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Covid-19 pandemic and food security in India: Can authorities alleviate the disproportionate burden on the disadvantaged?☆

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Abstract

The present study examines covariates of food security and the impact of Covid-19 induced shocks, among households in India using a nationally representative survey. Using a 2SLS panel regression model, we find an important role of incomes, relative food prices, household characteristics, as well as mobility restrictions in response to the rising number of infections in a given region in explaining varying food expenditure shares prior to and during the Covid-19 pandemic. The disproportionate burden of the pandemic induced lockdowns on the disadvantaged and minorities calls for effective action on the part of policymakers to boost aggregate demand, fix supply chains and reduce food price volatility.

JEL Classification: D12; C36; Q18

Keywords: Covid-19; India; Food expenditure shares; Household; Two-stage least squares

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1. Introduction

Globally, the number of people unable to afford a healthy diet rose from 112 million in 2019–3.1 billion in 2020 (FAO et al., 2022). This reflects the massive impact of the Covid-19 pandemic and the associated containment measures adopted by governments on global food security and nutrition. Food Security can be seen as economic access to food (which is a function of income generation and food prices), availability (which is a function of robust food supply systems), utilization (which is a function of food composition and nutrient content) and stability of these three dimensions over time. Disruptions to the food systems due to the pandemic relate to both the supply side (food production, processing and distribution) and demand side (economic and physical access to food). Restrictions on movement due to policies to contain the spread of the coronavirus have had an impact in the form of disrupted value chains, and particularly in informal markets, but the impact on prices depends on the resilience of the value chains (Devereux, Béné, & Hoddinott, 2020; Reardon, Bellemare, & Zilberman, 2020). Despite the success of the food supply system as measured by its capacity to adapt to challenges such as COVID-19 or provide a variety of food at relatively low prices, the increased household food security can be explained by the loss of incomes and employment (Deaton & Deaton, 2020).

In India, the nationwide lockdowns and the associated economic downturns, combined with suspension of school nutrition programmes, may have worsened the food security status of several adults and children. Our present study analyses food demand among households in India prior to and during the Covid-19 pandemic, based on nationally representative household consumption and expenditure survey data. The extent to which households allocate their income between food and non-food items, depends on household location, market prices, and income opportunities (Barrett, Reardon, & Webb, 2001). The Engel curves have been used to analyse household expenditure behaviour in both developing and developed countries using a variety of functional forms and estimation techniques (Behrman & Deolalikar, 1987; Deaton, 1988). In the present study, we examine the shifts in Food Engel Curves in India during the period January 2019 to August 2021, and offer plausible explanations for varying degrees of shifts and their policy implications.

To our knowledge, this is the first empirical study examining the impact of the pandemic induced economic stressors such as declining incomes and rising prices on food expenditure shares using a nationally representative dataset. This study provides evidence of the potential mechanisms driving food consumption patterns. In addition to the household socio-economic and demographic characteristics (used in the extant literature), it uses region specific Covid-19 infections as an explanatory variable. Findings from this study are expected to help policymakers formulate suitable policies to improve food security and nutrition outcomes not only in India but other developing countries as well.

This study is structured as follows. Section 2 discusses the data sources, variables, and methodology. Section 3 presents the descriptive and analytical results and discussion. Section 4 concludes from a policy perspective.

2. Data and methodology

We examine the covariates of food expenditure shares overtime in rural and urban India using a range of household level socio-economic demographic and location characteristics, food prices, and Covid-19 pandemic indicators.
We use 8 waves (16th wave for the period January – April 2019–23rd wave for the period May 2021 – August 2021) of data from the Consumer Pyramids Household Survey conducted by the Centre for Monitoring Indian Economy (CMIE). Pooling the cross-sectional data from these 8 waves helps us assess the factors influencing food expenditure shares over time, especially before and during the Covid-19 pandemic in India. Consumer Pyramids Household Survey (CPHS) is a continuous survey administered on a panel of sample households by Centre for Monitoring Indian Economy (CMIE). It delivers fast or high-frequency data on consumption expenditure of households, collected thrice every year.¹

We use a multiple regression model with the following specification where our dependent variable, i.e., the share of food in total expenditure, is estimated by a set of explanatory variables such as household level characteristics, food prices, and progression of the Covid-19 pandemic in the state.

\[
FES_{ijt} = \beta_0 + \beta_1 X_{1ijt} + \beta_2 X_{2jt} + \delta T_t + \epsilon_{ijt}...
\]  

where \( FES_{ijt} \) is the food share in total expenditure of household \( i \) in time period \( t \) (\( t = 1–32, \) monthly from January 2019 to August 2021). \( X_{1ijt} \) refers to the vector of household socio-economic and demographic variables, namely, the lagged household expenditure per capita (and its square), age and gender of the household head, household size, household caste and religion, composition of the households in terms of proportion of adults and children, the education group of the household and whether the household has farming as a primary occupation or not. \( X_{2jt} \) refers to the state specific variables (\( j \)th state; \( j = 1–28 \)), namely, the food price ratios and the progression of the Covid-19 pandemic (as measured by the number of reported infections in a state). In addition, we use the lag of the dependent variable and time dummy variables, \( T_t \), to examine changes in food expenditure shares over time.

Given that the Covid-19 cases may be endogenous, we instrument using a 2SLS (two stage least squares) estimation. In the first stage, we estimate Covid-19 cases by two instruments, namely, the length of the transmission of the pandemic, calculated as the number of days between the first reported Covid case in the particular state and the first reported Covid case in the country, i.e., in Thrissur, Kerala, and the distance between the city that reported first Covid case in a particular state, and Thrissur, Kerala.² In the second stage, we use an estimate of the Covid-19 cases from the first stage as the explanatory variable. Since the coronavirus infection was contagious in nature, maintaining distance from the infected was the sole protection against it. Hence, it is plausible to argue that the longer the distance from Thrissur, and the larger the time of transmissions, the lower will be the intensity of the pandemic as measured by the number of infections.

Our first stage specification is as follows:

¹ CMIE adopts a multi-stage stratified sampling approach. Within states, districts with similar agro-climatic conditions, urbanization levels, and female literacy rates are clubbed together to form homogenous regions (HR) which are further divided into rural and urban strata consisting of all Census 2011 villages and towns, respectively. The urban strata are further sub-divided into four sub-strata – very large, large, medium and small – based on the population of towns. From the rural stratum, villages are chosen via simple random sampling, whereas from the urban stratum, one town is randomly sampled from each of the four sub-strata. In each sample town, census enumeration blocks (CEB) are randomly sampled.

² The distance has been calculated in km, and has been obtained with the help of Google Maps. The distance is calculated between the first city in a state where a Covid-19 case was reported and Thrissur.
where the dependent variable is the number of coronavirus cases reported in state \( j \) at time \( t \). \( Z_{jt} \) and \( Z_{jt2} \) represent the instruments, namely, the Distance from Thrissur (in km) and Length of Transmission (in days). Consistent with equation [1], \( X_{ijt} \) represents a vector of household socio-economic demographic variables, \( X_{2jt} \) refers to the state specific variables (\( j \)th state; \( j = 1–28 \)), namely, the food price ratios and \( T_t \) represents the time dummy variables.

Since the fear of coronavirus intensified only after infections started spreading all over the nation, we believe that the relationship between the instruments and the food expenditure shares of households is far from direct. The first case of coronavirus in India was reported on 31st January, 2020; however, the first nationwide lockdown was implemented after almost 2 months, on 25th March, 2020, when the virus had spread to other states as well. Therefore, while the length of transmission and the distance from Thrissur may have a direct impact on the COVID cases in a particular state, it affects the food expenditure shares indirectly. Thus, our instruments are not just strong instruments but also satisfy the exclusion restriction, that is, they do not directly influence the food expenditures of households and affect the food expenditures of households only through the intensity of Covid-19 infection in the respective states.

The summary statistics of all the variables are provided in Table 1.

Our choice of the explanatory variables is guided by the extant literature and our a priori considerations.

The study of the relationship between commodity expenditure and income (the Engel curve) has been at the centre of applied microeconomic analysis (Deaton & Muellbauer, 1980; Engel, 1895; Leser, 1963; Working, 1943, Gaiha et. al., 2014). The Engel’s Law states the following: “the poorer is a family, the greater is the proportion of the total outgo which must be used for food. The proportion of the outgo used for food, other things being equal, is the best measure of the material standard of living of a population”. We include in our demand specification, the natural logarithm of lagged monthly expenditure per capita (MPCE) as the leading term and an additional higher order (square of the natural logarithm of lagged expenditure per capita). The quadratic logarithmic model permits goods to be luxuries at some income levels and necessities at others (Lewbel, 1996; Banks et. al., 1997). The food expenditure shares are expressed in terms of percentage of total expenditure allocated by each household towards food. The household per capita expenditures have been deflated using the monthly CPI index data provided by the RBI for rural and urban India (base year 2012) to adjust for any part of change in total expenditure that is attributable to the price movements, to arrive at a real, or inflation-adjusted indicator.

We include in our demand specification, household characteristics, namely, age of head of household, gender of head of household, household size (measured by number of members in a household) and composition (whether the household is dominated by children or grownups), education (whether the household comprises mostly illiterates, matriculates or graduates) and occupation group of households (whether the household’s primary occupation is farming or not), and household caste and religion. The literature on household welfare advocates the role of household size and composition in explaining various aspects of well-being such as food

\[ \text{Covid - 19 Infections}_{jt} = \alpha_0 + \alpha_1 Z_{jt} + \alpha_2 Z_{jt2} + \gamma_1 X_{ijt} + \gamma_2 X_{2jt} + \delta T_t + \varepsilon_{ijt}, \]

\[ (2) \]
expenditure and income and consumption poverty (Deaton, 1997; Ravallion, 1992). Empirical results support the finding that food expenditure increases with household size, number of adults and age of head of household (Asefach & Nigatu, 2007; Lewbel & Pendakur, 2008; Mango, Table 1
Summary Statistics.

| Variable                                                   | Obs  | Mean  | Std Dev. | Min | Max  |
|------------------------------------------------------------|------|-------|----------|-----|------|
| Food Expenditure Share (in percentage)                     | 3,971,479 | 47.09 | 11.68    | 0   | 100  |
| Lagged Food Expenditure Share (in percentage)              | 37,98,921 | 47.03 | 11.70    | 0   | 100  |
| Log monthly per capita expenditure (MPCE) - inflation adjusted | 3,971,479 | 7.61  | 0.54     | 0   | 16.05|
| Log monthly per capita expenditure (MPCE) square - inflation adjusted | 3,971,479 | 58.16 | 8.22     | 0   | 257.73|
| Sector                                                     |      |       |          |     |      |
| Rural                                                      | 33.21%|
| Urban                                                      | 66.79%|
| Age of head of household                                  | 3,958,191 | 51.12 | 11.29    | 0   | 110  |
| Household Composition                                      |      |       |          |     |      |
| Balanced Households                                        | 26.67%|
| Children Dominated                                         | 18.04%|
| Grownups Dominated                                         | 55.28%|
| Household Size                                             | 3,971,479 | 3.88  | 1.52     | 1   | 16   |
| Household Education group                                  |      |       |          |     |      |
| .All or Some Illiterate                                    | 37.32%|
| Matriculates                                               | 26.86%|
| Graduates                                                  | 35.82%|
| Household Occupation group                                 |      |       |          |     |      |
| Farmers                                                    | 14.75%|
| Non-Farmers                                                | 85.25%|
| Gender of head of the household                            |      |       |          |     |      |
| Male                                                       | 87.15%|
| Female                                                     | 12.85%|
| Household Caste                                            |      |       |          |     |      |
| Unreserved                                                 | 34.14%|
| OBC                                                        | 38.90%|
| SC                                                         | 20.40%|
| ST                                                         | 4.89% |
| Household Religion                                         |      |       |          |     |      |
| Hindu                                                      | 84.48%|
| Muslim                                                     | 9.15% |
| Sikh                                                       | 3.24% |
| Christian                                                  | 1.84% |
| Other                                                      | 0.94% |
| Price Ratios                                               |      |       |          |     |      |
| Vegetables to Cereals&Pulses                               | 3,764,456 | 0.62  | 0.20     | 0.19| 1.94 |
| Sugar to Cereals&Pulses                                    | 3,764,456 | 0.98  | 0.15     | 0.20| 2.61 |
| Milk to Cereals&Pulses                                     | 3,764,456 | 1.08  | 0.24     | 0.21| 3.26 |
| Oil to Cereals&Pulses                                      | 3,646,060 | 2.66  | 0.53     | 0.80| 8.71 |
| Log Covid cases (State-level)                              | 3,971,479 | 6.47  | 6.44     | 0   | 15.7 |
| Instruments:                                               |      |       |          |     |      |
| Length of transmission (in days)                           | 3,971,479 | 42.43 | 10.87    | 0   | 115  |
| Distance from Thrissur (in km)                             | 3,971,479 | 1857.48 | 877.14 | 0 | 3773.1|

Source: Authors’ computations from the CMIE-CPHS data
It is also empirically recognized that households with children are relatively more food insecure on average, as compared to households without children (Nnakwe & Yegammia, 2002; Zhang & Yen, 2017). Female headed households are found to be more food secure than male headed households (Hoddinott & Haddad, 1995; Kennedy & Peters, 1992; Sraboni, Malapit, Quisumbing, & Ahmed, 2014), and food security rises with education of household head (Mutisya, Ngware, Kabiru, & Kandala, 2016). Whether a household has a farm or a non-farm business or not, is an important determinant as the former are likely to have higher food consumption due to higher calorie requirements based on vigorous physical activities as well as have greater availability of food from home production. In addition, the agricultural production diversity has a positive impact on food security outcomes of the household (Sraboni et al., 2014).

The caste-based inequality in India exists not only in terms of income and wealth, but household food consumption patterns as well. These caste related disparities in Indian diets, lead to disparities in nutrition levels too. As observed by Akerlof and Kranton (2000), gender and religion have a major impact on consumer choices. This is evident in the Indian context as well. Religion and religious beliefs play a major role in food consumption patterns, as well as food consumption choices of Indian households. For example, a large section of Jains are pure vegetarians, and avoid even root vegetables. At the same time, the Islamic religion only allows consumption of certain types of meats. Thus, we have controlled for household caste and religion in our specification.

Data on monthly household expenditures on food, incomes, and other household demographic and socio-economic characteristics are obtained from the CMIE-CPHS over the period January 2019 to August 2021.

In our demand specification, relative price ratios of Vegetables, Sugar, Milk and Oil to price of Cereals & Pulses are added. Controlling for relative food price changes is important because a change in relative prices of goods has a significant impact on the household’s shopping baskets (Griffith et. al. 2015). The CPHS does not provide information on food prices. For the food prices, we use the monthly retail prices of 19 essential commodities at the state level from the Department of Consumer Affairs. The geometric means of the various commodities are used to get average food prices for the following food groups: cereals, pulses, vegetables, sugar, oil and milk. These are then converted to 4 non-staples to staples food ratios, with vegetables, sugar, oil and milk in the numerator, one at a time, and the weighted average price of cereal and pulses (with household expenditures on these items as weights) in the denominator.

India reported its first death due to Covid-19 on 13 March 2020. Since then, there was first a gradual, followed by a steep increase in both confirmed cases and deaths linked to the deadly virus. In order to control the spread of the coronavirus, the government announced and implemented complete nationwide lockdowns starting March 25th 2020 which continued in different phases till May 2020. This was followed by gradual opening up of the country, but the number of Covid-19 related cases also continued to increase. How the pandemic containment

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4 Price of Vegetables is calculated as the geometric mean of prices of Onions, Potatoes and Tomatoes. Price of Sugar equals geometric mean of prices of sugar and jaggery. Price of Oil is the geometric mean of prices of Mustard Oil, Vanaspati, Groundnut Oil, Soyabean Oil, Sunflower Oil and Palm Oil. Price of Cereals and Pulses is calculated as the weighted average of price of cereals and price of pulses, where the weights are calculated as shares of monthly expenditures on both of them.

5 As the prices for Delhi and Telangana were not available, they were dropped in the concerned regression specifications.
measures and the associated economic downturns affected food expenditure is of considerable interest. We include in our demand specification, the cumulative Covid-19 cases at the end of each month at the state level. The data are collected from the Ministry of Health & Family Welfare, India, with familiar caveats of underestimation (Anand et. al., 2021).

3. Results and discussion

3.1. Trends in food expenditure shares

Figure 1 shows the share of food in total expenditure in rural and urban India for the period January 2019 to August 2021. The pandemic induced lockdowns resulted in a sharp increase in the share of food in total expenditure across rural and urban India, and for all expenditure levels. The share of food in total expenditure for rural India ranged from 45 per cent to 50 per cent, and for urban India from 41 per cent to 45 per cent in the 14 months preceding March 2020. However, this figure rose to 61 per cent for rural India and 59 per cent for urban India in April 2020, the period coinciding with strict nationwide lockdown. The movement restrictions at the onset of the pandemic acted more like a temporary shock than a permanent one, which resulted in declining shares of food in total expenditure, but stabilizing at a level higher than that observed pre-pandemic. A slight increase was also observed during the more deadly second wave, where some states used closures and containments as measures to control the spread of the coronavirus, but no nationwide restrictions were imposed.

This phenomenon is seen for households across expenditure levels. We plot the Lowess\(^6\) of food expenditure share on logarithm of total expenditure per capita of households for January 2020 (pre-covid), April 2020 (first nationwide strict lockdown), and August 2021 (after subsiding of the second wave) in Figure 2.

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\(^6\) Lowess or the locally weighted estimated scatterplot smoothing is a non-parametric regression technique. It plots a smoothing function that attempts to capture general patterns in stressor-response relationships while reducing the noise and it makes minimal assumptions about the relationships between variables (households’ food expenditure shares and expenditure per capita).
There is an upward shift of the Lowess (representing the Engel Curve in our case) between January 2020 and April 2020 in both rural and urban areas. In rural areas, the gap in food expenditure share between January 2020 and April 2020 was narrower for lower expenditure deciles, and wider for higher expenditure deciles. This may partly be attributed to substitution of expenditure on food sourced from outside with expenditure on home-cooked food by the higher expenditure deciles, as the cases and fear of infection rose. In urban areas, we see a similar

Fig. 2. Engle Curves using Lowess of Food Expenditure Share on Expenditure per capita. Source: Authors’ Calculations using CMIE-CPHS.
upward shift of the Engel curves in April 2020. The gap between the Engel curves of January 2020 and April 2020 is, however, similar across all expenditure deciles.

The Engel curve shifted downward between April 2020 and August 2020 once the lockdown restrictions were removed. The shift was minimum for the poorest as well as the higher deciles, suggesting the resilience of household consumption of food to shocks. There was almost no shift in the subsequent 12 months; and the curve remained above the pre-pandemic levels even after the more deadly second wave had subsided.

3.2. Econometric results

This section discusses the results of the two stage least squares regression model. The model is run for rural and urban areas separately, and then pooled at the all-India level.

Table 2 presents the results of the first stage of the 2SLS estimation. The cumulative Covid cases at state level are instrumented by length of transmission (in days) and distance from Thrissur (in km), as explained above. The negative and significant coefficients, of both the instruments, is consistent with our hypothesis that the longer the distance from Thrissur, and the time of transmissions, the lower will be the incidence of the pandemic as measured by the number of Covid-19 infections. The F-test of excluded instruments, is greater than the Stock-Yogo critical value, indicating that the maximum relative bias of 2SLS estimates (compared with OLS) is less than 10%, implying that there is no weak instrument problem (Stock & Yogo, 2002). The Sargan-Hansen J statistic is statistically significant, indicating that one of the two instruments is endogenous. This implies that causal inferences cannot be obtained. However, Hansen (2016) is cautious and suggests that the Hansen J test should not be used as a definitive test for validating or invalidating the IV model given the ambiguous nature of the test.

In both rural and urban areas as well as at the all India level, the cumulative Covid-19 cases in a state are positively associated with the household monthly expenditure per capita (MPCE), and negatively associated with its square, implying rising intensity of Covid-19 with affluence but at a decreased rate. The number of cases in a state reduces with higher education levels. On an average, the Covid-19 cases in a state are found to be lower in the case of OBCs, STs and SCs households compared to the unreserved category. Similarly, the incidence of Covid-19 in a state is lower in case of Sikh and Christian households, and higher in the case of Muslim households vis-à-vis the reference category of Hindu households.

Demand theory shows that prices have both income and substitution effects. The income effect is positive: as a food commodity price rises, real income decreases, and the demand for the food item falls. Given real income, the higher the price of a food commodity, a cheaper food commodity substitutes for it. What we have are four relative food prices: vegetables, sugar, milk and oil, each relative to cereals’ and pulses’ weighted price.

In rural areas as well as at the all-India level, the negative association between cumulative Covid-19 cases and (relative) vegetable price ratio suggests that higher vegetable price induces a lower demand for vegetables as real income falls and there is substitution of cheaper cereals and pulses. This lowers the cumulative incidence of Covid-19 cases. This is also true of (relative) prices of milk and oil and a similar process operates that lowers the demand for these food commodities and increases the demand for cereals and pulses. An exception is the (relative) price of sugar which increases the incidence of the Covid-19 cases through a lower demand for sugar through income and substitution effects and higher demand for cereals.
Table 2
First Stage results of IV 2SLS estimation.

| Dependent Variable: | I - RURAL | II - URBAN | III - ALL INDIA |
|---------------------|-----------|------------|----------------|
| Distance from Thrissur | -0.0001 *** | -0.0002 *** | -0.0002 *** |
| Length of transmission | -0.0229 *** | -0.0157 *** | -0.018 *** |
| Sector (=1 Urban, =0 Rural) |  |  | -0.381 *** |
| Urban * Lagged Log(MPCE) |  |  | 0.0603 *** |
| Lagged Food Exp Share | -0.0029 *** | -0.0031 *** | -0.0032 *** |
| Lagged Log(MPCE) | 0.2321 *** | 0.3314 *** | 0.1622 *** |
| Lagged Log(MPCE)^ 2 | -0.0348 *** | -0.035 *** | -0.0326 *** |
| Age of head of household | 0.0001 | 0.0015 *** | 0.0011 *** |
| Household Composition |  |  |  |
| Balanced Households |  |  |  |
| Children Dominated | 0.0209 *** | 0.0301 *** | 0.0286 *** |
| Grownups Dominated | 0.0292 *** | 0.0171 *** | 0.0207 *** |
| Household size | -0.0198 *** | -0.0059 *** | -0.0115 *** |
| Household Education |  |  |  |
| groupRef: All of some illiterates |  |  |  |
| Graduates majority | -0.061 *** | -0.0073 *** | -0.0191 *** |
| Matriculates majority | -0.0204 *** | -0.0229 *** | -0.0237 *** |
| Household Occupation | 0.0634 *** | 0.0507 *** | 0.0673 *** |
| (Farmers =1, Non-Farmer =0) |  |  |  |
| Gender of head of household | -0.0047 | 0.0096 *** | 0.005 ** |
| Household Caste |  |  |  |
| OBC | 0.0465 *** | -0.0979 *** | -0.084 *** |
| SC | -0.0231 *** | -0.0454 *** | -0.0392 *** |
| ST | -0.034 *** | -0.1445 *** | -0.0917 *** |
| Household Religion |  |  |  |
| Muslim | 0.0184 *** | 0.0071 *** | 0.008 *** |
| Sikh | -0.1795 *** | -0.2432 *** | -0.2189 *** |
| Christian | -0.296 *** | -0.3418 *** | -0.3313 *** |
| Other | 0.3252 *** | 0.4344 *** | 0.4172 *** |
| Price Ratios |  |  |  |
| Vegetables to Cereals&Pulses | -0.0497 *** | 0.0137 *** | -0.0117 * |
| Sugar to Cereals&Pulses | 0.0895 *** | -0.0162 *** | 0.0385 *** |
| Milk to Cereals&Pulses | -0.0683 *** | -0.283 *** | -0.2092 *** |
| Oil to Cereals&Pulses | -0.0902 *** | -0.033 *** | -0.0571 *** |
| Time Dummies | YES | YES | YES |
| Constant | 2.0584 | 1.18 | 1.8581 |
| R-squared | 0.9606 | 0.96 | 0.9602 |
| No. of observations | 1,149,440 | 2,328,047 | 3,477,487 |
| Test of excluded instruments: | F( 2,1149406) = 30,939.49 | F( 2,2328013) = 43,951.64 | F( 2,2328013) = 74,890.13 |
| Prob > F = 0.0000 | Prob > F = 0.0000 | Prob > F = 0.0000 |

***p < 0.00, **p < 0.05, *p < 0.1
While lower nutrition may lower immunity, there are various factors that contribute to immunity—a balanced diet consisting of certain foods including mushrooms, tomato, bell pepper and green vegetables—broccoli, spinach—that build resilience in the body.

In urban areas, however, the coefficient on the relative price of vegetables is positive. Using our distinction between income and substitution effects, we find that higher vegetable prices will produce a negative income effect, lowering the demand for vegetables, while cheaper cereals’ and pulses’ will substitute for vegetables. So it seems higher intake of cereals and pulses and lower intake of vegetables lowers immunity and is thus associated with higher cumulative Covid-19 cases. In contrast, higher (relative) price of sugar lowers demand for sugar through income and substitution effects, and increases demand for cereals and pulses. Since there is a negative association between cumulative Covid-19 cases and this price ratio, there is evidently higher immunity and lower risk of the Covid-19 infection. This explanation also holds for milk and oil prices. However, as noted earlier, the body immune system is complex and requires a balanced diet and a healthy life style (e.g., adequate sleep and physical exercise).

Table 3 presents the second stage results of the second stage structural equation. The positive and significant coefficient on the lagged food expenditure share of households, (0.58, 0.57 and 0.58 in rural, urban and all-India samples), indicates a strong positive relationship between the food expenditure shares of households last month and those of households in current month. In other words, adjustment of food expenditure share is high.

The negative coefficient on monthly per capita expenditures (MPCE) of rural households denotes an inverse relationship between household expenditure levels and their expenditure on food. A one percent increase in per capita expenditure of household is associated with 0.05% decline in their food expenditure shares. The positive and significant estimate of the squared term corroborates a concave Engel curve. These estimates together imply that the households’ food expenditure shares decrease as their total expenditure levels increase, but after the turning point where monthly household per capita expenditure levels are Rs.6634.24, the relationship between the two becomes positive. A quadratic Engel curve allows us to express the large expenditure variability among households belonging to different income categories. In addition, they also capture the varied household responses to various kinds of shocks in the economy.

The positive coefficient of the monthly per capita expenditures of urban households denotes the direct relationship between household expenditure levels and their expenditure on food. This is in sharp contrast to the results for rural households. In addition, the negative estimate of the squared term corroborates a convex Engel curve. These estimates together imply that the households’ food expenditure shares increase as their total expenditure levels increase, but at per capita expenditure levels above Rs.904.2, the relationship between the two becomes negative. A quadratic food Engel curve in case of urban India confirms the expenditure variability and the wide-ranging responses of households belonging to different income groups to the Covid-19 induced economic shocks. The all-India level results also corroborate a convex Engel curve. The negative and significant coefficients on the urban, as well as the urban x lagged log (expenditure per capita) covariates, point to the lower elasticity of food demand in urban areas.

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7 6634.24 is derived by the first order condition where the partial derivative of the first stage equation is set to be 0 with respect to the monthly per capita expenditures (that is, \( \frac{\partial Y_i}{\partial X_i} = 1 + 2 \cdot 2 \cdot \log X_i = 0 \) or \( \log X_i = -1 / 2 = -5.2566 / 0.597 \approx -8.80 \) or \( X_i = e^{8.80} \approx 6634.24 \).

8 904.2 is derived by the first order condition where the partial derivative of the first stage equation is set to 0 with respect to the monthly per capita expenditures (that is, \( \frac{\partial Y_i}{\partial X_i} = 1 + 2 \cdot 2 \cdot \log X_i = 0 \) or \( \log X_i = -1 / 2 = -6.7771 / (-0.4978) \approx 6.80 \) or \( X_i = e^{6.80} \approx 904.2 \).
In rural areas, the effect of age of head of household has a small but positive effect on food expenditure shares of households. Household size has a negative association with food share due to economies of scale in food consumption expenditures. As the household size increases by one member, the total outgo on food as a share of total expenditure reduces by 0.136 per cent. Our analysis accounts for the household composition and allows us to study its effects on the

Table 3: Second stage results of IV estimation.

| Dependent Variable: Food Expenditure Shares in Total | I - RURAL | II - URBAN | III - ALL INDIA |
|---------------------------------------------------|-----------|------------|----------------|
| Log (Covid Cases in a State)                      | -0.8198 *** | -0.2466 *** | -0.413 *** |
| Sector (=1 Urban, =0 Rural)                       |           |            |               |
| Urban * Lagged Log(MPCE)                          |           |            |               |
| Lagged Food Exp Share                             | 0.584 *** | 0.5698 *** | 0.5754 *** |
| Lagged Log(MPCE)                                  | -5.2566 *** | 6.7771 *** | 3.6045 *** |
| Lagged Log(MPCE)^2                                | 0.2985 *** | -0.4977 *** | -0.2907 *** |
| Age of head of household                          | 0.0172 *** | 0.0009 * | 0.0058 *** |
| Household Composition Ref:                        |           |            |               |
| Balanced Households                               |           |            |               |
| Children Dominated                                | 0.5848 *** | 0.5624 *** | 0.5612 *** |
| Grownups Dominated                                | 0.136 *** | 0.2106 *** | 0.1852 *** |
| Household size                                    | -0.136 *** | 0.0021 | -0.0505 *** |
| Household Education group Ref:                    |           |            |               |
| All of some illiterates                           |           |            |               |
| Graduates majority                                | -1.3221 *** | -2.0575 *** | -1.8544 *** |
| Matriculates majority                             | -0.7206 *** | -0.7874 *** | -0.7529 *** |
| Household Occupation (Farmers =1, Non-Farmer =0)  | -0.7912 *** | -0.4486 *** | -0.8021 *** |
| Gender of head of household (Female=1, Male=0)    | 0.6318 *** | 0.6458 *** | 0.6416 *** |
| Household Caste Ref: Unreserved                   |           |            |               |
| OBC                                               | 0.6435 *** | 0.57 *** | 0.6168 *** |
| SC                                                | 1.3281 *** | 1.0173 *** | 1.1512 *** |
| ST                                                | 0.6392 *** | 0.3474 *** | 0.4574 *** |
| Household Religion Ref: Hindu                     |           |            |               |
| Muslim                                            | 1.2783 *** | 1.2423 *** | 1.2855 *** |
| Sikh                                              | -2.2367 *** | -1.0646 *** | -1.4339 *** |
| Christian                                         | -1.1684 *** | -0.1694 *** | -0.3908 *** |
| Other                                             | 0.1461 | -0.7518 *** | -0.5066 *** |
| Price Ratios                                      |           |            |               |
| Vegetables to Cereals&Pulses                      | -1.5632 *** | -3.0066 *** | -2.5183 *** |
| Sugar to Cereals&Pulses                           | 2.4811 *** | 1.7928 *** | 2.0733 *** |
| Milk to Cereals&Pulses                            | 0.9973 *** | 1.5773 *** | 1.3273 *** |
| Oil to Cereals&Pulses                             | 0.4334 *** | 0.2672 *** | 0.3328 *** |
| Time Dummies                                      | YES       | YES        | YES           |
| Constant                                          | 37.0143 | 6.3405    | 5.7792        |
| R-squared                                         | 0.431    | 0.4582    | 0.4543        |
| No. of observations                               | 1149440  | 2328047   | 3477487       |
| Sargan-Hansen J stat (overidentification test of all instruments) | Chi-sq(1): 134.001 | Chi-sq(1): 1078.693 | Chi-sq(1): 930.556 |

***p < 0.00, **p < 0.05, *p < 0.1
food expenditure shares. The children-dominated households have about 0.58 per cent higher share of expenditure on food on average, relative to the balanced households. Similarly, the grownup dominated households have a higher average food expenditure share by 0.14 per cent as compared to the balanced households. The food expenditure share is lower by 0.72 per cent for households with majority of Matriculates, and lower by 1.32 per cent for households with majority of Graduates, than households with lower or no literacy. This indicates that the lower the schooling level, the higher is the household spending on food. Households with female head, on average, have food share higher by 0.63% points than a household with a male head. We get similar results for urban and all-India samples.

Food share is higher by 1.33 per cent for the scheduled caste households, and higher by 0.64 per cent for the scheduled tribes’ and OBC households, compared to the unreserved ones, implying that lower castes have a higher share of food in their total expenditures in rural areas. In urban areas, food share is higher by 1.02 per cent for the scheduled caste households, and higher by 0.35 per cent for the scheduled tribes’, and higher by 0.57 per cent for OBC households, compared to the unreserved ones. At the all-India level, food share is higher by 1.15 per cent for the scheduled caste households, by 0.45 per cent for the scheduled tribes’, and by 0.62 per cent for OBC households, compared to the unreserved ones, implying that lower castes have a higher share of food in their total expenditures. Thus, this caste-based disparity in food expenditure share is higher in rural areas.

In rural areas, as compared to Hindus, while Muslims, on average, have a higher food expenditure share by 1.28 per cent, the Sikhs and Christians have lower food expenditure shares. The coefficient of other religions (Buddhists, Jains and Khasi) is not statistically significant. Even in urban areas and at the all-India level, as compared to Hindus, Muslims, on average, have a higher food expenditure share and the Sikhs, Christians and Other religions (Buddhists, Jains and Khasi) have lower shares. More expensive non-vegetarian diets of Muslims compared to Hindu households-some of whom are non-vegetarian-could partly account for their higher food expenditure, quite apart from their lower incomes.

Farming households have lower shares of expenditures (by 0.79 per cent in rural areas and by 0.45 per cent in urban areas) on food in comparison to non-farming households.

The coefficient on (relative) price of vegetables is negative, implying lower food share, while those on sugar, milk and oil are positive, implying higher food shares. Specifically, the income effect will lower demand for vegetables. However, keeping real income constant, higher (relative) prices of vegetables will induce substitution by cereals and pulses. Taking these two effects into account, there is a reduction in the food share. In contrast, higher relative prices of sugar, milk and oil are associated with higher food shares. Rising prices of these more expensive sources of calories will reduce their demand through lower real income and substitution through cheaper cereals’ and pulses’ prices. So lower consumption of all these food items and higher intake of cereals and pulses are likely to entail loss of nutrition due to limited diet diversity. The results are consistent across rural, urban and all-India samples.

In both rural and urban areas as well as at the all-India level, the negative coefficient of (predicted) Covid-19 cases indicates that people spent more on food as supply chains were disrupted, supply contracted and retail food prices spiked. As argued in the preceding paragraph, as higher food expenditure share manifests larger intakes of cereals and pulses and lower intakes of more expensive sources of nutrients (such as vegetables, milk, sugar and oil), it is difficult to rule out large nutritional losses. Yet the design of our immune system is complex and influenced by an ideal balance of many factors, not just diet. However, a balanced diet consisting of a range of vitamins and minerals, combined with healthy lifestyle factors such as
adequate sleep and exercise and low stress, most effectively safeguard the body to fight infection and disease.

3.3. Discussion and policy recommendations

The pandemic induced lockdowns resulted in a sharp increase in the share of food in total expenditure across rural and urban India, and for all expenditure levels. The movement restrictions at the onset of the pandemic acted more like a temporary shock than a permanent one, which resulted in declining shares of food in total expenditure, but stabilizing at a level higher than that observed pre-pandemic. Our analysis of food demand among households in India prior to and during the Covid-19 pandemic, based on nationally representative household consumption and expenditure survey data, is perhaps the first empirical study illustrates the mechanisms driving food consumption patterns during the Covid-19 pandemic in India.

Our analysis reveals a concave (an inverted U-shaped) relationship between food expenditure shares and total expenditures in rural areas, and convex (U-shaped) relationship in urban areas, as well as at the all-India level. The spending behavior of households, as well as the households’ response to shocks vary largely in rural and urban India (Gupta & Kishore, 2022; Meenakshi & Ray, 1999). While urban households usually have higher per capita incomes and depend on purchased food, rural households depend on relatively cheap farm food (Hasan, 2016). This may well explain in part the different shapes of food Engel curves in both the sectors, apart from differences in consumer food preferences. It is not unlikely that urban households have unmet demands for necessary goods (including food) at low-income levels. As household incomes rise, they spend their additional earnings on food more than proportionally and this induces a reduction in shares of other types of household expenditures. When household incomes increase enough and reach a certain threshold level, they tend to spend more than proportionally on other categories of goods and services. The quadratic food Engel curves are perceived as a representation of the development status of a country. India is a developing nation, with a large share of low-income households. It, therefore, becomes very important from policy perspective to understand the households’ responses to income and price shocks. It is also important to make allowance for the household income groups and their location (rural or urban), as we witnessed varied responses of such households to the Covid-19 related economic shocks.

Our results also confirm lower elasticities of food demand in urban areas. An income shock induced by COVID-19 infection and nationwide lockdowns resulted in a higher responsiveness of rural India’s food demand, as compared to the urban India. Whether this is in part due to easier access to PDS/subsidized food distribution in urban areas cannot be ruled out. Food preferences for pre-cooked food necessitated by nuclear families in which both man and wife work could also account for difference in the food elasticities.

Age of household head has a positive impact on food expenditure shares in both rural and urban areas and at the all-India level. This is somewhat surprising. Household head age is positively related to the food security status of the households, in line with the life-cycle hypothesis. As age rises, assets accumulate, and these assets can be liquidated at the time of an income constraint. The positive coefficient in our results may reflect overstocking by the old, given the mobility restrictions during the pandemic-especially during the lockdowns.

Household size has a negative association with food expenditure share in rural areas. Deaton and Paxson (1998) lays out various possible explanations for why larger households may spend less on food. First, larger households may benefit from block pricing or buying in bulk; second,
the households may benefit from economies of scale in cooking food; third, as household size rises, the households may substitute food from outside (restaurants and pre-cooked meals) by home-prepared food, causing reduced expenditure on food; and fourth, larger households may have better storage capacities that eliminate wastage.

Household composition (in terms of proportion of children and adults) has significant associations with food expenditure shares. Children dominated households have the highest food expenditure shares, followed by grown up dominated households, compared to the balanced households. Children need energy, water and oxygen to support their growth process, and more diversified diets including of dairy, fruits and vegetables given the income constraint.

Spending on food as a share of total expenditure reduces as education levels rise. If schooling adds to awareness of safe and healthy diets which may also be cheaper, this could partly explain lower food expenditure. There may also be spillover effects through social networks.

Farming households have lower shares of expenditures on food in comparison to others. A possible explanation could be the consumption of self-produced food in such households which is presumably not fully accounted for in the CMIE survey. Another reason could be consumption of less diversified diets by such households, confining their intake of food mostly grown at home. The widening gap between energy requirements and intake is not sustainable except over short spells.

In both rural and urban areas as well as at the all India level, households with female head, on average, have higher food expenditure shares compared to households with a male head. A possible explanation of these results could be that women are more likely to spend a larger share of their incomes on their children and household consumption, relative to men who spend a greater proportion of their income on status consumer goods, alcohol, cigarettes (Hoddinott & Haddad, 1995). These results highlight the importance of women empowerment. Households where women have better representation and autonomy to take household decisions are better in terms of household food security (Kennedy, 1992) and nutritional outcomes (Imai et. al, 2014).

Caste plays an important role too. The caste-based hierarchy is deep-seated in India, with the Brahmins and other upper castes at the top and the Scheduled Castes (SCs) and Scheduled Tribes (STs) at the bottom. Traditionally, Brahmins are vegetarian, while SCs and STs are not. The more deprived socio-economic groups, namely, the scheduled castes, scheduled tribes and other backward classes have higher food expenditure shares compared to the unreserved category. Further, this caste-based disparity in food expenditure is higher in rural areas. The important point is that despite affirmative action (quotas for SCs, STs and OBCs in public employment and education) economic disparities persist.

Muslims have higher food expenditure shares compared to Hindus. Hindus in India are better-off than Muslims on average. While many Hindus are vegetarian, many also eat meat with the exception of beef. Muslims are non-vegetarian and eat all kinds of meat except pork.

Both lower castes and minorities bore the brunt of the alarming spurts of higher food expenditure shares. Even though discriminatory practices against religious minorities and lower castes are illegal, such practices remain pervasive. Even if attitudinal and behavioural changes are slow, social networks ought to be strengthened and motivated to initiate such changes. This is of course easier said than done.

Essentially, all the food consumed in urban areas is purchased, since almost all urban households are net buyers of food. And, of the 40% of India’s food that is consumed in rural areas, 80% (in value terms) is purchased (while the rest is home-produced on own farms). This illustrates the great importance of food supply chains (FSCs) for India’s food security (Reardon et al., 2020). Hence, COVID-19’s most important effect will be on national food security via its
effects on the FSCs. Our results suggest a negative relationship between relative prices of vegetables (to staples) and food expenditure shares in both rural and urban areas and at the all-India level. The relationship between the relative prices of sugar, oil and milk and food expenditure shares is positive. As explained earlier, this implies a higher price of more expensive sources of calories resulting in less diversified diets and a concentration of starchy staples and likely loss of nutrition. Moreover, consumer food prices in most urban areas have risen, driven by increased frictions in the supply chain in the form of limited availability of labour, higher transport costs (in some cases, double pre-lockdown costs) and uncertainties around logistics (Kaicker, et. al., 2021). With the largest food subsidy program in India — Targeted Public Distribution System (TPDS) being a dismal failure\(^9\) in targeting the poor- stronger policy planning and implementation are required to ensure food security amid the food price instabilities and broken supply chains.

A negative relationship is found between food expenditure shares and the incidence of cumulative Covid-19 in the state. This implies that as mobility restrictions tightened due to spiraling number of infections, households reduced their spending on non-essential items and primarily spent on food.

4. Conclusion

The Covid-19 pandemic and the mobility restrictions impact food security of households both through prices (due to supply side restrictions) as well as incomes (increased unemployment, and loss of incomes). This study has attempted to examine the covariates of food security among the households using a nationally representative sample and the impact of Covid-19 induced shocks on the food expenditure shares of the households with varied socio-demographic characteristics. We noticed spurts of higher food expenditures during the lockdowns and peaks of first and second waves, which is alarming for three reasons: inferior cereals are substituted for expensive cereals; lower amounts are spent on more nourishing foods such as fruits and vegetables; and other essential non-food items such as education and healthcare are neglected.

Our key results are evidence of higher food expenditure elasticities in rural areas, and higher shares of food expenditure among households with elderly head, female headed households, children dominated households, greater proportion of illiterates, and those belonging to more deprived socio-economic groups (SCs, STs and OBCs) and religious minorities (e.g.: Muslims). Given that the share of expenditure on food is a useful indicator to assess the welfare impacts of changing household incomes and prices, our results indicate a disproportionate burden of the pandemic induced lockdowns and the consequent food insecurity, particularly among the dis-advantaged and minorities. This calls for effective action on the part of policymakers to boost aggregate demand, especially among the deprived by promoting employment, better access to education, minimizing gender gaps in wages for women, provision of safety nets to safeguard in terms of crisis and better awareness of the importance of having nutritious diets. The cutback in food subsidy by about 28 per cent, mid-day meals by 12 per cent and MGNREGA by 25 per

\(^9\) Jha, Gaiha, Pandey, and Kaicker (2013) attribute the failure of the TPDS to high transaction costs - long waiting periods at Fair Price Shops (FPS), supply shortages and diversion to open markets resulting in frequent trips to FPS, cheating in weighing, poor quality of food grains sold.
cent in the budget for 2022–23, relative to the budget for 2021–22, by the finance minister in India are likely to curtail the already deficient demand.

Attention must be given to fixing disrupted food supply chains through better transportation and removal of inter-state barriers to free movement of food and other essentials, severe penalties on speculative hoarding of food-grains and ensuring more integrated food markets. On the demand side, increased market integration enables farmers, particularly smallholder farmers, to increase incomes and purchase a wide variety of goods, and reduce reliance on own production. On the supply side, better market linkages improve availability of a variety of nutritious foods for households.

Not just level of food prices but also their volatility needs to stabilize. The retail inflation is at 7.79%, much above the RBI’s upper limit of 6%, and food inflation soared up to 8.38% in April 2022, it may be seen as the biggest threat to food security. Although a major cause behind it can be attributed to the geopolitical tensions in Europe and the rising transportation costs worldwide, it also points towards the fact that the disrupted domestic supply chains during the pandemic haven’t been fully functional. RBIs response of increasing the repo rate by 40 basis points to control the rising inflation, and the government’s announcing the wheat- export ban as an action to stabilise domestic wheat prices are controversial decisions. While the higher repo rate may help curb inflation, it could also hurt growth. Whether wheat-export ban is justified given total wheat stocks with FCI of about 190 lakh MT is not self-evident in the context of falling foreign exchange reserves.

Above all, a greater preparedness for another Covid-19 epidemic and better monitoring and surveillance of recent rise in Covid-19 cases, and a well-designed coordination and expansion of healthcare facilities, and a deeper understanding of new Covid-19 virus mutations is imperative to prevent another crisis.

References

Akerlof, G., & Kranton, R. (2000). Economics and Identity. *Quarterly Journal Of Economics, 115*(3), 715–753. https://doi.org/10.1162/003355300554881

Anand, A., Sandefur, J., Subramanian, A., et al. (2021). Three New Estimates of India’s All-cause Excess Mortality During the COVID-19 Pandemic. Center for Global Development.

Asefach, A., & Nigatu, R. (2007). Correlates of household food security in densely populated areas of southern Ethiopia: does the household structure matter? *Studies on Home and Community Science, 1*(2), 85–91.

Banks, J., Blundell, R., & Lewbel, A. (1997). Quadratic Engel curves and consumer demand. *Review of Economics and Statistics, 79*(4), 527–539.

Barrett, C. B., Reardon, T., & Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: Concepts, dynamics, and policy implications. *Food Policy, 26*(4), 315–331.

Behrman, J., & Deolalikar, A. (1987). Will developing country nutrition improve with income? a case study for rural South India. *Journal Of Political Economy, 95*(3), 492–507. https://doi.org/10.1086/261469

Deaton, A. (1988). Quality, quantity, and spatial variation of price. *The American Economic Review, 78*(3), 418–430. (http://www.jstor.org/stable/1809142).

Deaton, A. (1997). *The Analysis of Household Surveys: A Micro Econometric Approach to Development Policy*. World Bank Publications.

Deaton, A., & Muellbauer, J. (1980). An almost ideal demand system. *The American Economic Review, 70*(3), 312–326.

Deaton, A., & Paxson, C. (1998). Economies of scale, household size, and the demand for food. *Journal of Political Economy, 106*(5), 897–930.

Deaton, B. J., & Deaton, B. J. (2020). Food security and Canada’s agricultural system challenged by COVID-19. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie, 68*(2), 143–149.

Devereux, S., Béné, C., & Hoddinott, J. (2020). Conceptualising COVID-19’s impacts on household food security. *Food Security, 12*(4), 769–772.
