# Inquiry into the Simultaneous Existence of Malnutrition and Overweight in India*

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## Abstract

India is facing a double burden of overnutrition and undernutrition; hence, the combination of a high proportion of malnourished people and an increasing proportion of obesity needs further exploration. This paper focuses on the Body Mass Index of Indian women using National Family Health Survey to investigate the simultaneous existence of malnutrition, and overweight and obesity. Logistic regression analysis determines the probability of having underweight and overweight, respectively. The results show that malnutrition is particularly serious for rural, illiterate, low-caste women with low standard of living. Obesity is becoming a substantial problem for urban, well-educated, and high standard of living women. Quantile regression uncovers the varying impact of socioeconomic factors across different BMI quantile groups. The regional differences in specific BMI quantiles obtained through quantile regression is pivotal in terms of policy recommendation.

KEYWORDS: India, stunting, obesity, underweight, nutritional transition

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## 1 Introduction

Many developing countries face a double burden of overnutrition and undernutrition contrary to the general view that malnutrition is typical of these countries. Several researchers highlighted that malnutrition is highly prevalent in developing countries, despite increasing over weight proportions. Nutritional transition occurs due to large shifts in diet and physical activity patterns, particularly in the last one or two decades of the twentieth century (Popkin et al 2001, Popkin, 2003 and Griffiths and Bently 2001). These changes affect on average stature, weight and life expectancy as well as morbidity through nutrition-related non-communicable diseases.

Mendez et al study (2005) shows that India is one of the few exceptions- in their sample of 36 developing countries[2] - where malnutrition prevalence is higher compared to over weight problems. They emphasize that India exhibited a high persistence of undernutrition (21.3 percent of urban and 48.2 percent of rural women) compared to other developing countries where the range is 0.7-16.5 in urban areas and 0.6-21.5 percent in rural areas.

In recent years, there has been a remarkable increase of interest in the nutritional problems of women in developing countries along with India, where 790 million people from the developing world do not have enough to eat. India alone has 204 million people who are facing starvation (FAO, 1999). Contrastingly, the prevalence of overweight and obesity increases in many developing countries including India, a phenomenon that is

[2] 19 countries in sub-Saharan Africa, 18 in Latin America and the Caribbean (including Brazil and Mexico), 2 in East and South Asia (China and India), 3 in Central Asia (all former Soviet republics), and 4 in North Africa and the Middle East (including Egypt and Turkey)

gaining more attention. However, until now there is still a dearth of research regarding the simultaneous existence of both malnutrition and obesity in India.

With more than a quarter of the population below the poverty line, chronic poverty seems to be disproportionately high among historically marginalized groups such as scheduled castes (Untouchables in the past), scheduled tribes, the elderly, women and people with disabilities (Mehta and Shah, 2003). Different forms of disadvantages tend to be mutually reinforcing so that people in these groups stuck by one factor are likely to face others as well (De Hann and Lipton, 1998).

In contrast, diet-related diseases including obesity, diabetes mellitus, cardio vascular disease, hypertension, and stroke are increasing in India due to changes in dietary patterns and lifestyle (Anate et al., 1998). Rapid changes in diets and lifestyles resulting from industrialization, urbanization, economic development and globalization have a significant impact on the nutritional status of populations with nutritional transition (Griffiths and Bentley, 2001; Shetty, 2002).

India has not yet exhibited an increase in the prevalence of obesity among urban poor that is characteristically observed in Chile, Brazil, and Morocco. Albala et al. (2002) showed that the largest burden of obesity has been placed on the poor in Chile. In case of Brazilian women as noted by Monteiro et al., (2002) obesity has replaced undernutrition and the shift in obesity among poor is already occurring for Brazilian women (not yet men). In Morocco – as stated by Benjelloun (2002) - income is positively associated with obesity, whereas education is inversely related with obesity. However, much less is known about the double burden of Indian adults.

Most of the nutritional research in India has concentrated either on malnutrition or overweight. Due to this fact, very little has been done on the real emerging problem: a mixture of malnutrition and overweight. Moreover, most of the research is focused on certain vulnerable groups, states, and regions (for example Griffiths and Bentley, 2001; Shukla et al, 2002). Summing up, there is still dearth of research on the dangerous combination of an already existing high proportion of malnutrition among vulnerable groups, and an alarmingly increasing proportion of overweight and obese population among elite groups in India.

**2.0 Overview of food consumption in India**

Calorie consumption data from 1967-2002 for India shows an increase from 2041 calories to 2420 calories in India, though it is lower compared to other nutritional transition countries like China, Brazil, and developed country like USA (Table 1). Protein consumption stagnated in India over time, whereas fat consumption increased strongly – but it is far from other countries with nutritional transition.

The share of total dietary consumption from various food products in India indicates that carbohydrates still plays a major role (Figure 1) compared to many countries, though its share of total dietary energy declined slightly overtime. The share of energy from pulses - that form a major source of vegetable protein among Indians - declined considerably, whereas the share of energy from fats among Indians increased continuously from 1969-2002 (Figure 2).

**3.0 Hypotheses**

This study is based on three hypotheses that question the impact of regional, social, and economic factors on malnutrition, and overnutrition.

### 3.1 Hypothesis (1)

Urbanization seems to be an important factor for determining over weight and obesity (Griffiths and Bentley, 2001; Shetty, 2002). Popkin (1998) hypothesised that increase in urbanization leads to changes in diet regarding fat content of food, animal products, sugar, and polished grains, along with more sedentary life style, compared to the rural counter parts. Along with urbanization, another commonly discussed indictor that determines the nutritional status of individuals is the standard of living.

Research on the relation between fat consumption and income in Philippines (Bisgrove and Popkin, 1996), China ( Ma and Popkin, 1995), and India (Shetty, 2001) shows increase in fat consumption with income. In addition, Dewnowski and Popkin (1997) find a strong relation between income and fat consumption on the individual and household level.

Contrarily, simple scatterplots (Figure 3)[3] illustrate that there is no relation between urbanization and obesity in India, and there seems to be a positive relation between underweight and obesity. Based on literature (Popkin, 1998), being urban decides obesity of women, whereas simple scatter plots do not confirm this relation. This hypothesis whether being urban and rich leads to obesity or not is tested using the compound variable of standard of living and urban/rural place of residence, which is tested with individual data.

**Hypothesis (2)**

Stunting in childhood continues into adulthood, resulting in adults of short stature (Darnton-Hill & Coyne, 1998; Popkin et al., 1996; Scrimshaw, 1995) and increases the

[3] Data of aggregate figures of state wise obesity and malnutrition are taken from National Family Health Survey whereas Urbanization (percent of urban population) is taken from xxxx

risk of obesity and cardiovascular diseases. Ravelli et al., (1999) argue that undernutrition during early gestation was associated with higher BMI and higher waist circumference in 50 year-old women. A recent study by Florencio et al., (2001) in Alagoas, one of the poorest states in Brazil, found a strong coexistence of stunting and obesity. Of the stunted Alagoas individuals, 30% suffered from overweight/obesity.

In India, like other countries with epidemiological transition, previous research suggests that obesity is possibly occurring as an outcome of undernutrition in the early life. One can test this hypothesis on the aggregate level by plotting the prevalence of obesity by state domestic product to see whether obesity is more serious in poorly performing states of India that had food shortages in previous years. This hypothesis tests whether stunted people in India are more obese by using individual information.

Based on the scattergram of state development products (SDP) and nutritional status, (Figure 4 and 5[4]) we can see that higher levels of SDP are associated with a higher percentage of overweight and obese people, whereas underweight and SDP have a negative relation.

Another way of testing this hypothesis on an aggregated level is by observing the relation between the percentage of women that are below 145 cm[5] and prevalence of overweight in 16 major states of India (Figure 6)[6]. The scatterplot reveals a negative interrelation between short stature women and the proportion of overweight.

However, the empirical models could confirm or correct the impression obtained from analyzing simple scatterplots and hence provides a more precise picture.

[4] Aggregate data for nutrition is taken from National Family Health Survey-2 whereas SDP data are taken from xxxx

[5] Women below 145cm were taken as stunted women as per National Family Health Survey-2

[6] Aggregate level data for this figures are taken from National Family Health Survey-2

### 3.3 Hypothesis (3)

Binary logistic models and OLS regressions are commonly used analytical tool to measure the impact of various socio-economic variables on nutritional status. However, I argue that especially in countries with nutritional transition quantile regressions represent amore efficient way of uncovering the partial impact of socio-economic factors, as the analysis is not focused on the average observation as in OLS regressions – but incorporate more information regarding the distribution (quantiles) of BMI. This hypothesis tests whether quantile regression is the best way of understanding dual existence of malnutrition and undernutrition.

Accordingly, this hypothesis focuses on the use of the quantile regression technique to understand the double burden of malnutrition and overnutrition. Along with the above-discussed variables, this paper also tests for the significance of other socioeconomic variables (i.e. religion, caste, employment etc.) that are related to the dual burden of nutritional problems of India.

## 4.0 Data and methodology

### 4.1 National Family Health Survey-2

This paper focuses on examining the nutritional status of Indian women with anthropometric indicator BMI (Body Mass Index[7]) using the National Family Health Survey -2 (NFHS-2[8]). Nutritionists have found it convenient to analyze weight given height (BMI), which is a popular indicator, used for assessing the contemporaneous

[7] From now on Body Mass Index would be termed as BMI

[8] From now on NFHS-2 would be used to refer to National Family Health Survey-2

health of the adult population. The BMI can be used to assess both thinness and obesity, which is defined as the weight in kilograms divided by the height in meters squared (kg/m2).

In the NFHS-2 survey, this index excluded women who were pregnant at the time of the survey and also women who had given birth during the two months preceding the survey. The mean BMI for women in India is 20.3, varying within the narrow range of 19–23 for the different groups (International Institute for Population Sciences and ORC Macro, 2000). In India, more than one-third (36 percent) of women have a BMI below 18.5, indicating a high prevalence of nutritional deficiency.

The major part of the data is from the National Family Health Survey-2, which is a large-scale, multi-round survey conducted in a representative sample of households throughout India. The NFHS is a collaborative project of the International Institute for Population Sciences, India, ORC Macro, USA, and the East-West Center, USA. NFHS was funded by the United States Agency for International Development (USAID) with supplementary support from the United Nations Children's Fund (UNICEF) for the nutrition part.

The survey covers a representative sample of about 91,000 ever-married women age 15-49 from 26 states in India who were covered in two phases, the first starting in November 1998 and the second in March 1999. The survey provides state-level estimates of demographic and health parameters as well as data on various socioeconomic components.

Health investigators attached to interviewing teams were given additional specialized training on measuring height and weight in a centralized training programme

conducted by International Institute for Population Sciences (IIPS) in collaboration with the All India Institute of Medical Sciences (AIIMS), New Delhi. This specialized training included classroom training and extensive field practice in schools, *anganwadis*, and communities.

### 4.2 Variables in the multivariate analysis

This paper attempts to understand the characteristics of nutritional transition in India by taking into account media exposure, standard of living and place of residence, religion and ethnicity using binary logistic regression and quantile regression.

**Age and age square**

Using age as an explanatory variable we can understand the changing probability of malnourishment and obesity with age. Age Square focuses on the nonlinear relation between age and BMI.

**Region**

India is divided into North, South, East, West, Northeast, and Central based on its geographical and culture related factors. For policy implications differential impact of regions on health status can be extremely helpful.

**Place of residence and SLI compound variable**

A compound variable for place of residence and SLI[9] is constructed which has 6 categories and will test hypothesis (1). This compound variable allowed to test whether there are differences in the likelihood of being underweight/overweight between socioeconomic groups both within urban and rural areas. As many researchers emphasized and reemphasized the role of urbanization (Mendez; WHO; xxxx), this compound variable throws direct light on urban rural differences in the occurrence of underweight/overweight between different categories of SLI.

**Religion**

For logistic regression 6 categories (Hindu, Muslim, Christian, Jain, Sikh and others) of religion were used whereas for quantile regression only 5 categories were taken into consideration (Hindu, Muslim, Christian, Jain, and others).

**Ethnicity/Caste**

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[9] SLI summary measure is calculated by adding the following scores for each household:

- House type: 4 for pucca, 2 for semi-pucca, and 0 for kachha;
- Toilet facility: 4 for own flush, 2 for public or shared flush toilet or own pit toilet, 1 for shared or public pit toilet, 0 for no facility;
- Source of lighting: 2 for electricity, 1 for kerosene, gas, or oil, 0 for other source of lighting;
- Main fuel for cooking: 2 for electricity, liquid petroleum gas, or biogas, 1 for coal, charcoal, or kerosene, 0 for other fuel;
- Source of drinking water: 2 for pipe, hand pump, or well in residence/yard/plot, 1 for public tap, hand pump, or well, 0 for other water source;
- Separate room for cooking: 1 for yes, 0 for no;
- Ownership of house: 2 for yes, 0 for no;
- Ownership of agricultural land: 4 for 5.0 acres or more, 3 for 2.0-4.9 acres, 2 for less than 2.0 acres or acreage not known, 0 for no agricultural land;
- Ownership of irrigated land: 2 if household owns at least some irrigated land, 0 for no irrigated land;
- Ownership of live stock: 2 if owns live stock, 0 if does not own live stock;
- Ownership of durable goods: 4 each for a car or tractor, 3 each for a moped/scooter/motorcycle, telephone, refrigerator, or colour television, 2 each for a bicycle, electric fan, radio/transistor, sewing machine, black and white television, water pump, bullock cart, or thresher, 1 each for a mattress, pressure cooker, chair, cot/bed, table, or clock/watch.

Index score ranges from 0-14 for a low SLI to 15-24 for a medium SLI and 25-66 for a high SLI.

[9] Type of place of residence has rural and urban categories

This variable controls for caste differences in India. Women from the sample belong to scheduled caste (have low socio economic status along with discrimination), Scheduled Tribe (have low socio economic status like Scheduled Caste), Other Backward Castes (slightly lower in terms of social status), or higher castes. The typical characteristics of tribes are simplicity of technology, geographical isolation, distinct culture, shyness to contact with the rest of society and economic backwardness. Scheduled caste people used to suffer from untouchability practice and many of them still are small and marginal farmers, and rural labors.

**Exposure to mass media**

This variable can act as proxy for availability of leisure time and women's sedentary lifestyle to some extent. Women who read news paper regularly, who watch television regularly, who listens to radio, and who watch movies regularly belong to exposure to all components of mass media category. The other two categories are exposure to some components, and no exposure to mass media.

**Employment**

This variable comprises of women who do not work, who work without getting paid, who work for salary, and self-employed women. This will helps us in understanding impact of employment of women on their nutritional status.

**Education of women and their husbands**

This variable helps us to test whether education of woman and her husband has any significant impact on her nutritional status.

**Height**

Using height as an explanatory variable one can test hypothesis (3) using both logistic regression and quantile regression to see whether shorter people are more obese.

**Number of household members**

This variable can be used to understand not only intrahousehold allocation but also the impact of size of family on the nutritional status of women.

### 4.3 Data analyses

Bivariate and multivariate techniques are used in this study to explore the nutritional status of women of different socio-economic background. Chronic energy deficiency[10] (taken as an indicator of malnourishment) is usually indicated by a BMI of less than 18.5. As per the WHO BMI classification (World Health Organization, 1985) 6 groups have been identified. For Women, BMI less than 16 is classified as very thin, BMI 16-16.99 is classified as moderately thin, BMI 17-18.49 is classified as mildly thin, BMI 18.5-24.9 is classified as normal, BMI 25-29.9 is classified as overweight, and finally BMI above 29.9 is under the obese category. In this paper, this 6 fold classification was used only for few bivariate analyses. For bivariate analyses all women are considered whereas for binary logistic regression and QR only adults were considered. Moreover extreme cases of BMI and height were removed from the data.

#### 4.3.1 Binary Logistic regression

Binary logistic regression analysis is used to estimate the predicted probability of having nutritional problems. In this paper binary logistic regression is used to identify socioeconomic, regional, diet, and, demographic and health determinants of malnutrition

[10] From now on BMI less then 18.5, chronic energy deficiency and malnutrition terms are used as synonyms.

and overweight. In total, 35 percent of the sample was malnourished and 11 percent are either overweight or obese. Two separate regressions were run for malnourishment, and overweight and obesity. Binary logistic regression model for malnutrition takes women with BMI below 18.5 as malnourished whereas logistic regression model for overweight and obesity takes women with BMI above 25[11]. In both the models, malnourished and overweight women were compared to normal women.

**Models for malnutrition assessment**

Variables included in the model for assessing malnutrition were classified into four main categories: region, location and standard of living, demographic variables, social variables and economic variables.

**Model estimation for malnutrition**

$$\text{Malnutrition} = a_0 + a_1\,(\text{woman's age})_i + a_2\,(\text{square of woman's age})_i + a_3\,(\text{region})_i + a_4\,(\text{compound variable of standard of living and type of place of residence})_i + a_5\,(\text{religion})_i + a_6\,(\text{caste})_i + a_7\,(\text{employment})_i + a_8\,(\text{exposure to media})_i + a_9\,(\text{women's education})_i + a_{10}\,(\text{husband's education})_i + a_{11}\,(\text{stunting in childhood})_i + a_{12}\,(\text{number of household members})_i + u_{1i}\ (i=1,\ldots..,N)$$

**Model estimation for overweight and obesity**

$$\text{Overweight and obesity} = b_0 + b_1\,(\text{woman's age})_i + b_2\,(\text{square of woman's age})_i + b_3\,(\text{region})_i + b_4\,(\text{compound variable of standard of living and type of place of residence})_i + b_5\,(\text{religion})_i + b_6\,(\text{caste})_i + b_7$$

[11] BMI below 18.5 is classified as malnutrition and BMI above 25 is taken as overweight and obese category. Both the models have women with normal BMI as their reference category.

$(\text{employment})_i + b_8\ (\text{exposure to media})_i + b_9\ (\text{women's education})_i + b_{10}\ (\text{husband's education})_i + b_{11}\ (\text{migration})_i + b_{12}\ (\text{number of household members})_i + u_{1i}\ (i=1,\ldots..,N)$

### 4.3.2 Quantile regression

In the beginning logistic regression was done by taking categories of BMI. In this way we lose information relating to the distribution of BMI as we simply divide the whole data into 2 categories. However, we can not use OLS regression as it focuses on the mean of the distribution of BMI and this does not provide much information on other parts of distribution (Buchinsky, 1998; Koenker and Hallock, 2001). Especially in terms of policy interventions exclusive emphasis on mean may not provide accurate design. In specific, we can not use the policy issues for addressing problem of malnourishment that occurs at the lower tail of BMI by seeing OLS which focuses on the mean. To overcome this problem Quantile Regression is used (abbreviated as QR hereafter) to estimate the explanatory variables' effects on the BMI level over the whole distribution.

QR is an estimation method which allows regression line to pass through different quantiles of the distribution of the dependent variable. In this way QR gives more complete picture of relation between dependent variable and its covariates. QR is also efficient compared to logistic regression due to the fact that there is growing consensus about cutoff point of BMI for Indians. We can not decide health of people based on too high and too low BMI. Moreover, these cut-off values are referential rather than definitive and, malnutrition and obesity is more a matter of degree.

Chamukuttan et al (2003) argued that the cutoff value for healthy urban Indian is less than 23 $kg/m^2$ (which is lower compared to WHO cutoff value 25). Their definition

of cutoff value for normal BMI depends on identifying the risk association with diabetes which is strongly associated with BMI (Chamukuttan et al, 2003). Shetty (2002) also emphasized that BMI does not provide good indicator of body fat for any given BMI among Indians. Increasing BMI is associated with central adiposity and higher waist/hip ratios along with risk of non communicable diseases appearing at much lower BMI ($<25 kg/m^2$) than any other population groups. Both Shetty and Chamukuttan et al leads to the direction that the true problem of obesity using BMI <25 was not exaggerated. In this context where the cutoff value is uncertain, QR is a good estimation method.

Another advantage of QR is that it is robust as it fits a hyperplane through the observations on the dependent variable so that a certain proportion of observations are below the hyperplane, the remainder being above it. Unlike OLS, QR is robust to extreme observations. In case of DHS data BMI is not normally distributed (Figure 9) and this argument also supports use of QR method.

**5.0 Prevalence of malnutrition, and overweight and obesity**

NFHS-2 data shows that more than one third of women aged 15-49 have a BMI less than 18.5 kg/m2 and 25 percent of urban women are either overweight or obese. The mean BMI for women in India is 20.3 varying within the narrow range of 19–23 for the different groups as shown in table 2 and 3.

**5.1 Malnutrition**

The nutritional status is appalling for the women belonging to low standard of living where half of the women suffer from chronic energy deficiency. Little more than one-third of the women from medium standard of living households and nearly $1/5^{th}$ of

the women from high standard of living households suffer from malnutrition. Summing up, the overall prevalence of nutritional deficiency is high among Indian adult women.

Percentage of women having malnutrition problems decreases when one moves from age 20 to age 49. Chronic energy deficiency is also prevalent among the rural women (43 %) compared with the urban women (24 %) (Table 2 and 3). Nearly $2/5^{th}$ of Hindu women, $2/3^{rd}$ of Muslim women and $1/4^{th}$ of Christian women have a low BMI. Furthermore, malnutrition is prevalent among women from scheduled caste (44 %) and scheduled tribe (48 %) compared to women belonging to other backward castes (38 %) and higher castes (32 %).

Literacy and malnutrition seem to have a very strong negative relation. Malnutrition is substantially prevalent among illiterate women (44.6%) and this gradually decreases steadily with increasing education. The working status of women seems to play a very important role in deciding BMI where working women seem to be on the unfavorable side. Chronic energy deficiency is considerably prevalent among women who are currently working (44.3%) as compared to women who have not worked in the past twelve months (33.3%). Among working women, the prevalence of malnutrition is low for women that are self-employed (36.8 %) compared with women who are employed by someone else (44%).

The central region (Madhya Pradesh and Uttar Pradesh) has 38-40 percent of women with nutritional deficiency and the Eastern region has 42-46 percent of women with malnutrition problems. Among Northern states, Rajasthan has the highest number of women with chronic energy deficiency (38%). In Southern region, Andhra Pradesh and Karnataka have $2/5^{th}$ of women suffer from malnutrition. In addition, all the states

mentioned above have high prevalence of malnutrition compared with the average malnutrition prevalence of India.

The proportion of severely thin and moderately thin women is higher from rural and urban low standard of living households. East and Western India have the highest proportion of severely and moderately thin women (Table 5 and 6). In summary, nutritional problems are particularly serious for rural, illiterate, and working women that are not self-employed. Women from scheduled caste and scheduled tribes also seem to suffer from deprivation of food. This research strongly supports the view that the social structural factors in India predispose certain groups to long-term poverty, discrimination and deprivation. As expected, women who live in households with a low standard of living seem to suffer from malnutrition.

### 5.1.1 Determinants of Malnutrition

The results of the logistic regression model comparing underweight women with those of normal BMI are shown in Table 7. Odd ratios are given in the table with 95 % confidence intervals. Women from Western and Eastern regions have the highest odds of being malnourished where as women from the Northeast India have the lowest probabilities of being malnourished. Women from rural low standard of living have the highest odds of being malnourished. The demographic variable, age is also playing a significant role in determining the malnutrition and younger women have higher odds of being malnourished compared to the older women. The religion variable shows that the probability of being underweight is low among women belonging to Christian and Sikh women compared to Hindu women. Scheduled caste and scheduled tribes have high odds of being malnourished compared with the women belonging to higher castes.

Economic variables have a significant impact on determining malnutrition. Women who have paid jobs have higher odds of being malnourished compared with the women who are unemployed, unpaid employees, or self-employed. The probability of being malnourished is lowest for women who do not work. Media exposure variable does not play significant role in deciding malnutrition.

As expected, both education of woman and her husband decrease Indian woman's probability of malnourishment occurrence. Shorter women have lower odds of being malnourished compared to taller women.

### 5.2 Overweight and Obesity

#### 5.2.1 Overweight

Nearly 11 percent of Indian women according to the WHO classification belong to the overweight category. Nearly 1/4th of the women from high standard of living households (24.6%) belong to the overweight category compared to women with a low standard of living (3.5%) (Table 3, and 4). The age of women has a strong positive relation with overweight. Urban women have a relatively disadvantageous position in terms of overweight compared with rural women. Seven percent of rural women and 22 percent of urban women are overweight. The percentage of women belonging to the overweight category is higher among women from Sikh (26.2%) and Jain (28.8%) religions.

Higher caste (15%) and other backward caste (10.2%) women are more over-weight compared with scheduled caste (7.1%) and scheduled tribe women (4.5%). Literacy has a strong positive relation with overweight, and work status has a negative

relation with overweight. Literate and working women are more likely to fall into this overweight category compared with their complementary group. The proportion of women belonging to the overweight category is high among women belonging to Southern states, Western states, Northern states (except Rajasthan) and women belonging to the states of Sikkim and Manipur compared with the Indian average value.

### 5.2.2 Obesity

Southern states, Western states and Northern states (except Rajasthan) have more percentage of women belonging to Obesity category compared with the Indian average value. Obesity has strong positive relation with age of woman, her standard of living and her education. Elderly women, educated women and working women are more likely to become obese. Sikh and Jain women are more obese compared with women belonging to other religions.

In sum, overweight and obesity are becoming a substantial problem among several groups of women in India, particularly women living in urban areas, women who are well educated, and women from households with a high standard of living. Approximately one-quarter of women in each of these groups have a BMI of 25 or more and 6–7 percent have a BMI of 30 or more. In addition to being relatively tall, Sikh and Jain women are more likely than women in any other groups to be obese.

### 5.2.3 Determinants of overweight and obesity

The results of logistic regression for overweight and obesity are shown in Table 8. The outcome of the regression compares overweight and obese women with those of normal weight women. Results are presented as odds with 95% confidence. Women from

the South have the highest odds of being overweight and obese. Urban women with a high standard of living have the highest odds of being overweight and obese and urban women with middle standard of living follow them. Rural women with high standard of living took the third position confirming the conviction that being urban positively influences the probability of being overweight and obese. This confirms the popular conviction that urban areas play an important role in deciding nutritional status. The demographic variable, age, is also playing a significant role in determining individual BMI, where older women have the highest odds for being overweight and obese.

The probability of having overweight and obesity problems is high among Sikh women. Women from high castes tribes have the highest odds of being overweight and obese. Economic variables play a significant role in determining the problems of overweight and obesity. Women who are jobless and women who are self employed are more likely to be overweight and obese than women who are in unpaid jobs. Women from higher castes have the highest odds of being overweight and obese, and vice versa.

Women with media exposure seem to have higher odds of being obese and overweight. This confirms the view that women with more leisure time to watch television, to listen to the radio or to watch movies regularly have more odds of having problems of overweight and obesity due to their sedentary nature. Education of both woman and her husband increases her odds of being overweight and obese. Compared to stunted women, taller women have the higher probability of being overweight and obese. This confirms that the hypothesis of stunted people having more probability for being overweight can be rejected.

**6.0 Determinants of BMI using QR**

Using binary logistic regression, we are losing information relating to the distribution of BMI as we divide the sample into 2 categories. However, we can not use OLS regression as it focuses on the mean of the distribution of BMI and this does not provide much information on other parts of distribution (Buchinsky, 1998; Koenker and Hallock, 2001). To overcome this problem QR was used to estimate the explanatory variables' effects on the BMI level over the whole distribution Table 9 shows the results obtained from estimation of BMI using QR for q values of 0.1, 0.2, 0.4, 0.6, 0.8, and 0.9. Age increases BMI and age has the strongest impact in the highest q value (0.9). Regional differences cannot only be observed within one quantile but also over different quantiles of the distribution that is pivotal in the view of policy. Interestingly, one can see that BMI of North Eastern women is deceasing severely when we move to higher quartiles of the distribution whereas in the lower quartiles of the distribution they are performing better. Southern women have the highest BMI in the highest quantiles (q=0.8 and 0.9).

As expected, women from urban areas with high SLI have the highest BMI through out the distribution and their BMI increases steadily when we move from lowest to highest quantile. Rural women with low SLI have the lowest BMI compared to their urban counterparts. Rural women with medium SLI follow rural women with low SLI. QR analysis confirms that it is very important to be urban than to have high standard of living as urban women with both middle and high standard of living have higher BMI compared to the rural high standard of living women.

For all q values, Hindus have the lowest BMI and Sikhs have the highest BMI (except for $10^{th}$ percentile). Being a Muslim leaves with no impact on BMI for the $10^{th}$

percentile. The impact of ethnicity on BMI increases when we move to higher quintiles. Nevertheless, being scheduled caste and scheduled tribe lowers BMI in all parts of distribution.

BMI seem to increase with increasing quantile for women who do not work and BMI is higher in this group of women when q is 0.4, 0.6, .0.8, and 0.9. The BMI of self employed women decreased with increasing quantile and they have the lowest BMI in all parts of the distribution. Media exposure does not have any significant impact on BMI of lowest half of the distribution. The impact of mass media on BMI of women with no exposure to mass media decreases steadily from $20^{th}$ percentile to $90^{th}$ percentile. QR reconfirmed the results that were obtained from binary logistic regression that showed that women who watch TV, read news papers, listen to radio and watch movies regularly have higher odds of being obese compared to women with no mass media exposure.

Education of both woman and her husband increases woman's BMI and the impact of education on BMI increases steadily from lowest quantile to highest quintile of the distribution. Education of husband has the highest impact on BMI of woman when Q=0.9. QR shows that stunting of women does not lead to obesity in all quartiles of the distribution and the BMI of taller women increases with each quartile of the distribution compared to the stunted women. This results confirms the logistic regression analysis.

**7.0 Conclusion**

NFHS-2 data shows that more than one third of women aged 15-49 have chronic energy deficiency and 25 percent of urban women are either overweight or obese. The analyses presented in this paper provide evidence of increasing inequality and socioeconomic differences in nutritional status. Factors associated with under and

overweight are similar. Women from urban high standard of living and rural high standard of living, who are educated above high school, who are either not working or self employed, or who have exposure to media (television, cinema, news papers or radio) are more likely to be overweight or obese. These factors are significantly inversely related to likelihood of malnutrition.

The results of this study go with other studies in some developing countries where women from low standard of living suffer from malnutrition and women from high standard of living have overweight and obesity problems (Monterio et al., 2000; Martorell et al., 2000). Moreover, this study shows higher significance of standard of living. Age was also a significant factor where older women are more likely to be obese or overweight where as younger women are having the higher probability of being malnourished. These findings are consistent with the findings of other studies (Dhurandhar et al., 1992; Gopinath et al., 1994; Seidell, 1995; Laurier et al., 1992).

Sikh women have the highest probability of being overweight and obese. This might be related to lower participation in the workforce, which leads to a sedentary lifestyle and high consumption of fat. Even though standard of living is playing a dominant role for deciding nutritional status, rural and urban place of residence still play an important role. Urban women have higher probability of being overweight and obese compared to rural women in all standard of living categories. Moreover, women from urban low standard of living have higher odds of being overweight and obese compared with rural middle and rural low standard of living women. Urban area of living plays a significant role in deciding the obesity status of the population, which is a threat to India in the context where urban population is increasing dramatically (Diwaker and Qureshi,

1992). At the same time, rural poor are worse affected in terms of malnutrition and urban poor follow them.

This paper not only shows the relation between malnutrition and poverty levels of different states but also the relation between HDI (Human Development Index), and overweight and obesity. Policy makers should take into consideration also regional differences in malnutrition and obesity. It is very important to focus on different regions of India in different way based on the target group we aim. For instance QR estimation results show that different regions follow differently in different parts of the distribution.

Another point that needs attention is the hypothesis that population with higher rates of stunting and low birth weight will have an increased risk of obesity related chronic diseases in the adulthood (Darton and Coyne, 1998; Barker 1998; Byers and Marshall, 1995; Himes, 2000; Popkin etal., 1996 Scrimshaw, 1995). This study shows that taller women are prone to obesity problems and this might be due to the fact that they have the higher access to food. It might be possible that in the later phases of nutritional transition we can see shorter women being obese. If this will happen, for Indian policy makers this is going to be a huge challenge in the future as children who are stunted will become overweight in adult stage. Moreover, India will also have to face high levels of malnutrition related problems. Both malnutrition and overweight will decrease the health status of population which will have negative impact on the development of country.

Rural poor and urban poor women should get more information regarding healthy diet and different components of health whereas urban and rural rich women should get more information about improving their diet and exercise to prevent overweight and obesity. There is also a need for continued commitment from state and country level

Government officials to ensure food security for the poor. Moreover, food distribution programs should be efficient and the massive stocks of food grains in the godowns of Food Corporation of India should be utilized to alleviate starvation in the situation where starvation deaths among farmers are more than 2000 in the past one-year only in Andhra Pradesh, southern state of India. Policy makers and politicians should be dedicated and committed for reducing these hunger deaths. Mass media should play an important role in educating people to prevent deaths related to both malnutrition and obesity.

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**Figures**

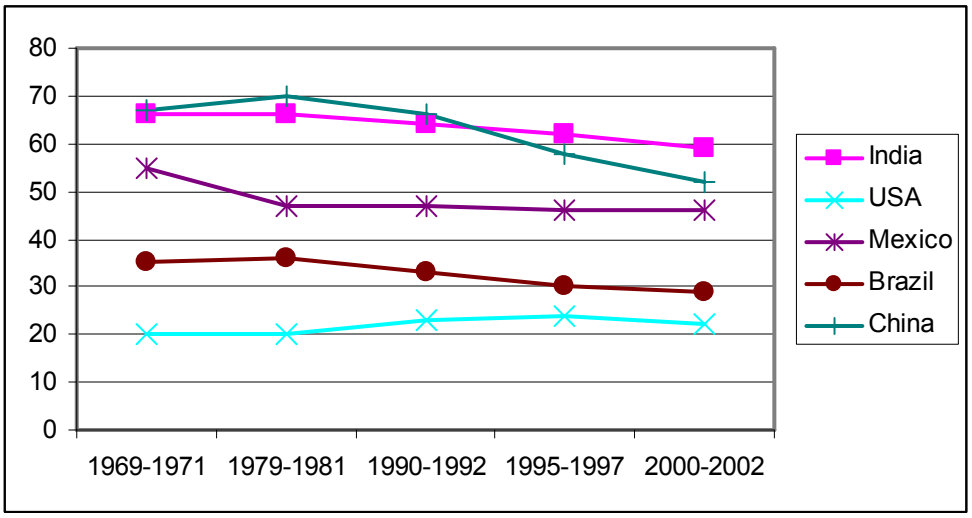


Figure 1: Share of total dietary energy consumption from Cereal and related products (FAOSTAT)

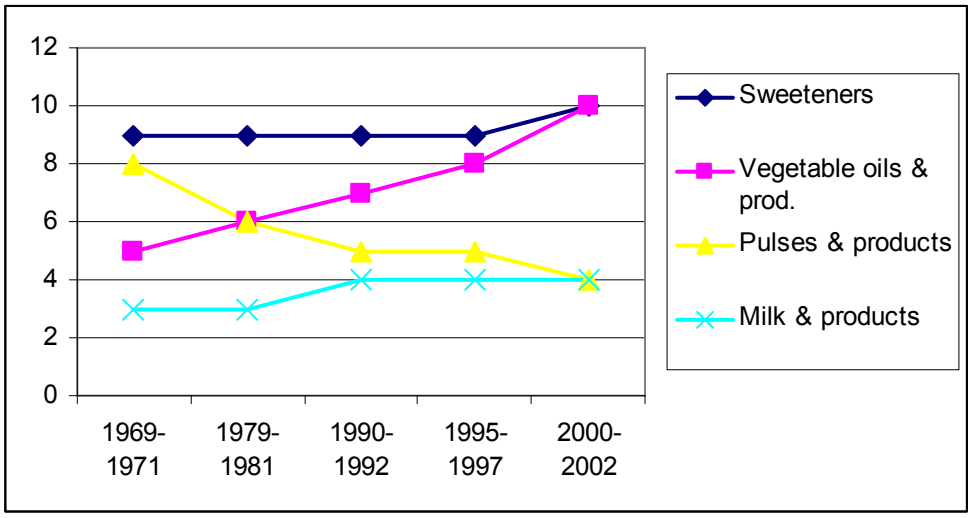


Figure 2: Share of various food items in total dietary energy consumption in India (FAOSTAT)

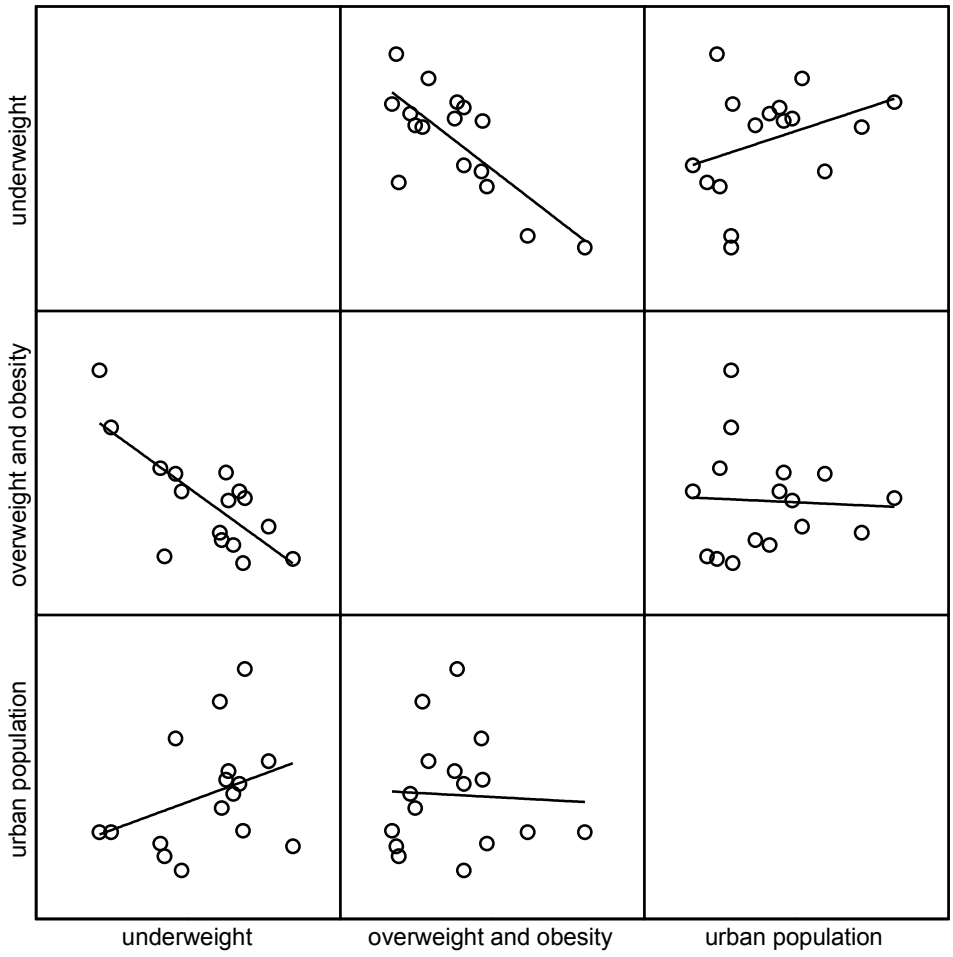


Figure 3: Scatterplots show the relation between urbanization and nutritional status.

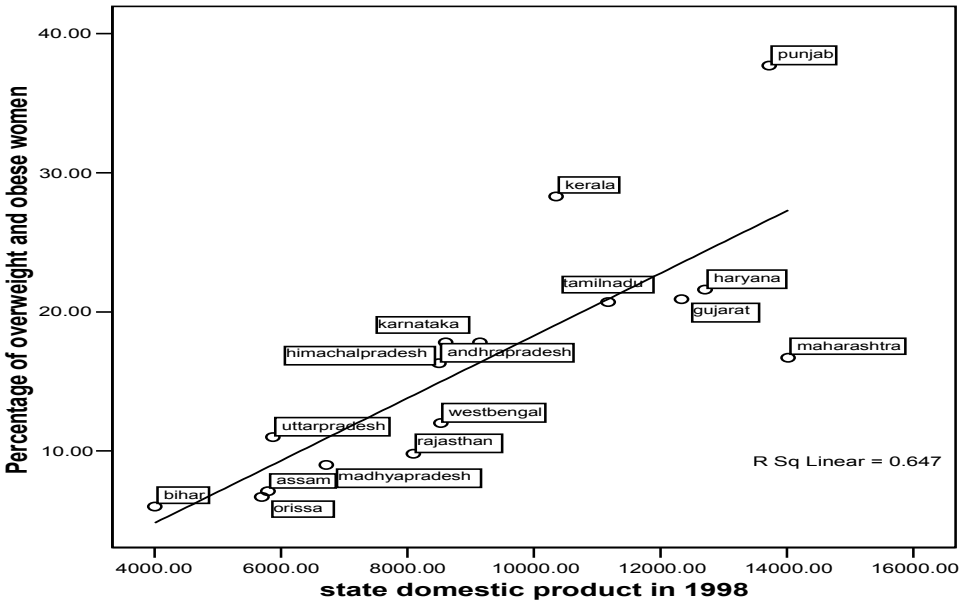


Figure 4: Scatterplot of state domestic product (SDP) and overweight and obesity

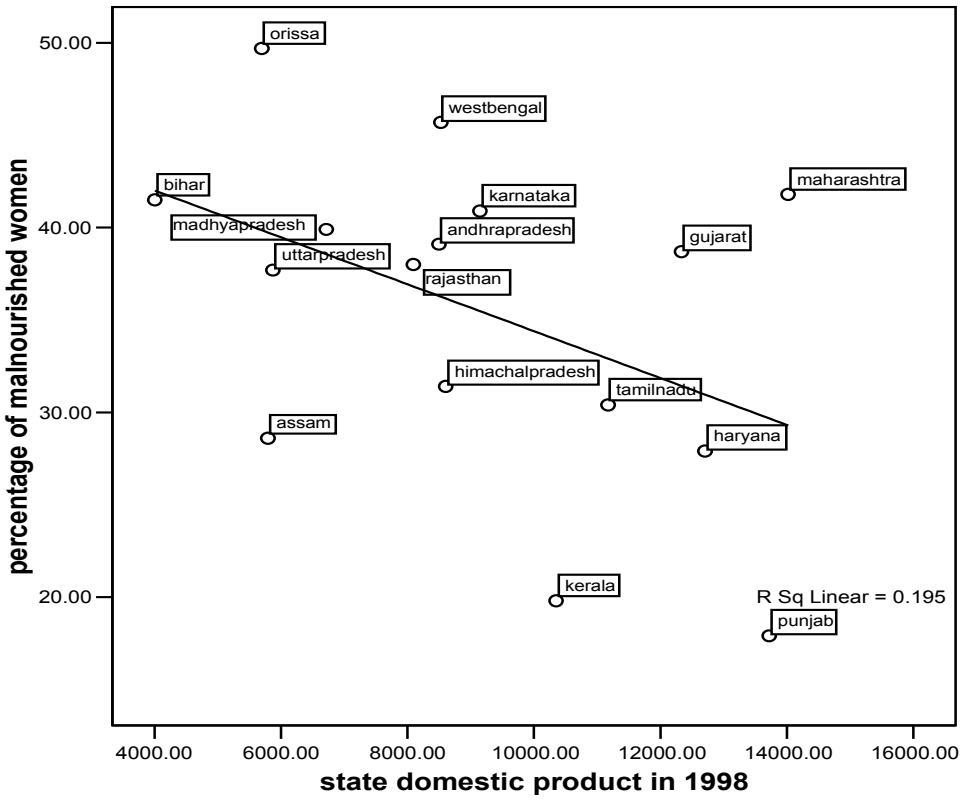


Figure 5: Scatterplot between state domestic product and malnutrition

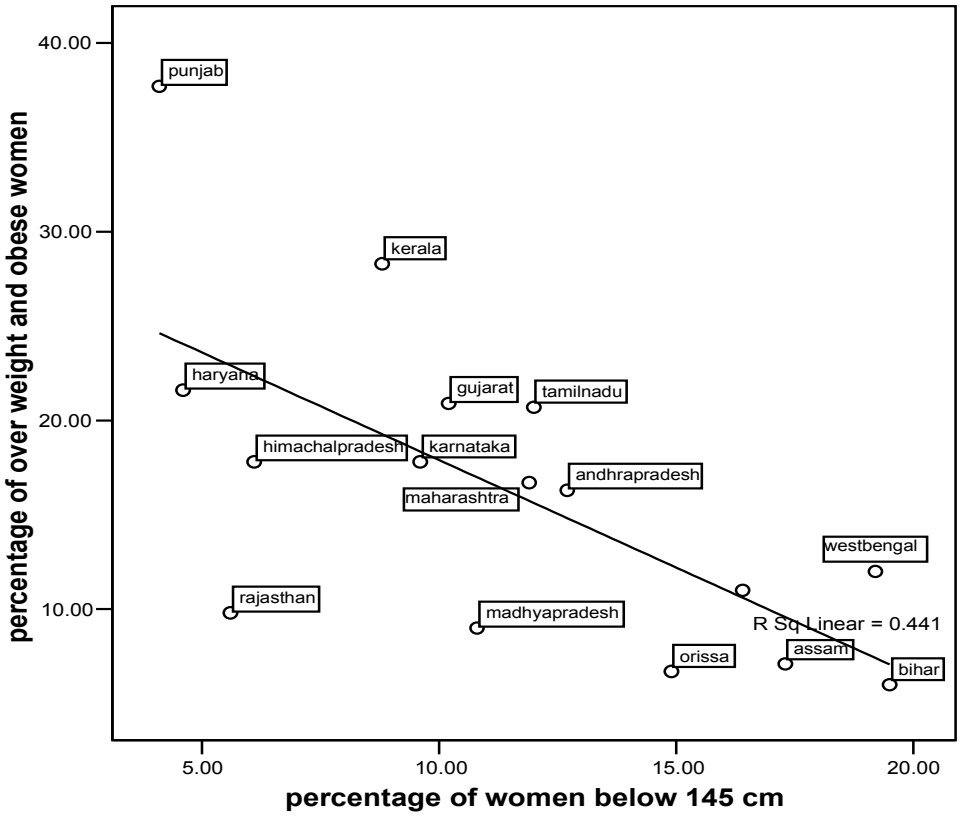


Figure 6: Scatterplot between stunting, and overweight and obesity

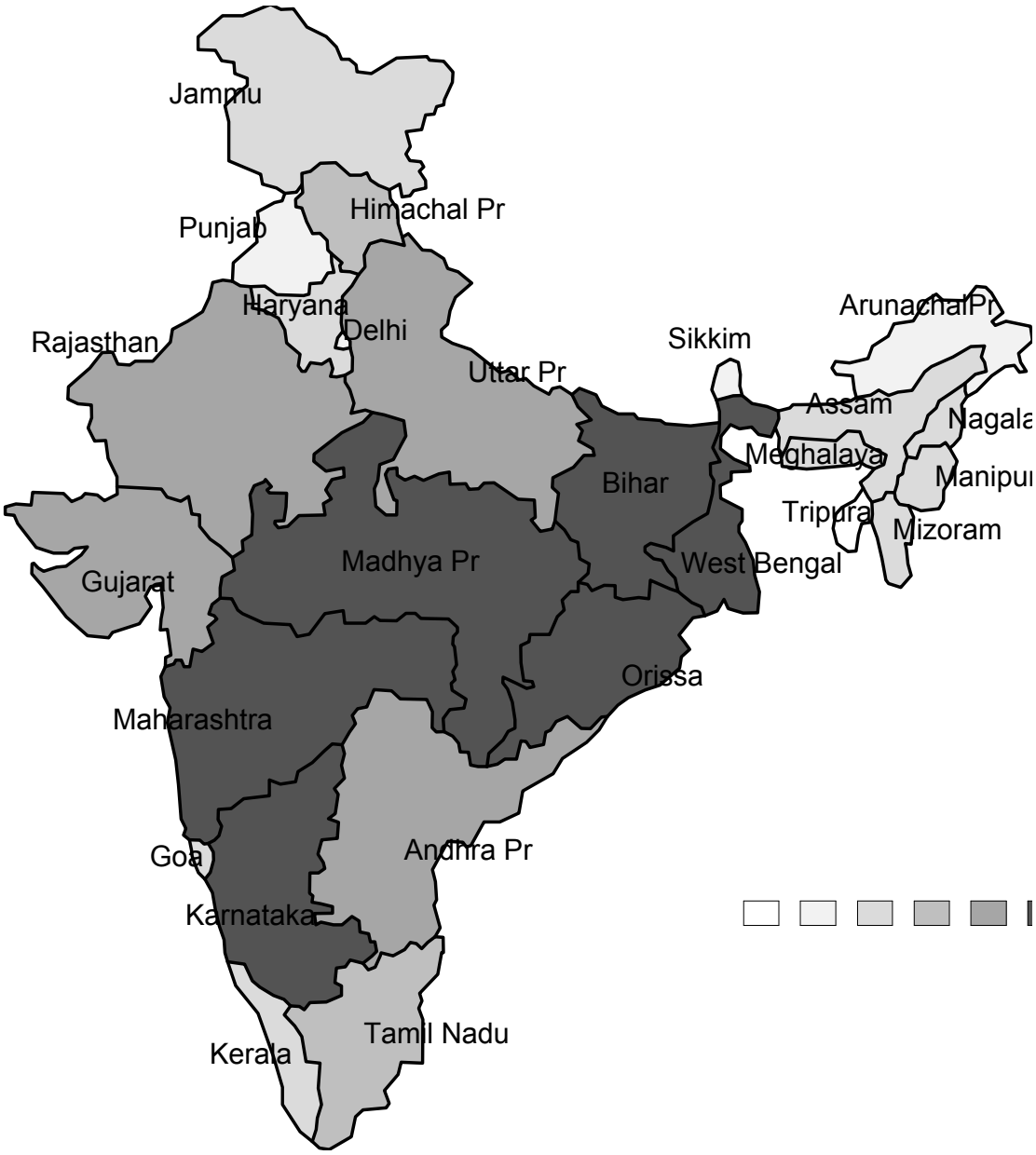


Figure 7: Map of Indian States with proportion of malnourished women
Darker color represents high percentage of malnourished women

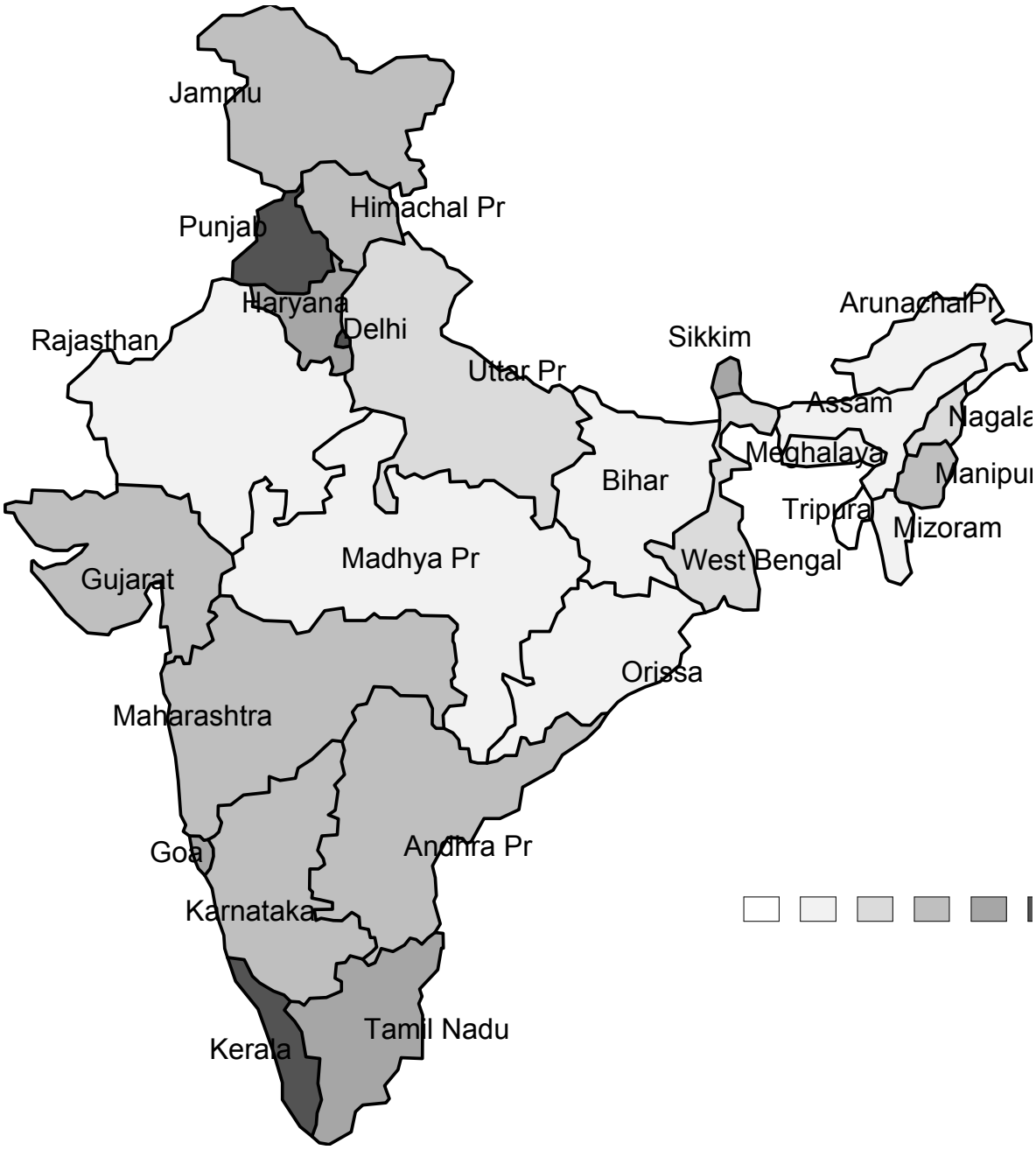


Figure 8: Map of Indian States with proportion of overweight and obese women

Darker color represents high percentage of overweight women

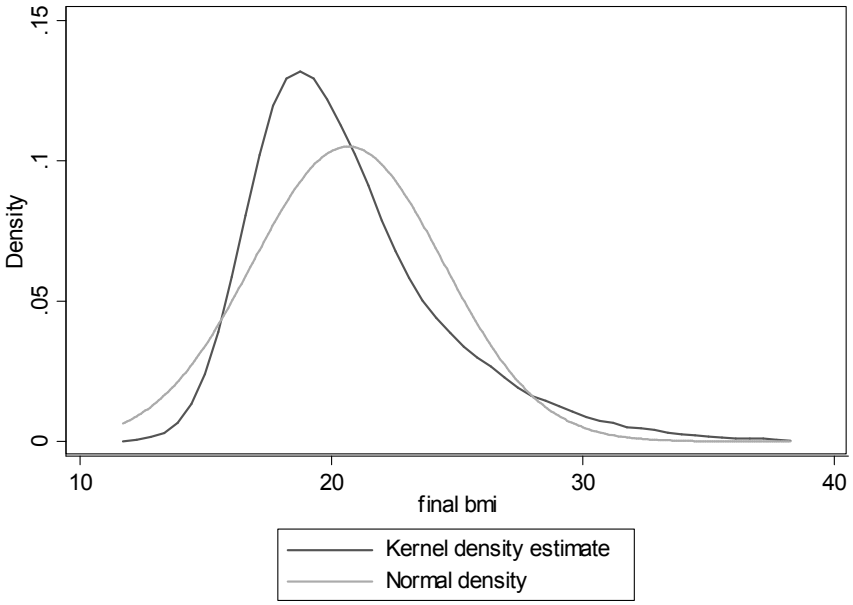


Figure 9: Test of normal distribution of the sample

**Tables**

Table 1: Food consumption measured in gram/per person /per day for proteins and fat

| | 1967-71 | 1990-92 | 2000-2002 |
|---|---|---|---|
| **Calorie** | | | |
| India | 2041 | 2366 | 2420 |
| China | 1994 | 2707 | 2958 |
| USA | 3035 | 3502 | 3794 |
| Brazil | 2428 | 2812 | 3010 |
| **Protein** | | | |
| India | 51 | 57 | 56 |
| China | 47 | 66 | 82 |
| USA | 99 | 108 | 114 |
| Brazil | 61 | 70 | 81 |
| **Fat** | | | |
| India | 30 | 41 | 51 |
| China | 24 | 55 | 87 |
| USA | 119 | 140 | 157 |
| Brazil | 46 | 84 | 92 |

Source: FAOSTAT

Table 3: Among ever-married women, percentage with specified levels of BMI by selected background characteristics, India, 1998-99

| Background characteristics | Mean | Under weight | Normal | Over weight | Obese |
|---|---|---|---|---|---|
| **Age** | | | | | |
| 15-19 | 19.1 | 43.8 | 53.8 | 2.2 | 0.3 |
| 20-24 | 19.3 | 44.1 | 50.6 | 4.5 | 0.9 |
| 25-29 | 19.8 | 41.0 | 48.1 | 8.7 | 2.2 |
| 30-34 | 20.4 | 36.3 | 47.5 | 12.2 | 4.0 |
| 35-39 | 20.9 | 32.9 | 46.8 | 14.9 | 5.4 |
| 40-44 | 21.1 | 32.7 | 44.1 | 17.0 | 6.2 |
| 45-49 | 21.3 | 31.1 | 44.1 | 17.0 | 7.8 |
| **Standard of living** | | | | | |
| Low | 18.9 | 50.1 | 45.7 | 3.5 | 0.7 |
| Medium | 20.1 | 37.5 | 49.9 | 10.0 | 2.6 |
| High | 22.7 | 18.4 | 46.2 | 24.6 | 10.8 |
| **Residence** | | | | | |
| Urban | 22.1 | 23.7 | 45.2 | 22.0 | 9.1 |
| Rural | 19.6 | 42.6 | 48.7 | 6.9 | 1.7 |
| **Education** | | | | | |
| Illiterate | 19.4 | 44.6 | 47.6 | 6.3 | 1.6 |
| Literate, < middle school complete | 20.6 | 34.2 | 47.9 | 13.2 | 4.6 |
| Middle school complete | 21.1 | 29.6 | 49.1 | 15.9 | 5.4 |
| High school complete and above | 22.6 | 18.7 | 47.3 | 23.9 | 10.1 |
| **Religion** | | | | | |
| Hindu | 20.1 | 38.7 | 47.8 | 10.1 | 3.4 |
| Muslim | 20.5 | 35.7 | 47.6 | 12.4 | 4.3 |
| Christian | 21.4 | 26.0 | 50.8 | 17.5 | 5.7 |
| Sikh | 23.0 | 17.8 | 44.5 | 26.2 | 11.5 |
| Jain | 23.5 | 16.5 | 41.0 | 28.8 | 13.7 |
| Buddhist/Neo-Buddhist | 20.3 | 35.6 | 49.2 | 10.9 | 4.2 |
| Other | 18.8 | 58.9 | 34.0 | 5.7 | 1.4 |
| **Caste/Tribe** | | | | | |
| Scheduled caste | 19.5 | 44.1 | 47.1 | 7.1 | 1.7 |
| Scheduled tribe | 19.1 | 48.1 | 46.4 | 4.5 | 0.9 |
| Other backward class | 20.1 | 37.5 | 49.2 | 10.2 | 3.1 |
| Other | 21.0 | 32.1 | 47.2 | 14.8 | 5.9 |
| **Work status** | | | | | |
| Work for Family | 19.4 | 44.0 | 48.2 | 6.3 | 1.6 |
| Employed by someone else | 19.7 | 46.1 | 44.6 | 7.1 | 2.1 |
| Self-employed | 20.4 | 36.8 | 46.0 | 12.9 | 4.3 |
| Not worked in the past 12 months | 20.7 | 33.3 | 48.9 | 13.1 | 4.7 |

Source: National Family Health Survey-2

Table 3: Among ever-married women, percentage with specified levels of BMI by place of residence and standard of living (SLI), India, 1998-99

| **BMI** | Total | Rural | | | Urban | | |
|---|---|---|---|---|---|---|---|
| | | Low SLI | MediumSli | HighSli | Low Sli | MediumSli | HighSli |
| <16 | 6,8 | 10,2 | 6,9 | 3,5 | 9,8 | 5,4 | 1,6 |
| 16-16,99 | 8,5 | 12,0 | 9,2 | 5,6 | 10,0 | 5,9 | 2,8 |
| 17-18,49 | 19,6 | 25,8 | 21,9 | 13,7 | 22,4 | 14,3 | 7,2 |
| 18,5-24,99 | 53,9 | 49,8 | 55,9 | 58,8 | 51,5 | 56,7 | 52,4 |
| 25,0-29,99 | 8,8 | 2,0 | 5,3 | 14,9 | 5,3 | 14,2 | 26,2 |
| >30 | 2,3 | 0,3 | 0,9 | 3,6 | 1,1 | 3,5 | 9,8 |
| Total (n) | 74541 | 21535 | 25375 | 7244 | 2530 | 9202 | 8655 |

Source: National Family Health Survey-2

Table 4: Among ever-married women, percentage with specified levels of BMI major regions of India, 1998-99

| **BMI** | Total | North | Central | East | NorthEast | West | South |
|---|---|---|---|---|---|---|---|
| <16 | 6,8 | 4,0 | 5,8 | 8,5 | 4,2 | 9,0 | 6,3 |
| 16-16,99 | 8,6 | 6,4 | 8,6 | 10,2 | 5,1 | 9,5 | 8,1 |
| 17-18,49 | 19,6 | 16,3 | 21,7 | 23,5 | 16,4 | 18,8 | 17,0 |
| 18,5-24,99 | 54,0 | 56,7 | 56,4 | 52,0 | 68,8 | 49,0 | 53,4 |
| 25,0-29,99 | 8,8 | 12,3 | 6,0 | 5,0 | 4,6 | 10,2 | 12,2 |
| >30 | 2,3 | 4,3 | 1,5 | 0,8 | 0,9 | 3,5 | 2,9 |
| Total (n) | 75324 | 9504 | 14525 | 17147 | 2680 | 11594 | 19874 |

Source: National Family Health Survey-2

Table 5: Effect of socio-economic and demographic factors on malnutrition

| Variables | Coefficient | Variables | Coefficient |
|---|---|---|---|
| **Age** | 0.963*** | **Schooling** | 1.003 |
| **Age square** | 1.000*** | **Husband's education** | |
| **Region** | | No | 0.915*** |
| North | 0.905** | Yes (ref) | |
| Central | 1.017 | **Number of household members** | 1.002*** |
| East | 1.180*** | **Height** | |
| NorthEast | 0.588*** | Not stunted | |
| West | 1.433*** | Stunted (ref) | 0.957* |
| South (ref) | | | |
| **SLI and Place** | | | |
| Urban Low | 1.579*** | | |
| Urban Middle | 1.048 | | |
| Urban High | 0.687*** | | |
| Rural Low | 1.700*** | | |
| Rural Middle | 1.448*** | | |
| Rural High (ref) | | | |
| **Religion** | | | |
| Hindu | 1.089 | | |
| Muslim | 1.068 | | |
| Christian | 0.814* | | |
| Sikh | 0.820* | | |
| Jain | 0.898 | | |
| Other (ref) | | | |
| **Caste** | | | |
| Scheduled caste | 1.070* | | |
| Scheduled tribe | 1.118* | | |
| Backward caste | 0.963 | | |
| High caste (ref) | | | |
| **Employment** | | | |
| No job | 0.907* | | |
| Paid | 1.086* | | |
| Self employed | 0.969 | | |
| Unpaid (ref) | | | |
| **Media exposure** | | | |
| No exposure | 1.055 | | |
| Some components | 1.026 | | |
| All components (ref) | | | |

* $p < 0.05$ ** $p < 0.01$ *** $p = 0.00$

Table 6: Effect of socio-economic and demographic factors on overweight and obesity

| Variables | Coefficient | Variables | Coefficient |
|---|---|---|---|
| **Age** | 1.350*** | **Media exposure** | |
| **Age square** | 0.997*** | No | 0.725*** |
| **Region** | | Some components | 0.997 |
| North | 0.780*** | **All components (**ref**)** | |
| Central | 0.591*** | **Years of schooling** | 1.032*** |
| East | 0.545*** | **Husband's education** | |
| Northeast | 0.396*** | No | 0.812*** |
| West | 0.854*** | Yes (ref) | |
| South (ref) | | **Number of household members** | 0.991* |
| **SLI and Place** | | **Height** | |
| Urban Low | 0.843 | Not stunted | 0.999*** |
| Urban Middle | 1.248*** | Stunted (ref) | |
| Urban High | 1.929*** | | |
| Rural Low | 0.399*** | | |
| Rural Middle | 0.614*** | | |
| Rural High (ref) | | | |
| **Religion** | | | |
| Hindu | 1.030 | | |
| Muslim | 1.249 | | |
| Christian | 1.121 | | |
| Sikh | 1.967*** | | |
| Jain | 1.306 | | |
| Other (ref) | | | |
| **Caste** | | | |
| Scheduled caste | 0.822*** | | |
| Scheduled tribe | 0.805*** | | |
| Backward caste | 0.886*** | | |
| High caste (ref) | | | |
| **Employment** | | | |
| No job | 1.607*** | | |
| Paid | 1.073 | | |
| Self employed | 1.472*** | | |
| Unpaid (ref) | | | |

* $p < 0.05$ ** $p < 0.01$ *** $p = 0.00$

Table 7: Estimation of impact of socio economic and demographic variables on BMI using Quantile Regression

| Variables | Q(10) | Q(20) | Q(40) | Q(60) | Q(80) | Q(90) |
|---|---|---|---|---|---|---|
| **Age** | 0.08*** | 0.11*** | 0.12*** | 0.16*** | 0.25*** | 0.32*** |
| **Age square** | -0.001** | -0.001*** | -0.001*** | -0.001*** | -0.002*** | -0.003*** |
| **Region** | | | | | | |
| North | 0.13* | 0.85* | -0.05 | -0.16** | -0.25* | -0.33 |
| Central | -0.06 | -0.11* | -0.30*** | -0.51*** | -0.70*** | -0.88*** |
| East | -0.24* | -0.29*** | -0.49*** | -0.74*** | -1.03*** | -1.20*** |
| NorthEast | 0.34** | 0.38*** | 0.14** | -0.17** | -0.57*** | -0.92*** |
| West | -0.55*** | -0.52*** | -0.53*** | -0.52*** | -0.51*** | -0.52*** |
| South (ref) | | | | | | |
| **SLI and Place** | | | | | | |
| Urban Low | -0.74*** | -0.83*** | -1.07*** | -1.30*** | -1.59*** | -1.49*** |
| Urban Middle | -0.18** | -0.12 | -0.09 | 0.02 | 0.12 | 0.24* |
| Urban High | 0.96*** | 1.27*** | 1.68*** | 1.92*** | 2.06*** | 2.20*** |
| Rural Low | -0.69*** | -0.85*** | -1.17*** | -1.54*** | -2.01*** | -2.39*** |
| Rural Middle | -0.48*** | -0.61*** | -0.89*** | -1.19*** | -1.59*** | -1.85*** |
| Rural High (ref) | | | | | | |
| **Religion** | | | | | | |
| Muslim | 0.07 | 0.15*** | 0.24*** | 0.40*** | 0.50*** | 0.70*** |
| Christian | 0.49*** | 0.46*** | 0.45*** | 0.39*** | 0.35*** | 0.56*** |
| Sikh | 0.40** | 0.79*** | 1.13*** | 1.37*** | 1.68*** | 2.07*** |
| Other | 0.27 | 0.45* | 0.81*** | 1.13*** | 1.35*** | 1.22** |
| Hindu (ref) | | | | | | |
| **Caste** | | | | | | |
| Scheduled caste | -0.14** | -0.17*** | -0.29*** | -0.31*** | -0.37*** | -0.42*** |
| Scheduled tribe | 0.01 | -0.12 | -0.21*** | -0.26*** | -0.40*** | -0.45** |
| Backward caste | -0.05 | -0.07* | -0.10** | -0.12** | -0.18** | -0.26* |
| High caste (ref) | | | | | | |
| **Employment** | | | | | | |
| No job | 0.01 | 0.05 | 0.18*** | 0.25*** | 0.45*** | 0.60*** |
| Paid | 0.09 | 0.08 | 0.13* | 0.13 | 0.30* | 0.39* |
| Self employed | -0.14* | -0.11* | -0.10* | -0.20*** | -0.14* | -0.13 |
| Unpaid (ref) | | | | | | |
| **Media exposure** | | | | | | |
| No | -0.12 | -0.25** | -0.27** | -0.39*** | -0.63** | -0.69** |
| Some components | -0.04 | -0.15* | -0.13 | -0.20* | -0.27* | 0.21 |
| All (ref) | | | | | | |

| Variables | Q(10) | Q(20) | Q(40) | Q(60) | Q(80) | Q(90) |
|---|---|---|---|---|---|---|
| **Schooling years** | 0.04*** | 0.05*** | 0.07*** | 0.09*** | 0.10*** | 0.01*** |
| **Husband's education** | | | | | | |
| No | 0.16*** | 0.15*** | 0.17*** | 0.16** | 0.20** | 0.29*** |
| Yes(ref) | | | | | | |
| **No. of house members** | -0.01 | -0.02*** | -0.02*** | -0.03*** | -0.05*** | -0.05*** |
| **Height** | | | | | | |
| Not stunted | 0.24*** | 0.21*** | 0.23*** | 0.24*** | 0.41*** | 0.50*** |
| Stunted (ref) | | | | | | |
| **Constant** | 15.50 | 16.07 | 17.14 | 18.10 | 18.54 | 18.68 |

* $p < 0.05$ ** $p < 0.01$ *** $p = 0.00$