Does Dietary diversity improve health outcomes among young children and women: a quantile regression analysis

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Abstract

This study investigates the relationship between dietary diversity, a measure of diet quality, and health outcomes of young children and women. We examine this relationship not just at the mean, but also at different points of the conditional distributions of weight-for-age (WAZ) and height-for-age (HAZ) z-scores for children below six and of BMI for women above 16 years of age, using quantile regression method. We construct five different dietary diversity measures using 14-day recall food consumption data collected in a primary survey conducted in the rural-urban interface of Bangalore. We find a positive and significant relationship only for the 95th quantile for HAZ scores. No other association for children for WAZ scores and for women were significant, indicating the possibility that the link between diet quality and child growth outcomes is much weaker than it is commonly believed.

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Introduction

The adverse effect of malnutrition among children on their physical and cognitive development, and thereby on economic and social achievements, quality of life and mortality are well known (Hoddinott et al., 2008; Victora et al., 2008; Martorell, 1999; Strauss and Thomas, 1998). Malnutrition among adolescent girls and women is a matter of concern not only for them, but poor reproductive health affects morbidity and mortality in next generation as well. Despite concentrated efforts, malnutrition remains a big challenge for the Indian government. While improvements have been observed in past decades, the rates are still substantially high. According to latest available national level data, more than a third of Indian children under the age of five are stunted (38 percent) and underweight (36 percent) (NFHS – IV). 23 percent of women are thin, while 21 percent are overweight (NFHS – IV). Rates of undernourishment are even higher for rural areas. While India failed to achieve its MDG of halving the proportion of underweight children, meeting SDG will require stronger commitment on part of the government.

Adequate quantity (calories) and quality (micronutrient) of food intake is not only a desirable end in itself but is also a critical factor that affect health outcomes (Black et al., 2008). Therefore, WHO even recommends that a diverse diet should be provided to infants and young children when introducing complementary feeding to ensure adequate intake of macro and micronutrients. Since measuring actual intake of micronutrients is difficult, dietary diversity is often used as an indicator of better quality diet or higher micronutrient intake (Ruel, 2003; Dewey et al, 2006; Moursi et al, 2008; Arimond et al, 2010).

There are many studies that studies that examine the relationship between dietary diversity measures and health outcomes. Though it is often difficult to compare across studies due to wide variation in methodologies and measures used, given the mixed nature of evidence, it might not be wrong to infer that the relationship seems to be context specific and could not be generalized. The nature of relationship between the dietary diversity and health outcomes in Indian context is not well researched. This study intends to fill that gap by examining the relationship between dietary diversity and health outcomes for young children and women in India. One limitation that has been identified with the health policy in India is its limited focus (Dreze, 2012). Most of the resources are focused on improving the availability of food to poor households and meeting the calorie requirements, and not much importance is given to quality of food, and other inputs. Evidence of positive and strong relationship will provide support to this criticism. However, it is important to remember that health outcomes are determined by a complex interaction of various factors, and absence of association with dietary diversity does not imply that better quality diet is not important, it might imply that other factors are more important. Another factor to bear in mind is that dietary diversity is but a simple measure of diet quality that does not account for quantity. A more diverse diet with low intake levels may not be effective in improving health outcomes.

One factor that sets this study apart is its unique setting. Most of the development literature studies the rural and urban areas as separate entity with strong boundaries and no interaction. However, given the fast pace of growth and urbanization in India, there are many areas where the boundaries of rural and urban are not as clearly marked and have become porous. Studies that examine urban and rural areas separately are not able to capture the behavior and responses of household within this interface.

This study is a based in a setting meant to capture the shifting rural-urban interface due to rapid urbanization in India. The shift in the interface is expected to bring a change in food and non-food consumption patterns, nutritional outcomes, living conditions etc. In such a dynamic environment, it is possible that the importance of diet quality in improving health outcomes may change. For example, by improving access to wide variety of foods, the diet quality may be high and not vary much between households across regions. It would then not be implausible to find no effect of further improving dietary diversity on health outcomes. On the other hand, if the diet pattern shifts more towards westernized diet, high in calories but low in micronutrients, a more diverse diet may not imply a better quality diet. Intakes of energy, saturated fat, sodium, sugar might increase, and a positive relationship with health outcomes would have a different implication in this context. We examine which of the two mechanism is observed in Bangalore region of India.

To examine the relationship between dietary diversity and anthropometric outcomes of children aged 0-6 years and adult women, our dietary diversity measures are based on recall period of 14 days and will better capture dietary quality as compared to shorter recall period. Marshall, Burrows and Collins (2014) in a literature review have identified 31 different specifications that have been used in the literature. It is possible that the ambiguity in results is driven by different specifications. We, therefore, consider five different measures of dietary diversity to check if the relationship depends on the choice of metric used. Based on a primary survey conducted in Bangalore in rural-urban interface, this study contributes to our understanding of the nature of relationship in the Indian context.

The paper is organized as follows. We review the existing literature in Section 1, section 2 explains the sampling design. Methodology is explained in section 3 and variable definitions are provided in section 4. Section 5 presents the results and we highlight the strengths and weakness of this study in section 6. Section 7 concludes.

I. Literature Review

Many studies examine whether better quality food intake is associated with better health outcome. Studies have been carried out for many countries and mainly focus on young children. A large proportion of studies use food count or food group-based measures of dietary quality. The advantage with such measures is that they can be easily estimated for the demographic group under study. [4]

The literature seems to have found evidence of positive relationship between dietary diversity and health outcomes of young children. Arimond and Ruel (2004) found a positive association between dietary quality and HAZ-scores for 10 out of 11 countries for children aged 6-23 months. Similar results were also found for 6-36-month-old Ethiopian children in urban areas, using two indicators over 7 day and 24-hour recall (Arimond and Ruel 2002). Amugsi et al. (2014) find reduced odds of being wasted with better quality diet in rural Ghana, and similar results for stunting among Ghanaian children were observed by Sakka and Osman (2013). Considering a broader age group, Rah et al. (2010) also find that consuming a diverse diet lowers the odds of stunting for children aged 6-59 months in Bangladesh. Frempong and Annim (2017) for Ghana, Darapheak et al (2013) for Cambodia, Hatloy et al (2000) for urban areas of Mali also find positive association for this age-group. Perkins et al. (2018) find a positive relationship with HAZ scores for children aged 24-59 months.

However, if one looks closely the evidence is not so robust when one considers different age-group and location. Arimond and Ruel (2014) study finds the relationship is stronger among younger children in some countries and for older children in some. Perkins et al. (2018) do not find any significant relationship for children between 12-24 months, and even negative relationship for children aged 6-12 months. Sakka and Osman (2013) find a stronger relationship for children aged 2 and above. Similarly, Arimond and Ruel (2002) and Hatloy et al (2000) find positive relationship in urban areas, but not in rural areas and the opposite is true for Amugsi et al. (2014). Studies such as Rannan Eliya et al. (2013) for Sri Lanka, Osei et al. (2013) for Nepal, Ali et al. (2013) for Bangladesh, Ethiopia and Vietnam, McDonald et al. (2014) for Cambodia and Luna-Gonzalez and Sorensen (2018) for Guatemala do not find any significant relationship.

It is true that comparing the results of all these studies is not possible because of wide variation in how each of these studies measure dietary diversity, one can still infer that the relationship is not universally positive and significant. It can be context specific. The literature also seems to suggest that there might be some threshold effect as well. One factor distinguishing rural and urban areas in Amugsi et al. (2014) was that dietary diversity was much lower in rural areas, where they find significant relationship. M'Kaibi et al. (2017) on the other hand suggest that there might be a minimum threshold as well.

The literature examining the relationship for women is quite scant. Among the few studies, Sakka and Osman (2013) find that BMI of adult women is positively associated

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[4] Many studies such as Torlesse et al. (2003), Campbel et al. (2010), and Humphries et al. (2017) have used household expenditure data to measure dietary diversity and find positive associations of these measures with health outcomes of children and adult women. However, such studies based on expenditure-based measures are not included here.

with dietary diversity in Ghana. Savy et al. (2005) study a sample of Burkina Faso women, surveyed during cereal shortage season, and find positive association. These women were then surveyed again at end of cereal shortage season. The dietary diversity improved dramatically in the second round. Savy et al (2006) find that the relationship between dietary diversity and health outcomes weakened in the surplus season as compared to shortage season, again suggesting some threshold effects. However, McDonald et al, (2014), Savy et al. (2007) do not find any association between dietary diversity women health outcomes.

All the studies discussed above do not consider if the degree of association varies for individuals with poorer health outcomes, as compared to healthier individuals. To our knowledge Amugsi et al (2017) and Amugsi et al (2016) are among the very few papers that investigates the differential effect of dietary diversity on health outcomes at different points of the conditional distribution of outcomes. Both studies consider sub-Saharan countries, the first examines children below 5 years, while the latter considers the BMI outcomes of women. Both studies find mixed results across countries, quantiles and age-groups, and conclude that the relationship might be context specific. Among adult women, positive association is observed only for Ghanaian women at 90th percentile. They do not find any relationship for Namibia and Sao Tome and Principe. Among children, while there was no significant relationship between dietary diversity and HAZ scores for three (Ghana, Kenya and Mozambique) of the five countries considered, a positive effect was observed for all quantiles except the top quartile for Nigeria. Disaggregating by age, the authors find positive relationships at all quantiles for children aged 24-59 months, but a negative relationship was observed at 50th and 75th percentile for children aged 6-23 months in Nigeria. In Congo, significant positive results are observed for 5th and 10th quantile. The only consistent result for these countries is that largest effect is observed for 5th quantile. The unifying theme in both these papers was the contradictory results from OLS method as compared to quantile regressions.

The nature of relationship between diet quality and anthropometric outcomes in Indian context is not well studied. Chandrashekhar et al. (2017) find that in the Indian state of Maharashtra, higher dietary diversity is associated with lower odds of stunting and being underweight among children aged 6-23 months. For Maharashtra and Odisha, Nithya and Bhavani (2018) conduct a study for adolescents and adults and use three different indicators of dietary diversity. They do not find a significant association with adolescent BMI, and weakly significant relationship with HAZ scores. Only for adults do they find robust relationships for all three measures.

This study contributes to the existing literature in four ways. First, this study adds to the understanding of the relationship in India. Second, the use of varied instruments in literature makes it difficult to compare results across studies, and we therefore use multiple instruments to check robustness of our results and improve comparability with other studies. Third, this is the only study that examines the relationship in a fast-changing environment due to urbanization. Fourth, we add to the understanding of heterogeneity in relationship, conditional on distribution of health outcomes by using quantile regression method.

II. Study area and sampling design

The empirical analysis is based on the primary socioeconomic survey conducted in the rural-urban interface of Bangalore in Karnataka state. It is a DFG[5] funded German-Indian collaborative project working on the social-ecological implications of urbanization. The survey includes around 1200 households from two transects cutting through the rural-urban interface of Bangalore. A stratified random sampling[6] approach was adopted to select the households for the survey. First, 61 villages were randomly selected from the total number of villages in both transects. The household selection was done randomly at village level using household lists managed by the "Anganavadi" center.

The survey included a comprehensive questionnaire on household socioeconomic conditions, its agricultural and non-agricultural activities, and food consumption patterns. For detailed understanding of the household food consumption behavior of the targeted household members, we collected in-depth information on the household food consumption using a standardized questionnaire. Health outcomes are measured through anthropometric outcomes that were collected for all children aged 0-15 years and all the women in the household. We focus on children of age 6 and below, leading to a study sample of 274 children from 222 households. Figure 1 shows the location of sampled households.

III. Empirical Methodology

Along with ordinary least square (OLS) technique, we have used quantile regression approach to estimate the effect of dietary quality on the conditional distribution of the health outcomes i.e., Weight for Age (WAZ) and Height for Age (HAZ) z-scores for children and BMI for women. The Quantile regression method was first introduced by Koenker and Basset[7] as a '*location model*'. To formalize quantile regression, consider a real-valued random variable Y characterized by the following distribution function:

$$F(y) = \Pr(Y \leq y) \qquad (1)$$

Then for any $\tau \epsilon (0,1)$, the τ^{th} quantile of Y is defined as:

$$Q(\tau) = \inf\{y: F(y) \geq \tau\} \qquad (2)$$

The most common quantiles τ from equation (2) are τ=0.25, τ=0.5, and τ=0.75 for the first, the median and the third quartile, respectively. Therefore, unlike OLS that

[5] Deutsche Forschungsgemeinschaft
[6] See Hoffmann et al (2017) for more information on sampling design
[7] Koenker and Bassett (1978)

minimizes the squared differences around the mean, quantile regression minimizes the weighted absolute difference between the observed value of y and the τ^{th} quintile of Y. It can easily demonstrate that OLS is nested in the quantile regression. In addition, while OLS can be inefficient if the errors are highly non-normal, quantile regression is more robust to non-normal errors and outliers. Quantile regression also provides a richer characterization of the data, thereby illuminating the effect of a covariate in the entire distribution of y, not merely on its conditional mean (Amugsi et al 2016).

IV. Variable Definitions

The anthropometric measurements of sampled children aged 0-6 were used to calculate the outcome variables – weight-for-age (WAZ) and height-for-age (HAZ) z-scores. The z-scores express the anthropometric value as of standard deviations from the reference mean or median value. These are used as indicators of child growth. The advantage of using z-scores is that they have the same statistical relation to the distribution of the reference around the mean at all ages, which makes the results comparable across age groups and indicators. z-scores are also sex-independent, thus enabling the evaluation of children's growth status by combining sex and age groups. BMI (Body Mass Index) is calculated for women above 16 years using their anthropometric measurements and used as outcome variable in the estimation.

Household food consumption expenditure and frequency data has been used to construct the dietary quality indicators, which are our main variables of interest here. **Household Dietary Diversity Score (HDDS)** was constructed by a simple count of different food groups consumed by the household in the past 14 days of the interview. , all the food items consumed in a household are grouped into 12 different groups: (i) cereals; (ii) white tubers and roots; (iii) legumes, nuts and seeds; (iv) vegetables; (v) fruits; (vi) meat; (vii) eggs; (viii) fish and fish products; (ix) milk and milk products; (x) sweets and sugars; (xi) oils and fats; (xii) spices and condiments Swindale and Bilinsky (2006). Each group is assigned a value of one if one or more of the food items belonging to a food group are consumed. The scores were then summed up to have a HDDS ranging from 0-12. We also construct **Food Consumption Score (FCS)[8]** as proposed by WFP (2008). While HDDS is a simple count of number of food groups consumed, FCS is calculated as a weighted average using frequency of consumption of food group. Additionally, to check the robustness of our results we also include a **simple count** of

[8]https://documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197216.pdf?_ga=2.245549057.40039945.1532140937-1661406307.1532140937

different food items consumed, **Mean Micronutrient Adequacy ratio**[9] **(MMAR)** and **share of non-cereal calorie**[10] in total household calorie intake in a day.

For young children, we classify other explanatory variables into three categories - (i) child characteristics (age and sex); (ii) maternal characteristics (mother age, education, height and occupation); (iii) household characteristics (family size, caste, religion, wealth index[11], gender of person buying food, decision maker characteristics, access to sanitary facilities and safe drinking water). In the regression estimation for women, the explanatory variables are classified into two categories – (i) women characteristics (age, education, occupation, number of children, marital status); (ii) household characteristics (family size, caste, religion, gender of buying food, decision maker characteristics, access to sanitary facilities and safe drinking water, agricultural activity). The choice of explanatory variables was based on the significant correlation with the outcome variable and an extensive review of the literature. Along with these we also control for location (transects) and regional (stratum) dummies in both analysis. Location dummies are included in the analysis to capture if there is any difference the relationship studied between the two transects. Six stratum were constructed in each transect based on Survey Stratification Index (SSI)[12] .

The model used for the multivariate quantile regression analysis summarized in the form of the following equation.

$$y_\tau = \beta_0 + \beta_1 DD + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + e_t \qquad (3)$$

where y_τ is our outcome variable WAZ, HAZ or BMI at quantile τ. β_1 is our coefficient of interest that quantifies the positive or negative impact of one unit increase in the dietary diversity indicator (mentioned above). X_1, X_2, and X_3 are the vectors of child-level, maternal-level, and household-level characteristics. Vector X_4 comprises of location and regional dummies.

Table 1 presents the descriptive statistics of the sample. Mean WAZ and HAZ of the sampled children is -1.09 and -1.33 respectively, 25 percent of the children were stunted, and 34 percent of them were underweight. These prevalence rates are similar to those observed for the state in DLHS-IV (2012-13). 15 percent of women have lower than normal BMI, or are thin, while 36 percent of women are overweight or obese. The HDDS for the sampled households is 10.5 and have an FCS of 93 (maximum obtainable value is 112), which indicates that all the sampled households are consuming good

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[9] https://inddex.nutrition.tufts.edu/data4diets/indicator/mean-adequacy-ratio-mar-based-nutrient-adequacy-ratio-nar
MAR is the average of adequacy ratios of ten micronutrients (calcium, iron, vitamin A, vitamin B6, vitamin C, zinc, thiamin, riboflavin, niacin, folate).

[10] Based on Bennett's law, J.V. Meenakshi (2016) compares changes in anthropometric outcomes with dietary quality as measured by the share of calories intake from non-cereal diet.

[11] Wealth index is calculated based on number of useful assets, access to cooking fuel, access to electricity and education level of the household decision maker.

[12] SSI was constructed based on two parameters such as distance from city center and built-up area. More information on SSI and stratum can be found in Hoffmann et al (2017).

quality diet. High diet quality is also reflected in an MAR of 0.73 (implying around 27 percent deficit from the recommended norm) and roughly 50 percent share of non-cereal calorie in total calorie intake. On average mothers, have 9 years of formal education, but only 15 percent are engaged in any kind of remunerative work outside home. The average household size is six. About half of the households belong to the lower caste groups (SC&ST; OBC) and a majority (92%) belong to Hindu religion. More than half of the households have access to the urban environment as only 35(%) of them belong to stratum 5 and 6 which are far away from the city center based on SSI.

In Table 2, we present the average levels of the dietary diversity measures discussed above, by the nutritional status of the child (underweight and stunting). The last column shows that there is not much difference between the dietary quality indicators of malnourished and well-nourished children, suggesting no correlation between the two. The few differences which are statistically significant have economically small values.

Using the food composition tables, we estimate the household level intake of calories, vitamin A and iron from the consumption expenditure data. Next, using the demographic information of the household we calculate the total requirement for these three. Comparing the intake and requirement, we can identify the percentage of households with inadequate intake of calories (58), calcium (55) and iron (61). In Table 3, we present the distribution of nutrient adequate households by nutritional status of the child. A strong correlation between the two would imply that a high percentage of households will be in either inadequate nutrient-malnourished child or adequate nutrient-well-nourished child category. However, that is not the case as is seen from Table 3. About 40-50 percent of children belongs to calorie, iron or calcium inadequate households but are well-nourished, implying lack of correlation with both quantity (calories) and quality (micronutrients) of food.

In Table 4, we present the average levels of dietary quality measures by nutritional status of women (low, normal and high BMI). Only the following differences were statistically significant - between the normal BMI and overweight; and low BMI and overweight for share of non-cereal-calorie in total calorie and all differences in count of food items. Even these differences are numerically small. From Table 5 we can see the similar relationship as in children that about 40-50 percent of women who belongs to calorie, iron and calcium inadequate households have the normal (BMI 18.5-25) or are overweight (BMI 25 and above).

V. Results and Discussion

We first present results for HDDS using OLS method in Table 6 and 7 (column2) for young children and Table 10 (column 2) for women. Some of the predictors may not have a significant association on average but possibly at different points along the conditional distribution of the outcome variable. In these cases, quantile regression is an efficient solution to estimate the covariates at different points of the distribution

(Uttamacharya et al 2013). We employ a multivariate analysis using quantile regression to capture this relation through the entire distribution of the outcome variable. The previous studies on the relationship between the child anthropometric outcomes and its determinants in India have considered only the average effects. We chose 5th, 10th, 25th, 50th, 75th, 90th and 95th quantile of the outcome variables in our estimation and the results are presented in Table 6, Table 7 and Table 10 (column 3-9).

The OLS results show that there is no relationship between HDDS and anthropometric outcomes. Looking at quantile regression results, we find positive and significant association of HDDS with WAZ Z-score at 5th, 10th and 50th quantile (Table 6) The strongest effect is for the 5th percentile. We do not find any significant association between HAZ and HDDS in any of the quantiles except for the 95th quantile (significant at 10%) (Table 7). Similar results are also observed in Amugsi et al. (2017) where they did not find any significant association between dietary diversity score and HAZ distribution for Kenya and Mozambique. Similarly, Perkins et al. (2018) have found mixed associations between dietary diversity and growth outcomes for children aged 6 to 12 months and found no association for children aged 12-24 months.

The coefficients when using other measures of dietary diversity – FCS, simple count of food items consumed, MMAR, and share of non-cereal calorie for both the z-scores are provided in Table 8 and Table 9.[13] The significant results that we observed for HDDS for three of the quantiles are not observed with other measures of dietary diversity. We also find negative relationship at 95th percentile using FCS and share of non-cereal calories. While these are perverse results, such results have also been observed in other studies (Perkins et al 2018). Nonetheless, these are not robust. For HAZ scores, we do find significant positive relationship at 95th quantile for four of the five measures used in the study. Thus, dietary diversity is associated with improved health outcomes at the top of the distribution for HAZ scores.

Among other covariates, mother's height is positively and significantly associated with both WAZ and HAZ Z-scores in the bottom half of the distribution. To the extent mother's height is an indicator of her long run nutrition, this points to the importance of maternal nutrition on child's health outcomes. Mother's age is significantly and negatively associated with the HAZ scores at 90th and 95th quantile but surprisingly there is a negative association of years of education of the mother at 95th quantile of HAZ distribution. Maternal engagement in labor-intensive activities (and therefore more likely to be low income earning activity) is associated with lower WAZ and HAZ scores for the uppermost quantile of the distribution. The negative association may be due to inadequate childcare due to limited time available with working mothers for childcare.

Household characteristics such as caste and religion have a heterogeneous association with the WAZ and HAZ distribution. We found no significant association between the household size and the health outcomes of the sampled children. Unlike other studies,

[13] We only present the coefficients for dietary quality variables. The full results, coefficients for all other covariates are available on request.

we do not find strong association with wealth index. Farming households have positive and significant associations in the first five quantiles of the HAZ distribution. Access to sanitation and clean drinking water facilities is positively and significantly associated with 90th (1.48) and 95th (1.67) quantile of the HAZ distribution but there is no significant association of access to sanitation and clean drinking water on WAZ scores.

Table 10 presents OLS and quantile regression results (column 3-9) for the BMI for women. We do not find any association between BMI of women and HDDS for any of the quantiles. When the same relationship is estimated with different measures of dietary diversity, the results do not differ much (see Table 11). With an exception for food count and MMAR, where there is positive and significant association in lowest quantiles, other measures of dietary diversity showed no significant association in any of the quantiles.

Among other covariates, age of women has positive and significant association in 10th (0.03) and 25th (0.03) quantile of conditional distribution of women BMI. Surprisingly there is a negative effect on BMI if the women in unmarried. Women who are engaged in heavy and labor intensive work have lower BMI. Caste and religion have mixed effects on BMI at different quantiles of the distribution. A household engaged in dairy farming has negative associations with BMI of women. This is because most of the times women are responsible for taking care of cows at home and in the grazing field, which is a labor-intensive work. As expected ownership of the house, sanitation and wealth index have positive and significant association with BMI. Women who live in stratum 6 which is farm away from the city center have lower BMI when compared to the ones who live in stratum 1. Overall, dietary diversity measures do not show a significant association with BMI of women in the sampled area. Whereas other factors such as women occupation, wealth index, sanitation facilities are some of the important factors having an influence on BMI.

It has been argued that dietary diversity measures are too simplistic and do not account for variation in quantity consumed. Savy et al. (2007) argue that when "*people have access to a range of different foods, diet quality cannot be restricted to adequate micronutrient intakes but must also take into account moderation behaviours regarding intakes in energy, saturated fat, cholesterol, sodium and sugar*". However, two of the measures considered in this study, share of non-cereal calories and MMAR account for quantity consumed. Though it is true that MMAR does not account for overconsumption. There are therefore two ways to explain mostly insignificant results. First that there is indeed no strong relationship between diet quality and health outcomes, and other factors might be more important in improving health outcomes. Second, there are threshold effects and the observed consumption patterns in our sample are above that threshold.

VI. Strengths and weaknesses

Our study uses primary data for the quantile regression analysis of dietary diversity and anthropometric outcomes in the rural-urban interface of Bangalore. Besides the detailed and rich data set, the use of quantile regression is one of the strengths of the study as most of the previous research has examined this association at mean providing only a partial view on the relationship between outcome and explanatory variable. Conducting a robustness check of the results using different measures of dietary diversity is another contribution of this study.

The study also has some limitations. The first, we use of cross-sectional data, which limits our ability to address potential endogeneity concerns. Another weakness is the use of 14-day recall period data to construct dietary diversity score. While it is a better compared to the commonly used one day recall period, it still limits the understanding of possible seasonal variations in the household dietary diversity and its implications for anthropometric outcomes. Additionally, dietary diversity measures have been calculated based on household consumption. To the extent household diversity is a good measure of individual diversity, our results are valid. However, particularly for young children, household dietary diversity might not reflect their own diet quality. Finally, while the enumerators were given comprehensive training on probing techniques for food consumed outside home and were regularly monitored during interview, it is possible that some of items consumed outside were not reported.

VII. Conclusion

Our study conducted a quantile regression estimation to analyze the association between the household dietary diversity and anthropometric outcomes of children aged 0-6 years. We used primary data on household food consumption and anthropometric outcomes for 274 children in 222 households and 1397 women in 1020 households in the rural-urban interface of Bangalore. The study finds some evidence of dietary quality being associated with better child growth outcomes among children (only for HAZ scores at 95th percentile) but no such association was observed for women. The results did not differ much even when different indicators of dietary quality are considered in the estimation model. One of the reasons for insignificant results can be high diet quality among sample households, leading to insufficient variation in the explanatory variable. Another important factor is that these dietary quality indicators are measured at the household level and not the individual level. However, it is also possible that the link between diet quality and child growth outcomes is much weaker than it is commonly believed.

Figures and Tables

Figure 1. location of sampled households in two transects

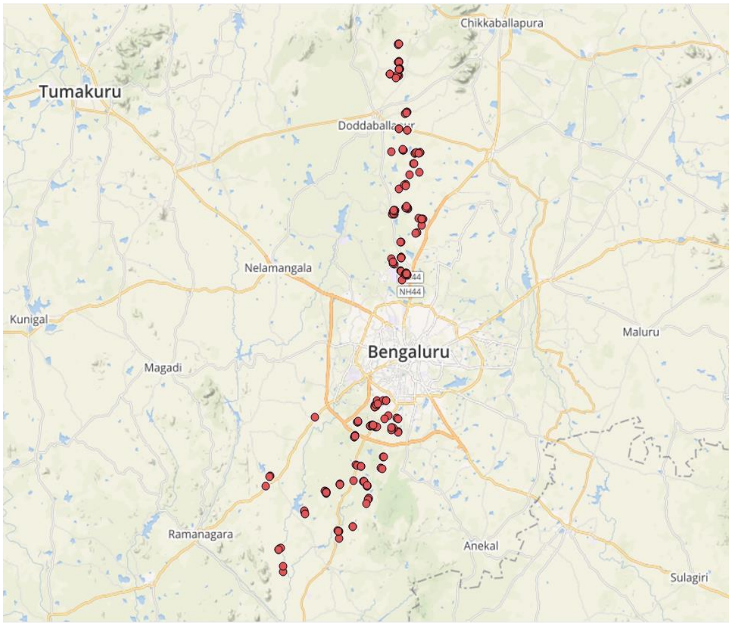

Table 1. Descriptive statistics

Variable	Mean/Percentage	SD
Weight-for-age (WAZ)	-1.09	1.55
Height-for-age (HAZ)	-1.33	1.96
BMI women	23.44	5.10
HDDS	10.5	1.13
FCS (food consumption score)	93	12.21
Food count	49	12.69
MMAR (mean micronutrient adequacy ratio)	0.73	0.15
Share of non-cereal calorie	45.31	12.65
Child age (months)	36.23	17.21
Child sex (dummy; 1=male)	52.99	
Mother height (cm)	153.96	6.39
Mother age (years)	26.51	5.06
Mother education (years)	9.75	3.88
Mother occupation, (housewife) ref cat	87.31	
Office work	8.96	
Heavy work	3.37	
Person buying food (female)	22.39	
HH size (count)	5.98	2.33
Caste (general) ref	51.49	
SC&ST	26.12	
OBC	22.39	
Wealth Index	9.03	2.47
Toilet (dummy, yes)	92.91	
Filtered water (dummy, yes)	54.1	
Religion (Hindu) ref	92.54	
Muslim	5.22	
Christian	2.24	
Stratum 1 (urban) ref cat	12.31	
Stratum 2 (urban)	16.04	
Stratum 3 (peri-urban)	13.06	
Stratum 4 (peri-urban)	24.63	
Stratum 5 (rural)	24.25	
Stratum 6 (rural)	9.7	
Vegetarian family (dummy, yes)	9.7	
Owned house (dummy, yes)	70.15	
Decision maker (Male)	78.36	
Number of children	2	1.6
Transect, north	50.75	

Table 2. Dietary diversity measures by health outcome of children

Variables	Health outcome of the children		Difference
	Underweight	Normal weight	
Calorie intake (per capita)	2382 (95)	2399 (57)	- 17 (111)
Calorie intake (consumer equivalence units)	3148 (123)	3141 (74)	6 (143)
Mean Micronutrient Adequacy ratio	0.73 (0.09)	0.74 (0.01)	0.002 (0.20)
Share of non-cereal calories	42 (1.14)	44 (0.80)	-2.28 (1.39)
HDDS	10.2 (0.15)	10.6 (0.06)	-0.4 (0.16)***
FCS	89 (1.66)	94 (0.67)	-5 (1.79)**
Food item count	44 (1.35)	50 (0.78)	6 (1.56)***
Percentage of children	25	75	
	Stunted	Not stunted	
Calorie intake (per capita)	2390 (90)	2393 (62)	2.09 (109)
Calorie intake (consumer equivalence units)	3113 (115)	3139 (80)	-26.10 (140)
Mean Micronutrient Adequacy ratio	0.72 (0.01)	0.74 (0.01)	-0.01 (0.01)
Share of non-cereal calories	44 (1.21)	44 (0.86)	0.11 (1.14)
HDDS	10.4 (0.10)	10.6 (0.08)	-0.2 (0.13)
FCS	91 (1.26)	94 (0.83)	-2 (1.51)
Food item count	46 (0.94)	50 (0.94)	-4 (1.43)***
Percentage of children	34	66	

Standard errors in parenthesis. ***p<0.01,**p<0.05,*p<0.1

Table 3: Nutrient adequacy status of the household by nutritional outcome of children.

Variables	Health outcome of the children	
	Underweight	Normal weight
Calorie		
Adequate households	11	31
Inadequate households	13	45
Calcium		
Adequate households	33	12
Inadequate households	13	42
Iron		
Adequate households	9	29
Inadequate households	15	47
	Stunted	Not stunted
Calorie		
Adequate households	15	27
Inadequate households	18	40
Calcium		
Adequate households	17	29
Inadequate households	17	37
Iron		
Adequate households	22	39
Inadequate households	12	27

Table 4. Dietary diversity measures by health outcome of women

Variables	Low BMI <18.5	Normal BMI (18.5-25)	Overweight or obese (BMI >25)
Calorie intake (per capita)	2670 (71)	2738 (39)	2751(48)
Calorie intake (consumer equivalence units)	3479 (127)	3566 (65)	3468 (62)
Mean Micronutrient Adequacy ratio	0.74 (0.01)	0.76 (0.01)	0.76 (0.01)
Share of non-cereal calories	41 (0.82)	41 (0.45)	43 (0.60)
HDDS	10 (0.06)	10 (0.04)	10 (0.05)
FCS	91 (0.82)	91 (0.55)	92 (0.61)
Food item count	43 (0.83)	46 (0.49)	47 (0.56)
Percentage of children	15	48	36

Standard errors in parenthesis.

Table 5: Nutrient adequacy status of the household by nutritional outcome of women.

Variables	Low BMI <18.5	Normal BMI (18.5-25)	Overweight or obese (BMI >25)
Calorie			
Adequate households	5	20	15
Inadequate households	10	28	21
Calcium			
Adequate households	11	36	26
Inadequate households	4	13	10
Iron			
Adequate households	7	23	16
Inadequate households	8	25	20

Table 6. OLS & Quantile regression; Dependent variable: WAZ Z-score for children <6 years of age

Variables	OLS	5th	10th	25th	50th	75th	90th	95th
HDDS	0.068	0.397*	0.277*	0.113	0.187**	0.0637	-0.137	-0.416
	(0.094)	(0.221)	(0.146)	(0.102)	(0.094)	(0.183)	(0.213)	(0.310)
Gender	0.102	-0.133	-0.016	-0.018	0.0512	-0.324	0.204	0.618
(male)	(0.206)	(0.316)	(0.351)	(0.257)	(0.233)	(0.231)	(0.439)	(0.654)
Age	-0.006	0.009	0.003	0.001	0.002	-0.011	-0.014	-0.015
(months)	(0.008)	(0.012)	(0.009)	(0.007)	(0.008)	(0.008)	(0.010)	(0.016)
Mother height	0.024	0.022	0.037**	0.048***	0.006	0.008	-0.034	-0.034
(cm)	(0.015)	(0.020)	(0.017)	(0.013)	(0.027)	(0.024)	(0.026)	(0.040)
Mother age	-0.018	-0.012	-0.011	0.000	-0.010	-0.002	-0.007	-0.049
(years)	(0.019)	(0.046)	(0.085)	(0.018)	(0.021)	(0.046)	(0.040)	(0.045)
Mother edu	0.001	0.066	-0.025	0.007	0.046	0.064	0.044	-0.021
(years)	(0.035)	(0.056)	(0.071)	(0.050)	(0.053)	(0.052)	(0.064)	(0.075)
mother occ								
Mother occ	-0.358	0.317	0.420	-0.162	-0.260	-0.460	-0.033	-0.594
(office)	(0.357)	(0.644)	(0.710)	(0.516)	(0.360)	(0.506)	(0.466)	(0.394)
Mother occ	-0.109	0.863	0.350	0.501	0.035	-0.359	-0.948	-2.060***
(heavy)	(0.419)	(1.698)	(0.561)	(0.330)	(0.643)	(1.053)	(1.278)	(0.374)
Person buying	-0.220	0.412	0.112	-0.261	-0.140	-0.251	-0.451	0.004
food (female)	(0.206)	(0.394)	(0.308)	(0.345)	(0.275)	(0.373)	(0.318)	(0.311)
HH size	0.034	0.031	0.043	0.070	0.066	0.002	0.066	0.118
(count)	(0.043)	(0.073)	(0.084)	(0.051)	(0.051)	(0.051)	(0.084)	(0.074)
caste (general)								
caste	-0.285	-0.063	-0.133	-0.010	-0.466**	-0.152	-0.263	0.113
(SC&ST)	(0.219)	(0.370)	(0.410)	(0.238)	(0.220)	(0.262)	(0.406)	(0.587)
caste	-0.161	-0.159	-0.149	-0.021	-0.274	-0.240	0.024	0.721*
(OBC)	(0.270)	(0.698)	(0.424)	(0.253)	(0.301)	(0.456)	(0.383)	(0.413)
Wealth Index	0.055	0.185*	0.087	0.0631	0.039	0.028	-0.105*	-0.077
	(0.040)	(0.105)	(0.075)	(0.048)	(0.054)	(0.067)	(0.058)	(0.089)
Toilet	0.251	-0.080	0.040	0.060	0.037	0.188	0.118	0.487
(yes)	(0.398)	(0.877)	(0.718)	(0.480)	(0.444)	(0.814)	(0.744)	(0.474)
Filtered water	-0.060	0.134	-0.033	0.251	-0.210	-0.222	-0.176	-0.116
(yes)	(0.212)	(0.371)	(0.359)	(0.275)	(0.254)	(0.254)	(0.307)	(0.678)
Religion(Hindu)								

Religion	0.047	1.541**	1.177**	0.588	0.299	0.032	-0.659	-0.602
(Muslim)	(0.305)	(0.708)	(0.563)	(0.385)	(0.427)	(0.397)	(0.567)	(0.623)
Religion	-0.876***	-0.494	-1.413*	-0.737	-1.057***	-0.818**	0.375	1.176
(Christian)	(0.233)	(1.207)	(0.795)	(0.601)	(0.375)	(0.378)	(1.869)	(1.274)
Stratum 1								
Stratum 2	0.534	2.315***	0.940	0.148	0.469	0.097	-0.039	0.349
(urban)	(0.351)	(0.877)	(1.207)	(0.295)	(0.493)	(0.350)	(0.541)	(0.813)
Stratum 3	0.162	1.633*	0.037	-0.128	-0.137	-0.228	0.641	0.283
(peri-urban)	(0.442)	(0.861)	(1.036)	(0.429)	(0.497)	(0.487)	(0.600)	(0.837)
Stratum 4	-0.111	1.000	-0.061	-0.422	-0.177	-0.314	-0.169	-0.246
(peri-urban)	(0.344)	(0.903)	(1.243)	(0.473)	(0.488)	(0.341)	(0.543)	(1.013)
Stratum 5	0.095	1.272	0.465	-0.176	-0.124	-0.249	0.036	0.040
(rural)	(0.396)	(0.859)	(0.921)	(0.320)	(0.433)	(0.441)	(0.599)	(0.853)
Stratum 6	-0.370	0.310	-0.029	-0.559	-0.461	-0.592	-0.917	-1.166
(rural)	(0.448)	(1.782)	(0.989)	(0.409)	(0.543)	(0.550)	(0.610)	(0.884)
Transect	-0.151	0.344	0.101	-0.427	-0.145	-0.0116	-0.403	-0.309
(North)	(0.194)	(0.354)	(0.324)	(0.260)	(0.229)	(0.367)	(0.338)	(0.873)
Constant	-5.620**	-14.8***	-12.2***	-11.31***	-4.670	-2.208	8.527*	12.35***
	(2.537)	(3.755)	(2.898)	(2.053)	(3.976)	(4.208)	(4.680)	(3.582)
Observations	268	268	268	268	268	268	268	268
R-squared	0.104	0.038	0.042	0.058	0.077	0.063	0.008	0.005

Robust standard errors in parentheses
Standard errors clustered at village level
*** p<0.01, ** p<0.05, * p<0.1

Table 7. OLS & Quantile regression; Dependent variable: HAZ Z-score for children <6 years of age

Variables	OLS	5th	10th	25th	50th	75th	90th	95th
HDDS	0.064	-0.274	-0.071	-0.008	0.102	0.213	0.160	0.333*
	(0.116)	(0.272)	(0.234)	(0.166)	(0.131)	(0.170)	(0.441)	(0.179)
Gender	0.077	-0.676*	-0.539	-0.191	-0.023	0.224	0.462	1.328***
(male)	(0.302)	(0.388)	(0.442)	(0.408)	(0.307)	(0.282)	(0.417)	(0.289)
Age	0.014*	0.040***	0.032***	0.020**	0.004	0.017*	0.013	0.033***
(months)	(0.008)	(0.013)	(0.012)	(0.009)	(0.009)	(0.009)	(0.012)	(0.008)
Mother height	0.036**	0.115***	0.078*	0.033	0.055***	0.020	0.075	0.032
(cm)	(0.017)	(0.043)	(0.041)	(0.021)	(0.017)	(0.031)	(0.054)	(0.025)
Mother age	-0.022	-0.005	-0.003	0.005	-0.012	0.000	-0.087***	-0.083***
(years)	(0.021)	(0.055)	(0.055)	(0.030)	(0.028)	(0.026)	(0.029)	(0.015)
Mother edu	-0.001	0.019	0.057	0.002	0.004	0.049	-0.0846	-0.146***
(years)	(0.046)	(0.053)	(0.069)	(0.053)	(0.054)	(0.060)	(0.057)	(0.026)
Mother occ	houswife							
Mother occ	-0.173	-0.024	0.374	0.360	-0.293	-0.387	-0.271	-0.576
(office)	(0.334)	(0.710)	(0.807)	(0.490)	(0.389)	(0.469)	(0.451)	(0.387)
Mother occ	1.047	0.232	0.807	1.024	1.132	1.381	2.383***	2.672***
(heavy)	(0.793)	(1.356)	(0.877)	(0.661)	(1.148)	(1.633)	(0.750)	(0.754)
HH size	0.009	0.093	0.0227	-0.007	-0.031	-0.000	-0.095	-0.006
(count)	(0.051)	(0.085)	(0.100)	(0.046)	(0.057)	(0.094)	(0.112)	(0.075)

caste	(general)							
caste	-0.007	0.570	-0.158	-0.187	-0.144	-0.107	-0.355	-0.646**
(SC&ST)	(0.328)	(0.550)	(0.467)	(0.374)	(0.356)	(0.323)	(0.620)	(0.288)
caste	0.0835	-0.077	-0.580	-0.504	-0.356	0.622	0.634	1.322***
(OBC)	(0.439)	(0.532)	(0.479)	(0.417)	(0.440)	(0.866)	(0.865)	(0.458)
Religion	(Hindu)							
Religion	0.466	0.220	0.359	0.498	0.695	0.336	0.591	-0.206
(Muslim)	(0.549)	(0.692)	(1.118)	(0.923)	(0.716)	(0.816)	(0.966)	(0.657)
Religion	0.288	1.117	0.657	0.170	0.167	0.035	-1.189	-1.925***
(Christian)	(0.355)	(0.849)	(0.684)	(0.471)	(0.561)	(0.466)	(0.880)	(0.745)
Farming	0.812**	1.341**	1.409**	1.035**	0.659*	0.902*	0.589	-0.008
(yes)	(0.347)	(0.601)	(0.649)	(0.439)	(0.347)	(0.486)	(0.649)	(0.522)
Toilet	0.601	0.798	0.473	0.073	0.385	0.892	1.480***	0.481
(yes)	(0.586)	(0.673)	(1.121)	(0.607)	(0.536)	(0.564)	(0.560)	(0.821)
Wealth Index	0.0494	0.096	0.067	0.147**	0.093	0.031	0.126	0.014
	(0.060)	(0.075)	(0.089)	(0.071)	(0.073)	(0.074)	(0.103)	(0.076)
Person buying food	-0.234	-1.281*	-0.650	-0.461	-0.336	0.031	0.451	-0.235
(female)	(0.364)	(0.750)	(0.482)	(0.404)	(0.386)	(0.529)	(0.485)	(0.425)
vegetarian	0.430	-1.639	-1.138	-0.304	-0.255	0.676	0.687	1.928***
(yes)	(0.765)	(1.198)	(0.890)	(0.666)	(0.732)	(1.128)	(1.220)	(0.477)
owned house	-0.295	-0.765	-0.451	0.055	-0.299	-1.023*	-0.461	0.424
(yes)	(0.420)	(0.804)	(0.709)	(0.614)	(0.633)	(0.577)	(0.660)	(0.516)
source_water	0.188	0.597	0.250	-0.027	0.000	0.290	0.774*	1.679***
	(0.340)	(0.423)	(0.381)	(0.368)	(0.379)	(0.380)	(0.463)	(0.285)
decision maker	0.129	-0.443	-0.488	0.0406	0.168	0.060	0.427	0.943***
(male)	(0.261)	(0.526)	(0.398)	(0.409)	(0.353)	(0.405)	(0.534)	(0.238)
Stratum 1								
Stratum 2	1.110**	1.711*	1.659	0.256	0.323	1.498*	3.164***	2.799***
(urban)	(0.508)	(1.011)	(1.516)	(0.665)	(0.944)	(0.824)	(0.762)	(0.473)
Stratum 3	0.933	2.082	2.198	0.339	0.019	1.646**	1.925**	2.486***
(peri-urban)	(0.631)	(1.328)	(1.661)	(0.696)	(1.085)	(0.721)	(0.871)	(0.466)
Stratum 4	0.223	0.367	0.243	-0.724	-0.347	0.869	1.382	1.429***
(peri-urban)	(0.514)	(1.325)	(1.568)	(0.636)	(0.957)	(0.582)	(0.841)	(0.451)
Stratum 5	0.553	0.622	0.748	-0.790	0.139	1.829***	2.426***	2.043***
(rural)	(0.608)	(1.384)	(1.548)	(0.664)	(1.048)	(0.548)	(0.895)	(0.405)
Stratum 6	-0.416	1.146	0.889	-1.343*	-0.935	0.646	0.620	0.640
(rural)	(0.676)	(1.360)	(1.571)	(0.725)	(1.116)	(0.684)	(0.985)	(0.583)
Transect	-0.303	-1.179***	-0.930*	-0.394	-0.285	-0.642**	0.655	-0.497
(North)	(0.206)	(0.440)	(0.508)	(0.380)	(0.326)	(0.281)	(0.658)	(0.492)
Constant	-9.365***	-22.36***	-17.53***	-9.402**	-11.73***	-8.970	-14.63	-8.842*
	(3.143)	(6.730)	(6.800)	(4.241)	(3.160)	(5.758)	(12.50)	(4.826)
Observations	243	243	243	243	243	243	243	243
R-squared	0.136	0.063	0.071	0.085	0.090	0.100	0.068	0.046

Robust standard errors in parentheses
Standard errors clustered at village level
*** p<0.01, ** p<0.05, * p<0.1

Table 8. Children (below 6 years) – WAZ Z-score – Coefficients from OLS and Quantile regressions

Variables	OLS	5th	10th	25th	50th	75th	90th	95th
HDDS	0.068	0.397*	0.277*	0.113	0.187**	0.064	-0.137	-0.416
	(0.094)	(0.221)	(0.146)	(0.102)	(0.094)	(0.183)	(0.213)	(0.310)
FCS	0.006	0.010	0.0230	0.019	0.014	0.004	-0.015	-0.032**
	(0.008)	(0.023)	(0.021)	(0.013)	(0.011)	(0.013)	(0.036)	(0.014)
Food count	0.009	0.023	0.0171	0.007	0.014	0.002	0.002	0.015
	(0.007)	(0.022)	(0.020)	(0.009)	(0.010)	(0.009)	(0.011)	(0.011)
MMAR	0.417	-1.641	0.516	0.231	-0.217	0.598	0.016	0.107
	(0.701)	(1.119)	(0.964)	(0.673)	(1.059)	(0.914)	(1.531)	(0.925)
share of non-cereal calorie	-0.006	0.023	-0.003	-0.004	-0.001	-0.015	-0.016	-0.039***
	(0.009)	(0.019)	(0.019)	(0.011)	(0.013)	(0.019)	(0.017)	(0.015)

Robust standard errors in parentheses
Standard errors clustered at village level
*** p<0.01, ** p<0.05, * p<0.1
Notes – Controls include age and gender of the child, mother's age, education, height, working status, gender of the person buying food, household size, wealth index, access to clean water and sanitation facility, caste, religion, and regional dummies.

Table 9. Children (below 6 years) – HAZ Z-score – Coefficients from OLS and Quantile regressions

Variables	OLS	5th	10th	25th	50th	75th	90th	95th
HDDS	0.064	-0.274	-0.071	-0.008	0.102	0.213	0.160	0.333*
	(0.116)	(0.272)	(0.234)	(0.166)	(0.131)	(0.170)	(0.441)	(0.179)
FCS	0.008	-0.030	-0.021	0.005	0.0140	0.016	0.036***	0.030***
	(0.009)	(0.019)	(0.021)	(0.009)	(0.012)	(0.024)	(0.012)	(0.010)
Food count	0.013	-0.014	0.016	0.010	0.033***	0.020	-0.002	0.016**
	(0.009)	(0.014)	(0.018)	(0.014)	(0.009)	(0.017)	(0.017)	(0.008)
MMAR	0.816	1.269	0.679	0.169	0.908	0.917	-1.274	2.971***
	(0.916)	(1.965)	(1.842)	(1.484)	(0.982)	(1.712)	(1.735)	(0.811)
share of non-cereal calorie	-0.008	-0.043	-0.017	-0.002	-0.006	-0.007	-0.007	0.001
	(0.010)	(0.033)	(0.034)	(0.012)	(0.014)	(0.014)	(0.031)	(0.007)

Robust standard errors in parentheses
Standard errors clustered at village level
*** p<0.01, ** p<0.05, * p<0.1
Notes – Controls include age and gender of the child, mother's age, education, height, working status, gender of the person buying food, household size, wealth index, access to clean water and sanitation facility, caste, religion, and regional dummies.

Table 10. Women (above 16 years) – BMI – Coefficients from OLS and Quantile regressions

Variables	OLS	5th	10th	25th	50th	75th	90th	95th
HDDS	0.054	0.053	0.115	0.058	0.096	-0.075	-0.075	-0.267
	(0.145)	(0.238)	(0.221)	(0.209)	(0.252)	(0.132)	(0.325)	(0.349)
Age	0.028	0.028	0.035***	0.039***	0.018	0.029	0.024	0.005
(years)	(0.018)	(0.023)	(0.013)	(0.012)	(0.018)	(0.028)	(0.039)	(0.041)
Marital state	(married) ref							
Unmarried	-1.318**	-1.374	-1.040	-1.378**	-1.275*	-2.100***	-2.276*	-2.516**
	(0.522)	(0.848)	(0.690)	(0.592)	(0.686)	(0.734)	(1.344)	(1.011)
Widow	-0.128	-0.466	0.700	-0.189	-0.215	-0.153	-0.571	-0.754
	(0.573)	(1.240)	(0.491)	(0.461)	(0.863)	(0.880)	(1.431)	(2.060)
Education	0.007	-0.074	-0.044	0.017	-0.023	0.019	0.052	0.048
	(0.035)	(0.070)	(0.047)	(0.031)	(0.035)	(0.036)	(0.084)	(0.129)
Occupation	(housewife)							
Occupation	0.014	-0.247	0.439	-0.052	-0.171	0.221	-0.398	-0.442
Office work	(0.450)	(0.641)	(0.565)	(0.463)	(0.581)	(0.507)	(1.415)	(0.670)
Occupation	-0.455	-1.278*	-0.762	-0.638	-0.144	-0.815*	-2.210***	-1.846
Heavy work	(0.371)	(0.695)	(0.520)	(0.467)	(0.470)	(0.420)	(0.613)	(1.732)
Addtional occ	0.273	0.607	0.092	0.301	0.143	0.567	0.913	0.221
(yes)	(0.388)	(0.734)	(0.423)	(0.524)	(0.418)	(0.578)	(0.907)	(0.750)
HH size	0.0218	-0.057	-0.035	0.037	0.052	0.098	0.070	-0.002
	(0.054)	(0.146)	(0.100)	(0.059)	(0.079)	(0.068)	(0.102)	(0.118)
Religion	(hindu) ref							
Religion	1.997	-0.347	0.776	1.681	2.793	2.223**	4.636*	3.589*
Muslim	(1.213)	(1.885)	(1.163)	(4.644)	(1.704)	(1.115)	(2.605)	(2.071)
Religion	-0.777**	-5.050***	-1.332**	-1.266**	-1.053*	-0.176	0.956	2.004
Christian	(0.360)	(0.996)	(0.676)	(0.511)	(0.564)	(0.642)	(2.684)	(1.254)
Caste	(general) ref							
Caste	-0.280	-0.671	-0.325	-0.207	-0.646	0.224	1.056	-0.586
SC&ST	(0.335)	(0.595)	(0.432)	(0.412)	(0.416)	(0.451)	(0.763)	(0.958)
Caste	1.121***	-0.023	0.242	0.888**	1.056***	1.577***	1.659*	0.492
OBC	(0.349)	(0.702)	(0.513)	(0.427)	(0.410)	(0.478)	(0.903)	(1.310)
Farming	0.214	-0.360	-0.315	0.122	-0.053	0.626	-0.395	2.146
(yes)	(0.489)	(0.953)	(0.682)	(0.575)	(0.530)	(0.843)	(0.954)	(2.263)
Cows	-1.047**	-0.543	-0.211	-0.904*	-0.900*	-1.311**	-1.275*	-3.007
(yes)	(0.397)	(0.968)	(0.530)	(0.515)	(0.472)	(0.637)	(0.683)	(2.323)
Owned house	1.216***	1.144	1.181**	1.380**	1.613**	0.682	0.779	-0.484
(yes)	(0.385)	(0.728)	(0.583)	(0.588)	(0.703)	(0.481)	(1.121)	(1.006)
Bathroom	-1.163	-2.485*	-1.393	-1.338	-2.580**	-2.325	-0.764	0.602
(yes)	(1.192)	(1.453)	(1.330)	(0.875)	(1.062)	(2.362)	(2.670)	(2.774)
Toilet	2.091**	1.191	1.467	1.659***	2.874***	2.987***	1.357	2.442
(yes)	(0.840)	(1.331)	(1.239)	(0.535)	(0.623)	(1.061)	(1.737)	(2.249)
Person buying	0.128	0.328	0.243	0.173	0.270	0.023	-0.349	0.651
food(female)	(0.301)	(0.504)	(0.410)	(0.444)	(0.397)	(0.457)	(0.767)	(0.781)
Vegetarian	0.447	-0.549	0.193	0.011	0.995	0.217	0.633	-0.553
(yes)	(0.584)	(1.008)	(0.630)	(0.602)	(0.825)	(0.536)	(1.062)	(1.315)
water source	0.042	0.110	0.201	-0.126	0.199	-0.295	-0.424	-0.105
(filtered)	(0.299)	(0.487)	(0.372)	(0.405)	(0.425)	(0.408)	(0.631)	(0.804)
Wealth index	0.305***	0.248**	0.236**	0.303***	0.332***	0.298***	0.293**	0.377**

	(0.072)	(0.126)	(0.104)	(0.074)	(0.078)	(0.110)	(0.126)	(0.177)
Stratum 1								
Stratum 2	0.380	0.438	0.247	0.539	0.619	0.687	-0.778	-1.655
(urban)	(0.505)	(0.675)	(0.788)	(0.677)	(0.984)	(0.688)	(1.060)	(1.695)
Stratum 3	0.130	-0.513	-0.909	-0.342	0.681	0.591	0.646	-0.407
(peri-urban)	(0.449)	(0.775)	(0.765)	(0.705)	(0.583)	(0.765)	(0.925)	(1.510)
Stratum 4	-0.969**	-0.810	-0.243	-1.118*	-0.538	-0.917	-0.929	-0.898
(peri-urban)	(0.454)	(0.919)	(0.809)	(0.578)	(0.566)	(0.794)	(0.956)	(1.683)
Stratum 5	-1.161**	-0.955	-0.942	-1.762***	-1.076*	-1.010	-0.734	-0.652
(rural)	(0.453)	(0.816)	(0.783)	(0.491)	(0.584)	(0.776)	(1.123)	(1.904)
Stratum 6	-1.909***	-2.268**	-1.789*	-1.909**	-1.857**	-2.204**	-1.884	-1.596
(rural)	(0.640)	(1.008)	(0.924)	(0.785)	(0.726)	(0.861)	(1.404)	(1.547)
Number of	0.243**	-0.135	-0.000	0.133	0.359**	0.346**	0.377	0.373
children	(0.110)	(0.218)	(0.134)	(0.105)	(0.176)	(0.144)	(0.231)	(0.261)
transect_id	0.110	0.392	0.141	0.057	0.049	0.161	0.826*	0.505
(north)	(0.287)	(0.451)	(0.371)	(0.343)	(0.352)	(0.356)	(0.471)	(0.661)
Constant	17.65***	16.11***	13.84***	15.17***	16.99***	21.44***	24.95***	28.27***
	(1.774)	(3.003)	(2.713)	(2.708)	(3.499)	(2.236)	(3.959)	(4.831)
Observations	1,341	1,341	1,341	1,341	1,341	1,341	1,341	1,341
R-squared	0.135	0.078	0.098	0.129	0.130	0.128	0.106	0.089

Robust standard errors in parentheses
Standard errors clustered at villagelevel
*** p<0.01, ** p<0.05, * p<0.1

Table 11. Women (above 16 years) – BMI – Coefficients from OLS and Quantile regressions

Variables	OLS	5th	10th	25th	50th	75th	90th	95th
HDDS	0.054	0.051	0.115	0.058	0.096	-0.075	-0.075	-0.267
	(0.145)	(0.238)	(0.221)	(0.209)	(0.252)	(0.132)	(0.325)	(0.349)
FCS	0.010	0.006	0.012	0.013	0.016	-0.003	-0.008	0.008
	(0.011)	(0.024)	(0.015)	(0.016)	(0.015)	(0.011)	(0.030)	(0.027)
Food count	0.022*	0.032**	0.015	0.033**	0.023	0.011	-0.008	0.025
	(0.012)	(0.013)	(0.015)	(0.013)	(0.015)	(0.013)	(0.023)	(0.036)
MMAR	1.467	1.681	3.525*	2.829**	1.588	0.845	-0.766	-0.881
	(1.109)	(1.892)	(2.000)	(1.256)	(1.453)	(1.092)	(2.974)	(3.865)
share of non-cereal	0.008	0.014	0.020	0.017	0.014	-0.003	-0.014	0.012
calorie	(0.012)	(0.022)	(0.021)	(0.015)	(0.014)	(0.012)	(0.022)	(0.032)

Robust standard errors in parentheses
Standard errors clustered at village level
*** p<0.01, ** p<0.05, * p<0.1
Notes – Controls include age, marital status, education, working status, gender of the person buying food, household size, wealth index, number of children, access to clean water and sanitation facility, caste, religion, and regional dummies.

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