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GENDER DIFFERENCES IN DOUBLE BURDEN OF MALNUTRITION IN INDIA: QUANTILE REGRESSION ESTIMATES

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Archana Agnihotri and Brinda Viswanathan

Abstract

India has witnessed growing prevalence of double burden of malnutrition among both men and women. Based on BMI quantile regression estimates using NFHS-4 data, a comparative assessment on the role of dietary patterns, lifestyle, education, health and hygiene, household's demographic composition and region of residence on double burden of malnutrition, is provided separately for men and women in India. NFHS-4 data differs in sample size and nature of questions for men and women. In order to provide robustness checks gendered comparisons are also discussed by contrasting the results from full sample with the sub-samples for couples, and women only from the households of male sample.

Within each BMI quintile BMI increases with education except for women in top quintile where the magnitude reduces for 10 or more years and even more for 12 or more years of education, after controlling for other factors. This perhaps is a reflection of an expectation for women to be lean than it may be for men as they are more likely to be younger and exposed to media particularly social media. Vegan diets worsen BMI for the lowest quintile while the same diet is beneficial to those at the top quintile. For men sedentary occupations are associated with overweight and for women household drudgery is associated with increased underweight. There is a broad geographic segregation of malnutrition with low BMI more prevalent in Central and Eastern India and high BMI in Southern and Northern India while double burden is more prevalent among men in Western India. Overall, the conditional quantile estimates are discerning of the covariates associated with double burden of malnutrition in India compared to the conditional mean (OLS) estimates.

Key words: *BMI, Quantile Regression, Gendered Difference, Diet, Lifestyle, Sample Size*

JEL Codes: *C21, C83, I12, J16, L66*

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INTRODUCTION

India has not only maintained its position among countries with largest number of underweight men and women but also has jumped to a higher position among countries with largest increase in the proportion of overweight men and women in the last three decades (Lancet 2016). This coexistence of substantial number of undernourished and overweight and obese population is referred as double burden of malnutrition (Viswanathan and Agnihotri, 2020). India is among the several middle income countries with a high prevalence of this double burden of malnutrition (DBM, henceforth). In the decade between 2005 and 2015, undernutrition rates fell from 34 percent to 20 percent among men and from 36 percent to 23 percent among women, while overweight/obesity rates increased from 9.3 percent to 19 percent among adult men and from 13 percent to 21 percent among adult women (IIPS, 2017).

A study of factors associated with high prevalence of malnourishment is essential for prevention of some diseases and in many instances for quick recovery or cure of those affected by any serious disease. Dietary habits, hygienic environment and lifestyle patterns are at the core of factors connected with malnourishment. Among the less nourished these are further connected with affordability of diets, public goods and services that provide hygienic living conditions and access to low-cost and timely healthcare. The nutrition transition among the better-off has become an important issue to grapple with, for the developing countries. Alongside the provision of basic amenities to a large underprivileged population, the country has to also provide quality healthcare at a far lower level of per capita incomes compared to the rich nations, in order to treat Cardio Vascular Diseases (CVD) including its associated risk factors like diabetes-2 and hypertension. One of the approaches to ease the challenges for the state would be to reduce the pace of rising morbidity and mortality due to malnutrition by moderating individual behavior relating to diets and physical fitness and awareness towards healthy lifestyle.

The differences in quantitative estimates between the bottom and top quintile of BMI associated with life-style habits after controlling for their socioeconomic status, access to healthcare and demographic characteristics (like age, marital status, household size and composition) is an important objective of this study.

For adults Body Mass Index defined as the ratio of weight (in kgs) to squared height (in meters) is used to categorise current undernourishment statuses at the time of measurement in any representative sample survey. Underweight (or thinness) are those with BMI below 18.5 and BMI ranging between 25 (inclusive) and 30 are overweight while obese are with BMI 30 and above. In 2004, a WHO Expert Consultation group, proposed BMI criterion for overweight as 23–27.49 kg/m^2 and that for obesity as ≥27.5 kg/m^2 for people residing in the Asia-Pacific region. These revised thresholds are arrived at based on the higher risk for cardio-vascular diseases On the other hand, nutrition experts have recently added 5 kg to the ideal body weight and heights for adult Indian men (65 kgs and 5 feet 8 inches) and women (55 kgs and 5 feet six inches) as nutrients intakes and height of the population have increased (GoI, 2020).

The challenges in data collection and recording the information on the prevalence of diseases or the risk factors associated with it including the demographic, social, economic and environmental features is enormous for the developing countries. The periodic surveys by the Measured-DHS (Demographic and Health Surveys) for several nations including India are an important source of data. A major advantage is that much of this information is at the individual level including broad categories of dietary habits and some lifestyle aspects. This rich source of information has proved very useful in documenting developmental changes particularly, the gender differentials. For a large and diverse country like India an added challenge is the large sample size that may be required to administer such surveys to account for heterogeneity in the measured variables. For instance, the National Family Health Survey Data for India that is part of the DHS collects more detailed information for women in the age of 15-49 years with a far larger sample size. In comparison to this, data for men are limited in detail and sample size is far lower even with a slightly larger age range from 15 to 54 years, being covered.

Further, as the challenges in documenting very detailed and disaggregated food intake patterns are even higher, the dietary habits are recorded based on food frequency. Lastly, information on physical activity patterns needs a detailed time-use approach which would be rather daunting for a large country like India. Keeping these data gaps in mind, we attempt to extract relevant information that could possibly indicate variations in physical activity patterns and will be discussed in the data section.

In this study we make use of the food frequency of broad categories of food habits prevalent in India and the lifestyle patterns to understand the correlates of the double burden of malnutrition. To the best of our knowledge, no studies have used a quantile regression model to understand the determinants and the factors associated with double burden of malnutrition and more so for separately for adult women (20-49 years) and adult men (20-54 years). We also examine the differences in the quantitative results arising from differences in sample size for men and women.

LITERATURE REVIEW

Double burden of malnutrition DBM for short, can be defined based on the prevalence of undernutrition and overweight and obesity among different section of the population or changes over time for the same set of individuals. Viswanathan and Agnihotri (2020) discuss several ways in which undernutrition is measured in the developing countries including India. However, the other feature of malnutrition dealing with overweight and obesity is measured based on excessive value of BMI. The proportion of population that consume inadequate amounts nutrients is the single biggest challenge in the low and middle income countries (LMICs) but a segment of this population is also recording increases in overweight/obesity and this has exacerbated the problem of DBM in these nations.

Most of the world's population live in countries where overweight and obesity kills more people than underweight (WHO, 2020). The current emergence of DBM is brought about by the rapid changes in the food system like the availability of cheap ultra-processed food and beverages, reductions in physical activity at work, transportation, home and even leisure due to introductions of activity-saving technologies in LMICs. Double burden of malnutrition is found to be the most prevalent in Sub-Saharan Africa, South Asia, and East Asia and Pacific. Nearly all LMIC countries saw declines in child wasting or stunting and increase in overweight among women from 1990s to 2010s. (Popkin *et. al.*,2020). Among the LMICs, Nepal is facing the emergence of overweight/obesity as a major public health concern along with the chronic problem of undernutrition. A recent study showed that prevalence of underweight and overweight and/or obesity was 19.2 percent and 18.2 percent respectively among men and women of Nepal. Based on the Asian cutoff for Body Mass Index (BMI >22.9 kg/m2), the prevalence of overweight and/or obesity was 31.4 percent (Shrestha *et. al.*, 2020). A study based on China Health and Nutrition Survey (CHNS), 2015 shows that nearly 46 percent of men and 40 percent of women aged 18 to 59 years faced the problem of DBM which was defined as having underweight/ overweight/ obesity and micronutrient deficiency (Huang *et. al.*, 2020). In Philippines, underweight prevalence declined from 16.2 percent to 13.7 percent among women and 13.8 percent to 10.9 percent among men while overweight prevalence increased from 19.8 percent to 26.1 percent and 23.7 percent to 28.9 percent for men and women respectively from

2005-2015 (Global Nutrition Report, 2020). Two thirds of female participants (65.6 percent rural and 66.2 percent urban) were overweight or obese while fewer men were overweight or obese (23.3 percent rural; 16 percent urban) in South Africa. A third (33.1 percent) of rural men and 23 percent of urban men were underweight. On the other hand, 9.2 percent of rural women and 8.8 percent of urban women were underweight in South Africa (Tydeman-Edwards *et. al.*, 2018). A recent study on women in Ghana used logistic regression to study double burden of malnutrition, namely the coexistence of undernutrition or overnutrition and micronutrient deficiency in the same individual, household, community and population. Women who were formerly married were twice as likely to have the double burden of malnutrition than never married women (Kushitor *et. al.*,2020). The same study found that odds of experiencing the double burden of malnutrition increased with the economic status. Based on Asian cut-offs for BMI, 29.1 percent of men were found to be underweight while 20.5 percent of men were found to be overweight in Bangladesh. The proportion of both underweight and overweight women was much higher than men at 36 percent and 24.4 percent respectively (Biswas *et. al.*, 2020). Thus, we observe that rate of decline in thinness based on BMI has declined rapidly with a very high transition rate to overweight and obesity with a shrinking rate among those within normal BMI range among LMICs. Limited data for men (including perhaps) sample differences in size indicates lower proportion of men are either thin or overweight and obese.

Several recent studies in the Indian context have sought to examine the nutrition transition based on BMI of adult men and women however, the focus is more on overweight and obesity and less so on thinness. A recent study showed that the prevalence of underweight have decreased and the prevalence of overweight/obesity have increased among both men and women in India. However, the prevalence of both underweight and overweight/obesity were higher among women than men (Dutta *et. al.*, 2020). Print media have also addressed similar concerns for double burden of malnutrition in India (Bhattacharya, 2017).

In order to understand the factors associated with variations in a person's BMI, earlier studies have used the econometric approaches that model BMI using a categorical variable with cutoffs for underweight (BMI<18.5 kg/m^2) and overweight (BMI>25 kg/m^2). More recently WHO cutoffs to study overweight and obesity in population of India have been revised and are different from that for other nations as the lower cutoffs have shown to give a better assessment of the risk towards diabetes, hypertension and cardiac diseases. However, given the ethnic diversity of the Indian population there is limited evidence to show whether these newer cutoffs hold for all the population or the thresholds and risks may vary across sub-groups. Hence this study has preferred to estimate a quantile regression model that will allow estimated coefficients to vary across different BMI quantiles. This will enable us to understand how the determinants vary at low and high levels of BMI.

India has a large diversity in dietary habits due to its socio-cultural diversity partly arising from being a very old civilization and varied climatic conditions. With increasing income, urbanization, improved connectivity and globalization, dietary habits have been observed to make a nutrition transition. The consumption of energy dense and nutrient poor diet has increased due to easy availability of fast food. On the other hand, there are several households and particularly young children consume inadequately diverse diets (Agrawal *et. al.*, 2019 and Tak et. al 2019) Thus this study uses variation in dietary habits as an important explanatory variable. An earlier study for 2005-06 classifies Indian diets into vegetarian and classification of animal product based diets. Agrawal *et. al.*, 2014) and a similar dietary classification is used in this study for the more recent data for 2015-16 with an objective to understand the role of the purely plant based and variants of animal based food habits. The details of this classification are given in the Section where the covariates are discussed in more detail.

Another major reason for the prevalence of double burden is a shift towards more sedentary lifestyles while a substantial population is still involved with manual jobs including a large number of women from household drudgery like fetching water or firewood. The wage gap between the skilled and unskilled manual worker in India has widened substantially with a four-fold increase in real wages for the former compared to the latter in the last two decades (ILO, 2018). Compounding this is the differences in disease environment and sanitary conditions. Access to safe sanitation and clean cooking fuel has direct linkages with health of the members in the household (MoF-DEA, 2021). About 1.03 million households in India do not have access to any type of toilets and about 1.56 million households use solid fuel for cooking and thus suffer from infectious diseases like tuberculosis or vector borne diseases like malaria and dengue acute respiratory infection. There is a significant variation in the prevalence of tuberculosis according to the type of cooking fuel used in the household, ranging from a low of 207 persons per 100,000 usual residents in households using clean cooking fuel to a high of 566 persons per 100,000 in households using solid fuel for cooking. (IIPS, 2017). There has been sharp increase in the proportion of households with improved sanitation in many states over last 4-5 years in India, with an increase from 26 percent to 49 percent for Bihar and increased from 52 percent to 73 percent for Maharashtra in 2019-20. The proportion of households using clean cooking fuel has also increased in these states from 18 percent to 38 percent for Bihar and 60 percent to 80 percent for Maharashtra (IIPS, 2021). Economic Survey for 2020-21 (MoF-DEA, 2021) shows improvement in sanitation access for all States in rural areas and for most of the States in urban areas in 2018 compared to 2012. Limited access to healthcare and inadequate nutritional intake makes them susceptible to repeated infection and poor health including thinness.

Lastly we focus on the role of education to be an important factor associated with lower malnutrition; for the bottom quintile we expect education to have a positive association with BMI and a negative association for the upper quintile.

It has been observed that there is a positive association between people of different socio-economic groups and their BMI status. Women who are highly educated are aware of the consequences of high BMI and they try to control their diet accordingly to mitigate any health risk. People residing in rural areas and those belonging to lower economic status in urban areas experience lower BMI. On the other hand, people living in urban areas as well as people in rural areas closer to the urban centers and among higher economic status experience higher BMI (Aiyar *et. al.* 2020). Education level, wealth index and type of jobs were found to be strong determinants of BMI and their variation across each quantile of BMI needs to be studied. Along with these, the effect of individual factors, religion and caste on BMI is also important to be taken into consideration.

In this study we use health care variables like visit to hospital and health insurance and use of vehicle and mobile which have not been taken into account by earlier studies will be used as other control variables. Visit to hospital and insurance coverage indicates health awareness and thus we expect both to have a negative association with lower and upper quantiles of BMI. Use of motor vehicle and mobile are expected to show positive association with upper quantile and negative association with lower quantile of BMI.

The results of the study are presented separately for men and women. NFHS-4 survey like the previous surveys collects data for women aged 15-49 years and for men ages 15-54 but the sample size is substantially larger for women than for men. Consequently, the discussions focusing on the three main objectives of the study are carried out for men and women separately. However, we also carry out an analysis for women with a reduced sample size by matching the women in those households where the data for men is surveyed and collected.

Further, in this matched sample for women we do not analyse by combining the data for men and women as some important covariates particularly on life-style patterns are different based on the availability of the pertinent data from the survey.

METHODOLOGY

This study uses Quantile regression models (QRM) to estimate the effects of different variables used in the analysis on BMI of men and women separately. Recent studies have preferred quantile regression method which provides estimates of the impact of the determinants (and control variables) across the distribution of a continuous variable rather than the OLS model that estimates the effects on mean outcome (Koenker, 2005). QRM has better properties in the presence of heteroscedasticity and is also less sensitive to outliers. As compared to OLS, it can be used to estimate marginal effects at the tails of the distribution, accommodating the possibility of change in signs (Jolliffe, 2010). For this study, coefficients for men, women and men-matched women samples are estimated separately through quantile regression of the respective explanatory variables on 20th and 80th quantiles of the outcome variable BMI to signify the prevalence of double burden of malnutrition. In this study, 20^{th} quantile of BMI is referred to as undernutrition/underweight and 80^{th} quantile of BMI is referred to as overweight/ obesity. The model used in this study can be represented by the equation:

$$\mathbf{Y_i = X_i'\beta_q + e_i}$$

where Y_i represents the outcome variable BMI for individual i and X_i is the matrix of all explanatory variables for individual i. The estimate β_q is the set of estimated coefficients for the qth quantile. A quantile represents a particular proportion of sample below q_t. βq is the coefficient of each covariate for quantile q of BMI and e_i is the estimation error term for individual i. If F represents the cumulative distribution function (CDF) of the variable Y then: $\mathbf{t = (P \leq q_t) = F_Y(q_t), 0<t<1}$

DATA

This study uses a cross-sectional data based on a secondary survey from India's fourth National Family Health Survey (NFHS-4) conducted during 2015 to 2016 across all 29 states and 7 Union Territories. The survey was in the line with the Demographic and Health Surveys (DHS) that have been conducted in many countries usually once in five years. Ministry of Health and Family Welfare, Government of India along with International Institute of Population Studies conducts NFHS survey which provides information on men and women's individual characteristics e.g., age, education in single years, occupation, nutritional status, aspects of fertility, marriage, family planning, and women's empowerment, HIV/AIDS etc. NFHS-4 collected demographic, socioeconomic and health information from a nationally representative probability sample of 124,385 women aged 15-49 years and 74,369 men aged 15-54 years residing in 109,041 households. Face-to-face interviews were conducted at individual levels in the respondents' homes to obtain the data. The individual data is based on interview of 112,122 eligible men of age group of 15-54 years and 699,686 eligible women of age group 15-49 years. The secondary data was collected through stratified two-stage sampling and appropriate sampling weights are provided for arriving at estimates at the district, state and national level. NFHS-4 provides data for sexual behavior; husband's background and women's work; HIV/AIDS knowledge, attitudes, and behavior; and domestic violence only for the state module (a subsample of 15 percent of households), while most indicators in the district module are reported at the district level. The primary sampling units are divided into two main strata– rural (villages) and urban (wards/municipal localities) and are drawn separately based on the relative sizes of the state and of the urban and rural populations within the state.

This study is restricted to men aged 20-54 years with sample sizes of 89,374 and women aged 20-49 years with total sample size of 525,454 and which is reduced to 75,588 when matched with the households where men's data is collected. The main dependent variable under analysis in this study is the BMI which is collected in the survey. BMI is calculated as the weight in kilograms divided by the square of height in meters (i.e., kg/m^2). Given that BMI involves height in it's calculations we restrict the lower age limit to 20 years for both men and women as adult height stabilizes by the age of 20 years. The upper age limit is retained to what has been provided by the data source of 49 years for women and 54 years for men. Though one could have restricted upper age limit of the male samples to 49 years as for women but this would reduce the sample size further.

Covariates and Descriptive Statistics

The survey collected information on select anthropometric measurements of a large number of individuals[1] along with demographic, socioeconomic and lifestyle characteristics of these individuals and their households. This enables us to study the association between bottom 20th percentile (0.20 quantile) and the top 80th percentile (0.80 quantile) of BMI for men and women separately and different (a) individual factors like demography, lifestyle and health and hygiene, (b) household factors like socio-economic status and household composition and (c) geographical factors on. The covariates associated with the variations in these two BMI quintiles discussed below are grouped into individual, household and geographic variables with the descriptive statistics reported in Table 1.

Individual Factors

Demographic factors

Scientific studies have proved that under-nutrition in the pre-natal stage programs the fetal tissues to utilize food efficiently, making it difficult for low birth weight babies to deal with an abundance of food in later life

[1]Women who are into three months of pregnancy and those with a birth in the preceding two months of the interview were excluded in this study as weight gains are expected during this phase thereby excluding about 29,000 observations from the sample. Lastly we exclude some outlier values of BMI below 15 Kg/m^2 and above 35 Kg/m^2.

which leads to overweight or obesity as an adult (Bhattacharya, 2017). Many developing countries around the world have shown rapid changes in lifestyle in a short span of time among a section of the population and thus a section of the population still remains undernourished, while many others are over-nourished (henceforth, overweight and/or obesity will be referred so). Table 1 shows that the mean BMI value in the bottom 0.20 quantile is below the normal BMI cut off value of 18.5 kg/m^2 while top 0.80 quantile has the mean of about 28 kg/m^2 depicting the double burden of malnutrition among men and women in India. Further both men and women show similar values. According to a recent study, the prevalence of underweight was found to be the highest among men and women in the 15-19 years age group, while overweight/obesity was highest among men and women aged 35-49 years (Dutta *et. al.*, 2019). Another recent study by author shows that undernutrition rates decline as age increases while over nutrition rates increase with increase in age for both men and women (Viswanathan and Agnihotri, 2020). In this analysis we have included both age and age squared as covariates to account for non-linearity. We expect the linear term of the age coefficient to have a higher magnitude in the top 20th quantile thereby indicating younger men and women to belong to bottom 20th quantile of BMI. However, a gendered comparison of the coefficient may not be possible given the separate estimations.

In this study, education based on number of years of education as: less than 5 years of education, 5-7 years of education, 8-9 years of education, 10-11 years of education and 12 years or more years of education. Table 1 shows that among low BMI group, among men, the share with no schooling and 8-9 years of education dominate and among women the share with no schooling dominates. Among high BMI group those with 12 or more years of education are about 40 percent among men and about 25 percent among women. Viswanathan and Agnihotri (2020) also shows that the gap in undernutrition rates and over nutrition rates was very high for men and women who had completed 14 or above years of education. The mean proportion of uneducated women with bottom 20th quantile of BMI was much higher (42 percent) than those with top 20th quantile of BMI (24 percent). This indicates gendered difference in double burden when considered in association with education levels. An earlier study based on 2005-06 and 2015-16 NFHS surveys, shows that education for females initially exhibits a positive association with the predicted probability of overweight/obesity, but beyond a threshold of around 7–9 years a negative association is observed with the additional years of educational attainment. The inverted U-shaped finding is not observed for males in either of the two rounds (Siddiqui, 2020). Given the differences in specification of the econometric model as well as the education variable in this study we expect a negative association of higher education with women in top quantile of BMI and also with the bottom quantile of BMI for both men and women.

As per the results of a large-scale survey across India in 2019, single (never married) respondents were found to be the most underweight while married respondents were found to be the most overweight/obese (Statista Research Department, 2020). This result was similar across genders. Based on other studies, we consider marital status as an important control variable that explains the variations in BMI. Marital status is classified as *currently married*, *formerly married* (separated, divorced or widowed) and *never married*. The demographic distribution both for men and women shows that about 75-83 percent are currently married. The never married are about 12 percent among women and 22 percent among men and about 5 percent (2 percent) of the women (men) are formerly married. The summary results show that compared to overall distribution, the never married have a slightly higher than average population share among the bottom BMI quintile for both men and women. However, the share of currently married is much above the overall average share in the top BMI quintile. In the quantile regression model, never married is the reference category, and we expect a positive coefficient for low BMI group among both men and women but a much larger magnitude for high BMI group for currently married. Among currently women one of the reasons for increase in overweight and obesity is post-pregnant and postpartum weight gain (Chopra *et. al.*, 2020). This study has excluded women with 20 or above weeks of pregnancy and less than 2 months of child birth.

Dietary Diversity

The information on dietary habits of an individual in NFHS-4 is reported based on the frequency of consumption of milk or curd, pulses or beans, dark green leafy vegetables, fruits, eggs, fish, chicken or meat. These food items as reported in the survey are grouped as follows (Agrawal *et. al.*, 2014).:

(a) *Non vegetarian*: milk, pulses, vegetables, fruits, eggs, fish or chicken;
(b) *Semi vegetarian*: milk, pulses, vegetables, fruits, eggs or chicken and no fish;
(c) *Pesco vegetarian*: milk, pulses, vegetables, fruits, eggs or fish and no chicken;
(d) *Lacto-ovo vegetarian*: milk, pulses, vegetables, fruits or eggs and no chicken and fish;
(e) *Lacto vegetarian*: milk, pulses, vegetables or fruits and no eggs, chicken and fish and
(f) *Vegan*: pulses, vegetables or fruits and no milk, eggs, chicken and fish.

These groups are binary coded with a value *one* assigned to those if any of those food items in a group is consumed daily or weekly and zero assigned if reported not consuming those food items at all or occasionally. It must be noted that these are mutually exclusive. For example, in the food groups (a), (b), (c) though all consume fruits and vegetables but (b) differs from (a) and (c) in non-consumption of fish while (c) differs from (a) and (b) on non-consumption of chicken. Similarly, other groups can also be distinguished from each other in differing on one or some exclusive food items. Agrawal *et. al.*, (2014) shows that mean BMI for adult Indian population (20-49 years) was the lowest for pesco-vegetarians (20.3 kg/m^2) and vegans (20.5 kg/m^2) while it was the highest for lacto-vegetarians (21.0 kg/m^2) and lacto-ovo vegetarians (21.2 kg/m^2) in 2005-06 (NFHS-3 data).

Table 1 shows that in 2015-16, for the age group considered here, about one-third of men and women are lacto-vegetarians while a slightly higher share among women (19 percent) are vegans than among men (13 percent). Non-vegetarian food group has the most diverse diet and we observe that overall this is the next most preferred food habit accounting for about 28 percent men and 21 percent women. This disparity in diets between men and women could be reflective of intra-household discrimination where men health and preferences are given priority over women under resource constraint. Compared to the overall average, vegans are higher among the bottom two BMI quintiles. Among women, lacto-vegetarians and non-vegetarians are both over represented in the top two BMI quintiles while for men the non-vegetarians are over-represented among the two BMI quintiles; both, when compared to their overall average. Among women the pesco-vegetarian and semi-vegetarian diets are over represented in the middle two quintiles (results not reported here) and perhaps are indicative of a healthier diet. The 0.40th and 0.60th quintiles have average BMI as 21.7 and 24.4 respectively with a much smaller standard deviation, indicative of healthier BMI values. Further, though Agarwal (2014) used the dietary groups, their study focused more on studying their relationship with diabetes rather than BMI. Siddique (2020) uses NFHS 4 data to study the factors behind dramatic increase in the prevalence of overweight and obesity in India but does not focus on diet. Earlier studies have mixed results in terms of the association of diets to anthropometric measures. Satija *et. al.* (2015) shows positive associations between consumption of animal based food and anthropometric measures like BMI and waist circumference of men and women but the results are based on a very limited data. However, an earlier study showed that consumption of non-vegetarian diets have a mixed effect on increase in BMI of women (Agrawal,2005). Thus, we model dietary diversity to capture the variations in BMI across the quintiles for a comparison of the impact after controlling for other regressors.

NFHS-4 also provides the information on the intake of aerated drinks and fried food which are shown to be strongly associated with the risk of NCDs and obesity (Mathur *et. al.*, 2020). The data used in this study also indicates higher BMI of men and women consuming aerated drinks and fried food daily or weekly. Consumption of aerated drinks and fried food is marginally higher among the top BMI quintile while the qualitative information is not reflective of the quantity of consumption. This is also true of alcohol consumption among men while there were more missing data among women on alcohol consumption. Based on the findings from our data and another study, consumption of alcohol and tobacco was also taken into account to study men’s BMI specifically as the proportion of women consuming alcohol/tobacco had many missing information (Agrawal *et. al.*, 2014).

Lifestyle and Physical Activity Measures

A person’s involvement in any type of physical activity is considered to have a great influence on BMI. Researchers have shown that occupational, transportation and other household activities have become increasingly mechanized with time, leading to a more sedentary lifestyle for Indians, especially for those living in urban areas (Ramachandran, 2018).

NFHS data does not collect information on physical activity for both men and women as suggested by the data collection techniques given in WHO GPAQ (2002). However, certain features of day to day activities and lifestyles in terms of transportation usage and TV watching time per week indirectly indicate a more active or sedentary lifestyle. This in turn proxies for some aspects of physical activities while carrying out daily activities.

Lifestyle and Physical Activity Measures: Men

Frequency of watching television, possession of mobile phone, occupation (not working, more sedentary, less sedentary, active manual and other jobs)[2], and type of vehicle (non-motor, bike and car) used for transportation are aspects that would reflect sedentary/non-sedentary lifestyle habits and are known to be associated higher BMI. Occupation and vehicle use are available only for male sample.

Exposure to media and use of mobile are considered to increase sedentary lifestyle with the advent of such technology. The data here provides information on frequency of watching television which can be considered as exposure to media. In this study, watching television almost every day is defined as 1 otherwise 0. The data shows that more than 70 percent (56 percent) of the overweight (total) men watch television daily and more than 90 percent of men use mobile phone across all the BMI quantiles that increases to nearly 100 percent among the top BMI quintile. Dang *et. al.*, (2019) find that BMI is positively and significantly associated with labor market inactivity in India and more so for women; men in white-collar work have higher BMI than men in blue-collar work (24.20 kg/m^2 vs 23.03 kg/m^2).

The data for occupations is available for all the men in the sample while for women, it has been collected for a randomly selected sub-sample of women (and not for the entire sample). Thus occupational categories are included only for men's BMI. In the male sample, about 70 percent of men's occupations get classified into active manual work. The remaining 30 percent gets somewhat equally distributed in the remaining three activity categories. In the low BMI group, more than 75 percent are involved in active manual work while about 60 percent of men in the high BMI group are involved in active manual work like waiters, maids, sweepers, miners, farm workers etc. On the other hand, 9 percent of underweight men and 29 percent of overweight men and are involved in

[2] The is author's own classification and the codes from NFHS-4 are mentioned in Appendix Table A1

sedentary jobs like computer operating, technical salesmen, shopkeepers, merchants etc. About 11 percent of low BMI men and 7 percent of high BMI are not working and could be either unemployed or have other challenges that keep them away from participating in the labour market.

About 70 percent of men belonging to the bottom 20th quantile of BMI used non motor means of transport like walking or bicycle. On the other hand, more than 60 percent of men in the top 20th quantile of BMI used motor vehicles like bike or car. We expect a negative association with lower quantile of BMI and positive association with upper quantile of BMI for men involved in sedentary jobs, watching television almost daily and using mobile and motor vehicles in econometric analysis.

Lifestyle and Physical Activity Measures: Women

TV watching is more prevalent among women as their daily activities involve primarily household chores and care-giving activities. About 73 percent of overweight women and 44 percent of underweight women watch television almost daily; while only 9 percent of women use mobiles on an average which reduces to 6 percent in the low BMI group and increases to 12 percent in the high BMI group. According to a study, women watching television almost every day had 24 percent increased odds of being overweight and obese compared to their counterparts who never watched television after controlling for several individual and household factors (Das Gupta *et. al.*, 2019).

In the absence of data on occupation in for all the sampled women in NFHS-4, we have used access to clean fuel and duration of fetching water which indicate variations in lifestyle and physical activity among women. Clean fuel is defined as 1 if woman uses electricity, LPG, natural gas and biogas for cooking and 0 otherwise. The data here shows that among low BMI women 22 percent and among high BMI women 61 percent use clean fuel for cooking. Literature has shown that women who have access to clean fuel have a higher likelihood of overweight/obesity. On the other hand, use of firewood and other fuels that require more labor leads to undernutrition among women (Siddiqui and Donato, 2015). Fetching water is defined as 1 if time involved is 10-900 minutes and 0 otherwise. Data shows that 35 percent of underweight women travelled 10-900 minutes daily to fetch water. The study here expects a positive relationship of access to clean fuel and watching television with upper quantile of women BMI and a negative relationship between fetching water and upper quantile of women BMI.

In the context of these lifestyle variables it must however be understood that these are also reflect the standard of living. So if these variables have the statistical significance and relative magnitudes as suggested above after controlling for the socio-economic status of the households then we could expect the role played by these lifestyle variables as proxy for physical activity.

Health and Hygiene Factors

Malnutrition is directly related with the lack of healthy and hygienic practices in our day to day lives. The data shows that among low BMI men and women, more than 50 percent of defecate openly while this is less than 20 percent among high BMI men and women. A print media article has shown that both men and women have a negative relationship between undernutrition and improved sanitation in household, with higher concentration of undernourished women than men in major states. It showed that most of the districts with less than 20 percent households with improved sanitation have 5 percent-10 percent of overweight/obese men and 10-15 percent of overweight/obese women (Bhattacharya, 2017). Based on these findings, we have included the practice of open defecation as one of the covariates and expect it to have a positive association with bottom quantile of BMI for men and women in our analysis.

In our study, insurance coverage is classified into: *none*, *public*, *private* and *employer* insurance using definitions similar to a study by Perianayagam and Goli (2013). The insurance categories are defined as :

none or no insurance if the person has no insurance coverage of any type; Public if covered by Employees State Insurance Scheme (ESIS), Central Government Health Scheme (CGHS), State Health Insurance Scheme or *Rashtriya Swasthya Bima Yojana*; Private if covered by Community health Insurance programme and other privately purchased commercial health insurance; and Employer if covered by medical reimbursement from employer and other health insurance from employer. We consider insurance coverage as being important in access to health care along with good quality of treatment when there is a major illness. Both types of malnourishment could have different sets of morbidity while the difference in type of insurance could also reflect socio-economic status and quality of health care access. In a country like India where urban health care services is dominated by private ownership and rural health services has a very unequal presence of primary health care. The access to diagnosis and treatment in the first and second waves of COVID19 in India has highlighted the major gaps in service delivery in India. A recent statewide study in Rhode Island (USA) found that government insurance beneficiaries were about 26 percent more likely to have obesity than those who had commercial insurance (Mylona *et. al.*, 2020).

Close to 80 percent of men and women do not have any form of insurance and this is uniform across all the BMI quintiles for women but for men there is a slight decline for the top most BMI quintile. The remaining report largely public insurance coverage while a very small percentage of men in the upper BMI quintiles also report insurance from private or employer.

Household Factors

Socio-Economic Factors

The study here uses the groups for wealth quintiles as defined in the data source (NFHS-4) based on 33 assets and housing characteristics that are poorest, poorer, middle, richer and richest for the gendered analysis. The data here shows a clear prevalence of double burden of malnutrition for both men and women belonging to middle income section of the society. More than 50 percent of underweight men and women belonged to poorest or poorer sections of the society while more than 60 percent of overweight men and women belonged to richer and richest sections. Dutta *et. al.*, (2019) showed that poor adults are more likely to be underweight while wealthier adults tend to be overweight/obese rather than underweight. The results of a study focused on Indian women indicated a large concentration of underweight women among the low socioeconomic group and of overweight/obese women among the high socioeconomic group (Kulkarni *et. al.*, 2017). In this study we also hope to find similar results and document the differences if any for men and women. However, wealth status is more of a control variable than one of main interest in this study.

Household Size and Composition

We consider household size and composition to reflect any possible intra-household distribution effects with limited financial resources among the poorer households as well as increased household work for women. Household size is the number of persons in household and demographic composition is defined as: share of young (age 4 or less years) and older (age 5-12 years) children, share of male and female teenagers (age 13-19 years), share of adult males and females (age 20-65 years) and share of elder males and females (more than 65 years of age) in the house. The data here shows that among bottom two BMI quintiles for men or women the average household size is higher and so is the share of young children compared to other BMI quintiles and for the total sample.

Religion and Caste

People in India belong to different religions and castes and apart from differences in genetic factors across these groups and very limited inter-group marriages, the differences in culture, sentiments, eating and fasting habits could impact differences in body mass index among them. The study here uses religion (Hindu, Muslim, Christian, Sikh, Jains and Others) to observe its association with top 20th and bottom 20th BMI quantile for men and women separately. Our data shows that the except for Hindus, most other religions among men or women has a marginally higher share in the top two quintiles compared to their population share in the total sample. More than 80 percent of men and women belonging to lower quantile of BMI and more than 70 percent of those belonging to upper quantile of BMI are Hindus. A cross sectional analysis of MASALA study based on South Asians living in America with data from 2010-13 found that Hindus had a mean BMI of 25.8 kg/m^2, Sikhs 27.2 kg/m^2, Muslims 26.7 kg/m^2, Jains 25.6 kg/m^2, Christians 26.4 kg/m^2, and Others 22.9 kg/m^2, multiple religions 28.4 kg/m^2, and no religious affiliation 26.1 kg/m2 (Bharmal *et. al.*, 2018).

Caste/Tribe is defined in our study the same way as in NFHS as scheduled caste, scheduled tribe, other backward class, others and missing caste. Data indicates a higher prevalence of underweight men and women belonging to SC and ST. About 40 percent of both underweight and overweight men and women are OBC, indicating the presence of double burden.

Geographic Factors

Literature has many evidences to show that geographic factors, especially the place of residence (rural/urban) plays a major role in determining BMI of a person. The data in our study shows that 46 percent of overweight men and women and about 20 percent of underweight men and women are residing in urban areas. In this study, we have tried to group the states based on their respective geographic locations in India and address the comparative effect across men and women BMI. State groups referred as zones are: *North* - Jammu and Kashmir, Himachal Pradesh, Punjab, Chandigarh, Uttarakhand, Haryana, Delhi; *Central* - Rajasthan, Uttar Pradesh, Chhattisgarh, Madhya Pradesh; *West* - Gujarat, Daman and Diu, Dadra and Nagar Haveli, Maharashtra, Goa; *South* - Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Pondicherry; *East*- Bihar, Jharkhand, Odisha, Sikkim, West Bengal; North-

East - Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya, Assam.

A higher share of overweight men and women can be seen in Northern and Southern regions of India. Underweight men and women have a higher share in Central and Eastern states. Western and North Eastern states have similar share of underweight and overweight men and women. In a study with Asian population-specific cut-offs, 11 states were classified as double burden states by a study based on women's data in NFHS-2 and NFHS-3 (Sengupta *et. al.*, 2014). Another study based on WHO cut-offs for BMI showed that a higher prevalence of underweight was clustered in Uttar Pradesh, Bihar, and Madhya Pradesh among men and Bihar and Jharkhand among women. A high prevalence of overweight/obese men (more than 30 percent) was found in Goa, Andhra Pradesh, and Sikkim while for women overweight/ obesity was found to be clustered in the southern states of India. The most similar prevalence for underweight and overweight men was in Telangana while that for women was in Maharashtra and Karnataka (Dutta *et. al.*, 2019).

Table 1: Mean and Standard Deviation of Variables for bottom 20th and top 20th BMI quantiles

Variables	Men (20-54 years; N=89,374)		Women (20-49 years; N=525,454)	
	bottom 20 percent	top 20 percent	bottom 20 percent	top 20 percent
	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
BMI	17.82 (0.98)	27.72 (2.05)	17.36 (0.93)	28.42 (2.27)
Age	33.15 (10.1)	37.44 (9.02)	30.68 (8.4)	36.3 (7.75)
Age squared	1200.72 (719.02)	1483.29 (679.8)	1011.64 (557.37)	1377.97 (554.51)
No schooling	0.21 (0.41)	0.09 (0.29)	0.42 (0.49)	0.24 (0.43)
< 5 years of education	0.09 (0.29)	0.05 (0.22)	0.07 (0.26)	0.06 (0.23)
5-7 years of education	0.18 (0.39)	0.13 (0.33)	0.14 (0.35)	0.15 (0.36)
8-9 years of education	0.21 (0.41)	0.17 (0.38)	0.14 (0.34)	0.16 (0.37)
10-11 years of education	0.11 (0.31)	0.18 (0.38)	0.08 (0.27)	0.14 (0.35)
≥12 years of education	0.2 (0.4)	0.38 (0.49)	0.16 (0.36)	0.24 (0.43)
Currently married	0.7 (0.46)	0.84 (0.36)	0.8 (0.4)	0.89 (0.31)
Formerly married	0.02 (0.15)	0.01 (0.1)	0.05 (0.21)	0.05 (0.22)
Never_married	0.27 (0.45)	0.14 (0.35)	0.15 (0.36)	0.06 (0.23)
Non vegetarian	0.25 (0.44)	0.32 (0.47)	0.19 (0.39)	0.24 (0.43)
Semi vegetarian	0.09 (0.29)	0.12 (0.32)	0.07 (0.25)	0.1 (0.3)

Continued…Table 1

Continued…Table 1

Variables	Men (20-54 years; N=89,374)		Women (20-49 years; N=525,454)	
	bottom 20 percent	top 20 percent	bottom 20 percent	top 20 percent
	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
Pesco vegetarian	0.08 (0.27)	0.08 (0.27)	0.09 (0.29)	0.09 (0.29)
Lacto-ovo_vegetarian	0.09 (0.28)	0.08 (0.28)	0.08 (0.27)	0.07 (0.26)
Lacto vegetarian	0.31 (0.46)	0.32 (0.47)	0.32 (0.47)	0.36 (0.48)
vegan	0.18 (0.38)	0.08 (0.27)	0.25 (0.43)	0.13 (0.34)
Aerated drinks	0.26 (0.44)	0.35 (0.48)	0.19 (0.39)	0.27 (0.44)
Fried	0.43 (0.5)	0.48 (0.5)	0.43 (0.49)	0.47 (0.5)
Alcohol	0.36 (0.48)	0.35 (0.48)		
Tobacco	0.41 (0.49)	0.33 (0.47)		
Not working	0.11 (0.31)	0.07 (0.25)		
More sedentary jobs	0.04 (0.2)	0.14 (0.35)		
Less sedentary jobs	0.05 (0.23)	0.15 (0.35)		
Active manual jobs	0.76 (0.43)	0.6 (0.49)		
Other jobs	0.04 (0.19)	0.05 (0.21)		
Fetch water			0.35 (0.48)	0.16 (0.36)
Clean fuel			0.22 (0.41)	0.61 (0.49)

Continued…Table 1

Continued…Table 1

Variables	Men (20-54 years; N=89,374)		Women (20-49 years; N=525,454)	
	bottom 20 percent	top 20 percent	bottom 20 percent	top 20 percent
	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
Media	0.44 (0.5)	0.72 (0.45)	0.44 (0.5)	0.73 (0.45)
Mobile	0.9 (0.29)	0.98 (0.15)	0.06 (0.24)	0.12 (0.32)
Non-motor transport	0.69 (0.46)	0.37 (0.48)		
Bike	0.28 (0.45)	0.48 (0.5)		
Car	0.03 (0.17)	0.15 (0.36)		
Open defecation	0.51 (0.5)	0.17 (0.38)	0.52 (0.5)	0.17 (0.38)
Visit hospital	0.11 (0.31)	0.08 (0.27)	0.03 (0.16)	0.02 (0.14)
No insurance	0.8 (0.4)	0.76 (0.43)	0.82 (0.38)	0.81 (0.39)
Public insurance	0.18 (0.39)	0.2 (0.4)	0.17 (0.37)	0.17 (0.38)
Private insurance	0.01 (0.08)	0.02 (0.13)	0.01 (0.09)	0.02 (0.12)
Employer insurance	0.00 (0.07)	0.02 (0.15)	0.00 (0.04)	0.01 (0.08)
Poorest	0.28 (0.45)	0.04 (0.21)	0.31 (0.46)	0.05 (0.22)
Poorer	0.27 (0.44)	0.11 (0.31)	0.27 (0.44)	0.12 (0.32)
Middle	0.21 (0.41)	0.2 (0.4)	0.2 (0.4)	0.2 (0.4)
Richer	0.15 (0.35)	0.28 (0.45)	0.14 (0.34)	0.28 (0.45)
Richest	0.09 (0.29)	0.37 (0.48)	0.09 (0.28)	0.35 (0.48)

Continued…Table 1

Continued…Table 1

Variables	Men (20-54 years; N=89,374)		Women (20-49 years; N=525,454)	
	bottom 20 percent	top 20 percent	bottom 20 percent	top 20 percent
	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
No of persons in house	5.7 (2.6)	5.42 (2.63)	5.87 (2.64)	5.5 (2.68)
Share of young children	0.1 (0.13)	0.08 (0.12)	0.11 (0.14)	0.07 (0.11)
Share of old children	0.13 (0.17)	0.13 (0.17)	0.16 (0.18)	0.14 (0.17)
Share of teen females	0.06 (0.11)	0.05 (0.11)	0.06 (0.1)	0.07 (0.12)
Share of teen males	0.06 (0.11)	0.06 (0.11)	0.07 (0.11)	0.08 (0.13)
Share of adult males	0.27 (0.12)	0.3 (0.12)	0.32 (0.14)	0.33 (0.14)
Share of adult females	0.34 (0.18)	0.34 (0.17)	0.26 (0.13)	0.28 (0.15)
Share of elder males	0.01 (0.05)	0.02 (0.06)	0.01 (0.05)	0.02 (0.05)
Share of elder females	0.02 (0.06)	0.02 (0.06)	0.02 (0.05)	0.02 (0.06)
Hindu	0.81 (0.39)	0.72 (0.45)	0.81 (0.39)	0.71 (0.46)
Muslim	0.12 (0.33)	0.14 (0.35)	0.11 (0.32)	0.16 (0.37)
Christian	0.04 (0.2)	0.07 (0.25)	0.04 (0.2)	0.07 (0.25)
Sikh	0.01 (0.1)	0.04 (0.19)	0.01 (0.11)	0.04 (0.19)
Jain	0 (0.03)	0 (0.05)	0 (0.03)	0 (0.05)
Other religions	0.02 (0.13)	0.03 (0.18)	0.02 (0.14)	0.02 (0.15)

Continued…Table 1

Continued…Table 1

Variables	Men (20-54 years; N=89,374)		Women (20-49 years; N=525,454)	
	bottom 20 percent	top 20 percent	bottom 20 percent	top 20 percent
	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
SC	0.21 (0.41)	0.14 (0.35)	0.2 (0.4)	0.15 (0.36)
ST	0.19 (0.39)	0.13 (0.33)	0.2 (0.4)	0.11 (0.31)
OBC	0.4 (0.49)	0.4 (0.49)	0.4 (0.49)	0.4 (0.49)
Other castes	0.16 (0.36)	0.28 (0.45)	0.19 (0.39)	0.34 (0.47)
Urban	0.22 (0.42)	0.45 (0.5)	0.19 (0.39)	0.46 (0.5)
North	0.11 (0.31)	0.2 (0.4)	0.09 (0.28)	0.2 (0.4)
Central	0.4 (0.49)	0.21 (0.41)	0.38 (0.48)	0.26 (0.44)
West	0.12 (0.32)	0.13 (0.33)	0.1 (0.29)	0.09 (0.29)
South	0.09 (0.29)	0.21 (0.41)	0.1 (0.3)	0.2 (0.4)
East	0.19 (0.39)	0.14 (0.35)	0.24 (0.43)	0.14 (0.35)
North East	0.1 (0.3)	0.11 (0.31)	0.1 (0.3)	0.12 (0.32)

Source: Author's own calculations from NFHS 4

Quantile Regressions Estimates: Results and Discussions

In this section we first discuss the results for the full sample and followed by a comparison with two sub-samples in the respective gender category: (a) couple sample for both men and women and (b) matched sample for women. The couple sample is one where married couples are only considered and the sampling weights used are that for the male sample in the regression estimates[3]. As the sample size for women is much larger in the full sample compared to the full sample for men, a separate analysis is carried out in order to understand if there are any differences in estimates if the women sample is restricted to only those households for which the men sample was collected. The matched sample analysis is relevant only for women where the index woman's sample is only from those households where at least one male member has also been surveyed.

As indicated earlier, the sample size for adult men and women samples are different and there are also differences in covariates particularly concerning occupations and daily activities and hence, the models are estimated separately for men and women.

Full Sample: Men and Women

In this section the estimated coefficients (Table 2) for men and women samples are contrasted for their statistical significance, sign and if the (relative) magnitude compared to other coefficients within the sample are similar.

Within each quintile BMI increases with age and then at a much older age there is a very marginal decline. Similar result is observed for education up to 9 years, after which the coefficient magnitude for top quintile is lower than that for bottom quintile indicating that at higher levels of education, both men and women do not have that high a BMI. Within a quintile, BMI increases secularly with education for men while for women the magnitude dips for 10 or more years of education marginally and a larger dip for 12 or more years of education though BMI is still higher compared to those who are not educated. This is an important result where more educated women are perhaps more aware

[3] This is based on the NFHS user forum discussions including responses from Senior DHS STATA specialist https://userforum.dhsprogram.com/index.php?t=msg&th=4862&goto=9258&S=Google

of their health and being lean could be an important component of a style statement affecting women more than men.

The unmarried have lower average BMI among men and women but marital status plays an important role for women - with a higher magnitude for currently married women compared to those who are not with their spouse - which is not the case for men. The proportion of ever married women who are not with their spouse is far higher than it is for men and this could be the reason for the difference within the married category.

Type of diet preferences has a far more significant effect on women than on men. A common result is that vegan diet reduces BMI which is harmful for those at the bottom quintile but beneficial for those at the top. Among women, the highest average BMI is observed among those who consume all types of non-vegetarian diet or the semi-vegetarian (only chicken). Compared to this, the largest decline is for vegans in the low BMI quintile while it is for pesco-veg in top BMI quintile. The least decline is for lacto-vegetarian in the top BMI quintile and has been discussed in the literature that the overweight and obese are high among those who consume non-vegetarian food which is cooked with high usage of fat/oil while the lacto-vegetarians are known to consume more of butter and *ghee* which would increase BMI unless the calories are not burnt from more physical activity. Pesco-vegetarian (only fish) and lacto-ovo-vegetarian (milk products and egg only) has a moderating effect on the BMI. Among men also, non-vegetarian diet increases BMI but no different from most other diets except vegan. Thus, it substantiates that women's BMI is more strongly affected by dietary habits and we analyse later if this could be due to a large sample size than that for men. Consumption of aerated drinks is on an average higher among men with positive effects on BMI only in the top quintile. Impact of alcohol and tobacco consumption on BMI is studied only for men as the proportion of women consuming alcohol and tobacco is very less. Tobacco consumption leads to significant decline in BMI of men, with a higher decline in top quintile.

Among women, strenuous physical activity like fetching water compared to accessing water inside the household premise and collection and management of firewood, crop residue or cow dung cake as cooking fuel compared to a cleaner fuel LPG has negative influence on BMI, irrespective of the quintile they belong to. With likely contamination of water from open sources, or the use of cooking fuels causing high indoor air pollution, would adversely affecting women's BMI women from weight loss due to frequent illness.

Women's labour market participation in India is low and hence limited data was collected in the survey on their employment aspects and for men activities related to household chores are not available in the data. This clearly depicts gendered segregation of unpaid household work carried out by women while men engage only on gainful economic activity. NFHS-4 provides a description of men's occupation in some detail that helps in classifying then into activities that are sedentary or manual jobs including those who are not active in the labour market like students enrolled in colleges, unemployed and retired. As shown in Table 2 compared to the reference category of those not in any occupation, all men in any occupation have a positive and significant coefficient with the magnitude being the highest for the most sedentary and declines with the increase in the manual nature of the occupation in the bottom quintile. In the top quintile the gaps across the occupation category is smaller though all are positive except that men in active manual occupation are no different from those not in employment. Once again like diets, physical activity has a balancing role: among the bottom quintile those with more physical activity are have further lower BMI while in the top quintile the BMI is lower among the physically active occupations. Those with no occupation is a mix of age groups- the youthful students group could be more physically active while the older men without an occupation could perhaps be challenged in some way and hence a lower BMI even after controlling for other factors. Longer hours of TV watching and mobile phone usage are well-known reasons for lower physical activity among men and women and similarly use of motorized vehicle (car and motorbike) for transportation by men compared to walking or cycling. Even though economic status determines the affordability to buy and use gadgets or own a vehicle, we find that such coefficients are positive and statistically significant even after controlling for wealth status and education.

Open defecation captures poor hygienic environment and thereby higher morbidity from infectious disease and that could lead to loss of body weight due to frequent illness. The significant negative coefficient for men and women in households with no toilet facility is reflective of this condition irrespective of the BMI quintile. Not having access to toilets at home would additionally affect women in their menstrual hygiene and reproductive health with further adverse effect on BMI and perhaps contributing to a larger negative value for women compared to men.

Visit to a doctor in the last 12 months indicates ill health of some severity either from short or long term morbidity that could affect body weight adversely resulting in a lower BMI. Possessing health insurance policy perhaps facilitates timely (particularly private) and quality health care access and countervails the impact of illness severity as reflected in a positive and significant coefficient for bottom quintile, is a relevant finding.

Those in the top quintile have a higher risk to non-communicable diseases and with higher treatment cost, the insurance policies cover the risk for such idiosyncratic ailments than from a covariate risk associated with communicable disease (which would be higher among the bottom BMI quintile). The positive effects of all such associations are becoming apparent in the positive coefficient for health insurance access. For women, none of these coefficients are significant in the top quintile and that for men any type of health insurance access is significant could also be reflective of the fact that such insurance may be individual specific rather than for all family members. Not only is there a need to safeguarding the health of the adult males in the family who are the primary breadwinners but access to monetary resources also enables them to pay their premiums regularly. This is further substantiated by the fact that the coefficient is positive for both men and women who have access to health insurance from their employer. With women's employment rate being higher among the underprivileged it is more obvious in the bottom quintile for them. The gendered difference in association of BMI and health insurance access could be from a bias against them -either they do not have insurance in their names or even if they have their health concerns may get limited or delayed attention as their contributions cannot be easily monetized as for a man who has an earning and hence controls the household's finances.

Access to good diet and lifestyle depends largely on economic conditions of a person. As expected, poorest and poorer wealth quintiles have negative effects on men and women BMI (with higher magnitude for top quintile) and richer and richest wealth quintiles have positive effects on men and women BMI, keeping middle wealth quintile as reference. Unlike women, men belonging to the richest category have higher increase in bottom quintile BMI than the increase in top quintile BMI.

Household size and composition controlling for other economic characteristics in a study like this would capture the time use and hence the energy expended in taking care of family members particular very young children or elderly members. A negative coefficient for family size in lowest quintile for both men and women is reflective of limited resources available (including nutritious diet) that has to be shared among more members. Households with higher share of 0-4 year old children is also reflective of more resources and effort required for care-giving after accounting for quality of diet and some form of physical activity. The coefficient has a large negative value for women and the dip substantial among the top BMI quintile, is indicative of the tilting in body's balance towards higher energy expenditure compared to its intake in such households. A similar pattern for elderly care is not observed and the negative coefficient for share of teens among men in bottom BMI is unexplainable.

An important predictor of BMI is the religion variable for both men and women and for top and bottom quintiles as observed from its statistical significance. Fasting and lifestyle habits that vary with religious practices seem to have an additional effect even after controlling for economic status and physical activity pattern in explaining the variations in BMI. Hindu households on an average have lower BMI compared to Muslims, Christians and Sikhs with similar pattern for both men and women and among top and bottom quintiles. For women the coefficients for other remaining religions are also significant in bottom and top quintile perhaps due to a larger sample size and hence the variability among them is better captured. In the Indian context vegetarian diets and fasting habits are strongly linked to religious beliefs and one such religion is Jainism (Agarwal, 2005 and Bharmal, 2018). Detailed studies based on primary surveys indicate a higher risk to cardio-vascular diseases for men and women and higher rates of obesity among Jains. This becomes important as they follow very strict vegetarianism but have a higher intake of milk based products and as we have already controlled for lacto-vegetarian diet as an indicator variable so we do not find evidence similar to what other studies have shown for Jains. However, in the sub-sample analysis discussed later we find support for this and will be discussed again.

Hindus (in particular) are further divided into several castes and the official data on such identity is grouped into OBC, SC, ST and Others. The social hierarchy and discrimination with geographic concentration of the tribes in forest areas may give them limited access to economic opportunities and healthcare facilities. Only for women and that too among scheduled castes we find that they have lower BMI on an average for both bottom and top quintile.

Urban areas have higher BMI compared to rural irrespective of gender and quintile after controlling for economic and social infrastructure variables. Compared to northern states, higher BMI is concentrated in southern states while all other states have lower BMI or are no different from it across quintiles and gender. The western region is an exception with negative coefficient for low BMI and a positive coefficient for top BMI among men capturing the presence of double burden of malnutrition in that region. However, for women we find that for both bottom and top quintile the coefficient is negative with the gap being largest for bottom quintile compared to all other regions.

Overall, the quantile regression estimates enable us to understand the double burden of malnutrition and the balance one needs to maintain between healthy diets and lifestyle habits, as well as the role of social and health infrastructure variables in enabling it. The OLS estimates reported in Appendix A2 are inadequate to capture the differences. Multinomial logit model is more preferred in this strand of empirical analysis to distinguish between the underweight, normal weight, overweight and obese. Compared to regression estimates from a non-linear polychotomous discrete regression model, the interpretation of coefficients in a quantile regression model is easier, being similar to the marginal effects from a linear regression model.

Full Sample Versus Matched Sample: Women

In order to understand if the differences in results for men and women are to some extent drives by the differences in sample size, we match the sample of 20-49 year old women with that of at least one male in the sample. This reduces the sample size to 75,588 as shown in Table 2. We find that the results in terms of significance and sign remain largely same between the full and matched samples for bottom quintile. However, in the top quintile coefficient estimates for dietary habits, household and social demography are insignificant. In both top and bottom quintile, among the statistically significant coefficients, very rarely the magnitudes are similar to the full sample, including the intercept indicating that relative effect of a particular variable within a given sample could be different from the smaller sub-samples.

For variables that we focus on, the results for top quintile is similar to couple sample discussed below. We find statistically insignificant coefficients compared to the reference group in the respective categorical variable for: 12 or more years of education, diet variables and the household composition variable like adult male share. Among statistically significant coefficients, dip in the coefficient value is observed for women with 10 or more years of education compared to the women with fewer years of education, significantly negative (positive) coefficient for those with employer insurance in the top (bottom) quintile, large and positive coefficient for Jain women and larger magnitude for women from Western India.

Table 2: Quantile Regression Analysis of the impact of different covariates on bottom 20th and top 20th quantiles of BMI

			Women (20-49 years)			
	All Men (20-54 years; N=89,374)		**All (N=525,454)**		**Matched with All Men Sample (N=75,588)**	
Variables	**bottom 20 percent**	**top 20 percent**	**bottom 20 percent**	**top 20 percent**	**bottom 20 percent**	**top 20 percent**
Age	0.27*** (0.02)	0.36*** (0.02)	0.27*** (0.01)	0.49*** (0.01)	0.33*** (0.03)	0.47*** (0.04)
Age squared	-0.003*** (0.0003)	-0.004*** (0.0003)	-0.004*** (0.0004)	-0.005*** (0.0005)	-0.004*** (0.0004)	-0.005*** (0.0005)
No schooling (base)						
1-4 years of education	0.15* (0.08)	0.28*** (0.09)	0.22*** (0.03)	0.43*** (0.06)	0.23*** (0.08)	0.36*** (0.13)
5-7years of education	0.27*** (0.06)	0.44*** (0.09)	0.47*** (0.03)	0.72*** (0.04)	0.40*** (0.06)	0.59*** (0.09)
8-9years of education	0.37*** (0.06)	0.42*** (0.09)	0.56*** (0.03)	0.85*** (0.04)	0.47*** (0.07)	0.68*** (0.11)
10-11years of education	0.67*** (0.08)	0.62*** (0.09)	0.59*** (0.03)	0.78*** (0.05)	0.52*** (0.08)	0.53*** (0.12)
≥12 years of education	0.85*** (0.07)	0.65*** (0.09)	0.58*** (0.03)	0.46*** (0.05)	0.36*** (0.07)	0.15 (0.11)
Never married (base)						
Currently married	0.45*** (0.07)	0.51*** (0.08)	0.85*** (0.03)	1.14*** (0.05)	0.69*** (0.08)	0.93*** (0.13)
Formerly married	-0.23 (0.15)	-0.33 (0.23)	0.55*** (0.06)	0.74*** (0.08)	0.39** (0.16)	0.44** (0.19)
Non vegetarian (base)						
Semi vegetarian	-0.16* (0.08)	0.01(0.10)	-0.21*** (0.04)	-0.10 (0.06)	-0.39*** (0.11)	0.07 (0.13)
Pesco vegetarian	0.03 (0.07)	-0.36*** (0.09)	-0.04 (0.03)	-0.24*** (0.05)	-0.09 (0.08)	-0.08 (0.21)
Lacto-ovo vegetarian	-0.14** (0.07)	-0.10 (0.08)	-0.21*** (0.04)	-0.22*** (0.06)	-0.26*** (0.08)	-0.10 (0.12)
Lacto vegetarian	-0.05 (0.06)	-0.16** (0.08)	-0.13*** (0.03)	-0.19*** (0.04)	-0.12* (0.07)	0.05 (0.09)

Continued…Table 2

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			Women (20-49 years)			
	All Men (20-54 years; N=89,374)		All (N=525,454)		Matched with All Men Sample (N=75,588)	
Variables	**bottom 20 percent**	**top 20 percent**	**bottom 20 percent**	**top 20 percent**	**bottom 20 percent**	**top 20 percent**
Vegan	-0.20*** (0.07)	-0.38*** (0.09)	-0.23*** (0.03)	-0.21*** (0.04)	-0.36*** (0.07)	-0.15 (0.10)
Aerated drinks	-0.02 (0.05)	0.12** (0.06)	0.02 (0.02)	0.04 (0.03)	0.07 (0.05)	-0.07 (0.07)
Fried	0.03 (0.04)	-0.03 (0.05)	0.06*** (0.02)	0.01 (0.03)	0.11** (0.05)	-0.02 (0.06)
Alcohol	0.05 (0.05)	-0.02 (0.06)				
Tobacco	-0.08* (0.04)	-0.14** (0.06)				
Fetch water			-0.15*** (0.02)	-0.24*** (0.03)	-0.13*** (0.04)	-0.03 (0.07)
Dirty fuel			-0.36*** (0.03)	-0.63*** (0.04)	-0.37*** (0.06)	-0.73*** (0.09)
Not working ; Non-motor transport ; (base)						
Less sedentary jobs	0.66*** (0.10)	0.27** (0.13)				
Active manual jobs	0.30*** (0.07)	-0.05 (0.11)				
Other jobs	0.25** (0.12)	0.65*** (0.21)				
Media	0.06 (0.05)	0.24*** (0.06)	0.22*** (0.02)	0.37*** (0.03)	0.25*** (0.05)	0.48*** (0.07)
Mobile	0.48*** (0.06)	0.55*** (0.10)	0.25*** (0.03)	0.31*** (0.05)	0.45*** (0.05)	0.66*** (0.07)
Bike	0.38*** (0.05)	0.33*** (0.06)				
Car	0.69*** (0.10)	0.49*** (0.15)				

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			Women (20-49 years)			
	All Men (20-54 years; N=89,374)		All (N=525,454)		Matched with All Men Sample (N=75,588)	
Variables	**bottom 20 percent**	**top 20 percent**	**bottom 20 percent**	**top 20 percent**	**bottom 20 percent**	**top 20 percent**
Open defecation	-0.16*** (0.05)	-0.31*** (0.07)	-0.20*** (0.02)	-0.47*** (0.03)	-0.15*** (0.05)	-0.55*** (0.08)
Visit to hospital	-0.31*** (0.06)	-0.23*** (0.06)	-0.45*** (0.06)	-0.57*** (0.09)	-0.46*** (0.15)	-0.81*** (0.21)
No insurance; Wealth Quintile: Middle (base)						
Public insurance	0.07 (0.05)	0.12* (0.07)	0.03 (0.02)	-0.02 (0.03)	0.15** (0.06)	0.13 (0.08)
Private insurance	0.39* (0.22)	0.69*** (0.22)	0.24*** (0.07)	-0.11 (0.12)	0.77*** (0.24)	-0.16 (0.13)
Employer insurance	0.41* (0.23)	0.45* (0.31)	0.57*** (0.08)	0.17 (0.26)	1.22*** (0.43)	-0.59** (0.57)
Poorest	-0.43*** (0.07)	-0.99*** (0.09)	-0.55*** (0.03)	-1.21*** (0.04)	-0.53*** (0.07)	-1.11*** (0.10)
Poorer	-0.26*** (0.06)	-0.59*** (0.07)	-0.34*** (0.03)	-0.52*** (0.04)	-0.30*** (0.06)	-0.47*** (0.09)
Richer	0.42*** (0.07)	0.56*** (0.09)	0.42*** (0.03)	0.62*** (0.05)	0.54*** (0.07)	0.78*** (0.10)
Richest	1.06*** (0.09)	0.94*** (0.11)	0.98*** (0.04)	1.12*** (0.06)	0.89*** (0.10)	1.11*** (0.13)
No. of persons in house	-0.03*** (0.01)	-0.01 (0.01)	-0.01*** (0)	0 (0)	-0.01 (0.01)	0.01 (0.01)
Share of children 0-4 years	-0.39** (0.21)	-0.67*** (0.25)	-0.85*** (0.09)	-1.75*** (0.14)	-1.04*** (0.24)	-1.85*** (0.38)
Share of children 5-14 yrs	0.07 (0.17)	0.23 (0.21)	-0.36*** (0.08)	-0.74*** (0.12)	-0.59*** (0.23)	-0.82*** (0.32)
Share of teen females	-0.42** (0.23)	-0.82*** (0.24)	-0.15 (0.10)	-0.23 (0.15)	-0.29 (0.26)	-0.26 (0.38)

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			Women (20-49 years)			
	All Men (20-54 years; N=89,374)		All (N=525,454)		Matched with All Men Sample (N=75,588)	
Variables	**bottom 20 percent**	**top 20 percent**	**bottom 20 percent**	**top 20 percent**	**bottom 20 percent**	**top 20 percent**
Share of teen males	-0.51** (0.23)	-0.30* (0.31)	-0.05 (0.09)	-0.70*** (0.15)	-0.55* (0.29)	-1.10*** (0.37)
Share of adult males			-0.02 (0.09)	-0.50*** (0.15)	-0.09 (0.32)	-0.44 (0.41)
Share of adult females	0.08 (0.24)	0.36 (0.27)				
Share of elder males	0.18 (0.31)	-0.60 (0.50)	-0.11 (0.19)	-0.40 (0.26)	-0.77* (0.44)	0.17 (0.70)
Share of elder females	-0.17 (0.39)	0.73 (0.57)	-0.37** (0.16)	-0.24 (0.22)	-0.20 (0.45)	-0.37 (0.57)
Hindu ; OBC; (base)						
Muslim	0.35*** (0.07)	0.27*** (0.08)	0.31*** (0.03)	0.70*** (0.04)	0.39*** (0.08)	0.65*** (0.10)
Christian	0.61*** (0.13)	0.05 (0.19)	0.48*** (0.07)	0.45*** (0.07)	0.47*** (0.08)	0.31 (0.25)
Sikh	0.50*** (0.15)	0.93*** (0.16)	0.50*** (0.05)	0.72*** (0.08)	0.42*** (0.14)	0.62*** (0.16)
Jain	0.25 (0.69)	0.14 (0.80)	-0.06 (0.04)	0.42 (0.31)	-0.16 (0.41)	1.22*** (0.14)
Other religions	0.24 (0.22)	0.31 (0.42)	0.22*** (0.06)	0.22* (0.13)	0.26*** (0.08)	0.22* (0.13)
SC	0.05 (0.05)	-0.07 (0.07)	-0.01 (0.02)	0.02 (0.03)	-0.07 (0.06)	0.02 (0.08)
ST	0.06 (0.05)	-0.28*** (0.08)	-0.14*** (0.03)	-0.40*** (0.04)	-0.13** (0.06)	-0.52*** (0.10)

Continued… Table 2

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			Women (20-49 years)			
	All Men (20-54 years; N=89,374)		All (N=525,454)		Matched with All Men Sample (N=75,588)	
Variables	**bottom 20 percent**	**top 20 percent**	**bottom 20 percent**	**top 20 percent**	**bottom 20 percent**	**top 20 percent**
Other castes	0.09 (0.06)	0.16** (0.07)	0.17*** (0.02)	0.31*** (0.03)	0.15*** (0.06)	0.25*** (0.08)
Rural, North (Base)						
Urban	0.15*** (0.05)	0.46*** (0.07)	0.33*** (0.02)	0.57*** (0.04)	0.27*** (0.05)	0.38*** (0.08)
Central	-0.50*** (0.07)	-0.35*** (0.08)	-0.28*** (0.03)	-0.05 (0.05)	-0.32*** (0.07)	-0.10 (0.10)
West	-0.34*** (0.09)	0.42*** (0.11)	-0.79*** (0.04)	-0.20*** (0.07)	-0.84*** (0.09)	-0.22* (0.13)
South	0.32*** (0.09)	0.73*** (0.10)	-0.07 (0.04)	0.61*** (0.06)	-0.07 (0.09)	0.65*** (0.13)
East	-0.01 (0.08)	0.17 (0.10)	-0.26*** (0.04)	0.04 (0.06)	-0.27*** (0.07)	0.16 (0.12)
North East	-0.25*** (0.09)	-0.11 (0.11)	-0.44*** (0.04)	-0.52*** (0.06)	-0.51*** (0.08)	-0.55*** (0.14)
Constant	12.60*** (0.36)	15.80*** (0.45)	12.44*** (0.17)	13.53*** (0.25)	11.48*** (0.42)	13.58*** (0.61)
R^2	**0.09**	**0.12**	**0.09**	**0.14**	**0.09**	**0.14**

Source: Author's own estimations from NFHS 4; Note: p-values are in parentheses
Note: **** p<0.01, ** p<0.05, * p<0.1*

Couple Sample Versus Full Sample: Men

The results for men based on the full and the couple sample shows that results vary and more so for top BMI quintile (Table 3). BMI increases with education within both low and top BMI quintile but those with 12 or above years of schooling the magnitude declines in the couple sample. The results for dietary habits are different between the two samples except for pesco-vegetarian and vegan diets which show a decline in BMI.

Most importantly, those in active manual jobs show an expected and large decline in top 20^{th} quintile of BMI for couple sample while they are no different from the reference category of not in employment in the full sample results.

The association of wealth quintiles is not very different in a relative sense either between full and couple sample or between low and high BMI quintiles. While region specific variables including rural-urban show similar and expected results in both the samples, there are significant differences in the results for demographic and social variables as well as health seeking behavior like insurance and hygiene variables.

Couple Sample Versus Full Sample: Women

The results for these two samples are slightly different with respect to the education variables but differ substantially for the diet, socio-demographic and regional variables (Table 3). Otherwise, results are largely similar even though the sample size declines from 525,454 to 56,429 between full and couple sample.

Among women with 12 or more years of education it is observed that in the couples sample the average BMI are no different from those without any education in the top quintile. However, what is relevant to note is that in the couple sample the dip in magnitude for those with 10 or more years of education compared to those with lower years of education (keeping no education as reference category) is similar to the finding for full sample among those with 12 or more years of education. This difference from the full sample result could be because the couple sample may have fewer women who are better educated as it curtails the sample to only ever married women. Married women are likely to be less educated for two reasons. The older among them would have not had access to education due to lower economic development of India in earlier times. We are also less likely to find younger married women who have 10 or more years of education as being enrolled in school would have postponed their marriage to a later age. However, this only further substantiates that better educated women irrespective of the sub-sample are relatively thinner within their respective BMI quintile.

A second source of difference in the couple sample is that none of the diet variables are statistically significant for top quintile. In the bottom quintile the difference for the couples sample is in the pesco-vegetarian diet contributing to further lowering of BMI while it is no different from the non-vegetarian diet in the full sample. Apart from that, compared to non-vegetarian diets, all other diets lead to lower average BMI but with magnitude that are much higher in the couples sample than in the full sample. The similarity lies in the relative ranking of the diets with lacto-vegetarian being closer to non-vegetarian followed by lacto-ovo-vegetarian or vegan diets.

The results also differ for the two samples for activities like fetching water or for different types of insurance coverage (proxy for health seeking behavior) but largely in the bottom quintile. Child care and elderly care are strenuous activities for women, with lower BMI in both the quintiles in the full sample but the impact is large and significant only for women with very young children in the couple sample. Perhaps a smaller couple sample is unable to capture the wider range of variations in the full sample.

Household and social demographic variables also show somewhat different results in the couple sample compared to the full sample. Household size and share of 0-4 year old children in the family have a larger magnitude in the lowest BMI quintile for the couple sample while in both the models they have a significant negative effect. In the couple sample all women are married and are likely to take on more of domestic activities and the share of women with small children would be higher in this case. This perhaps leads to stronger effect for demographic coefficients. Women following Jain religion have a large positive and significant coefficient in the couple sample among the top BMI quintile. We highlight this result as their diets are known to be categorized in lacto-vegetarian diet and with morbidity risk from cardio-vascular diseases (Dhall *et. al.*, 2011).

Table 3: Quantile Regression Analysis based on Couple's Data (NFHS 4)

	Men (20-54 years; N=61,383)		Women (20-49 years;N=56,429)	
	20th Quantile	80th Quantile	20th Quantile	80th Quantile
Age	0.27*** (0.02)	0.32*** (0.02)	0.33*** (0.03)	0.45*** (0.05)
Age squared	-0.004*** (0.0003)	-0.004*** (0.0003)	-0.005*** (0.0006)	-0.004*** (0.0004)
1-4 years of education	0.13 (0.07)	0.32*** (0.11)	0.23*** (0.08)	0.36*** (0.13)
5-7years of education	0.21*** (0.08)	0.43*** (0.09)	0.42*** (0.07)	0.54*** (0.1)
8-9years of education	0.33*** (0.07)	0.45*** (0.09)	0.38*** (0.07)	0.57*** (0.13)
10-11years of education	0.61*** (0.09)	0.70*** (0.12)	0.46*** (0.08)	0.37** (0.15)
≥12 years of education	0.77*** (0.09)	0.59*** (0.11)	0.41*** (0.09)	0.12 (0.14)
Semi vegetarian	-0.13 (0.10)	-0.26* (0.15)	-0.40*** (0.11)	0.09 (0.17)
Pesco vegetarian	0.03 (0.09)	-0.28*** (0.11)	-0.21** (0.09)	0.07 (0.14)
Lacto-ovo vegetarian	-0.13 (0.09)	-0.12 (0.12)	-0.28*** (0.08)	-0.05 (0.18)
Lacto vegetarian	-0.06 (0.07)	-0.11 (0.09)	-0.15** (0.07)	0.13 (0.11)
Vegan	-0.21*** (0.07)	-0.39*** (0.10)	-0.40*** (0.07)	-0.03 (0.11)

Continued… Table 3

Continued… Table 3

	Men (20-54 years; N=61,383)		Women (20-49 years; N=56,429)	
	20th Quantile	**80th Quantile**	**20th Quantile**	**80th Quantile**
Aerated drinks	-0.02 (0.06)	0.12 (0.07)	0.05 (0.06)	-0.03 (0.09)
Fried	0.04 (0.04)	0.01 (0.05)	0.09* (0.05)	-0.02 (0.08)
Alcohol	0.01 (0.04)	-0.06 (0.06)		
Tobacco	-0.12** (0.04)	-0.13** (0.06)		
Fetch water			-0.09** (0.05)	-0.09 (0.08)
Clean fuel			0.31*** (0.07)	0.77*** (0.11)
More sedentary jobs	0.67*** (0.16)	-0.20 (0.18)		
Less sedentary jobs	0.60*** (0.15)	-0.33* (0.17)		
Active manual jobs	0.16 (0.13)	-0.64*** (0.13)		
Other jobs	0.22 (0.16)	0.14 (0.23)		
Media	0.08 (0.06)	0.30*** (0.07)	0.25*** (0.05)	0.52*** (0.09)
Mobile	0.42*** (0.07)	0.55*** (0.08)	0.41*** (0.05)	0.59*** (0.09)
Bike	0.52*** (0.06)	0.44*** (0.08)		
Car	0.67*** (0.12)	0.48*** (0.19)		
Open defecation	-0.17*** (0.06)	-0.45*** (0.09)	-0.19*** (0.05)	-0.58*** (0.1)
Visit to hospital	-0.31*** (0.07)	-0.16* (0.09)	-0.41*** (0.14)	-0.73*** (0.11)

Continued… Table 3

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	Men (20-54 years; N=61,383)		Women (20-49 years;N=56,429) mv005	
	20th Quantile	**80th Quantile**	**20th Quantile**	**80th Quantile**
Public insurance	0.10 (0.06)	0.20*** (0.07)	0.15** (0.06)	0.08 (0.09)
Private insurance	0.37* (0.20)	0.88** (0.35)	0.76*** (0.09)	-0.29(0.19)
Employer insurance	0.23 (0.24)	0.47 (0.33)	1.24*** (0.34)	-0.94*** (0.16)
Poorest	-0.40*** (0.09)	-1.15*** (0.11)	-0.55*** (0.07)	-1.20*** (0.12)
Poorer	-0.26*** (0.08)	-0.77*** (0.09)	-0.31*** (0.06)	-0.50*** (0.11)
Richer	0.59*** (0.09)	0.45*** (0.11)	0.60*** (0.08)	0.84*** (0.13)
Richest	1.24*** (0.11)	0.88*** (0.13)	1.13*** (0.1)	1.24*** (0.17)
No. of persons in house	-0.02** (0.01)	-0.01 (0.01)	-0.02* (0.01)	-0.01 (0.01)
Share of children 0-4 yrs	0.32 (0.28)	-0.10 (0.37)	-1.02*** (0.27)	-1.76*** (0.47)
Share of children 5-14 yrs	0.57** (0.25)	0.79** (0.33)	-0.51* (0.26)	-0.67 (0.42)
Share of teen females	0.13 (0.32)	-0.66* (0.39)	-0.11 (0.29)	-0.15 (0.52)
Share of teen males	0.30 (0.30)	0.51 (0.41)	-0.4 (0.32)	-0.94** (0.45)
Share of adult males			-0.04 (0.41)	-0.19 (0.58)
Share of adult females	1.14*** (0.39)	1.20** (0.50)		
Share of elder males	0.60 (0.39)	0.78 (0.76)	-0.87** (0.44)	0.8 (0.77)
Share of elder females	0.59 (0.47)	1.20* (0.66)	-0.11 (0.51)	-0.69 (0.65)

Continued… Table 3

Continued… Table 3

Muslim	0.42*** (0.08)	0.31*** (0.10)	0.34*** (0.1)	0.66*** (0.11)
Christian	0.75*** (0.13)	0.04 (0.18)	0.47*** (0.16)	0.26 (0.32)
Sikh	0.63*** (0.13)	1.05*** (0.20)	0.43*** (0.11)	0.80*** (0.26)
Jain	0.19 (0.75)	-0.30* (1.08)	0.35 (0.55)	1.37*** (0.4)
Other religions	0.16* (0.09)	0.17 (0.43)	-0.01 (0.06)	0.13 (0.34)
SC	0.09 (0.05)	-0.02 (0.07)	-0.05 (0.06)	-0.01 (0.09)
ST	0.08 (0.07)	-0.19** (0.09)	-0.19*** (0.06)	-0.58** *(0.11)
Other castes	0.17** (0.07)	0.15 (0.09)	0.14** (0.06)	0.19* (0.1)
Urban	0.13** (0.06)	0.36*** (0.08)	0.32*** (0.06)	0.48*** (0.1)
Central	-0.54*** (0.09)	-0.28*** (0.10)	-0.35*** (0.07)	-0.04 (0.13)
West	-0.32*** (0.10)	0.40*** (0.14)	-0.80*** (0.09)	-0.24 (0.15)
South	0.41*** (0.11)	0.87*** (0.13)	-0.05 (0.09)	0.76*** (0.16)
East	0.03 (0.10)	0.20* (0.12)	-0.27*** (0.08)	0.23 (0.15)
North East	-0.30** (0.12)	-0.23* (0.14)	-0.48*** (0.09)	-0.59*** (0.16)
Constant	12.55*** (0.49)	17.19*** (0.69)	12.35*** (0.52)	14.81*** (0.87)
R2	**0.10**	**0.12**	**0.10**	**0.14**

Note: The reference categories for dummy variables, sources, * are same as in Table 2; sampling weights are the sample as men's sample (mv005)

CONCLUSIONS

In conclusion, this study explains gendered differences in double burden of malnutrition by an attempt to bridge the gap of sample sizes of men and women, which has not been attempted earlier. Unlike the methodologies used in literature, this study has not followed any strict BMI cut-offs for undernutrition and over-nutrition to respect the ethnic diversity of Indian population. It has used quantile regression model which enables us to understand how the determinants vary at low and high levels of BMI and the balance one needs to maintain between healthy diets and lifestyle habits, as well as the role of social and health infrastructure variables in enabling it.

Similar to the findings of author's previous paper, this study has shown that women with 12 or above years of education are perhaps more aware of their health and being lean could have been an important component of a style statement affecting women more than men. In the couple sample, similar results are found for women with 10-12 years of education owing to the smaller sample of ever-married women as compared to full sample. The study supports the literature by showing that lacto-vegetarian and non-vegetarian diets (having more fat/oil) increase the top quintile of BMI and also add that vegan diets worsen BMI for the lowest quintile but could be beneficial to those at the top quintile. Women following Jain religion have a large positive and significant coefficient in the couple sample among the top BMI quintile as their diets are known to be categorized in lacto-vegetarian diet. Diet variables are statistically insignificant for top quintile while pesco-vegetarian diet has more adverse effect on lower quintile in couple sample.

Unlike the literature, the unavailability of data on physical activity has been addressed by this study for men and women differently as it's an important aspect that affects BMI of a person. The study clearly depicts gendered segregation of unpaid household work carried out by women like fetching water, collection of firewood, crop residue or cow dung cake as cooking fuel and child care and gainful economic activities carried out by men that worsen BMI if they are more manual in nature and involve strenuous physical activity. Men in active manual jobs show an expected and large decline in top 20^{th} quintile of BMI for couple sample while the result is insignificant for full sample. We find that the effect of watching television and using mobiles by men and women are positive and statistically significant even after controlling for wealth status and education. The effect of health and hygiene on BMI of men and women in India which is least discussed in literature is also addressed in this study. It shows that open defecation due to inaccessibility of toilets at home have adverse effects on BMI, with a larger negative value for women compared to men due to poor menstrual and reproductive hygiene. Visit to a doctor in the last 1 year is found to be indicative of ill health that might affect BMI adversely. A relevant finding is that possessing health insurance policy countervails the impact of illness severity as reflected in a positive and significant coefficient for bottom quintile. The fact that it's considered more important to safeguard the health of the adult males in the family who are the primary breadwinners and are able to pay their premiums regularly as compared to adult females of the family, indicates gendered differences in association of BMI and health insurance access. It is also observed that poor men having top BMI quintile are becoming more and more underweight while rich men having low BMI quintile are becoming more and more overweight.

Another important finding shows that energy expended in taking care of larger household size and greater share of young children (0-4 years) worsens BMI of both men and women, with higher magnitude for women (particularly ever-married) and those having BMI in top quintile. Apart from urbanization which is discussed in literature too, this study also considers the effect of geography. Results show clear signs of double burden of malnutrition among men and decline in BMI for top and bottom quintiles among women (majorly in bottom quintile and ever-married women) in the western region of India. Higher BMI is concentrated in southern region for both men and women as compared to northern regions.

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APPENDIX

Table A1: Occupation Classification

Occupation	Occupation groups
Not in Active Employment (0)	Not working
11,12,13,14,15,21,22,23,24,25,26, 27,29,30,31,32,33,34,35,36,40,44, 45	More sedentary jobs
1 ,3, 4 ,5 ,6 ,7 ,8 ,9 ,10 ,16 ,19 ,20 ,37, 38, 39 ,41, 42 ,56 ,57 ,59, 86, 90 ,91 ,93	Less sedentary jobs
18, 43, 49, 50, 51, 52, 53, 54, 55, 60, 61, 62, 63, 64, 65, 66, 67, 68, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83,84, 85, 87, 88, 89, 92, 93, 94, 95	Active manual jobs
96, 98	Other jobs

Source: Men's occupation variable in NFHS 4 *mv716.*

Table A2: OLS Regression Estimates for BMI

Variables	Men (20-54 years; N =89,374)	Women Total (20-49 years; N=525,454)
Age	0.31*** (0.02)	0.39*** (0.01)
Age squared	-0.004*** (0.0002)	-0.004*** (0.0001)
<5 years of education	0.19** (0.08)	0.33*** (0.03)
5-7years of education	0.34*** (0.06)	0.58*** (0.03)
8-9years of education	0.39*** (0.06)	0.66*** (0.03)
10-11years of education	0.67*** (0.07)	0.66*** (0.03)
≥12 years of education	0.72*** (0.06)	0.48*** (0.03)
Currently married	0.49*** (0.06)	0.97*** (0.03)
Formerly married	-0.28* (0.15)	0.61*** (0.05)
Semi vegetarian	-0.05 (0.07)	-0.14*** (0.04)
Pesco vegetarian	-0.15** (0.06)	-0.15*** (0.05)
Lacto-ovo vegetarian	-0.11 (0.09)	-0.23*** (0.04)
Lacto vegetarian	-0.07 (0.05)	-0.17*** (0.02)
Vegan	-0.29*** (0.2)	-0.23*** (0.06)
Aerated drinks	0.06 (0.04)	0.03 (0.02)
Fried	0.03 (0.04)	0.03** (0.02)
Alcohol	-0.02 (0.04)	
Tobacco	-0.12*** (0.04)	
Fetch water		-0.18*** (0.02)
Clean fuel		0.46*** (0.02)
More sedentary jobs	0.51*** (0.09)	
Less sedentary jobs	0.43*** (0.09)	
Active manual jobs	0.09 (0.07)	
Other jobs	0.34*** (0.12)	
Media	0.16*** (0.04)	0.30*** (0.02)
Mobile	0.49*** (0.07)	0.29*** (0.03)
Bike	0.38*** (0.05)	
Car	0.64*** (0.09)	
Open defecation	-0.19*** (0.05)	-0.33*** (0.02)
Visit to hospital	-0.29*** (0.06)	-0.51*** (0.05)
Public insurance	0.08* (0.05)	-0.01 (0.02)
Private insurance	0.53*** (0.18)	0.06 (0.08)

(Contd…Table A2)

..Continued Table A2

Variables	**Men (20-54 years; N =89,374)**	**Women Total (20-49 years; N=525,454)**
Employer insurance	0.46*** (0.18)	0.35** (0.15)
Poorest	-0.80*** (0.05)	-0.92*** (0.03)
Poorer	-0.51*** (0.06)	-0.45*** (0.02)
Richer	0.49*** (0.07)	0.52*** (0.03)
Richest	0.95*** (0.07)	1.03*** (0.03)
No. of persons in house	-0.02*** (0.01)	-0.01* (0)
Share of young children	-0.55*** (0.21)	-1.25*** (0.09)
Share of old children	0.01 (0.17)	-0.54*** (0.08)
Share of teen females	-0.83*** (0.2)	-0.20** (0.09)
Share of teen males	-0.51** (0.22)	-0.41*** (0.09)
Share of adult males		-0.26*** (0.09)
Share of adult females	-0.36* (0.19)	
Share of elder males	-0.56* (0.34)	-0.34** (0.17)
Share of elder females	0.11 (0.31)	-0.32** (0.15)
Muslim	0.33*** (0.06)	0.53*** (0.03)
Christian	0.36*** (0.12)	0.44*** (0.06)
Sikh	0.75*** (0.11)	0.58*** (0.05)
Jain	0.05 (0.34)	0.21 (0.24)
Other religions	0.25 (0.19)	0.12 (0.08)
SC	-0.02 (0.05)	0 (0.02)
ST	-0.09* (0.05)	-0.32*** (0.03)
Other castes	0.15*** (0.05)	0.22*** (0.02)
Urban	0.29*** (0.04)	0.45*** (0.02)
Central	-0.46*** (0.06)	-0.17*** (0.03)
West	0.02 (0.07)	-0.44*** (0.04)
South	0.52*** (0.07)	0.25*** (0.04)
East	0.05 (0.07)	-0.11*** (0.04)
North East	-0.18** (0.07)	-0.51*** (0.04)
Constant	14.72*** (0.34)	12.92*** (0.16)
R^2	**0.19**	**0.21**

Source and Notes: Same as Table 3.

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