

Malnutrition among Women in Kerala: An Analysis of Trends, Differentials and Determinants

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Abstract

While under-nutrition (underweight and stunting) is still prevalent in most of the developing countries, the rates of overweight and obesity are steadily increasing, especially among adults. In Kerala, overweight/obese exceeded underweight. This paper attempts to examine the trends in the shift from underweight to overweight and identify the major determinants of the co-existence of 'double burden' of malnutrition among women of reproductive age 15-49 years in Kerala using the data from National Nutrition Monitoring Bureau (NNMB) and the Second National Family Health Survey (NFHS-2, 1998-99). The results of the multivariate logistic regression analyses show that household standard of living, religion and age are significantly associated with both underweight and overweight/obesity. On the other hand, woman's education, work status, residence and caste are not significant on women's nutritional status. In summary, both chronic energy deficiency and overweight/obesity are widespread in Kerala and there is a need for public health programs that are able to address both simultaneously.

Introduction

Malnutrition refers to any disorder of nutrition — whether it is due to dietary deficiency, called under-nutrition, or to excess diet, called over-nutrition (Britannica Student Encyclopedia, 2005). Malnutrition results from imbalance between the needs of the body's and the intake of nutrients. Malnutrition worldwide includes a spectrum of nutrient-related disorders, deficiencies, and conditions such as intrauterine growth retardation, protein-energy malnutrition, iodine deficiency disorders, vitamin A deficiency, iron-deficiency anemia, and overweight/obesity and other diet-related non-communicable diseases (Ratzan *et al.*, 2000).

In earlier days, developing countries experienced high prevalence of under-nutrition, but this era of transition has brought a double burden of under-nutrition and over-nutrition. While under-nutrition (underweight and stunting) is still prevalent in most of the developing countries, the rates of overweight and obesity are steadily increasing, especially among adults. Hence, the countries in transition face today new public health problems, while they are yet to eradicate completely the nutritional deficiencies. Once

considered a problem related to affluence, overweight and obesity is growing rapidly in many developing countries. This is due in large part to increasing urbanization and changes in diet and life style, in particular the “nutrition transition” away from fruit, vegetables and greater consumption of more ‘energy-dense, nutrient-poor’ diets, dependence on television for leisure along with reduced levels of physical activity (World Health Organization 2000, 2003). Overweight and obesity is a risk factor for a number of chronic non-communicable diseases, such as diabetes, hypertension, asthma, cardiovascular disease, some cancers, gall bladder disease and osteoarthritis – all of which are on the rise in developing countries, particularly among the middle-class, urban populations (Gopalan, 1998; Popkin *et al.*, 2001). On the other hand, the Chronic Energy Deficiency (CED) is associated with impaired physical capacity (Durmin, 1994), reduced economic productivity (Kennedy, 1994; Untoro, 1998), increased mortality (National Institute of Nutrition, 1991) and poorer reproductive outcomes (World Health Organization, 1995; Schieve *et al.*, 2000). Some evidence in developing countries indicates that malnourished individuals, that is, women with a Body Mass Index (BMI) below 18.5 kg/m², show a progressive increase in mortality rates as well as increased risk of illness (Rotimi *et al.*, 1999). The World Health Organization estimates that in 1995, about one million adult deaths resulted from health problems exacerbated by over-nutrition, while half of it were associated with under-nutrition (WHO, 1998).

For social and biological reasons, women of the reproductive age are amongst the most vulnerable to malnutrition (UNACC/SCN, 1992). Several reviews have also emphasized the vulnerability of women throughout their life cycle (Tinker, 1995; Merchant and Kurtz, 1993). Many factors have been associated with both forms of malnutrition of women in the literature. These include the socioeconomic (e.g., occupation, educational background and the standard of living); cultural (e.g., religion and caste); the demographic (e.g., age and marital status) and dietary characteristics (De Vasconcellos, 1994; Shetty and James, 1994; Stunkard, 1996; Griffiths and Bentley, 2001; Monteiro *et al.*, 2002, 2004b; Shukla *et al.*, 2002; Shetty, 2002; Radhakrishna and Ravi, 2004; Radhakrishna *et al.*, 2004; Roy *et al.*, 2004). Based on the analysis of anthropometric measurements for women age 20-49 in 36 developing countries, Mentez *et al.*, (2005) observed that the proportion overweight exceeded the proportion underweight in a majority of the counties in both urban and rural areas. These results are contrary to the general belief that in developing counties overweight is less prevalent than underweight and that it is primarily concentrated in urban, higher socioeconomic status households. There are several studies on nutrition transition in Asia and the Pacific, as well as the developing world, in general (Popkin 1994; 1998; Popkin *et al.*, 2001). In India, which is typically known for large incidence of under-nutrition, significant proportions of overweight and obese now coexist with the undernourished (IIPS and ORC Macro, 2000) and there is some evidence of even emerging nutrition transition also (Shetty and James, 1994; Griffiths and Bentley, 2001; Shetty, 2002; Shukla *et al.*, 2002; Radhakrishna and Ravi, 2004; Radhakrishna *et al.*, 2004; Arnold *et al.*, 2004).

Prevalence of Malnutrition among Women in India

Though, malnutrition among women has long been recognized as a serious problem in India, but national-level data on levels and causes of malnutrition have been scarce. However, with the availability of data from the Second National Family Health Survey (NFHS-2) carried out in 1998-99 all over the country, we may be able to sort out such

limitations. The NFHS-2 collected anthropometric data from a nationally representative sample of 92,486 households (IIPS & ORC Macro, 2000). This data provides an opportunity for examining the prevalence of malnutrition among ever-married women of reproductive age 15-49.

The Body Mass Index [BMI, weight (kg)/height (m)²] can be used to assess individual and community nutritional status (Bailey and Ferro-Luzzi, 1995). As per the Second National Family Health Survey, the mean body mass index for women of age 15-49 in India is 20.3, varying within the narrow range of 19-23 among various states, from 19.2 in Orissa to 23.7 in Delhi (IIPS and ORC Macro 2000:244). Table A-1 shows the percentage of women age 15-49 according to level of body mass index by state. More than 60 per cent of women in Kerala and all the northeastern states (except Tripura) fall in the healthy weight category (BMI, 18.50-24.99). Punjab, Orissa, West Bengal, Goa, Gujarat, Maharashtra, Andhra Pradesh, Karnataka and metro cities of Kolkata and Mumbai has a level lower than the national average of 53 per cent (Table A-1, Col. 5). The BMI can also be applied to define chronic energy deficiency/ underweight (Shetty and James, 1994; Ferro-Luzzi *et al.*, 1992) and overweight/obesity (Garrow, 1988). Underweight/CED is usually indicated by a BMI of less than 18.5 kg/m² and overweight and obese indicated by a BMI of more than 25.0 kg/m². More than one-third (36 per cent) of women in India have a CED (20 per cent have mild CED, 9 per cent have moderate CED, and 7 per cent have severe CED). At state level, the disparities are quite widespread and CED ranges from 11 to 48 per cent. Prevalence was \geq 20 per cent in 19 (70 per cent) of the 27 states and \geq 30 per cent in 11 states (41 per cent) of India. Among the states, the level of CED is the high in Orissa (48 per cent) followed by West Bengal (44 per cent). Andhra Pradesh, Bihar, Gujarat, Karnataka, Madhya Pradesh and Maharashtra have a CED in the range of 37-40 per cent. The lowest percentages (11-12) of women with chronic energy deficiency/underweight (low BMI) are found in the states of Arunachal Pradesh, Sikkim, and Delhi (Table A-1, Col. 4).

Although under-nutrition is still prevalent, there is an alarming prevalence of overweight and obesity among Indian women of childbearing age. Eleven per cent of ever-married women of age 15-49 in India are overweight or obese and it ranges from 4-34 per cent. Among the states, the level of overweight or obesity is much high in Delhi (34 per cent) followed by Punjab (30 per cent) and least common (less than 10 per cent) in Rajasthan and all parts of central, eastern and northeastern (except Sikkim and Manipur) states (Table A-1, Col. 8). In all the three metro cities and Delhi, Punjab, Sikkim and Kerala states, the proportion of overweight or obese is exceeded the proportion of underweight. In Kerala, about two-fifths (20 per cent) of underweight women are coexisting with 21 per cent of overweight or obese women.

Most of the research on determinants of malnutrition among women in India has concentrated either on underweight (for example, Shetty and James, 1994; Singh, 1999) or overweight (Gopalan, 1998; Dudeja *et al.*, 2001). Very little has been done on the emerging dual burden of both forms of malnutrition, particularly among women (Griffiths and Bentley, 2001; Shukla, 2002; Roy *et al.*, 2004). With this backdrop, this paper sheds light on the emerging 'double burden' of malnutrition among women in Kerala and its linkages with socioeconomic, demographic and other factors. Specifically, this paper will attempt first, to explore the trends in the shift from underweight to overweight among rural women during the last three decades and finally, it analyses the differentials and identify the distinct factors that may influence

malnutrition among women of reproductive age 15-49. In this paper, malnutrition covers problems of both under-nutrition and over-nutrition.

The Setting

Kerala is situated on the southwest coast of India with the Western Ghat Mountains forming its eastern border. Various demographic and socioeconomic features of Kerala and India are outlined in Table A-2. According to the 2001 Census, Kerala had a population of 31.8 million, accounts for 3.1 per cent of India's population and for 1.2 per cent of its land area. Kerala is predominantly an agricultural state with 73 per cent of the population living in rural areas. Kerala has achieved remarkable progress in human development, as reflected in the high levels of education and health of its population. Kerala's demographic experience has attracted wide attention both at the national and the international levels (Bhat and Irudaya Rajan, 1990; Zachariah and Irudaya Rajan, 1997; Irudaya Rajan and Aliyar, 2005). Crude death rate, infant mortality rate, and life expectancy at birth are comparable even to those in the developed countries. As of 2002, the birth rate in Kerala was estimated as 16.9 births (per 1000 population), as against 25.0 for all-India. The crude death rate was 6.4 deaths (per 1000 population), compared to the national average of 8.1 (India, Registrar General, 2004). Thus, Kerala has apparently entered the third or final phase of the demographic transition characterized by low death rate and declining birth rate leading to a slow down in the growth rate of population. Kerala has made significant advances not only in demographic transition but also in epidemiological, and health care transitions (for more discussion on epidemiological and health care transitions in Kerala, *see* Panikar and Soman, 1981; Panikar, 1999).

Trends of Malnutrition and Food Consumption in Rural Kerala

The National Nutrition Monitoring Bureau (NNMB) conducted diet and nutrition surveys in three periods (1975-79, 1988-90 and 1996-97) and two separate rural diet and nutrition surveys (1990-91 and 2000-2001) in a sub-sample of villages of NSSO, adopting the sampling design of NSS consumer expenditure survey in rural areas of nine states including Kerala. The availability of repeated, representative cross-sectional surveys provides a basis for the careful understanding of secular trends in the nutritional status of population in rural Kerala. From these NNMB surveys, among rural women, a decreasing trend in the prevalence of underweight/CED and an increasing trend in the proportions of 'normals' and overweight or obese were observed over the last two decades. Between 1975-79 and 2000-2001, the extent of CED declined from 47 per cent in 1975-79 to 25 per cent in 1996-97 (NNMB repeat surveys) and from 28 per cent in 1991-92 to 19 per cent in 2000-01 (NNMB-NSS sample design). On the other hand, during the same period, a consistent increasing trend was observed in the proportions of overweight or obese among rural women from 2 per cent to 12 per cent and then from 16 to 24 per cent, respectively (Table A-3).

Since the formation of the State in 1956 to 1970 (i.e., during the period 1950-70), the nutrient intakes (both energy and proteins) had been consistently lower than the recommended dietary allowances (Panikar and Soman, 1981: 24). The average intakes of energy and protein observed during the three NNMB survey periods (during 1975-79 to 1996-97) reflect almost steady increase. Between 1975-79 and 1996-97, the average intake of energy by rural households increased from 1,978 to 2,106 Kcal, but below the

recommended dietary allowances (RDA) of 2,425 Kcal. On the other hand, the average intake of proteins in rural households increased from 46 g to 56 g, as against the RDA of 60g. During the same periods (1975-79 and 1996-97), the proportion of households with protein-adequacy and calorie-adequacy showed an increase of 28 per cent and 13 per cents, respectively. Thus, the proportion of households with adequate protein and energy intake registered a moderate increase between the late 1970s and the 1990s (Table A-4).

Data and Methods

Data: The anthropometric data used for analysis in this paper were derived from the Second National Family Health Survey, 1998-99 (NFHS-2) for the state of Kerala. The objective of the survey were to provide state-level estimates on fertility, family planning practices, infant and child mortality, reproductive and child health, quality of health and family welfare services and nutrition of women and children. Data were collected between March and July 1999 from 2,884 ever-married women of age group 15-49 in 2,834 households. The household response rate was 98 per cent and women's response rate was 93 per cent. In addition, the survey also collected measures of height and weight from 2,770 ever-married women (96 per cent of those ever-married women interviewed). The details of the study design as well as sampling frame and sample implementation are provided in the national and state NFHS-2 reports (IIPS and ORC Macro, 2000; 2001).

Measures: In NFHS-2, all ever-married women aged 15-49 years were weighed using a solar-powered scale with an accuracy of ± 100 g. Their height was measured using an adjustable wooden measuring board, specifically designed to provide accurate measurements (to the nearest 0.1 cm) in a developing country field situation. The weight and height data were used to calculate the BMI. The BMI is defined as weight in kilograms divided by the height in meters squared (kg/m^2). According to the WHO (1995) recommendations, the BMI variable was categorized into six groups for preliminary analysis. The six groups identify women who are: severely thin (BMI, $<16.00 \text{ kg/m}^2$), moderately thin (BMI, $16.00\text{--}16.99 \text{ kg/m}^2$), mildly thin (BMI, $17.00\text{--}18.49 \text{ kg/m}^2$), normal weight (BMI, $18.5\text{--}24.9 \text{ kg/m}^2$), overweight (BMI, $25.0\text{--}29.9 \text{ kg/m}^2$) or obese, $\text{BMI} \geq 30 \text{ kg/m}^2$. For the 15-17 years old females in the NFHS-2 sample, the cut-off points recommended by Cole *et al.*, (2000) for adolescent obesity and overweight were used because the BMI values change substantially with age in adolescents. For obesity, these points are 29.29 for 15-years old, 29.56 for 16-years old and 29.84 for 17-years old females. For overweight, the recommended cutoff points are 24.17 for 15 years old, 24.54 for 16-years old and 24.85 for 17-years old females. Normal weight categories used for adolescent females were $18.5\text{--}24.17$ for 15-years old, $18.5\text{--}24.54$ for 16-years old and $18.5\text{--}24.85$ for 17-years old females. The same definition of underweight/thinness was used for all women in the sample regardless of age because no age-specific definitions of thinness for adolescents have been suggested (Cole *et al.*, 2000). The WHO (1995) overweight grade-III definition of $\text{BMI} >40$ was not used because of only five women in the sample. Women who were pregnant at the time of the survey or women who had given birth during the two months preceding the survey were excluded from the analysis. This is to avoid the exaggerated BMI values for the women due to their pregnancy status.

Table 1: Definition of Variables and Percentage Distribution of Ever-married Women Age 15–49, NFHS–2, Kerala, 1998-99

Variable	Definition of the Variable	Per cent
Socio-cultural and Economic		
Place of Residence		
Rural	Women lives in Rural areas	76.9
Urban	Women lives in Urban areas	23.1
Religion		
Hindu	Women lives in a household whose head is Hindu	51.3
Muslim	Women lives in a household whose head is Muslim	32.6
Others	Women lives in a household whose head is neither Hindu nor Muslim	16.1
Caste		
SC/ST	Woman lives in a household whose head belongs to Scheduled Caste (SC) or Scheduled Tribe (ST)	9.8
OBC	Woman lives in a household whose head belongs to Other Backward Class (OBC)	43.1
OC	Woman lives in a household whose head does not belong to OBC or SC or ST	47.0
Education		
Illiterate	Woman is illiterate	12.6
Literate, < middle	Woman literate with less than middle school education	30.2
Middle school	Woman is literate with middle school education	17.1
High school & above	Woman is literate with high school or above education	40.2
Work Status		
Not working	Woman is currently not working besides from her own household work	76.9
Working	Woman is currently working besides from her own household work	23.1
Standard of Living		
Low	Woman lives in a household with low standard of living	15.5
Medium	Woman lives in a household with medium standard of living	55.1
High	Woman lives in a household with high standard of living of living	29.3
DEMOGRAPHIC		
Current Age		
15-24	Woman's age is 15–24 years at the time of the survey	15.9
25-34	Woman's age is 25–34 years at the time of the survey	37.4
35-49	Woman's age is 35–49 years at the time of the survey	46.7
Marital Status		
Currently married	Woman is currently in married status	92.8
Not currently married	Woman is widowed or divorced/separated or abandoned	7.2
Life Style (Media & Food Habits)		
Watches Television (TV)	Every week	62.4
Frequency of Eating Fruits		
	Daily	17.9
	Weekly	38.6
	Occasionally	41.8
	Never	1.7
Frequency of Consuming Meat/Chicken/Fish		
	Daily	61.6
	Weekly	21.2
	Occasionally	13.5
	Never	3.6
N	Total Number of women	2884

Source: NFHS-2, 1998-99 Data files of Kerala.

Dependent variables: Based on the WHO cutoffs, a three-category variable of nutritional status of women was created, indicating underweight (BMI <18.50 kg/m²), normal weight (BMI 18.5–24.9 kg/m²) and overweight or obese (BMI ≥25.00 kg/m²). Among 2770 ever-married women from whom anthropometric data were collected, measurements of height and weight for six women were incomplete or affected by measurement errors. Women who were pregnant at the time of the survey are 145 and 31 women gave birth during the two months preceding the survey. These 181 women (6+145+31) were excluded from the analysis. Thus, 2589 ever-married women were included in the analysis, of whom, 489 were underweight, 1560 were normal weight and 540 were overweight or obese.

Explanatory variables: The effect of one variable on the prevalence of malnutrition is likely to be confounded with the effects of other variables. Therefore, socioeconomic demographic and life style characteristics were controlled statistically. The variables included as controls are: residence, religion, caste/tribe, education, work status, standard of living (measured by an index based on the housing conditions and ownership of consumer durables, which is used as a proxy for economic status), current age, marital status, media and food habits. For definition and categories of these variables, see Table 1.

Analysis: In analyzing the data, both bivariate and multivariate analyses were carried out. In the bi-variate analysis, the chi-square test is employed to see the association between each of the independent variables and the nutritional status of women. The chi-square test in the bi-variate analysis does not consider confounding effects. Therefore, multivariate analysis is used to examine the net effect of each independent variable on malnutrition of women, while controlling for the other independent variables. Two separate logistic (logit) regression models were used to identify and to compare the factors associated with *women being underweight* (BMI <18.50 kg/m²) in the first model (n=2,039) and *women being overweight or obese* (BMI ≥25.00 kg/m²) in the second model (n=2,112). In both of the models, underweight and overweight women were compared with normal weight (BMI 18.5–24.9 kg/m²) women. Details of the multivariate statistical technique used in the analysis are provided in the *Appendix-2*. In the survey, certain geographical regions of Kerala and certain categories of households were over-sampled. Therefore, survey-specific sample weights are used to restore the representativeness of the sample. Further, sample sizes varied between analyses as a result of missing data for certain variables, and sample sizes were lower in the multivariate analyses than in the bi-variate analyses.

Results

Characteristics of women

The percentage distribution of ever-married women of age 15-49 according to selected socioeconomic, demographic characteristics (i.e., residence, religion, caste/tribe, education, work status, standard of living, age, and marital status) and life style indicators such as media and food habits are presented in Table 2. More than three-fourths (77 per cent) of respondents were from rural areas. Fifty-one per cent of the respondents were Hindus and 33 per cent were Muslims. Forty-three per cent of respondents belong to the other backward classes, ten per cent belong to the scheduled castes/tribes and nearly half (47 per cent) of women did not belong to any of these caste

or class groups. Thirteen per cent of women were illiterates and two-fifths (40 per cent) of women completed high school and above level of education. More than three-quarters of women (77 per cent) did not participate in work other than their regular housework during the 12 months preceding the survey. Twenty-nine per cent of women hailed from high household standard of living group and 16 per cent from low standard of living group. Nearly half of respondents (47 per cent) were in the age group 35-49 and more than one-third (37 per cent) of respondents were in the age group of 25-34. The very small share (16 per cent) of the age group 15-24 was due to the relatively high age at marriage in Kerala. Ninety-three per cent of respondents were currently married and seven per cent were not currently married i.e., widowed, divorced, separated, or abandoned women. With regard to lifestyle indicators, such as media and food habits, 62 per cent watched television at least once a week. More than three-fifths (62 per cent) of women consumed chicken or meat or fish daily and 83 per cent consumed these items at least once a week. In addition, 18 per cent of women consumed fruits daily and 57 per cent consumed them at least once a week.

Bi-variate Analysis: Differentials of Malnutrition

The percentage of ever-married women of age 15-49 in Kerala with chronic energy deficiency/underweight and the percentage with overweight or obese by selected background characteristics are presented in Table 2. The results of the bi-variate analysis using chi-square test showed a significant association between the BMI groups and each of the explanatory variables. More than one-fifths (21 per cent) of women were overweight or obese, but this percentage is considerably higher for some groups of women (30 per cent of women who consume fruits daily, 26 per cent of women of age 35-49, 25 per cent of urban women, 23 per cent of women who consume chicken/meat/fish daily, or who have completed at least high school education). Moreover, it has been observed that the prevalence of overweight or obese varies significantly according to the household's living standard. Among the higher economic group, the prevalence of overweight or obese was 33 per cent and it declines to 9 per cent for the lower economic group.

The total prevalence of underweight/CED among the Kerala women was 19 per cent. CED was particularly serious for women who belong to households with a low standard of living i.e., women from households with a low standard of living were more than thrice as likely to have a low BMI as women from households with a high standard of living. In addition, underweight or suffering from CED was particularly pronounced among women of scheduled caste (28 per cent), illiterate women (26 per cent), younger women (25 per cent) Hindu or workingwomen (22 per cent), and rural women (20 per cent). Women who eat fruits or chicken, meat, or fish on a daily basis were less likely than the other women to have CED. Moreover, it has been observed that the prevalence of overweight or obese exceeded underweight among women from urban areas, Muslim, Christian and 'other' caste (OC) women, well educated, non-working, women from higher standard of living group, older women, who watches television at least once in a week and who consumes fruits daily (Table 2).

Table 2: Percentage Distribution of Non-pregnant Women Aged 15-49 Years, Classified as Underweight (BMI, <18.50 kg/m²), Normal Weight (18.50–24.99 kg/m²) and Overweight or Obese (BMI, ≥25.00 kg/m²), according to Selected Background Characteristics, Kerala, NFHS-2, 1998-99

Characteristic	Under	Normal	Over	Number of Women ² (N)	χ^2 value & level of Significance
	weight (<18.50)	weight (18.5-24.99)	weight (≥25.00)		
Level of BMI ¹					
Place of Residence					16.35***
Rural	20.2	60.2	19.5	1987	
Urban	14.3	60.2	25.5	601	
Religion					36.32***
Hindu	21.8	61.1	17.1	1351	
Muslim	17.4	58.0	24.6	814	
Christian	12.5	61.8	25.7	424	
Caste					
Scheduled caste/tribe	28.2	59.9	11.9	252	
Other backward class	19.9	59.6	20.5	1125	
Other caste	16.0	60.9	23.1	1212	
Education					26.31***
Illiterate	26.5	59.9	13.6	339	
Literate, < middle	19.8	59.4	20.9	805	
Middle school	17.3	60.9	21.8	445	
High school and above	16.2	60.9	22.9	999	
Work Status					12.22**
Not working	17.8	60.0	22.2	1971	
Working	22.2	61.2	16.6	616	
Household Standard of Living					165.66***
Low	33.7	57.1	9.1	406	
Medium	19.3	62.9	17.9	1422	
High	10.3	57.0	32.8	760	
Current Age					76.09***
15-24	25.4	66.6	8.0	350	
25-34	22.4	59.0	18.7	953	
35-49	14.5	59.5	26.0	1285	
Marital Status					10.287**
Currently married	18.2	60.5	21.3	2397	
Not currently married	26.9	57.5	15.5	193	
Watches TV Every Week					58.22***
No	25.5	59.2	15.3	961	
Yes	15.0	60.8	24.2	1627	
Fruits Daily					31.78***
No	19.8	61.4	18.9	2141	
Yes	14.7	54.8	30.5	449	
Chicken/Meat or Fish Daily					9.66**
No	20.2	62.0	17.8	989	
Yes	18.1	59.2	22.8	1601	
Total ³	18.9	60.3	20.9	2589	

Note: 1. The body mass index (BMI) is the ratio of the weight in kilograms to the square of the height in metres (kg/m²). For the 15-17-year-old adolescent females in the sample, the cut-off points recommended by Cole *et al.* (2000) for adolescent obesity, over-weight and normal weight was used (For details, See Data & Methods).

2. Table excludes women who are pregnant and women with a birth in the preceding two months.

3. Total includes a small number of women with missing information on standard of living, education, and work participation, who are not shown separately.

4. Level of significance: *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$

Source: NFHS-2, 1998-99 Data files of Kerala.

Multivariate Regression Analysis: Determinants of Malnutrition

It was observed from the earlier bi-variate analysis that there are differentials in the malnutrition by socioeconomic, demographic and other variables. However, some of these variables are associated. For instance, standard of living is highly associated with education (contingency coefficient of 0.40) and moderately with watching TV every week (contingency coefficient of 0.32). Similarly, the contingency coefficient between education and watching TV every week is 0.33. Such association confounds the differentials observed in the bi-variate analysis. Hence, there is a need to assess the effect of an individual factor when other variables are controlled. Moreover, many of the factors associated with malnutrition are also associated with each other. So, any apparent effect of one factor on malnutrition may be due to the confounding effects of one or more of these other factors. Therefore, when assessing the effects of any one factor on malnutrition, a multivariate analysis is necessary to control for the effects of other potentially confounding factors. To this end, logistic regression analysis is carried out to quantify the net effects of these background factors on each of the dependent variable and the results are presented in Table 3. The results of the multivariate analysis are presented in the form of regression coefficients and odds ratio. The *odds ratio*, which is determined from the logistic regression coefficients, tells us the increased or decreased chance of malnutrition given a set level of the independent variable while controlling for the effects of the other variables in the model. Estimates of odds greater than 1.0 indicate that the risk of malnutrition is greater than that for the reference category. Estimates less than 1.0 indicate that the risk of malnutrition is less than that for the reference category of each variable.

Table 3 depicts the results of the multivariate analysis of both underweight and overweight or obese in relation to socioeconomic, cultural, demographic characteristics and life-style indicators. This multivariate analysis adds to the bi-variate discussion by identifying the factors that significantly affect the likelihood of *women being underweight* or *being overweight/obese* net of all other factors. The results of the logistic regression analysis on overweight or obese women (BMI ≥ 25 kg/m²) with those of normal weight (BMI, 18.50-24.99) show that overweight or obesity was positively and significantly associated with religion, standard of living, age, media and food habits. The results revealed that Muslim women (OR=2.03) and Christian women (OR=1.36) were more likely to be overweight or obese than the Hindu women. Women who live in households with high standard of living had a significantly higher probability of being overweight or obese. As compared with women residing in households with low standard of living, women residing in medium and high standard of living households were about 1.4 and 2.3 times more likely to be overweight or obese, respectively. The risk of being overweight or obese increases rapidly with age, older women displayed a higher probability of being overweight or obese compared to younger women. Women in the age group 25-34 and 35-49 were 3.3 and 5.4 times more likely to be overweight or obese as compared with women in youngest age group (15-19). Watching television every week (OR=1.43) had a significant positive effect on the risk of being overweight or obese. For the diet/nutrition variables, women who reported eating fruits daily (OR=1.55) and women who consume chicken, meat or fish (OR=1.26) were more likely to be overweight or obese than those who ate them occasionally or rarely. Among the other variables, residence, caste, education, work status and marital status of women did not pose significant effect on women's overweight and/or obese status (Table 3, col. 1 & 3).

Table 3: Results of Logistic Regression Analysis Showing the Effects of Selected Variables on Women being Underweight (BMI, <18.50 kg/m²) and Women being Overweight/Obese (BMI, ≥24.99 kg/m²) compared to Normal weight (BMI, 18.50–24.99 kg/m²), Kerala, NFHS-2, 1998-99

Characteristic	Values of β Coefficient		Values of Odds Ratios	
	Overweight Vs Normal weight	Underweight Vs Normal weight	Overweight Vs Normal weight	Underweight Vs Normal weight
Col.	(1)	(2)	(3)	(4)
Place of Residence				
Rural®	0.0	0.0	1.000	1.000
Urban	0.090	-0.165	1.094	0.848
Religion				
Hindu®	0.0	0.0	1.000	1.000
Muslim	0.710	-0.234	2.034***	0.791
Christian	0.305	-0.341	1.357*	0.711
Caste				
Other caste®	0.0	0.0	1.000	1.000
Other backward class	0.109	0.120	1.115	1.128
Scheduled caste/tribe	-0.007	0.126	0.993	1.134
Education				
Illiterate®	0.0	0.0	1.000	1.000
Literate, < middle school	0.375	-0.235	1.455	0.790
Middle school	0.422	-0.386	1.524	0.679*
High school and above	0.393	-0.356	1.482	0.701
Work Status				
Not working®	0.0	0.0	1.000	1.000
Working	-0.227	0.092	0.797	1.096
Household Standard of Living				
Low®	0.0	0.0	1.000	1.000
Medium	0.343	-0.503	1.409	0.605***
High	0.822	-0.944	2.276***	0.389***
Current Age				
15-24®	0.0	0.0	1.000	1.000
25-34	1.206	-0.106	3.339***	0.899
35-49	1.688	-0.709	5.409***	0.492***
Marital Status				
Currently married®	0.0	0.0	1.000	1.000
Widowed/divorced	-0.276	0.387	0.759	1.473*
Watches TV Every Week				
No®	0.000	–	1.000	–
Yes	0.353	–	1.434**	–
Fruits Daily				
No®	0.0	0.0	1.000	1.000
Yes	0.437	0.047	1.549**	1.048
Chicken, Meat, or Fish Daily				
No®	0.0	0.0	1.000	1.000
Yes	0.230	-0.021	1.259*	0.979
-2 Log Likelihood	2213	2153		
Chi-square (d.f.)	181(17)	97 (16)		
Constant	-4.031	-0.021		
Total N	2112	2039		

Note: ® - Reference category; Level of significance: *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$

‘–’ Variable not used in the model

Source: NFHS-2, 1998-99, data files of Kerala.

The results of the logistic regression model comparing underweight (BMI, <18.5 kg/m²) women with those of normal weight (BMI, 18.50-24.99) are similar to those shown for

the model of overweight or obese, but in the opposite direction. In this model also standard of living, age and marital status of women are found to be significant risk factors of chronic energy deficiency in women. Conversely, a woman's residence, religion, caste, work status and media/dietary variables are not significant on women's nutritional status. The results indicates that women living in poorer households were much more likely to be underweight than those living in households with higher socioeconomic status. As compared with women residing in poorer households/low standard of living, women who lived in households with a high standard of living (OR=0.39) and with a medium standard of living (OR=0.61) have significantly lower probability of being underweight. Women with middle school level of education and older women were at a significantly lower risk (OR=0.68 & 0.49, respectively) of CED malnutrition compared to their counterparts. Never married women were 1.5 times more likely to be undernourished than currently married women (Table 3, col. 2 & 4).

Discussion

Epidemiological, demographic and nutritional transitions are taking place in many developing countries. In India also, there is some evidence of an emerging nutrition transition (Radhakrishna and Ravi, 2004; Shetty, 2002; Shukla *et al.*, 2002; Griffiths and Bentley, 2001). The state of Kerala has made significant advances in demographic, epidemiological and health care transitions. Considerable proportions of women were underweight and overweight or obese, with only slightly greater preponderance of the latter. The proportion of under/over weight women in the state was consistent with the nutrition transition and the state of Kerala is under-going rapid transition. This paper consequently examined the levels, trends and determinants of the coexistence of underweight (BMI <18.5 kg/m²) and overweight or obesity (BMI ≥25.0 kg/m²) among women of reproductive age 15-49 years in Kerala using the NNMB and NFHS-2 data.

Major findings emerged from this study are as follow. First, the prevalence of malnutrition (includes both under-nutrition and over-nutrition) among women in Kerala is quite high. Time-trend analysis based on NNMB data shows that there has been a decreasing trend in the prevalence of chronic energy deficiency and an increasing trend in the proportions of 'normals' and overweight or obese. The trends in the intake of both energy and proteins also reflect almost steady increase over the last two decades in the rural areas of Kerala. Second, the findings from the multivariate analysis suggest that, broadly similar set of factors is relevant to both under-and-overweight. For example, standard of living and age are positively and significantly associated with overweight or obesity and these factors are all inversely related to under-nutrition or with low BMI. These results are fairly consistent findings in many other developing countries (including India), which are in the early stage of nutrition transition (Singh *et al.*, 1999; Shukla *et al.*, 2002; Griffiths and Bentley, 2001; Monteiro *et al.*, 2004a).

Though the results from the bi-variate analysis show that the proportion of the overweight in the urban areas (25 per cent) is more in comparison to the rural areas (19 per cent), the logistic regression analysis reveals that the place of residence is not a significant determinant in deciding the overweight, and the differences between rural and urban areas were removed, when controlled for socioeconomic and other variables. Thus, socioeconomic status, not rural-urban residence, was the most important predictor of women's nutritional status in Kerala. This finding is also consistent with Popkin's perspective that urban residence *per se* is not the cause of over-weight rather;

differences in lifestyle factors that predict over-weight and obesity are associated with living in an urban environment (Popkin, 1998). A similar study conducted with the data in the state of Andhra Pradesh also reveals the same tendency (Griffiths and Bentley, 2001).

The economic condition of the household is one of the most significant predictors of malnutrition (includes both under-nutrition and over-nutrition). It has been observed that the prevalence of malnutrition varies significantly according to the household's living standard. Women in the highest socioeconomic groups are more likely to be overweight or obese and less likely to be underweight. About one-third of women from high household standard of living are overweight or obese, where as one-third of poor women are underweight. Apart from household economic status, current age of women also a significant predictor of both forms of malnutrition, older women are more likely to be overweight or obese and younger women having a higher probability of being underweight or severely thin, which is consistent with the findings of other studies (Shetty and James, 1994; Griffiths and Bentley, 2001). The risk of CED is significantly higher among never married women.

Among socio-cultural factors, religion is significantly associated with overweight or obese status. Muslim and Christian women show a very high tendency to be overweight or obese. This is likely related to differences in diet, physical activity and socioeconomic status. Further examination of NFHS-2 data show that Muslims and Christians were more likely to be found in the higher socioeconomic groups (30 per cent of Muslims and 40 per cent of Christians in the high standard of living group compared with 26 per cent among Hindus); lower rates of participation in the workforce (91 per cent of Muslims and 74 per cent of Christians reported not working compared with 69 per cent in the Hindus), a greater likelihood of consuming chicken or meat or fish daily (73 per cent of Muslims and 65 per cent of Christians compared with 54 per cent in the Hindu). Therefore, it is possible that Muslim and Christian women have lifestyles that increase their susceptibility to becoming overweight or obese. Among other variables, women who watch television more than once a week are more likely to be overweight or obese. Women who reported eating fruits daily and consume chicken or meat or fish are more likely to be overweight or obese than those who ate them occasionally or rarely.

This study has certain methodological limitations. The survey (NFHS-2) being cross-sectional, anthropometric measurements were taken only once. Therefore, issues of seasonal variation that may occur in measurements were not addressed. Further, the NFHS-2 did not include many factors on life styles, physical activity patterns and diets. Therefore, with the limited information available in the data set, women who ate fruits or consume meat/chicken/fish daily and women who watch television at least once a week are used as proxy variables for life-style or physical activity factors. Another limitation in the study is, although parity show a significant positive association with overweight or obese (women with parity greater than two had a higher risk of being overweight or obese) but not with CED, parity is not included as an explanatory variable in the analyses. Since, evaluation of women's nutritional status across age and parity is probably not the correct way to investigate maternal depletion (Winkvist *et al.*, 1994; Mendez *et al.*, 2005).

Conclusions

While the focus of attention in the field of nutrition continues to be on the substantial proportion of women with a chronic energy deficiency, the problem of overweight and obesity cannot be ignored. The substantial proportion of overweight or obese persons, together with continuing high overall levels of under-nutrition, produces a dual burden of nutritional disorders for the state. In the analysis, the WHO classification for overweight (BMI, 25.0–29.9) and obese (BMI, >30.0) is used. However, it has been identified that different ethnic groups have different amount of fat content and among Asian population, abdominal or central obesity is more common than obesity defined by BMI, (Mc Keigue *et al.*, 1991) and health risks associated with overweight and obesity occur at lower levels of BMI than in North America or Europe (Deurenberg-Yap *et al.*, 1999; Dudeja *et al.*, 2001; Chamukuttan *et al.*, 2003). In a study Gopalan (1998) observed that about 20 per cent of adults who were not overweight or obese as per the BMI definition still had abdominal obesity. In this situation, a WHO expert consultation in July 2002 has proposed a BMI lower limit of 23 for overweight among Asians instead of the 25 kg/m² used now (Choo 2002). If 23 had been used as the lower cutoff point for overweight women, the gravity overweight situation in the country and in the State of Kerala would worsen and the proportion of women classified as overweight or obese would increase from 11 per cent to 19 per cent in India as a whole, and from 22 per cent to 36 per cent for Kerala. The percentage of overweight and obese women in Kerala would also rise from 33 per cent to 51 per cent among women living in households with a high standard of living; from 26 per cent to 51 per cent among Christian women and older women and from 25 per cent to 39 per cent among Muslim women.

In sum, this study has shown that both chronic underweight and overweight are equally present in Kerala, with important public health implications for the burden of diseases associated with both extremes of physical status. Like overweight, marked thinness (underweight) is also responsible for higher morbidity and mortality (Naidu and Rao, 1994; Yap *et al.*, 1999). Thus, the overweight and obesity makes people prone to non-communicable and degenerative diseases, whereas, under-nutrition may make them prone to communicable diseases and reduce productivity. According to the World Bank estimates, the malnutrition costs India at least US\$10 billion annually in terms of lost productivity, illness, and death (World Bank, 2000). Therefore, the existence of a double burden poses a big challenge.

What are the policy implications of these findings? First of all, effective policies and programmes are urgently required to reduce the both forms of malnutrition. As these may be coexisting, not only at state level but also even at household level, no uniform intervention strategy can be advocated. Although the factors associated with underweight, obesity and overweight are very similar, the challenges and solutions required to, tackle the extremes of both over-and-underweight in the upper and lower socioeconomic groups are not. Hence, information and health education programs for women are needed to help them to understand the components of a healthy diet and to ensure adequate access to health services. Further research studies on socio-cultural practices, dietary practices, intra-household food distribution, women's physical activity patterns as well as life styles, seasonal food insecurity and other related factors are urgently required to obtain a fuller picture of high risk populations for both extremes of BMI.

Appendix 1

Table A-1: Percentage of All Ever-married Women Age 15-49 Years by Level of Body Mass Index (BMI), according to State and Metropolitan Areas, India, 1998-99

Level of BMI, kg/m ²	16.0–	17.0–	18.5–	25.0–				
States	<16.0	16.99	18.49	<18.5	24.99	29.99	≥30.0	≥25.0
Col.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
North								
Delhi	(1.2)	2.6	8.4	12.1	53.9	24.7	9.3	34.0
Haryana	3.8	6.4	15.9	26.1	57.2	12.8	3.9	16.7
Himachal Pradesh	5.6	7.9	16.4	29.9	56.8	10.9	2.4	13.3
Jammu & Kashmir	4.6	5.4	16.6	26.6	59.7	10.7	3.0	13.7
Punjab	2.7	4.5	9.8	17.0	52.4	21.4	9.2	30.6
Rajasthan	5.3	8.8	22.5	36.6	56.3	5.5	1.7	7.2
Central								
Madhya Pradesh	6.1	9.2	23.3	38.6	55.3	4.9	1.2	6.1
Uttar Pradesh	5.6	8.5	22.1	36.2	56.3	5.9	1.6	7.5
East & North-east								
Bihar	6.9	9.2	23.6	39.7	56.6	3.2	(0.5)	3.7
Orissa	8.9	12.1	27.4	48.4	47.2	3.8	(0.6)	4.4
West Bengal	9.6	11.4	23.4	44.4	46.9	7.3	1.3	8.6
Arunachal Pradesh	(1.3)	(2.0)	7.8	11.1	83.7	(4.5)	(0.6)	(5.2)
Assam	4.4	5.6	17.1	27.1	68.6	3.5	(0.7)	4.3
Manipur	(2.0)	4.1	13.2	19.3	69.9	9.7	(1.1)	10.8
Meghalaya	(3.8)	(7.2)	14.8	25.8	68.4	(4.7)	(1.2)	(5.9)
Mizoram	(1.8)	(4.1)	16.8	22.8	71.9	(4.9)	(0.6)	(5.3)
Nagaland	(2.0)	(4.0)	12.7	18.7	72.8	7.8	(0.8)	8.6
Sikkim	(1.2)	(1.5)	8.6	11.3	73.1	13.1	(2.5)	15.6
Tripura	6.6	7.0	21.9	35.4	56.0	6.8	(1.7)	8.5
West								
Goa	6.7	6.3	14.5	27.5	51.2	16.8	4.5	21.3
Gujarat	9.3	9.7	18.6	37.6	46.5	11.4	4.4	15.9
Maharashtra	9.5	10.6	20.1	40.2	47.9	9.0	2.9	11.9
South								
Andhra Pradesh	7.7	10.1	20.0	37.8	50.1	9.8	2.3	12.1
Karnataka	8.3	10.3	20.9	39.4	46.9	10.8	2.9	13.7
Kerala	2.8	4.0	12.1	18.9	60.3	17.0	3.9	20.9
Tamil Nadu	5.7	8.0	15.6	29.3	55.9	12.1	2.7	14.7
Metros								
Chennai	(2.7)	(3.8)	(9.5)	16.0	57.8	20.5	(5.7)	26.2
Kolkata	(3.3)	(3.3)	11.7	18.2	52.8	22.4	(6.5)	29.0
Mumbai	(3.8)	4.7	9.3	18.0	50.0	23.7	8.5	32.1
India	6.8	9.0	20.4	36.2	53.2	8.4	2.3	10.6

Notes: (1) The body mass index (BMI) is the ratio of weight in kilograms to the square of the height in metres (kg/m²); (2) According to BMI status, women are categorized in to six groups (col. 1-3 & 5-7). Women who are Severely thin/under-weight (BMI, <16.00 kg/m²); Moderately thin (BMI, 16.00–16.99 kg/m²); Mildly thin (BMI=17.00–18.49 kg/m²); Normal weight (BMI = 18.5–24.9 kg/m²); Overweight (BMI = 25.0–29.9 kg/m²) and Obese (BMI ≥ 30 kg/m²). From these six groups, two categories (col. 4 & 8) Total Thin/underweight (BMI <18.50 kg/m²) and Total Overweight/obese (BMI = ≥25.0 kg/m²) were used for the analysis of nutritional status of women; (3) For the 15-17-year-old adolescent females in the sample, the cut-off points recommended by Cole *et al.*, (2000) for adolescent overweight or obesity were used. (For details, see Data & Methods); (4) Results for states incorporate state-level sample weights, and results for India incorporate national-level sample weights; (5) All-India estimates in these tables will differ slightly from similar estimates in the NFHS-2 national report (IIPS and ORC Macro 2000). Because, Tripura state was not included in the tables of NFHS-2, India report due to late start of fieldwork (survey) in Tripura; (6) Table excludes women who are pregnant and women with a birth in the preceding two months; (7) () Percentage based on fewer than 50 un-weighted cases.

Source: Data files of the NFHS-2, India.

Table A-2: Selected Demographic and Socio-economic Indicators, Kerala and India

Indicators	Kerala	India
Demographic Indicators		
Population, 2001 in (in millions)	31.8	1028.6
Population decadal growth rate (per cent), 1991-2001	9.42	21.35
Population Density (persons/Km ²), 2001	819	324
Per cent urban, 2001	26.0	27.8
Crude death rate, 2002	6.4	8.1
Crude birth rate, 2002	16.9	25.0
Natural Growth rate, 2002	10.5	16.9
Infant mortality rate, 2002	10	63
Total fertility rate (NFHS-2, 1996-98)	1.96	2.85
Life Expectancy at Birth (in years) – Males, 1993-97	70.4	60.4
Life Expectancy at Birth (in years) – Females, 1993-97	75.9	61.8
Infant mortality rate (NFHS-2, 1999)	20.9	67.6
Under-five mortality rate (NFHS-2, 1999)	26.0	94.9
Incidence of Low Birth (< 2.5 kg) Weight (NFHS-2, 1998-99)	15.1	5.7
Per cent of small size baby's at birth (NFHS-2, 1998-99)	24.9	24.4
Per cent of miscarriages (NFHS-2, 1998-99)	8.8	8.1
Prevalence of Asthma (No. of persons per 1,00,000 population, NFHS-2)	4,806	2468
Socioeconomic Indicators		
Per cent literate (females age 7+), 2001	87.7	53.6
Work participation rate, 2001	32.3	39.1
Percentage of Population Below Poverty Line, 1999-2000	13	26
Per Capita Net State Domestic Product (at 1993-94 prices, Rs.) 1998-99	9,542	9,647
Per capita Income at constant 1993-94 prices (Rs) 2000-01	10,627	10,306
Per capita income at current prices (Rs.), 2000-01	19,463	16,707

Source: India, Registrar General (2004); IIPS and ORC Macro (2000; 2001); CSO (1999).

Table A3: Percentage Distribution of Adult Women in Rural Areas of Kerala by Body Mass Index (BMI): NNMB & NFHS-2 estimates

Level of BMI (Kg/m ²)	1975-79*	1991-92*	1996-97@	2000-01@	1998-99\$
Underweight/Thinness					
Grade-3 (Severe)	<16.0	10.5	6.1	5.1	3.0
Grade-2 (Moderate)	16.0-16.9	10.5	6.5	6.4	4.7
Grade-1 (Mild)	17.0-18.49	26.2	15.2	13.1	11.0
Total Underweight	<18.5	47.2	27.8	24.8	18.7
Normal weight	18.5-24.99	50.5	60.0	59.7	57.7
Overweight/obese	≥25.0	2.3	12.2	15.8	23.6
Total N		2366	1062	3480	1913

Note: *- NNMB Repeat Surveys; @- NNMB-NSS Sample design surveys; \$- NFHS-2, 1998-99

Source: National Institute of Nutrition (1991, 1993, 1999, 2000 and 2002); NFHS-2, Data files of Kerala.

Table A-4: Trends in Average Consumption of Nutrients (CU per Day) and Proportion of Households with Protein-energy Adequacy Status in Rural Areas of Kerala, NNMB Estimates

Consumption of Nutrients	1975-79	1988-90	1996-97	RDA
Energy (Kcal per consumption unit)	1978	2140	2106	2425
Protein (g per consumption unit)	46.4	52.9	56.4	60.0
Protein adequate (per cent)	55.7	71.5	83.5	-
Calorie adequate (per cent)	36.0	39.7	49.3	-

Note: RDA: Recommended Dietary Allowance by ICMR (1990)

Source: National Institute of Nutrition (1991: 50 & 52; 1999:8).

Appendix-2

Brief Description of Statistical Technique used for Analysis

The details of the multivariate statistical technique used for the analysis of data and the need to use the technique and basic model are briefly provided below. However, formulae and algorithms are not described. Appropriate references have been cited for them.

Logistic Regression Analysis

Logistic regression (logit regression) is used when the response or dependent variable is dichotomous (i.e., binary, or 0-1). The predictor variables may be quantitative, categorical or a mixture of the two. Suppose, the probability of the occurrence of event Y, [P (Y=1)] depends on a set of explanatory variables X₁, X₂, X₃, X_k.

The basic form of the logistic function is

$$P = P \left(Y = \frac{1}{X_1, X_2, X_3, \dots, X_k} \right) = \frac{e^z}{1 + e^z} = \frac{\exp(Z)}{1 + \exp(Z)}$$

Where Z, is a linear function of a set of predictor variables, X₁, X₂, X₃, X_k, given by

$$Z = b_0 + b_1X_1 + b_2X_2 + \dots + b_kX_k,$$

and b₀, b₁, b₂, b_k are regression coefficients.

Logit of P is derived by taking natural logarithm, that is, log [(p/1-p)] = Z

The quantity [(p/1-p)] is called the odds and hence log [(p/1-p)], the log odds (For details, see Retherford and Choe, 1993; Fox, 1984; Kendall, 1975). The coefficients b₀, b₁, b₂,.....b_k are similar to regression coefficients and are called logit regression coefficients. These coefficients are used to compute odds ratios (reported in results), which give the ratio of two odds of an event occurring (Y=1). In the case of a dichotomous independent variable, the odds ratio can be interpreted as the increased odds of a positive outcome on the dependent variable for the affirmative category (X=1) over the negative one (X=0). An odds ratio more than one indicates a positive association between the independent and dependent variables and an odds ratio less than one indicate a negative association.

Owing to the dichotomous nature of the dependent variable malnutrition (*Underweight Vs. Normal weight and Overweight or obese Vs. Normal weight*), the technique of logistic regression has been used for the analyses. The logistic regression technique can be used not only to identify the risk factor but also to predict the probability of success.

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