Prevalence and Causes of Chronic Energy Deficiency and Obesity in Indian Women

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Abstract We investigate the nutritional status of women in India and its relation to the prevalence of chronic energy deficiency (CED) and obesity. To do this, we have used the data from the Indian National Family Health Survey, 1998–1999, on body mass index (BMI) of ever-married women, ages 15–49 years, along with several socioeconomic factors, such as level of education, religion or caste, occupational status, and standard of living index. The study was based on 81,712 women from 26 states and 6 zones, which were grouped according to geographic proximity of the states of India. A multiple linear regression analysis was done to see the relation between nutritional status of women and different socioeconomic factors. The data reveal that the prevalences of CED, overweight, and obesity in India are 31.2%, 9.4%, and 2.6%, respectively. The incidences of CED and obesity are negatively related. The prevalence of CED is the lowest in Arunachal Pradesh and highest in Orissa. Punjab has the highest prevalence of obesity, and Bihar has the lowest. For the zonewise distribution the Northeast zone has the lowest degree of prevalence of CED and the East zone is at the bottom of the list with the highest degree of malnutrition. We also found that the nutritional status of women goes together with the enhancement of their educational status, standard of living, and so on. There are also significant differences between rural and urban sectors and among castes, religions, and occupations. Furthermore, regression analysis shows that all the socioeconomic variables considered here significantly affect BMI in Indian women.

Nutritional anthropometry is one of the methods for determining the health status of individuals in a community through a set of indicators. In general, in tropical countries anthropometric measurements are mainly focused on children younger than 5 years because these measurements are more suitable for assessment of malnutrition in children than in adults. The status of malnutrition in adults is based on a set of anthropometric indicators that are different from those used for children. A task force of the International Dietary Energy Consultative Group (1992)

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suggested that body mass index (BMI) should be used to define adult chronic dietary energy deficiency. BMI is not only a useful indicator in the study of health but also helps to indicate the prevalence of specific conditions.

The 20th century witnessed an increase in body weight. Because BMI is directly proportional to body weight, BMI has also been increasing, resulting in a good proportion of people suffering from obesity. Obesity is fast growing in many developing and poor countries as well as in countries near developed countries (World Health Organization 2000, 2003). Significant proportions of overweight and obese individuals now coexist with the undernourished (Popkin 2002). In many developing countries, because of the increase in urbanization, the availability of processed and fast foods, and dependence on television for leisure, people are fast adopting less physical activities and consuming energy-dense, nutrient-poor diets, which leads to overweight and obesity (World Health Organization 2003; Bell et al. 2002; Popkin 2001, 2002; Drewnowski and Popkin 1997). In India the prevalence of obesity is higher among women and economically better off individuals who live in urban areas and have a family history of obesity and sedentary lifestyle (Misra et al. 2001; Zargar et al. 2000; Gopinath et al. 1994; Griffiths and Benley 2001; Singh et al. 2000; Bhasin et al. 2001; Tiwari et al. 1998; Dhrurandhar and Kulkarni 1992; Subramanian and Smith 2006).

Many studies have focused on the relationship between BMI and mortality from past to recent periods (Waaler 1984; Costa 1993; Riley 1994; Fogel and Costa 1997; Allison et al. 1997; Calle et al. 1999). Obesity has a great effect on mortality because it is associated with an increased risk of several chronic diseases, such as hypertension (Anita 1989; Gillum 1987), abnormalities of pulmonary function (Kleuter 1980; Sharp et al. 1983), diabetes mellitus (Bernnet and Knowler 1984; Shils 1988), gallstones (Bray 1985; Xavier 1988), gout (Eva et al. 1979), osteoarthritis (Pi-Sunyer 1991; World Health Organization 2000), and some types of cancer (Kleuter 1980; Van-Ittalie 1985; Xavier 1988).

On the other hand, chronic energy deficiency (CED) is defined as a steady-state condition in which a person is in energy balance at a cost to their health (James et al. 1988). Evidence from the study of developing countries indicates that women with a BMI less than 18.5 (CED) show a progressive increase in mortality rate and an increased risk of illness (Rotimi et al. 1999) and other health problems, especially during pregnancy (Allen et al. 1994) and lactation (Prentice et al. 1994). There is also a close association between malnutrition in the early growth stage and occurrence of chronic diseases in later life (Hoet 1997). Socioeconomic and demographic factors have great implications for women's CED. It has been found that there is a negative relationship between women's higher level of education and the proportion of undernourished women (Teller and Yimar 2000). A higher rate of malnutrition in rural women is also evident from many studies (Teller and Yimar 2000; Zerihun et al. 1997; Ferro-Luzzi et al. 1990).

In India 31% of women have a BMI less than 18.5, indicating a high prevalence of nutritional deficiency. Mainly, low-BMI women are found in rural areas, among uneducated women and scheduled caste and scheduled tribe groups, and

in families with a low standard of living index (International Institute for Population Sciences and ORC Macro 2000). (Scheduled castes and tribes, formerly "outcasts," were traditionally the menial laborers with no chance of upward mobility. They were disadvantaged socially, educationally, and economically and were excluded from Indian society until the government recognized the groups formally in the 1930s.) A general trend of obesity is found among women who live in urban areas, are educated, and have a high standard of living index. There is also a regional difference in the levels of CED and obesity in India. There are high prevalences of obese women in Delhi and Punjab. The lowest prevalence of overweight and obesity is found in most parts of the central, eastern, and northeastern states and in Rajasthan (International Institute for Population Sciences and ORC Macro 2000).

The main aim of the present study is to find the relationship between nutritional status and different socioeconomic variables. In doing so, we have also investigated the prevalence of CED and obesity among Indian women over different states and zones. This study will serve as a basic device for planning regional preventive health care programs for improving women's health.

Materials and Methods

In this analysis we have used data collected by the International Institute for Population Sciences (IIPS) from the Second National Family Health Survey (NFHS-2), conducted in 1998–1999. Funded by the United States Agency for International Development (USAID) through ORC Macro, this survey was designed to create an important demographic and health database in India and to strengthen the earlier survey (NFHS-1), conducted in 1992–1993. The NFHS-2 is a result of the collaborative effort of the IIPS, which acted as the nodal center, and other organizations, including five population research centers of the Ministry of Health and Family Welfare of the Government of India.

The NFHS-2 covers representative samples of about 90,000 ever-married women, ages 15–49, from 26 states in India. The population from which the current sample was taken covers more than 99% of the Indian population. It leaves the union territories out of its purview. The survey provides information on fertility, mortality, family planning, and important aspects of nutrition, health, and health care. A uniform sample design was adopted in all the states. The rural sample was selected in two stages in each state. First, villages were sampled according to probability proportional to population size (PPS), and then a random selection of households within each village was made. In urban areas the samples were taken in three stages: wards, census enumeration blocks, and households. Only wards were selected using the PPS; blocks and households were chosen using a simple random sampling.

We selected 81,712 ever-married women in the age group 15–49 years from 26 states of India. Women who were pregnant at the time of the survey and who had given birth during the 2 months before the survey were excluded from the

analysis. For the assessment of nutritional status of women, we regarded BMI as the best instrument to measure the degree of CED and obesity (Shetty et al. 1994; Food and Agriculture Organization 1993; Ferro-Luzzi et al. 1992; Roche et al. 1981). The value of BMI was calculated for each subject as follows: BMI = weight (kg)/height^2 (m^2).

The classification of BMI was as follows:

Underweight: <18.5 kg/m^2
Normal: 18.5–24.9 kg/m^2
Overweight: 25.0–29.9 kg/m^2
Obese: ≥ 30.0 kg/m^2

Apart from the BMI, we also recorded many relevant socioeconomic variables, such as woman's age, woman's formal educational level, religion or caste, husband's formal educational level, husband's occupation, woman's occupation, and standard of living index of the household for each subject. The standard of living index was constructed from a set of proxy indicators: house type, availability of water on the premises, toilet facility in the household, electricity, fuel for cooking, ownership of the house, ownership of agricultural land, and possession of consumer durables (such as a tractor, scooter, motorcycle, bicycle, electric fan, radio, TV, water pump, mattress, cot, and table). Each item was assigned a score ranging from 0 to 4. Thus the total scale for the household to which the woman belongs ranges from 0 to 30. A standard of living index of 0–5 was considered low, 6–14 medium, and 15–30 high (International Institute for Population Sciences and ORC Macro 2000).

To determine the relationships and differences between different socioeconomic variables and BMI, we carried out a multivariate linear regression analysis. Nutritional status (i.e., BMI) was considered the dependent variable, and socioeconomic variables were taken as independent variables. However, for the regression analysis many of the independent variables, which are categorical, were transformed into binary variables. The SPSS program was used for all the analyses.

Results and Discussion

The results reveal the prevalences of CED and overweight and obesity of adult females in different zones and rural and urban sectors in India. They also provide some important information on socioeconomic and demographic factors, which are useful for determining the causes of CED and obesity.

State-, zone-, and sectorwise occurrences of CED and obesity ascertained through BMI among adult females in India are presented in Table 1. The data reveal that in India 31% of females are malnourished, 57% are normal, 9.4% are overweight, and 2.6% are obese. A low prevalence of CED is found in Arunachal Pradesh (10.5%), Sikkim (10.9%), New Delhi (12.2%), Punjab (16.4%), Nagaland (17.4%), Manipur (17.8%), Kerala (18.0%), and Mizoram (21.0%), and a high

Table 1. Prevalence of BMI in Different States of India

State	BMI Prevalence (%)				N
	Malnourished (BMI < 18.50)	*Normal (BMI = 18.50–24.99)*	*Overweight (BMI = 25.00–29.99)*	*Obese (BMI ≥ 30.00)*	
Andhra Pradesh	36.5	51.4	9.9	2.2	3,914
Assam	25.9	68.6	4.6	0.9	2,969
Bihar	38.3	58.1	3.2	0.5	6,677
Goa	26.8	52.1	16.7	4.4	1,206
Gujarat	36.3	48.2	11.3	4.3	3,644
Haryana	25.6	58.4	12.3	3.7	2,785
Himachal Pradesh	26.5	56.9	13.2	3.3	2,924
Jammu	24.7	60.4	11.7	3.3	2,608
Karnataka	38.2	48.7	10.3	2.8	4,131
Kerala	18.0	61.2	17.0	3.8	2,756
Madhya Pradesh	35.5	58.4	5.0	1.1	6,634
Maharashtra	33.2	50.1	12.6	4.1	4,899
Manipur	17.8	71.6	9.5	1.1	1,359
Meghalaya	24.0	70.3	4.7	1.0	768
Mizoram	21.0	73.9	4.6	0.5	995
Nagaland	17.4	74.6	7.3	0.7	713
Orissa	45.7	49.3	4.3	0.7	4,295
Punjab	16.4	53.5	21.1	9.0	2,681
Rajasthan	35.2	58.4	5.0	1.4	6,250
Sikkim	10.9	74.7	12.1	2.3	994
Tamil Nadu	26.1	57.4	13.4	3.1	4,508
West Bengal	37.9	49.5	10.3	2.3	3,986
Uttar Pradesh	34.7	58.0	5.8	1.5	5,827
New Delhi	12.2	54.9	24.1	8.9	2,122
Arunachal Pradesh	10.5	84.6	4.3	0.7	1,051
Tripura	34.5	57.2	6.5	1.8	1,016
All India	31.2	56.9	9.4	2.6	81,712

prevalence is found in Orissa (45.7%), Bihar (38.3%), Karnataka (38.2%), West Bengal (37.9%), Andhra Pradesh (36.5%), and Madhya Pradesh (35.5%). A high prevalence of overweight and obesity are found in New Delhi (24.1% and 8.9%, respectively), Punjab (21.1% and 9.0%, respectively), Kerala (17.0% and 3.8%, respectively), and Goa (16.7% and 3.8%, respectively). A low prevalence of overweight and obesity were found in Bihar (3.2% and 0.5%, respectively), Arunachal Pradesh (4.3% and 0.7%, respectively), Orissa (4.3% and 0.7%, respectively), Assam (4.6% and 0.9%, respectively), Mizoram (4.6% and 0.5%, respectively), and Meghalaya (4.7% and 1.0%, respectively).

Punjab and New Delhi have exceptionally high percentages of obese individuals (9.0% and 8.9%, respectively). Percentages of malnourished women in these two states are also very low (16.4% and 12.2%, respectively). These two states are economically developed.

Table 2. Distribution of BMI in Different Zones of India

Zone	BMI (%)				N
	Malnourished (<18.5)	*Normal (18.5–24.99)*	*Overweight (25.00–29.99)*	*Obese (≥ 30.00)*	
Northeast	21.2	71.3	6.4	1.1	9,865
North	26.0	57.4	12.5	4.1	19,370
South	30.6	54.2	12.3	2.9	15,309
West	33.6	49.6	12.6	4.2	9,749
Central	35.1	58.2	5.4	1.3	12,461
East	40.3	53.3	5.4	1.0	14,958
All India	31.2	56.9	9.4	2.6	81,712

Arunachal Pradesh and Nagaland are the only two states where there are low percentages of malnourished and obese individuals. These two states seem to be the ideal states so far as women's health is concerned. Percentages of women with a normal BMI are also highest in these two states.

Bihar and Orissa, being the poorest states in India, have high percentages of malnourished women and low percentages of obese women.

High percentages of malnourished as well as high percentages of obese women coexist in Gujarat and Maharashtra. There are large rural-urban differences in these two states. Although there has been much capital investment in these two states compared to other states, a large section of the population, especially in the rural areas, did not benefit from it much. Unequal distribution of investments and resources has led to glaring regional disparity, poverty, and unemployment, and this may be relevant to the causes of high malnutrition and obesity (Katakam 2002).

The lowest prevalence of CED is found in the Northeast zone (21.2%), and the highest prevalence is in the East zone (40.3%) (Tables 2 and 3; Figure 1). The North zone has the highest concentration of overweight and obese women, and the East zone has the lowest concentration. When the zonewise distribution is considered separately for rural and urban sectors, the lowest prevalence of CED is found in the urban sector of the North zone (15.7%) and the highest prevalence of CED is found in the rural sector of the West zone (44.8%).

Tables 4 and 5 summarize the percentage distribution of status of nutrition by different socioeconomic variables. All the socioeconomic variables play a great role in determining the status of BMI in adult females in India. The analysis reveals that the percentage of malnourished women is inversely related to an increase in age, woman's education, husband's education, and standard of living index. There is a relatively higher prevalence of both CED and overweight and obesity among women in the age group 35–49 (Table 4). The explanation for this can be found in the relationship between age and the level of nutrition and the rural-urban differences given in Table 5. Level of nutrition increases as age increases. Naturally

Table 3. Distribution of BMI by Zones of India and by Place of Residence

Zone	BMI (%)								N	
	Malnourished (<18.50)		*Normal (18.50–24.99)*		*Overweight (25.00–29.99)*		*Obese (≥ 30.00)*			
	Rural	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*
Northeast	22.5	17.3	71.7	69.9	4.8	11.3	1.0	1.5	7,465	2,400
North	31.3	15.7	59.5	53.3	7.4	22.2	1.7	8.7	12,713	6,657
South	36.8	18.8	53.3	55.8	8.3	19.9	1.5	5.5	10,016	5,293
West	44.8	22.5	47.9	51.3	5.9	19.3	1.4	6.9	4,841	4,908
Central	38.1	25.5	58.6	56.9	2.9	13.5	0.4	4.1	9,497	2,964
East	43.8	27.2	53.1	54.2	2.9	14.9	0.3	3.7	11,801	3,157
All India	36.0	20.4	57.5	55.5	5.4	18.2	1.1	5.9	56,333	25,379

we can expect higher percentages of overweight and obese women in the older age groups (James 1996; Norgan 1994). Moreover, because of the high standard of living and high fat and protein intake, the nutritional level of urban women is much higher than that of rural women (Table 5).

Several studies (e.g., Despres and Lamarche 1993; Garrow 1993; McNair 1994) have found a positive association between sedentary lifestyle and overweight and obesity, and the women in cities are known to maintain a sedentary lifestyle. This is reflected in the percentages in Table 4, which gives the combined percentages of rural and urban sectors.

The prevalence of CED is almost equally high regardless of religion or caste, except for the groups other than scheduled castes, scheduled tribes, Hindus, or Muslims. This religious group of people mainly consists of Christians and Parsis, and they are the most educated group. The percentage of high-income people is high in this group. Similarly, regardless of husband's occupation, the prevalence of CED in women is high except for professional group. The variation of percentages of malnourished women over different occupation groups of husbands is less for each category of the standard of living index and husband's education (Tables 6 and 7). The lowest percentage is in the "Professionals, Sales, and Services" category. Further subdivision of this category might have given a sharper variation in these percentages. It is the woman's occupation and education that has more influence on the well-being of the family members, especially her health status. Regarding overweight and obesity, the relationship is simply the reverse of that of CED. The same trend is observed in rural and urban settings of India.

A multiple linear regression analysis (Table 8) has been carried out taking BMI as the dependent variable and family background variables as independent variables, which are thought to be the major determinants of nutritional status of adult females in India. This is done separately for rural and urban sectors and also for rural and urban sectors combined. All three regressions show significant relations in the expected direction along with the family background variables. The level of BMI is substantially greater in urban sectors compared to rural sectors on

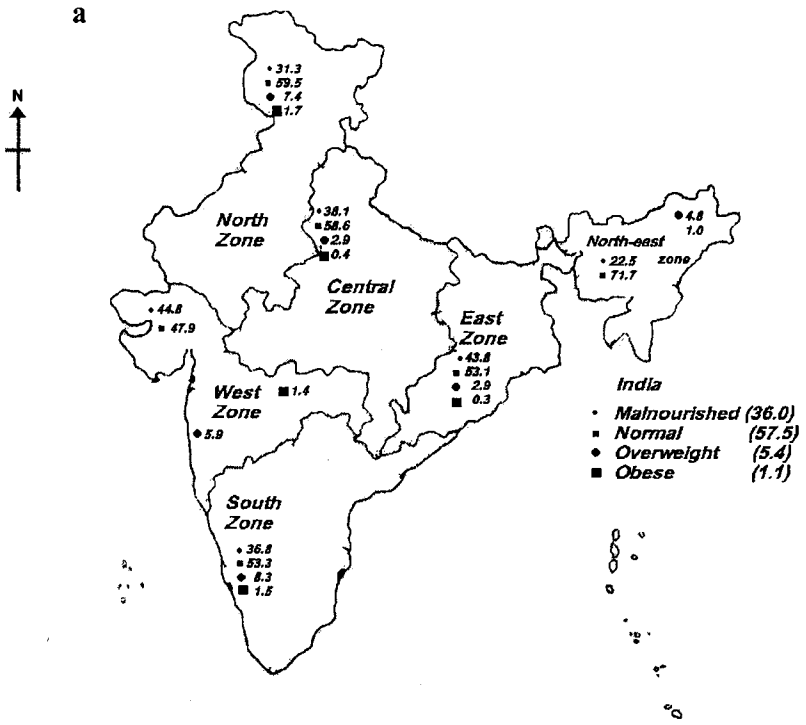

Figure 1. (a) Distribution of BMI in different rural zones of India; (b) distribution of BMI in different urban zones of India.

average, and this is reflected in the regression coefficients being higher in urban areas in most of the cases. The only exception is husband's occupation.

The picture is similar when this relation is obtained for each zone (Table 9). Age, education level of women, and standard of living index of the households have been found to affect the level of BMI in all cases. Race or caste is not an influential factor to determine BMI in the urban sector of some zones. However, in rural areas people still maintain the race and caste hierarchy, and thus its effect on BMI is seen to be strong. The coefficients for urban zones are higher than the corresponding rural zones. We can also see incremental effects on BMI resulting from an increase in each of the explanatory variables. The effects are highest in the northern region for woman's age and education, in the western region for race or caste, in the eastern region for husband's education and husband's occupation, in the southern region for woman's occupation, and in the western region for standard of living index. All these effects are in the urban sectors. The effect of BMI in the eastern region is thus dominated by husband's achievement. Does this mean that the urban sector of the eastern region is more patriarchal than in other regions? In

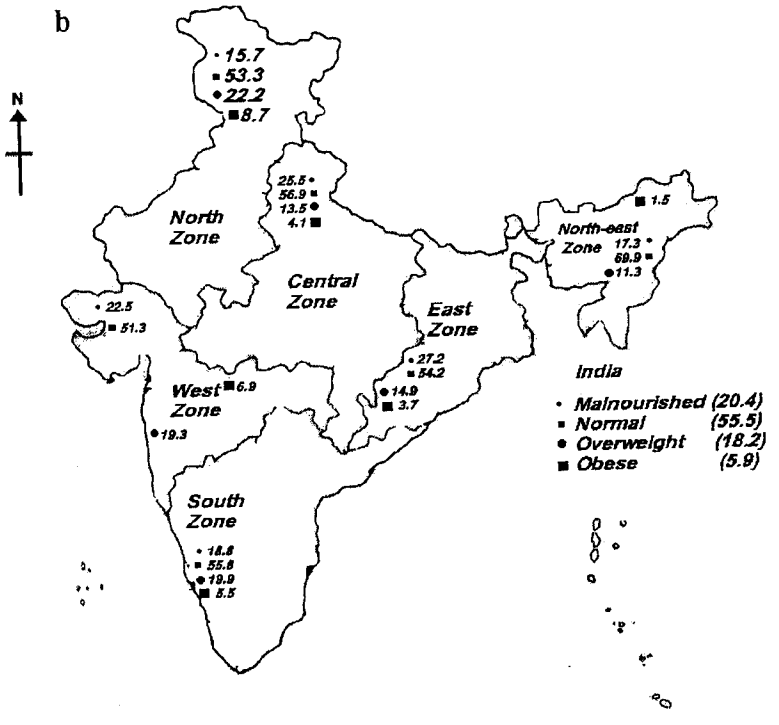

Figure 1. Continued

the rural sector the incremental effect is highest in the southern region for almost all the variables, including woman's age, education, and occupation, except for race or caste and husband's occupation. The effect of these two variables, race or caste and husband's occupation, is highest in the northern and western regions, respectively. Thus the role of women is greater in the southern sector for determination of BMI. Although the values of the coefficients are larger in the urban sectors for most regions, the southern sector is an exception. The values are higher in the rural sector for woman's education, race or caste, and husband's education. In the southern region education has a pronounced effect on the nutritional status of women.

When we combine the rural and urban sectors, the largest zonewise effects do not remain the same because of the rural-urban differences (Table 10). Age and standard of living index have a greater effect on BMI in the western zone compared to other zones. The coefficients of education and race or caste take the highest values in the northern zone. For husband's education and woman's occupation, it is the southern zone that takes the leading role. However, it is best to treat the

Table 4. Relationship Between BMI and Socioeconomic Variables in India

Variable	*Malnourished (BMI < 18.50)*	*Normal (BMI = 18.50–24.99)*	*Overweight (BMI = 25.00–29.99)*	*Obese (BMI ≥ 30.00)*	*N*
Age group					
15–24	35.90	60.60	3.10	0.40	20,578
25–34	32.00	57.40	8.50	2.00	30,950
35–49	27.10	53.90	14.50	4.60	30,184
Place of residence					
Rural	36.00	57.50	5.40	1.10	56,333
Urban	20.40	55.50	18.20	5.90	25,379
Woman's education					
No education	38.50	55.0	4.70	1.00	40,098
Primary	31.50	57.30	9.00	2.20	14,158
Secondary	23.00	58.90	14.00	4.10	19,924
Higher	13.20	56.40	23.00	7.40	7,532
Religion or caste					
Scheduled tribe	38.80	54.20	5.80	1.20	14,016
Scheduled caste	32.90	62.50	3.90	0.70	10,040
Hindu other than scheduled caste or tribe	30.10	56.60	10.50	2.90	44,831
Muslim other than scheduled caste or tribe	29.30	57.10	10.50	3.10	9,205
Others other than schedule caste or tribe	15.30	55.40	21.70	7.50	3,620
Husband's education					
Illiterate	41.00	54.40	3.70	0.90	21,140
Primary	35.70	56.30	6.60	1.40	15,040
Secondary	28.50	58.40	10.40	2.70	30,210
Higher	18.60	58.00	17.80	5.70	15,322
Husband's occupation					
Nonworker	29.80	56.80	10.30	3.00	2,415
Professional, sales, and services	20.70	57.80	16.30	5.10	23,512
Agriculture	38.80	56.30	4.20	0.70	29,266
Manual	32.30	56.70	8.80	2.20	26,459
Woman's occupation					
Nonworker	28.40	57.40	11.10	3.10	52,007
Professional, sales, and services	16.60	58.00	19.60	5.80	4,552
Agriculture	40.90	55.90	2.80	0.40	18,761
Manual	35.70	54.90	7.60	1.80	6,392
Standard of living index					
Low	44.00	53.30	2.30	0.40	22,741
Medium	31.60	59.30	7.60	1.50	39,275
High	15.50	56.30	21.10	7.10	19,696

Table 5. Relationship Between BMI and Socioeconomic Variables in India: Rural Versus Urban Differences

	Malnourished (BMI < 18.50)		*Normal (BMI = 18.50–24.99)*		*Overweight (BMI = 25.00–29.99)*		*Obese (BMI ≥ 30.00)*		*N*	
Variable	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*
Age group										
15–24	37.40	31.20	60.60	60.70	1.90	7.00	0.20	1.10	15,649	4,929
25–34	36.90	21.70	57.50	57.20	4.70	16.70	0.90	4.50	21,038	9,912
35–49	34.00	14.10	55.20	51.60	8.90	24.90	1.90	9.50	19,646	10,538
Woman's education										
Illiterate	40.20	29.80	55.80	55.90	3.30	11.30	0.60	3.00	33,409	6,689
Primary	34.20	24.90	57.80	56.20	6.60	14.70	1.40	4.10	10,026	4,132
Secondary	28.00	17.00	61.10	56.30	8.90	19.90	1.90	6.80	10,802	9,122
Higher	19.20	10.90	64.30	53.40	14.00	26.50	2.50	9.20	2,096	5,436
Religion or caste										
Scheduled tribe	42.60	27.80	53.70	55.90	3.20	13.20	0.50	3.20	10,421	3,595
Scheduled caste	35.20	21.70	61.50	67.20	2.80	8.90	0.40	2.10	8,337	1,703
Hindu other than scheduled caste or tribe	35.70	18.80	57.40	54.80	5.80	19.80	1.00	6.50	29,808	15,023
Muslim other than scheduled caste or tribe	33.60	22.50	58.60	54.70	6.40	17.00	1.40	5.80	5,630	3,575
Others other than scheduled caste or tribe	18.10	11.30	58.80	50.60	17.60	27.60	5.50	10.40	2,137	1,483
Husband's education										
Illiterate	42.40	32.20	54.30	55.20	2.70	9.80	0.50	2.90	18,123	3,017
Primary	38.00	28.20	56.50	55.50	4.70	12.90	0.80	3.40	11,463	3,577
Secondary	32.40	20.90	59.40	56.50	6.90	17.20	1.30	5.50	19,896	10,314
Higher	26.40	12.30	62.20	54.60	9.30	24.70	2.10	8.50	6,851	8,471
Husband's occupation										
Nonworker	34.50	21.40	57.60	55.40	6.60	17.10	1.30	6.10	1,596	879
Professional, sales, and services	26.80	15.40	61.50	54.70	9.50	22.20	2.10	7.70	10,886	12,626
Agriculture	39.30	27.90	56.10	60.10	3.90	9.90	0.70	2.00	27,783	1,483
Manual	36.80	25.30	57.20	56.00	5.10	14.60	1.00	4.10	16,068	10,391
Woman's occupation										
Nonworker	33.40	20.00	58.70	55.30	6.60	18.60	1.30	6.20	32,675	19,332
Professional, sales, and services	23.30	12.30	61.50	55.80	12.20	24.40	3.10	7.60	1,801	2,751
Agriculture	41.30	32.90	55.70	60.40	2.70	5.80	0.40	0.90	17,864	897
Manual	40.00	28.50	54.50	55.60	4.60	12.50	0.90	3.40	3,993	2,399
Standard of living index										
Low	44.40	41.10	53.30	53.10	1.90	4.80	0.30	1.00	19,963	2,778
Medium	34.40	24.70	59.60	58.40	5.10	13.70	0.90	3.20	27,980	11,295
High	21.60	11.00	60.40	53.30	14.50	26.00	3.50	9.70	8,390	11,306

Table 6. Percentage of Malnourished Women by Standard of Living Index and by Husband's Occupation

Standard of Living Index	Husband's Occupation, % (Number of Women)				
	No Occupation	*Professionals, Sales, and Services*	*Agriculture*	*Manual*	*Total*
Low	44.21 (252)	38.73 (967)	45.84 (5,088)	43.16 (3,701)	44.01 (10,008)
Medium	29.54 (377)	25.04 (2,549)	36.98 (5,382)	30.89 (4,099)	31.75 (12,470)
High	17.33 (109)	12.38 (1,342)	24.18 (874)	15.94 (736)	15.54 (3,061)

rural and urban zones separately. There are negative correlations between level of development and rural-urban differences in the development parameters. In other words, development is achieved through the enhancement of the condition of the rural sector, that is, by minimizing the gap between rural and urban sectors.

The results indicate that in India more than 31% of women are malnourished and that the percentage of overweight and obese women in urban areas is about four times that of rural areas. There is also a high level of regional disparities in India because of disparity in literacy, awareness, exposure to media, and so on.

In most of the states of northeast India the status of health of more than 70–80% of women is normal. The probable reasons are (1) the high proportion of working and self-employed women in this region compared to other regions of India and (2) the high prevalence of Christians among the tribal groups (International Institute for Population Sciences and ORC Macro 2000). Self-employed working women and Christians are the most educated groups in India. In addition, (3) the literacy gap between males and females is the least in Mizoram and Meghalaya. Last, (4) the possession of toilet facilities is highest in most of the states of northeast India.

The highest concentrations of CED are found in Orissa, Bihar, West Bengal, Karnataka, Andhra Pradesh, and Madhya Pradesh. Fifty percent of the people in Bihar are classified as belonging to "other backward communities," and 30% of the people in all of east India belong to a scheduled caste (International Institute for

Table 7. Percentage of Malnourished Women by Husband's Education and Husband's Occupation

Husband's Education	Husband's Occupation, % (Number of Women)				
	No Occupation	*Professionals, Sales, and Services*	*Agriculture*	*Manual*	*Total*
No education	38.67 (198)	34.77 (595)	42.85 (4,946)	39.60 (2,920)	40.96 (8,659)
Primary	33.72 (117)	27.52 (636)	39.10 (2,628)	35.15 (1,990)	35.71 (5,371)
Secondary	27.54 (274)	22.01 (2,058)	35.24 (3,167)	28.52 (3,103)	28.47 (8,602)
Higher	23.99 (149)	15.47 (1,569)	29.91 (603)	20.57 (523)	18.56 (2,844)

Table 8. Regression Analysis of BMI on Different Socioeconomic Variables in India: Rural, Urban, and Rural + Urban

Independent Variable	Result of Regression of BMI (Dependent) Variable on Different Independent Variables					
	Rural		*Urban*		*Rural + Urban*	
	Regression Coefficient	*t Ratio*	*Regression Coefficient*	*t Ratio*	*Regression Coefficient*	*t Ratio*
Constant	16.889	307.86	13.721	98.68	15.598	295.52
Woman's age	0.046	31.19	0.137	44.22	0.078	55.64
Woman's education	0.311	17.97	0.380	12.07	0.456	29.60
Woman's occupation	0.185	13.03	0.372	8.05	0.273	18.63
Husband's education	0.041	2.67	0.098	2.77	0.048	3.19
Husband's occupation	0.177	14.38	0.163	6.14	0.276	23.89
Religion or caste	0.184	14.17	0.260	10.03	0.193	15.77
Standard of living index	0.756	34.33	1.330	27.84	1.021	48.47
R^2	0.101	900[a]	0.185	825[a]	0.188	2,704[a]

a. F ratio. All the coefficients are significant at the 1% level.

Population Sciences and ORC Macro 2000). So these zones are mainly inhabited by low-caste people, causing low literacy and less awareness. In Madhya Pradesh the main inhabitants are tribal groups.

States with a high prevalence of overweight and obesity are New Delhi, Punjab, Kerala, and Goa. The proportion of people belonging to scheduled castes, scheduled tribes, and other backward communities are much less in Goa. Higher education and exposure to mass media such as TV and radio are also potential factors for the occurrence of overweight and obese women in Delhi, Punjab, and Kerala.

The causes of rural-urban differences may include the effects of urbanization, processed and fast food, and dependence on TV and radio, leading to less physical activity and the consumption of an energy-dense but nutrient-poor diet.

All the independent variables have been found to affect the level of CED and overweight and obesity significantly. Education is one of the most important regulatory factors; it enhances awareness of health and hygiene in the society. The standard of living is another important factor. The northeast zone of India has a low prevalence of CED, but the standard of living index is not very high in this zone. Higher educational level has been associated with healthier dietary patterns and decreased prevalence of obesity (Jacobesen and Thelle 1988; Rasheed 1998). Nube et al. (1988) and Delpeuch et al. (1994) have found a strong association between socioeconomic status, particularly income and standard of living, and BMI in developing countries.

To sum up, Bihar, Orissa, and central India have the highest percentage of malnourished women. These states are also the most underdeveloped states in many respects. On the other hand, New Delhi, Kerala, Punjab, and Goa have the highest percentage of overweight and obese women. These are also the states that

Table 9. Zonewise Regression Analysis of BMI on Different Socioeconomic Variables in India Separately for Rural and Urban Sectors

	Constant		*Age*		*Education*		*Race or Caste*		*Husband's Education*		*Husband's Occupation*		*Woman's Occupation*		*Standard of Living Index*		*Urban*			*Rural*		
Zone	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	R^2	*F*	*Significance*	R^2	*F*	*Significance*
North																						
b	12.6	16.1	0.18	0.07	0.57	0.30	0.25	0.35	0.10	0.08	0.13	0.10	0.39	0.19	1.28	0.69	0.19	228	(b)	0.11	219	(b)
t	39.6	124.7	26.2	20.3	8.8	7.5	4.9	13.6	1.4	2.4	2.3	3.6	3.6	5.8	10.7	13.1						
Significance	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	0.16	0.02	0.02	(b)	(b)	(b)	(b)	(b)						
Northeast																						
b	16.8	19.1	0.07	0.02	0.19	0.09	−0.05	−0.14	0.22	0.14	0.03	0.14	0.34	−0.02	0.73	0.65	0.10	39	(b)	0.05	57	(b)
t	48.3	123.4	8.7	6.4	2.1	1.9	−0.6	−4.0	2.3	3.2	0.5	4.7	3.6	−0.6	6.4	10.3						
Significance	(b)	(b)	(b)	(b)	0.033	0.059	0.54	(b)	0.02	(a)	0.59	(b)	(b)	0.55	(b)	(b)						
East																						
b	14.3	17.9	0.09	0.01	0.39	0.17	0.16	0.08	0.28	0.09	0.32	0.20	0.42	0.05	1.09	0.61	0.19	109	(b)	0.07	117	(b)
t	35.7	168.4	11.7	4.2	4.3	4.5	2.0	2.9	2.9	3.1	4.5	9.0	2.7	1.7	8.4	12.9						
Significance	(b)	(b)	(b)	(b)	(b)	(b)	0.04	(a)	(a)	(a)	(b)	(b)	(a)	0.09	(b)	(b)						
West																						
b	12.4	15.7	0.17	0.06	0.30	0.18	0.30	0.30	0.11	−0.02	0.08	0.24	0.49	0.34	1.52	1.01	0.21	182	(b)	0.15	124	(b)
t	37.9	75.9	22.8	10.8	3.8	2.8	5.0	5.7	1.3	−0.3	1.3	5.0	4.7	6.7	12.5	12.7						
Significance	(b)	(b)	(b)	(b)	(b)	(a)	(b)	(b)	0.20	0.77	0.20	(b)	(b)	(b)	(b)	(b)						
Central																						
b	14.4	18.0	0.12	0.02	0.45	0.15	0.23	0.12	−0.02	0.06	0.24	0.16	0.21	0.08	1.01	0.48	0.17	86	(b)	0.04	59	(b)
t	39.0	156.1	14.3	7.0	5.7	3.6	3.1	3.7	−0.2	2.0	3.4	5.9	1.7	2.5	7.9	9.9						
Significance	(b)	(b)	(b)	(b)	(b)	(b)	(a)	(b)	0.80	0.05	(a)	(b)	0.09	0.01	(b)	(b)						
South																						
b	14.7	15.7	0.12	0.07	0.17	0.35	0.08	0.18	0.11	0.17	0.26	0.20	0.51	0.51	1.31	0.70	0.17	156	(b)	0.17	290	(b)
t	50.7	115.3	19.2	19.9	2.3	7.7	1.4	5.1	1.4	4.0	4.6	5.9	5.4	12.9	12.9	12.1						
Significance	(b)	(b)	(b)	(b)	0.02	(b)	0.16	(b)	0.16	(b)	(b)	(b)	(b)	(b)	(b)	(b)						

a. $0.001 \leq p < 0.01$.
b. $p < 0.001$.

Table 10. Zonewise Regression Analysis of BMI on Different Socioeconomic Variables in India

Zone	*Constant*	*Age*	*Education Level*	*Race or Caste*	*Husband's Education*	*Husband's Occupation*	*Woman's Occupation*	*Standard of Living Index*	R^2	*F*	*Significance*
North											
b	14.4	0.11	0.62	0.30	0.09	0.26	0.29	0.96	0.21	720.6	(b)
t	115.5	35.1	18.3	12.3	2.8	9.9	8.2	18.6			
Significance	(b)	(b)	(b)	(b)	(a)	(b)	(b)	(b)			
Northeast											
b	18.5	0.04	0.14	−0.13	0.16	0.12	0.05	0.69	0.08	115.9	(b)
t	133.2	10.5	3.5	−4.1	4.1	4.7	1.4	12.6			
Significance	(b)	(b)	(a)	(b)	(b)	(b)	(b)	(b)			
East											
b	17.0	0.03	0.39	0.07	0.09	0.32	0.09	0.85	0.15	385.7	(b)
t	156.6	12.3	11.3	2.7	2.9	14.1	2.6	18.3			
Significance	(b)	(b)	(b)	(a)	(a)	(b)	(a)	(b)			
West											
b	13.6	0.12	0.29	0.28	0.06	0.29	0.59	1.29	0.24	451.7	(b)
t	77.0	25.1	5.6	6.8	1.1	7.2	12.5	18.2			
Significance	(b)	(b)	(b)	(b)	0.257	(b)	(b)	(b)			
Central											
b	16.9	0.05	0.41	0.15	0.01	0.27	0.13	0.69	0.12	254.7	(b)
t	147.5	16.1	11.4	4.7	0.39	10.4	4.1	14.4			
Significance	(b)	(b)	(b)	(b)	0.693	(b)	(b)	(b)			
South											
b	15.1	0.09	0.30	0.12	0.18	0.31	0.60	0.95	0.22	610.7	(b)
t	121.7	28.0	7.8	4.1	4.6	10.6	16.1	18.5			
Significance	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)			

a. $0.001 \leq p < 0.01$.
b. $p < 0.001$.

are most developed. Nutritional status and level of development thus go hand in hand. This explains why rural women are more malnourished than urban women. The nutritional deficiency is acute among the rural, illiterate, and younger women and also among women with a low standard of living. The northeast zone is the balanced zone, with low percentages of both malnourished and overweight and obese people. Woman's education is one of the reasons behind this. Thus a program of development and awareness should be undertaken with a greater emphasis on education, particularly in the rural and less-developed areas of India.

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Ancestral Consanguinity and Mortality Among Three Endogamous Populations of Chittoor District, Andhra Pradesh, India

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Abstract Consanguineous marriages have been practiced around the globe by many societies from time immemorial, particularly in South India. Consanguineous marriages play a major role in the health of a population, and diseases leading to mortality of the progeny are a consequence of detrimental recessive genes. To evaluate the effects of ancestral consanguinity on mortality in relation to consanguineous marriage, we have ascertained data from 1,500 women belonging to three endogamous communities (Akuthota Reddy, Odde, and Madiga) of Chittoor District, Andhra Pradesh, India. There were 500 women from each community. For each marriage we drew a family pedigree, extended upward to two earlier generations on either side of the spouses, to determine the prevalence and pattern of consanguinity, with detailed information on fertility and mortality. We observed a significant difference in the mortality rates between consanguineous and nonconsanguineous marriages when all the marriages of the women, women's parents, and (women's) husband's parents were considered in all three communities. In inbreeding, the offspring of earlier generations might have passed on deleterious genes to later generations (under unfavorable conditions), which resulted in a negative aspect of reproduction (among the offspring of the present couple).

The Hardy-Weinberg principle of equilibrium in gene frequencies is disturbed under conditions of nonrandom mating such as inbreeding; and where this custom has persisted over several generations, the gene frequencies have fluctuated depending on the selection for or against the specific genotypes (Emery 1976). Estimates of such effects and time trends can be made through an assessment of specific mortality and morbidity among the observed populations (Reddy and Govinda Reddy 1996).

Consanguineous marriage has been practiced by many societies around the globe from time immemorial, but it is widely practiced in Asia, North Africa,

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