***	–0·30**	–1·05***
	(0·14)	(0·13)	(0·20)
head_age	–0·02***	–0·003	0·07***
	(0·002)	(0·003)	(0·005)
urban (base: urban)	1·48***	1·30***	–1·72***
	(0·09)	(0·09)	(0·12)
head_edu_below primary (base: illiterate)	–0·96***	–0·03	–0·13
	(0·11)	(0·08)	(0·17)

Table A3. (*Continued*)

	DI		
	1983	2004–2005	2011–2012
head_edu_primary	–0·93***	–0·26**	–0·13
	(0·11)	(0·13)	(0·17)
head_edu_secondary	–0·57***	–0·51***	0·07
	(0·13)	(0·16)	(0·17)
head_edu_secondary and above	–0·91***	–0·80***	–0·09
	(0·15)	(0·14)	(0·15)
N (sample size)	103,050	124,641	101,637
Pseudo R^2	0·1	0·09	0·05
F(43, N-47)	1303·61	1008·02	500·94

Source: Authors' calculation.
†Monthly per capita consumption expenditure. *Note*: Robust standard errors are in parentheses.
*** $p < 0·01$, ** $p < 0·05$, * $p < 0·01$.

Table A4. Censored (Tobit) regression result of revised†,‡ excess index.

	Unweighted			Weighted		
	1983	2004–2005	2011–2012	1983	2004–2005	2011–2012
Lmpce	–555·1***	–471·1***	–470·8***	6·97***	–26·93***	–34·47***
	(100·7)	(66·82)	(50·36)	(1·75)	(2·57)	(1·47)
lmpce2	35·33***	31·08***	34·30***	–3·78***	0·46*	2·28***
	(9·19)	(5·72)	(4·25)	(0·20)	(0·26)	(0·15)
Children	1·06	–2·23	–5·57***	–0·91***	–0·77***	–0·48***
	(0·83)	(1·61)	(1·74)	(0·05)	(0·05)	(0·06)
adult_male	6·232***	13·51***	5·31	1·254***	0·95***	1·70***
	(1·60)	(2·39)	(3·25)	(0·08)	(0·09)	(0·07)
adult_female	–1·55	0·64	4·44	0·59***	0·52***	0·17*
	(1·86)	(2·18)	(3·99)	(0·09)	(0·09)	(0·09)
muslim	19·26***	–4·92	15·45**	0·59***	0·85***	0·23
	(5·156)	(9·71)	(7·83)	(0·22)	(0·26)	(0·21)
scst	13·09***	25·59***	14·23**	0·96***	0·35**	0·95***
	(3·93)	(5·81)	(6·01)	(0·17)	(0·17)	(0·16)
head_female	14·34***	–7·18	–15·74**	2·46***	–0·34	–0·26
	(4·26)	(5·45)	(6·12)	(0·26)	(0·27)	(0·24)
head_age	0·16	–0·32**	–0·25	0·07***	0·04***	–0·04***
	(0·10)	(0·16)	(0·20)	(0·005)	(0·006)	(0·006)
urban (base: urban)	24·03***	33·53***	54·41***	3·99***	1·62***	2·97***
	(3·74)	(5·43)	(6·02)	(0·17)	(0·19)	(0·15)
head_edu_below primary (base: illiterate)	9·10**	–6·64	–1·79	2·10***	0·69***	0·36
	(4·19)	(5·52)	(8·57)	(0·21)	(0·18)	(0·22)
head_edu_primary	6·92	–7·76	–1·84	3·23***	1·37***	0·87***
	(4·21)	(7·16)	(8·08)	(0·22)	(0·30)	(0·22)
head_edu_secondary	17·81***	–6·89	–5·59	3·78***	2·33***	0·52**
	(4·54)	(12·06)	(7·12)	(0·26)	(0·42)	(0·22)
head_edu_secondary and above	34·34***	21·67***	0·25	7·06***	4·01***	0·47**
	(4·32)	(7·53)	(6·80)	(0·30)	(0·40)	(0·21)
N (sample size)	103,050	124,641	101,637	103,050	124,641	101,637
Pseudo R^2	0·22	0·14	0·16	0·07	0·05	0·05
F (43, N-47)	47·27	18·56	18·63	1221·34	528·91	334·38

Source: Authors' calculation.
*** $p < 0·01$, ** $p < 0·05$, * $p < 0·01$.
† Monthly per capita consumption expenditure. *Note*: Robust standard errors are in parentheses.
‡ Here, the excess index includes protein, fat, carbohydrate, Ca and Fe.