Vulnerability to Chronic Energy Deficiency: An Empirical Analysis of Women in Uttar Pradesh, India [#]

Maithili Ramachandran, K.S. Kavi Kumar and Brinda Viswanathan*

Madras School of Economics
Gandhi Mandapam Road
Chennai – 600 025, India
Tel: +91-44-2235 2157, 22300304 / 7
Fax: 91-44-2235 2155, 22354847
Email: kavi@mse.ac.in

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* Corresponding author, email: brinda@mse.ac.in

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MADRAS SCHOOL OF ECONOMICS
Gandhi Mandapam Road
Chennai 600 025
India

Phone: 2230 0304/ 2230 0307/2235 2157
Fax : 2235 4847 /2235 2155
Email : info@mse.ac.in
Website: www.mse.ac.in

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Abstract

Prevalence rate of chronic energy deficiency (CED) is used as a measure of (adult) nutrition and health status for any region or country. That these rates in India have been rather high particularly for women is a matter of concern. As Floud (1992) and Fogel (1997) have shown, among several anthropometric measures weight-for-height or Body Mass Index (BMI) is an effective predictor of morbidity and mortality rates. BMI is shown to indicate the current nutritional status thereby reflecting the difference between food intake and the demand for these intakes. The present study uses this indicator as a measure of health status.

Due to limited information base on BMI very few studies in India have analysed the determinants of CED (which is the current health status) and even far fewer studies estimating the persons vulnerable to it (that is future health status). This paper attempts to do so based on a sample of ever-married women in the age group of 15-49 years in the North Indian state of Uttar Pradesh (UP) for the year 1998-99.

The results indicate that education, social infrastructure and quality of diet influence those who are likely to be CED in future, with significant rural urban differences. Apart from these well-known indicators, presence of drinking water source within the residence (whether piped or otherwise), women in the age group of 15-19 years, and education status of the husband seems important.

More importantly, the results clearly highlight that the CED rates and vulnerability rates can be very different across two sub-groups of population. Hence, the results from this study would be more useful in targeting policy most effectively as the emphasis would now be on 'potential' deficient persons rather than on current ones, which is the convention in policy intervention.

Key Words: *Body Mass Index and Chronic Energy Deficiency; Women; Vulnerability; Uttar Pradesh.*

JEL codes: *I12, I31, R1*

1. Introduction

In the last half a century many countries including the poorer ones gained in health status greater than at any other period in history with unprecedented increases in life expectancy and child survival (Evans *et al.*, 2001). Improvements in nutrition, general conditions of life, universal education – particularly of women – along with advances in medical science with the availability of new and cheaper drugs have lowered the risk of communicable diseases, and have contributed immensely to better health among people. However, as in other spheres of development, disparities have grown significantly in the health status, especially between the 'haves' and 'have-nots', which are strikingly near universal occurring in both developed and developing countries (World Bank, 2006). Social and cultural norms prevalent in backward regions further exacerbate the gap, particularly for the women.

Gender disparity in health outcomes are more pronounced in India than in other countries. Inequity in health stemming from gender-related determinants can be thought of in two distinct ways. First, specific biological needs of men and women may not be fairly accommodated by health and social systems.[1] Second, differentials in health between men and women may arise from societal construction of gender and not from biological differences between the sexes. Probably, the worst example of this is the phenomenon of "missing women" in India (Sen, 1992); cultural preference for male children has led to a disproportionate number of males relative to females.[2] Gender

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1 An extremely stark example of this is seen in international differences in maternal mortality: in the poorest countries, women's chances of dying in childbirth are 1 in 16 compared to 1 in 2000 in the richest countries (Evans *et al.*, 2001, p8).

2 Only 48.4 percent of India's population is female, the eighth lowest proportion in the world (World Bank, 2001).

disparities show up in many other respects too: life expectancy at birth is usually 6.2 years higher for females than males in high-income countries but in India, the difference is only 1.5 years. The nutritional status of Indian women is also very poor. In 1998-99, 52 percent of all Indian women of reproductive age were found to be anaemic, and 36 percent were chronically malnourished (IIPS, 2000).

The current health status is usually well-documented in most countries and for most population groups. Projections of the future health status – especially at a micro level – are comparatively rare. Why is projecting the future health status at the individual-level important? To put it pithily, the answer is the old adage that prevention is better than cure. By knowing who is likely to fall victim to poor health tomorrow, a policy-maker is better prepared to protect them against it. In a country where the scale of health burden is already very large, such forecasts are bound to be useful in containing future health problems. Further, from an individual's perspective, well-being is enhanced in a setting where not only her current health achievement is high but her ability to maintain that level of health in the future is also reinforced. In essence, there is a big challenge for policymakers here: one of identifying individuals who are liable to be less well off tomorrow than they are today and protecting them against such an eventuality. Simply put, these individuals are vulnerable to a loss of welfare[3].

This study is concerned with measuring vulnerability to chronic energy deficiency (CED) among the women of Uttar Pradesh, India. The state of CED is akin to poverty wherein the body mass index (BMI)

[3] The challenge of vulnerability occurs not merely in the health context but in any dimension of welfare as discussed in the later sections of the paper.

- an index of weight for a given height – falls below a certain threshold.[4] Further, BMI is known to be a good predictor of risk to morbidity and mortality as shown in Floud (1992) and Fogel (1997). The focus on women is also justifiable for several reasons. Female health has significant life-cycle impact – very often, children tend to be malnourished because their mothers are. Women's health is of particular concern in India due to the economic, social and cultural reasons mentioned above.

The study argues in favour of a vulnerability assessment: policy should not only alleviate 'poor' health status but also try to prevent it. The results of the study confirm the assertion that current prevalence rates of poor health status may not be a good guide to vulnerability as it is only an ex-post measure. Vulnerability is found to exceed the rate of observed CED. The vulnerability rates are 63.2% for rural UP (against a 38.1% rate of observed CED) and 41.5% for urban UP (where 21.3% of the population are CED).[5]

The rest of this paper is organized as follows: Section 2 presents an overview of the literature on using the BMI as a health status indicator. Section 3 elaborates on the concept of vulnerability followed with a description of the methodology to measure it. Section 4 describes the data and motivation for the choice of study area. Section 5 along with a discussion of the determinants of chronic energy deficiency in rural and urban UP also highlights the characteristics of the vulnerable population. Section 6 concludes the paper.

[4] As an analogue to consumption or income poverty the term health-poverty could be coined. An individual is "health-poor" if her observed health status falls short of the minimum norm of good health defined for a particular health standard. However, it need not imply that poor health is a consequence of low incomes.

[5] These vulnerability figures are obtained at a probability of 0.38 and 0.21 for the rural and urban sectors respectively, that a woman will be chronically energy-deficient in the next time period. The details are in Section 5.

2. Body Mass Index and Adult Health Status

Even though most studies in economics have shown that poor health does mar productivity and wages, by now clear evidence exists that relying solely on monetary measures of well-being could give an inaccurate picture about social well-being. For instance, India has had a high level of economic growth since the 1990s but health indicators like maternal and child mortality, the proportion of under-nourished population or even life expectancy have not taken major strides. Two recent findings further substantiate the argument for deviating from money-metric measures: (a) despite growing international disparity in incomes over the last three decades, life expectancies show signs of convergence (Becker *et al.*, 2005); (b) in the face of health shocks, poor rural households in Cambodia sold land or other assets to pay for treatment; yet they had not resorted to similar extreme steps when floods affected crop produce in a particular year (Kenjiro, 2005). Hence health – either as a stand-alone measure or as an indicator of welfare status – needs further evaluation.

A crucial input needed to assess the well-being of individuals on the health front is an objective measure of their health status. This could be a health index accompanied by specific norms that reflect a healthy society. A brief survey of limited evidence presented here suggests that a low BMI, in combination with other indicators of individual socio-economic status, could be used for this purpose.

Two easy-to-obtain measures of anthropometry are the heights and weights of individuals. Even though some studies tend to use only one of them (e.g., Schultz, 2002), it is generally agreed that an index that combines both provides a better understanding of the individual's

health status. BMI (Quételet's index), or the ratio of weight to squared height, is shown to be highly correlated with weight but independent of height (Shetty and James, 1994). Although BMI combined with physical activity level (PAL) would give a more accurate assessment of CED, observations on PAL are rather difficult to gather; hence the grades of CED presented in the table below are followed in practice.

Table 1. Simple Classification of Adult Chronic Energy Deficiency

BMI (in kg/m^2)	Less than 16.0	16.0-16.9	17.0-18.4	Greater than 18.5
CED grade	III	II	I	Normal

Source: Shetty and James (1994)

A normal distribution of BMI values with mean ranging between 18.5 and 20 is usually observed in healthy societies but can either be left skewed as in undernourished and economically poorer societies, or right skewed as in richer societies. Despite the fact that women on an average tolerate lower BMIs than men, the same norm is used currently for both men and women. This is partly based on the argument that women need additional energy to sustain pregnancy, lactation, child-rearing, household care and also agricultural activities in developing countries. The normal BMI range is usually prescribed for adults between 17 and 60 years. Though a few studies indicate that BMI varies with age and sex, no clear age-wise BMI ranges are laid down. In fact, unlike sex, no justification is provided for an age-neutral norm being followed currently. Given that present study is based on women in the age group of 15-45 years, the normative ranges of BMI for: CED – below 18.5, normal – 18.5-25, overweight – 25-30, and obese – above 30, are considered reasonable (FAO/WHO/UNU, 1985).

Since BMI is strongly correlated with weights, any phenomenon that affects food intake and related activity affects the state of CED. Socio-economic variables are typically important correlates of BMI. For instance, in Nigeria it has been observed that during the period of structural adjustment, the BMI dropped from the early to the late nineties due to harsh economic conditions in an unfavourable political situation. Similarly African evidence shows a drop in BMI during lean agricultural seasons and in spite of the fact that on days of no farming activity, lower physical work does not compensate for lower food intake (Shetty and James, 1994).

2.1 Impact of CED on Morbidity and Mortality

The evidence based on historical data from Europe and America suggests a positive relationship between CED and mortality (Fogel, 1997). On the other hand Shetty and James (1994) document mixed evidence from various regions of the developing world in this regard. Based on Norwegian adults aged 50-64, Fogel (1997) demonstrated a U-shaped relationship between BMI and risk for mortality, indicating that both low and high BMI levels are likely to be fatal. In this study women were shown to carry greater risk than men, but evidence from other studies suggests that women in general have higher tolerance for lower BMI than men (Shetty and James, 1994). In a recent study of Nigerian men and women based on cohorts in early and late 1990s indicated that a significant proportion of deaths are strongly predicted by low BMIs (Rotimi *et al.*, 1999).

Behavioural adjustments by the individuals make it difficult to establish precise relationship between CED and morbidity. For instance

lower energy intake by individuals may be associated with reduced (increased) work (rest/leisure) hours. In other words weight gain may also be prevented as is observed in many parts of the developing world due to performance of higher physical activities under conditions of lower energy (food) intakes. This then leads to a vicious cycle of low work productivity (and wages), poorer health stock and susceptibility to illnesses linking it back to poverty. In a Brazilian study it has been shown that BMI and sickness (measured as number of days in bed) along with sickness details followed a U-shaped curve, indicating that both lower and higher values are harmful to health (Shetty and James, 1994). A study of adult males in urban slums of Bangladesh indicated work related disability among males with CED (Pryer, 1993). Similarly, a study based on a sample of 1400 males and females in a rural Vietnamese village indicated that lower BMI values after controlling for acute and chronic diseases is a good predictor of fever (Do *et al.*, 2004). In the Indian context also similar studies are reported but a more recent one based on sample from the north-eastern region indicates that rather than body mass, body fat mass after controlling for age, income and fat free mass, is a good indicator of self reported morbidity (Khongsdier, 2005).

Overall, available limited evidence indicates that BMI (and CED) does influence morbidity and mortality. Further, low BMI of pregnant and lactating women are known to have significant impact on the health status of the to-be-born or the newborn. In this context the present study assumes importance, as the sample is mainly of women in their reproductive age.

3. Vulnerability Assessment

3.1 Concept of Vulnerability

The notion of vulnerability is captured neatly in an example from Ligon and Schechter (2002): a household that has very low expected consumption expenditures but no chance of starving may well be poor; yet it might not wish to trade places with a household having higher expected consumption but greater consumption risk. In other words, a measure of household welfare must not only consider average expenditure but also variations around the mean. Just as measures of consumption poverty do not take into account the probability of a household becoming poor, health assessments often fail to reflect the likelihood of an individual falling ill in the future. Poor health outcomes and vulnerability to such outcomes must therefore go hand-in-hand and such information could be critical in tackling the problem *per se*.

In contrast to an ex-post (static) state of illness, vulnerability represents an ex-ante state that may or may not persist and hence is dynamic. In other words, it is a condition that implies an outcome in the future after states of nature are realized. Vulnerability can be conceptualized as the probability of experiencing a loss in the future relative to some benchmark of welfare. In the health-context, the chosen health norm serves as the benchmark. Vulnerability could then be measured as the probability that an individual would fall short of that benchmark in the future. A profile of vulnerability might vary over the lifecycle of the household as attitudes toward risk, potential for bearing and managing risk, and the length of the household's planning horizon change (Alwang *et al.*, 2001). This explains why a household that is

not consumption-poor today might be consumption-poor tomorrow and *vice-versa*. By the same token, there will also be *individuals* who are not 'health-poor' *today* but may become 'health-poor' *tomorrow*. Such people may be said to be vulnerable to poor health outcomes. Vulnerability has similar implications for the goal of good health as it does for the goal of consumption. In both cases, deficiency in the requisite levels (e.g. nutrition, income, education) exacerbates an individual's proneness to a poor outcome. The concept of vulnerability and more importantly its measurement are briefly reviewed in other studies (Hoddinot and Quisumbing, 2003 and Kumar and Viswanathan, 2006).

3.2 Vulnerability Measurement: Methodology

Vulnerability studies in economics largely deal with consumption-poverty. The studies prefer to employ panel datasets where they are available since ideally, vulnerability is best estimated with panel data of sufficient length and richness. Yet as argued by Chaudhuri *et al*. (2002), a priori, in some settings at least, vulnerability assessments using cross-sectional (CS) data may be worthwhile. This is of interest in the present study because the data that is available is a CS survey. The intuition behind using CS data for vulnerability analysis lies in the possibility of explaining much of variation in health status across individuals through differences in the observable characteristics of the individuals. The observed health-poverty status of an individual is the ex-post realization of a state, the ex-ante probability of which can be taken to be the individual's level of vulnerability. So if we are able to generate predicted probabilities of health-poverty for individuals, we will have, in effect, estimates of the vulnerability of these individuals.

With only a cross-sectional survey, there is a challenge of not only trying to overcome the lack of the time dimension, but also that of having no information on the risks faced and the options available to mitigate such risks. Therefore, it is necessary to make simplifying assumptions about how shocks evolve over the cross-sectional space. Estimating the standard deviation of consumption using a single cross-section implies that cross-sectional variability proxies for inter-temporal variation. That is, in a single cross-section, one can only estimate the variability of expenditures *across* households and this variation is assumed to mirror consumption variability *over time*. This is a very stringent assumption. Nevertheless, the above formulations are still useful to think through the possible implications of the various restrictions that will need to be imposed in any attempt to estimate vulnerability with CS data.

3.3 Vulnerability Estimation from Cross-section Data

Vulnerability estimation is a three-step regression procedure and follows closely from Chaudhuri *et al.* (2002). The first step is an OLS estimation of regression of the log of BMI on a set of explanatory variables, which pertain to individual and household characteristics.

$$ln(BMI_i) = \boldsymbol{X}_i \boldsymbol{\beta} + e_i \qquad i = 1,2,....n \tag{1}$$

where $\hat{\boldsymbol{a}}$ is a vector of the parameters, $\boldsymbol{X}_i$ is the matrix of explanatory variables, e_i is the error term, and i denotes the i^{th} individual in the sample of given size n. The $\boldsymbol{X}_i$ matrix consists of both quantitative and qualitative explanatory variables. The kernel density of *logarithm* of BMI rather than BMI (in levels) fitted a normal distribution. The normality of log BMI is helpful because it permits the use of the normal distribution for post-estimation purposes, such as predicting the percentage of vulnerable women. Accordingly, the natural logarithm of BMI is used as the dependent variable.

The OLS regression is followed by estimation of heteroscedastic correction model. The motivation for the heteroscedastic regression stems from the fact that BMI may be sensitive to certain shocks, embodied in some of the explanatory variables. The correction also provides the standard deviation of the dependent variable, which is required subsequently to obtain the standardized values of *ln(BMI)*.

$$\hat{e}_i^{\,2} = \boldsymbol{Z}_i \boldsymbol{\alpha} + u_i \qquad i = 1,2,.....n \tag{2}$$

where $\acute{\boldsymbol{a}}$ is a vector of coefficients, $\boldsymbol{Z}_i$ is a matrix of explanatory variables and may not be identical to $\boldsymbol{X}_i$ and u_i are the error terms.

To obtain asymptotically efficient estimators of α equation (2) above is re-estimated with $\boldsymbol{Z}_i \hat{\boldsymbol{\alpha}}^{OLS} = \hat{\hat{e}}_i^2$ as weights as given in equation (3) below:

$$\frac{\hat{e}_i^{\,2}}{\mathbf{Z}_i \hat{\boldsymbol{\alpha}}^{OLS}} = \boldsymbol{\alpha}\left(\frac{\mathbf{Z}_i}{\mathbf{Z}_i \hat{\boldsymbol{\alpha}}^{OLS}}\right) + \frac{u_i}{\mathbf{Z}_i \hat{\boldsymbol{\alpha}}^{OLS}} \qquad i = 1,2,.....n \tag{3}$$

$\boldsymbol{Z}_i \hat{\boldsymbol{\alpha}}^{FGLS}$ obtained from equation (3) is a consistent estimate of $\sigma_{e,i}^2$, the variance of the 'idiosyncratic component' of *ln(BMI)*. To reiterate, the heteroscedastic correction is made because each woman's BMI might fluctuate around her average, depending on the variations in certain explanatory variables.

Finally to obtain an asymptotically efficient estimator of $\boldsymbol{\beta}$ based on equation (1) the following GLS regression of the logarithm of BMI on the set of explanatory variables is estimated, with weights as the estimated standard error $\hat{\sigma}_{e,i} = \sqrt{\boldsymbol{Z}_i \hat{\boldsymbol{\alpha}}^{FGLS}}$.

$$\frac{\ln(BMI_i)}{\hat{\sigma}_{e,i}} = \frac{\mathbf{X}_i \boldsymbol{\beta}^{GLS}}{\hat{\sigma}_{e,i}} + \frac{e_i}{\hat{\sigma}_{e,i}} \qquad i = 1,2,.....n \tag{4}$$

Using the predicted values of *ln(BMI)=* $\boldsymbol{X}_i \hat{\boldsymbol{\beta}}^{GLS}$ from the generalized least squares regression in (4), and the standard error of *ln(BMI)* $\hat{\sigma}_{e,i} = \sqrt{\boldsymbol{Z}_i \hat{\boldsymbol{\alpha}}^{FGLS}}$ from the heteroscedastic correction in equation (3), the standardized values of *ln(BMI)* are constructed.

$$\ln(\mathrm{BMI})_i^{std} = \frac{\ln(\mathrm{BMI})_i - \mathbf{X_i}\hat{\boldsymbol{\beta}}^{GLS}}{\sqrt{\mathbf{Z}_i \hat{\boldsymbol{\alpha}}^{FGLS}}} \tag{5}$$

From the model, the following definition of vulnerability (V_i) emerges:

$$\hat{V}_i = Pr[ln(BMI_i) < ln(18.5) \mid X_i] = \Phi\left[ln(BMI)_i^{std}\right] \tag{6}$$

The probability that the BMI of a particular individual will fall short of 18.5 – the benchmark for chronic energy deficiency – is derived from the cumulative standard normal distribution of *ln(BMI)*, Φ and $ln(BMI)_i^{std}$ is from equation (5). If this probability exceeds a chosen value (between zero and one) – say, p_0 – for a particular individual, then she is counted among the women predicted to be *chronic energy-deficient in the next period*. The women who are *predicted to become chronic energy-deficient in the future* make up the vulnerable population. It may be noted that p_0 is only an arbitrary threshold and needless to say, the vulnerability estimates based on equation (6) are a monotonically decreasing function of the probability levels.

The novelty of this study lies more in conceptual re-orientation proposed for studying vulnerability to health poverty as against conventional consumption poverty. The regressions are executed separately for rural and urban Uttar Pradesh.

4. Objectives and Data Source

Henceforth, the term health poverty or health-poor would be used to refer to the state of a woman whose BMI value is below the threshold of 18.5. A social policy aimed at reducing *vulnerability to health poverty* is likely to be more potent than one that tries to reduce just the *incidence* of malnutrition, stunting, wasting or anaemia. The focus of such a policy is more comprehensive since it addresses the health-poor population today as well as the population susceptible to health-poverty at a later date. Given this, the objectives of this study are four-fold:

- Foremost is the aim to measure health-poverty using BMI against established benchmarks.
- The second objective is to estimate a forward-looking, probabilistic model to assess vulnerability to health-poverty as a function of individual and household level characteristics.
- The third is to compare vulnerability with health-poverty across demographic and social groups and
- Last of all, to compare the profiles of vulnerable women from rural and urban Uttar Pradesh.

The choice of UP as study region is made keeping in mind significant socio-economic and demographic diversity that this large state showcases. The motivation for focus on women of UP comes from both empirical facts and development concerns.

a. Women in India are far more likely to be under-nourished than their male counterparts. While gender bias has a definite role in this, a related reason for women's health-poverty is their general lack of empowerment.

b. Women's health-achievement has strong implications for their children's health status. Healthier women may also have more ambitious educational aspirations for their sons and daughters – an aspect that could translate into superior health outcomes for the latter. In short, women's health status has a strong life-cycle impact.

c. Reducing women's vulnerability to health poverty might also contribute towards checking the spread of diseases.

A time profile of adult anthropometric status is available only for some states in the Southern and Western regions of India as provided by the National Nutrition Monitoring Bureau. The National Family Health Survey (NFHS) provides rich information across all regions in India albeit for only two periods: 1992-'93 and 1998-'99. Based on this dataset, the present study derives similar information on North India (as in UP) so that one might eventually be able to compare vulnerability to health-poverty across different regions in India. The NFHS sample sizes are significantly larger than the National Nutrition Monitoring Bureau samples and provide other household and individual level data not just anthropometric information aggregated across age-groups or sex or some socio-economic classification. Hence NFHS data is considered appropriate for the present study. Specifically the study uses data from the National Family Health Survey, Round-2 (NFHS-2) from 1998-'99 for the state of Uttar Pradesh. NFHS-2 provides data on the BMI for ever-married women in the age group of 15-49 years along with the following related information.

- The demographic characteristics of the woman's household – her age, the age of the household head, the household size, the number of children (total and below 5 years).

- The social background of the woman: her religion, caste, hers and her husband's educational status, etc.
- The employment status of the woman: whether the woman works – if yes – what her occupation is, whether she earns cash, the nature of her work, her husband's occupation.
- How 'empowered' the woman is: whether she takes decisions for herself on various matters, whether she uses any kind of family planning methods.
- Some qualitative information on woman's nutrition-intake: her frequency of consumption of certain food items (but not the actual intakes).
- The physical and social infrastructure a household has access to: sanitation facilities, the source of drinking water, electric power, health facilities, etc.

The number of ever-married women in the UP sample is 8682 (7479 rural and 1203 urban). Information on the body mass index is available for about 67% of the rural population (4995 women) and 72% of the urban population (867 women).[6] A point of interest with the BMI is that it is undesirable to have a value that is too low or too high – both CED and obesity are undesirable states of health[7]. Consequently, in using the BMI to measure health-poverty and vulnerability, it is necessary

[6] Before carrying out the regressions, the samples for rural and urban were restricted to 4988 and 848 observations respectively, by dropping all women who had body mass indices of 34 or more. This was done in order to improve the explanatory power while predicting the proportion of women who are vulnerable to falling below the threshold of 18.5.

[7] As described above a U-shaped relationship between mortality (also morbidity) and BMI are observed in several studies (Fogel, 1997 and Shetty and James, 1994).

to define two benchmarks: a lower and an upper one. This is in contrast to studies on consumption-poverty where vulnerability is assessed only against a lower threshold. In the poverty literature, higher incomes and consumption expenditures have always been assumed to be “good”; however, this is not the case with the BMI. The population estimates of overweight and obesity rates are respectively 4.1% (14.6%) and 0.6% (5.1%) for the rural (urban) women. Except the prevalence rate of overweight among urban women, other rates are rather low compared to the national average of 11% and hence the present study focuses on measuring vulnerability against a single (i.e. the lower) threshold only. An extension to this work in the future proposes to assess vulnerability against the upper threshold as well.

5. Results and Discussion

The results are presented in two sub-sections: first for rural UP and then for urban. In each sub-section, the outcome of the three-step GLS regressions is first discussed, followed by the vulnerability results and finally, the characteristics of the vulnerable female population are identified.

In almost all regressions low R-square values are observed and before proceeding further it is worth taking note of some related literature that reports similar low R-square values when information used in the models is mostly qualitative in nature. Several studies using the NFHS data in India report low R-square values ranging between 0.07 and 0.35. These studies include, access to nutrition program by pre-school children by Das Gupta *et al.* (2005); determinants of child malnutrition in India by Deolalikar (2004); sources that explain stunting among

children below 5 years as in Gaiha and Kulkarni (2005). Other studies like Guha-Khasnobis and Hazarika (2005) using LSMS data on child malnutrition in Pakistan or the study by Pezzinni (2005) using the world values survey to explain the determinants of happiness also report very low R-square values sometimes even below 0.01. In this context the R-square values reported in this study are among the higher end values.

One crucial difference of this present study compared to the ones mentioned above is that the estimated parameters are used for further prediction here. In the small area estimation studies such as Fujji (2004), predicted values from the survey estimates are used to calculate the small areas estimates based on census data. The problem of low goodness of fit values has been mentioned in Fujji (2004) and improvement in R-square occurs with the inclusion of some quantitative variables capturing the environmental and geo-climatic features of the regions. However such possibilities are limited in the present study as analysis is at individual level. As the geographic information does not pertain to individuals but only to the regions that they reside in and without denying their importance in impacting body mass we feel that its usage is not directly relevant to this study.

The present study is among the first ones to attempt to use the data on health information to estimate vulnerability and future refinements include attempts to achieve improvement in model fit. However it may be noted that the (Wald’s) F-test for the joint significance of the coefficients is statistically accepted, and hence use of such a model for explaining the variation in the dependent variables is not considered invalid despite its poor model fit. Moreover as reported below the cross-validation results and justifiable estimated proportion of vulnerable population support further use of estimated coefficients.

5.1 Rural Uttar Pradesh

Determinants of Rural Women's BMI

Table 2 reports the results of GLS regression with *ln(BMI)* as dependent variable (i.e., equation 3 in section 3). Slightly different set of explanatory variables used in estimating equations (1), (2) and (3) resulted in dropping some observations and hence GLS regression is performed using 3723 observations. All variables are significant at, at least 5% level.

Table 2. GLS Estimation of *ln(BMI)* for Women in Uttar Pradesh: Rural

Explanatory variable	Coefficient	p-value
Age	-0.0064	0.00
Age-squared	0.0001	0.00
Now pregnant	0.0435	0.00
Proportion of children below 5 years of age	-0.0407	0.004
Use family planning	0.0131	0.003
Suffer from asthma	-0.0376	0.015
Consumption of milk	0.0114	0.005
Partner employed in agriculture	-0.0103	0.02
Partner employed in unskilled labour	-0.0116	0.043
Husband is educated up to high school or beyond	0.0196	0.00
Proportion of villages electrified	0.0306	0.00
Low standard of living	-0.0093	0.032
High standard of living	0.0463	0.00
Constant term	3.024	0.00

Note: (1) Adjusted R^2=0.0633. Number of observations=3723.

The (log of) body mass index appears to decrease with age at an increasing rate. Older women therefore seem more likely to be chronic energy deficient than their younger counterparts. Women see a significant weight gain during pregnancy. The regression controls for them and as expected, returns a positive coefficient for the variable, "now pregnant". The greater the proportion of children below 5 years of age in the total number of children within the household, the lower the woman's BMI. This result can be interpreted along two dimensions: women with a greater number of young children are likely to have more care-taking responsibilities. The higher work burden could easily take its toll on their overall health, with the outcome manifesting itself in lower body mass indices. Unhappy as such a state of affairs is it tends to get much worse when mothers deliberately curtail their food-intake so their children can have more. Since this is often the case, especially in low-income households with a large number of young children, the lower nutrition intake could contribute greatly towards women's increased health-poverty.

The coefficient of the dummy for use of birth control measures is positive and significant at the 5% level. Therefore, women who practise family planning are predicted to have higher body mass indices than those who do not. Birth control measures help women to not only avoid unwanted pregnancies, but to space out births as well. One indirect benefit of this could well be a higher BMI. While there is some indication that this is indeed the explanation for the significance of the birth-control dummy, the data does not corroborate it forcefully. Perhaps, the qualitative nature of the variable must caution against any emphatic conclusion on how exactly the use of birth-control measure impacts BMI.

By contrast, the coefficient of the indicator variable, "suffers from asthma" shows a negative value of –0.0376 (p-value = 0.015). The inference is that women who suffer from asthma are likely to have lower BMI. This need not be very surprising because diseases like asthma and TB are known to take a toll on the victim's weight. As discussed in Section 2.1 a bi-directional relationship exists between low BMI and morbidity. Here the impact of morbidity on BMI is only captured. NFHS collects information on asthma and TB as indicators of morbidity among adult women and hence 'suffering from asthma' is used as an explanatory variable in the study[8]. Policy-wise, the finding that BMI is affected significantly by respiratory diseases is striking. Reducing the incidence of asthma, it would seem, will now have an additional pay-off: a reduction in the prevalence of chronic energy deficiency.

A daily or weekly intake of milk as opposed to an occasional or no intake has a positive effect on the body mass index. Since milk is in some sense a complete food item, containing all essential nutrients including proteins, the regularity of its consumption could serve as a good pointer to a woman's nutritional status.

If the woman's husband is employed in agriculture or as unskilled labour, it has an adverse impact on her body mass index. On the other hand, if the husband has attained an education of high school or above, it has a significantly positive impact on the woman's BMI. In addition to these results, the data shows that three-quarters of the men employed in unskilled labour or agriculture have less than a high-school education. Putting together all three results suggests that higher levels of education among husbands would have positive externality for women's BMI. These spillovers may come in various ways: through higher household incomes, and perhaps reduced gender-bias in intra-household resource allocations.

[8] It may be noted that these are self-reported illness as known to the 'patient' and the surveyors perform no clinical examinations.

The greater the proportion of villages electrified, the higher is the woman's BMI. The coefficient of this variable (0.0306) is also among the highest four in the regression. Electrification could ease out many physically demanding chores and hence benefit women. Village electrification thus should be an important policy objective. Higher the household standard of living, the better the body mass index. The coefficient for high standard of living is the largest (0.0463). Therefore, improving it will have the greatest impact on women's BMI.

Although the standard of living index takes into account various aspects, like access to various infrastructure facilities, the kinds of assets owned, it appears in the regression in its own right, besides the variable for electrified villages. This is not really surprising because there is apparently a component of the variation in the dependent variable that is not captured by "village-electrification" but gets reflected in the dummies for high and low living standards. The weak correlation between the proportion of electrified villages and the living-standards dummies (-0.11 with low standard of living & 0.22 with high standard of living) supports this contention.

Vulnerability Estimates for Rural Women

Table 3 reports the vulnerability profile for rural UP. Since the observed CED rate corresponds to the mean vulnerability level, anyone with a probability level more than mean vulnerability carries greater risk of becoming CED in the population. Hence one may define relatively vulnerable as those with a probability level (p_0) that is greater than 0.38 (i.e., mean vulnerability proportion) but less than 0.50 (any other chosen probability threshold) and highly vulnerable are those with a probability level greater than equal to 0.50. Vulnerable population thus comprises of relatively vulnerable and highly vulnerable. The vulnerable rate in the population is as high as 63.2% whereas the observed CED rate is only 38.1%. Also current CED rate in the vulnerable population is only about 42% indicating that currently chronic energy deficient women are not the only ones of concern to policymakers: appropriate intervention programmes must also target those who are vulnerable to CED.

Table 3. Chronic Energy Deficiency and Vulnerability Profile for Uttar Pradesh: Rural

	Overall Population	**CED Population**	**Vulnerable Population**
Mean BMI (Kg/m^2)	19.53	17.11	19.18
Mean Vulnerability Rate (%)	37.7	39.5	44.4
Proportion of Population (%)			
Chronically Energy Deficient	38.1	1.00	41.9
Vulnerable	63.2	69.4	1.00
Relatively Vulnerability	33.8	40.1	53.4
Highly Vulnerability	29.4	29.3	46.6

Note: (a) Relatively vulnerable are those for whom probability of becoming CED lies between 0.38 (mean CED proportion) and 0.50 (chosen probability p_o); (b) Highly vulnerable are those for whom probability of becoming CED lies above 0.50; (c) Vulnerable include both relatively vulnerable and highly vulnerable.

The characteristics of the vulnerable population in rural UP are shown in Table 4. A few general observations from the tables are that (a) though most often the distribution of the CED and vulnerable population across sub-groups is the same as the overall population,

there are a few exceptions and more so for vulnerability; (b) since vulnerability rates are always higher than CED rates one may expect the former to be always higher than the latter for a given attribute but once again there are exceptions; (c) the pattern of CED and vulnerability are sometimes not found to be the same across sub-groups of a given characteristic of the population. These and some other results are elaborated below.

Impact of Infrastructure Variables

Drinking water is obtained from various sources like a pipe within the residence or from a public tap, hand pump from within or outside the residence, well etc. What is usually observed from most other studies on health indicators is that a 'clean' source like pipe makes a larger impact compared to any other source. Women dependent on open source water, as against those dependent on water from pipes and hand pump, are 5 times more likely to be vulnerable (results not reported here). However, the striking difference is in terms of having access to either water pipe, handpump or well within the residence when compared to a public source. The proportion of women reporting usage from either within or outside the residence is nearly equal but the vulnerability rates are far higher for the public source. It is well known that women predominantly perform the job of fetching water which expends a lot of energy and thereby reflects in lower BMI. More importantly it is worth noting that the same does not hold for CED rates. Consequently a major reduction in the CED rates in future can be obtained by reduction in energy spent in carrying water from a possibly distant (and time-consuming) source. Similarly, women having no access to any kind of sanitation are significantly more likely to be vulnerable than those having access to some form. Lack of any proper sanitation makes one susceptible to certain communicable diseases which in turn affect weight loss and hence higher vulnerability. Not only is the distribution of vulnerable (and CED) population more skewed than the distribution of actual women population the contrast between the 'haves' and 'have-nots' is highlighted more in the case of vulnerability than CED rates. Access to electricity also has a similar impact in reducing the risk to CED.

Impact of Household Features

A woman in a two-person household seems to face a much larger risk to CED than larger household sizes as the vulnerability rates among this group is about 1.3 times the average vulnerability rate of 63%. Despite similar distribution of CED and vulnerability rates across different size classes of households, the risk to CED rate is more than two times that of current CED rate thereby highlighting the magnitude of the problem. Female-headed households account for only about 9% of the total sample but have marginally lower vulnerability than their counterparts in male-headed households; on the other hand the CED rate shows a reverse pattern. Further an interesting result is noted regarding a two person household wherein the risk to low BMI for a woman is far higher for a male-headed household than that of a female headed one, while CED rates are not so different between male and female headed households. As can be seen this difference in risk comes down significantly for three-person (and higher numbers as well) households. Excessive work burden and unequal distribution of resources due to lower bargaining power and lack of attention within such a household could be contributing to this result.

Religion does not seem to have major difference in current or future BMI status among women as those belonging to Hindu households are only having marginally less rates of CED and vulnerability than those belonging to other religions. Caste, representing social discrimination, has the expected result in that SC/ST households having a larger proportion of CED women and having a higher risk rate than the average vulnerability rate. Women from SC/ST, compared to other castes, are 2.5 times more likely to be vulnerable with the decline in rates not so striking between SC/ST and OBCs as between SC/ST and other castes.

A lower level of education of the husband has a significant impact on risk to CED in contrast to current BMI status while there is a substantial reduction in vulnerability rate to about 38% - about 0.6 times lower than the average vulnerability rate of 63%. Better educated males are likely to be from upper economic classes with better access to infrastructure facilities and other positively contributing features to higher BMI levels. This is corroborated by the standard of living index which is the lowest for the 'high' group, in fact lower than that observed for any sub-group being about 0.4 times the average rate. The gap between the 'low' and 'high' group is substantial both in terms of distribution of vulnerable population and vulnerability rates. More interestingly and perhaps predictably, even though the CED distribution is similarly skewed as the vulnerability rate, the future CED rates are lower than the existing rates in the population for the 'high' group. A high standard of living which is a composite of several indicators (as calculated by the NFHS) highlights the effect of several confounding factors. Of course, higher awareness about 'dos' and 'don'ts' of basic healthy living cannot also be ruled out at a higher level of education and income resulting in betterment of BMI level.

Impact of Personal/Individual Characteristics

Women in the age-group of 15-19 years are substantially more vulnerable than women belonging to higher age-groups. Similarly illiterate women, those working as agricultural labourers and married women (when compared with widows) have higher rates. Finally quality of diet as reflected by consumption of milk either daily or weekly carry substantially lower risk of CED. Meat consumers are far lower in the population and there does not seem to be a substantial reduction in risk rate between the consuming and non-consuming groups (and similar results are also observed for egg consumption). About 88% of rural women consume green vegetables daily or weekly (results not reported here) and have their vulnerability rates lower than the average vulnerability rates. But interestingly such women do not show much different vulnerability rate than those who consume rarely or never. Consumption of 'greens' is perhaps not so important for gain/loss in body weight and may have other impacts not captured by BMI directly.

Thus, vulnerability seems influenced by social infrastructure like access to water, access to electricity and sanitation which affect personal hygiene and also increase physical stress while carrying out jobs like fetching water etc. Consequently improved public health facilities can provide effective preventive measures. Among the household characteristics women in female-headed households with household size of two have much lower risk and high standard living has a very significant reduction in the risk to CED. Among the personal attributes education and occupation are the policy relevant variables that have significant influence on women's vulnerability.

Table 4: CED and Vulnerability Rates of Women for Sub-groups of Population: Rural

Characteristic	Across Group Distribution of (%)			Within Group Distribution of (%)		Ratio of Vulner to CED *(within group)*
	Populn	***CED***	***Vulner***	***CED***	***Vulner***	
Infrastructure variables						
Access to any kind of water source						
Inside the residence	53.2	50.3	47.7	36.0	56.5	1.57
Public facility	45.8	49.0	51.4	40.7	71.0	1.75
Access to any kind of sanitation facility						
Yes	11.5	9.2	8.6	30.5	47.4	1.55
No	88.5	90.8	91.4	39.0	65.3	1.67
Access to electricity						
Yes	27.5	23.3	18.1	32.3	41.8	1.29
No	72.5	76.7	81.9	40.4	71.4	1.77
Household Characteristics						
Size of the household						
2	2.1	2.1	2.8	38.5	82.8	2.15
3	4.1	4.2	4.4	39.1	66.9	1.71
4-6	33.8	36.8	36.2	41.5	67.9	1.63
7-10	37.5	36.3	38.1	36.9	64.3	1.74
>10	22.3	20.3	18.5	34.7	52.3	1.51
Head of the household						
Male-headed	91.3	90.4	91.3	37.6	63.2	1.68
Female-headed	8.7	9.6	8.6	41.9	62.9	1.50
Head and size of the household						
Two person						
Male-headed	78.8	79.0	82.2	38.6	86.5	2.24
Female-headed	21.2	21.0	17.8	38.2	69.6	1.82
Three person						
Male-headed	78.6	79.0	79.5	39.4	67.6	1.72
Female-headed	21.4	21.0	20.5	38.5	64.2	1.67
Religion						
Non-Hindu	88.1	87.2	87.7	37.7	62.9	1.67
Hindu	11.9	12.8	12.3	40.8	65.2	1.60
Caste (Social Group)						
SC/ST	25.3	27.8	28.5	41.3	70.7	1.71
OBC	33.0	33.1	33.4	37.8	63.6	1.68
Other castes	41.7	39.1	38.0	35.3	57.1	1.62

(Table contd..)

Table 4: CED and Vulnerability Rates of Women for Sub-groups of Population: Rural *(Contd...)*

Characteristic	Across Group Distribution of (%)			Within Group Distribution of (%)		Ratio of Vulner to CED *(within group)*
	Populn	***CED***	***Vulner***	***CED***	***Vulner***	
Household Characteristics (Contd.)						
Husband's Education						
illiterate	30.2	35.0	37.2	44.1	77.7	1.76
literate <middle school	18.9	19.9	22.0	40.0	73.2	1.83
middle school	17.9	18.1	20.8	38.7	73.6	1.90
high school & above	33.0	26.9	20.0	31.1	38.2	1.23
Standard of living						
Low	31.4	36.1	41.3	43.8	82.1	1.87
Medium	56.8	55.6	54.1	37.3	59.7	1.60
High	11.8	8.3	4.5	26.9	24.1	0.90
Personal / Individual Characteristics						
Age Groups						
15-19	13.1	13.1	13.1	33.9	75.5	2.23
20-29	40.2	38.2	41.6	36.1	65.3	1.81
30-39	28.2	30.9	29.6	41.6	66.2	1.59
40-49	18.4	19.2	13.2	39.9	45.3	1.14
Own Education						
illiterate	75.6	80.0	80.6	40.3	67.5	1.68
literate <middle school	12.4	11.3	10.8	34.7	55.0	1.58
middle school	6.2	5.1	5.1	31.4	51.7	1.65
high school & above	5.8	3.6	3.5	23.7	38.3	1.62
Marital Status						
Married	96.4	95.7	96.5	37.9	63.3	1.67
Widowed	2.9	3.4	2.7	44.0	58.7	1.33
Occupation						
Not working	73.6	70.5	70.6	34.3	41.3	1.20
Self-employed agriculture	15.5	17.3	16.2	42.2	65.8	1.56
Agricultural labourer	5.1	6.3	6.7	46.9	82.9	1.77
Consumption of Milk						
daily+weekly	55.6	50.6	48.1	34.7	54.8	1.58
Occasionally+never	44.4	49.4	51.9	42.4	73.9	1.74
Consumption of Meat etc.						
daily+weekly	5.0	6.1	4.9	40.3	61.8	1.53
Occasionally+never	95.0	93.9	95.1	37.9	63.4	1.67

5.2 Urban Uttar Pradesh

Determinants of Urban Women's BMI

Table 5 reports GLS regression results for urban UP. Similar to rural analysis, the dependent variable is log of BMI. While the number of observations is much smaller compared to rural UP, the goodness of fit is much better in the urban sample. Once again, the body mass index is related to age: but where rural women showed a tendency to have lower BMI at an older age, urban women show that BMI increases with age. Controlling for pregnant women is justified by the significant positive coefficient value (0.0822) for the variable, "now pregnant".

Table 5. GLS Estimation of *In(BMI)* for Women in Uttar Pradesh: Urban

Explanatory variable	Coefficient	p-value
Age	0.0044	0.00
Now pregnant	0.0822	0.00
Not a Hindu	-0.0219	0.074
Woman is educated up to high school	0.0412	0.002
Use family planning	0.0337	0.003
Sanitation facility is a flush toilet	0.0555	0.00
High standard of living	0.036	0.007
Constant term	2.846	0.00

Note: (1) Adjusted R^2=0.1902 and number of observations=835.

It emerges that non-Hindu women – the majority of whom are Muslims – have a significantly lower mean body mass index than their Hindu counterparts. Given that the coefficient (-0.0219) is significant only at the 10% level, it has to be interpreted a little conservatively. While the result is not an endorsement of any particular religion, it probably indicates that in urban areas – unlike rural areas, where religion made no real difference to the BMIs – women of some social groups fare better than others because they have more opportunities for self-development. There is some empirical evidence on this: Srinivasan and Mohanty (2004), using data from NFHS-2, estimate a household's level of deprivation based on its ownership of certain basic amenities. The deprivation levels are categorized as 'abject', 'moderate', 'just above deprivation' and 'well above deprivation' and the households are examined according to caste and religion across 16 states. The contrast between rural and urban Uttar Pradesh is very sharp: in rural UP, the difference between the percentage of deprived Hindu or Muslim households in any category is never more than 1 percentage point. However, in urban UP, the difference is almost 7% in the 'just above deprivation' category and somewhat lower in others. Another study by John and Mutatkar (2005) based on NSS data, also finds that the prevalence, depth and severity of poverty are the highest among Muslims almost throughout urban India, including UP. Hence, the poorer health outcomes of Muslim women may be largely due to the comparatively high degree of poverty in Muslim households of urban Uttar Pradesh.

A woman who is educated up to high school or above is predicted to have a higher body mass index than one who is not. This result establishes the strong influence education can have on a woman's health status, *provided* it is persisted with. The reasons are many and interlinked. But it is safe to say that among other explanations, education would make women more aware of their ailments and enable them to identify when medical attention must be sought. It would also make them more conscious of the importance of a balanced diet. Above all, education would help in giving a woman greater control over her reproductive rights, something that is borne out by the fact that the use of family planning is once again a highly significant variable in the regression. Last but not the least, the benefits of higher-education in terms of increased productivity and earning potential would improve women's health outcomes generally. Policy-wise, the implication is that promoting female literacy may not be enough; effort must be made to help girls obtain more than a primary level education.

The access to a flush toilet makes a significant positive impact on BMI of urban women and so does higher standards of living. Women belonging to households with higher standards of living also have higher BMIs. Ignoring the coefficient of the control variable for currently pregnant women (0.082), high standard of living (0.036) and flush toilets (0.056) are likely to have the maximum impact on improving women's BMI. The coefficient of the dummy for high-school educated women is again one of the highest in the regression.

Vulnerability Estimates for Urban Women

Again, similar cross-validation technique as followed in the rural analysis is used to check the estimates of vulnerability. The mean estimate of vulnerability rate is 18.2% which comes reasonably close to the observed rate of CED in urban women (21.8%) as in Table 6 below. Vulnerable population is much lower (41.5%) in urban UP compared to rural UP (63.2%). Table 6 shows the observed and predicted health status of urban women.

Table 6. Chronic Energy Deficiency and Vulnerability Profile for Urban Uttar Pradesh

	Overall Population	**CED Population**	**Vulnerable Population**
Mean BMI (Kg/m^2)	21.81	17.18	20.21
Mean Vulnerability Rate (%)	18.23	11.74	30.99
Proportion of Population (%)			
Chronically Energy Deficient	21.3	1.00	30.6
Vulnerable	41.5	59.5	1.00
Relatively Vulnerability	39.1	56.4	94.1
Highly Vulnerability	2.4	3.1	5.9

Note: (a) Relatively vulnerable are those for whom probability of becoming CED lies between 0.21 (mean CED proportion) and 0.50 (chosen probability p_o); (b) Highly vulnerable are those for whom probability of becoming CED lies above 0.50; (c) Vulnerable include both relatively vulnerable and highly vulnerable.

An idea of who exactly are vulnerable to CED among urban women in Uttar Pradesh can be gleaned from table 7. The physical infrastructure variables have similar effect as in the rural sector. Accessing water from a public facility, or lack of access to sanitation facility or electricity contribute towards higher vulnerability rates as found in the rural sector.

Among household characteristics, household size does not have the similar impact particularly for the two-person household and in contrast to rural result urban women in female headed-households are more prone to the risk of CED. Unlike rural UP the vulnerability rates among Hindus is far lower than that of non-Hindus even though their population proportion is higher. As discussed earlier, this result is similar to that found in the regression analysis. Further, the contrast between SC/ST, OBCs and others is not as stark as in rural households. The gap in the risk rates between 'low', 'middle' and 'high' standard of living is very high in the urban sector. Women in urban areas belonging to upper economic status have the lowest risk rate. Among the individual/ personal characteristics age and education, have near similar impact as in rural sector but the high school education and above has a more dramatic effect with vulnerability rate being lower than that of current CED rate. Further, unlike in rural, married women are less vulnerable compared to widowed women. Perhaps the urban pressures and coupled with lack of any social insurance in the form of family support etc. given higher proportion of nuclear families imposes higher burden on physical stature of widowed women. As expected the occupation structure is substantially different from rural but women who are working but not in professional or clerical or sales job carry a far higher risk to CED. Once again well paid regular incomes bring down the risk to vulnerability as observed from lower vulnerability rates than CED rates for this category.

Regular consumption of milk once again has a positive impact on risk to CED but the difference is not that stark as in the rural sector. Even though regular meat consumers are higher in proportion than rural, quite surprisingly, this again does not seem to be having higher advantage when compared to those who rarely or never consume such a food item.

Table 7: CED and Vulnerability Rates of Women for Sub-groups of Population: Urban

Characteristic	Across Group Distribution of (%)			Within Group Distribution of (%)		Ratio of Vulner to CED *(within group)*
	Populn	***CED***	***Vulner***	***CED***	***Vulner***	
Infrastructure variables						
Access to any kind of water source						
Inside the residence	85.6	81.9	78.9	20.4	38.4	1.88
Public facility	14.4	18.1	21.1	26.9	61.0	2.26
Access to any kind of sanitation facility						
Yes	89.4	85.7	81.1	20.5	37.7	1.84
No	10.6	14.3	18.9	28.7	73.9	2.58
Access to electricity						
Yes	86.8	82.4	78.6	20.3	37.6	1.85
No	13.2	17.6	21.4	28.4	67.2	2.37
Household Characteristics						
Size of the household						
2-3	1.8	2.4	1.9	28.8	43.5	1.51
4-6	42.3	42.7	35.3	21.5	34.0	1.58
7-10	37.6	41.0	42.1	23.3	45.7	1.96
>10	14.7	12.7	18.2	18.5	50.6	2.74
Head of the household						
Male-headed	88.2	87.5	86.3	21.1	40.7	1.92
Female-headed	11.8	12.5	13.7	22.6	48.0	2.13
Religion						
Hindu	69.1	60.7	50.3	18.7	30.1	1.61
Non-Hindu	30.9	39.3	49.7	27.0	66.3	2.46
Caste (Social Group)						
SC/ST	10.4	12.5	12.9	25.5	52.3	2.05
OBC	16.0	16.4	18.5	22.0	46.6	2.12
Other castes	73.4	71.2	68.0	20.8	37.5	1.80

(Table contd..)

Table 7: CED and Vulnerability Rates of Women for Sub-groups of Population: Urban *(Contd...)*

Characteristic	Across Group Distribution of (%)			Within Group Distribution of (%)		Ratio of Vulner to CED *(within group)*
	Populn	***CED***	***Vulner***	***CED***	***Vulner***	
Household Characteristics (Contd.)						
Husband's Education						
Illiterate	16.9	22.3	30.5	27.8	75.1	2.70
literate <middle school	13.7	20.3	21.0	31.3	63.4	2.03
middle school	14.2	15.8	18.0	23.5	52.6	2.24
high school & above	55.2	41.7	30.5	16.0	23.0	1.44
Standard of living						
Low	9.0	15.3	17.8	36.2	80.8	2.23
Medium	43.4	52.8	69.8	26.0	65.9	2.53
High	47.6	32.0	12.4	14.3	10.6	0.74
Personal / Individual Characteristics						
Age Groups						
15-19	5.0	7.6	9.6	32.4	79.7	2.46
20-29	35.4	36.7	42.8	22.1	50.2	2.27
30-39	36.5	34.0	33.5	19.8	38.0	1.92
40-49	23.0	21.7	14.1	20.1	25.4	1.26
Own Education						
Illiterate	39.3	52.9	60.7	28.7	64.2	2.24
literate <middle school	12.7	11.3	15.6	19.0	50.8	2.68
middle school	11.9	14.0	14.3	25.0	49.9	2.00
high school & above	36.0	21.8	9.4	12.9	10.8	0.84
Marital Status						
Married	95.5	89.2	92.7	19.9	40.3	2.03
Widowed	3.6	8.6	5.4	51.4	63.3	1.23
Occupation						
Not working	85.5	82.4	86.3	20.3	41.8	2.06
Professional/Clerical/Sales	7.2	7.4	3.1	21.7	17.7	0.81
Others	7.3	10.1	10.6	29.4	60.4	2.05
Consumption of Milk						
daily+weekly	62.9	49.7	49.3	16.8	31.9	1.90
Occasionally+never	37.1	50.3	50.7	28.9	55.8	1.93
Consumption of Meat etc.						
daily+weekly	16.0	15.5	14.7	20.6	37.4	1.82
Occasionally+never	84.0	84.5	85.3	21.5	41.4	1.93

6. Conclusions

Health is important to all people. At the individual level, health has been observed to share a high degree of positive correlation with productivity, earnings and standard of living. Historically, the healthiest countries of the world have also ranked among the most developed. In the light of these facts, achieving higher health status and health equity become important social objectives.

The basic proposition of this study is that for forward-looking interventions, what really matters is the vulnerability to poor health status and the policy should not only alleviate it but also aim at preventing it. An individual's observed health-poverty status is an ex-post measure of her well-being (or lack thereof). But for much policy purpose, what really matters is the vulnerability to health-challenge: the ex-ante risk that the individual will become health-poor in the future, even if she is currently healthy; or will get worse in the future, if she is already health-poor. Besides, the individual's current health status will probably be an inadequate guide to her vulnerability to health-poverty. Consequently, for thinking about forward-looking interventions that aim to prevent rather than alleviate health-poverty, it is necessary to go beyond a cataloguing of who is currently health-poor and who is not, to an assessment of who is vulnerable to various health-challenges.

This study uses cross-sectional data on individual and household characteristics to determine the relationship between BMI of women in the age group of 15-45 years and potential explanatory variables. The study further estimates the vulnerability to health poverty. The results show that the expected level of vulnerability is close to the prevailing rate of observed poverty, validating the estimated models.

The study identifies the proportion of the female population that is vulnerable to CED both in rural and urban areas of the state of Uttar Pradesh. Significantly, it finds that the proportion of women predicted to be in risk of CED is greater than the proportion already suffering from malnutrition. Just this result serves to confirm that it is worthwhile to undertake an exercise in vulnerability assessment. For real policy action though, information on the determinants of vulnerability is required. The study makes an attempt to answer this question as well.

Broadly stated, given higher population and CED rates in rural areas clearly women residing there are more disadvantaged than their urban counterparts. The norm for CED being the same irrespective of rural or urban sector CED rates can be directly compared but not the vulnerability rates as, the urban probability threshold of falling into the risk of CED is very different. Given this, there are however similarities in pattern of vulnerability inducing factors across the two sectors. Infrastructure for one plays a major role in influencing health outcomes and so does caste status of the household, husband's level of education, a woman's age and religious affiliation. The last of these attributes has a higher impact in urban than in rural.

Given that the average vulnerability rate is higher than the observed CED rates and more so for rural, a similar result is also observed across various characteristics of the household. However, there are notable exceptions to it and for more variables in urban than in rural. In both rural and urban sector 'high' standard of living results in substantial lowering of risk to CED. In urban, woman's own education being high school and above and or possessing a sales/clerical or professional job has tremendous impact on risk reduction.

Fogel (1997) indicates that substantial improvements in heights and BMIs achieved during 18th and 19th centuries in England and France were contributed largely by improvements in nutritional intake and to a lesser extent by sanitation. In the absence of information on dietary intake it has not been possible to estimate the contribution of dietary intake. However, the results from this study are corroborated by recent evidence that basic infrastructure facilities play a very significant role in determining child health status across countries and consequently are important in attaining the Millennium Development Goals (Fay *et al.*, 2005). Thus, resolving issues of infrastructure promises to advance women's nutritional status considerably.

Before generalizing one must see to what extent these results are replicated across other regions of this vast country with varying features and differing public health policies. Similarly, as low BMI is a concern so is high BMI and risk to diseases associated with that. In the absence of panel or longitudinal data, single cross-section based information is being used to assess future risk rates and this needs some cross-checks and validations. Instead of looking at the impact of each attribute separately, on vulnerability rate, it may have been more appropriate to carry out a principal component analysis to assess the effects of those components. These and other modelling issues are areas for future work.

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