The Nutrition Transition Is Underway in India1,2,3

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ABSTRACT Nutrition research in India has previously focused on the serious problem of undernutrition related to nutrient deficit and high rates of infection. Recent data from the National Family Health Survey 1998/99 (NFHS 2), however, identified a significant proportion of Indian women as overweight, coexisting with high rates of malnutrition. This paper examines the emerging nutrition transition for women living in rural and urban communities of Andhra Pradesh, India. NFHS 2 provides nationally representative data on women’s weight and height. In this paper, we examine representative data from the state of Andhra Pradesh (n = 4032 women). Logistic regression analyses are applied to the data to identify socioeconomic, regional and demographic determinants of overweight and thinness. The major nutrition problem facing women continues to be undernutrition, with 37% having a low body mass index ([BMI] < 18.5 kg/m²). 8% of these women are severely malnourished ([BMI] < 16 kg/m²). However, 12% of the women can be classified as overweight ([BMI] > 25 kg/m²) and 2% are obese ([BMI] > 30 kg/m²). Furthermore, in the large cities of the state in which 4% of the sample live, 37% of women are overweight or obese, whereas in the rural areas in which 74% reside, 43% have a low BMI. Women from lower socioeconomic groups are also significantly more likely to have a low BMI. Findings from the logistic regression models reveal socioeconomic status to be a more important predictor of both over- and underweight than location of residence. J. Nutr. 131: 2692–2700, 2001.

KEY WORDS: • India • women’s nutritional status • nutrition transition • obesity and underweight.

Nutrition research in India has focused primarily on the problem of undernutrition, particularly among vulnerable women and children. There is some evidence of an emerging nutrition transition in India. Data from other developing countries demonstrate that in many resource-poor settings, rising urbanization and improvements in economic development lead to concurrent under- and overnutrition in the population (1–3). Recent data from the Indian National Family Health Survey 1998/99 (NFHS 2)4 (4) report a significant proportion of overweight women, coexisting with high rates of undernutrition and anemia (3).

By nearly any measure, India remains one of the poorest countries in the world, with a population of over one billion and a fertility rate well above replacement level (6). Nevertheless, infant mortality rates dropped from 115 in 1980 to 70 in 1998, and the total fertility rate dropped from 5 to 3.2 during the same period (6). Improvements in the nutritional status of the population have been less impressive. More than half of the world’s undernourished population live in India (7), and more than half of Indian children are undernourished (8). Health status of women in India reflects gender discrimination from birth (9–11), inequitable distribution of health resources (12), and early and frequent reproductive cycling and infection (13,14). More than half of Indian women are anemic; 13% and 2% have moderate and severe anemia, respectively (4).

Although the growing prevalence of overweight and obesity has received attention in many developing countries, there is a dearth of data for India, partly because of the persisting high prevalence of undernutrition (3,15). Small-scale studies conducted in the 1990s, based mainly on urban samples, suggest that the proportion of the overweight population in Indian towns and cities is large and increasing, ranging from 33 to 51% (16). A study in North India of 3575 men and women found the urban prevalence of overweight to be more than double that of the rural population, with 27% having a body mass index (BMI) > 25 kg/m² compared with 11% in the rural population (17). Data collected by the National Nutrition Monitoring Bureau in 1990 reported that 4.1% of Indian women had a BMI > 25 kg/m², with no increase in this proportion between 1970 and 1990 (18). Popkin and Doak (19) reported the results of a 1988–1990 study in India based upon 21,361 individuals in which 3.5% of the population were found to have a BMI > 25 kg/m² and 0.5% a BMI > 30 kg/m². The recent NFHS 2 data for India show that more than one third of women aged 15–49 y have

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2692
a BMI  18.5 kg/m², whereas nearly a quarter of urban women, who account for 27% of the sample population, are overweight or obese (20). In the state of Andhra Pradesh, in which 26% of the sample population are urban, 25% of women are overweight or obese. This compares with the large cities, which account for 4% of the population, in which 37% of women have a BMI  25. In contrast, 42% of rural women have a BMI  18.5 kg/m² (4). As rates of overweight and obesity rise, India is beginning to experience the burden of associated chronic diseases, particularly cardiovascular disease and adult onset diabetes (21,22). The WHO estimates that diabetes in India will increase from 19.4 million in 1995 to 57.2 million in 2025 (21).

There are few data available that shed light on changes in lifestyle in urban areas of India. The World Development report (23) showed an increase in the consumption of fat, saturated fat, sugar, salt, and vegetable ghee (clarified butter) in India. National surveys by the National Nutrition Monitoring Bureau show that 5% of the population consumes 40% of the available fat (24). Shetty (25) reported that high income groups in India consume a diet with >32% of the energy from fat. Data from NFHS 2 reported large differences in dietary diversity between urban and rural women, with urban women reporting regular consumption of milk, fruits and curd, and nearly double the frequency of eating eggs and meat compared with rural women (4).

Using NFHS 2 data, this paper examines demographic, socioeconomic, cultural and health determinants of overweight and thinness among women living in the southern Indian state of Andhra Pradesh. We hypothesize that socioeconomic status, not urban/rural residence, is an independent and strong predictor of women’s BMI.

SUBJECTS AND METHODS

Data. We analyzed data from the second Indian National Family Health Survey 1998/1999 (NFHS 2) for the state of Andhra Pradesh (4). NFHS 2 is a demographic and health survey collected as part of the Demographic and Health Survey (DHS) program, which is funded primarily by the United States Agency for International Development. Additional funding for the nutritional components of the survey in India was provided by the United Nations International Children’s Emergency Fund (UNICEF). The national survey covered a representative stratified random sample collected between November 1998 and December 1999 of  95,000 women aged 15–49 y from the 26 states of India. The main strata used in the sampling process were rural and urban areas. The primary sampling units (villages in rural areas and census enumeration blocks in urban areas) were selected with probability proportional to size from the rural and urban areas. Households were selected from within the selected primary sampling units. Andhra Pradesh, a state in southern India that was the first state to publicly release NFHS 2 data, provided the sample for the present analysis. It includes survey and nutrition status data on 4032 ever married women aged 15–49 y from 3872 households.

Measures. In the first National Family Health Survey 1992/1993 (NFHS 1), height and weight measurements were taken among children  5 y old in sample households, but not of women respondents. NFHS 2 included weights and heights of women of reproductive age and children  3 y old, as well as hemoglobin measures.

Women were weighed using a solar scale with accuracy  0 g. Height was measured using an adjustable wooden measuring board designed to give accuracy of measurement of within 0.1 cm in a field situation. A BMI was calculated for all nonpregnant women who had not given birth within 2 mo of the survey, to avoid producing BMI values that were inflated by the woman's current pregnancy status.

Data analysis. Logistic regression was used to identify socioeconomic, regional, health, diet and demographic determinants of overweight and underweight. Primary outcome variables in the analyses were created from BMI measurements collected in the survey. We categorized the BMI variable into six groups that classify women’s nutritional status, using the WHO (26) recommendations for preliminary analysis. The six groups identify women who are obese, BMI  30 kg/m²; overweight, BMI 25.0–29.9 kg/m²; normal weight, BMI 18.5–24.9 kg/m²; mildly thin, BMI 17.00–18.49 kg/m²; moderately thin, BMI 16.00–16.99 kg/m²; or severely thin BMI < 16.00 kg/m² (26). For the 15- to 17-y-old adolescent females in the sample, we used Cole’s definitions of adolescent obesity, overweight and normal weight (27). The same definition for thinness was used for all women in the sample regardless of age because no age-specific definitions of thinness for adolescents have been suggested (27).

Dichotomous variables were created in 1995 [based on the WHO (27) groups] to create the outcome variables used in the logistic regression models. Two logistic regression models were utilized to compare the factors associated with being overweight (BMI  18.5 kg/m²) vs. normal (BMI 18.5–24.9 kg/m²) and overweight or obese (BMI > 24.9 kg/m²) vs. normal in the second model.

Variables tested for significance in their association with BMI in each of the logistic regression models are presented in Table 1. The variables fall into five main categories, i.e., demographic, socioeconomic, health, diet and cultural factors. Model 1 included only the urban location variable. Model 2 introduced the demographic variables in addition to the location variable. Four additional models were tested, adding to the variables already included in the earlier models. Model 3 introduced the cultural variables, model 4 the health variables, model 5 the diet variables, and finally in model 6, we included the socioeconomic variables. Models 1–6 were repeated twice, once for the model of overweight vs. normal, and a second time for the model of underweight vs. normal. Building the models in this way allowed the significance of the association between location and BMI to be tested, controlling for a range of other factors. In addition, this allowed the detection of factors that reduced the significance of the location variable in each model, hence allowing the identification of variables associated with the urban living environment and women’s weight status.

The data from NFHS 2 are being made available state by state by ORC Macro during 2000–2002.

All women were given the results of the hemoglobin (Hb) test and had them explained to them. In addition, women with severe anemia (Hb < 70 g/L) were read a statement asking whether they would give permission for the health investigator to inform a local health official about the problem.

We did not use the WHO (26) overweight grade three definition of BMI  40 because this applied only to obese women in the Andhra Pradesh sample.

Because BMI values change substantially with age in children and adolescents, Cole et al. (27) developed a range of age- and sex-specific cut-off points for overweight and obesity in children and adolescents by linking adolescent and child BMI cut-off points to those already in existence for adults. These reference points use data from six large nationally representative cross-sectional surveys. For the 15- to 17-y-old females in the NFHS 2 sample we used the cut-off points recommended by Cole et al. (27) for adolescent obesity and overweight. For obesity this applies only to those women in the Andhra Pradesh sample.

For overweight, the recommended cut-off points are 24.17 for 15- to 17-y-old females. For obesity, the recommended cut-off points are 24.17 for 15- to 17-y-old, 24.54 for 16- and 24.85 for 17- to 19-y-old females. Normal weight categories used for adolescent females were 18.5–24.17 for 15- to 17-y-old, 18.5–24.54 for 16- and 18.5–24.85 for 17- to 19-y-old females.

* The International Institute for Population Sciences based in Mumbai, India coordinated the data collection with technical assistance from MEASURE DHS at ORC Macro, Calverton, MD and the East-West Center, Honolulu, HI. Researchers can apply for permission to analyze the data through MEASURE DHS; data collected in all of the DHS surveys are available for analysis through their website: www.measuredhs.com. The survey was approved by the institutional review board at ORC Macro, and the entire questionnaire and all of the procedures were approved by a multiagency technical advisory committee in India, which considered human subject protections and ethical issues. Informed consent was obtained from participants; to take part in the survey; a separate, more detailed consent was obtained for hemoglobin and lead measures (see [4], Chapter 10 and appendix B). The main objectives of the survey were to provide estimates of fertility, family planning practices, infant and child mortality, maternal and child health and nutrition, the utilization of maternal and child health services, the quality of these services, the status of women, women’s reproductive health problems and domestic violence.
TABLE 1

Variables tested for significant association with overweight/obesity or underweight in logistic regression models 1–6

<table>
<thead>
<tr>
<th>Model 1: Location of residence</th>
<th>Model 2: Demographic variables</th>
<th>Model 3: Cultural variables</th>
<th>Model 4: Health variables</th>
<th>Model 5: Diet variables</th>
<th>Model 6: Socioeconomic variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1: Location of residence</td>
<td>Model 2: Demographic variables</td>
<td>Model 3: Cultural variables</td>
<td>Model 4: Health variables</td>
<td>Model 5: Diet variables</td>
<td>Model 6: Socioeconomic variables</td>
</tr>
<tr>
<td>Location of residence (urban)</td>
<td>Age (5-y age groups)</td>
<td>Number of living children ≤5 y</td>
<td>Total children ever born</td>
<td>Model 3: Cultural variables</td>
<td>Model 4: Health variables</td>
</tr>
<tr>
<td>Location of residence (rural)</td>
<td>Number of living children ≤5 y</td>
<td>Total children ever born</td>
<td>Model 3: Cultural variables</td>
<td>Model 4: Health variables</td>
<td>Model 5: Diet variables</td>
</tr>
<tr>
<td>Model 1: Location of residence</td>
<td>Model 2: Demographic variables</td>
<td>Model 3: Cultural variables</td>
<td>Model 4: Health variables</td>
<td>Model 5: Diet variables</td>
<td>Model 6: Socioeconomic variables</td>
</tr>
<tr>
<td>Location of residence (urban)</td>
<td>Age (5-y age groups)</td>
<td>Number of living children ≤5 y</td>
<td>Total children ever born</td>
<td>Model 3: Cultural variables</td>
<td>Model 4: Health variables</td>
</tr>
<tr>
<td>Location of residence (rural)</td>
<td>Number of living children ≤5 y</td>
<td>Total children ever born</td>
<td>Model 3: Cultural variables</td>
<td>Model 4: Health variables</td>
<td>Model 5: Diet variables</td>
</tr>
<tr>
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<td>Model 2: Demographic variables</td>
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<td>Model 4: Health variables</td>
<td>Model 5: Diet variables</td>
<td>Model 6: Socioeconomic variables</td>
</tr>
<tr>
<td>Location of residence (urban)</td>
<td>Age (5-y age groups)</td>
<td>Number of living children ≤5 y</td>
<td>Total children ever born</td>
<td>Model 3: Cultural variables</td>
<td>Model 4: Health variables</td>
</tr>
<tr>
<td>Location of residence (rural)</td>
<td>Number of living children ≤5 y</td>
<td>Total children ever born</td>
<td>Model 3: Cultural variables</td>
<td>Model 4: Health variables</td>
<td>Model 5: Diet variables</td>
</tr>
</tbody>
</table>

Model estimation. We used SPSS (Chicago, IL) version 10 for the preliminary statistical analyses. All women with height and weight data in the survey were included in the preliminary analysis (98% of the original sample). Descriptive statistics were produced for Andhra Pradesh using the individual sampling weights. In Andhra Pradesh, the sampling weight corrects for differential nonresponse between the geographical regions in which the survey was administered. Using the sample weight in the analysis allows correction of disproportionate representation of women from certain regions because of nonresponse. Failure to account for weights in the analysis can produce misleading point estimates (28). Pearson's $\chi^2$ was used to determine significant differences observed within the various categories of the WHO (26) BMI grouping variable in relation to the three indicators of socioeconomic status, i.e., standard of living index, location of residence and maternal education. Differences were considered significant at $P < 0.05$.

RESULTS

The percentage of women observed in each of the WHO (26) BMI groups by three different indicators of socioeconomic status is presented in Table 2. Frequencies were adjusted using the sample weights to account for variations in the response rate in the different geographical regions of Andhra Pradesh in NFHS 2. The three socioeconomic indicators were as follows: the standard of living index of the household, the location of residence and whether the woman received at least a primary school education. In the weight category, 36.5% of women were classified as thin and 12.2% had a BMI $\geq 25$ kg/m$^2$; of these, 2.2% were obese (BMI $> 30$ kg/m$^2$). Although the percentage of overweight women was much smaller than those classified as underweight, there were specific subgroups of the population in which a much higher proportion of women fell within the overweight category.

Urban women were much more likely to be classified as overweight or obese compared with rural women, and women living in large cities had the greatest probability of being overweight. Of women living in large cities, 37% had a BMI $\geq 25$ kg/m$^2$ compared with 8% in the rural population. Similarly, the proportion of the rural population with a BMI $< 18.5$ kg/m$^2$ was 42%, compared with only 12% in the large cities. As expected, the group with a high standard of living had a higher proportion of the population (33%) with a BMI $\geq 25$ kg/m$^2$ compared with the group with a low standard of

10 In Table 3 we do not present the results of model 4 because no health variables were found to be significant in predicting overweight and obesity vs. normal weight. In Table 4, we do not present results of models 3 and 4 because no health or cultural variables were found to be significantly associated with being underweight vs. normal weight.

The standard of living index is a composite index calculated by the International Institute of Population Sciences and ORC Macro and is based upon household ownership of possessions/consumer durables and land/livestock (4).

12 A large city is a capital city or city with a population $> 1$ million; small cities have a population $> 50,000$ but $< 1$ million, and towns are areas classified as urban by the Indian government.
TABLE 2

Weighted percentages of women in body mass index (BMI) groups, by standard of living, location of residence and maternal education based on data from Andhra Pradesh National Family Health Survey 1998/99

<table>
<thead>
<tr>
<th>BMI, kg/m²</th>
<th>Total</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;16.00</td>
<td>7.2</td>
<td>10.2</td>
<td>6.7</td>
<td>2.1</td>
</tr>
<tr>
<td>16.00-16.99</td>
<td>9.8</td>
<td>13.1</td>
<td>9.3</td>
<td>4.2</td>
</tr>
<tr>
<td>17.00-18.49</td>
<td>19.5</td>
<td>25.9</td>
<td>18.6</td>
<td>8.0</td>
</tr>
<tr>
<td>18.50-24.99</td>
<td>51.3</td>
<td>46.4</td>
<td>54.4</td>
<td>53.2</td>
</tr>
<tr>
<td>25.00-29.99</td>
<td>10.0</td>
<td>3.5</td>
<td>9.4</td>
<td>25.7</td>
</tr>
<tr>
<td>&gt;30 plus</td>
<td>2.2</td>
<td>0.8</td>
<td>1.6</td>
<td>6.9</td>
</tr>
<tr>
<td>Total (n)</td>
<td>3948</td>
<td>1441</td>
<td>1823</td>
<td>666</td>
</tr>
<tr>
<td>Chi-square</td>
<td>472.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(P-value)</td>
<td>(&lt;0.001)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location of residence</th>
<th>Large city</th>
<th>Small city</th>
<th>Town</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>No school</td>
<td>156</td>
<td>444</td>
<td>435</td>
<td>2913</td>
</tr>
<tr>
<td>Completed primary</td>
<td>2304</td>
<td>1644</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maternal education</th>
<th>No school</th>
<th>Completed primary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2304</td>
<td>1644</td>
</tr>
<tr>
<td>Chi-square</td>
<td>472.60</td>
<td>(P-value) (&lt;0.001)</td>
</tr>
</tbody>
</table>

1 Descriptive statistics were produced for Andhra Pradesh using the sampling weights. [For details of how the sample weight was calculated see (4)]. Using the sample weight allows correction of disproportionate representation of women from certain regions because of nonresponse.

In the models for underweight, the location variable retained significance when adjusting for all other explanatory variables. The introduction of the demographic, health and socioeconomic variables in model 6 removed the significance of the location variable.

The results of the logistic regression model comparing underweight women (BMI < 18.5 kg/m²) with those of normal weight are presented in Table 3. Results are presented as odds ratios with 95% confidence intervals. Older women displayed a higher probability of being overweight or obese compared with younger women, with the probability increasing for each 5-y age group.

Religion was a significant cultural factor because Muslim women were more likely to be overweight or obese than women from other religious groups (primarily Hindu). For the nutrition variables, women who daily consumed non-green leafy vegetables were more likely to be overweight or obese than those who ate them weekly, occasionally or rarely. In addition, women who reported eating fruits daily or weekly were more likely to be overweight or obese than those who ate them occasionally or rarely. Finally, mothers who reported breast-feeding at the time of the survey had a lower probability of being overweight or obese than those who did not.

In addition, there were a number of socioeconomic and environmental variables associated with overweight or obesity. Respondents living in households with higher socioeconomic status were more likely to be either overweight or obese than those living in poorer households. The respondent's occupation, the highest level of education of any household member and the standard of living index were all significantly associated with being overweight and obese. Women who lived in households with a high standard of living index had a significantly higher probability of being overweight or obese. Women who did not work were significantly more likely to be overweight or obese than their counterparts who were working outside of the home. However, women working in professional, technical, managerial, office, clerical or sales positions were not significantly different in their probability of becoming overweight or obese compared with housewives. Women living in households in which at least one member had > 12 yrs of education were more likely to be overweight or obese. This was a more significant predictor of overweight and obesity than the woman's own level of education.

Despite the strong association between urban residence and overweight and obesity in model 1, the location variable was no longer significant in model 6, after controlling for the other factors entered into the analysis. The introduction of the religion variable in model 3 removed the significant difference between large cities and other urban areas in the proportion of women who were overweight or obese, as was shown in models 1 and 2. A significant difference between large cities and rural areas was retained until model 5, when the introduction of the socioeconomic variables in model 6 removed the significance of the location variable.

The results of the logistic regression model comparing underweight women (BMI < 18.5 kg/m²) with those of normal BMI are presented in Table 4. The findings were similar to those shown for the models of obesity and overweight. Younger age was the most important demographic predictor of underweight. Consistent with the findings in the models for obesity and overweight, the dietary variables significantly associated with being underweight were the reported frequency of consumption of fruits, and non-green leafy vegetables.

Socioeconomic and living environment variables associated with being underweight were also consistent with factors that predicted overweight and obesity status. Respondents living in poorer households were much more likely to be underweight than those living in households with higher socioeconomic status. The socioeconomic factors found to be significantly associated with underweight were partner's education level, respondent's occupation and the standard of living index. Respondent's education was again not a significant variable in models of underweight.

In the models for underweight, the location variable retained significance when adjusting for all other explanatory variables. The introduction of the demographic, health and nutrition variables in models 2, 4 and 5 did not greatly alter
## TABLE 3
**Odds ratios (OR) and 95% confidence intervals (CI) for the significant predictors of women being overweight or obese**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 5</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>15–19</td>
<td>0.02**</td>
<td>0.02**</td>
<td>0.02**</td>
<td>0.02**</td>
<td></td>
</tr>
<tr>
<td>20–24</td>
<td>0.25**</td>
<td>0.25**</td>
<td>0.29**</td>
<td>0.27**</td>
<td></td>
</tr>
<tr>
<td>25–29</td>
<td>0.50**</td>
<td>0.50**</td>
<td>0.51**</td>
<td>0.48**</td>
<td></td>
</tr>
<tr>
<td>30–34</td>
<td>0.70*</td>
<td>0.70*</td>
<td>0.72*</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>35–49</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 The model excludes 13 out of 2509 cases because of missing data for the standard of living index variable. Asterisks denote that the probability of being overweight in the relevant category is significantly different from that in the reference category at the following levels: * 0.01 < P < 0.05, ** P ≤ 0.01.

2 Ref is used to indicate the reference category.
the significance of the location variable. However, when the socioeconomic variables were introduced in model 6, a significant difference between large cities and smaller urban areas was no longer observed, although a significant difference between large cities and rural areas was maintained. Women living in the rural areas were significantly more likely to be underweight than those living in large cities.

### DISCUSSION

Rapid social and economic change in India has led to improvements in a number of health indicators in the last decade (27). These include reductions in infant and child mortality and fertility, and increases in adult longevity (27). Changes in nutritional status in India, however, suggest only...
modest improvements in levels of undernutrition (8). The analyses presented in this study provide baseline evidence for the emerging nutrition transition and the large resource inequities that differentiate women’s health in India. Although undernutrition is experienced by nearly 40% of all rural women, the majority of whom are poor, middle- and upper-class women, particularly those living in urban areas, have an increased risk of overnutrition and may face serious associated health problems.

Factors associated with under- and overweight are similar. Women who report a higher standard of living, who live in households where at least one member is educated beyond high school, who work in nonmanual occupations, or who watch television more than once a week are more likely to be overweight or obese. These factors are all inversely related with low BMI. In common with other studies in developing countries that are in the early stage of nutrition transition, Indian women in the highest socioeconomic groups are more likely to be overweight or obese, whereas nearly half of poor women are underweight (1,3,16,29).

Although there were clear differences in weight status between women living in rural and urban areas in the bivariate analyses, these differences were either removed or reduced when controlling for demographic, cultural, health behavior, diet and socioeconomic variables. In particular, socioeconomic status, not rural/urban residence, was the most important predictor of women’s nutrition status in India. Although larger proportions of urban women are overweight or obese, we also observed that nearly 8% of rural women fell into these categories. Given that 74% of the Andhra Pradesh population is rural, the number of overweight rural women was larger than among the urban sample, suggesting that the factors associated with overweight and obesity are not restricted to the urban environment. Our findings are consistent with Popkin’s perspective that urban residence per se is not the cause of overweight; rather, differences in lifestyle factors that predict overweight and obesity are associated with living in an urban environment (15). The data are also consistent with the urbanization literature in India, which notes enhanced lifestyle, occupational and health opportunities available to urban residents, factors that pull migrants from rural to urban areas (30).

Our data confirm recent reports of a range of overweight and obesity between 33 and 51% in the large cities of India and a rapid increase in its prevalence over the last decade. Studies completed in the early 1990s reported prevalence rates between 3.5 and 4.1%, compared with 11% in NHFS II (20). At the same time, the prevalence of undernutrition has changed only marginally (6,8). Urbanization has increased steadily since 1950 in India; the most rapid period of growth was from 1971 when the proportion of the population living in urban areas rose from 19 to 26% in 1991 (31). Recent projections for central south Asia suggest that urbanization will continue to grow, with 49% of the population living in urban areas by 2030 (32). Given that many of the lifestyle factors associated with overweight and obesity are found in urban areas, and because in-migration to urban areas is growing (33), an increasingly large proportion of the Indian population will be at risk of overweight, obesity and associated chronic diseases in the coming decades. Such factors include diets higher in fat, increased consumption of animal products, superior grains, sugar, and larger quantities of processed foods and meals eaten outside of the home. Urban environments are also associated with less physically demanding occupations, reductions in physical activity from increased leisure time, occupa-

tional shifts and a lack of exercise opportunities and facilities (1,15,34–36).

Sedentary lifestyles have been associated with the urban living environment in India (17), and also with increased probability of being overweight and obese (33). Although the NFHS 2 did not include physical activity data, it did collect information on women’s occupational status and television viewing, which are possible proxy variables for physical activity. Women who watched television once a week were more likely to be overweight or obese as were women who reported not working outside of the home. In households with lower socioeconomic status, many poor women have little choice in whether they work or stay at home and many must work in manual occupations with high energy demands (37). These households are less likely to have access to the resources to purchase high energy or nutrient dense diets to meet their energy requirements.

Age was a significant predictor of BMI, with older women more likely to be overweight or obese and younger women having a higher probability of being underweight or severely thin, consistent with the findings of other studies in developed and developing countries (29,38–40). Religion was also significantly associated with being obese and overweight. In this sample, Muslim women were more likely to be overweight or obese than Hindu women. This is likely related to differences in diet, activity and socioeconomic status. We are limited in our ability to explore these associations, although there may be differences in socioeconomic status between the two groups that we were unable to control for in the models. The NFHS data show that Muslims were significantly more likely to be found in the higher socioeconomic groups (30% of Muslims in the high standard of living group compared with 16% in the other religious groups) and to live in urban areas of Andhra Pradesh (64% of Muslims live in urban areas vs. 23% in the other religious groups). Although we do not have good measures to explore this question, we hypothesize that Muslim women may be more sedentary, based on lower rates of participation in the workforce (80% of Muslims reported not working compared with 40% in the other religious groups), a greater likelihood of watching television at least once a week (78% of Muslims compared with 58% in the other religious groups) and because of religious restrictions that may limit their freedom of movement outside of the household (41,42). Therefore, it is possible that Muslim women have lifestyles that increase their susceptibility to becoming overweight or obese.

A limitation of our analysis is that many lifestyle factors cannot be fully explored using the NFHS 2 data. It is likely that the relationship between socioeconomic status and BMI would be greatly reduced when controlling for diet and lifestyle factors in the models. The survey did not collect information to estimate either energy intake or expenditure. With the limited dietary information available in the data set, we observed that women who more frequently ate fruits and other vegetables other than green leafy vegetables were more likely to be overweight. The NFHS 2 data showed that women who ate fruits and vegetables more frequently also lived in households with a higher standard of living index. These households were more likely to have the resources available to buy expensive fruits and vegetables, processed foods and to consume diets high in fat and sugar. It is therefore likely that frequent consumption of fruits and vegetables is a proxy measure for other aspects of socioeconomic status not captured in the standard of living index used.

What are the implications of the emerging nutrition transition and the rapid change in overweight and obesity among
INDIAN WOMEN AND THE NUTRITION TRANSITION

the higher socioeconomic groups in India? First, their risk of noncommunicable diseases, such as heart disease, hypertension and adult onset diabetes is increased (43). Second, it is hypothesized that in populations with high rates of stunting and low birthweight, there may be an increased risk of obesity-related chronic diseases in adulthood (44–49). If this hypothesis is correct, India will face a large public health challenge as children who were stunted become overweight. At the same time, a large proportion of the population will face a significant risk of morbidity and mortality related to undernutrition (8). Others have noted the difficulty of focusing resources on the dual problems of under- and overnutrition (46). For India, the emerging nutrition transition has enormous resource implications for future health and nutrition programs and policies.

Although the factors associated with underweight, obesity and overweight are very similar, the challenges and solutions required to tackle the extremes of over- and underweight in the upper and lower socioeconomic groups are not. Monteiro and colleagues suggest that as the nutrition transition progresses, educated people within high socioeconomic groups are the first to respond to nutrition education messages and reduce their risk of obesity (1,50). Hence, providing health education messages and interventions for overweight women in the higher socioeconomic groups on healthy diets and healthy lifestyles might be effective in reducing the incidence of overweight and obesity in this group. However, for the lower socioeconomic groups, the challenges are far greater. Measham and Chatterjee (8) suggest that one of the key causes of malnutrition among the poor in India is a lack of access to sufficient food and resource inequities. There is a need for continued commitment from the Indian government to ensure food security for the poor and for long-term rural development strategies. At the same time, information and programs for rural women are needed to help them understand the components of a healthy diet and to ensure adequate access to health services (8).

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LITERATURE CITED