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Double burden of malnutrition: Why are Indian women likely to be underweight and obese?

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Abstract

India has one of the highest underweight burdens in the world, with signs of rising obesity. Coexistence of underweight and overweight women is symptomatic of the double burden of malnutrition. The present study aims to throw new light on the double burden of malnutrition among Indian women in the age group 22-49 years. The analysis is based on a nationally representative household survey, *India Human Development Survey*, 2005. The results indicate that the factors underlying this burden include socio-economic status (SES), location, marital status, age, education, physical activity, media exposure, and dietary composition and frequency of eating. We find that there is a socio-economic patterning of underweight and overweight women, with a large concentration of underweight women among those with a low SES and of overweight women among high SES. Given that the health implications of being underweight and overweight are grim, it is imperative that there is a simultaneous increase in the focus on the health needs of overweight and obese people and on the needs of the large number of severely undernourished people in society. For Indian women, the glaring health/nutrition disparities are matched only by the grimness of their existence and survival prospects.

Keywords: underweight, overweight, obese, women, socio-economic status, rural, urban, diets, diseases, India.

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Introduction

Recent research in the context of gender and health in India has drawn attention to what is often referred to as the 'double burden of malnutrition' for women – the co-existence of a high prevalence of underweight and a not so high but rising prevalence of obesity (Griffiths and Bentley 2001, Subramanian et al. 2009, and Corsi et al. 2011, among others). India has one of the highest underweight burdens in the world, coupled with signs of rising obesity. A recent global study (Corsi et al. 2011), using the WHO classification of underweight with BMI (kg/m^2) below 18.5 and overweight above 25, shows that the percentage of underweight women in the age-group 20-49 reduced from 31.5 in 1998 to 26.6 in 2005. In contrast, the share of overweight rose from 13 percent to 18.2 percent. Hence, while undernutrition – albeit declining – remains a concern, there is a new apprehension as reflected in the rising rates of overweight and obesity. Growing risks of overweight and obesity are directly related to the incidence of chronic diseases, such as cardiovascular disease and adult onset diabetes. For instance, the WHO estimates that diabetes in India will rise from 19.4 million in 1994 to 57.2 million in 2025.

As a country develops economically, the burden of overweight and obesity has or will shift to households with lower socio-economic status (SES). It is posited that before a nutrition transition, overweight and underweight tend to be concentrated in high and low SES groups of households, respectively. However, during the transition, the overweight burden tends to shift to the low SES groups, while the underweight burden remains high, exposing them to the double burden. It is hence important from a health policy perspective to understand better the reasons underlying the prevalence of underweight and obesity among women and why the latter is likely to rise. The goal of the present study is to throw new light on the double burden of malnutrition among Indian women aged 22-49 years. The analysis is based on a nationally representative household survey, *India Human Development* Survey, 2005.

1. Literature review

Previous research posits a positive SES–weight relation and that underweight women were concentrated among low SES groups, while the overweight were mostly among high SES groups. Recent studies, albeit limited, throw new light on this socio-economic patterning in underweight and overweight women in India (Griffiths and Bentley, 2001, and Subramanian et al. 2009).

Griffiths and Bentley (2001), using the National Family Health Survey (NFHS-2) for 1998/99, examine demographic, socioeconomic, dietary, cultural and health determinants of overweight and thinness among women living in the southern Indian state of Andhra Pradesh. They hypothesise that socioeconomic status, not rural/urban residence, is an independent and strong predictor of women's BMI.

The results show that more than one-third of women aged 15-49 years had a BMI of less than 18.5, whereas about 27 percent were overweight or obese. Factors associated with under- and overweight are largely similar. Women who reported a higher standard of living, who lived in households where at least one member was educated beyond high school, who worked in non-manual occupations, or who watched television more than once a week were more likely to be overweight or obese. These factors were inversely related with low BMI. Women living in households in which at least one member had more than 12 years of education were more likely to be overweight or obese. This was a more significant predictor of overweight and obesity than the woman's own level of education. Thus, consistent with the experience of other countries in the early stages of nutrition transition, women (of Andhra Pradesh) in the higher socioeconomic groups were more likely to be overweight or obese, while just under half of the sample population was underweight. Age was a significant predictor of BMI, with older women more likely to be overweight or obese and younger women more likely to be underweight or severely thin.

Religion made a difference too. Muslim women were more likely to be overweight or obese than Hindu women, due presumably to differences in diets, activity and socioeconomic status. Diets of Muslim women are generally richer, and social mobility is lower, restricting their occupational choice. But it seems unlikely that the socioeconomic status of Muslim women is better than that of Hindu women.

Although there were clear differences in weight status between women living in rural and urban areas, these ceased to be statistically significant when there were controls for demographic, cultural, health behaviour, diet and socioeconomic variables. In fact, socioeconomic status, and not rural/urban residence, was the most important predictor of women's nutrition status. Women who watched television once a week were more likely to be overweight or obese, as were women who reported not working outside the home. It is plausible, but not confirmed, that the latter is a proxy for more leisure, as opposed to working outside.

The claim that it is not so much urban location *per se* as lifestyles associated with urban residence that cause overweight or obesity (e.g. less physically demanding occupations, greater leisure time, diets higher in fats), as emphasised by Popkin (1998), is plausible but not fully demonstrated. As our analysis shows, with a different data set and specification, metros have a significant effect on nutrition status in India relative to rural, even after controlling for many aspects of urban residence. Another issue is that the diet is specified in terms of consumption of different food commodities (e.g. milk, vegetables, fish, eggs and meat). A finding is that women who more frequently ate fruits and vegetables other than the green leafy variety were more likely to be overweight. But food commodities' intakes are endogenous to relative food prices and income (e.g. Gaiha et al. 2012). So the coefficients cannot be taken at face value and are devoid of any causal significance. Further, step-wise regression using different blocks of explanatory variables (e.g. location, demographic, socio-economic status) amounts to data mining. A prior complete specification would have been the appropriate strategy.

Subramanian et al. (2009) offer a more detailed and insightful analysis, as they focus on changes in the socio-economic patterning of underweight and overweight among adult Indian women between 1998-99 and 2005-06, based on the nationally representative NFHS-2 and 3. Besides, a comparison of these nutrition categories by gender in 2005-06 is carried out. As this was a period of rapid economic growth, the findings are of considerable significance. The analysis is restricted to ever married women in the age group 15-49 years after eliminating those pregnant or suffering from tuberculosis. The analysis of social patterning of men is restricted to the sample for 2005-06, as BMI data were not collected in the 1998-99 survey.

The methodology used comprises several techniques. These include: (i) multivariate linear regression models to assess the independent effects of wealth and education on BMI and how their magnitudes changed over the period 1998-99 and 2005-06; (ii) multilevel regression models allowing for clustering at the primary sampling unit (PSU) level by including a random effect for PSU and clustering at the state level by including state fixed effects; and (iii) multivariate unordered, multinomial logistic regression model to estimate the independent effects of wealth and education on the risk of being in one of the five BMI categories with the normal range of 18.5 to 22.9.[1]

The effect of wealth on BMI was positive and significant in both periods. The BMI difference between women in the lowest wealth quintile and women in the highest quintile, regardless of location, was larger in 2005-06. Education was also positively associated with BMI. Specifically, in 1998-99, women with a college education were 0.62 heavier than those with no education. In 2005-06, the difference was 0.47. The positive association between education and BMI was also observed within the urban populations at both time periods, while the association within the rural populations was not consistent. The relation between BMI and wealth was strong among men in 2005-06.

The double malnutrition burden was thus socially disaggregated in both rural and urban areas over the period 1998-99 and 2005-06. High SES women were more likely to be overweight, while low SES women were more likely to be underweight. Even though the ratio of underweight to overweight decreased (from 3.3 in 1998-99 to 2.2 in 2005-06), there were considerably more underweight than overweight women. There was, however, a slight excess of overweight over underweight women in the highest wealth quintile.

Is there a cultural explanation for fatty women among the affluent? Subramanian et al. (2009) conjecture that cultural norms encourage fat body shapes. Apart from the strong positive relation between weight and wealth, they rely on a positive interaction effect of age and SES in all age groups to bolster this conjecture. Additional indirect evidence includes high-income groups obtaining a much larger share of energy from fats (32 percent) compared with low-income groups consuming a much lower share from this source (17 percent). Whether high SES women – if mostly from the upper castes – face resistance in engaging in physically strenuous activities is yet another contributory factor. The difficulty, however, is that neither dietary patterns nor nature of physical activity were controlled for to arrive at a more definitive cultural explanation. Although dietary influence is sought to be captured in Griffiths and Bentley (2001), its endogeneity is overlooked. Besides, controls for occupational characteristics are feasible with NFHS 2 and 3. So the cultural explanation is not persuasive.

Subramanian et al. (2009) surmise that the social segregation of the underweight and overweight burdens is likely to continue, on the grounds that growth has been highly unequal. The social patterning of weight status, therefore, will closely approximate the maldistribution of income and other resources. This is contestable on the grounds: (i) that lifestyles are generally becoming more sedentary, even in rural areas (Deaton and Dreze, 2009); and (ii) that diets are becoming more diversified, with a rising share of energy-dense foods (Gaiha et al. 2013 a, 2013 b).

[1] Five nutrition categories are considered: <18.5 (underweight); 18.5-22.9 (normal weight); 23-24.9 (at risk of overweight or pre-overweight); 25-29.9 (overweight); and ≥ 30 (obese). Disaggregation is fine, but there is a risk of being overprecise when the BMI ranges for Asian populations are being questioned. In particular, a WHO expert consultation reviewed the BMI cut-offs for overweight and obese in 2002. It concluded that Asians generally have a higher percentage of body fat than white people of the same age, sex and BMI. Also, the proportion of Asian people with risk factors for type 2 diabetes and cardiovascular disease is substantial, even below the existing WHO BMI cut-off point of $25kg/m^2$. However, while the consultation agreed on the need for revision, it refrained from recommending precise adjustments (WHO, 2004).

Underweight women pose serious health risks for children born to them, provided they survive. They are more vulnerable to diabetes, cardiovascular disease and other chronic ailments in adulthood.[2] An alternative channel is also serious: mothers with energy deficiency are more likely to give birth to low-weight infants, leading to their growth failure and adverse social and educational outcomes, which in turn leads to underweight in adulthood (Subramanian et al. 2009).

A third study (Corsi et al. 2011) breaks new ground in quantifying the double burden of malnutrition, based on 57 Demographic and Health Surveys conducted between 1994 and 2008 in low- and middle-income countries – including India and other south Asian countries, among others. Multinomial and multilevel models were estimated to assess the extent to which underweight (BMI<18.5 kg/m^2) and overweight (BMI$\geq$25.0 kg/m^2) correlate at the country and neighbourhood levels within each country. The covariates included age, household wealth, education and residence.

A point of departure and an innovation is to go beyond the coexistence of underweight and overweight within populations. The focus is on the residual covariance from the multinomial model as a measure of the correlation in the prevalence of underweight and overweight in a given geographic context. A strong negative correlation implies that, say, a higher prevalence of underweight coexists with a lower prevalence of overweight, while a strong positive correlation implies the presence of the double burden of malnutrition. The analysis is confined to women in the age group 22-49 years.

The results show a robust negative correlation between underweight and overweight globally across countries, and for neighbourhoods within a majority of countries. This finding also held for rural/urban disaggregation. The inverse correlation was also reflected among low SES groups globally and within countries, suggesting that underweight and overweight did not occur simultaneously in this group. Among the subsample of countries with multiple measurements, the negative correlation did not change at the country or neighbourhood levels, either in direction or magnitude.

A conclusion therefore is that the hypothesised double malnutrition burden has yet to occur in a majority of low- and middle-income countries – including India (with a correlation of -0.42). Among countries with repeated surveys, the prevalence of overweight rose in all countries, while underweight decreased in two-thirds of the countries, but at a much slower rate.

2. Data

Our analysis is based on data collected under *India Human Development Survey*, 2005 (IHDS), by the University of Maryland and the National Council of Applied Economic Research (NCAER). Salient features of this survey are described below. IHDS covers over 41,000 households residing in rural and urban areas, selected from 33 states.[3] The sample comprises 384 districts out of a total of 593 identified

[2] The foetal origins hypothesis of adult disease postulates that foetal undernutrition, reflected in low birthweight, is linked to susceptibility to ischemic heart disease and other chronic non-communicable diseases (NCDs) in later life. Foetal nutritional deprivation followed by later excesses lead to obesity and vulnerability to disease. Indian infants, for example, with poorly nourished mothers are born with weight deficits, but, in relative terms, the deficits in lean mass are greater than those in adiposity. In later life, when high-energy and high-fat diets are consumed, the previously 'thin fat' babies also have greater central adiposity and vulnerability to disease (Popkin et al. 2012)

[3] This is a summary of the material provided by Sonal Desai – the principal author of IHDS.

in the 2001 population census. Villages and urban blocks constituted the primary sampling unit from which the households were selected.

The rural sample contains about half the households that were interviewed initially by NCAER in 1993-94 in a survey entitled *Human Development Profile of India* – HDPI – and the other half of the sample households were drawn both from districts surveyed in HDPI as well as from districts located in the states and union territories not covered in HDPI. The original HDPI was a random sample of 33,230 households, located in 16 major states, 195 districts and 1,765 villages. In states where the 1993-94 survey was conducted and recontact details were available, 13,593 households were randomly selected for reinterview in 2005. About 82 percent of the households were contactable for reinterview, resulting in a resurvey of 11,153 original households, as well as 2,440 households which had separated from the original households but were still living in the same village.

In each district where reinterviews were conducted, two fresh villages were randomly selected using a probability proportional to size technique. In each village, 20 randomly selected households were chosen. Additionally, 3,993 households were randomly selected from the states where the 1993-94 survey was not conducted, or where recontact information was not available.

In order to draw a random sample of urban households, all urban areas in a state were listed in the order of their size, with number of blocks drawn from each urban area allocated based on probability proportional to size. After determining the number of blocks, the enumeration blocks were selected randomly. From these enumeration blocks (of about 150-200 households), a complete household listing was obtained and a sample of 15 households was selected per block.

The questions fielded in IHDS were organised into two separate questionnaires, one for households and another for women. The household questionnaires were administered to the individual most knowledgeable about income and expenditure, frequently the male head of the household; the questionnaire for health and education was administered to a woman in the household – typically, the spouse of the household head. Questions on fertility, marriage and gender relations in the households were addressed to an ever-married woman aged between 15 and 49 in the household. If no household member fit these criteria, that portion of the questionnaire was skipped (about 19 percent of all households); if the household had more than one ever married woman aged between 15 and 49, one woman was selected randomly to answer those questions.

Anthropometric data (height and weight) were confined to women in the age-group 15-49 years and men were included opportunistically (i.e. those around at the time of the interview). A standard method of measurement (i.e. weight was measured using a solar-powered scale and height with an adjustable wooden board) was used by trained investigators.

We have classified women in the age group 22-49 years into four BMI ranges: <18 (underweight); 18-25 (normal); 25-30 (overweight); and >30 (obese). We have deleted observations pertaining to pregnant women.

Comparison of IHDS data with the National Sample Survey or NSS (2004–05), National Family Health Survey III (2005–06) and Census (2001) confirms the robustness of IHDS data. For example, IHDS sample distribution on urban residence, caste and religion is remarkably similar to NSS and NFHS 3, although all three surveys (IHDS, NSS and NFHS) have higher proportions of households claiming Scheduled Caste status than enumerated in Census (2001).

3. Correlates of underweight, overweight and obesity

We first present select descriptive statistics. This is followed by an econometric investigation designed to capture economic status, demographic characteristics, marital status, caste, education, location, media exposure and relative food prices in explaining variations in these measures of malnutrition among women.

As Table 1 indicates, if the states are classified into five regions – Northern, Eastern, Western, Southern and Central – the highest proportion of underweight was in the Central region and the lowest in the Southern. Of the total overweight and obese, the Southern region accounts for the largest share, while the Central for the lowest. By contrast, the Northern region had high prevalence rates of both underweight (21.11 percent) and obese (25.1 percent).

The disaggregation by location, rural, metro cities and other urban shows that the prevalence rate of underweight among women was highest in rural areas, higher than the all-India rate, and considerably lower in metros and in non-metro urban areas. The overweight rates are high in metros and non-urban metro areas. The rural/urban divide appears to be more marked in respect of the prevalence of overweight. Further, about 80 percent of the underweight were in the rural areas and about 14 percent in the non-metro urban areas. About 46 percent of the overweight and about 37.5 percent of the obese were in the rural areas, while over 34 percent of the overweight and under 46 percent of the obese were in non-metro urban areas. Metros accounted for the lowest shares of the overweight and obese.

A little over one-quarter of women in the lowest expenditure interval were underweight and a little over six percent were overweight/obese. But the underweight women accounted for about 31 percent of the total underweight women. The lowest two expenditure intervals accounted for a large majority of the underweight (a little under 71 percent). In contrast, 33.5 percent of the overweight and over 27 percent of the obese were in these two lowest expenditure intervals. Comparison with the highest expenditure interval shows that a considerably lower share of the women were underweight and considerably larger shares were overweight and obese. This expenditure interval accounted for under 13 percent of the underweight and considerably larger shares of the overweight (under 44 percent) and obese (over 53 percent). Thus the economic patterning is clear cut: higher expenditure groups account for the majority of the overweight (about 66.5 percent) and of the obese (over 72.5 percent), while the two lowest expenditure groups accounted for the majority of the underweight women.

Similar inferences follow from a cross-tabulation of assets by weight. The share of underweight women was highest in the low asset interval and lowest in the high asset interval. The low asset group alone accounted for about 60 percent of the underweight women. In contrast, the high asset group alone accounted for over 47 percent of the overweight and over 57 percent of the obese. So to the extent that

Table 1. Prevalence of Underweight, Normal, Overweight and Obese Women by Select Socio-economic Characteristics, 2005

Variable	Underweight	Normal	Overweight	Obese
Region				
Northern	21.11	20.84	21.7	25.1
Eastern	26.26	27.02	20.37	17.2
Western	22.78	20.98	19.8	21.75
Southern	21.22	23.31	33.25	30.8
Central	8.63	7.85	4.88	5.16
Total	100	100	100	100
Location				
Rural	79.84	69.35	45.61	37.49
Metro	6.21	10.77	20.12	16.87
Non-Metro Urban	13.95	19.88	34.27	45.65
Total	100	100	100	100
Monthly per capita consumption (Rs.)				
0-400	30.82	23.93	9.73	6.01
400-700	39.9	35.21	23.77	21.42
700-1000	16.49	18.4	22.78	19.47
>1000	12.79	22.47	43.71	53.1
Total	100	100	100	100
Household Assets (Number)				
0-9 (Low)	59.97	42.96	19.38	14.44
10-16 (Medium)	31.3	35.37	33.58	28.5
>16 (High)	8.74	21.67	47.04	57.06
Total	100	100	100	100
Caste				
SC	28.73	21.71	15.43	11.69
ST	9.84	7.4	3.45	2.52
OBC	34.7	36.49	32.91	30.41
Other	26.74	34.4	48.21	55.38
Total	100	100	100	100
Age (Years)				
22-28	32.95	29.17	14.9	14.88
29-35	30.66	31.62	27.91	25.71
36-42	23.17	25.28	32.51	34.17
43-49	13.21	13.94	24.68	25.24
Total	100	100	100	100

Source : Authors' calculation based on IHDS, 2005.

high asset groups are the most affluent, this is further corroboration of the economic patterning of underweight and overweight/obese.

With respect to the caste affiliation, the most disadvantaged groups – the Scheduled Tribes (STs), the Scheduled Castes (SCs), and Other Backward Classes (OBCs) – experience significant rates of undernutrition. There is a clear progression in the prevalence of underweight from the least disadvantaged (Others) to the most disadvantaged (STs). However, of the total underweight women, more than a third were OBCs, followed by SCs (28.73 percent), Others (26.74 percent) and then STs (9.84 percent).

Unsurprisingly, there is a reversal of this pattern in respect of prevalence of overweight. Of the total overweight women, Others accounted for just under half (48.21 percent), OBCs for about one-third, and the STs for a very small share (barely 3.5 percent). In general, the former are the most advantaged and the latter the least advantaged.

Prevalence rates of underweight declines with age group. The pattern with the shares of total underweight women shows that the youngest account for about one-third and the oldest for the lowest (a little over 13 percent). The prevalence rate of overweight among women, by contrast, rises with age group, with the lowest among the youngest age group, and highest among the oldest. However, shares in total overweight women also rise with agegroup, but only up to 36-42 years (from 14.9 percent among the youngest, to 32.51 percent in the older group), after which the share declines (to just under one-quarter). As in the case of overweight, shares of total obesity rise from the youngest to women in the age group 36-42 years (from 14.88 percent to 34.17 percent) and then the share of the oldest falls (to a little over one-fourth).

In order to demonstrate the two burdens more clearly, we present the cross-tabulations using the ratio of underweight to overweight/obese. These show more starkly the two burdens of malnutrition among women.[4] To avoid repetition, the cross-tabulations are given in condensed form. At the all-India level, the ratio of underweight to overweight/obese was 1.21, implying that there were 121 underweight women for 100 overweight/obese women.

The regional variation shows that the higher the ratio, the higher is the number of underweight women relative to overweight and obese women. The lowest ratio is observed in the Southern region and a moderately higher ratio in the Northern region. The highest was in the Central region, followed by the Eastern and then the Western region. So, if there is a sharp divide, it is between the Central and Southern regions.

A sharp contrast in this ratio is revealed across different locations, with the highest value observed in the rural areas and the lowest in metros. Non-metro urban areas had a slightly higher ratio than metros. Altogether, these differences point to a glaring excess of numbers of underweight women relative to overweight/obese women in rural areas as compared with urban.

[4] As the econometric analysis had to be done with PSU averages (as only one woman's height and weight were recorded in a household), the cross-tabulations are based on these averages suppressing within PSU variation.

We examine in greater detail the differences in the ratio of underweight to overweight/obese women at the state level. In Table 2, we have arranged the states in ascending order of this ratio. As may be noted, the first eight states and the region of Northeast, excluding Assam (see Table 2), had fewer underweight women than overweight/obese. In Punjab, for example, there were 18 underweight women for 100 overweight/obese women, while in Kerala the corresponding number of underweight women was 25. In sharp contrast were the rest – especially the bottom six states (see Table 2) – where the underweight women exceeded the overweight and obese. Among Madhya Pradesh, Uttarakhand, Chattisgargh and Bihar, there were twice as many or more underweight women than the overweight/obese. In Bihar, there were 257 underweight women for 100 overweight/obese women. Orissa stands out as the worst, with 367 underweight women for 100 overweight and obese women.

Table 2. Ratio of Underweight, Normal, Overweight and Obese Women by States/Region, 2005

State/Region	Ratio
Punjab	0.18
Delhi	0.22
Kerala	0.25
Northeast	0.26
Jammu & Kashmir	0.36
Tamil Nadu	0.57
Himachal Pradesh	0.65
Assam	0.73
Haryana	0.8
Andhra Pradesh	1.05
West Bengal	1.1
Gujarat	1.2
Maharashtra, Goa	1.42
Rajasthan	1.46
Karnataka	1.53
Jharkhand	1.8
Uttar Pradesh	1.98
Madhya Pradesh	2.07
Uttarakhand	2.1
Chhattisgarh	2.19
Bihar	2.57
Orissa	3.67

Source : Authors' calculation based on IHDS, 2005.

The cross-classification of this ratio by range of per capita monthly expenditure shows that the higher the expenditure, the lower was the ratio of underweight to overweight/obese women. In the lowest expenditure range, for example, there were 416 underweight women for 100 overweight/obese women, while in the highest expenditure range the number plummets to 34 (See Table 3). So it may be inferred that there is an inverse association between this ratio and affluence at the PSU level. A confirmation of this relationship, however, is only feasible through a regression analysis carried out in a subsequent section.

Another measure of affluence (or wealth) is based on various assets that households possessed. These include TV, fridge, motorcycle, telephone and refrigerator, among others. Instead of following a sophisticated measure that assigned weights based on their values, we have opted for a simple unweighted aggregation of assets and their ranges.[5]

The association with assets is similar to that obtained using expenditure. It is plausible to the extent that higher expenditure intervals are associated with more diversified assets. As may be noted from Table 3, there were about 400 underweight women per 100 overweight/obese women in the lowest asset group (or, the least wealthy group), while in the highest asset interval (or the wealthiest) there were barely 22 underweight women. So the number of underweight women declines sharply as wealth rises (at the PSU level). As before, a more definitive conclusion can only be drawn on the basis of a regression analysis carried out subsequently.

As expenditure and assets (excluding human capital) are essentially monetary measures of economic status, these are often supplemented by caste affiliation. As noted earlier, the caste hierarchy manifests not just different levels of economic wellbeing, but also aspects of social deprivation. The Scheduled Tribes (STs) are, for example, the most isolated, excluded and deprived group. There is an interplay of social, cultural and economic factors that impedes their economic and social advancement (Gaiha et al. 2008).

As may be noted, the ratio is highest among the STs – the most disadvantaged and socially excluded group – followed by the SCs. Among the former, there were 365 underweight women per 100 overweight/obese women. In sharp contrast, the most advantaged group, Others, had fewer underweight women than overweight and obese. So this is yet another manifestation of why in certain groups there is an excess of underweight women and in others there is a deficit relative to the overweight/obese.

The association between the ratio of underweight to overweight/obese women and age group of women in the sample is inverse. The ratio is highest in the youngest age-group, 22-28 years, and lowest in the oldest, 43-49 years. In the former, the number of underweight women was 268 per 100 overweight/obese women and in the highest 65 per 100 overweight/obese women. Whether this pattern is linked to level of physical activity and dietary patterns needs investigation.

[5] Subramanian et al. (2009) use a principal component analysis to determine a weighted measure of wealth. This is a seemingly appropriate measure, but whether it helps overcome the valuation difficulties is not self-evident – in particular, whether book values or replacement values are used. Griffiths and Bentley (2001), in contrast, use a measure similar to ours. It is *ad hoc* and notional, but illustrative. The assets include bicycles, electric fan, sewing machine, car, motor cycle, refrigerator, mixer/grinder, television, telephone, computer, washing machine, electricity generator, sewing machine, among others.

Table 3. Ratio of Underweight, Normal, Overweight and Obese Women by Select Socio-economic Characteristics, 2005

Variable	Ratio
Region	
Northern	1.14
Eastern	1.61
Western	1.37
Southern	0.78
Central	2.12
Location	
Rural	2.2
Metro	0.39
Non-Metro Urban	0.46
Monthly per capita consumption (Rs.)	
0-400	4.16
400-700	2.07
700-1000	0.9
>1000	0.34
Household Assets (Number)	
0-9 (Low)	3.95
10-16 (Medium)	1.16
>16 (High)	0.22
Caste	
SC	2.37
ST	3.65
OBC	1.3
Other	0.65
Age (Years)	
22-28	2.68
29-35	1.35
36-42	0.85
43-49	0.65

Source : Authors' calculation based on IHDS, 2005.

4. Model specifications

Two sets of econometric analyses are carried out. First, considering the sample of underweight and normal women in the age group 22-49 years, we examine the probability of being underweight, taking into account measures of economic status, age, educational attainment, marital status, caste affiliation, household hygiene and sanitation, region, rural/urban location, exposure to media, and relative food prices, to capture the effect of diet on nutritional status. Similarly, the probability of being overweight/obese in the sub-sample including normal conditional on these variables is analysed. These analyses are based on probits. Second, we analyse variation in the ratio of underweight to overweight/obese at the PSU level. As the dependent variable is continuous, robust regression is used. The explanatory variables are similar to those used in the probits. Brief algebraic expositions of these two methods are given below.[6]

Suppose y = 1 if the woman is underweight, and 0 otherwise (in the present sample, normal). In that case, the probit model takes the form:

$$P[y=1|x] = \Phi(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots\dots + \beta_k x_k) = \Phi(\beta_0 + X\beta)\dots\dots(1)$$

Φ is the standard normal cumulative distribution function (CDF) and defined as

$$\Phi(z) = \int_{-\infty}^{z} \phi(v)dv$$

where $\phi(.)$ is the standard normal density

$$\phi(z) \equiv \frac{d\Phi(z)}{dz} = (2\pi)^{-1/2} \exp(-z^2/2)$$

The function $\Phi(.)$ is increasing in z and takes on values strictly between 0 and 1. The model is estimated using maximum likelihood estimation, together with the marginal effect.[7] If x_j is a roughly continuous variable, its marginal effect on $P(x)$ is given by $P[y=1|x] = \frac{\partial P(x)}{\partial x_j} = \phi(\beta_0 + X\beta)\beta_j$

A similar specification is used and estimated when the woman is overweight, where y=1 when overweight/obese and 0 otherwise.

In the case of the ratio of underweight to overweight/obese women, the dependent variable is continuous. Since the analysis is based on a cross-section, robust regressions are estimated. A general form is:

$y_i = \beta_0 + \boldsymbol{X_i \beta} + \boldsymbol{Z_i \gamma} + \epsilon_i$ (2)

where y_i denotes ratio of underweight to overweight/obese women in i[th] PSU, and the right side variables are those stated earlier. Some of these denoted by $\boldsymbol{X_i}$ are continuous variables (relative food prices, proportion of women who listen to radio and/or read newspaper regularly in i[th] PSU), while others in which different ranges of explanatory variables (asset intervals, age groups, castes, educational attainment, kitchen with ventilation, clean drinking water, indoor toilet, rural, metro, or non-metro urban location) are included in $\boldsymbol{Z_i}$ in the i[th] PSU. A similar construct is used for ratio of female to male workers and for membership of Mahila Mandals (women's associations). So if there are four income intervals, we consider three proportions of women in each case and the fourth is omitted.

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[6] For details, see Greene (2003).
[7] For details of the probit model, see Greene (2003).

5. Results

a) Determinants of underweight

Let us first consider the probit results on underweight women in the sub-sample, including normal women in rural India, as shown in Table 4.

Table 4
Probit analysis of underweight women in rural India, 2005

	Equation 1			Equation 2		
Variables	coeff.	z-value	elasticity	coeff.	z-value	elasticity
Monthly per capita consumption Rs 401 - 700	-0.0225	(-0.83)	-0.0108			
Monthly per capita consumption Rs 701-1000	-0.0700**	(-1.98)	-0.0164*			
Monthly per capita consumption Rs >1000	-0.181***	(-4.66)	-0.0449***			
Household assets 10-16				-0.201***	(-7.51)	-0.0975***
Household assets >16				-0.381***	(-8.02)	-0.0773***
SC	0.109***	(3.50)	0.0304***	0.0961***	(3.07)	0.0268***
ST	0.0346	(0.86)	0.00472	0.0129	(0.32)	0.00175
OBC	-0.00513	(-0.18)	-0.00248	-0.00897	(-0.32)	-0.00435
Age 29-35	-0.0734***	(-2.65)	-0.0305***	-0.0761***	(-2.74)	-0.0316***
Age 36-42	-0.110***	(-3.65)	-0.0378***	-0.116***	(-3.87)	-0.0402***
Age 43-49	-0.0845**	(-2.36)	-0.0160**	-0.0947***	(-2.66)	-0.0180**
Education 6-9	-0.0461	(-1.46)	-0.0110	-0.000671	(-0.02)	-0.000160
Education >9	-0.106**	(-2.48)	-0.0172**	-0.0290	(-0.66)	-0.00467
Eastern	-0.0740**	(-2.01)	-0.0213**	-0.115***	(-3.12)	-0.0332***
Western	0.144***	(3.80)	0.0367***	0.149***	(3.92)	0.0380***
Southern	0.0965**	(2.34)	0.0284**	0.0813**	(1.97)	0.0240**
Central	-0.0581	(-1.33)	-0.00888	-0.0706	(-1.63)	-0.0108
Ever married	0.0414	(0.13)	0.0549	0.00823	(0.03)	0.0109
Vent in cooking place	-0.0346	(-1.51)	-0.0221	-0.0102	(-0.44)	-0.00654
Household toilet	-0.315***	(-10.23)	-0.138***	-0.254***	(-7.97)	-0.112***
Water within house - PSU proportions	-0.123***	(-3.11)	-0.0706***	-0.0861**	(-2.16)	-0.0494**
Women either listen to radio or read newpaper - PSU proportions	-0.0887	(-1.38)	-0.0174	-0.0817	(-1.26)	-0.0161
Ratio of cereal to pulse prices	0.126	(1.23)	0.0709	0.0773	(0.75)	0.0434
Ratio of cereal to milk and product prices	0.0962*	(1.71)	0.0417*	0.0722	(1.28)	0.0313
Ratio of cereal to meat prices	-0.245***	(-6.18)	-0.0661***	-0.220***	(-5.53)	-0.0595***
Ratio of cereal to eggs prices	-0.255	(-1.53)	-0.111	-0.202	(-1.23)	-0.0880
Ratio of cereal to vegetables prices	0.125***	(3.85)	0.198***	0.114***	(3.56)	0.182***
Ratio of cereal to oil prices	-1.641***	(-3.80)	-0.465***	-1.487***	(-3.51)	-0.423***
Constant	-0.301	(-0.90)		-0.254	(-0.76)	
Observations	16,823			16,823		
Wald chi2	557.5			604.4		
Prob > chi2	0			0		
Pseudo R2	0.0292			0.0324		
Log pseudolikelihood	-8945			-8916		

Robust z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Economic status matters, measured either in terms of per capita expenditure intervals or in terms of asset intervals. There is an inverse relationship between probability of being underweight and economic status. The higher the latter, the lower was the probability of being underweight. The elasticity, however, of being underweight with respect to per capita expenditure is low, but not so with respect to assets.

The caste affiliation matters, but only the coefficient of SCs is positive and significant relative to Others (the omitted category). The elasticity is, however, low in both equations. So higher socio-economic status lowers the probability of underweight women.

Age and underweight are positively related in both equations. Relative to the youngest women, aged 22-28 years, the probability of being underweight falls with age. Elasticities of underweight with respect to age, however, are low. The marital status (whether a woman was ever married?) of the woman is unrelated to being underweight. Further, higher education (more than nine years) relative to the omitted case of illiterates and with education up to five years or simply less than six years of education lowers the probability of being underweight but only in equation 1. The elasticity in this case too is low.

Relative to the Northern region/states, the Eastern had a lower probability of underweight women while both Southern and Western regions had higher probabilities. The elasticities are, however, low.

Sanitary and hygienic living conditions lower the probability of being underweight. Both a toilet within a house and access to safe drinking water significantly lower the probability of being underweight. The elasticities are moderate, but that with respect to the former is larger.

Somewhat surprising is the absence of association between underweight women and regular media exposure at the PSU level.

Nutritional status is linked to diets and the latter to relative food prices. As cereals are a major source of calories in Indian diets, ratios of cereal prices to other food commodities at the PSU level are constructed. Of the six relative food prices, four have significant coefficients: cereal to milk and milk product prices (+); cereal to meat prices (-); cereal to vegetable prices (+); and cereal to edible oil prices (-). Higher cereal prices relative to those of milk and milk products and vegetables induce switches to these two food products that contain lower calories per gm than cereals. So a higher probability of being underweight is not implausible. Note also that the elasticity with respect to the ratio of cereal and vegetables is 4.75 times that of cereal to milk prices. By contrast, the elasticities with respect to ratio of cereal to meat prices and to that of cereal to edible oil prices are both negative and the latter in absolute value is large. If their intakes rise substantially in response to changes in relative prices, despite their lower calorie content per gm, the higher intakes and that of complements (e.g. potato, onion) could more than compensate for the lower calorie content, resulting in a lower probability of being underweight.[8]

Is this plausible? We believe it is, given the dietary diversification that accelerated between 1993 and 2004/5 (Gaiha et al. 2013a, 2013b). Besides, meat is rich in protein. As this is essentially a conjecture, a more detailed investigation is necessary for a definitive conclusion. Further disaggregation of food commodities (e.g. eggs are boiled or fried, leafy and non-leafy vegetables, fruits, fat-free milk, cheese, ice cream) is also crucial for understanding nutritional outcomes. But the important point is that neglect of

[8] Potatoes and onions are subsumed under vegetables. The presumption here is that (i) their consumption is complementary to meat consumption and (ii) their intake rises faster than the aggregate of vegetables. The overall nutritional effect is thus not implausible. For a major contribution illustrating curvature in the Slutsky matrix, see Timmer (1981).

diets in understanding the prevalence of underweight women is a serious omission. As it turns out, these results raise doubts about the primacy of SES as the key explanatory variable.[9]

The Wald chi^2 test confirms that all coefficients of explanatory variables taken together in the probit are significantly different from 0.

Table 5 portrays results of two probit specifications applied to the urban sample, the first with monthly per capita expenditure intervals, and the second in which expenditure intervals are replaced with asset intervals. To avoid repetition, we will give a selective summary of the results.

Although there are similarities, in so far as most of the variables with significant coefficients in rural India are also significant, most of the elasticities in absolute values differ. Higher per capita expenditure is associated with a lower probability of being underweight in urban areas. But the elasticities in (absolute) values are much larger than in the rural areas. Similarly, higher assets reduce significantly the probability of being underweight and the elasticities are larger than in rural areas. Also, elasticities with respect to assets are much larger than those with respect to expenditure in the urban sample. As in rural areas, only SCs have a significant positive coefficient (relative to Others), but the elasticity (in urban areas) is similar to that in rural India. As in the rural sample, there is an inverse relationship between underweight and age group, with higher (absolute) elasticities in the urban sample. These are relative to the youngest age group of women 22-28 years old. Education of more than nine years lowers the probability of being underweight relative to all women in the omitted group with less than six years of education. The (absolute) elasticity is also much higher than that in the rural sample. This variable, however, ceases to have a significant effect in the second specification with assets instead of expenditure.

The regional contrast is striking. The Eastern region had a lower probability of underweight women (relative to the Northern), while the Western had a significantly higher probability. In both cases, the elasticities were larger than in the rural sample. A notable difference is the lack of significance of the Southern coefficient.

Household sanitation and hygiene matter in the urban sample, as in the rural, with significant negative coefficients of a vent in a kitchen (specification 1) and an indoor toilet (specification 2). Unlike the rural sample, availability of water within a house did not have a significant effect. Affiliation to a women’s group (a Mahila Mandal) did not have a significant coefficient. Nor did regularly listening to a radio and/or reading a newspaper have any effect. W omen living in metros had significantly lower probability of being underweight relative to those in non-metro urban areas.

Diets matter greatly, as illustrated by significant effects of relative food prices. Unlike the rural sample, the higher the ratio of cereal to milk prices, the lower was the probability of underweight women. Higher cereal to meat prices also lowered the probability of underweight women. In both cases, the key is the nutritional effect through complements to milk and meat. Our food commodity classification is not

[9] Specifically, doubts are raised about the overemphasis on SES in Subramanian et al. (2009) in the absence of an explicit role for diets in their models.

Table 5
Probit analysis of underweight women in urban India, 2005

Variables	Equation 1			Equation 2		
	coeff.	z-value	elasticity	coeff.	z-value	elasticity
Monthly per capita consumption Rs 401 - 700	-0.237***	(-4.08)	-0.101***			
Monthly per capita consumption Rs 701-1000	-0.245***	(-3.93)	-0.0925***			
Monthly per capita consumption Rs >1000	-0.395***	(-6.12)	-0.275***			
Household assets 10-16				-0.204***	(-3.88)	-0.118***
Household assets >16				-0.527***	(-7.96)	-0.460***
SC	0.123**	(2.56)	0.0335***	0.0681	(1.38)	0.0187
ST	0.103	(1.09)	0.00555	0.0817	(0.85)	0.00445
OBC	0.0660	(1.59)	0.0343	0.0461	(1.09)	0.0242
Age 29-35	-0.135***	(-3.19)	-0.0696***	-0.122***	(-2.84)	-0.0632***
Age 36-42	-0.219***	(-4.60)	-0.0880***	-0.205***	(-4.29)	-0.0834***
Age 43-49	-0.309***	(-5.20)	-0.0739***	-0.289***	(-4.84)	-0.0701***
Education 6-9	-0.0424	(-0.94)	-0.0158	0.0385	(0.83)	0.0145
Education >9	-0.132***	(-2.71)	-0.0746***	0.0295	(0.59)	0.0167
Eastern	-0.117*	(-1.85)	-0.0432*	-0.183***	(-2.88)	-0.0678***
Western	0.235***	(4.30)	0.0753***	0.232***	(4.17)	0.0745***
Southern	0.0997	(1.55)	0.0420	-0.0399	(-0.59)	-0.0171
Central	-0.0762	(-0.96)	-0.00719	-0.100	(-1.22)	-0.00945
Ever married	-0.247	(-0.95)	-0.401	-0.136	(-0.53)	-0.223
Vent in cooking place	-0.0874**	(-2.37)	-0.0912**	-0.00812	(-0.21)	-0.00858
Household toilet				-0.175***	(-3.90)	-0.220***
Water within house				-0.0858	(-1.34)	-0.101
Member Mahila Mandal	0.0433	(0.28)	0.00367	0.0580	(0.37)	0.00497
Women either listen to radio or read newspaper	-0.0443	(-0.55)	-0.0219			
Ratio of cereal to pulse prices	0.0831	(0.65)	0.0617	0.0195	(0.16)	0.0146
Ratio of cereal to milk and product prices	-0.215**	(-2.19)	-0.131**	-0.228**	(-2.30)	-0.140**
Ratio of cereal to meat prices	-0.518***	(-3.83)	-0.194***	-0.397***	(-4.93)	-0.145***
Ratio of cereal to eggs prices	-0.240	(-0.76)	-0.150	0.0911	(0.29)	0.0572
Ratio of cereal to vegetables prices	0.274***	(4.58)	0.560***	0.246***	(4.09)	0.504***
Ratio of cereal to oil prices	-1.484**	(-2.20)	-0.580**	-1.399**	(-2.08)	-0.551**
Metro	-0.309***	(-7.06)	-0.151***	-0.312***	(-7.01)	-0.154***
Constant	-0.106	(-0.37)		-0.173	(-0.61)	
Observations	8,575		8,575	8,517		8,517
Wald chi2	286.2			408.9		
Prob > chi2	0			0		
Pseudo R2	0.0443			0.0596		
Log pseudolikelihood	-3345			-3273		

Robust z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

sufficiently detailed to address this issue. The higher the ratio of cereal to vegetable prices, the greater was the probability of being underweight, as in the rural sample. Higher ratio of cereal to edible oil prices significantly lowers the probability of underweight women. In all these cases, the (absolute) elasticities are higher than in the rural sample. Within the urban sample, the elasticities of cereal to vegetable prices and cereal to meat prices are substantially higher than other food price elasticities.

The sign reversal of cereal to milk and milk products from positive in the rural to negative in the urban sample may partly be due to aggregation of milk and milk products (e.g. fat and skimmed milk, cheese, ice cream).

The Wald chi^2 test confirms that all coefficients taken together are significantly different from 0.

Table 6
Probit analyses of underweight women in all-India, 2005

	Equation 1			**Equation 2**		
Variables	coeff.	z-value	elasticity	coeff.	z-value	elasticity
Monthly per capita consumption Rs 401 - 700	-0.0511**	(-2.08)	-0.0236**			
Monthly per capita consumption Rs 701-1000	-0.0796***	(-2.63)	-0.0225***			
Monthly per capita consumption Rs >1000	-0.194***	(-5.99)	-0.0774***			
Household assets 10-16				-0.199***	(-8.47)	-0.103***
Household assets >16				-0.440***	(-12.00)	-0.187***
SC	0.1000***	(3.84)	0.0276***	0.0889***	(3.40)	0.0246***
ST	0.0379	(1.04)	0.00412	0.0221	(0.61)	0.00240
OBC	0.00399	(0.17)	0.00198	0.00198	(0.08)	0.000987
Age 29-35	-0.0873***	(-3.76)	-0.0392***	-0.0886***	(-3.80)	-0.0398***
Age 36-42	-0.139***	(-5.46)	-0.0505***	-0.142***	(-5.61)	-0.0520***
Age 43-49	-0.137***	(-4.51)	-0.0282***	-0.144***	(-4.73)	-0.0296***
Education 6-9	-0.0404	(-1.57)	-0.0114	0.00514	(0.20)	0.00146
Education >9	-0.0914***	(-2.87)	-0.0271***	-0.0105	(-0.32)	-0.00311
Eastern	-0.0846***	(-2.71)	-0.0266***	-0.128***	(-4.08)	-0.0403***
Western	0.167***	(5.42)	0.0463***	0.180***	(5.81)	0.0500***
Southern	0.0726**	(2.09)	0.0244**	0.0488	(1.41)	0.0165
Central	-0.0577	(-1.53)	-0.00767	-0.0634*	(-1.69)	-0.00844*
Metro	-0.339***	(-8.42)	-0.0558***	-0.295***	(-7.25)	-0.0486***
Urban non-metro	-0.00697	(-0.27)	-0.00267	0.0282	(1.09)	0.0108
Ever married	-0.128	(-0.63)	-0.183	-0.101	(-0.50)	-0.144
Vent in cooking place	-0.0401**	(-2.05)	-0.0311**	-0.0111	(-0.56)	-0.00863
Household toilet	-0.298***	(-12.11)	-0.212***	-0.224***	(-8.77)	-0.160***
Water within house	-0.118***	(-3.55)	-0.0912***	-0.0749**	(-2.23)	-0.0580**
Women either listen to radio or read newspaper	-0.0128	(-0.26)	-0.00380	0.00248	(0.05)	0.000738
Ratio of cereal to pulse prices	0.0735	(0.94)	0.0457	0.0345	(0.44)	0.0215
Ratio of cereal to milk and Product prices	0.0126	(0.26)	0.00620	-0.0114	(-0.24)	-0.00564
Ratio of cereal to meat prices	-0.286***	(-8.32)	-0.0857***	-0.263***	(-7.65)	-0.0791***
Ratio of cereal to eggs prices	-0.211	(-1.44)	-0.105	-0.142	(-0.97)	-0.0707
Ratio of cereal to vegetables prices	0.162***	(5.77)	0.280***	0.152***	(5.47)	0.265***
Ratio of cereal to oil prices	-1.532***	(-4.34)	-0.489***	-1.445***	(-4.13)	-0.463***
Constant	-0.137	(-0.65)		-0.170	(-0.81)	
Observations	25,340			25,340		
Wald chi2	1156			1261		
Prob > chi2	0			0		
Pseudo R2	0.0460			0.0503		
Log pseudolikelihood	-12269			-12213		

Robust z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Even though rural-urban results differ in magnitude, the all-India analyses that consolidate the rural and urban samples are worthwhile in themselves, with the caveat that these are somewhat restrictive, as the slope coefficients are not allowed to vary. However, the locational disaggregation is more detailed, as the effects of living in metros and non-metro urban areas relative to rural are captured. As may be noted from Table 6, both higher expenditure and assets significantly lower the probability of women being underweight, with the (absolute) elasticities with respect to assets much larger than those of expenditure. Among the caste variables, SCs have a significantly higher probability of being underweight relative to Others, with low elasticities in both specifications. Further, Underweight and age are inversely related, but with low (absolute) elasticities. Education of more than nine years reduces the probability of being underweight relative to those with less than six years of education.

Underweight, and hygienic and sanitary living conditions are inversely related. A vent in a kitchen, access to safe drinking water within a house and an indoor toilet reduce the probability of women being underweight (in the first specification). Except for the vent coefficient, the remaining two coefficients are significant (in the second specification). Media exposure does not have a significant effect. Women living in metros are less likely to be underweight than those in the rural areas.

Relative food prices as drivers of diets matter a great deal, with negative coefficients of ratio of cereal to meat prices and of cereal to edible oil prices and a positive coefficient of cereal to vegetable prices. As in the previous cases, (absolute) elasticities of the probability of being underweight with respect to the latter two food price ratios are substantially higher.

The Wald chi^2 test is significant, confirming that all coefficients of explanatory variables are significantly different from 0.

(b) Determinants of overweight and obesity

Overweight and obesity are combined principally because the BMI ranges which heighten the risk of non-communicable diseases are controversial. As shown in Table 7, both expenditure and assets are positively related to overweight and obesity in rural India, but their elasticities are moderate. The risks of overweight/obesity are lower among the SCs, STs and OBCs relative to Others. The elasticities are higher for SCs and OBCs. Age and overweight/obesity are positively related, implying greater risks among older women. The elasticities were moderate, but decreased with age.

Higher educational attainments relative to the omitted group of illiterate women and others with fewer than six years of education elevated the risks of being overweight/obese, but the elasticities were low. Although previous studies do not offer a clearcut explanation (e.g. Griffiths and Bentley 2001, Subramanian et al. 2009), they corroborate this finding.

SCs, STs and OBCs display lower risks of overweight/obesity than the omitted group, Others, in the first specification. However, in the second specification, SCs have a weakly significant coefficient. All these groups have low elasticities with the highest (absolute) elasticity associated with OBCs. Age and overweight/obesity are positively associated, implying older women are more prone to being overweight/obese. The elasticities are moderate, but slightly higher in the age group 36-42 years. Education and overweight/obesity display a positive association, but with low elasticities.

Table 7
Probit analyses of overweight/obese women in rural India, 2005

Variables	Equation 1			Equation 2		
	coeff.	z-value	Elasticity	coeff.	z-value	elasticity
Monthly per capita consumption Rs 401 – 700	0.135***	(3.28)	0.0842***			
Monthly per capita consumption Rs 701-1000	0.338***	(7.41)	0.0935***			
Monthly per capita consumption Rs >1000	0.553***	(12.40)	0.146***			
Household assets 10-16				0.333***	(9.74)	0.192***
Household assets >16				0.676***	(15.41)	0.138***
SC	-0.232***	(-5.89)	-0.0878***	-0.206***	(-5.18)	-0.0782***
ST	-0.176***	(-3.06)	-0.0331***	-0.156***	(-2.72)	-0.0295***
OBC	-0.158***	(-4.89)	-0.0983***	-0.144***	(-4.43)	-0.0897***
Age 29-35	0.321***	(8.18)	0.169***	0.324***	(8.20)	0.171***
Age 36-42	0.440***	(10.91)	0.184***	0.455***	(11.23)	0.190***
Age 43-49	0.633***	(14.22)	0.138***	0.664***	(14.93)	0.145***
Education 6-9	0.173***	(4.74)	0.0495***	0.0942**	(2.50)	0.0270***
Education >9	0.234***	(5.52)	0.0412***	0.122***	(2.72)	0.0215***
Eastern	-0.287***	(-6.40)	-0.109***	-0.216***	(-4.67)	-0.0819***
Western	-0.284***	(-6.42)	-0.0961***	-0.303***	(-6.83)	-0.103***
Southern	-0.108**	(-2.36)	-0.0386**	-0.100**	(-2.16)	-0.0359**
Central	-0.252***	(-4.37)	-0.0541***	-0.266***	(-4.61)	-0.0571***
Ever married	-0.0891	(-0.26)	-0.150	-0.0971	(-0.28)	-0.164
Member Mahila mandal - proportions .0 -0.2	0.00635	(0.19)	0.00282	0.000504	(0.02)	0.000224
Member Mahila mandal - proportions >0.2	0.00428	(0.10)	0.00103	0.0134	(0.32)	0.00322
Ratio of female to male who were employed 0.5 - 0.8	-0.150***	(-4.33)	-0.117***	-0.113***	(-3.24)	-0.0881***
Ratio of female to male who were employed > 0.8	-0.200***	(-5.13)	-0.117***	-0.143***	(-3.67)	-0.0841***
Women either listen to radio or read newspaper	0.229***	(3.25)	0.0534***	0.180**	(2.53)	0.0420***
Ratio of cereal to pulse prices	0.272**	(2.20)	0.193**	0.328***	(2.64)	0.233***
Ratio of cereal to milk and product prices	0.00678	(0.10)	0.00368	0.0588	(0.84)	0.0320
Ratio of cereal to meat prices	-0.0685	(-0.74)	-0.0232	-0.109	(-1.08)	-0.0368
Ratio of cereal to eggs prices	-0.357*	(-1.83)	-0.195*	-0.483**	(-2.44)	-0.265**
Ratio of cereal to vegetables prices	-0.0917**	(-2.22)	-0.186**	-0.0875**	(-2.03)	-0.178**
Ratio of cereal to oil prices	0.428	(0.96)	0.153	0.402	(0.88)	0.144
Constant	-1.283	(-3.65)		-1.317	(-3.73)	
Observations	14,967			14,967		
Wald chi2	971.5			1023		
Prob > chi2	0			0		
Pseudo R2	0.0907			0.0952		
Log pseudolikelihood	-5486			-5459		

Robust z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Unlike rural areas, in both income and asset equations for urban areas, only the Southern region has a significant positive coefficient, but the elasticities are low. The possibility that cultural norms of fatness as a sign of beauty are more prominent in the urban parts of the Southern region, as conjectured by Subramanian et al. (2009), cannot be ruled out.

Women living in metros were less likely to be overweight/obese, but the elasticity was low. Marital status – ever married – was associated with considerably higher risks of overweight and obesity, with the highest elasticity among all explanatory variables in the income equation. This finding is, however, not replicated in the asset equation. Somewhat surprisingly, an indoor toilet was positively associated with a higher risk of being overweight/obese in the asset equation and a kitchen vent was positively related to this risk in the income equation. However, the elasticities are low.

Media exposure had a positive effect on urban women's risk of being overweight/obese. However, this effect is weakly significant in the asset equation. Food prices had varying effects. Ratio of cereal to pulse prices had a negative effect, with a moderate (absolute) elasticity; ratio of cereal to egg prices had a positive effect (high absolute elasticity), while that of cereal to meat prices had a negative effect (low absolute elasticity), ratio of cereal to vegetable prices had a positive effect (high elasticity); and, finally, ratio of cereal to oil prices had a negative effect, but with highest (absolute) elasticity among food prices. An intriguing result is the *reversal* of the effect of ratio of cereal to egg prices, from negative in the rural sample to positive in the urban sample. It is plausible that eating more cooked eggs could be part of the explanation, but it is not self-evident that this could explain the sign reversal unless consumption of complements (e.g. potatoes) was higher too in urban areas.

The Wald chi^2 test confirms that all coefficients were significantly different from 0 in both equations.

As in the rural and urban samples, affluence, measured either in terms of expenditure or assets, is positively associated with the risk of women being overweight/obese. The highest elasticity is observed in the most affluent group. All regions had lower risks of overweight/obesity relative to the Northern region. The (absolute) elasticities with respect to Eastern and Western regions were (relatively) high. Marital status and overweight/obesity were unrelated.

To allow for threshold effects of membership of women's associations (Mahila Mandals) on overweight/obesity, we disaggregated the former at the PSU level into three ranges (none, 0-.2, and > .2). With or without the disaggregation, membership of women's associations had no effect on the risk of being overweight/obese.

We also disaggregated ratio of female to male workers at the PSU level into three intervals: <.5, between .5-.8 and > .8, to capture the effects of opportunities for female employment relative to male employment on the risk of being overweight/obese. The omitted interval is <.5. It turns out that in both intervals the risk of being overweight/obese is lower than in the omitted group. Although the coefficient of the highest interval is larger in (absolute) value, the two elasticities are identical.

Interestingly, greater media exposure is associated with higher risk of being overweight/obese presumably because it reflects greater leisure time, exposure to fatty and processed food and greater frequency of eating. It may be recalled that media exposure and risk of being underweight were unrelated.

Relative food prices had mixed effects. Higher ratios of cereal to pulse prices, and cereal to edible oil prices elevated the risk of being overweight/obese, while ratios of cereal to egg prices, and cereal to vegetable prices lowered the risk. Recall that some of these food price effects differed in the context of underweight (e.g. ratio of cereal to vegetable prices had a positive coefficient, while ratio of cereal to edible oil prices had a negative coefficient). Except for the elasticity of being overweight/obese with respect to the ratio of cereal to vegetable prices, all other (absolute) food price elasticities were larger in the second specification with assets instead of expenditure.

The Wald chi^2 test confirms that all coefficients of explanatory variables taken together are significantly different from 0.

As in rural India, higher expenditure is positively related to the risk of overweight/obesity among women in urban India, and elasticities rise with expenditure interval. A similar relationship is observed between assets and overweight/obesity, and the elasticity is higher in the higher asset intervals (see Table 8).

Caste hierarchy matters as SCs, STs and OBCs display negative associations with overweight/obesity but with low elasticities among SCs and STs and a slightly higher elasticity among OBCs (recall that these are relative to the omitted group of Others who are the least disadvantaged/or most advantaged).

Age and overweight/obesity are positively related with higher elasticities among women aged 29-35 years and 36-42 years (relative to the youngest age group of women aged 22-28 years). Education elevates the risk of being overweight/obese, but with low elasticities.

In the first specification (or with income intervals), both Eastern and Western regions had higher risks of women being overweight/obese, while in the second or asset equation only the Southern region displayed a higher risk (relative to the Northern region). In all cases, however, the (absolute) elasticities were low.

Both metro and non-metro urban areas displayed higher risks of being overweight/obese relative to the rural, with a higher elasticity with respect to non-metro urban areas. A somewhat surprising result is that marital status – ever married – did not possess a significant coefficient. Exposure to media reduces the risk, but in both specifications the elasticity was low.

Relative food prices had mixed effects. The ratio of cereal to meat prices had a negative coefficient, while the ratio of cereal to vegetable prices had a positive effect. The latter had a much higher elasticity (in absolute value) – especially in the asset specification. Surprisingly, cereal to edible oil prices had no effect on the risk of being overweight/obese.

The Wald chi^2 test confirms that all coefficients are significantly different from 0 in both specifications.

Table 8

Probit analysis of overweight/obese women in urban India, 2005 (1)

Variables	Equation 1 coeff.	z-value	elasticity
Monthly per capita consumption Rs 401 - 700	0.117*	(1.88)	0.0396*
Monthly per capita consumption Rs 701-1000	0.262***	(4.15)	0.0739***
Monthly per capita consumption Rs >1000	0.467***	(7.50)	0.219***
SC	-0.0875**	(-2.19)	-0.0186**
ST	-0.258***	(-3.12)	-0.0107***
OBC	-0.182***	(-5.70)	-0.0714***
Age 29-35	0.346***	(9.19)	0.131***
Age 36-42	0.572***	(14.84)	0.159***
Age 43-49	0.671***	(15.70)	0.108***
Education 6-9	0.143***	(3.98)	0.0393***
Education >9	0.148***	(4.06)	0.0574***
Eastern	-0.0308	(-0.68)	-0.00831
Western	0.0105	(0.25)	0.00257
Southern	0.132***	(2.81)	0.0402***
Central	-0.0930	(-1.40)	-0.00684
Metro	-0.137***	(-4.36)	-0.0473***
Ever married	0.537*	(1.75)	0.642*
Vent in cooking place	0.0504*	(1.70)	0.0378*
Member Mahila Mandal	-0.170	(-1.35)	-0.0108
Women either listen to radio or read newspaper	0.154***	(2.61)	0.0542***
Ratio of cereal to pulse prices	-0.304***	(-2.81)	-0.166***
Ratio of cereal to milk and product prices	-0.0486	(-0.68)	-0.0214
Ratio of cereal to meat prices	-0.206***	(-4.17)	-0.0519***
Ratio of cereal to eggs prices	0.768***	(3.46)	0.350***
Ratio of cereal to vegetables prices	0.241***	(5.71)	0.358***
Ratio of cereal to oil prices	-1.302***	(-2.92)	-0.373***
Constant	-1.929	(-5.98)	
Observations	10,504		10,504
Wald chi2	774.1		
Prob > chi2	0		
Pseudo R2	0.0646		
Log pseudolikelihood	-5997		

Robust z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8 (contd.)

Probit analysis of overweight/obese women in urban India, 2005 (2)

Variables	Eq.(1) coeff.	Eq.(2) z-value	Eq.(3) elasticity
Household assets 10-16	0.295***	(5.18)	0.133***
Household assets >16	0.570***	(9.11)	0.331***
SC	-0.0645[w]	(-1.60)	-0.0138[w]
ST	-0.240***	(-2.86)	-0.0101**
OBC	-0.177***	(-5.49)	-0.0696***
Age 29-35	0.338***	(8.92)	0.127***
Age 36-42	0.572***	(14.80)	0.160***
Age 43-49	0.678***	(15.82)	0.110***
Education 6-9	0.103***	(2.81)	0.0284***
Education >9	0.111***	(2.98)	0.0430***
Eastern	-0.00414	(-0.09)	-0.00112
Western	-0.00697	(-0.16)	-0.00172
Southern	0.182***	(3.70)	0.0563***
Central	-0.106	(-1.57)	-0.00777
Metro	-0.122***	(-3.82)	-0.0419***
Ever married	0.465	(1.50)	0.558
Vent in cooking place	0.0117	(0.38)	0.00879
Household toilet	0.0661*	(1.64)	0.0581*
Water within house	0.0336	(0.62)	0.0282
Member Mahila Mandal	-0.152	(-1.19)	-0.00965
Women either listen to radio or read newspaper	0.0986[w]	(1.59)	0.0347[w]
Ratio of cereal to pulse prices	-0.287***	(-2.61)	-0.157***
Ratio of cereal to milk and product prices	-0.0351	(-0.48)	-0.0155
Ratio of cereal to meat prices	-0.232***	(-4.57)	-0.0583***
Ratio of cereal to eggs prices	0.599***	(2.67)	0.274***
Ratio of cereal to vegetables prices	0.257***	(6.02)	0.383***
Ratio of cereal to oil prices	-1.093**	(-2.46)	-0.314**
Constant	-2.024	(-6.22)	
Observations	10,418		
Wald chi2	774.7		
Prob > chi2	0		
Pseudo R2	0.0668		
Log pseudolikelihood	-5928		

Robust z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1, and w denotes weakly significant (>0.1).

(c) Determinants of ratio of underweight to overweight women

Analysis of variation in the ratio of underweight to overweight (including obese) women supplements the preceding separate analyses of prevalence rates of underweight and overweight/obese women, as it helps focus better on the double malnutrition burden that Indian women face.[10] As noted earlier, while on average the prevalence of underweight is higher than that of overweight women in the age-group 22-49 years, in eight states (Punjab, Delhi, Kerala, Jammu and Kashmir, Tamil Nadu, Himachal Pradesh, Assam, Haryana) and in the Northeast region (excluding Assam), there was an excess of overweight women. As the health implications of underweight and overweight differ and there are concerns that obesity is rising, changes in this ratio could signal evolving health priorities in different states. The results at the all-India level are presented in Table 9.[11]

The specifications are similar to those used earlier, but the method of estimation is robust regression analysis (to correct for heteroscedasticity). The ratios and explanatory variables are constructed at the PSU level primarily because anthropometric data were collected for a single woman selected randomly in a household.

Using the two alternative measures of economic status, expenditure and assets, there are strong associations between them and the ratio of underweight to overweight women. Highest expenditure range has an inverse relationship with this ratio, with a modest elasticity, relative to the lowest expenditure range. By contrast, both asset groups have significant negative coefficients, with much higher (absolute) elasticities, relative to the lowest asset group. Thus affluence and underweight/overweight ratio are *inversely* related. In the urban sample, all expenditure groups had significant negative coefficients, with sharply rising (absolute) elasticities. Both asset ranges too had significant negative coefficients, with even larger (absolute) elasticities. In fact, the (absolute) elasticity in the highest range of assets was 1.34.

Following Deaton (2008), we also examined whether inequality in monthly per capita expenditure (the Gini) and its square were related to this measure of inequality in nutritional status. In the expenditure (or the first) specification, neither had a significant coefficient.

Using the caste hierarchy, both STs and OBCs had higher ratios of underweight/overweight women, relative to Others. The elasticity of this ratio with respect to OBCs was moderate, but much larger than that with respect to STs in both specifications. Women in the age-group 29-35 years had a significantly higher ratio, relative to the youngest group of women in the age group 22-28 years, with high elasticities in both specifications. Education had no effect on this ratio in the all-India sample. However, education of more than nine years had a negative effect in the urban sample with a high (absolute) elasticity.

While the Eastern region had a significantly lower ratio, the Western region had a significantly higher ratio, relative to the Northern. Their (absolute) elasticities were low – especially of the Eastern region. Similar results were obtained with the asset specification. Marital status was not related to this ratio. However, in the urban sample, ever married women were negatively correlated with the ratio of

[10] For expositional convenience, overweight is combined with obese. So sometimes we will refer to the ratio of underweight to overweight including obese as simply the ratio of underweight to overweight.
[11] We conducted a separate analysis of the ratio of overweight to obese women in rural and urban samples. These results are available upon request.

Table 9

Robust regression analysis of ratio of underweight to overweight + obese women in all-India, 2005

	Equation 1			Equation 2		
Variables	coeff.	t-value	elasticity	coeff.	t-value	elasticity
Monthly per capita consumption Rs 401 – 700	-0.0834	(-0.79)	-0.0301			
Monthly per capita consumption Rs 701-1000	-0.140	(-1.25)	-0.0549			
Monthly per capita consumption Rs >1000	-0.299**	(-2.55)	-0.159**			
Household assets 10-16 - PSU proportion				-0.476***	(-4.47)	-0.232***
Household assets >16 - PSU proportion				-0.635***	(-4.54)	-0.315***
Inequality per capita consumption	1.689	(0.29)	0.888			
Square of gini_psu	-4.329	(-0.50)	-0.897			
SC - PSU proportion	0.120	(1.28)	0.0313	0.131	(1.41)	0.0340
ST- PSU proportion	0.477***	(3.15)	0.0303***	0.358**	(2.43)	0.0228**
OBC- PSU proportion	0.336***	(4.29)	0.146***	0.330***	(4.28)	0.144***
Age 22-28 - PSU proportion	0.539***	(2.87)	0.190***	0.572***	(3.09)	0.202***
Age 29-35 - PSU proportion	-0.0673	(-0.36)	-0.0279	0.00211	(0.01)	0.000875
Age 36-42 - PSU proportion	-0.0428	(-0.22)	-0.0150	0.00605	(0.03)	0.00213
Education 6-9 - PSU proportion	-0.0757	(-0.58)	-0.0215	0.0195	(0.15)	0.00556
Education >9 - PSU proportion	0.00770	(0.06)	0.00257	0.0329	(0.25)	0.0110
Metro	-0.367***	(-5.54)	-0.0643***	-0.285***	(-4.27)	-0.0500***
Non-metro urban	-0.164***	(-3.31)	-0.0834***	-0.120**	(-2.38)	-0.0612**
Eastern	-0.181**	(-2.57)	-0.0432**	-0.214***	(-3.00)	-0.0512***
Western	0.323***	(5.27)	0.0830***	0.342***	(5.74)	0.0881***
Southern	-0.00898	(-0.13)	-0.00326	-0.0298	(-0.43)	-0.0108
Central	0.124	(1.46)	0.0123	0.119	(1.44)	0.0118
Women ever married - PSU proportion	-1.217	(-1.29)	-1.625	-0.991	(-1.07)	-1.327
With vent in kitchen – PSU proportion	-0.0647	(-0.86)	-0.0493	-0.0220	(-0.29)	-0.0168
With toilet - PSU proportion	-0.409***	(-5.07)	-0.309***	-0.325***	(-3.91)	-0.246***
Water within house – PSU proportion	-0.261***	(-3.51)	-0.209***	-0.190**	(-2.51)	-0.152**
Women either listen to radio or read newspaper - PSU proportions	0.0157	(0.16)	0.00504	0.00611	(0.06)	0.00197
Ratio of cereal to pulse prices	0.0275	(0.18)	0.0162	0.0105	(0.07)	0.00621
Ratio of cereal to milk and product prices	0.0118	(0.12)	0.00558	-0.0232	(-0.24)	-0.0110
Ratio of cereal to meat prices	0.208	(0.75)	0.0495	0.274	(1.01)	0.0654
Ratio of cereal to eggs prices	-0.469	(-1.52)	-0.225	-0.374	(-1.23)	-0.180
Ratio of cereal to vegetable prices	0.257***	(4.34)	0.412***	0.222***	(3.81)	0.357***
Ratio of cereal to oil prices	-1.594**	(-2.32)	-0.485**	-1.595**	(-2.36)	-0.486**
Constant	2.561	(1.82)		2.375	(2.53)	
Observations	1,714			1,714		
R-squared	0.310			0.317		
F	25.24			28.96		
df_m	30			27		
df_r	1683			1686		

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

underweight to overweight with a high (absolute) elasticity (a little over four in the income specification). Similar results were obtained with the asset specification.

Both indoor toilet and safe drinking water facility lowered the underweight/overweight ratio. The (absolute) elasticity with respect to indoor toilet was high. In the urban sample, however, even a kitchen with a vent lowered the ratio. All three variables had high absolute elasticities, with the highest associated with an indoor toilet. Both metro and non-metro urban areas had significantly lower ratios relative to the rural. Both (absolute) elasticities were low.

Of the relative food prices, two were significant. One was the ratio of cereal to vegetable prices, which increased the underweight/overweight ratio with a high elasticity. By contrast, the ratio of cereal to edible oil prices lowered this ratio, with a higher (absolute) elasticity. As emphasised earlier, further disaggregation is necessary to understand better the cross-price effects, including demand for complements and substitutes.

The Wald chi^2 test confirmed that in both specifications all the coefficients were significantly different from 0.

6. Discussion

Using the WHO BMI ranges, it is generally argued that the overweight (including the obese) are more susceptible to diabetes, heart disease and stroke, and tend to die younger, while those classified as underweight have a higher risk of death from complications related to being malnourished. This classification of nutritional status based on BMI ranges and their links to risk of mortality has been questioned in recent years. Burkhauser and Cawley (2008), for example, are deeply sceptical of the use of BMI as a classification criterion. They argue that, relative to percent body fat, BMI misclassifies substantial fractions of individuals as obese or non-obese; in general, BMI is less accurate classifying men than women. Furthermore, when percent body fat instead of BMI is used to define obesity, the gap in obesity between white and African American men increases substantially, but the gap in obesity between African American and white women is cut in half. While a case for alternative measures has merit, BMI continues to be widely recommended and used (WHO 2004; Manson et al. 1995). Besides, the IHDS on which our empirical analysis is based does not have any other measure of body fat (e.g. waist circumference, waist-to-hip ratio).[12] On the relationship between low and high BMIs and risk of death, we will summarise recent evidence later, and, in light of this evidence, comment on health priorities in the Indian context.

Examining the socio-economic pattern in India over the period 1998-99 and 2005-06, Subramanian et al (2009) report that the positive and strong association between SES and BMI did not change. The double weight burden thus remains socially disaggregated, with overweight women concentrated among high socio-economic status groups and underweight mostly in low socio-economic status groups.

[12] Recent studies have shown that South Asians have the weakest correlation between waist circumference and BMI when comparing them against Europeans, Chinese, and Aboriginal persons, although the correlation is still substantial (Subramanian and Smith, 2006).

As our analysis is based on a different but nationally representative source, IHDS, 2005, and a different age group of adult women, some of the key estimates differ in magnitude, but the findings are similar. Based on our cross-tabulations and the econometric results, the socio-economic patterning is largely intact. Overweight and obese women were largely concentrated in affluent households, while underweight women were mostly in lower income and asset ranges. Besides, socially and economically disadvantaged groups, SCs, STs and OBCs, had more underweight than overweight women, while the least disadvantaged, Others, had more overweight women.

Another finding is the spatial pattern in the ratio of underweight to overweight women. Although on average there were more underweight than overweight women, in eight states (Punjab, Delhi, Kerala, Jammu and Kashmir, Tamil Nadu, Himachal Pradesh, Assam, Haryana) and in the region of Northeast excluding Assam, there as an *excess* of overweight women. In metros and non-metro urban areas, too, there was an excess of overweight women. Although we control for sanitary and hygienic living, diets, socio-economic status, a (weak) proxy for leisure, it would be an overstatement to claim that there is a complete specification of lifestyle differences between these and rural areas (e.g. more sedentary lives, less strenuous physical activities, better communication and transport facilities, easier access to fast food, duration of sleep in urban environments).[13] So some of these differences may show up in the positive coefficients of urban living environments (Popkin et al. 2012; Griffiths and Bentley 2001). Besides, there may be stronger peer effects among urban women compared with rural women (e.g. drinking of alcohol, cigarette smoking) that are often overlooked. Finally, migrants' diets and health-seeking behaviour may adapt slowly to the urban living environment. To reduce rural–urban differences to lifestyle differences is therefore not just incomplete, but also an oversimplification.

Age and underweight are inversely related, while age and overweight are positively related. Thus younger women are more likely to be underweight and older are more likely to be overweight.

Although the relation between education and underweight is not so robust, more than nine years of education reduces its prevalence among women. However, a positive relation between education and overweight is more robust. While Subramanian et al. (2009) report a positive association between education and overweight, Griffiths and Bentley (2001) report a similar association, but between a household member educated for more than 10 years and overweight. Similar evidence exists for Bangladesh, where more educated women were more likely to be overweight in rural areas.[14] The closest to an explanation is Reddy et al. (2007), which analysed the association between educational status and cardiovascular disease risk factors in industrial populations in India. Their main finding was

[13] Eating out contributes to diet diversification. This refers to meals or snacks served in restaurants, roadside eating places, tea and snack shops, and street vendors. As the mix of food served includes fast food (e.g. burgers, pizzas, *pakora*, *samosa*), junk food (chips, chocolate, soft drinks), instant foods (noodles, soup powder), and street foods (*chaat, tikki, golgappa*), they are high in sugar, saturated fat, salt, and calorie content, which are associated with higher risks of obesity, hypertension, and impaired glucose tolerance. A related concern is that some of these foods are prepared, handled and stored in unhygienic conditions that lead to microbiological contamination. A recent analysis based on IHDS, 2005, shows that eating out is a pervasive phenomenon – especially in the urban areas and, more specifically, in the metros. While the relatively affluent are more prone to eating out and spend larger amounts, some of the deprived segments, using not just income/expenditure criteria but also caste and location, do not seem to lag far behind. Nor is eating out merely an urban phenomenon, as large segments in rural areas eat out too (Gaiha et al. 2013 a, b).

[14] In rural areas, women with 14 years of schooling had an eightfold higher risk of being overweight compared with their non-educated peers (Shafique et al. 2007).

that people with lower socio-economic status were increasingly vulnerable to cardiovascular disease risk factors. In particular, treating educational attainment as an SES variable, a significantly higher BMI was found for those with higher education than for those with lower education, and the prevalence of obesity was more than 2.5 times that among those with higher education than among those with low or no education at all. Despite the high prevalence of hypertension, significantly fewer men in the low-educational group sought treatment, compared with the high-educational group. However, this relationship was exactly the opposite among women, because significantly more individuals in the low-educational group sought treatment for hypertension compared with the high-educational group.

This finding is in sharp contrast to many developed countries, where either no relationship is found between education and obesity among women or a negative one. Devaux et al. (2011) and Webbinka et al. (2010), for example, review recent evidence for developed countries confirming an inverse association between education status and the probability of being overweight, as well as a few that did not find any association. Their own analyses, however, confirm the negative association. But Webbinka et al. (2010) do not find a negative effect of education on body size among Australian women. So, while the evidence differs between India and Bangladesh, and a few developed countries, we are still far from a satisfactory explanation of why the associations differ so sharply.

The regional contrast is striking, but varies depending on whether the focus is on underweight, overweight, or ratio of underweight to overweight women. In earlier studies (e.g. Miller 1981; Bardhan, 1974; Rosenzweig and Schultz, 1982), there was an overemphasis on the North-South divide in female survival rates, due to differences in cropping patterns, prospects of female employment, and property rights. Recent years have witnessed a blurring of this divide and a sharpening of other divides. To illustrate, the underweight/overweight ratios in rural areas were significantly higher in the Western and Central regions, while the ratios in urban areas were significantly lower in the Eastern and higher in the Western, relative to the Northern. As these are a manifestation of a complex interplay of educational, economic, cultural and political factors over time, we will not offer any conjectures.

The effect of marital status – ever married women – was not robust, except in the regression of the ratio of underweight/overweight women in the urban sample with a very large (absolute) elasticity (4.1). The ratio was significantly lower among ever married women.

Wilson (2012) offers new insights. Does marriage promote a healthy BMI, even after controlling for other health factors? Researchers have recently argued that social obligations may play an important role, but without direct evidence, particularly with respect to how eating patterns change upon marriage. Wilson (2012) categorises marital obligations as one of many shared risk factors that may affect body mass. In support of that view, a limited but growing body of literature explores the interaction between diet and marriage. A study in Greece, for instance, reports that married couples have a healthier (Mediterranean) diet, even though they weigh more than singles. In general, being married is associated with more healthful eating habits, including eating more fruit and vegetables. Other research found that married people smoke less, and also exercise less, both factors that tend to increase body weight.[15]

[15] For further details, see Wilson (2012).

Sanitation and hygiene (e.g. indoor toilet, safe drinking water facility, and a kitchen with a vent) are associated with lower ratios of underweight to overweight – especially in all-India and urban samples – as the risks of infectious diseases are lower (especially those acquired by ingesting contaminated food or water or other exposures in the environment). These results are corroborated by others (e.g. Corsi et al. 2011).

Several studies have drawn attention to favourable effects of physical activity on nutrition outcome (Griffiths and Bentley 2001; Subramanian et al. 2009; Subramanian and Smith 2011). However, occupational choice is taken as given, when in fact it is *endogenous* (Kijima 2006). To overcome this difficulty, we take the ratio of female to male workers at the village level in the rural sample and disaggregate it into different ranges to capture threshold effects. The risk of overweight/obesity is considerably lower, with higher ratios of female/male workers, implying greater opportunities for female employment are associated with greater physical activity and a lowering of the risk of overweight/obesity[16].

Media exposure is linked to more leisure and more frequent eating and a higher risk of overweight/obesity. This is robustly confirmed in the probits of overweight in urban and all-India samples. Although much of the extant literature focuses on the effects of watching TV regularly (e.g. Griffiths and Bentley 2001), we used instead regular listening to a radio or reading of a newspaper as proxies for media exposure. Although we controlled for diets, there was no control for frequency of eating and a weak proxy for leisure. It is therefore plausible that media exposure through greater leisure and frequency of eating is responsible for higher probability of overweight/obesity.

Our analysis is a methodological improvement on some of the studies reviewed earlier – notably, Griffiths and Bentley (2001), which uses *actual* intake of various food commodities without an allowance for their endogeneity to income and relative food prices, and Subramanian et al. (2009), which does not incorporate any diet-related variables in their econometric analysis – as we use relative food prices to reflect food choices, given income/wealth.[17] The relative food prices are significant determinants of risks of underweight and overweight/obesity. However, a limitation of our analysis is its lack of sufficiently detailed disaggregation of food commodities that comes in the way of understanding their nutritional implications. A few relationships are, however, plausible. There is, for example, a positive relationship between ratio of underweight to overweight and ratio of cereal to vegetable prices. Leafy green vegetables lower the risk of overweight, while potatoes (especially French fries) elevate it. Another is the negative relationship between the ratio of cereal to edible oil prices and the ratio of underweight to overweight women. As noted earlier, a more detailed food commodities' classification would yield richer insights into what food items are complements and substitutes. An omission is the analysis of the effects of higher consumption of sugar (including through sweetened beverages).

[16] A recent comment in *The Lancet* (Das and Horton 2012) using a broader view of physical activity, draws attention to its various favourable effects extending beyond reduction of obesity and risks of diseases associated with it. They observe: "But it is a mistake to view physical activity only in terms of its disease-specific associations. The benefits of physical activity are far-reaching and extend beyond health alone. Being physically active is a major contributor to one's overall physical and mental well-being. Positive outcomes include a sense of purpose and value, a better quality of life, improved sleep, and reduced stress, as well as stronger relationships and social connectedness" (p.189).

[17] For details, see Gaiha et al. (2013a, b).

In a recent contribution, Mozaffarian et al. (2011) offer an insightful analysis of the links between diet and weight. They demonstrate that weight gain seen for specific foods and beverages could relate to varying portion sizes, patterns of eating, effects on satiety, or displacement of other foods or beverages. Strong positive associations with weight change were seen for starches, refined grains and processed foods. These findings corroborate the results of short-term trials: consumption of starches and refined grains is less satiating, and increases subsequent hunger signals and total caloric intake, as compared with equivalent numbers of calories obtained from less processed, higher-fibre foods that also contain healthy fats and protein.[18] Consumption of processed foods that are higher in starches, refined grains, fats and sugars increases weight gain.

Another interesting finding from recent research is that all calories are not created equal and the way the body processes the same calories may vary dramatically from one person to the next (*The Economist* 2013). The metabolic syndrome, including high blood pressure, high blood sugar, unbalanced cholesterol and, of course, obesity is key to understanding why some foods are particularly harmful and why some people gain more weight than others. Diets with a high “glycaemic index”, raising glucose levels in the blood, seem to promote metabolic problems. Those on a diet with a low glycaemic index experience metabolic changes that help them keep weight off, compared with those fed a low-fat diet. This challenges the notion that a calorie is a calorie. Others, however, blame fructose, which seems to promote obesity and insulin resistance. But glucose does its harm, in part, through its conversion to fructose.

So, in brief, one type of calorie may be metabolised differently from another. But the effect of a particular diet depends on a person’s genes and bacteria. And that person’s bacteria are determined in part by his/her diet. Metabolic syndrome thus involves an intricate relationship between food, bacteria and genetics.

Recent experimental evidence unravels a relationship between sleep, diet and obesity (Mozaffarian et al. 2011). Reduced sleep alters leptin, ghrelin, subjective hunger, and preferences for calorie-dense, refined-carbohydrate foods. Weight gain is lowest among persons who sleep six to eight hours a night and is higher among those who sleep less than six hours or more than eight hours.

The health implications of being underweight and overweight/obese are well documented (e.g. Griffiths and Bentley 2001; and Subramanian et al. 2009). Underweight women are highly prone to risks for disease, disability and mortality. Besides, children born to undernourished women, if they survive, are more likely to succumb to diabetes, cardiovascular disease or other chronic diseases in adulthood.[19] Overweight and obesity, on the other hand, elevate risks of non-communicable diseases, such as heart disease, hypertension and adult onset diabetes. Although underweight and overweight are concentrated

[18] Ruhm (2012) argues that interplay of economic and biological factors results in overeating in the current environment of cheap and readily available food. He develops a “dual decision” approach, where choices reflect the interaction of a “deliberative” system, operating as in standard economic models, and an “affective” system that responds rapidly to stimuli without considering long-term consequences. As in the standard model, weight is related to prices. However, another potentially important reason for rising obesity is that food producers have incentives to engineer products to stimulate the affective system so as to encourage overeating. See also Brownell et al. (2010).

[19] As Osmani and Sen (2003) point out, sex inequality can contribute to poor health within a society through such interuterine mechanisms.

in different socio-economic groups – underweight among low socio-economic groups and overweight among the affluent – it is oversimple to project that this social patterning is likely to remain intact, given rapid dietary changes, urbanisation and ageing of the population.

About 62 percent of the total disease burden (including injuries) is now attributable to NCDs, a larger share than communicable diseases, and maternal and child health (MCH) issues. But communicable diseases (e.g. tuberculosis, respiratory infections, and water and vector-borne disease) are still prominent in the total population, reflecting a 'double disease burden'.

The shift of the disease burden toward NCDs will increase demand on the healthcare system. With more healthcare currently financed with private out-of pocket resources, it will be increasingly hard for households to escape poverty, while more will be driven into poverty. As rural population migrates to urban areas, the associated lifestyle changes are likely to elevate NCD risks. Extreme poverty and foetal and early childhood undernutrition are likely to create a large pool of those at elevated risk (World Bank 2011; Gaiha et al. 2013b). As India increases its focus on the health needs of overweight and obese people, it is imperative that simultaneously it addresses the needs of the large number of severely undernourished people in society.

A brief comment on the obesity paradox provoked by a recent controversial study by Flegal et al. (2013) is necessary from a health policy perspective. They reported that people deemed 'overweight' by international standards were six percent less likely to die than were those of 'normal' weight over the same time period. There was a hostile backlash from few public-health experts.[20] A few others were more inclined to accept the evidence as another illustration of the obesity paradox. Being overweight increases a person's risk of diabetes, heart disease, cancer and many other chronic illnesses. But evidence also suggests that for some people – particularly those who are middle-aged or older, or already sick – a bit of extra weight is not particularly harmful, and may even be helpful. A common explanation is that people who are overweight have more energy reserves to fight off illness.

Manson et al. (1995) found, after excluding women who had ever smoked and those who died during the first four years of the study (reasoning that these women may have had disease-related weight loss), a direct linear relationship between BMI and death, with the lowest mortality at BMIs below 19. But an issue is whether it is biologically plausible that overweight and obesity could both increase the risk of life-threatening diseases and yet lower mortality rates. The Harvard group further contends that the Flegal study (2013) did not make appropriate corrections for age, sickness-related weight loss and smoking. Flegal's comment on a more recent study by de Gonzalez et al. (in which Willett was a coauthor, 2010) was that deletion of large swathes of data – nearly 900,000 people in all – could potentially introduce selection bias apart from errors of self-reported height and weight. So, as matters stand, the obesity paradox cannot be dismissed.

7. Concluding observations

India has one of the highest underweight burdens in the world, with signs of rising obesity. It is argued that the burden of overweight and obesity has or will shift to households with lower socio-economic status

[20] Walter Willet of Harvard School of Public Health dismissed this finding as a "pile of rubbish…" (*Nature* 2013; HSPH 2013).

(SES) as a country develops economically. So, if the overweight burden shifts to the low SES groups while the underweight burden remains high, these groups will be exposed to the double burden of malnutrition. Our review suggests that the increase in the exposure has been slow.

In line with previous findings confirming that the socio-economic patterning of underweight and overweight has not changed much, our analyses corroborate that the double weight burden remains socially disaggregated, with overweight women largely concentrated among high socio-economic status groups (SES) and underweight mostly in low SES. In fact, socially and economically disadvantaged groups, SCs, STs and OBCs, had more underweight than overweight women, while the least disadvantaged, Others, had more overweight women.

Another interesting finding relates to the spatial pattern in the ratio of underweight to overweight women. Although on average there were more underweight than overweight women, in several states, there was an excess of overweight women. Besides, in metros and non-metro urban areas too, there was an excess of overweight women. The argument that much of this excess is due to lifestyle differences between rural and urban areas is not persuasive, if not an oversimplification. Migrants' diets and health-seeking behaviour, for example, adapt slowly to the urban living environment.

The regional contrast is striking, but varies with whether the focus is on underweight, overweight or ratio of underweight to overweight women. In earlier studies, there was an overemphasis on the North-South divide in female survival rates. Recent years have witnessed a blurring of this divide and a sharpening of other divides. As these are a manifestation of a complex interplay of educational, economic, cultural and political factors over time, no conjecture is offered.

Age and underweight are inversely related, while age and overweight are positively related. Thus younger women are more likely to be underweight and older women more likely to be overweight. But ageing of the population, dietary shift towards consumption of processed foods that are higher in starches, refined grains, fats, and sugars, and higher prevalence rates of NCDs among older groups imply a rising burden of such diseases.

Although the relation between education and underweight is not so robust, having more than nine years of education reduces its prevalence among women. However, a positive relation between education and overweight is more robust. Although a similar finding is obtained from an analysis of industrial populations in India, the underlying reasons remain obscure.

The effect of marital status – ever married women – was not robust, except in one case. The ratio of underweight to overweight was significantly lower among ever married women. Other evidence suggests that married couples have healthier diets, even though they weigh more than singles.

Favourable effects of physical activity on nutrition outcome are well documented, except that in the studies reviewed the empirical validation is unsatisfactory. Our analysis suggests that opportunities for greater female employment in productive work lower the risk of overweight/obesity among women considerably. That there is also a cost in the form of longer hours of work ought not to be overlooked.

Sanitation and hygiene (e.g. an indoor toilet, a safe drinking water facility, and a kitchen with a vent) are associated with lower ratios of underweight to overweight, as the risks of infectious diseases are lower (especially those acquired by ingesting contaminated food or water, or other exposures in the environment). That these effects are observed after controlling for wealth effects adds to their significance in household decision-making.

Media exposure is linked to more leisure and more frequent eating and a higher risk of overweight/obesity. But this link needs a detailed investigation.

Relative food prices are significant determinants of risks of underweight and overweight/obesity among women. However, a limitation of our analysis is its lack of sufficiently detailed disaggregation of food commodities that comes in the way of understanding their nutritional implications. A few plausible links between relative food prices and weight are confirmed, but we need a clearer understanding of food complements and substitutes. Further, it is not just composition of food, but also portion sizes, patterns of eating, and effects on satiety that help understand better why the body processes the same calories differently among different individuals.

Underweight women are highly prone to risks of disease, disability and mortality. Besides, children born to undernourished women, if they survive, are more likely to be overweight and obese adults. Overweight and obesity elevate risks of non-communicable diseases, such as heart disease, hypertension and adult onset diabetes.

The shift of the disease burden toward NCDs will increase demand on the healthcare system. With more healthcare currently financed with private out-of pocket resources, it will be increasingly hard for households to escape poverty, while more will be driven into poverty. As rural population migrates to urban areas, the associated lifestyle changes are likely to elevate NCD risks. Extreme poverty and foetal and early childhood undernutrition are likely to create a large pool of those at elevated risk. As India increases its focus on the health needs of overweight and obese people, it is imperative that it address *simultaneously* the needs of the large number of severely undernourished people in society.

A recent controversy around the obesity paradox that the overweight are less likely to die than those of 'normal' weight over the same time period drew sharp battle lines between nutrition experts. Being overweight increases a person's risk of diabetes, heart disease, cancer and many other chronic illnesses. But evidence also suggests that for those who are middle-aged or older, or already sick, a bit of extra weight is not particularly harmful, and may even be helpful. The opposite camp, however, insists that with more appropriate controls for sickness-related loss of weight and smoking the paradox disappears. As matters stand, the obesity paradox is far from fully resolved.

In conclusion, the pervasiveness of the double burden of nutrition among women is a stark illustration of the grimness of their existence and survival.

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