

Overweight exceeds underweight among women in most developing countries¹⁻³

Michelle A Mendez, Carlos A Monteiro, and Barry M Popkin

ABSTRACT

Background: It is generally believed that overweight is less prevalent than undernutrition in the developing world, particularly in rural areas, and that it is concentrated in higher socioeconomic status (SES) groups.

Objective: The purpose of this study was to examine patterns of adult female overweight and underweight in the developing world by using categories of urban or rural status and SES strata.

Design: Body mass index (BMI; in kg/m²) data collected in 36 countries from 1992 to 2000 by nationally representative cross-sectional surveys of women aged 20–49 y (*n* = 148 579) were classified as indicating underweight (BMI < 18.5) and overweight (BMI ≥ 25). Associations between the nutritional status of urban and rural women and each country's per capita gross national income (GNI) and level of urbanization were explored in the overall sample and among different SES groups.

Results: Overweight exceeded underweight in well over half of the countries: the median ratio of overweight to underweight was 5.8 in urban and 2.1 in rural areas. Countries with high GNIs and high levels of urbanization had not only high absolute prevalences of overweight but also small urban-rural differences in overweight and very high ratios of overweight to underweight. In the more-developed countries, overweight among low-SES women was high in both rural (38%) and urban (51%) settings. Even many poor countries, countries in which underweight persists as a significant problem, had fairly high prevalences of rural overweight.

Conclusions: In most developing economies, prevalences of overweight in young women residing in both urban and rural areas are higher than those in underweight women, especially in countries at higher levels of socioeconomic development. Research is needed to assess male and child overweight to understand the dynamics facing these groups as well. *Am J Clin Nutr* 2005;81:714–21.

KEY WORDS Overweight, malnutrition, income, urbanization, socioeconomic status, women, developing countries

INTRODUCTION

As the pandemic of overweight around the globe continues to rise, many developing countries face a double burden of overnutrition and undernutrition (1). The scope and distribution of both types of malnutrition must be understood so that public health resources can be channeled appropriately. Studies have highlighted the fact that, despite increases in overweight, undernutrition among young children remains more prevalent than overnutrition in many developing countries; this is particularly

true in the poorest countries (2). Much less is known about this double burden in adults. The current study used nationally representative data collected between 1992 and 2000 in 36 developing countries to update our knowledge about the prevalence and distribution of underweight and overweight among women.

Our primary objective was to compare patterns of overweight and underweight in adult women in both urban and rural areas. Many documents focus on urbanization as an underlying cause of rising overweight in the developing world, and they emphasize that overweight is more prevalent in urban than in rural areas (1, 3). At present, there are far fewer data on the extent to which rural communities face the burden of overweight or the double burden of underweight and overweight.

This study also evaluated the ways in which urban and rural malnutrition patterns are related to 2 indicators of socioeconomic development, urbanization and gross national income (GNI). Rising national incomes and increasing urbanization are believed to be central elements fueling the pandemic of overweight (1, 3–6), but there are few published reports on worldwide patterns of obesity (3, 5). Finally, this study examines the ways that malnutrition patterns in women in different socioeconomic status (SES) groups vary across countries at different levels of development; in this study, the level of education was used as the measure of SES. We compared the ways in which malnutrition patterns within low- and high-SES groups change with increasing development, and we assessed the ways in which higher levels of development affect the relation between SES and malnutrition in both urban and rural environments.

MATERIALS AND METHODS

Nutritional status data

Information on the prevalence of underweight and overweight comes from representative surveys conducted between 1992 and 2000 in 36 developing countries: 19 in sub-Saharan Africa, 8 in

¹ From the Carolina Population Center, University of North Carolina, Chapel Hill, NC (MAM and BMP), and the Center for Epidemiological Studies in Health and Nutrition, São Paulo University, São Paulo, Brazil (CAM).

² Supported by National Institutes of Health grants no. R01-HD30880 and no. R01-HD38700 and by the Fogarty International Center of NIH.

³ Reprints not available. Address correspondence to BM Popkin, Carolina Population Center, University of North Carolina at Chapel Hill, 123 West Franklin Street, Chapel Hill, NC 27516-3997. E-mail: popkin@unc.edu.

Received March 29, 2004.

Accepted for publication November 3, 2004.

Latin America and the Caribbean (including Brazil and Mexico), 2 in East and South Asia (China and India), 3 in Central Asia (all former Soviet republics), and 4 in North Africa and the Middle East (including Egypt and Turkey). The data for China and Mexico are from national health and nutrition surveys conducted by these countries in 1997 and 1999, respectively (7, 8). All other data come from standardized US Agency for International Development Demographic Health Surveys (referred to as DHS surveys; 9). Multistage cluster sampling was used in all surveys, which are nationally representative, except that for China, the data for which are representative of 8 geographically and economically diverse provinces out of the 31 provinces in China (7–9; also *see* www.measure.dhs). The data from China and Mexico were available for all women in survey households; DHS surveys collected anthropometric data among women with children aged <5 y.

We used only the most recent data for countries in which ≥ 2 DHS surveys were conducted in the period of 1992 to 2000; a number of DHS surveys were not used because of a lack of anthropometric data for adult females. DHS data sets were downloaded from <http://www.macint.com/dhs/> or obtained directly from the state statistical offices that conducted the surveys (eg, those of South Africa, Turkey, and Jordan). We restricted analyses in all data sets to nonpregnant women aged 20–49 y. The average sample size was 4266 [range: 1460 (Bolivia)–21 171 (Peru)] women, and a total of 157 844 women were studied. Mean response rates for DHS country surveys were 94.5% (range: 85.4–99.4%), and those for household surveys in China and Mexico were 78.2% and 82.3%, respectively. Among participants, the rate of nonresponse in the DHS surveys was <0.2% for weight and height measurements and <0.7% for questions on SES (ie, education). Data were available for 73.5% and 98% (anthropometric data) and for 86.5% and 100% (education data) of respondents in China and Mexico, respectively.

As measured by using body mass index (BMI; in kg/m^2), the overall prevalences of underweight (BMI < 18.5) and overweight (BMI ≥ 25) were calculated for women in each country. The ratio of overweight to underweight was also calculated for each country to illustrate the relative magnitude of these 2 manifestations of malnutrition. Prevalence data were estimated for both urban and rural areas, and the urban and rural classifications were defined by using official criteria for each country. Data were age-adjusted by using a direct method with the age distribution of the world population as a reference (10). We used survey-specific sample weights, so estimates are nationally representative with the exception of the China survey, which represents 8 provinces of the 31 in that country.

Development indicators

Per capita GNI in US dollars was obtained from the 2002 World Bank database on national economic indicators (11). Data on each country's level of urbanization, defined as the percentage of the midyear population residing in areas classified as urban according to official national criteria, came from the United Nations (12). Whereas no single definition of urban areas is universally applicable because of differences in settlement patterns (12), the use of different thresholds for classifying localities as urban did not appear to create bias. For example, Kenya was less urbanized than Ghana (28.5% and 34.5%, respectively), despite the use of a lower population threshold in Kenya than in Ghana to define an urban locale (ie, 2000 and 5000 people,

respectively); the 2 countries had similar per capita GNIs (\$350 and \$390, respectively). GNI and urbanization for the year corresponding to the baseline for each survey were used in the analysis. The correlation between GNI and urbanization was high ($r = 0.75$); however, numerous countries—eg, Nigeria, Senegal, and Cameroon—were highly urbanized without having high GNIs, and others—eg, Namibia, Guatemala, and China—ranked significantly higher for GNI than for urbanization.

Socioeconomic status

Because income data are not available from the DHS surveys, educational attainment was used as a measure of individual SES. Women were categorized into education quartiles; in some countries, intermediate quartiles had to be collapsed into smaller groups because there were clusters of women with similar levels of education.

Statistical analysis

Within-country analysis

Three measures of malnutrition patterns are described for women residing in urban and rural areas and for women with different levels of education: prevalence of overweight, prevalence of underweight, and overweight:underweight. The z distribution was used to assess the significance of differences in the proportions of overweight and underweight women in urban and rural areas, as well as in the proportion of overweight: underweight within urban and rural areas. Prevalence ratios were used to compare prevalences of malnutrition between women in the highest and lowest quartiles of education.

Between-country analysis

To allow for potential nonlinearities, natural cubic splines and smoothers were used to examine bivariate relations between development indicators and malnutrition prevalences in the 36 countries. Multivariate analysis used linear splines (with cutoffs based on bivariate analysis) to estimate associations between development and malnutrition patterns, after adjustment for urbanization, GNI, and survey year. Supplementary models using linear regression with centered variables and higher-order terms (eg, GNI-squared) to allow for nonlinear relations yielded similar results (not shown). Coefficients represent the adjusted mean increase in each outcome (eg, percentage overweight) for a \$100 increase in GNI or a 1% increase in urbanization. Predicted values with standard errors from the multivariate models were graphed to illustrate how malnutrition patterns were associated with different levels of development. Log outcomes were used for overweight:underweight, which was highly skewed. For non-ratio outcomes, results did not differ significantly when log-transformed and nonlog-transformed variables were used. Model diagnostics included ensuring that results did not change after the exclusion of potential multivariate outliers identified on the basis of the highest and lowest 5% $\Delta\beta$ values and examining variance inflation factors to ensure the absence of collinearity. Findings were also similar after the exclusion of non-DHS data or of countries with the highest GNIs and levels of urbanization. Analyses were conducted with the use of STATA software (version 7.0; Stata Corporation, College Station, TX).

TABLE 1Prevalence of overweight and underweight and the ratio of overweight to underweight among women aged 20–49 y from 36 developing countries¹

Country	Year	GNI	Percentage of urbanization	Sample size	% Overweight		% Underweight		Overweight: underweight	
					Urban	Rural	Urban	Rural	Urban	Rural
			%			%	%			
Africa										
Benin	1996	350	38.4	2603	18.4	10.5 ²	9.7	15.5 ²	1.9 ³	0.68 ⁴
Burkina Faso	1992	290	15.0	3622	21.3	5.4 ²	8.7	15.5 ²	2.5 ³	0.35 ⁴
Central African Republic	1994	360	39.1	2369	12.3	5.6 ²	13.6	16.7 ⁵	0.9	0.34 ⁴
Cameroon	1998	610	44.7	1603	36.7	19.5	5.2	5.9	—	—
Cote d'Ivoire	1994	660	41.7	3013	30.7	8.4 ²	5.0	12.0 ²	6.1 ³	0.70 ⁴
Ghana	1998	390	34.8	2221	32.2	12.2 ²	5.5	12.6 ²	5.9 ³	0.97
Kenya	1998	350	28.5	3368	27.9	15.3 ²	7.0	12.1 ²	4.0 ³	1.26 ⁴
Madagascar	1997	250	26.4	2579	10.3	3.6 ²	14.1	21.5 ²	0.7 ⁶	0.17 ⁷
Malawi	1992	220	13.1	2754	27.0	10.5 ²	5.8	9.2 ²	4.7 ³	1.14 ⁴
Mali	1996	240	26.9	5030	21.6	6.1 ²	13.5	14.6	1.6 ³	0.42 ⁴
Namibia	1992	2110	28.6	2535	41.1	15.2 ²	6.2	16.5 ²	6.6 ³	0.92
Niger	1998	200	18.2	3464	31.6	4.5 ²	12.1	19.6 ²	2.6 ³	0.23 ⁴
Nigeria	1992	290	39.6	2234	23.9	23.4	13.6	13.3	1.8 ³	1.76 ⁴
Senegal	1998	520	43.8	3165	33.0	11.0 ²	8.5	14.4 ²	3.9 ³	0.76 ⁴
South Africa	1998	3310	52.6	4359	61.0	55.8 ²	4.3	5.7	14.2 ³	10.94 ⁴
Tanzania	1996	190	26.9	3955	28.5	11.4 ²	8.6	9.6	3.3 ³	1.19 ⁴
Uganda	1995	250	12.5	3385	23.3	9.4 ²	6.6	9.8 ²	3.5 ³	0.96
Zambia	1996	360	39.2	4082	25.9	11.5 ²	5.9	9.9 ²	4.4 ³	1.16 ⁷
Zimbabwe	1994	630	31.8	1948	36.8	23.7 ²	1.9	4.90 ²	19.4 ³	4.84 ⁴
North Africa and Middle East										
Egypt	1995	990	43.1	7417	69.9	46.6 ²	0.7	1.8 ²	99.9 ³	25.89 ⁴
Jordan	1997	1590	78.3	3574	69.4	63.0 ²	1.6	1.8	43.4 ³	35.00 ⁴
Morocco	1992	1100	52.0	3211	50.3	27.9 ²	2.6	4.5 ²	19.4 ³	6.20 ⁴
Turkey	1998	3160	63.7	1708	63.2	65.6	2.1	1.5	30.1 ³	43.73 ⁴
Central Asia										
Kazakhstan	1999	1290	56.4	1935	36.3	36.3	6.3	6.0	5.8 ³	6.05 ⁴
Kyrgyz Republic	1997	590	36.0	3056	34.7	34.5	4.9	4.4	7.1 ³	7.84 ⁴
Uzbekistan	1996	630	38.4	3438	32.4	26.1 ²	7.0	7.4	4.6 ³	3.53 ⁴
East and South Asia										
China	1997	710	31.4	2851	20.5	15.2 ²	7.4	6.1	2.8 ³	2.49 ⁴
India	1999	440	26.6	7608	26.4	5.6 ²	23.1	48.2 ²	1.1 ³	0.12 ⁴
Latin America and the Caribbean										
Bolivia	1998	1000	59.4	1460	57.9	47.1 ²	0.7	0.6	82.7 ³	78.50 ⁴
Brazil	1996	4320	78.1	3100	42.8	33.0 ²	5.2	9.3 ²	8.4 ³	3.55 ⁴
Colombia	2000	2020	72.0	3347	48.8	51.4	2.0	2.1	24.4 ³	24.48 ⁴
Dominican Republic	1996	1570	62.1	6208	50.2	40.2 ²	4.5	6.2 ²	11.2 ³	6.48 ⁴
Guatemala	1998	1650	38.6	2478	61.9	42.6 ²	1.5	1.6	41.3 ³	26.63 ⁴
Haiti	1994	270	32.6	2103	20.4	8.0 ²	16.5	20.8 ²	1.2 ⁶	0.38 ⁷
Mexico	1999	4440	73.4	14162	65.4	58.6 ²	1.5	2.2 ²	43.6 ³	26.64 ⁴
Peru	2000	2080	70.9	21171	60.2	43.3 ²	0.8	0.7	75.3 ³	61.86 ⁴
Median	1997	620	38.9		32.4	19.4	5.9	9.3	5.8	2.10

¹ Data from references 8 (China), 7 (Mexico), and 9 (all other countries).^{2,5} Significantly different from urban: ² $P < 0.01$, ⁵ $P < 0.05$.^{3,6} Significantly different between overweight:underweight in urban areas: ³ $P < 0.01$, ⁶ $P < 0.05$.^{4,7} Significantly different between overweight:underweight in rural areas: ⁴ $P < 0.01$, ⁷ $P < 0.05$.

RESULTS

Urban and rural prevalences of overweight and underweight

The prevalence of overweight among urban women ranged from 10.3–69.9% (median: 32.4%). Prevalence was $\geq 20\%$ in 33 (92%) of the countries studied and $\geq 50\%$ in 10 countries ($\approx 33\%$), as shown in **Table 1** and **Figure 1**. Whereas overweight was generally higher in urban areas than in rural areas, rural

overweight (median: 19.4%; range: 3.6–65.6%) was also substantial: half of the countries ($n = 18$) had prevalences $\geq 20\%$. Although, on average, overweight prevalence was about twice as high in the urban areas as in the rural areas ($\bar{x} \pm SD$ ratio: 2.1 ± 1.3), there was substantial variation in the ratio of urban to rural overweight. This ratio was < 1.5 in 15 of the 36 countries surveyed.

Most countries had substantially less underweight than overweight among young women. The main exception was India,

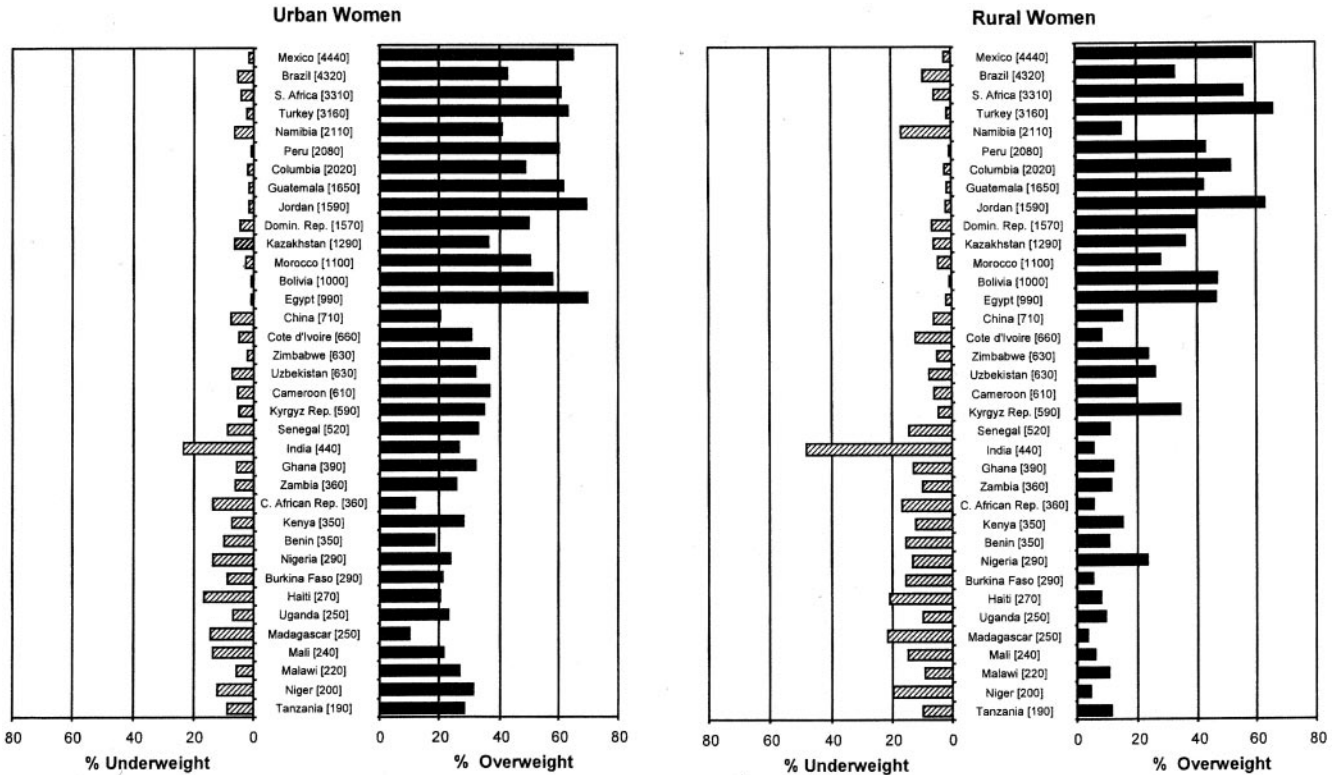


FIGURE 1. Prevalence of overweight [BMI (in kg/m²) ≥ 25] and underweight (BMI < 18.5) in women aged 20–49 y in 36 developing countries ranked by per capita gross national income (GNI; in brackets).

where very high prevalences of undernutrition persist (23.1% of urban and 48.2% of rural women). Underweight in the other countries in the sample ranged from 0.7–16.5% in urban and 0.6–21.5% in rural areas (medians: urban, 5.9%; rural, 9.3%). Underweight prevalence was on average ≈50% higher in rural areas than in urban areas (urban:rural, 1.48 ± 0.53).

Comparative prevalences of overweight and underweight

In most countries, the prevalence of overweight was significantly greater—and in many cases several times greater—than was that of underweight in both urban and rural areas (Table 1, Figure 1). The median overweight:underweight was 2.1 in rural and 5.8 in urban areas. Overweight:underweight in urban women was ≥ 2.0 in 80% of the sample; 50% of the countries had overweight:underweight of >2.0 among rural women.

GNI, urbanization, and nutritional status patterns

As shown in Figure 1, there was a high prevalence of overweight and a low prevalence of underweight in both urban and rural areas of the countries with relatively high GNIs. Closer examination of this relation found that a marked increase in overweight was associated with increasing GNI up to ≈\$3000, a threshold above which the prevalence leveled off or declined (Figure 2). GNI was significantly associated with overweight in both urban and rural women after multivariate adjustment [β /\$100 for GNI < \$3000: 1.57 ± 0.42 in urban women, 1.30 ± 0.42 in rural women ($P < 0.05$); for GNI > \$3000: -0.52 ± 0.41 in urban women, -0.31 ± 0.40 in rural women (NS)]. Slopes were similar in urban and rural areas ($P > 0.05$), and slopes above

and slopes below the threshold were significantly different ($P < 0.05$).

The prevalence of overweight also increased with rising urbanization: there was an increase in overweight observed above a threshold of ≈32% urbanization, which is slightly below the median of 39% (Figure 2). However, the magnitude of association was weaker than that for GNI. Whereas the multivariate-adjusted slopes for rural areas were strong and significant [urbanization ≥32%: $\beta = 0.50 \pm 0.02$; urbanization < 32%: $\beta = 0.25 \pm 0.36$ (NS); difference between slopes, $P > 0.05$], associations among urban women were weaker and not significant [urbanization ≥32%: $\beta = 0.29 \pm 0.20$ (NS); urbanization <32%: $\beta = -0.01 \pm 0.36$ (NS); difference between slopes, $P > 0.05$]. Nonetheless, slopes were not significantly higher in rural than in urban areas ($P > 0.05$).

Variations in urban and rural overweight prevalence by GNI and level of urbanization, considered jointly, are shown in Figure 3. As shown, in conjunction with the rising overall prevalence of overweight, the disparity between urban and rural overweight declined substantially as GNI and urbanization increased. Patterns of overweight prevalence were the inverse of those for underweight: prevalences of underweight were substantial in the least developed countries but were < 5% in countries with high GNI and levels of urbanization (Figure 3). Consequently, associations of GNI and urbanization with overweight:underweight were similar to those of GNI and urbanization with overweight (not shown). Overweight:underweight, which was close to equality in the least developed countries, increased dramatically in countries with high GNI and greater urbanization (Figure 3).

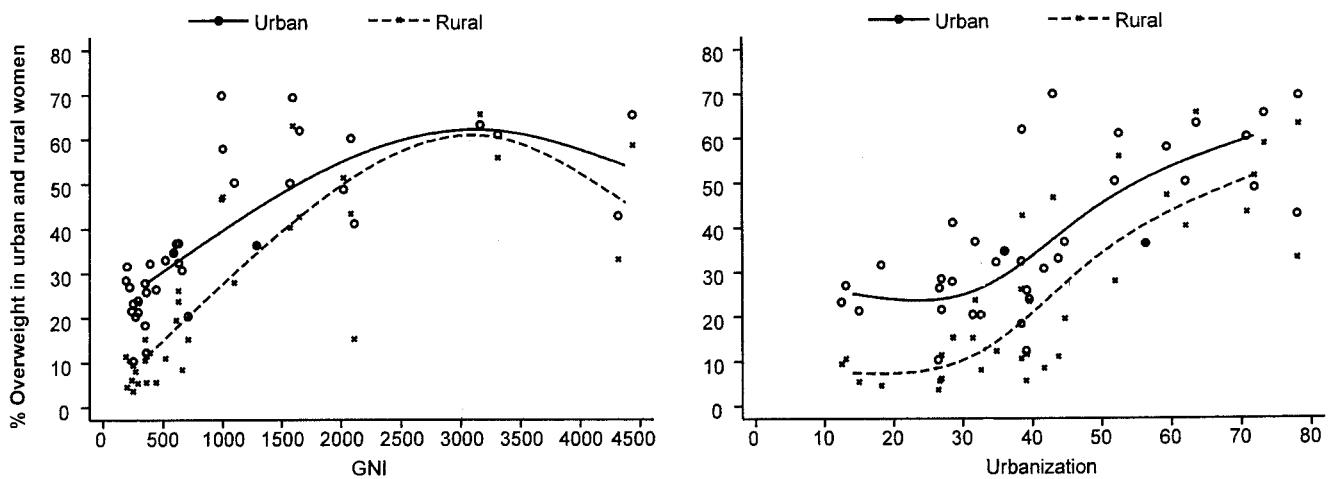


FIGURE 2. Smoothed plots of the prevalence of overweight [BMI (in kg/m^2) ≥ 25] in urban and rural women aged 20–49 y in 36 developing countries by gross national income (GNI) and level of urbanization. Slopes for associations between the 2 indicators and overweight did not differ significantly between urban and rural areas.

In the countries with the highest values for both indicators, the adjusted mean ratio was 23.0 in urban and 17.3 in rural areas.

Differences in nutritional status by GNI, urbanization, and SES

Additional analysis showed that GNI and levels of urbanization were strongly and positively associated with higher prevalences of overweight among women of low SES (**Figure 4**). In countries with low GNI and urbanization, predicted mean overweight prevalence (adjusted for GNI, urbanization, and survey year) among women in the lowest education quartile was 7.0% in rural and 17.0% in urban areas. In these countries, overweight was substantially higher in the most educated women (15.9% and 32.7% for rural and urban women, respectively). However, in highly urbanized countries with high GNIs, 37.8% of rural and 50.9% of urban women in the lowest education quartile were overweight, and these prevalences were comparable to those

among rural and urban women in the highest education quartile (41.4% and 47.6%, respectively; **Figure 4**).

In the more highly developed countries, as a result of the strikingly higher prevalences of overweight, the disparity in overweight between different SES strata was negligible. In the countries with the highest GNI and greatest urbanization, the ratio of overweight prevalence in the highest to that in the lowest SES quartile was nearly 1.0 for both urban and rural women (**Figure 5**). Among women living in countries with low GNI and levels of urbanization, however, the ratio was large: ≈ 2.0 in rural as well as in urban women. In addition, in most countries, overweight exceeded underweight even among women in the lowest education quartile: this was true among urban women in 31 countries, and among rural women in 18 countries. In women in the highest education quartile, urban overweight exceeded underweight in all 36 countries studied, and rural overweight exceeded underweight in 32 countries.

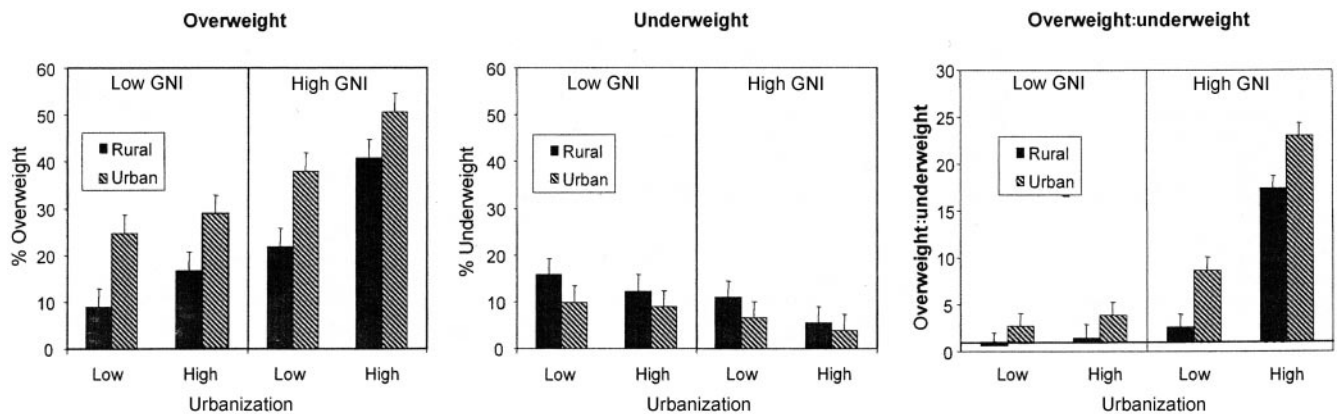


FIGURE 3. Predicted $\bar{x} \pm \text{SE}$ prevalences of overweight and underweight and ratios of overweight to underweight in women aged 20–40 y by gross national income (GNI) and level of urbanization. Low GNI, a median of $< \$630$ per capita; low urbanization, a median of $< 39\%$ of the population residing in urban areas. Results are predicted from multivariate models by using linear splines for GNI and level of urbanization after adjustment for survey year. The log of overweight:underweight was used as the outcome; results were transformed and are presented in the original metric form. The solid horizontal line in the lower part of the righthand panel represents a ratio of 1.0, ie, an equal prevalence of overweight and underweight. The associations with urbanization were significantly larger in the rural than in the urban areas ($P = 0.05$).

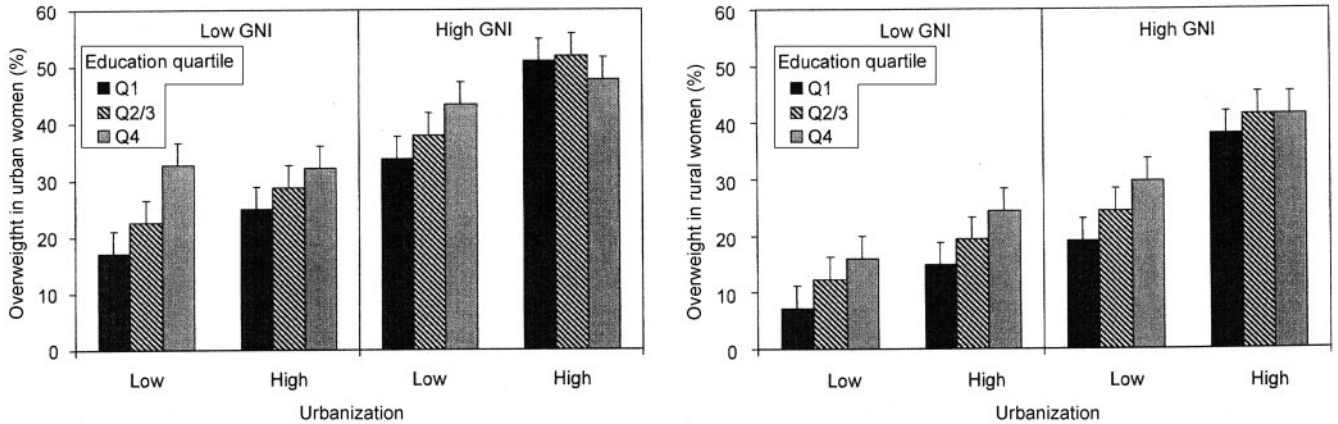


FIGURE 4. Predicted $\bar{x} \pm SE$ prevalence of overweight in women aged 20–49 y by education quartile (Q), gross national income (GNI), and level of urbanization. Low GNI, a median of <\$630 per capita; low urbanization, a median of <39% of the population residing in urban areas. Results are predicted from multivariate models by using linear splines for GNI and level of urbanization after adjustment for survey year.

DISCUSSION

The prevalence of overweight among young women in the developing world has reached an alarming state. Whereas overweight in urban areas has been widely acknowledged, these data indicate that the burden in rural areas is also substantial. Half of the countries surveyed had a $\geq 20\%$ prevalence of overweight in their rural areas. In some of the most highly developed countries, overweight exceeded 50% in urban and 40% in rural women, prevalences that are comparable to those in many industrialized countries (13–15). Notably, there was far more overweight than underweight among young women in most of the countries. This predominance of overweight was found in most of the urban areas (median overweight:underweight, 5.8) as well as in the rural areas of many countries (median ratio: 2.1). In many of the most developed countries, overweight:underweight was on the order of 20.0 (overweight: > 50%; underweight: $\approx 2\text{--}3\%$), which is well above the values for industrialized countries before the current epidemic of obesity (overweight: 27–47%; underweight: 3–4%) (15–18). Whereas underweight remains a concern, it predominated only among women living in rural areas of the least developed countries. There are few data on trends in the underweight and overweight status of women in developing

countries, and thus it is not known whether these patterns have existed for some time (3, 5).

Two indicators of the broad socioeconomic environment—GNI and urbanization—were positively associated with the prevalence of overweight and negatively associated with that of underweight in both urban and rural women. Furthermore, whereas there were substantial urban-rural differences in overweight prevalence in the poorest countries, these differences were smaller in the more developed countries. It is interesting that the overall level of urbanization was related to overweight as strongly in rural women as in urban women. We hypothesize that the proportion of the population residing in urban areas may serve as an indicator of rural development. In these countries, residents of areas officially designated as rural may have access to infrastructure and services that facilitate the more “urbanized” lifestyles that may increase risk of obesity, such as access to energy-dense foods and motorized transportation.

Moreover, as GNIs and levels of urbanization increased, there were especially dramatic increases in prevalences of overweight among women of low SES (ie, those in the lowest education quartile) living in both urban and rural areas (19). Consequently, the strong positive association between SES and overweight

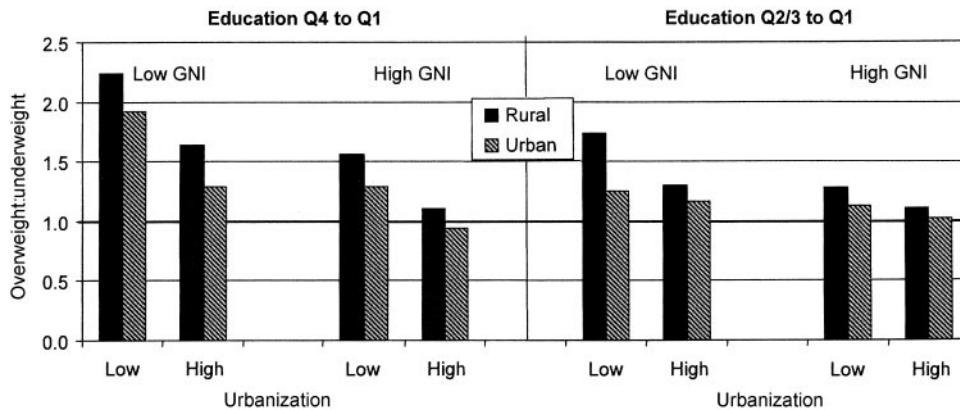


FIGURE 5. Predicted $\bar{x} \pm SE$ ratio of overweight to underweight in higher and lower education quartiles (Q) by gross national income (GNI) and level of urbanization in women aged 20–49 y. Low GNI, a median of <\$630 per capita; low urbanization, a median of <39% of the population residing in urban areas. The thick solid horizontal line represents a ratio of 1.0, ie, an equal prevalence of overweight and underweight.


observed in the least developed countries was sharply attenuated or reversed (*see* Figure 4) in the most developed countries, where the overall prevalence of overweight was high.

Our ability to explore relations between individual SES and overweight was constrained by the fact that education was the only available measure of SES. A study in Brazil (20), one of the most developed countries in our sample, found that income was positively related but education was negatively related to obesity in women from the northeastern part of the country; associations with education were even stronger, whereas income effects were absent in women from the more economically developed southeastern part of Brazil. These data suggest that multiple SES measures should be examined because distinct effects of education or income may become more apparent as countries develop and as potentially obesogenic material resources (eg, energy-dense foods, mechanized transport, and television) become more widely accessible and more easily available to the poor. Nonetheless, we speculate that education is a useful component of SES with which to explore shifts in the distribution of overweight across countries that span a broad spectrum of development.

We defined overweight and underweight by using BMI cutoffs recommended for worldwide use (21, 22). These cutoffs, established on the basis of the relation of BMI with mortality in Western Europe and North America, also provided measures of increased morbidity risk, although the relation of BMI to morbidity is fairly linear (18, 21). Numerous studies of well-nourished persons from urban and rural areas of developing countries in the past decade supported the use of cutoffs in the same range, and they reported mean BMIs of 20.5–25.5 (18). Although these cutoffs remain controversial, particularly for studies in some Asian populations in whom mean BMIs are relatively low and the percentage of body fat relatively high (22), they continue to be advocated in the absence of sufficient data on which to base alternative values that minimize bias and maximize the specificity, sensitivity, and comparability of measures across countries. It is not possible to properly ascertain the magnitude of potential bias derived from the use of these cutoffs. For example, the cutoff of 18.5 that is used to define underweight likely includes healthy persons, which implies some overestimation of undernutrition. However, there is also some likelihood of underestimation: even though BMIs of 11.0–13.0 are compatible with survival, there is increased risk of mortality at extremely low BMIs (18, 21).

Another limitation of this analysis is that the DHS surveys that are the source of most of the data include women with children aged < 5 y. Despite the association of parity with weight gain, studies with similar results conducted in the United States and the developing world show that such weight gain is generally small in women with low prepregnancy BMIs (23, 24). For example, among women whose prepregnancy BMI was 23.0, parous women had mean BMIs only 0.1–0.2 units higher (depending on the number of pregnancies) than did nulliparous women after a 5-y follow-up (23). As a result, the inclusion of parous women is unlikely to have a strong effect on estimates of overweight prevalence. Parity was, however, associated with substantial increases in follow-up BMIs among women who were overweight before parity (0.3–0.4 units for a prepregnancy BMI of 27.0; 0.6–0.8 units for a prepregnancy BMI of 32; 20). Thus these data may be more problematic if used for estimates of the prevalence of obesity rather than of overweight or for assessments of the severity of obesity; none of these estimates are included in this analysis.

The results of this study suggest that, in the absence of policies to shift current trends, continued economic development and urbanization in developing countries will likely be accompanied by increased prevalences of overweight in both rural and urban settings, as well as among low-SES groups. Indeed, in most countries where earlier DHS surveys were conducted, prevalences of overweight have increased substantially over time in both urban and rural areas. Similarly, data collected after 1996 (the median year of the surveys) were characterized not only by significantly higher GNIs and levels of urbanization but also by significantly higher urban and rural overweight and significantly greater overweight in low-SES groups ($P < 0.05$, *t* test). Furthermore, although data collected before and after 1996 showed similar associations between development indicators and overweight in urban areas, the more recent data showed significantly ($P < 0.05$) stronger associations between GNI and overweight in rural areas than in urban areas. It may well be that these data underestimate the extent to which overweight in rural areas may increase as national incomes rise.

Overall, these data suggest that, whereas extensive child underweight persists in many parts of the developing world, far fewer countries face such a burden of acute undernutrition in young women, even though the overweight burden is generally higher among that group (2, 25). Elsewhere, we have shown in a case study from Brazil that overweight in adults appears to be replacing undernutrition as a public health problem, rather than being added to undernutrition in adults (26). There is, of course, the possibility that child undernutrition is linked to adult overweight, as the fetal origins hypothesis suggests (28–30). If so, persistent child undernutrition may well contribute to the burden of overweight in women. To more fully understand how adult nutritional status in the developing world is changing as countries develop and are influenced by the process of globalization, additional data are needed on the changing nutritional status of men and on the tracking of nutritional status from childhood into adulthood. 

We thank several colleagues who shared data with us, including Juan Rivera (Mexico), Debbie Bradshaw (South Africa), and the data coordinator of DHS. We also thank Frances L Dancy for administrative assistance, Tom Swasey for graphics support, and Lu Bing for research assistance.

BMP and CAM prepared the database and the initial descriptive statistics, MAM was responsible for the statistical analysis and the final draft of the manuscript, and all 3 authors revised the manuscript and reviewed the final version. None of the authors had any personal or financial conflict of interests.

REFERENCES

1. WHO/FAO. Report of the Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases. Geneva: World Health Organization, 2002.
2. de Onis M, Blossner M. Prevalence and trends of overweight among preschool children in developing countries. *Am J Clin Nutr* 2000;72:1032–9.
3. Martorell R, Khan LK, Hughes ML, Grummer-Strawn LM. Obesity in women from developing countries. *Eur J Clin Nutr* 2000;54:247–52.
4. Caballero B, Rubinstein S. Environmental factors affecting nutritional status in urban areas of developing countries. *Arch Latinoam Nutr* 1997;47(2 suppl 1):3–8.
5. Popkin BM. The nutrition transition in the developing world. *Dev Policy Rev* 2003;21:581–97.
6. Mendez MA, Popkin BM. Globalization, urbanization and nutritional change in the developing world. *Electron J Agric Devel Econ* 2004;1:220–41.
7. Rivera JA, Bargaera S, Campirano F, Campos I, Safdie M, Tovar V.

- Epidemiological and nutritional transition in Mexico: rapid increase of noncommunicable chronic diseases and obesity. *Public Health Nutr* 2002;5:113–22.
8. Popkin BM, Ge K, Zhai F, Guo X, Ma H, Zohoori N. The nutrition transition in China: a cross-sectional analysis. *Eur J Clin Nutr* 1993;47:333–46.
 9. Boerma JT, Sommerfelt AE. Demographic and health surveys (DHS): contributions and limitations. *World Health Stat Q* 1993;46:222–6.
 10. Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M. Age standardization of rates: a new WHO standard. In: *Global Programme on Evidence for Health Policy Discussion Paper Series no. 31*. Geneva: World Health Organization, 1999.
 11. *World development indicators—CD ROM*. Washington, DC: World Bank, 2003.
 12. United Nations. *World Urbanization Prospects, 2001*. New York: United Nations, 2002.
 13. Hedley AA, Ogden CL, Johnson CL, Carroll MD, Curtin LR, Flegal KM. Prevalence of overweight and obesity among US children, adolescents, and adults, 1999–2002. *JAMA* 2004;291:2847–50.
 14. Martinez-Gonzalez MA, Martinez JA, Hu FB, Gibney MJ, Kearney J. Physical inactivity, sedentary lifestyle and obesity in the European Union. *Int J Obes Relat Metab Disord* 1999;23:1192–201.
 15. Visscher TL, Kromhout D, Seidell JC. Long-term and recent time trends in the prevalence of obesity among Dutch men and women. *Int J Obes Relat Metab Disord* 2002;26:1218–24.
 16. Maillard G, Charles MA, Thibault N, et al. Trends in the prevalence of obesity in the French adult population between 1980 and 1991. *Int J Obes Relat Metab Disord* 1999;23:389–94.
 17. Centers for Disease Control and Prevention. *Chartbook on trends in the health of Americans*. Atlanta, GA: Centers for Disease Control and Prevention, 2003. Internet: <http://www.cdc.gov/nchs/data/hus/hus03cht.pdf> (accessed 19 August 2004).
 18. Shetty PS, James WPT. *Body mass index—a measure of chronic energy deficiency in adults*. FAO Food and Nutrition Paper 56. Rome: FAO, 1994. Internet: <http://www.fao.org/docrep/T1970E/t1970e00.htm#TopOfPage> (accessed 12 July 2004).
 19. Monteiro CA, Conde WL, Lu B, Popkin BM. Obesity and inequities in health in the developing world. *Int J Obes Relat Metab Disord* 2004;28:1181–6.
 20. Monteiro CA, Conde WL, Popkin BM. Independent effects of income and education on the risk of obesity in the Brazilian adult population. *J Nutr* 2001;131:881S–6S.
 21. WHO Expert Committee on Physical Status. Physical status: the use and interpretation of anthropometry. *World Health Organ Tech Rep Ser* 1995;854:1–452.
 22. WHO Expert Consultation. Appropriate body mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004;363:157–63.
 23. Rosenberg LL, Palmer JR, Wise LA, Horton NJ, Kumanyika SK, Adams-Campbell LL. A prospective study of the effect of childbearing on weight gain in African American women. *Obes Res* 2003;11:1526–35.
 24. Coitinho DC, Sichieri R, D’Aquino Benicio MH. Obesity and weight change related to parity and breastfeeding among parous women in Brazil. *Public Health Nutr* 2001;4:865–70.
 25. *The state of the world’s children 1998: a UNICEF report*. Malnutrition: causes, consequences and solutions. *Nutr Rev* 1998;56:115–23.
 26. Monteiro CA, Conde WL, Popkin BM. Is obesity replacing or adding to undernutrition? Evidence from different social classes in Brazil. *Public Health Nutr* 2002;5:105–12.
 27. Barker D. *Fetal origins of cardiovascular and lung disease*. New York: Marcel Dekker Inc, 2001.
 28. Barker DJP. *Mothers, babies and disease in later life*. London: BMJ Publishing Group, 1994.
 29. Popkin BM, Richards MK, Monteiro C. Stunting is associated with overweight in children of four nations that are undergoing the nutrition transition. *J Nutr* 1996;126:3009–16.