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Women's Malnutrition in India: The Role of Economic and Social Status

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Abstract

This study has used India Human Development Survey, 2005 to study the factors influencing the Body Mass Index(BMI) of women between 20 to 40 years of age in India. BMI captures both undernutrition and over nutrition and a quantile regression model has been used to capture the differential impact of the explanatory variables across the wide range of its values.

Variables like per capita income, per capita consumption expenditure and wealth are all important in explaining the variations in BMI but the impact varies across the quantiles. Impact of per capita consumption expenditure is higher than that of the per capita income indicating the effectiveness with which the resources are converted to consumption. Higher levels of wealth status impact BMI more across all the quantiles.

Women's autonomy index shows a positive impact only for higher levels of the index value but the magnitude is very small. In comparison to this, poor dietary diversity, women with younger children, and those working in agriculture related economic activities are worse off with significantly higher impact. Similarly access to clean and safe drinking water, good sanitation facility and use of clean cooking fuel like LPG have a favourable impact on women's BMI.

Keywords:*BMI, Women, Quantile Regression, Income, Dietary Diversity*
JEL Codes:*C40, I12, J10, O18*

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INTRODUCTION

Nutrition forms the basis of overall well being of a person. It is even more important in the case of women since an unhealthy woman gives birth to an unhealthy child. This results in a vicious circle, the results of which linger for a long period of time. The health status of women in India is one of the lowest in the world with India having one of the highest proportions of malnourished women in the developing countries (Naveentham and Jose, 2008). A recent study reveals that in 2000 about 70 per cent of non-pregnant and 75 per cent of pregnant women aged 15-49 years in India were anaemic (Mason *et. al.,* 2005). According to a UNDP report, there have been some improvements over the last 50 years for instance, female life expectancy at birth has increased to 65.3, maternal mortality rate has fallen to 450 (per lakh live births) and infant mortality rate has reduced to 56 (per thousand live births) in 2005, (UNDP, 2008) but there is still lot of scope for improvement.

The reasons behind women's undernutrition in India are multiple and complex. The discriminatory practices in India combined with high repression and low socio-economic standards play major role in determining the overall (low) nutrition status of women. Women in India are also expected to do heavy household work manually with limited assistance from other male members and in many instances are subjected to frequent pregnancies. Along with this, inadequate quantity and quality of diet also takes a toll on her health and her nutritional status. Undernutrition is both the cause and effect of poverty. Poor women do not get the right diet and are neither aware of the benefits of it.

Today the urban women have become more empowered and are more aware. This change is increasingly evident in her nutrition status and over-all well being. Education has played a major role in providing more autonomy to women. Studies show that education not only

contributes to her own physical well being but also to that of the whole family.

This study uses body mass index (BMI) of women in India (between 20 to 40 years of age) as an indicator of the nutrition level and tries to assess the factors affecting it. An OLS as well as quantile regression analysis has been carried out. It is well known that both low (chronic energy deficiency) and high (overweight and obesity) levels of BMI are not considered healthy and are caused by malnourishment but of different kinds. Hence a quantile regression model is used which will help in distinguishing between different factors affecting women with different levels of BMI.

The primary focus of this study is on different aspects of economic prosperity i.e. income, consumption and wealth. These variables are supposed to be complements or substitutes of each other but each of them may have a different and significant impact on the BMI. There are several studies which discuss the relevance of income in improving nutritional intakes, the earliest in this being Behrman and Deolalikar (1987). However, such discussions are limited in the context of nutritional outcomes partly because fewer studies exist on nutritional outcomes in India and that the only large scale data set available has information only on wealth status which is more of a long-term indicator of economic status. Hence the IHDS data set for the first time allows us to analyse the impact of flow variables like income or consumption along with a stock variable like wealth. It is expected that these three variables would be endogenous in determining nutritional outcomes, but we treat them as exogenous because the nutritional outcome indicator is at the individual level while the economic status variables are at the household level and this would pose difficulty in model specification. Further, BMI is measured only for some of the women (referred to as 'eligible' women) in the sampled households and is not available for all members of the household. This makes it difficult to create an index of nutritional

outcome for the household and then consider estimating a household level model for allowing for feedbacks between nutritional outcomes and economic status. The advantage of estimating an individual level model is that we also consider using variables like women's empowerment or their work status that would determine her individual nutritional outcome. Besides these variables, other social and infrastructural variables have also been included as control variables in the quantile regression analysis.

BRIEF REVIEW OF LITERATURE

Navaneetham and Jose (2008) based on the National Family Health Survey 2004-05 show that around 40 percent women in rural India are affected by chronic energy deficiency (CED) i.e. having a BMI below 18.5. This is 15 percentage points larger than the incidence among urban women. They also showed that nearly one-fourth of urban women suffer from obesity (i.e. having BMI above 25) which is a new nutrition problem emerging in urban India. About half of women below 20 years of age suffer from CED but this figure reduces to half for women in 40 to 49 years of age. So there is clearly improvement in CED rates with age but this age group also shows a higher rate of overweight and more so in urban areas as well as among states like Tamil Nadu, and Kerala (Seshadri, 2009). According to NFHS-3, 50 percent of women from the poorest quintile suffer from CED while women belonging to disadvantaged social groups also show a far higher rate. Ackerson *et. al.* (2008) show from an earlier round of NFHS at a more granular level of districts and villages that there are clearly regional patterns. Contiguity of low BMI regions and high BMI regions and its association with regional development is an important finding of this study. According to NFHS-3 data, the highest incidence of CED is found in the eastern states, such as Bihar (45.1 percent), Jharkhand (43.4 percent), Orissa (41.7 percent) and West Bengal (39.1 percent), in India. On the other hand, Southern states have lowest incidence of CED (Deaton, 2008). There is high variation in health conditions of women belonging to different states. In

our work, we have thus controlled for the regional effects by including the state dummies. IHDS shows that highest mean BMI of women is in the state of Punjab (23.59) and Kerala (23.10) while lowest in Bihar (20.81) and Orissa (20.91).

Women's access to basic social infrastructure facilities like access to toilet facilities, clean cooking fuel and time taken to fetch drinking water are also important variables determining her well-being. Lack of access to sanitation makes a woman vulnerable to infections and hence feeble health in the longer run. Unclean fuels on the other hand, expose her to toxic pollutants and fetching water from far off distance consumes a lot of energy. There is a difference of 20 percentage points between women with access to toilet facilities and those without it in terms of incidence of chronic energy deficiency. If women have access to clean cooking fuels then the incidence of undernutrition tends to get almost halved. Access to drinking water at home also plays important role in determining CED among women in India, but the effect is relatively smaller (Jose and Navneetham, 2010). In this study access to sanitation, regular availability of tapped water, access to electricity and use of clean cooking fuel have also been considered as variables affecting BMI of women.

Women empowerment has a significant effect on a woman's as well as her children's health status. Many women in developing countries cultivate, purchase and prepare much of the food eaten by their families, but they often have limited access to information about nutrition. An educated woman is more likely to spend on food, health care, and will make an effort to diversify the diet of the family. She has better abilities for the control of physical and financial assets and is motivated to eat a healthy diet and feed their babies and children foods that meet their special nutritional requirements. There is significant evidence that a mother's educational status directly influences her as well as her children's nutritional and health status. Many studies have used proxy

measures of women's status, for example, indicators that depict sources of power such as education or age at marriage as measures of women autonomy. Bhagowalia *et. al.,* 2012has used direct evidence on women's empowerment that includes her mobility, decision-making power, attitudes toward verbal and physical abuse. This may impact their power of making decisions about food to consume, visiting the health care centre, dietary diversity, attitudes towards domestic violence etc. This is positively associated with her nutritional outcome as well as that of her children. In another study of malnutrition in Zimbabwe, Malawi and Zambia, evidence suggests that women who have lower levels of autonomy and status within the household are more likely to experience undernutrition (Hindin, 2005).

Studies have also shown that women's participation in paid work enhances her well-being; for instance, Sen (1990) concludes that 'women's paid employment would enable them through a variety of ways to attain a higher well-being'. In this study, dummy variables related to the occupation of women in different sectors have been used to assess their impact individually including a reference category for women who do not work in the labour market. The focus should not be only on the provision of jobs but also on the nature, working conditions and the minimum wage earned by women.

Education is another form of capturing empowerment and awareness. Smith and Haddad (2000), based on an OLS regression and an error components model study 63 developing countries from 1975 through 1996. They find that for all countries in the sample, women's education alone explains 43 percent of the overall decline in childhood malnutrition experienced by these countries during the years of the study. They also showed that national income played an important role in reducing child malnutrition in these countries. But this relationship was not seen in sub-Saharan Africa because of decline in overall income of the region between 1970 and 1995.

To bring this discussion in the context of this study we need to understand that there are multiple factors that influence women's nutrition in India. There are not many studies on adult nutritional outcomes in India. India is growing fast economically with notable changesin socio-cultural aspects. Hence household's economic well-being and the changing status of women in society can play major role in improving women's health. Subramanian and Smith (2006) used Indian National Family Health Survey for the 1998-99 and found that standard-of-living index which they consider as directly related to the amount of disposable household income available for food, is most strongly associated with undernutrition and over nutrition. They also showed that undernutrition was most prevalent among women belonging to lowest quintile of standard of living. As the standard of living became better, the risk of being malnourished declined with it systematically. People from higher income groups consume a diet containing 32 percent of energy from fat while people from lower income group consumed only 17 percent of their energy from fat. This partially according to them explained the positive relationship between socio-economic standards and BMI of women.

In poor households women are at greater risk of undernutrition than men. Undernutrition in mothers, especially those who are pregnant or breast feeding, can be very detrimental since an unhealthy mother gives birth to an unhealthy child. The child is hence more susceptible to diseases, poor school performance contributes inadequately to the economy in the longer run. This may lead to undernutrition in women and girls and hence forms a vicious circle of undernutrition and poverty. Also, women require more dietary iron than men, and women need more protein than usual when pregnant and lactating. Poor women, especially those in female-headed households, tend to have less access than men to income, credit and other financial services and other resources needed to improve food security. It is important to study, learn and

analyze the severity and nature of the complex factors responsible for the low nutritional/health standard of women in India.

Based on the findings of the earlier studies and the nature of information available in the IHDS data set the study aims to understand the relevance of variables capturing economic prosperity and food intakes on the one hand and women's work status and empowerment on the other hand after controlling for other social and infrastructure variables on a nutritional outcome indicator like BMI. Further, the aim is to also assess how the relevance of these variables vary across different quantiles of BMI.

DATA AND METHODOLOGY

The analysis has been done using data from the India Human Development Survey, 2005 (Desai *et. al.,* 2007) conducted jointly by University of Maryland and National Council of Applied Economic Research (NCAER). It contains information from 41,554 households in 1,503 villages and 971urban neighborhoods across all the states and union territories of India.

Logarithm of BMI (*lnbmi*, henceforth) of women is taken as the dependent variable. BMI signifies the nutrition status in the shorter run while height signifies longer run health status. Hence, here an attempt has been made to study variables affecting the health of women in the shorter run. The outlier values have been dropped so that the results are more efficient and reliable. There can be changes in body height due to physiological changes before menarche and after menopause and later due to old age. Height remains constant between 20 to 40 years of age indicating that the numeraire in BMI (weight in kgs divided by square of height in meters) doe not vary with age. So, the changes in body weight due to various social, economic and environmental factors are effectively

captured by BMI. Hence, analysis in this study is carried for women in the age group of 20 to 40 years of age.

The data set provides information on the variables related to health, education, employment, economic status, marriage, fertility and social capital. Interviews related to village, school, and medical facility are also available. The data provides regional segregated information and offers gender centric and institutional information also. The survey included two questionnaires, one for the household head and the other for the eligible women who is typically the wife of the household head. The question related to household wealth, income and expenditure were asked from the household head while the questions related to health, education and some other social indicators were administered to women.

This study emphasizes on the impact of wealth, income and consumption on the BMI of women in India. Though all three of them are closely related but they have differential and significant effect on the well being of women. Income as a whole does not guarantee the rightful use of the resources. Hence per capita consumption and wealth index are also taken as explanatory variables. Per capita consumption of a household reflects the use of the income available to the household. IHDS provides information regarding some basic availability of assets in a household which can significantly ease the work of women and hence save a lot of energy. Also, income is a short term representation of economic well-being while wealth is a long term indicator. A household accumulates assets after saving from income earned over a period of time.

The data set has collected information on expenditure for broad groups of food and non food items. Consumption of certain food items like cereals is available in quantities but for many other food items either the information is not available or the food group is too broad like for pulses and products or meat, egg and fish. Consequently the conversion

of such broad groups of food intakes in quantities into their macro and micro nutrient content is not possible. Hence expenditure related on various food items is used to calculate dietary diversity.

To analyse the impact of social status of women, various empowerment related variables have been used. IHDS also provides the occupational information of women who participate in the labour market and has been used in this study as one of the explanatory variables.

A quantile regression model is estimated to assess the impact of various variables on the BMI. A quantile regression provides a comprehensive strategy to study the impact throughout the distribution of BMI. Here an attempt has been made to study mostly the micro-economic variables using the BMI of women as dependent variable which reflects short term health status. There may be different factors that affect women who are chronically malnourished and those who are obese hence the quantile regression helps to determine factors affecting women belonging to different quantiles of BMI.

In this study, an attempt has been made to study the factors influencing women's Body Mass Index across its entire distribution which is captured in a quantile regression model (QRM). Here analysis has been made for five different quantile of *lnbmi* i.e., 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} quantile where 10^{th} quantile represents women in the bottom 10 percent (0.10) of the distribution of *lnbmi*. Similalry, 25^{th} quantile represents all those women whose *lnbmi* is such that the area under the probability density function of *lnbmi* lies between 10 percent (0.1) and 25 percent (0.25) and finally the 90^{th} (0.90) quantile includes *lnbmi* in the top 10 percent of the distribution. The lower quantiles would encompass those who are CED while the top quantiles would include those who are overweight and obese. As one would expect the determinants of the undernutrition and overnutrition to be different so a quantile regression model is expected to capture this difference. Compared to ordinary least

squares (OLS) method where a single estimated coefficient is obtained for the different explanatory variables as shown in equation (1) below; in the quantile regression model the number of estimated coefficient would be the number of quantiles specified by the researchers as shown in equation (2) below.

Ordinary Least Squares Model:

$$Y_i = \beta X + \varepsilon_i \qquad (1)$$

Quantile Regression Model:

$$Y_i = \beta(p)X + \varepsilon_i(p), \text{ p=0.1, 0.25, 0.5, 0.75 and 0.9.} \qquad (2)$$

Here Y is the *lnbmi* and $X$is the vector of the explanatory variables and β is the vector of coefficients for the OLS model to be estimated by the specification in equation (1) and $\beta(p)$ would be coefficient vector for any given p^{th} quantile so each quantile has an estimated vector of coefficients.

Other socio-economic variables like caste and religious affiliation, household composition and household size, and social infrastructural like access to clean and safe drinking water, sanitation, electricity and clean cooking fuel are also used as explanatory variables. State level dummy variables have been used to control for regional variations. The analysis has been carried out for women in the age group of 20 to 40 years of age as explained above. Further details on the set of explanatory variables and related descriptive statistics are given in the next Section below.

PRELIMINARY ANALYSIS OF THE DATA

According to this data 26.3 percent of women in rural areas and 15.1 percent of women in urban areas are chronically undernourished i.e. they have a BMI less than 18.5. The national average of BMI of women is about 21.3 with rural areas having 20.7 while in urban areas is 22.4. It is

important to note that mean BMI is higher than 18.5 in all the states. It can be seen from Figure 1 that the mean BMI does not vary too much across the states as much as the standard deviation of BMI. Some of the smaller states and union territories show high values of standard deviation while many states in the north eastern region show far low values of standard deviation.

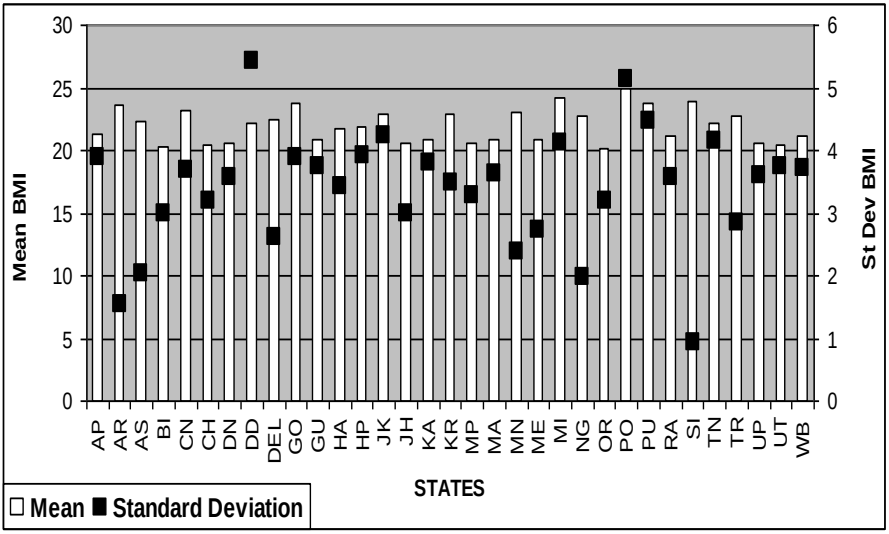

Figure 1: Mean and Standard Deviation of BMI across States of India, 2005-06

A brief discussion on the choice of explanatory variables used in the model is given below.

Economic Variables

Per Capita Income

Per capita income will take into effect the resources available per person and reflects the ability of the household, ex-ante to be able to spend on goods and services that would allow them to attain a healthy level of

BMI. Larger the per capita income better would be the standard of living and hence the coefficient is expected to be positive.

Per Capita Consumption

Resources expended per person is the revealed standard of living which is inclusive of availability and accessibility of goods and services. At lower levels of income, per capita income and consumption would be highly correlated as income is low to meet mainly subsistence consumption; while it would be less correlated at higher levels of income depending on the household's preferences for current and future consumption. Thus, after controlling for per capita income we can expect this coefficient to be positively significant for some of the quantiles.

Wealth Index

The wealth index is estimated using principal component analysis by taking into account the basic household amenities like owned house, cycle, motor, sewing machine, wall clock, cot, chair, fan etc. The quality of the house such as pucca wall, roof etc. is also taken into consideration. The first principle component forms the index which is then categorized into five groups comprising the five quintiles and referred to as the poorest, poor, middle, rich, richest wealth groups (from lowest to highest quintile). The poorest quintile is taken as the reference category in the econometric models. Table 1 shows that women in the poorest quintile of wealth index have a mean BMI of 19.4 which increases to 23.3 for the richest wealth group but so does the standard deviation. There is more steep increase in standard deviation across the wealth groups compared to the mean values. Given this observation and the model specification, we expect the magnitude of the coefficients for the remaining quintiles to increase in magnitude though we can expect the lower wealth groups to be not significant for some of the lower quantiles in the quantile regression model.

Table 1: Mean and Standard Deviation of BMI (kg/m^2) across Wealth Groups

Wealth Groups	Mean	Standard Deviation
Poorest	19.4	2.68
Poor	20.2	2.95
Mid-Wealth	20.7	3.35
Rich	21.8	3.69
Richest	23.3	4.11

Note: The wealth groups are formed on the basis of quintiles of wealth index.
Source: Own calculations.

Dietary Variables

Share of Food Expenditure in Total Household Expenditure

At the outset, the effect of this variable on BMI is ambiguous. This is because as we increase the expenditure on food in absolute terms the nutrition status of a person is expected to rise. But on the other hand, as the proportion of food expenditure with total expenditure falls, the household is expected to be better off as per the Engel's Law. The average propensity to consume food items for the poorest families is usually close to 1 and this ratio falls as the household becomes economically better off. This implies that the nutrition status should improve with fall in the ratio of food expenditure to total expenditure. Hence the effect on the log of BMI cannot be predicted a priori.

Dietary Diversity

This variable is estimated by finding the proportion of expenditure on various food groups (f_i^h) with total food expenditure (f^h), taking a square of each of these terms and adding them up. For the hth household and with i= 1,2,…n food commodities it is defined as:.

$$DD^h = \sum_{i=1}^{n} \left(\frac{f_i^h}{f^h} \right)^2$$

The value of the above expression lies between 0 and 1. The lower the value of this index, the higher is the diversity of food items consumed by the household. One would expect women to have a higher average BMI if they consume more diversified diet and hence dietary diversity index as defined above (lower value, higher dietary diversity) is expected to have a negative relationship with BMI. However, high levels of BMI leading to overweight and obesity is also due to inappropriate diet and one can expect this coefficient to be smaller in magnitude for the uppermost quantile of BMI in the quantile regression model compared to other quantiles. Given that not many women are overweight and obese and also this is a household indicator of dietary diversity and not individual's dietary diversity there can be some variations in this expected significance and magnitude of the estimated coefficient compared to what has been hypothesized.

Other Social Infrastructure Variables

This consists of dummy variables like access to LPG cooking fuel, regular piped drinking water, sanitation facility at home and electricity. These variables signify some very basic needs of civilized social life and have a direct impact on the individual's health status by preventing frequent illnesses. Access to regular piped drinking water shows that women are less receptive to diseases. Also it implies that she does not have to travel long distance in search of water everyday. Similarly having proper sanitation facility at home is more hygienic and reduces the chances of falling ill. Use of unclean fuel exposes a woman to harmful smoke which is not good for her health avoiding respiratory diseases. Access to electricity is another basic amenity for households thatcan increases access to electrical gadgets that would reduce her household drudgery. It has reached the majority of towns and villages in India but its absence signifies severe incompetency for a household. Also all these variables reflect the well being and awareness of a family indirectly. Government also plays a major role in providing these facilities to the people and

hence these variables also show regional effectiveness of some public programs.

Socio-Demographic and Regional Variables

Religion

There are four religion dummy variables – Hindu, Muslim, Christian and Other Religions, out of these 'Hindu' is taken as the reference category. This variable is included to capture another aspect of dietary diversity that is the consumption of plant based food in comparison to animal based food products. The dietary diversity variable does not capture this feature adequately. Though there is information in the data on consumption of different food items but many of them are in aggregated groups like meat, egg, chicken and fish are all grouped into a single category. This makes conversion of food items into its nutrient content difficult and also due to this aggregation a large number of households report the consumption in value terms. Majority of Hindus are vegetarians while a majority of Muslim and Christian population in India consume non-vegetarian food items. Animal based protein intake is known to have a better impact on nutritional status and therefore, one could expect better nutrition status among Muslim and Christian women than their Hindu counterparts. Of course, the frequency and adequacy of diets is also important to consider but one would expect lower frequency and per capita consumption to be correlated with economic status of the household capturing affordability and also the prosperity of a region which would improve regular accessibility. Since economic status is already controlled for using several other variables and also regional (state) dummy variables are used which would in a very broad sense control for accessibility we expect these coefficients to be a net effect of all that. However, if such dietary habits are not latently captured by the religion dummy variable one can expect the coefficients to be not significantly different from each other.

Table 2 below shows that mean and standard deviation of BMI does not vary substantially across the groups though Hindus have the lowest mean value followed by Muslims and then Christians while other religions have an intermediate value between Christians and Muslims. Since these are pure effects not controlling for social status one can expect such a pattern of variation across religious groups.

Table 2: Mean and Standard Deviation of BMI (kg/m^2) Across Religious Groups

Religious Group	Mean	Standard Deviation
Hindu	21.0	3.62
Muslim	21.6	3.77
Christian	22.6	3.77
Other religions	21.8	3.99

Source: Own calculations.

Caste

Indian society has been divided into various castes (*varna* system of the Hindus) on the basis of their occupation since ancient times. Relegation of menial jobs to some social groups with limited or no access to productive resources and subsequently persistent discrimination in several other domains of social and economic status, has created high socio-economic disparity among these different groups in the Indian society. Due to this disparity and repression by the so called 'upper caste' people on the so called 'lower caste' has resulted in not so good state of well-being including health. This could reflect in their low BMI and high percentage of people suffering from CED.

Table 3 shows that the mean BMI of Brahmin women is 22.4 while women belonging to Scheduled Tribe have a mean BMI of 20.4. Percentage of women belonging to Brahmin caste with BMI less than 18.5 is 14.8 percent. On the other hand, percentage of women belonging to Scheduled tribe with BMI less than 18.5 is 28.8 percent.

Table 3: Mean and Standard Deviation of BMI (kg/m^2) Across Caste Groups

Caste Groups	Mean	Standard Deviation
Brahmins	22.4	4.02
Other Backward Castes (OBC)	21.1	3.60
Scheduled Caste (SC)	20.4	3.33
Scheduled Tribe (ST)	20.0	2.89
Others	22.0	3.95

Source: Own calculations.

Household Composition Variables

This relates to the proportion of people in the following age groups in a household:

- 0 to 4 years of age (nf1)
- 5 to 14 years of age (nf2)
- 15 to 60 years of age (nf3)
- above 60 years of age (nf4)

Since these proportions add up to one, the first proportion is excluded and is taken as equivalent to the reference category as would be in the case of categorical variables. If a household has more proportion of people in the first category i.e. 0 to 4 years of age group, then it requires the women to make a significant effort in taking care of the children. This consumes considerable energy and hence her BMI is expected to be comparatively less. Also it implies that her BMI is negatively affected by the frequent pregnancies. This consequently leads to other kinds of deficiencies such as iron deficiency causing anemia. Hence the three variables are expected to have a positive sign. A woman who belongs to household which has high proportion of people in the 3rd category, i.e. the adult category, her BMI is expected to be relatively better than women belonging to households in other three categories. It is however important to control for household size while the effect of household composition is analysed as a four member household can have

three adults and one child or two adults and one child which could make a difference to the women's BMI status. Thus, household size is also included in the model but we expect it to be insignificant for most quantiles.

Alongside this regional variables like rural/urban residence and state in which currently residing are also controlled for as categorical variables.

Individual Variables

Age

Since BMI captures change of nutritional status in short run, age can have a negative or a positive impact on BMI of women. It shows the change of BMI with time. It can have negative impact on BMI since younger generations are supposed to be enjoying the benefits of economic and infrastructural changes over time. It can also turn out to be positive showing that older women tend to improve their BMI. Younger women would tend to have lower BMI as reproductive and child caring phases would have an adverse impact on their body weight alongside other household chores and drudgeries that many women may have to face. One can also expect the coefficient to be insignificant if explanatory variables capturing these aspects are factored into the model adequately.

Education Levels

This is a categorical variable represented by five groups: not literate, or have finished primary, or secondary, or higher secondary or college level education. The reference category in the model is chosen as 'illiterate' and the mean BMI is expected to improve with education (controlling for other factors) since an educated women is more likely to be conscious about her health and well-being. She is more likely to diversify her diet to get better nutrition and does not support frequent pregnancies. Table 4 presents the mean and standard deviation of BMI of women for different

education levels which rises consistently with rise in each category of education level.

Table 4: Mean and Standard Deviation of BMI (kg/m^2) across Education Levels

Completed Education Levels	Mean	Standard Deviation
Illiterate	20.4	3.26
Primary	21.4	3.71
Secondary	22.1	3.86
Higher Secondary	22.3	4.07
Graduation	23.5	4.14

Source: Own calculations.

Women's Occupation Status

There are five dummies referring to the occupation of women:

(i) Only as self employed in agriculture comprising of farm workers and animal rearing
(ii) Self employed in agriculture and sometimes engaged as agricultural wage labor
(iii) Only as Agricultural wage labor
(iv) Non-agricultural labor
(v) Salaried worker or Business women
(vi) Not actively engaged in an economic activity in the labour market.

The reference category chosen in the econometric model is the last one, consisting of women who do not actively participate in the labour market and are involved in domestic work. The sign of the coefficients of the categorical variables may be ambiguous and cannot be predicted *a priori*. It can however be expected that women who are involved in household chores alone are likely to have lesser physical activity when compared to those who are involved in agricultural work or non-agricultural labour work. Women working as agricultural laborers or as self-employed in agriculture spend a lot of energy in doing the hard

manual work on the farm and receive meager wages which are spent on the necessities of the household. In fact, we expect women in category (ii) above to have the least BMI followed by that in (i) and then (iii) and (iv) could have near similar magnitudes. However, working women are expected to be better empowered and having access to cash income would find better quality diet more affordable which would be the case predominantly for women in 'other' work. Further women involved in other work could also have lesser physical activity. So compared to the reference category either the coefficient for this group could be insignificant and more so in quantile regssion model for the lower quantiles.

Women who do not work or who do 'other work' have the highest mean BMI i.e.22 and women who work as agricultural wage labor have the lowest mean BMI i.e. 19.6 as shown in Table 5. Percentage of women suffering from chronic energy deficiency is highest in the agricultural wage labor category while women who stay at home have the lowest percentage of CED.

Table 5: Mean and Standard Deviation of BMI (kg/m^2) Across Work Status

Work Status	Mean	Standard Deviation
Self employed in agriculture alone (seag)	20.5	3.28
Self employed in agriculture and agricultural wage labor (seaglab)	19.6	2.69
Agricultural wage labor (aglab)	20.2	3.03
Non-agricultural wage labour (naglab)	20.6	3.24
Other Work includes Salaried and Business (othwk)	22.1	4.07
Not participating in the labour market	22.0	3.90

Note: Work Status refers to the type of work carried out by the women in the labour market.
Source: Own calculations.

Women's Short term Morbidity Status

We use short term morbidity status captured by the number of days ill with fever etc. prior to the survey in the last month so that we expect that this could have resulted in loss of body weight and hence a lower average BMI even after controlling for other variables.

Women's Pregnancy Status

Similarly a pregnant woman is expected to have a somewhat higher average BMI compared to others and has also been used as control variable.

Women's Autonomy Index

This index captures the autonomy enjoyed by a woman within the household. It is created by considering various aspects of empowerment like if she has a bank account in her name, cash in hand and if she is consulted at the time of making important short term expenditures like, child sickness or large expenditures like child marriage. Other variables reflecting her freedom of thoughts and actions such as permission to visit a friend, health centre and *kirana* shop is also taken into account while estimating this index using principle component analysis with the first principal component being taken as the index. This index is further classified into five quintiles to create the categories with increasing levels of autonomy. The bottom quintile corresponds to the least autonomy level so that higher level indicates higher autonomy in decision making etc. The first quintile of the autonomy index is taken as the reference category in the regression models.

A woman who is better empowered is less dependent on others in making her decisions and hence has more freedom and access to resources to take care of her health. Given this, coefficients of the higher quintiles of autonomy index are expected to have a positive sign. Table 6 shows that mean BMI increases marginally from the first level to the second level but there is very little variation after that even though the magnitude increases. The standard deviation also does not show the kind

of increases that was noticed for some of the other categorical variables but does increase in magnitude with the level of autonomy. We expect the autonomy to be correlated with socio-economic status and also with the education levels. So after controlling for these variables it could also be so that this coefficient is insignificant by and large across quantiles of BMI in the quantile regression model but as can be observed from the values of standard deviation, there could be substantial variation in women's status even among the richer sections of the population as well as among the educated given that socio-culturally decision making for the household is largely by the adult male members of the household.

Table 6: Mean and Standard Deviation of BMI (kg/m^2) Across Levels of 'Autonomy'

'Autonomy' Level	Mean	Standard Deviation
Autonomy_1	20.9	3.51
Autonomy_2	21.3	3.75
Autonomy_3	21.2	3.78
Autonomy_4	21.7	3.68
Autonomy_5	21.6	3.96

Note: 'Autonomy' refers to the choice and freedom in decision making for the family as well as for self by the woman. This is an index and the five levels are the five quintiles of this index capturing higher 'autonomy' for a higher number.
Source: Own calculation.

Table 7 below summarizes the explanatory variables along with the abbreviations used in the tables where results are presented.

Table 7: Summary of the Explanatory Variables.

Variable Name	Type	Description
Economic Variables		
lnCOPC	Continuous	Log of monthly consumption expenditure by household
lnPCI	Continuous	log of monthly per capita income
Poor, mid-wealth, rich and richest	Categorical	5 quintiles of wealth index created through principle component analysis; poorest quintile is taken as reference category
Dietary Variables		
fdexp_sh	Continuous	Proportion of food expenditure in total household expenditure
Dietdiv	Continuous	Dietary diversity index
Social Infrastructure Variables		
Ckfuel	Categorical	Access to proper LPG facility for cooking
wtr_grp1, wtr_grp2	Categorical	Dummy for access to regular piped water inside (wtr_grp1), outside but consumes less time (wtr_grp2). Base category is time taken to fetch water is more than 20 minutes
Qwtr	Categorical	Whether water is purified or not (reference group)
Vwtr	Categorical	
san_grp2, san_grp3, San_grp4	Categorical	Dummy for sanitation whether it is a flush toilet (san_grp4), pit latrine (san_grp3), traditional toilets (san_grp2), reference category is taken as 'no facility' or open defecation
own_elec	Categorical	Access to electricity or not

Table 7 *(contd...)*

Socio-Demographic and Regional Variables		
Muslim, Christian, Others	Categorical	Dummies for religious groups: Muslims, Christians and Others with Hindus as the reference category.
UCH, OBC, SC, Oth Caste	Categorical	Dummies for caste groups: upper caste Hindus (UCH), Other backward Caste (OBC), Scheduled Castes (SC) and Other Castes (Oth Caste) with Scheduled Tribes (ST) as the reference.
nf2, nf3, nf4	Continuous	Dummies for composition of family according to age as mentioned above, nf1 is taken as base category)
npersons	Continuous	Number of persons in family
urban	Categorical	Belonging to urban area with rural as the reference category
Individual Variables		
Age	Continuous	Age of woman
ed_prim, ed_sec, ed_hsc, ed_grad	Categorical	Completed level of education: primary, secondary, higher secondary and graduation and above, not literate is the base category
seag, seaglab, aglab, naglab, othrwrk	Categorical	Farm work (seag), farm work and agricultural wage labour (seaglab), agricultural wage labor (aglab), non-agricultural wage labor (naglab), salaried work and business (othwrk), not in the labour market is the reference group.
preg	Categorical	Dummy for pregnant woman, non-pregnant woman is reference category
sm2	Continuous	Number of days sick capturing the effect of short term morbidity
Women Empowerment Variables		
autonomy_2, autonomy_3, autonomy_4, autonomy_5	Categorical	Quantiles of women autonomy index estimated through principle component analysis; first category is taken as the reference category.

RESULTS: QUANTILE REGRESSION ESTIMATES

The estimates of quantile regression as well as OLS regression are given in Table 8 with the explanatory variables described in the Table 7 above. OLS regression estimates show that almost all variables in the five categories- Individual, household, dietary, social infrastructure and women empowerment are significant in determining women's BMI. All the variables representing the economic status of the household i.e. log of monthly consumption expenditure, log of per capita income and all the wealth quintiles are significant in the OLS estimates. The quantile estimates are also similar; except the lower wealth quintiles estimates are not different from each other in explaining the variation in*lnbmi* across the quantiles. We observe that for very large wealth effects we notice a significant increase in the impact on the estimated coefficients.

As mentioned earlier, we incorporate two different aspects of food consumption variables in the analysis. Food expenditure share coefficients are all significant and positive indicating a quality effect though from Engel's Law we could observe that the estimated coefficient could also be negative as households with better incomes could have lower expenditure share on food and hence an inverse relationship. After controlling for food expenditure share (and other socio-economic variables) we observe that the coefficient on dietary diversity index is negative and significant and this is an expected result. Smaller values of the index indicate larger diversity in food basket and related to higher values of *lnbmi* and hence the inverse relationship. The estimated coefficient has lower magnitudes for the bottommost (0.1) and topmost (0.9) quintiles compared to the middle ones clearly signifying that the diets are not that diversified for both the under and over nourished.

Social infrastructure variables like access to LPG fuel, electricity and good quality sanitation (toilet) facility at home also show a significant positive impact on BMI of women. Access to regular piped water does

influence women's health significantly if it is available inside the house or if she does not consume much time to fetch water. Access to cleaner cooking fuels (like LPG or kerosene) in terms of reducing the indoor air pollution also seems to be an important factor in determining the BMI of women. But it is important to note that this is not the case for lower quantiles and one observes the effect only after the 50^{th} percentile. This could be because women with BMI values in lower quantiles are perhaps in households where most households use primarily firewood or other less clean cooking fuel so that there is not much variation in the values and income or the wealth variable is perhaps capturing the effect. However, women who use more polluting cooking fuels among those in the upper quantiles of BMI are definitely disadvantaged compared to their counterparts even though economically they may be well off to afford a better cooking fuel but perhaps regular access to it may be an issue. Households without proper sanitation facility are at higher risk of suffering from communicable diseases. This reduces the resistance of women further and leads to negative impact on her health. The quantile estimates show clearly that all other types of toilet facility are significantly better off than no facility (mainly open defecation). The results once again highlight that,such women in upper *lnbmi* qunatiles are more disadvantaged compared to their counterparts even though their average BMI is higher than those in the lower *lnbmi* quantiles. There is a significant improvement in moving from no facility to a traditional to a flush toilet in the lower quantiles and this is an important result to take note of.

Electricity is one basic infrastructural facility provided by the government. Access to electricity has a significant positive impact on the BMI of women in the upper quantiles and is not significant in either the OLS model or for the bottom quantile. This could be because electricity has an amenity value as access to regular and clean source of lighting and possibility of using cooking and cleaning related gadgets reduces the drudgery of household chores among those who can afford such

appliances. Hence among women in upper quantiles the disadvantaged are those who do not have access to electricity.

Women belonging to Muslim, Christian and Other religions have significantly higher BMI than Hindu women. As explained earlier the dietary habits of the different religious groups vary and we expect that to be reflected in variation in average *lnbmi.* Even though some aspect of dietary diversity was included but aspects of the quality of diets in terms of vegetarian versus non-vegetarian food habits may not have been reflected in them. Caste structure in India originated amongst the Hindus and has since got widely entrenched in a rigid socio-economic hierarchy yet we observe that even after controlling for several socio-economic and regional variables the socially disadvantaged women from scheduled tribes and scheduled castes are worse off. More importantly, Brahmins in most part of India are predominantly vegetarian and yet we observe that after religious affiliation is controlled for, women in such households benefit substantially with the exception of the lowest (0.1) quantile where caste is not salient similar to religion. However, the increase in average *lnbmi* is also substantial for the topmost quantile (0.9) which would also signify overweight and obesity given that the average *lnbmi* is higher as noted from the intercept value for this group.

Number of persons in a household as well as household composition dummies are significant. Household size impacts more in the middle quantiles while in the lowest and topmost there is no impact observed. Household composition coefficients show that women with younger children (0-4 year old) at home spend considerable energy in taking care of them which affects their BMI adversely. This is observed all through the quantiles but equally important to observe that even after controlling for household size women in lowest *lnbmi* quantile (0.1) are disadvantaged even with somewhat older children (5-14 years). Age has a significant impact on the BMI of women in OLS regression as well as the quantile regression. This shows that older women have better BMI

than younger women and this is true for women belonging to all the quantiles but once again the possibility of older women with substantial BMI is also a matter of concern.

The education dummies except for higher secondary level of education are positive and significant for the OLS estimates but many of these coefficients are not significant across the quantiles. However, wherever they are significant women with a higher level of education has better average but with very small changes in the estimated coefficients. The women's occupation dummy coefficients are all negative and significant indicating that women who are engaged in household activities alone have higher average *lnbmi*than women who are involved in labour market activities as well. The reason behind this is that most women are likely to be engaged in manual work related to agriculture or non-agriculture activities and along side drudgery of household activities with limited amenities results in using a lot of physical energy but with limited ways to balance it with adequate dietary intakes and health inputs. Women working in the formal and organized service sector form a very small part and given their lifestyle the regular salaried or business occupation dummy is insignificant in the 75^{th} and 90^{th} quantile so that they are no different from the reference group. However, for the lower quantiles we find that even these women have a lower average *lnbmi* after controlling for various other factors.

Short-term morbidity captured by number of days ill (with average being about three) is negative and significant for all quantiles and with very similar magnitude. We would have expected this coefficient to be insignificant in the upper quantile as women are healthier and hence their chance of loosing weight during short illnesses would be lesser. Similarly, pregnant women would have a higher BMI but that the magnitude of the coefficients does not vary much across quantiles is somewhat unexpected.

The autonomy index captures aspects of women's empowerment where they have larger freedom and are able to involve themselves in decision making about some important things such as going to the hospital when ill, spending on her diet etc. The women's empowerment index does not show the expected results in that only higher levels of autonomy index are significant. Women living in urban areas have significantly better BMI than women living in rural areas throughout the distribution of BMI. The state dummy coefficients are also significant and the results are not reported here. Despite controlling for several socio-economic variables that could explain variations in *lnbmi* of women the state of residence still explains a lot of variation.

CONCLUSION

In this study the factors affecting the BMI of women in India have been analyzed focusing on three different types of economic variables and other socio-demographic variables including women's empowerment index. BMI captures both undernutrition and over nutrition and a quantile regression estimates from this study highlights the variation in impacts of different explanatory variables across the distribution of BMI. For instance, the coefficients of dietary diversity, women's work status and water quality have clear variation in impact across the quantiles. Women's autonomy index has an impact only for higher levels indicating that after other variables are controlled for only a fairly high level of autonomy makes an impact and there is some variation in the impact across the quantiles.

Table 8: OLS and Quantile Regression Estimates with lnBMI as the Dependent Variable

Variable	OLS		Quantiles									
			0.1		0.25		0.5		0.75		0.9	
	coefft.	***p-value***	**coefft.**	***p-value***	**coefft.**	***p-value***	**coefft.**	***p-value***	**coefft.**	***p-value***	**coefft.**	***p-value***
lnCOPC	0.021***	*0.000*	0.010***	*0.010*	0.015***	*0.000*	0.018***	*0.000*	0.020***	*0.000*	0.019***	*0.000*
lnPCI	0.005**	*0.012*	0.006***	*0.002*	0.009***	*0.000*	0.006***	*0.000*	0.007***	*0.000*	0.005**	*0.026*
poor	0.008**	*0.028*	0.002	*0.624*	0.002	*0.707*	0.008**	*0.026*	0.004	*0.298*	-0.010**	*0.036*
midwlt	0.010*	*0.060*	0.002	*0.627*	0.002	*0.730*	0.008**	*0.029*	0.005	*0.224*	0.006	*0.264*
rich	0.025***	*0.000*	0.017***	*0.003*	0.018***	*0.000*	0.025***	*0.000*	0.024***	*0.000*	0.025***	*0.000*
richst	0.045***	*0.000*	0.039***	*0.000*	0.039***	*0.000*	0.049***	*0.000*	0.047***	*0.000*	0.046***	*0.000*
fdexp_sh	0.041***	*0.001*	0.028**	*0.024*	0.033***	*0.003*	0.021**	*0.021*	0.023**	*0.033*	0.009	*0.492*
dietdiv	-0.046**	*0.048*	-0.038**	*0.045*	-0.052***	*0.002*	-0.044***	*0.001*	-0.033**	*0.050*	-0.038*	*0.065*
qwtr	0.014***	*0.000*	0.018***	*0.000*	0.018***	*0.000*	0.012***	*0.000*	0.006*	*0.076*	0.001	*0.735*
vwtr	0.009**	*0.015*	0.003	*0.515*	0.006	*0.150*	0.007**	*0.020*	0.004	*0.258*	0.001	*0.798*
wtr_grp1	0.007**	*0.024*	0.003	*0.403*	0.006*	*0.065*	0.006**	*0.018*	0.010***	*0.002*	0.011***	*0.006*
wtr_grp2	0.008**	*0.039*	0.008*	*0.061*	0.007*	*0.059*	0.002	*0.482*	0.003	*0.458*	0.005	*0.229*
ckfuel	0.011***	*0.003*	0.006	*0.113*	0.004	*0.274*	0.005*	*0.066*	0.006*	*0.082*	0.012***	*0.003*
san_grp2	0.028***	*0.000*	0.023***	*0.000*	0.028***	*0.000*	0.034***	*0.000*	0.035***	*0.000*	0.040***	*0.000*
san_grp3	0.019***	*0.000*	0.013**	*0.041*	0.026***	*0.000*	0.024***	*0.000*	0.021***	*0.000*	0.021***	*0.001*
san_grp4	0.031***	*0.000*	0.028***	*0.000*	0.030***	*0.000*	0.028***	*0.000*	0.030***	*0.000*	0.028***	*0.000*
own_elect	0.004	*0.300*	0.004	*0.357*	0.010***	*0.012*	0.007**	*0.022*	0.014***	*0.000*	0.015***	*0.001*
Muslim	0.009***	*0.020*	-0.003	*0.486*	0.006	*0.153*	0.018***	*0.000*	0.024***	*0.000*	0.027***	*0.000*
Christian	0.014*	*0.075*	0.007	*0.490*	0.010	*0.274*	0.016**	*0.019*	0.009	*0.295*	0.019*	*0.053*
Oth relg	0.016***	*0.005*	0.014*	*0.068*	0.007	*0.316*	0.012**	*0.035*	0.011*	*0.103*	0.019**	*0.020*
Brahmin	0.026***	*0.000*	0.008	*0.321*	0.015**	*0.048*	0.020***	*0.001*	0.026***	*0.000*	0.045***	*0.000*
OBC	0.014***	*0.007*	0.005	*0.376*	0.005	*0.349*	0.009**	*0.033*	0.010*	*0.065*	0.013**	*0.037*
SC	-0.005	*0.378*	-0.010	*0.131*	-0.008	*0.160*	0.0004	*0.929*	0.002	*0.771*	0.004	*0.497*
Oth Caste	0.018***	*0.001*	0.011*	*0.100*	0.008	*0.153*	0.011**	*0.017*	0.019***	*0.001*	0.022***	*0.001*

Table 8 (*contd…*)

Variable	OLS		Quantiles									
			0.1		0.25		0.5		0.75		0.9	
	coefft.	***p-value***	**coefft.**	***p-value***	**coefft.**	***p-value***	**coefft.**	***p-value***	**coefft.**	***p-value***	**coefft.**	***p-value***
nf2	0.026***	*0.010*	0.008	*0.529*	0.020*	*0.066*	0.036***	*0.000*	0.046***	*0.000*	0.031**	*0.018*
nf3	0.038***	*0.001*	0.021*	*0.099*	0.029**	*0.011*	0.050***	*0.000*	0.048***	*0.000*	0.032**	*0.020*
nf4	0.053***	*0.001*	0.027	*0.138*	0.040**	*0.015*	0.062***	*0.000*	0.065***	*0.000*	0.060***	*0.003*
Npersons	0.001*	*0.070*	0.001	*0.209*	0.001***	*0.007*	0.002***	*0.000*	0.001**	*0.025*	0.0004	*0.569*
Age	0.004***	*0.000*	0.002***	*0.000*	0.003***	*0.000*	0.003***	*0.000*	0.004***	*0.000*	0.005***	*0.000*
ed_prim	0.012***	*0.001*	0.001	*0.777*	0.006*	*0.081*	0.005*	*0.064*	0.005*	*0.084*	0.006*	*0.084*
ed_sec	0.012***	*0.007*	-0.004	*0.432*	0.001	*0.854*	0.005	*0.122*	0.007*	*0.094*	0.006	*0.282*
ed_hsc	0.006	*0.366*	-0.014**	*0.035*	-0.008	*0.171*	-0.004	*0.399*	0.001	*0.806*	0.003	*0.724*
ed_grad	0.021***	*0.001*	0.021***	*0.004*	0.010	*0.144*	0.008	*0.116*	0.011*	*0.087*	0.010	*0.201*
Seag	-0.028***	*0.000*	-0.012***	*0.002*	-0.013***	*0.000*	-0.019***	*0.000*	-0.015***	*0.000*	-0.025***	*0.000*
Seaglab	-0.036***	*0.000*	-0.015**	*0.017*	-0.023***	*0.000*	-0.033***	*0.000*	-0.035***	*0.000*	-0.052***	*0.000*
Aglab	-0.013**	*0.020*	-0.016**	*0.013*	-0.018***	*0.002*	-0.018***	*0.000*	-0.020***	*0.000*	-0.043***	*0.000*
Naglab	-0.025***	*0.000*	-0.008	*0.336*	-0.023***	*0.002*	-0.030***	*0.000*	-0.036***	*0.000*	-0.038***	*0.000*
Othwrk	-0.013**	*0.019*	-0.010*	*0.075*	-0.011**	*0.034*	-0.013***	*0.002*	-0.007	*0.153*	-0.008	*0.210*
sm2	-0.002***	*0.000*	-0.002***	*0.000*	-0.002***	*0.000*	-0.002***	*0.000*	-0.002***	*0.000*	-0.001**	*0.023*
Preg	0.044***	*0.000*	0.052***	*0.000*	0.049***	*0.000*	0.039***	*0.000*	0.041***	*0.000*	0.032***	*0.000*
autnmy_2	-0.002	*0.747*	-0.017*	*0.063*	-0.006	*0.479*	-0.001	*0.857*	0.001	*0.931*	0.003	*0.796*
autnmy_3	-0.006*	*0.072*	0.001	*0.844*	0.003	*0.352*	-0.00003	*0.992*	-0.001	*0.733*	-0.004	*0.380*
autnmy_4	0.005	*0.148*	0.018***	*0.000*	0.015***	*0.000*	0.013***	*0.000*	0.004	*0.260*	0.003	*0.455*
autnmy_5	0.0002	*0.978*	0.005	*0.295*	0.013***	*0.001*	0.017***	*0.000*	0.017***	*0.000*	0.015***	*0.001*
Urban	0.022***	*0.000*	0.006	*0.129*	0.008**	*0.023*	0.014***	*0.000*	0.030***	*0.000*	0.036***	*0.000*
Intercept	2.68***	*0.000*	2.63***	*0.000*	2.59***	*0.000*	2.66***	*0.000*	2.70***	*0.000*	2.84***	*0.000*

Note: * denotes significance at 10 percent level, ** denotes significance at 5 percent level and *** denotes significance at 1 percent level.

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