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Is there a Convergence in Dietary Energy Intake among Expenditure-Classes in India?

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Abstract

The study has empirically revealed that the widely discussed 'calorie-consumption puzzle' appears to have disappeared in the recent years and has established a positive marginal effect of income on dietary energy intake among Indian households. Nevertheless, nutritional effect of improvement in income varies across expenditure-classes, and rural and urban areas. The temporal changes have revealed a tendency of convergence in calorie intake across expenditure-classes between 1993-94 and 2011-12. The formal test of β-convergence (conditional) has shown that convergence in calorie intake is taking place at the rate of 7 per cent. Among factors conditioning β-convergence, real MPCE, food expenditure share and calorie intake from PDS have shown positive effects on growth in calorie intake. On the other hand, calorie prices and dietary diversification index have depicted negative marginal effects on growth in calorie intake. Resulting phenomenon is a decline in inter-class dispersion in calorie intake, which is proved through the test of σ-convergence. While this 'picking up of poor' in terms of calorie intake indicates strong welfare gains, analysis has shown that around four-fifths of the rural and three-fifths of the urban households are still undernourished. The findings imply that there should be targeted policy and program interventions to improve the nutritional status of poor households, while effective nutrition communication strategies are necessary to address the undernourishment among rich households.

Key words: Calorie intake, expenditure-classes, β-convergence, σ-convergence

JEL Classification: Q18, Q11

Introduction

India has witnessed significant progress in food production and income growth during the past two decades. The food production has increased by 69 per cent with positive implications on food security. The economic development is evident from the substantial increase in real per capita monthly income, from ₹ 1388 to ₹ 3554, and reduction in poverty levels from 45 per cent to 22 per cent between 1993-94 and 2011-12. However, these developments are not accompanied by the commensurate increase in energy intake from food (Radhakrishna, 2005; Chand and Jumrani, 2013). There is enough literature focusing on plausible interpretations of high level of undernourishment in Indian households (Deaton and Dreze, 2009; Patnaik, 2010; Basu and Basole, 2012). A wide variation in food consumption pattern of poor and rich households also exists (Shariff and Mallick, 1999; Kumar *et al*., 2007; Srivastava *et al*., 2013). A large portion of poor households lacks access to adequate food and nutrition even though a sizable part of family income is spent on food.

The existing literature however, lacks in evidence on the changes in relative nutritional status of poor and rich households in the context of overall economic development in India. This is critical for effective

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policy design and program interventions aimed at food and nutritional security. The present study addresses this gap and tracks transition in dietary energy intake among consumer expenditure-classes using household consumption and expenditure data from the quinquennial surveys of National Sample Survey Office (NSSO), Government of India. The specific objectives of this study are: (i) examine trend in consumption expenditure and establish its relationship with calorie intake in rural and urban areas of the country; (ii) test whether temporal changes in consumption are leading to convergence or divergence in dietary energy intake among expenditure-classes; and (iii) estimate expenditure-class wise incidence and extent of undernourishment in the country and discuss policy implications for improved nutritional security in the nation.

Data and Methodology

The long-run trends in consumption expenditure and nutritional status of Indian households were examined using quinquennial consumption expenditure surveys (CES) of NSSO pertaining to the years 1993-94, 2004-05, and 2011-12. The per capita calorie intake was estimated by applying standard conversion factors on consumption of individual food commodities reported in the surveys (GoI, 2014a). The trend in mean calorie intake was examined separately for rural and urban areas and expenditure-classes due to varying consumption habits of Indian households across geographical settings and income levels (Srivastava *et al*., 2013).

The relationship between income and calorie intake was established by estimating a fixed-effect panel regression function. The panel data set was constructed by estimating mean calorie intake and monthly per capita consumption expenditure (MPCE) from 17 major states in the years 1993-94, 2004-05, 2009-10 and 2011-12. Although 2009-10 was a non-normal year (GoI, 2014b), the estimates out of the 2009-10 quinquennial survey were also included in the dataset to have more degree of freedom. The nominal MPCE, a proxy for income, was expressed in real terms using consumer price index (CPI) for agriculture labours for rural areas and CPI for non-manual employees for urban areas. The functional form of fixed-effect panel regression function is as follows;

$$\ln CALPERCAPITA_{it} = (\alpha + u_i) + \beta * \ln REALMPCE_{it} + v_{it} \quad \ldots (1)$$

where, $\ln CALPERCAPITA_{it}$ and $\ln REALMPCE_{it}$ are per capita calorie intake and real MPCE in logarithmic forms in the i^{th} state in the t^{th} year. The α, u_i, β and v_{it} are the parameters to be estimated. The estimated β coefficient gives expenditure-elasticity of calorie intake indicating the response of calorie intake to increase in consumption expenditure. In regression analysis, both cross-section and time effects were fixed to control the regional differences in consumption pattern and changing consumers' food preferences over time.

The expenditure-calorie relationship was further explored by examining mean calorie intake across consumer expenditure-classes. The expenditure-classes were constructed by categorizing households into hundred percentile groups based on MPCE. To know the adequacy of nutritional intake across expenditure-classes, mean calorie intake was compared with the recommended Indian Council of Medical Research (ICMR) norm of 2400 kcal per capita per day in the rural areas and 2100 kcal in the urban areas. The incidence of undernourishment across expenditure-classes was examined by estimating *head count ratio* (proportion of population with calorie intake less than the recommended norm) of undernourished persons.

The study hypothesizes that temporal changes in calorie intake are not uniform across expenditure-classes and evaluates whether dietary energy intake across expenditure-classes is converging (or diverging) over time. This hypothesis was tested by adopting the framework suggested in the neoclassical growth theory. The study employed conditional β-convergence and σ-convergence tests for this purpose. While the former test regresses growth in calorie intake against the initial level, the later regresses cross-sectional dispersion in calorie intake against time. Following the work of Sala-i-Martin (1996), we used Equation (2) to investigate unconditional β-convergence:

$$\ln (y_{i,t}) = \alpha + (1-\beta) \ln (y_{i,t-1}) + u_{i,t} \quad \ldots (2)$$

where, $y_{i,t}$ represents the average per capita daily calorie intake of households belonging to the i^{th} expenditure class at time t, $0<\beta<1$ and $u_{i,t}$ has zero mean, finite variance, σ_u^2, and is independent over t and i. The value of β greater than zero ($\beta > 0$) implies a negative

correlation between growth and initial calorie intake, hence, supports convergence. But the present notation doesn't control for exogenous variables that affect growth in calorie intake, thus, stands incomplete. Moreover, solving Equation (1) to obtain the equation to be tested (Appendix 1) considers just initial and final calorie-intake estimates in computing growth. To address these issues, we estimated Equation (3):

$$r = \alpha - \beta \ln(y_{i,t}) + \delta \ln(x_{i,t}) + u_{i,t} \quad \ldots(3)$$

where, *r* is the trend growth rate and $x_{i,t}$ is a set of variables conditioning growth in calorie intake among expenditure classes during the period under consideration. The conditioning factors taken into consideration were real MPCE, food expenditure share, Simpsons index of diet diversification, calorie prices, calorie intake from PDS food and a dummy variable for rural and urban areas.

The existence of β-convergence provides necessary but not the sufficient condition of convergence (Balaji and Pal, 2014). The existence of σ-convergence, which explains the trend in cross-sectional dispersion in calorie intake across expenditure-classes, along with β-convergence provides sufficient condition of convergence. We tested the sufficiency condition using Equation (4):

$$\text{std}[\ln(y_{i,t})] = \gamma_1 + \gamma_2 t + \varepsilon_t \quad \ldots(4)$$

where, ε_t is the zero mean random disturbance-term. The sufficient condition for convergence across expenditure-classes is that γ_2 is negative and significantly different from zero.

Results and Discussion

Trends in Consumption Expenditure and Calorie Intake

Household income plays a significant role in access to nutrition from food. Although, real MPCE increased at an annual growth rate of 2.17 per cent during the past two decades, the increase was not uniform throughout the period under consideration and across rural and urban areas (Table 1). Even though growth rate in real MPCE was not very substantial for the period 1993-94 to 2004-05 (0.9%), the rate accelerated to 4.17 per cent during the period 2004-05 to 2011-12. The increase in real MPCE was much higher among urban than rural households.

The long-run trends in real MPCE and calorie intake revealed an interesting picture about calorie-income relationship. Between 1993-94 and 2004-05, mean calorie intake declined by 112 calories despite increase in real MPCE. However, cross-sectional data revealed a positive association between MPCE and calorie intake (Figure 1). This contrasting temporal and cross-sectional trend is termed as 'calorie-consumption puzzle' and many scholars have provided plausible explanations for this puzzle (Patnaik, 2004; 2010, Deaton and Dreze, 2009; Basu and Basole, 2012). Interestingly, in the period after 2004-05, both calorie intake and real MPCE moved in the same direction, though at different rates of growth. Thus, empirical evidences show that a widely debated 'calorie-consumption puzzle' seems to be ceased to exist in the recent years. In order to establish calorie-MPCE

Table 1. Trend in real MPCE and real food expenditure in India

Particulars	Sector	Value			CGR (%)		
		1993-94	2004-05	2011-12	1993-94 to 2004-05	2004-05 to 2011-12	1993-94 to 2011-12
MPCE	Rural	927	1016	1287	0.83	3.44	1.84
(₹/capita/month)	Urban	1586	1865	2477	1.48	4.14	2.51
	Combine	1106	1222	1627	0.91	4.17	2.17
Food expenditure	Rural	599	553	622	-0.72	1.69	0.21
(₹/capita/month)	Urban	914	766	923	-1.60	2.70	0.05
	Combine	688	602	708	-1.21	2.35	0.16
Food calorie	Rural	2153	2047	2098	-0.46	0.35	-0.14
(kcal/capita/day)	Urban	2071	2020	2056	-0.23	0.25	-0.04
	Combine	2146	2034	2088	-0.49	0.38	-0.15

Source: Authors' estimates based on unit-level NSS data

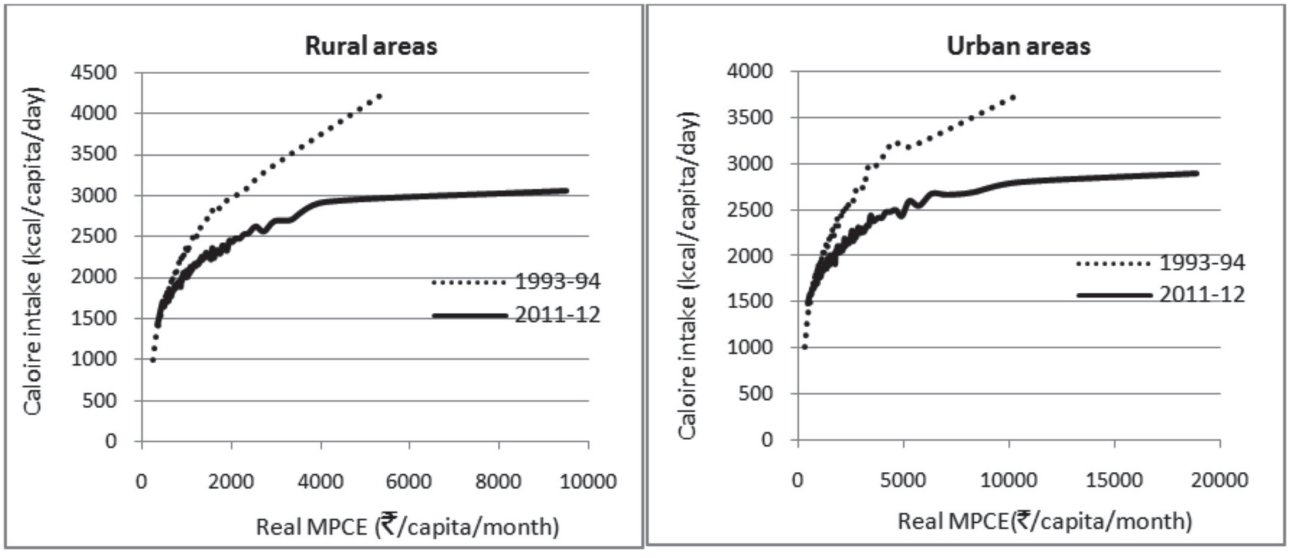

Figure 1. MPCE percentile class-wise mean real MPCE and mean calorie intake in rural and urban areas

association, both cross-sectional and time-series data were pooled and state-level fixed effect panel data regression function between calorie intake and real MPCE was fitted. The estimated positive and significant coefficient of MPCE in log-linear regression analysis implies direct association between MPCE and calorie intake (Table 2). It can be concluded that on average, marginal effect of improvement in income on calorie intake is positive. The identification of factors behind declining calorie intake in spite of the increase in consumption expenditure during 1993-94 to 2004-05 followed by trend reversal in subsequent period assumes paramount importance. But, such an analysis is outside the scope of the present paper.

Table 2. Estimated coefficients of fixed effect panel regression analysis

Particular	Rural	Urban
Intercept	6.45***	6.88 ***
	(0.317)	(0.235)
Real MPCE(ln)	0.23***	0.14***
	(0.059)	(0.042)
Cross-section effects	Yes	Yes
Time- effect	Yes	Yes
R^2	0.9021	0.8887
Observations	68	68
Dependent variable	Per capita calorie intake (ln)	

Note: *** refers to significance at 1 per cent level, figures within parentheses are standard errors of the estimated parameters; the estimated coefficients of individual states and time period could not be given due to paucity of space and the same can be obtained from authors on demand.

The estimated expenditure elasticity of calorie for rural and urban households came out to be 0.23 and 0.14, respectively. Higher value of calorie elasticity for rural households implies that effect of increase in consumption expenditure on nutritional intake will be much higher among them as compared to urban households. Thus, food and nutritional security can be improved by providing attractive avenues for earning income. Nevertheless income effect would vary across expenditure-classes and rural and urban areas depending upon the level of income earned, nature of occupation, and marginal propensity to consume a food commodity.

Calorie Intake among Expenditure Classes

The sample households were grouped into hundred percentile classes based on MPCE, and trend in average MPCE and per capita calorie intake were examined across expenditure-classes. The calorie intake was found to vary considerably across expenditure classes (Figure 1). The average per capita daily calorie intake varied from 1418 calories for the bottom (1st) expenditure class to 3061 calorie for top (100th) expenditure class in rural areas during 2011-12. Similarly, in urban areas household belonging to top expenditure class consumed 1425 calories more than the poorest households. It is evident from Figure 1 that

as MPCE increases across successive expenditure-classes, calorie intake increases at a sharper rate among lower income households than the rich. The stronger calorie-MPCE relationship for households belonging to lower expenditure-classes could be due to their higher marginal propensity to consume food than the households belonging to higher expenditure classes. Notwithstanding, households belonging to the bottom expenditure class in the rural areas spent 61 per cent of total consumption expenditure towards food as compared to only 16 per cent by the households belonging to top expenditure class during 2011-12. The propensity to consume food was found to be lower in urban than rural areas across all the expenditure classes. These evidences imply that nutritional effect of improvement in household income is much higher for poor households than rich households.

The downward shift in MPCE-calorie curve over time indicated that the MPCE-calorie relationship has become weaker over time (Figure 1). However, the nutritional effect of temporal change in real MPCE was not found to be uniform across expenditure classes. The mean calorie intake among the households belonging to first 33 percentile classes in rural areas and first 32 percentile classes in urban areas increased between 1993-94 and 2011-12. On the other hand, rich households reduced calorie intake during the same period. It is to be noted that reduction in calorie intake was observed in expenditure classes where mean calorie intake was higher than the recommended dietary allowances (2400 kcal in rural areas and 2100 kcal in urban areas) during 1993-94. This corresponded to top 27 percentile classes in rural areas and top 42 percentile classes in urban areas. The possible factors behind the increasing calorie intake by poor households might be related to higher income and improved access to food, whereas the factors like increasing health consciousness, sedentary life-style and changing food habits might be leading to a declining calorie intake by richer households. Thus, temporal changes in calorie intake across expenditure classes are tending towards the recommended level of energy and leading to a decline in inequality in calorie intake across expenditure classes (Figure 2).

Convergence in Calorie Intake across Expenditure Classes

The convergence in dietary energy-intake across expenditure classes was examined both graphically and statistically using two different approaches, namely β and σ-convergences. The β-convergence approach examined growth in calorie intake across expenditure-classes against the initial calorie intake levels, whereas the σ-convergence approach examined the cross-sectional dispersion in calorie intake over time. The graphical exploration indicated strong tendency of low expenditure-classes to have higher growth in calorie intake than of high expenditure-classes between 1993-94 and 2011-12 (Figure 3a). The direction and rate of changes in calorie intake across expenditure-classes were found to be almost similar in both rural and urban areas. Declining cross-sectional dispersion in calorie intake in both rural and urban areas (Figure 3b) reaffirmed the behaviour observed above.

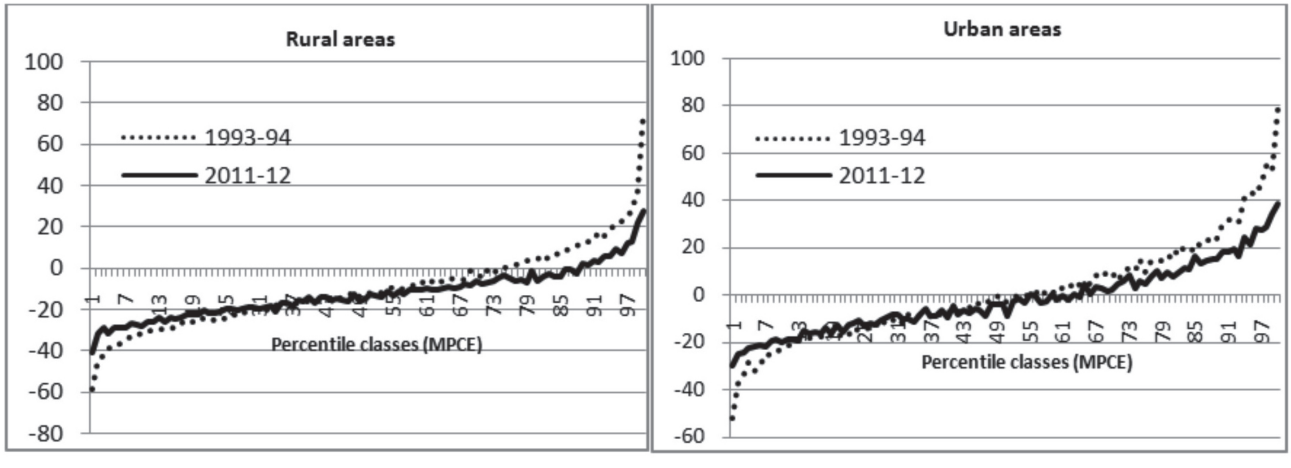

Figure 2. MPCE percentile class-wise deviation in calorie intake from recommended dietary allowance in rural (2400 kcal) and urban areas (2100 kcal)

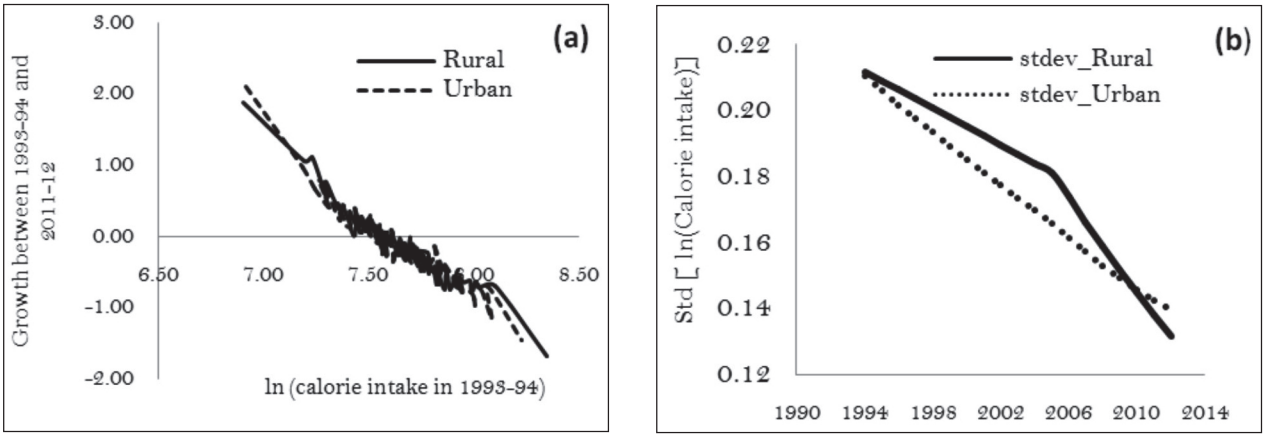

Figure 3. (a) Growth verses initial level of calorie intake, and (b) Cross-sectional dispersion in calorie intake during 1993-94 to 2011-12

To test statistical significance of the observed relation, regression analyses were carried out. The results of the regression analysis for testing the presence of β-convergence in calorie intake are presented in Table 3. The direction and speed of convergence in calorie intake are indicated by the sign (negative) and value of estimated coefficient of *initial calorie intake,* respectively. The negative and significant coefficient of *initial calorie intake* confirmed that the average calorie intake among poor and rich households are converging over time. The average speed of convergence was found to be about 7.35 per cent during the period under consideration.

The convergence in calorie intake was conditional on several factors. As expected, MPCE had positive marginal effect on growth in calorie intake (Table 3). Apart from income, nutritional intake is greatly influenced by the expenditure pattern of households. The analysis revealed a positive and significant association between the proportion of food expenditure and growth in calorie intake. It is worth mentioning that the real food expenditure registered only 0.17 per cent growth against 2.17 per cent growth in total consumption expenditure leading to a decline in food share from 62 per cent in 1993-94 to 44 per cent in 2011-12 (Table 1). This implies that the positive nutritional effects of increased MPCE were subdued by the squeezed food budget due to increased spending towards non-food items.

The nutritional status is also affected by the composition of food basket. The evidences point out that food basket of Indian households is shifting from

Table 3. β-convergence in calorie intake between 1993-94 and 2011-12 (conditional)

Variables	Estimated coefficients
Dependent variable: Growth in calorie intake (%)	
Explanatory variable	
Initial level of calorie intake (kcal/capita/day)	-7.351*** (0.432)
Real MPCE (₹/capita/month)	4.005*** (0.391)
Food expenditure share (%)	3.784*** (0.398)
Dietary diversification index (SID)	-1.078* (0.573)
Calorie price (₹/1000 kcal)	-1.926*** (0.365)
Calorie intake through PDS (kcal/capita/day)	0.263*** (0.051)
Sector dummy (Rural=1; 0 otherwise)	0.712*** (0.069)
Constant	15.247*** (2.075)
R^2	0.9654
Observations (No.)	200

Note: Explanatory variables are expressed in logarithmic form; Figures within the parentheses are standard errors of estimated parameters; Estimates are robust to heteroscedasticity;
*** and * refer to significance at 1 per cent and 10 per cent levels, respectively.

cereals to high-value food commodities (HVFCs) such as milk, meat, fruits, vegetables, processed foods, etc (Meenakshi, 1996; Rao, 2000; Radhakrishna, 2005; Srivastava *et al.*, 2013). The implications of declining cereals consumption and increasing diversification of food basket on nutritional security depend on the net nutritional intake. Surprisingly, the regression analysis revealed a negative association between dietary diversification index and growth in calorie intake, meaning that diet diversification has resulted in lesser calorie intake. The decomposition of total calorie intake into food sub-groups showed that the loss of 233 calories due to decline in cereals consumption was more than the gain of 175 calories from increased consumption of non-cereals food commodities between 1993-94 and 2011-12 (Appendix 2). Thus, the nutritional outcome of dietary diversification away from cereals was found to be inadequate.

The growth in calorie intake was found to be inversely associated with the calorie prices. Managing price rise would go a long way to improve the affordability of food commodities, especially by the poor households and contribute positively towards food and nutritional security. As reported in Himanushu and Sen (2013), the study also found a positive marginal effect of public distribution system (PDS) on growth in calorie intake through which government provides staple food at subsidized prices (central issue price). This suggests that further reforms in PDS on increasing its efficiency and reach will contribute positively to ensure adequate nutrition to poor households of the nation. The estimated coefficient of sectoral dummy showed that growth in calorie intake was higher among rural households than urban households.

While β-convergence approach provided necessary evidence of a higher growth in calorie intake among poor than rich households, the alternative approach (σ–convergence) was adopted to provide sufficient evidence against it. In the σ–convergence approach, standard deviation of calorie intake among expenditure-classes was regressed against time. The estimated coefficient was found to be negative and significant showing a declining trend in cross-sectional dispersion in calorie intake (Table 4). It provides strong evidence of convergence in calorie intake across poor and rich households.

Table 4. σ-convergence in calorie intake between 1993-94 and 2011-12

Variable	Rural areas	Urban areas
Dependent variable: Standard deviation [ln(Calori intake)]		
Explanatory variable		
Time	-0.004***	-0.004***
	(0.001)	(0.001)
R^2	0.937	0.984
Observations (No.)	19	19

Note: *** refers to significance at 1 per cent level; Figures within the parentheses are standard errors of estimated coefficients

Expenditure Class-wise Incidence and Extent of Undernourishment

Increasing convergence or declining inequality in calorie intake across expenditure-classes is a desirable trend from nutritional security point of view. However, it should be accompanied by intake of at least minimum level of required energy, which is rather inadequate in the country. Based on the conventional ICMR norms, 77.24 per cent of the rural population and 59.41 per cent of urban population were found to consume lesser calories than the recommended levels during the year 2011-12. The incidence of undernourishment was found significantly higher among the poor households (Figure 4). Surprisingly, more than 90 per cent of the households belonging to the first 34 percentile classes in the rural areas and first 7 percentile classes in the urban areas were found undernourished in 2011-12. The extent of undernutrition, estimated as deviation of actual energy intake from the recommended level, was up to 41 per cent and 30 per cent among rural and urban households, respectively (Figure 2). As the nutritional level of households belonging to lower expenditure classes is improving with time, measures are needed to strengthen the ongoing efforts to further accelerate increase in calorie intake among them.

It is worth mentioning that even in the top expenditure classes, up to 35 per cent of rural households and 33 per cent of urban households were found undernourished in 2011-12. This necessitates increasing awareness about nutrition so that households with adequate income do not suffer from undernutrition (Chand, 2007).

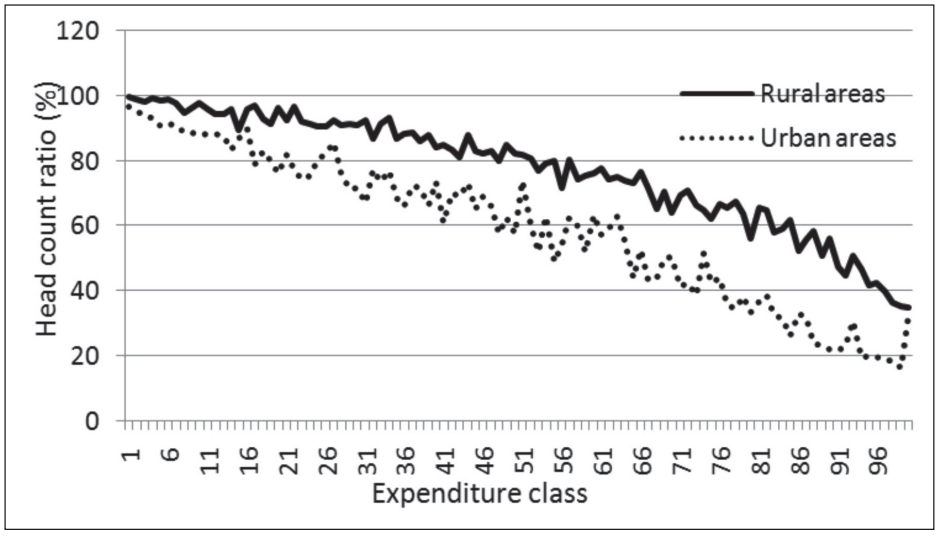

Figure 4. Head count ratio of undernourished persons in 2011-12

Conclusions and Policy Implications

The successive NSSO surveys have revealed contrary trends in real MPCE and dietary energy intake among Indian households. The cross-sectional data show a positive association between calorie intake and real MPCE, whereas the temporal trends between 1993-94 and 2004-05 have shown an opposite MPCE-calorie relationship. This contrasting temporal and cross-sectional trend is termed as 'calorie-consumption puzzle' in the literature.

The post 2004-05 period has witnessed 'trend reversal' in calorie intake and empirical evidence suggests that calorie-consumption puzzle seems to have disappeared in the recent years. The study has established that marginal effect of MPCE on calorie intake is positive and any deviation could be the net outcome of several other factors influencing access to food. Therefore, food and nutritional security can be improved by providing attractive avenues for earning income. As indicated by calorie expenditure-elasticities, the response of increase in income would be higher among rural households than urban households. Similarly, MPCE-calorie relationship is found to be much stronger for households belonging to lower expenditure classes because of their higher marginal propensity to consume food than the relatively rich households.

The temporal changes in calorie intake across expenditure-classes are tending towards the recommended level of energy intake. The households belonging to lower 32-33 expenditure-classes witnessed increase in calorie intake between 1993-94 and 2011-12. On the other hand, relatively rich households, particularly those with higher calorie intake than recommended norms, reduced dietary energy intake. The possible factors behind the increasing calorie intake by poor households might be related to higher income and improved access to food, while the factors such as increasing health consciousness, sedentary life-style and changing food habits might be leading to declining calorie intake by richer households.

The results of conditional β-convergence have revealed a higher rate of growth in calorie intake among poor households than richer households. Among factors conditioning β-convergence, real MPCE, food expenditure share and calorie intake from PDS have shown positive effects on growth in calorie intake. On the other hand, calorie prices and dietary diversification index have depicted marginal effects on growth in calorie intake. The convergence in calorie intake among expenditure-classes was further confirmed by the σ-convergence test.

Although convergence in calorie intake between poor and rich households is desirable from equity point of view, actual energy intake shall be accompanied by intake of at least minimum level of required energy, which has been found to be inadequate especially among poor households. The study has provided strong evidences to prioritize and target poor households in

ongoing efforts to ensure adequate food and nutrition. The nutritional status of poor households can be improved by providing avenues of income, strengthening of PDS, and managing price rise. The finding that there is a substantial percentage of undernourishment among rich rural households highlights the need to create general awareness about nutrition and healthy diet among the rural households, irrespective of their income status. Overall, findings from our study imply that there should be targeted policy and program interventions to improve the nutritional status of poor households while effective nutrition communication strategies are necessary to address the undernourishment among rich households. Although, not the focus of this paper, these communication strategies might contribute to prevent or reduce the increasing trend of obesity and overweight among rich households as well.

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Appendix 1

Following Sala-i-Martin's (1996) exposition, present study has used Equation (A1) to investigate unconditional β-convergence across states. Assume that β-convergence holds for states i=1,2,…,N. Natural log-income of i^{th} state at time t can be approximated by:

$$\ln y_{i,t} = \alpha + (1-\beta)\ln(y_{i,t-1}) + u_{i,t} \quad \ldots(A1)$$

where, $y_{i,t}$ is calorie intake in expenditure class i at time t, $0<\beta<1$ and $u_{i,t}$ has zero mean, finite variance, σ_u^2, and is independent over t and i. Since α is assumed to be constant across entities, balanced growth paths are identical (allowing different α_is for $0<\beta<1$ would imply conditional β-convergence). Manipulating Equation (A1) yields Equation (A2):

$$\ln(y_{i,t}|y_{i,t-1}) = \alpha - \beta\ln(y_{i,t-1}) + u_{i,t} \quad \ldots(A2)$$

Thus, $\beta>0$ implies a negative correlation between growth and initial log calorie intake. Between any period t and $t+T$, Equation (A2) can be written as:

$$\frac{1}{T}\ln\left(\frac{y_{i,t+T}}{y_{i,t}}\right) = \alpha - \beta ln(y_{i,t}) + u_{i,t} \quad \ldots(A3)$$

$B>0$ in Equation (A3) represents unconditional convergence in calorie intake. The growth rates obtained in Equations (A3) considers only the initial and terminal year calorie levels and ignores values in rest of the period. To avoid this limitation, the present study used the trend growth rate in Equation (A3) given by Equation (A4):

$$r_i = \alpha - \beta ln(y_{i,t}) + u_{i,t} \quad \ldots(A4)$$

where, 'r_i' is the trend growth rate between any two time periods t and $t+T$, which can be obtained from the OLS estimate β in the following regression.

$$lny_t = \alpha - \beta t \quad \ldots(A5)$$

$$r = exp(\beta) - 1 \quad \ldots(A6)$$

where, y_t is calorie intake at time 't'.

Appendix 2

Food group-wise trend in calorie intake in India

(kcal/capita/day)

Food groups	1993-94	2011-12
Cereals	1455	1222
Pulses	87	95
Edible oil	125	198
Vegetables	80	103
Fruits	17	18
Milk & milk products	148	168
Non-veg	16	19
Other food products	218	265
Total calorie intake	2146	2088