Nutrient consumption in India: Evidence from a village study

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Abstract
Adequate nutrition is generally regarded as a core dimension in any evaluation of well-being. In the context of India, a country with a high prevalence of poor nutrition, there is a dearth of nutrition studies with adequate coverage and comparability. Using primary data on food consumption from a village in a poorer state of India, we study the consumption of five key nutrients, namely, calories, protein, carbohydrates, calcium and iron. Among the various determinants of nutrition, we find that expenditure has a significant impact on nutrition and the expenditure elasticity of nutrition is comparatively high for all the key nutrients. By correcting for potential endogeneity, we demonstrate a causal link from expenditure and food subsidy provided by the public distribution system to nutritional intake. There is some evidence that household characteristics such as household size and gender of the household head matter for nutrition; however, they are not robust under various specifications.

JEL CLASSIFICATION
I1; I38; O12; O53

1 | INTRODUCTION

Nutrition is universally regarded as a core dimension in any evaluation of well-being. Policy initiatives from governments and multilateral agencies have increasingly focused on nutrition, given the high returns from investing in it (Economist, 2012; Development Initiatives, 2017; World Bank, 2006).
Despite this increasing interest in nutrition, for many developing countries, there is a dearth of detailed studies focusing on nutrient intake (Haddad et al., 2015). In the context of India, a country with high levels of stunting and wasting, recent national surveys on nutrition suffer from issues of comparability and lack of coverage, particularly for regions with high nutritional deficiencies (John, Knebel, Haddad, & Menon, 2015). This paper uses primary village-level data from a poor region in India to investigate both macro- and micro-nutrient consumption. Specifically, we study the consumption of three macro-nutrients (calories, protein and carbohydrates) and two micro-nutrients (calcium and iron). In addition to quantifying the level of nutritional intake in the village, we examine the causal factors that impact nutrient consumption.

India presents a rather puzzling case when it comes to nutrition. In an early pioneering study, going against the prevailing wisdom and using ICRISAT (International Crops Research Institute for the Semi-arid Tropics) village-level data from India, Behrman and Deolalikar (1987) demonstrated that income elasticities of demand for macro- and micro-nutrients are close to zero. They implied that increases in income would not necessarily be translated into increased nutrient consumption. They attributed their findings to strong preferences for particular kinds of diet. Using nationally representative data from the National Sample Survey (NSS), Subramanian and Deaton (1996) found that the expenditure elasticity for calorie consumption varies between 0.3 and 0.5. Analyzing NSS data, Deaton and Drèze (2009) found that, contrary to popular expectations, while income had increased, calorie intake had declined over time. This held true across the board for all income categories. They explained this puzzle mainly in terms of a reduced need for calories arising from a shift toward more sedentary jobs over time and overall improvement in health. Focusing on fats and proteins in addition to calories, Gaiha, Jha, and Kulkarni (2013) provide an alternative hypothesis whereby the decrease in demand for these nutrients is mainly due to a decrease in the consumption of food products resulting from higher prices.

Given the diverging views in the literature on both the trends and determinants of nutrition in India, there is a need for detailed micro-level studies on nutrition to enhance our understanding in several ways. First, such micro-level studies allow us to explore the specific problem in greater detail than is often possible in the case of national studies for a very large country such as India. Second, in studying the problem in a small area, it is often easier to identify the impact of the local social and cultural environment; the insights gained in this fashion may, in turn, suggest hypotheses which can be tested at the state or national level. It is in this spirit that we have collected primary data from the village of Mahidharpada in Odisha, India. Our research is also motivated by village studies in economics such as those undertaken by the London School of Economics (LSE) Palanpur Study Group (Bliss & Stern, 1982; Himanshu & Stern, 2018; Lanjouw & Stern, 1998), the ICRISAT village studies (Behrman & Deolalikar, 1987; Dercon, Krishnan, & Krutikova, 2013) and Townsend’s (2016) Thai village studies. Although one has to be cautious about drawing any general conclusions from village studies, they often capture the changes happening in the country at large. In the case of Palanpur, Stern (2017) claims that changes in India are reflected in the changes in the village, and long-term study of the village helps in understanding the broader changes happening in India. Thus, while recognizing the limitations of village studies such as ours, we believe that they can serve as useful supplements for corresponding studies on a much larger scale.

We contribute to the existing literature in several ways. We believe that, after the initial set of papers, such as Behrman (1988a, 1988b) and Behrman and Deolalikar (1987), which study nutrition at the village level using ICRISAT data, ours is the first paper to undertake a detailed analysis of the consumption of nutrients in a village in India. If village studies reveal interesting patterns and changes, then, given the size and diversity of India, it is imperative that we look beyond the initial established
village studies and focus on less prosperous regions. The village we study is located in Odisha, which is a state in eastern India with a very high level of poverty. Between 2004–2005 and 2009–10, Odisha experienced one of the greatest reductions in income poverty, as measured by the headcount ratio, among India states; during this period, the headcount ratio in Odisha declined from 57.2% to around 37%. The government of Odisha has undertaken several policy initiatives such as improving the delivery of subsidized food grains through the public distribution system (PDS) to improve nutrition among its citizens (see, among others, Gillespie, van den Bold, & Stories of Change Study Team, 2017; Shrivastav et al., 2017). All these changes make it an interesting case to study.

Unlike some studies of nutrition, our interest here is not on estimating the demand for different nutrients; instead, we examine the key determinants of nutrient consumption. It is generally accepted that income (or expenditure) is an important factor which influences nutrition (Burchi & De Muro, 2016). There is a strong interest also in understanding the impact of subsidized PDS food on nutrition. Though Odisha has seen significant improvement in the implementation of the PDS between 2004 and 2010 (Khera, 2011a, 2011b), we have not been able to find any systematic study of the impact of PDS on nutrition in Odisha. We undertake several robustness checks to establish the role of other household characteristics, such as household size, gender of the head of household, occupation, and caste of the household, in determining the consumption of macro- and micro-nutrients. Our analysis reveals that the impact of many of these characteristics such as caste, occupation, and gender on the macro- and micro-nutrients is not robust to different specifications of the model.

Additionally we examine the causal connections from key variables such as household expenditure and PDS subsidy to nutrition. Kochar (2005) uses instrumental variable (IV) methods to establish the causality of PDS subsidy on calorie intake. We extend that approach by correcting for potential endogeneity using IV methods on two fronts. First, we examine the causality of nutrition under multiple endogenous variables, which are household expenditure and PDS subsidy. Second, we examine the causality of these endogenous regressors on a range of macro- and micro-nutrients and not just calories. We demonstrate a causal link from both expenditure and PDS subsidy to this broad set of nutrients.

While our sample is not nationally representative as in the NSS, unlike NSS which is based on purchase data, we have focused on direct consumption. As recognized by Subramanian and Deaton (1996), there is a difference between nutrient intake and nutrient availability. Thus, for example, a household might have purchased 40 kg of rice but might have consumed only 20 kg. What we have documented is the latter figure of 20 kg. Purchase-based data may include food items that are purchased for other purposes such as gifts to others; also purchase-based data may include food stored and consumed in a period different from the period during which the actual purchase is made. Further, the focus at the village level has allowed us to take into account consumption of particular types of food which are specific to the region. For instance, we have documented substantial consumption of leafy vegetables such as *Amaranthus viridis* (leutia saag) and pulses such as horse gram (kolatha), which, although quite common in this region, is not consumed widely elsewhere.

The organization of the paper is as follows. In Section 2 we discuss in detail the data that we have collected and some broad descriptive statistics. Section 3 provides a brief description of our notation, and how we calibrate the different nutrients. Section 4 presents our estimation strategy and examines the results of our analysis. In this section we also discuss the evidence of the causal impact of key variables on nutrient consumption using the IV method. Section 5 considers two robustness checks, one based on quantile regressions and the other using adult equivalence scales which take in to account some aspects of intra-household distribution. Section 6 concludes with a few brief remarks and some directions for future research.
Mahidharpada is situated in eastern Odisha, a relatively prosperous part of the state, with the state capital, Bhubaneswar, in the North and the commercial city of Cuttack in the South. The village consists of 136 households. We were able to collect the food information for 134 households, with 776 people covered by the survey. The average size of households is 5.8. The village has three broad subgroups, based on caste lines: Scheduled Castes (SC), Other Backward Castes (OBC), and Other Hindus (OH), with SC being the dominant group with 81 households and the rest spread between OBC and OH. Slightly less than 80% of the households are headed by males. Mahidharpada is not an affluent village, with the main occupation in the village being wage laborers. The survey in this village was conducted between November and December 2011. We collected detailed information on living standards, including food consumption, using a questionnaire that we developed.4

The food consumption data was based on a 30-day recall. Among the two main data sets used to study nutritional intake in India, the NSS has moved from a 30-day recall period to a 7-day recall and back to a 30-day recall; the ICRISAT data are based on 24-hr recall. Short recall periods may have better accuracy in terms of the consumption people have undertaken; however, they may carry a lot of noise (Strauss & Thomas, 1995). In a rural context, we felt that the 30-day recall period might work better in two respects. First, some of the food items might not be consumed every week. For instance, non-staple food such as meat might be consumed bi-weekly, which under a 7-day recall would go unreported, depending on the week in which the survey takes place. Second, weekly consumption might be more prone to idiosyncratic shocks of unemployment or sickness, particularly in a rural area where many of the households are daily wage earners and have no insurance. Therefore, we decided on a 30-day recall to collect the consumption information.5

We have collected information on 55 food items across 11 food categories. For each food item we gathered information on the quantity of the household’s consumption and expenditure over the preceding 30 days, including both market and non-market transactions. Besides the consumption of food purchased in markets, we have taken three types of non-market transactions into account: consumption of food received in exchange of other goods or labor rendered; consumption out of home-grown stock; and consumption of food picked free from fields and communal lands. Drawing on our broad observations in the village, we found that high per capita consumption of cereals and pulses is not surprising since many households rely on just these two food types as their only staples. Hence, in order to filter out extreme values in food consumption, we focus on the food categories of vegetables and dairy products. We decided to drop households from our sample which reported per capita consumption of vegetables and dairy products greater than 20 kg per month. As a result, we consider 131 households in the analysis that follows.6 In terms of individuals, our sample now has 766 individuals, down from 776 in our raw data.

Table 1 provides a broad picture of the demographics of the village after all the exclusion criteria have been applied. The average size of the household remains 5.8 as before, with 4.6 adults and 1.2 children, where anyone 12 years old or under is considered a child and the rest are considered adults. In the modified sample, the overall proportion of female- to male-headed households is 26%. The SC are the dominant group followed by OBC and OH, both of which have similar levels of presence. The dominant occupation in the village remains wage labor. Around 27% of the households rely on subsidized food provided by the PDS.7

Table 2 provides descriptive statistics on household consumption of the different food categories in the last 30 days. Cereals and vegetables constitute the bulk of food consumption. Given food preferences in Odisha, rice constitutes the major component of consumption within cereals. Among the major food groups, meat, eggs, and fish together have one of the lowest average monthly levels of
consumption at just 0.61 kg. In comparison with other studies such as Drèze (2007), Khera (2011c),
and Ray (2007), the amount of food consumed in our village is around 10%–20% lower than statewide
and countrywide averages.

3 | CALIBRATION OF NUTRIENT CONSUMPTION

Since we are interested in the consumption of nutrients, we index the five nutrients (calories, protein,
carbohydrates, calcium, and iron) as 1, 2, 3, 4, and 5, respectively. We calibrate the level of nutrient
consumption for each household in the village using the information on the amount of food consumed
along with how much nutrient a specified quantity of each of these food items provides.

In general terms, let \( N \) be the set of all persons (including children) in the village. Suppose there
are \( K \) food items. From MedIndia (2013) we have, for every food item, information regarding the
amount of each of the five nutrients a person can get from one unit of that food item. \(^8\) For every food
item \( k \) (\( k = 1, 2, \ldots, K \)) and for every nutrient \( j \) (\( j = 1, 2, \ldots, 5 \)), let \( r_{jk} \) denote the amount of nutrient \( j \)
that an individual derives from one unit of food item \( k \). Suppose household \( h \) consumes \( a_{hk} \) units of

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**TABLE 1** Demographics based on caste and gender of the head of household

| Caste of the head | Other Backward Castes | Other Hindu Castes | Schedule castes | Gender of the head | Total | Female | Male |
|-------------------|-----------------------|--------------------|----------------|-------------------|-------|--------|------|
| Males             | 58                    | 58                 | 167            | Total             | 283   | 38     | 245  |
| Females           | 65                    | 75                 | 183            |                   | 323   | 69     | 254  |
| Male child        | 12                    | 7                  | 54             |                   | 73    | 7      | 66   |
| Female child      | 15                    | 17                 | 55             |                   | 87    | 22     | 65   |
| Total (individuals)| 150                   | 157                | 459            |                   | 766   | 136    | 630  |
| Number of households | 26                    | 24                 | 81             |                   | 131   | 27     | 104  |

**TABLE 2** Monthly food consumed by households

| Food Item          | Mean  | Median | SD    | Max.  | Min.  |
|--------------------|-------|--------|-------|-------|-------|
| Cereals (kg)       | 10.98 | 10.00  | 4.41  | 25.00 | 2.92  |
| Pulses (kg)        | 1.39  | 1.00   | 1.23  | 9.25  | 0.00  |
| Vegetables (kg)    | 7.06  | 5.80   | 3.97  | 19.67 | 1.57  |
| Fresh fruits (kg)  | 1.26  | 0.89   | 1.30  | 10.10 | 0.00  |
| Dry nuts (kg)      | 0.07  | 0.00   | 0.29  | 2.50  | 0.00  |
| Sugar, molasses, and salt (kg) | 1.28 | 1.00   | 0.82  | 5.20  | 0.29  |
| Spices (kg)        | 0.31  | 0.24   | 0.22  | 1.35  | 0.04  |
| Dairy products (kg)| 1.75  | 0.67   | 2.89  | 18.20 | 0.00  |
| Edible oil (kg)    | 0.52  | 0.38   | 0.45  | 2.63  | 0.07  |
| Meat, eggs, and fish (kg) | 0.61 | 0.47   | 0.58  | 4.00  | 0.00  |
| Beverages (kg)     | 0.06  | 0.03   | 0.12  | 0.94  | 0.00  |
| Pan tobacco and intoxicants (kg) | 0.24 | 0.14   | 0.34  | 2.88  | 0.00  |
food item \( k \) per day. Then household \( h \) consumes \( a_{hk} \cdot r_{jk} \) units of nutrient \( j \) per day from the consumption of food item \( k \). The total daily consumption of nutrient \( j \) by household \( h \) is given by \( b^h_j = \sum_{k=1}^{K} a_{hk} r_{jk} \). The per capita daily consumption of nutrient \( j \) by household \( h \) will be \( b^h_j / n_h \), where \( n_h \) is the number of members in household \( h \). Based on these steps, we calibrate the per capita daily consumption of macro- and micro-nutrients in the village.

Within macro-nutrients, calories are measured in kilocalories (kcal) and carbohydrate and protein in grams (g); micro-nutrients (calcium and iron) are measured in milligrams (mg). In calibrating nutrition we dropped the food groups of beverages and intoxicants because most nutrition comes from other food groups, and attributing the nutrition from beverages and intoxicants to the whole household may be problematic since these items are not consumed by the whole household. Table 3 provides summary statistics on the daily per capita consumption of the five nutrients in which we are interested.

The daily per capita mean consumption of calories in our village is around 1,950 kcal and protein is around 52 g. Deaton and Drèze (2009) estimate that, for 2004–2005, in rural areas of India the daily per capita mean calorie and protein consumption was 2,047 kcal and 55.8 g, respectively. Kumar, Bantilan, Kumar, Kumar and Jee (2012) report that, in rural India for 2009–2010, the daily per capita calorie and protein consumption was 2,147 kcal and 59 g, respectively. As with food consumption, the average nutrient values in our data are around 5%–10% below the reported national averages.

## 4 | RESULTS AND ANALYSIS

### 4.1 | Estimation strategy: Determinants of nutrient consumption

To understand the determinants of nutrient consumption, we run a set of regressions based on per capita daily nutrient consumption as the dependent variable and a set of control variables as our independent variables. Our analysis is done at the household level with the same household level covariates for the regressions for all nutrients. In our data we do not have information on intra-household allocation of food; hence, we mainly work with per capita values. We undertake robustness checks using adult equivalence and quantile regressions in Section 5.

Thus, for our estimation strategy, we use standard ordinary least squares (OLS) regression with robust standard errors. The estimated equation for nutrient \( j \) is given by

\[
\ln (y_{hj}) = \alpha_j + \beta_j \ln (E_h) + \delta_j \ln (S_h) + \lambda_j X_h + \epsilon_{hj},
\]

where \( y_{hj} \) is the daily per capita nutrient consumption of household \( h \), \( E_h \) is the daily per capita total expenditure in the household, \( S_h \) is the daily per capita level of implicit subsidy received by the household from PDS rice, and \( X_h \) represents a vector of household-level variables which comprise the household.
size, caste, gender and age of the household head, and the proportion of household members involved in farming and wage labor occupations. Since there are three castes in the village, we have two caste dummies, one for OH and another for OBC, with SC as the base category. So far as the gender of the head of household is concerned, we take female-headed households as the base category.

In investigating the determinants of nutrient consumption, one of the key variables is income. Since we do not have any earnings information, we have used expenditure as the proxy for income, as has been done elsewhere in the literature (Subramanian & Deaton, 1996). Our expenditure includes expenditure on food and non-food items. In particular, for non-food items, we consider expenditure on clothes, personal items, small household appliances, insurance, vacations, health, and fuel. We do not consider expenditure on jewelry and social functions as part of the overall expenditure. This is because these expenditures happen as lump sums and are usually planned in advance. They are generally not part of an everyday household budget. For food expenditure, apart from the value of marketed transactions of food, where a food item has been secured by the household through non-market transactions, we have included an imputed value of the food item provided by the household. Although most of our estimated expenditure comes from marketed transactions, we felt that it was important to include non-marketed transactions as some of the food items are procured free from the village commons.

We also collected data on the amount of subsidized rice each household bought through the PDS. Most research so far finds that the PDS program has little or no effect on a range of indicators, from children’s weight to reduction of poverty. Following Kochar (2005), we take the implicit subsidy received from buying PDS rice as a determinant of nutrient consumption. In the village, the open market price of rice was 15 rupees (Rs) per kilogram, whereas the cost of PDS-provided rice was Rs 2 per kg. Thus, the implicit subsidy per kilogram of PDS rice bought was Rs 13. We multiply the amount of PDS rice bought by each household by Rs 13 per kg to get the total implicit subsidy received by each household. Specifically, we use the log of the daily per capita level of subsidy provided through PDS rice in our regressions. Note that, owing to lack of information, we do not include subsidized food items, apart from rice, received by the household.

Our next set of covariates capture information related to the household. In our analysis, following Behrman and Deolalikar (1989) and Imai, Anim, Kulkarni, and Gaiha (2014), we consider the total number of household members as a measure of the size of the household. There is strong evidence (Himanshu & Stern, 2018; Panda, 1997; Pujari, 2004; Sinha, 2011) that nutrient consumption differs between social castes and is influenced by the gender of the household head in India. Thus, we control for both the caste and gender of the household head in our regressions. Further, as in the literature (Behrman & Deolalikar, 1990; Kumar et al., 2012), we consider the age of the head of household as a determinant of nutrition. This can be seen as a reasonable proxy for the human capital of the head of household, which may influence food consumption patterns. The nutrient consumption of the household also differs based on the occupational status of the household (Kumar et al., 2012; Pujari, 2004). Hence, we differentiate households in terms of occupational categories by considering the proportion of members who work as farmers or wage laborers. This captures Deaton and Drèze’s (2009) claim that sedentary lifestyles impact the consumption of nutrients.

## 4.2 Regression analysis

In this subsection we estimate the determinants of daily per capita nutrient consumption. Household-level determinants such as expenditure and PDS consumption are also assessed in daily per capita terms. The standard regressions along with robust standard errors for each nutrient are presented in Table 4.
The results in Table 4 show interesting patterns. For all macro- and micro-nutrients the expenditure elasticity of nutrient consumption is positive and strongly significant. Thus, for every 1% increase in per capita expenditure, the per capita consumption of calories increases by 0.52%, protein by 0.66%, carbohydrates by 0.44%, calcium by 0.94%, and iron by 0.73%. Although the expenditure elasticities of nutrient consumption are substantial, they are less than 1 except for calcium. This indicates that, for each percentage change in expenditure, nutrient consumption changes by less than 1% for all nutrients other than calcium. On the other hand, it also means that if expenditure is reduced by 1%, the reduction in consumption of these nutrients would be less than 1%. Taken together, they imply consumption smoothing of nutrients.

In terms of the impact of PDS subsidy on nutrition, we find that the elasticity is positive and significant for macro-nutrients at the 10% level of significance. Thus, a 1% increase in rice provided by PDS would yield a 0.09% increase in per capita consumption of calories, a 0.08% increase in protein, and a 0.09% increase in carbohydrates. This is no surprise since most of the expenditure among food groups is on cereals (of which rice is the mainstay), which make the highest per capita contribution in terms of calories, protein, and carbohydrates. In comparison to expenditure, the impact of PDS subsidy on the consumption of main nutrients that come with rice (such as calories and carbohydrates), although significant, is very small. One plausible reason could be that for a majority of households a

| TABLE 4 | Determinants of nutrient consumption |
|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|             | Calories        | Protein         | Carbohydrates   | Calcium         | Iron            |
| Log per capita daily expenditure | 0.518***          | 0.664***         | 0.443***         | 0.941***         | 0.724***         |
|             | (0.048)         | (0.053)         | (0.051)         | (0.090)         | (0.081)         |
| Log per capita daily PDS subsidy | 0.089*            | 0.075*           | 0.092*           | 0.040           | 0.097           |
|             | (0.045)         | (0.042)         | (0.051)         | (0.062)         | (0.061)         |
| Household size | −0.022****      | −0.021**         | −0.021**         | −0.006          | −0.016          |
|             | (0.008)         | (0.010)         | (0.009)         | (0.017)         | (0.020)         |
| Other Hindu Castes (dummy) | −0.014           | 0.042            | −0.085           | −0.065          | −0.053          |
|             | (0.066)         | (0.073)         | (0.076)         | (0.135)         | (0.122)         |
| Other Backward Castes (dummy) | 0.036            | 0.043            | 0.043            | 0.049           | 0.021           |
|             | (0.053)         | (0.059)         | (0.059)         | (0.103)         | (0.090)         |
| Gender of head (dummy) | −0.067           | −0.129**         | −0.077           | −0.121          | −0.131*         |
|             | (0.051)         | (0.053)         | (0.060)         | (0.092)         | (0.079)         |
| Age of head | 0.002            | 0.002            | 0.002            | −0.001          | −0.003          |
|             | (0.002)         | (0.002)         | (0.002)         | (0.003)         | (0.003)         |
| Occupation | 0.152            | 0.169*           | 0.194*           | 0.097           | 0.098           |
|             | (0.097)         | (0.087)         | (0.103)         | (0.161)         | (0.153)         |
| Constant   | 5.845***         | 1.780***         | 4.470***         | 2.857***        | 0.443           |
|             | (0.204)         | (0.211)         | (0.226)         | (0.343)         | (0.329)         |
| N           | 131              | 131              | 131              | 131             | 131             |
| R²          | .665             | .721             | .560             | .635            | .570            |
| F-statistic | 33.49            | 55.52            | 20.05            | 26.79           | 21.28           |

Notes: Robust standard errors in parentheses.

***p < .01; **p < .05; *p < .1.

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significant intake of nutrients is through the purchase of food through private expenditure rather than through PDS subsidy. In our data, over 70 percent of households do not buy PDS rice. However, all of our households, except one, have “ration cards,” which are needed to access PDS goods. Hence access to subsidized food itself may not really play a role in nutrition, but what seems to matter is the actual quantity of subsidized food and, by extension, the amount of implicit subsidy received.

In addition, there are several other interesting results that emerge. We find that the coefficient of household size is negative for all nutrients, but significant only for macro-nutrients. This implies that for macro-nutrients, greater household size leads to lower per capita consumption of nutrients, controlling for other covariates such as expenditure and household characteristics. Thus, any type of economies of scale that we associate with larger households is not manifested when it comes to nutrition. By way of explanation we explore a plausible channel through demographic composition within the household since nutritional requirements differ between groups. However, as we will see later, the negative effect of the household size remains even if we take into account the nutritional differences between demographic groups. Our result is similar to other findings in the literature by Behrman and Deolalikar (1989) and Imai et al. (2014), where larger household size is detrimental to nutrient consumption.

Although the coefficient of the gender of the head of household dummy is negative for all nutrients, it is statistically significant only for protein and iron. Thus, male-headed households fare worse in terms of protein and iron consumption than female-headed households. From the raw data, it seems that on average female-headed household consume more of high-protein and iron-rich foods (cereals, pulses, and vegetables). These results do not necessarily imply that female-headed households are better off nutritionally per se. The regression result holds after controlling for expenditure and other covariates. Thus, if the households were similar with respect to other covariates, then female-headed households would have a higher consumption of protein and iron. Intuitively, this result makes sense since evidence shows that females are more concerned about the overall well-being of their household (Behrman, Foster, Rosenzweig, & Vashishtha, 1999). There are, however, no differences for other macro- and micro-nutrients based on the gender of the head of household.

When it comes to caste, we observe that controlling for other variables, there is no statistically significant impact on nutrient consumption. Similarly, we find no statistically significant difference in nutrient consumption based on the age of the head of the household. This is in line with some of literature such as Behrman and Deolalikar (1990) who do not find the age of the household head to have any effect at all on nutrient consumption. However, we should note that Kumar et al. (2012) find that the consumption of macro-nutrients increases with the age of the household head.

In terms of occupation, we do find that households with a greater percentage of members working as farm and wage laborers consume a statistically significant higher amount of protein and carbohydrate, relative to the rest of the occupational groups. Broadly, this implies that those in sedentary jobs consume less macro-nutrients relative to those in non-sedentary jobs, thus lending some support for Deaton and Drèze’s (2009) claim that a shift toward sedentary jobs has resulted in lower calorie consumption in India over the years.

4.3 | Identification: IV approach

While the regression analysis demonstrates some interesting patterns, there is a possibility of endogeneity in two of our variables of interest. There may be endogeneity issues between expenditure and consumption of nutrients, as consumption of nutrients itself can impact income and expenditure through improved productivity (Deolalikar, 1988; Strauss & Thomas, 1998). This interdependence
between nutrient consumption and income (or expenditure) can in fact lead to poverty traps (Imai et al., 2014; Dasgupta & Ray, 1987). The endogeneity with respect to PDS subsidy arises from the possibility that nutrient intake itself might influence the subsidy received through the amount of PDS rice bought. The intuition here is that, if nutritional intake is more than adequate, then there would be less demand for PDS rice since typically the quality of PDS rice is not high (Khera, 2011c). Unobserved factors such as the distance of the household from village markets and ration shops, and health shocks, might also influence both the amount of PDS rice bought and intake of nutrients. We correct for both sources of endogeneity using IV methods.

We use an asset index as an IV for expenditure. Our survey asks households about their ownership of 16 assets and durable goods. The maximum number of assets in our sample owned by any one household is 16 and the minimum is 1. The median number of total assets is 5 and the mean is slightly higher at 5.7. We have taken the total number of assets each household owns as the IV for expenditure. This is akin to taking a count of the assets and has been used as an IV in the literature (Filmer & Scott, 2008). Further, to maintain the same structure as we have done for expenditure in our previous models, we have taken the log of per capita daily total assets as the IV for the log of daily per capita expenditure. Our intuition here is that the assets would be strongly correlated with income and expenditure. Therefore, the covariance of expenditure and the asset index is not zero.

At the same time we do not think that the number of assets would be correlated with the consumption of nutrients. The primary argument is that the purchase of assets typically had been undertaken in previous periods, therefore ownership of assets will not be able to influence current consumption of nutrients. While it is plausible that some of these assets are bought by incurring debts which would have a negative impact on nutrient consumption, there are very few credit facilities for the small consumer durables that we have focused on. We also do not have any evidence from our survey that households have incurred debt to finance these consumptions. In our sample, there are 26 households who borrowed money; they borrowed mainly for agricultural and business purposes, marriages, and house improvements. Another problematic possibility might be that assets are being sold to finance current food consumption. While that is plausible, it does not impact the exogeneity of our IV because what we use as an IV are the current assets the households own. Given that the assets are in the household’s ownership, they could not have been sold or leveraged to buy more food. Hence, the exclusion restriction for the IV is satisfied in this case.

We use the consumption of kerosene for lighting purposes as an IV for our PDS subsidy. PDS shops provide highly subsidized kerosene, which is used both as cooking and lighting fuel (Keiran, 2014; Khera, 2011c). Our intuition here is that for households the impetus to visit PDS shops will be higher if they need two products rather than one. Thus, greater consumption of kerosene will increase the likelihood that the household will visit PDS shops and procure other PDS-provided goods such as rice along with kerosene. Hence, we expect there to be a strong correlation between rice consumption from PDS shops and kerosene consumption. Specifically, we use the log of the daily consumption of kerosene per person per room for lighting purposes as our IV. Households with a larger number of rooms and members will require more kerosene for lighting purposes. We focus on the number of key rooms in the household where lighting is essential, which include living rooms, kitchen and bathrooms. In our data, 130 households out of 131 used kerosene over the last 30 days for lighting purposes, with an average consumption of 2.9 liters per household. Further, we find that those which use PDS rice also have a higher usage of kerosene than those which do not.

To conform to the exclusion restriction of an IV, we propose that the log daily consumption of kerosene per person per room for lighting purposes will not affect macro-nutrients directly. The main channel through which kerosene for lighting purposes may influence nutrition consumption is by making it easy for households to undertake more activities after dark. We expect that lighting from
oil lamps helps people become more functional in the dark, but in general, in the village we do not see any evidence of oil lamps leading to people undertaking more arduous activities which will impact their nutrient consumption. Most of the activity in the village happens during daytime. Further, we have not seen any evidence in the literature that kerosene consumption for lighting purposes could be a determinant of nutrient intake. Thus, we can be reasonably confident that the exclusion restriction holds.

The IV estimations are done using two-stage least squares (2SLS), with robust standard errors. Table 5 reports the second stage of the regression results.

Before discussing the results of the second-stage regression, let us examine the first-stage regression results and tests, all of which are robust. For the first-stage regression of log per capita total daily expenditure we find that among the excluded variables, the coefficient of total assets is positive and significant but kerosene consumption is not. Similarly, for the first-stage regression on the log

| TABLE 5 | Determinants of nutrient consumption IV (2SLS) |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                | Calories        | Protein         | Carbohydrates   | Calcium         | Iron            |
| Log per capita daily expenditure | 0.378***         | 0.582***        | 0.221**         | 1.050***        | 0.539***        |
|                  | (0.090)         | (0.103)         | (0.100)         | (0.163)         | (0.170)         |
| Log per capita daily PDS subsidy | 0.196*           | 0.203**         | 0.218*          | −0.131          | 0.186           |
|                  | (0.106)         | (0.097)         | (0.121)         | (0.181)         | (0.157)         |
| Household size   | −0.026***       | −0.021          | −0.030**        | −0.007          | −0.024          |
|                  | (0.011)         | (0.013)         | (0.013)         | (0.021)         | (0.026)         |
| Other Hindu Castes (dummy) | 0.082            | 0.115           | 0.056           | −0.163          | 0.061           |
|                  | (0.082)         | (0.091)         | (0.091)         | (0.147)         | (0.151)         |
| Other Backward Castes (dummy) | 0.054            | 0.044           | 0.077           | 0.047           | 0.051           |
|                  | (0.061)         | (0.067)         | (0.072)         | (0.117)         | (0.107)         |
| Gender of head (dummy) | −0.035           | −0.095          | −0.037          | −0.165*         | −0.102          |
|                  | (0.059)         | (0.061)         | (0.073)         | (0.100)         | (0.090)         |
| Age of head      | 0.001           | 0.001           | 0.000           | 0.000           | −0.004          |
|                  | (0.002)         | (0.002)         | (0.002)         | (0.003)         | (0.003)         |
| Occupation       | 0.129           | 0.158*          | 0.156           | 0.112           | 0.066           |
|                  | (0.103)         | (0.094)         | (0.117)         | (0.165)         | (0.158)         |
| Constant         | 6.332***        | 2.034***        | 5.262***        | 2.517***        | 1.111           |
|                  | (0.368)         | (0.427)         | (0.421)         | (0.659)         | (0.692)         |
| N                | 131             | 131             | 131             | 131             | 131             |
| R²               | .598            | .687            | .411            | .604            | .530            |
| F(8,122)         | 15.59           | 24.20           | 9.46            | 12.22           | 8.68            |
| Chi-sq.(2) (Endogeneity test) | 5.56*           | 3.70            | 10.34***        | 2.20            | 2.83            |

Notes: Robust standard errors in parentheses.

*aFirst-stage Sanderson–Windmeijer F-statistic is 21.08*** for log per capita daily expenditure and 13.26*** for log per capita daily PDS quantity. Kleibergen–Paap Wald -statistic is 9.08. Cragg–Donald F-statistic is 7.88. Corresponding Stock–Yogo critical values at 10% maximal IV size: 7.03.

**p < .01; ***p < .05; *p < .1.
of per capita daily PDS subsidy we find that kerosene consumption is positive and significant, while household assets, although positive, are not significant. This is captured in the under-identification test such as Kleibergen–Paap Lagrange multiplier test, where chi-square with 1° of freedom is 10.99 and significant at 1%. To further establish that the instruments are relevant, we still need to investigate whether our instruments are weak.

A standard test for weak instruments is whether the first-stage $F$-statistic is less than 10 (Stock & Yogo, 2005). Given that we have multiple endogenous regressors, the relevant first-stage statistic is the Sanderson–Windmeijer $F$-statistic, which for log per capita daily assets is 21.08 and for log daily kerosene consumption per person per room is 13.26, both over 10 and both significant at the 1% level. Among the weak IV identification tests, the Cragg–Donald $F$-statistic, which assumes homoskedasticity, is 7.88. The relevant Stock–Yogo weak IV critical value for 10% maximal IV size is 7.03. Hence, we can safely reject the null of the IVs being weak (Andrews, Stock, & Sun, 2019). A valid test for weak instruments in the presence of multiple endogenous regressors and non-homoskedasticity, which is more suitable here, is the Kleibergen–Paap Wald $F$-statistic, which is 9.06 and significant at 1 percent. Under asymptotic properties the Kleibergen–Paap Wald test also follows the above-mentioned Stock–Yogo critical values. Thus, from all these tests we can reasonably conclude that both IVs are strong. In addition, we conduct endogeneity tests (chi-square with 2° of freedom) for each second-stage regression of the five nutrients. The endogeneity tests in Table 5 show that there are statistically significant differences in the coefficients between IV and OLS regressions only for calories and carbohydrates. Hence, the analysis of the results from the IV method is mainly concentrated on the macro-nutrients.

From Table 5 it is clear that among the different covariates, household expenditure and PDS subsidy have a significant impact on nutrition. The IV estimates of expenditure elasticity are positive and significant for both macro- and micro-nutrients. Given the first-stage $F$-test statistics for expenditure along with the weak IV tests, we can be reasonably confident that expenditure has a causal impact on nutrition. These expenditure elasticities differ from the OLS estimates in Table 4 by around 45% on average. Interestingly, except for calcium, the IV estimates of expenditure elasticity are lower than the OLS estimates, indicating an overestimation of the impact of expenditure on nutrition under OLS. When it comes to PDS subsidy, based on the standard tests, the IV results confirm a positive and significant causal impact of PDS on macro-nutrients, and particularly for calories and carbohydrates. The intuition is that the implicit subsidy has a pure “income effect” where households buy more food, of which cereals (mainly rice) are the main component. Cereals, we know, are the highest contributor to all the macro-nutrients. However, the PDS elasticity for macro-nutrient consumption under IV is more than twice that under OLS in Table 4. For instance, for both calories and carbohydrates, the PDS elasticity under OLS is 0.09, while under IV estimates it is 0.20 and 0.22, respectively. Using an IV-based approach, Kochar (2005) finds the PDS elasticity of calorie consumption in India to be around 0.13 for a similar specification of the regression. It may be that OLS underestimates the impact of PDS on macro-nutrients compared to IV estimates due to attenuation bias associated with PDS subsidy, but it is also possible that, despite reasonable test statistics, our PDS IV is not strong enough (Wooldridge, 2002, p. 89). Hence, we would urge caution in interpreting the PDS results as a strong causal impact.

5 | ROBUSTNESS CHECKS

5.1 | Adult equivalence

While per capita consumption of nutrients treats every member of the household the same, we know that the food consumption among members of the household, say between children and adults, is very
different. Since we do not have intra-household allocation of food in our data, one way to capture the within-household distribution is through the notion of adult equivalence (see Deaton, 2003). In converting household members into adult-equivalent units, we use weights provided by the Indian National Sample Survey Organisation and as applied in Behrman and Deolalikar (1990).23

Suppose the number of persons in household $h$ is denoted by $n_h = \sum_{c=1}^{A} n_{hc}$, where $n_{hc}$ is the number of household members in age category $c$ and $A$ is the total number of age categories we consider. The adult equivalent for each household is defined as $n_{h}^{AE} = \sum_{c=1}^{A} \gamma_c n_{hc}$ where $\gamma_c$ is the weight given to age category $c$. Using earlier notation, the daily consumption of nutrient $j$ per “adult equivalent” in household $h$ can be written as $b_{j}^{h}/n_{h}^{AE}$. Similarly, if we consider $E_{T}^{h}$ as the total expenditure of household $h$, then the adult-equivalent expenditure in that household is $E_{AE}^{h} = E_{T}^{h}/n_{h}^{AE}$. Thus, for adult-equivalent expenditure, we implicitly assume that the shares of expenditure of different age groups in food and non-food items are the same. To be consistent, for the PDS subsidy, we consider its adult-equivalent value. Note that the adult-equivalent adjustment scales up consumption of nutrients as well as the expenditure and PDS subsidy in a similar manner.

The mean adult-equivalent consumption of calories is 2,771 kcal, protein 76 g, carbohydrates 533 g, calcium 547 mg, and iron 20 mg. These are considerably higher than the per capita values reported in Table 3. They perhaps reflect a more realistic allocation of food within the household. Table 6 shows the adult-equivalent regressions, based on the previous covariates, with robust standard errors.

| TABLE 6 | Determinants of nutrient consumption (adult equivalent) |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Calories | Protein | Carbo-hydrates | Calcium | Iron |
| Log daily expenditure per adult equivalent | 0.541*** (0.049) | 0.677*** (0.050) | 0.469*** (0.053) | 0.936*** (0.084) | 0.738*** (0.074) |
| Log daily PDS subsidy per adult equivalent | 0.101** (0.040) | 0.080** (0.035) | 0.108** (0.044) | 0.031 (0.051) | 0.097* (0.051) |
| Household size | −0.021** (0.008) | −0.021** (0.010) | −0.021** (0.009) | −0.007 (0.017) | −0.016 (0.019) |
| Other Hindu Castes (dummy) | −0.035 (0.063) | 0.027 (0.072) | −0.108 (0.073) | −0.069 (0.132) | −0.067 (0.120) |
| Other Backward Castes (dummy) | 0.002 (0.057) | 0.019 (0.060) | 0.004 (0.063) | 0.043 (0.102) | 0.000 (0.089) |
| Gender of head (dummy) | −0.094* (0.051) | −0.149*** (0.054) | −0.108* (0.060) | −0.127 (0.093) | −0.147* (0.080) |
| Age of head | 0.003 (0.002) | 0.002 (0.002) | 0.003 (0.002) | −0.001 (0.003) | −0.002 (0.003) |
| Occupation | 0.110 (0.095) | 0.138 (0.088) | 0.145 (0.101) | 0.088 (0.160) | 0.075 (0.151) |
| Constant | 5.887*** (0.220) | 1.823*** (0.209) | 4.519*** (0.246) | 2.907*** (0.346) | 0.466 (0.327) |
| $N$ | 131 | 131 | 131 | 131 | 131 |
| $R^2$ | .695 | .742 | .601 | .649 | .596 |
| $F$-statistic | 33.87 | 65.37 | 20.84 | 32.69 | 26.14 |

Note: Robust standard errors in parentheses.

***p < .01; **p < .05; *p < .1.
The expenditure elasticity of nutrient consumption is positive and significant for all nutrients. These values are very similar to the per capita case in Tables 4 and 5. As before, the impact of expenditure on nutrient consumption is substantial. For all nutrients other than calcium, the coefficients of expenditure are less than 1, suggesting consumption smoothing for the adult-equivalent case too.24

Similar to the OLS and IV regressions based on per capita nutrient consumption, we find the elasticity of adult-equivalent PDS subsidy on the adult-equivalent consumption of nutrients on macro-nutrients is statistically significant. The elasticities are similar to the OLS regressions. However, we also find that PDS subsidy affects iron consumption. This effect most probably is the result of the scaling factor due to adult equivalence as seen in the large difference in the adult-equivalent and per capita consumption of nutrients. Note that the scaling up under adult equivalence of average consumption of iron is larger compared to calcium. Thus, the same PDS subsidy now has an impact on iron but not on calcium.

For the other covariates, we observe very similar results compared to OLS. Household size effect is statistically significant for macro-nutrients only, with larger households consuming lower levels of nutrients. This result holds even after considering the different nutritional requirement between the groups through adult equivalence. Female-headed households have a statistically significantly higher consumption than male-headed households for all nutrients except calcium. The coefficients are quite close to the OLS estimates in Table 4. Again, this impact reflects the scaling up of nutrient consumption due to adult equivalence, since females typically have lower weight in the adult equivalence conversion scales than males, and female-headed households in our data have relatively more female members. Thus, in female-headed households consumption is scaled up more than in male-headed households. In terms of caste and age of household head, we find no statistically significant impact on nutrient consumption. Interestingly, compared to the per capita case, household members’ occupations do not play a role. Thus, broadly, when adult equivalence is considered the results are similar to the per capita case.

5.2 Quantile regressions

By way of further robustness checks, we undertake quantile regressions for several different percentile levels of nutrient consumption. In particular, our interest is in the bottom half of the distribution of nutrients. In 2011, when our data were collected, 37% of the population of Odisha was below the poverty line. To explore the determinants for similar levels of nutrient distribution we present the quantile regression results for the 35th percentile in Table 7, where the covariates are the same as before.

Broadly, the results remain consistent with what we have seen before. The coefficient of the expenditure term is positive and significant for all nutrients. As before, the expenditure elasticity of consumption for all other nutrients is less than 1, except for calcium which is equal to 1. The coefficient for PDS subsidy is positive and significant for calories only, instead of all macro-nutrients. This result is driven by the fact that households toward the bottom of the nutrient distribution consume relatively more PDS rice, which is calorie-rich. For instance, consider the calorie distribution where the per capita calorie consumption at the 35th percentile is around 1,500 kcal. For households above the 35th percentile (in terms of calories) the per capita monthly consumption of pulses and vegetables on average is almost double those below the 35th percentile.25 However, when it comes to PDS rice, the average per capita monthly consumption of households above and those below the 35th percentile is quite similar.26 Thus, the gap in food consumption between households toward the top of the distribution and those toward the bottom of the distribution is somewhat mitigated through consumption of PDS rice.

We investigated whether our results for expenditure and PDS subsidy for the 35th percentile hold true for other quantiles.27 For the median regression, expenditure elasticity is positive and significant for all nutrients, whereas PDS subsidy has no impact. On the other hand, if we focus on the
25th percentile, expenditure elasticity is positive and significant for all nutrients as before, and additionally the PDS elasticity of nutrient consumption is positive and significant for calories and carbohydrates. Thus, households toward the bottom of the nutrient distribution are receiving and benefiting from the implicit subsidy provided through PDS rice.

For other household-level covariates, such as household size and gender, we find results similar to those already found. Household size has a negative impact on nutrient consumption; and female-headed households do better than male-headed households for some macro-nutrients. Further, households with relatively more members in labor-intensive occupations have a higher consumption of macro-nutrients. We also find that OBCs consume more calories and protein than SCs. However, as before, these effects are not robust across all nutrients and, more importantly, they are not robust for other percentiles.

### CONCLUDING REMARKS

The main purpose of this paper was to undertake a study of the consumption of nutrients in a village in eastern India. The underlying motivation was that detailed micro-studies might reveal some
interesting patterns which might be missed in a broader study using aggregate-level data. Using information on food consumption from primary data, we focused on the determinants of five key nutrients: calories, proteins, carbohydrates, calcium and iron.

Some broad results emerge from our analysis. First, it is evident that household expenditure has a positive and significant impact on both macro- and micro-nutrients. This is different from previous results, in so far as we establish a causal link from expenditure to a broad set of nutrients and find that the per capita expenditure elasticities for the five nutrients are significantly higher than in studies such as Behrman and Deolalikar (1987), Kochar (2005), and Kumar et al. (2012). Our standard OLS estimate of expenditure elasticity is 0.52, but the more reliable IV estimate is 0.38. Thus, our results are closer to those of Subramanian and Deaton 1996, p. 142), who find the average per capita expenditure elasticity to be around 0.45.

Second, there is a positive and significant impact of PDS subsidy on macro-nutrients only. Using an IV, which satisfies standard test statistics, we establish a causal link from PDS to nutrient consumption. While we acknowledge some possibility of weakness in our IV for PDS subsidy, there is broad evidence which supports our claim of a causal impact of PDS subsidy on consumption. During our survey period Odisha was one of those states in India which really improved their PDS support in terms of the quantity of subsidized food grains disbursed and the timeliness of the disbursement (see Khera, 2011a). This is also reflected in the quantile regressions, which show a positive impact of PDS mainly in the bottom third of the nutrient consumption distribution, indicating effective targeting of the people through PDS. However, despite a causal link from PDS to nutrition, note that the PDS elasticity based on IV estimates is lower than that of expenditure. Thus, an increase in expenditure will have a greater impact on nutrition than a similar increase in the subsidy provided through PDS.

Third, in terms of other covariates, we find that some household characteristics play a more significant role than others. Our broad results indicate, in line with the wider literature, that larger household size is detrimental to nutrition. Further, under some specifications females do better in terms of nutrition than males, and individuals in non-sedentary occupations consume more macro-nutrients than other occupation groups. We do not observe much role of caste or age of the head of the household in determining nutrition. In general, though, the impact of household characteristics on nutrient consumption is not robust under various regression specifications.

One can obviously argue that some of these results might be unique to our sample. While we acknowledge that these results are based only on a village, the fact that the results are in some cases quite different from the existing literature indicates that village-level micro-studies can provide some unique insights. We need further investigation to understand whether similar results emerge in other village studies and, if so, why we observe different patterns in more aggregate-level studies.

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DATA AVAILABILITY STATEMENT
The data that support the findings of this study are openly available on GitHub at https://github.com/IDCorner/NutritionRDE.

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ENDNOTES
1 Using semi-parametric methods on the ICRISAT data set, Roy (2001) found that income elasticity of calorie intake was small but positive.
2 Based on the 2011 census of India, Odisha had a population of 41.94 million and was the eleventh largest state in the country.
3 Although we made it clear to each household head that we wanted the consumption data, given our 30-day recall (which we discuss in the next section), there is a possibility that some households reported habitual purchase data.
4 Given the detailed amount of information that the questionnaire sought and the general levels of literacy in the village, each household was assisted by a postgraduate research assistant from a local university. The head of the household answered the questionnaire, sometimes supported by input from other members. The survey team spent around 2–3 hr with each household and paid the household roughly half a day’s wage based on local wage rates (around £5).
5 It has been shown in the Indian case that the 30-day recall is often better than the 7-day recall (see Deaton, 2013, p. 255; Mookherjee & Chaudhury, 2020).
6 We had information for 135 households but dropped a household because the members mostly consumed food away from home. In our rural setting, we do not find other households who consume significant amounts of food away from home. Such issues may be more relevant for urban areas (see Smith, 2013).
7 Appendix Table A1 shows the monthly consumption of PDS-provided rice by households.
8 We have checked that the nutritive values are in line with Gopalan et al. (2014) which is widely used in the literature.
9 In some cases, where they did not provide such value we have used the prevailing market prices to construct the expenditure on the relevant food item. For the same item, the prices paid by the households varied. We considered the average price when constructing the imputed value.
10 The occupation of the head of the household, by itself, may not be fully informative for our purposes here since in quite a few cases the senior member of the household, who had retired, was considered to be the head even though the household did have younger members who actively participated in the labor market.
11 We have undertaken the standard diagnostics checks, particularly for multicollinearity. The variance inflation factor value is very low, indicating no multicollinearity.
12 For all the five nutrients, we tested whether (coefficients for expenditure), $\beta_{\text{Expenditure}} = 1$. We fail to reject the null for calcium.
13 Table A2 in the Appendix shows the daily per capita consumption of nutrients arising from different food groups.
14 From raw data, female-headed households’ average consumption of cereals, pulses, and vegetables over 30 days are 12.98, 1.96 and 8.80 kg, respectively. For male-headed households the corresponding quantities are 11.65, 1.51, and 7.90 kg.
15 The assets we take into consideration are: house, bicycle, sewing machine, generator set, electric fan, black and white television, color television, mixer grinder, air cooler, clock or watch, chair or table, cot, telephone, cell phone, fridge freezer, pressure cooker, computer.
16 Given that assets are essentially a stock, we have run our IV estimations using the log of per capita total assets as the IV for the log of daily per capita expenditure. Our broad results remain the same.
17 There were 28 households which borrowed money in the last 5 years, but two households have paid back any outstanding loans.
18 For those households without a living room or kitchen or bathroom, their average number of rooms was around 1.5 and we have assumed the number of key rooms to be one.

Electronic copy available at: https://ssrn.com/abstract=3706971
19 The mean usage of kerosene for each household which buys PDS rice is 3 liters per month and for those which do not buy PDS rice is 2.7 liters. This difference is significant and positive at the 1% level of significance.

20 We have avoided considering kerosene for fuel purposes, since it may have an indirect impact on nutritional requirements if, for instance, it reduces labor-intensive domestic activities associated with cooking, which non-kerosene cooking fuels such as wood may entail.

21 We have also run the regression using the limited information maximum likelihood (LIML) approach; however, there is very little difference between our LIML estimators and the reported 2SLS estimators.

22 We provide the first-stage regression results in Table A3 in the Appendix.

23 “These weights are .485 for persons aged 0–3 years, .795 for ages 4–9, 1.0 for males 10–15 years old, .865 for females 10–15 years old, 1.02 for males 16–19, .75 for females 16–19, 1.0 for males 20–39, .71 for females 20–39, .95 for males 40–49, .68 for females 40–49, .90 for males 50–59, .64 for females 50–59, .75 for males above 60 and .505 for females above 60” (Behrman & Deolalikar, 1990, p. 673, fn. 17).

24 We tested separately the hypothesis that the coefficient of expenditure in the regressions for the adult-equivalent case, \( \beta_{\text{Expenditure}} = 1 \).

25 For households above the 35th percentile in terms of calories, the average per capita monthly consumption of pulses is 1.93 kg and for those below the 35th percentile it is 0.62 kg.

26 The average per capita monthly consumption in household above the 35th percentile is 1.77 kg and in those below the 35 percentile is 1.59 kg.

27 We present the results of the median regression and the 25th percentile in the Appendix (Tables A4 and A5, respectively).

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**APPENDIX A**

**TABLE A1** Monthly PDS rice consumption by households

| PDS rice quantity (kg/month) | Number of households | Percent of households |
|-----------------------------|----------------------|-----------------------|
| 0                           | 96                   | 73.28                 |
| 10                          | 1                    | 0.76                  |
| 15                          | 1                    | 0.76                  |
| 25                          | 32                   | 24.43                 |
| 50                          | 1                    | 0.76                  |
| **Total**                   | **131**              | **100**               |

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| Food Category          | Calorie (kcal) | Protein (g) | Carbohydrate (g) | Calcium (mg) | Iron (mg) |
|------------------------|----------------|-------------|------------------|--------------|-----------|
| Cereals                | 1262.75        | 24.68       | 284.27           | 50.73        | 5.48      |
| Pulses                 | 159.91         | 11.72       | 27.40            | 57.43        | 2.82      |
| Vegetables             | 157.40         | 5.41        | 34.25            | 104.34       | 4.31      |
| Fresh fruit            | 51.01          | 3.48        | 5.38             | 8.38         | 0.16      |
| Dry nuts               | 13.85          | 0.61        | 0.64             | 2.20         | 0.05      |
| Sugar, molasses, and salt | 85.08        | 0.00        | 22.94            | 6.66         | 0.15      |
| Spices                 | 16.00          | 0.65        | 2.56             | 11.85        | 1.27      |
| Dairy products         | 44.69          | 2.09        | 2.45             | 77.13        | 0.00      |
| Edible oil             | 152.63         | 0.00        | 0.00             | 0.00         | 0.00      |
| Meat, eggs, and fish   | 24.82          | 4.54        | 0.43             | 78.75        | 0.18      |

|                | Log per capita daily expenditure | Log per capita daily PDS subsidy |
|----------------|----------------------------------|----------------------------------|
| Log per capita daily assets | 9.851***                         | −0.789                           |
| Log daily kerosene consumption per person per room | 2.721 (2.809) | 16.841*** (4.931) |
| Household size | −0.019 (0.017)                  | −0.007 (0.017)                  |
| Other Hindu Castes (dummy) | 0.217 (0.132)                  | −0.098 (0.130)                  |
| Other Backward Castes (dummy) | 0.042 (0.132)                  | 0.271** (0.137)                 |
| Gender of head (dummy) | 0.074 (0.107)                  | −0.070 (0.138)                  |
| Age of head | −0.002 (0.003)                  | 0.005 (0.004)                   |
| Occupation | −0.147 (0.173)                  | −0.190 (0.261)                  |
| Constant | 3.116*** (0.291)                | −0.074 (0.343)                  |
| N            | 131                              | 131                              |
| F-statistic  | 10.11                            | 6.72                             |
| Sanderson–Windmeijer $F(1,122)$ | 21.08  | 13.26 |

Notes: Robust standard errors in parentheses. Rooms include living rooms, kitchen and bathrooms.

***p < .01; **p < .05; *p < .1.
|                                | Calories | Protein  | Carbohydrates | Calcium | Iron   |
|--------------------------------|----------|----------|---------------|---------|--------|
| **Log per capita daily expenditure** | 0.513*** | 0.678*** | 0.395***      | 1.041***| 0.751***|
|                                | (0.039)  | (0.050)  | (0.044)       | (0.083) | (0.062) |
| **Log per capita daily PDS subsidy** | 0.035    | 0.036    | 0.031         | 0.109   | 0.075  |
|                                | (0.032)  | (0.042)  | (0.037)       | (0.072) | (0.062) |
| **Household size**              | -0.028***| -0.031***| -0.031***     | 0.005   | -0.042***|
|                                | (0.008)  | (0.010)  | (0.008)       | (0.018) | (0.015) |
| **Other Hindu Castes (dummy)**  | 0.009    | -0.083   | -0.012        | -0.075  | -0.018 |
|                                | (0.083)  | (0.060)  | (0.092)       | (0.128) | (0.143) |
| **Other Backward Castes (dummy)** | 0.101**  | 0.045    | 0.110***      | 0.129   | 0.160**|
|                                | (0.050)  | (0.058)  | (0.052)       | (0.106) | (0.063) |
| **Gender of head (dummy)**     | -0.059   | -0.105** | -0.073        | -0.136  | -0.072 |
|                                | (0.051)  | (0.051)  | (0.052)       | (0.117) | (0.102) |
| **Age of head**                | 0.002    | 0.002    | 0.002         | -0.002  | 0.000  |
|                                | (0.002)  | (0.002)  | (0.002)       | (0.003) | (0.002) |
| **Occupation**                 | 0.189**  | 0.235*** | 0.264**       | 0.079   | 0.499***|
|                                | (0.078)  | (0.083)  | (0.101)       | (0.155) | (0.180) |
| **Constant**                   | 5.917*** | 1.801*** | 4.701***      | 2.462***| 0.173  |
|                                | (0.192)  | (0.237)  | (0.194)       | (0.395) | (0.287) |
| **N**                          | 131      | 131      | 131           | 131     | 131    |
| **Pseudo-R²**                  | .463     | .530     | .363          | .462    | .427   |

**Note**: Robust standard errors in parentheses.

***p < .01; **p < .05; *p < .1.  

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Table A5  Determinants of nutrient consumption (quantile regression at 25th percentile)

|                        | Calories | Protein | Carbohydrates | Calcium | Iron  |
|------------------------|----------|---------|---------------|---------|-------|
| Log per capita daily   | 0.488*** | 0.633***| 0.388***      | 0.981***| 0.615***|
| expenditure            | (0.061)  | (0.049) | (0.059)       | (0.074) | (0.062)|
| Log per capita daily PDS subsidy | 0.109**  | 0.074   | 0.124**       | −0.009  | 0.060|
| subsidy                | (0.051)  | (0.050) | (0.050)       | (0.065) | (0.039)|
| Household size         | −0.016   | −0.030***| −0.014        | −0.019  | −0.056***|
|                        | (0.016)  | (0.009) | (0.014)       | (0.017) | (0.009)|
| Other Hindu Castes     | −0.037   | 0.073   | −0.077        | −0.104  | −0.129|
| (dummy)                | (0.081)  | (0.047) | (0.130)       | (0.165) | (0.112)|
| Other Backward Castes  | 0.097*   | 0.118*  | 0.069*        | 0.044   | −0.033|
| (dummy)                | (0.055)  | (0.070) | (0.037)       | (0.089) | (0.118)|
| Gender of head (dummy) | −0.063   | −0.129**| −0.092        | −0.100  | −0.022|
|                        | (0.074)  | (0.056) | (0.062)       | (0.078) | (0.051)|
| Age of head            | 0.002    | 0.004** | 0.002         | −0.002  | 0.002|
|                        | (0.002)  | (0.002) | (0.002)       | (0.002) | (0.002)|
| Occupation             | 0.179    | 0.247*  | 0.272***      | 0.164   | 0.052|
|                        | (0.172)  | (0.127) | (0.084)       | (0.165) | (0.160)|
| Constant               | 5.773*** | 1.605***| 4.428***      | 2.573***| 0.478*|
|                        | (0.305)  | (0.229) | (0.295)       | (0.312) | (0.249)|
| N                      | 131      | 131     | 131           | 131     | 131   |
| Pseudo-$R^2$           | .432     | .496    | .347          | .460    | .425  |

Note: Robust standard errors in parentheses.

***p < .01; **p < .05; *p < .1.