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PAPER

Obesity and inequities in health in the developing world

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OBJECTIVE: To update the social distribution of women's obesity in the developing world and, in particular, to identify the specific level of economic development at which, if any, women's obesity in the developing world starts to fuel inequities in health.
DESIGN: Multilevel logistic regression analyses applied to anthropometric and socioeconomic data collected by nationally representative cross-sectional surveys conducted from 1992 to 2000 in 37 developing countries within a wide range of world regions and stages of economic development (gross national product (GNP) from US$190 to 4440 per capita).
SUBJECTS: In total, 148 579 nonpregnant women aged 20–49 y.
MEASUREMENTS: Body mass index to assess obesity status; quartiles of years of education to assess woman's socioeconomic status (SES), and GNP per capita to assess country's stage of economic development.
RESULTS: Belonging to the lower SES group confers strong protection against obesity in low-income economies, but it is a systematic risk factor for the disease in upper-middle income developing economies. A multilevel logistic model—including an interaction term between the country's GNP and each woman's SES—indicates that obesity starts to fuel health inequities in the developing world when the GNP reaches a value of about US$2500 per capita.
CONCLUSIONS: For most upper-middle income economies and part of the lower-middle income economies, obesity among adult women is already a relevant booster of health inequities and, in the absence of concerted national public actions to prevent obesity, economic growth will greatly expand the list of developing countries where this situation occurs.
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Keywords: socioeconomic status; inequities in health; developing countries; GNP per capita

Introduction

There is abundant documentation in the developing countries on the burden of nutritional deficiencies, infections, and maternal and perinatal problems being highly concentrated among the poor; however, much less information is available on the inequities in health concerning noncommunicable diseases, including obesity—a disease in great expansion at the global level.[1]

An exhaustive review of the literature, based on studies published between 1933 and 1988 (130 in developed populations and only 14 in developing populations) concluded that socioeconomic status (SES) and women's obesity tended to be inversely related in developed populations and directly related in developing populations. In nearly 90% of the studies on developing populations, women's obesity was found to be more frequent among the higher SES groups; in nearly 10%, no association was detected; and none of the studies found obesity more prevalent among the lower SES groups.[2] In other words, until the late 1980s, there was no documented evidence that women's obesity could fuel inequities in health in the developing world.

More recent studies on SES and women's obesity in developing populations indicate a different situation. In some middle-income developing countries (eg, Chile,[3] Brazil[4–5] and Curaçao[6]), case studies conducted between 1987 and 1994 have shown inverse, or at least curvilinear associations, between SES and women's obesity. Specifically in Brazil, the comparison of results from three successive national surveys conducted in 1975, 1989, and 1997 detected a progressive shifting in women's obesity toward the lower-income groups in the economically more developed south-eastern region and, in general, in urban areas.[7–8] Finally, a comprehensive study on data from national

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surveys conducted in developing countries between 1987 and 1996 on women of reproductive ages found obesity levels in low-income countries greatly concentrated among women with a higher SES while, in relatively more developed countries, obesity levels were more equally distributed in the general population.[9]

This study uses recent data from nationally representative surveys conducted in 37 developing countries to update the social distribution of adult female obesity and, in particular, to identify the specific level of economic development at which, if any, women's obesity in the developing world starts to fuel inequities in health.

Methods

We included national data sets from surveys conducted between 1992 and 2000 in 37 developing countries in our analyses: 19 in Sub-Sahara Africa, seven in Latin America and the Caribbean (including Brazil and Mexico), six in Asia (including China and India), and four in North Africa and the Middle East. The China and Mexico data sets are from national health and nutrition surveys conducted by these countries in 1997 and 1999, respectively, and the Vietnam data set corresponds to the World Bank Living Standard Measurement Survey (LSMS) conducted in 1997.[10–12] All other national data sets correspond to standardized USAID/Macro Demographic Health Surveys (DHSs)[13] conducted between 1992 and 2000. DHS data sets were downloaded from http://www.macroint.com/dhs/ or obtained directly from the State Statistical Offices (SSOs) that conducted the surveys. We used only the most recent data for countries in which two or more DHSs were conducted in the period.

We restricted our analyses in all data sets to nonpregnant women aged 20–49 y. In the case of the DHSs, most women were mothers of children under 5 years of age. The average sample size was 4266 ranging from 1460 in Bolivia to 21 171 in Peru, with a total of 157 844 women studied. Average nonresponse rates were less than 0.2% for weight and height measurements and less than 0.7% for questions on SES.

We considered the following variables in our analyses: obesity status (body mass index (BMI) $\geq 30.0\,kg/m^2$), age groups (5-year intervals) and SES. Weight and height measurements were obtained in all surveys following standard procedures.[14] We used relative levels of formal education in each country as a proxy of overall SES—namely, the country's quartiles of the women's years of schooling. Cutpoints for the quartiles were selected in each country in such a way that each quartile would contain, as close as possible, one-fourth of the studied population. In countries where years of schooling were too clustered around certain values (eg zero years), we were able to define only three or two SES groups. In the case of two groups we labelled them as Q1 (the lower quartile) and Q4 (the higher quartile). In the case of three groups we labelled them as Q1, Q2 or Q3 (according to which was bigger of Q4 and Q1, respectively) and Q4. We used the gross national product (GNP) per capita at the year of the survey to express the level of economic development of each country included in the analyses. For certain analyses we grouped the studied countries into (a) low-income economies (GNP <US$745 per capita), (b) lower-middle-income economies (GNP <US$745–2994 per capita), and (c) upper-middle-income economies (GNP ≥ US$2995 per capita). The World Bank was the source for both the GNP values (all deflated for 2001) and the GNP-based country's classification.

We initially calculated for each country the overall age-standardized prevalence of obesity using the direct method of standardization, and having the age distribution of the world population[15] as a reference (survey-specific sample weights were used, so all estimates are nationally representative—except for the China survey, which only represents eight provinces). We also calculated for each country the age-standardized prevalence of obesity among women belonging to different SES groups. To summarize and test the direction of the association between SES and obesity in each country, we calculated age-standardized prevalence ratios (with 95% confidence intervals) in the higher SES group—having the lower SES group as a reference. To specifically address the hypothesis that the direction and intensity of the association between SES and obesity would vary across the countries—depending on the country's level of economic development—we first merged all national data sets into one single data set. In this single world data set, we studied the association between SES and obesity in three strata of countries grouped as low-income, lower-middle-income, and upper-middle-income economies. The null hypothesis of homogeneity of the associations across the strata was tested using the Mantel-Haenszel statistic.[16]

After testing the homogeneity of the associations between SES and obesity across the country's GNP categories, and as a final step of our analytical strategy, we ran a multilevel logistic model[17] on the risk of obesity having as explanatory variables: women's age (5-y intervals), women's SES (education quartiles), the country's GNP per capita, and an interaction term between the women's SES and the country's GNP per capita. From this model we produced predicted probabilities of obesity for each SES group at different levels of economic development. We evaluated the statistical significance of each model parameter, including the interaction term, using the Wald test. We assessed the performance of the logistic model in predicting obesity probability by calculating the area under the ROC (receiving operator characteristic) curve (this area is equal to the probability that a random obese woman in the sample has a higher predicted probability of obesity than a random nonobese woman).[18] Both the one-level and the multilevel statistical analyses of this study took into account survey sampling weights and design effects resulting from the specific sample design employed by each individual survey. We used STATA statistical software[19] for one-level analyses and MlwiN multilevel modelling software[20] for multilevel analyses.

Results

Figure 1 plots the age-standardized prevalence of obesity against the GNP per capita for 37 developing countries. Although not linear, obesity prevalence clearly tended to increase with the level of GNP per capita. Almost two-third of the variability found in national obesity figures (from 0.3% in Vietnam to 34.2% in Jordan) could be explained by the logarithm of the country's GNP per capita.

Table 1 displays the social distribution of women's obesity in the same 37 developing countries ordered according to GNP per capita. It is clear that not only was the overall prevalence of obesity influenced by the country's GNP level, but also its social distribution. In countries with low-income economies ($n=21$), obesity tended to increase strongly with quartiles of women's formal education (our country-specific SES measure). In these countries, the risk of obesity in the higher SES group was often five or 10 times higher than in the lower SES group. In countries with lower-middle-income economies ($n=12$), the pattern of association between SES and obesity was mixed. We found direct association between SES and obesity in Bolivia, Senegal, Egypt, Morocco, Guatemala, Namibia, and Peru; no association in Uzbekistan, Kazakhstan, Colombia, and Peru; and inverse association in Dominican Republic and Jordan. Finally, in the upper-middle-income economies (Turkey, South Africa, Brazil, and Mexico) the risk of obesity was always significantly higher in the lower than in higher SES group.

Table 2 describes homogeneity tests concerning the association between women's SES and obesity across low, lower-middle and upper-middle-income economies. It was clear that as the country GNP increased, the relative excess of obesity of the higher SES group decreased, or was even reverted. For instance, the age-standardized prevalence ratio for obesity among women in the higher SES group vis-à-vis the lower SES group was reduced from 2.63 to 1.08, and then reverted to 0.67 when we considered successively low-income, lower-middle-income and upper-middle-income economies. Similar trends were observed when we compared women in the intermediate SES groups to women in the lower SES group. The hypothesis of homogeneity of the association between women's SES and obesity was refuted in all comparisons (P-value <0.0001), and this indicated that the level of economic development was a statistically significant modifier of the SES effect on obesity.

Figure 2 displays predictive estimates from a two-level logistic model that included as explanatory variables of obesity: women's age, women's SES, the logarithm of the country's GNP per capita, and an interaction term between women's SES and the country's GNP (all terms significant at $P<0.0001$—model parameters are available from the authors upon request). The area under the ROC curve for this model was 0.774 (0.95 CI 0.770–0.777). The model estimates confirm the great influence of the country's economic development on the association between SES and obesity and show that the predicted probability of women's obesity in the lower SES group exceeds the same probability in the higher SES group at a GNP value of approximately US$2500 per capita. Essentially, this indicated that US$2500 is the GNP value 'necessary' to make women's obesity fuel health inequities in the developing world.

Discussion

Anthropometric and SES data from 148 579 young- and middle-age women living in 37 developing countries provided us with the opportunity to analyze the social distribution of obesity in a relatively recent period (1992–2000), and within a wide range of developing regions and stages of economic development (GNP from US$190 to 4440 per capita). Our results show that belonging to the lower SES group confers a strong protection against obesity in low-income economies (GNP below US$745 per capita), but it is a systematic risk factor for the disease in upper-middle-income economies (GNP $\geq$ US$2995 per capita). A multilevel logistic model including an interaction term

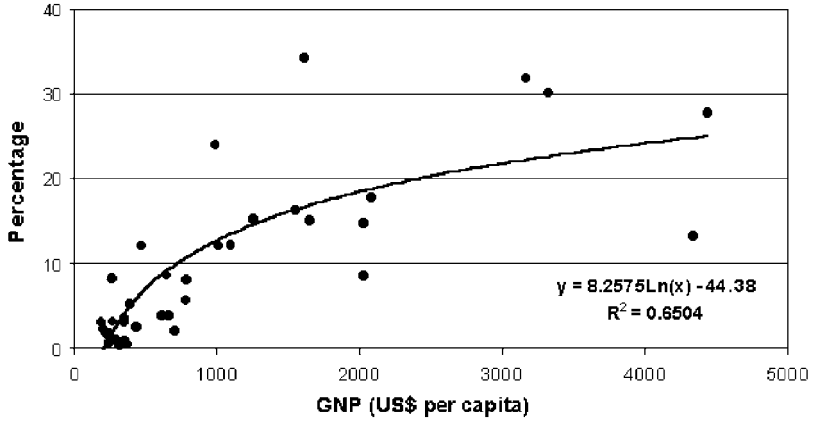

Figure 1 The relationship between the prevalence of women's obesity and Gross National Product per capita in 37 developing countries (1992–2000).

Table 1 Age-standardized prevalence of obesity in women 20–49 y by quartiles of years of education (*Q*) in 37 developing countries ordered according to GNP per capita (1992–2000)

		Obesity (%)				*Prevalence ratio Q4 vs Q1*
Country	*All*	*Q1*	*Q2*	*Q3*	*Q4*	*(0 · 95 CI)*
Tanzania	3.0	1.8	3.7	—	9.8	5.46 (5.31–5.60)
Niger	2.3	1.4	—	—	18.1	12.83 (12.73–12.92)
Malawi	1.8	0.8	—	2.8	5.9	7.63 (7.54–7.72)
Mali	1.5	0.7	—	—	10.9	16.78 (16.70–16.86)
Madagascar	0.7	0.2	0.9	0.2	2.5	10.83 (10.72–10.94)
Uganda	1.8	1.2	1.5	1.6	3.5	2.87 (2.78–2.96)
Nigeria	8.2	7.1	5.5	8.8	14.5	2.03 (1.92–2.13)
Haiti	3.2	1.8	—	1.4	15.7	8.95 (8.84–9.05)
Burkina Faso	1.0	0.6	—	—	4.8	7.66 (7.57–7.74)
Vietnam	0.3	0.2	0.2	—	0.4	2.03 (1.99–2.07)
Benin	3.1	2.1	—	—	8.5	3.98 (3.88–4.08)
Kenya	3.5	2.7	2.5	11.6	5.1	1.88 (1.78–1.97)
Central Africa Rep ·	0.9	0.5	—	1.0	2.5	4.66 (4.47–4.84)
Zambia	3.5	2.0	3.8	2.8	9.3	4.58 (4.48–4.67)
Ghana	5.2	2.7	5.2	3.2	11.1	4.14 (4.03–4.25)
India	2.5	0.8	0.9	3.2	5.9	7.78 (7.73–7.84)
Kyrgstan	12.1	18.0	11.5	12.1	10.2	0.57 (0.43–0.70)
Cameroon	3.8	0.4	3.7	7.6	9.6	23.37 (23.24–23.49)
Zimbabwe	8.6	6.7	6.9	8.2	27.2	4.06 (3.93–4.18)
Cote d'Ivoire	3.8	2.8	—	3.5	8.8	3.07 (2.99–3.16)
China	2.0	2.1	2.1	2.3	1.4	0.67 (0.56–0.78)
Senegal	5.6	4.2	—	—	17.1	4.05 (3.96–4.14)
Uzbekistan	8.0	8.9	7.6	7.0	9.6	1.07 (0.94–1.20)
Egypt	24.0	18.2	18.8	32.3	37.9	2.09 (2.01–2.17)
Bolivia	12.1	8.3	10.9	19.0	13.8	1.66 (1.51–1.80)
Morocco	12.2	10.4	—	—	25.0	2.41 (2.32–2.50)
Kazakstan	15.1	15.4	14.9	16.8	13.3	0.86 (0.70–1.03)
Dominican Rep.	16.3	17.1	18.1	15.8	15.6	0.91 (0.85–0.98)
Jordan	34.2	38.5	39.6	32.8	22.4	0.58 (0.49–0.68)
Guatemala	15.0	7.9	14.6	55.4	14.2	1.80 (1.67–1.93)
Colombia	14.7	13.7	17.9	10.4	15.1	1.10 (0.97–1.23)
Namibia	8.5	4.4	9.1	17.1	11.8	2.66 (2.55–2.77)
Peru	17.7	12.5	21.7	21.4	14.9	1.19 (1.10–1.29)
Turkey	31.8	38.0	31.2	20.6	14.5	0.38 (0.23–0.54)
South Africa	30.1	29.4	33.7	30.3	22.8	0.78 (0.66–0.89)
Brazil	13.2	12.4	16.6	11.8	9.1	0.73 (0.63–0.83)
Mexico	27.7	26.1	29.8	—	21 · 5	0.82 (0.77–0.88)

Table 2 Age-standardized prevalence ratio (and 0.95 CI) for women's obesity by quartiles (*Q*) of years of education in low, lower-middle, and upper-middle-income economies (1992–2000)

GNP (US$ per capita)	*Number of countries*	*Q1*	*Q2*	*Q3*	*Q4*
<745	21	1.0	2.27 (2.25–2.29)	2.03 (2.01–2.05)	2.63 (2.61–2.65)
745–2994	12	1.0	1.25 (1.23–1.27)	1.35 (1.33–1.37)	1.08 (1.06–1.10)
≥ 2995	4	1.0	1.12 (1.08–1.15)	0.85 (0.81–0.90)	0.67 (0.62–0.71)
P-value*	—	—	<0.0001	0.0001	<0.0001

**P*-value for homogeneity of prevalence ratios across GNP country categories.

between the country's GNP and each woman's SES indicated that obesity starts to fuel health inequities in the developing world when the GNP reaches a value of about US$2500 per capita. These results show a much greater nuance about obesity and SES in the developing world than heretofore presented.[2]

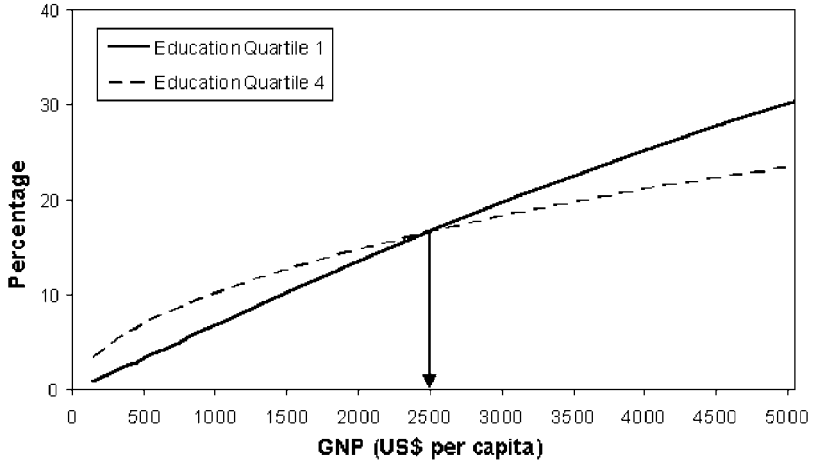

Figure 2 The predicted prevalence of women's obesity among the lower and the higher SES groups at different country GNP levels.

The nationwide probabilistic samples, large sample sizes, wide range of stages of economic development and regions of the world, highly standardized data collection procedures, and appropriate multilevel analyses—all favour the internal and external validity of our findings. The main limitation of our study is that it only surveyed women of reproductive ages, most of them mothers of one or more children under 5 years of age. This fact probably biased our national estimates of obesity toward higher values given the fact that pregnancy can be a contributory factor to obesity. In addition, it may be that women who have lower education may be more likely to be represented in our national data sets. However, it is less likely that the selection bias toward women of reproductive ages with young children could affect substantially the pattern of association between SES and obesity observed in different GNP intervals.

A recent national study on the social distribution of obesity conducted among the whole adult female population of the more, and the less, economically developed regions of Brazil (GNP per capita of US$4913 and 1728, respectively) showed findings similar to the ones described by our international study: obese women were more common among the top 25% richer families in the lower-income region (14.5% as opposed to 7.7% in the bottom 25% poorer families) while in the higher-income region obese women were more common among the bottom 25% poorer families (14.1% as opposed to 8.9% in the top 25% richer families).[21]

Another limitation of our study is the use of a single proxy—educational level—to assess SES. Although education is the SES indicator easiest to measure and with greatest cross cultural relevance,[22] income or occupation may be a better measure of an individual's social status in some populations.[23] Unfortunately, data on income and occupation were not available in all surveys.

The reasons the lower SES groups in the developing populations were protected against obesity have been usually explained as being related to (a) food scarcity and patterns of high-energy expenditures commonly found among the poor; (b) the greater capacity of the elite to obtain adequate food supplies, and cultural values favouring fat body shapes.[2] Most likely, these same reasons explain the greater obesity among lower SES women in developing countries with low-income economies.

Explanations of the inverse association between women's obesity and SES, shown to exist in part of the lower-middle-income and all upper-middle-income economies, are complex and more research on this topic is certainly necessary. Likely reasons are: (1) after a certain level of economic growth—expressed by a GNP of about US$2500 per capita, according to our estimates—lack of food and or high energy expenditure patterns are no longer common in the society, even among its poorer social segments and (2) the lower level of education and health-related knowledge among the poor, coupled with a greater difficulty to acquire more expensive low-energy dense foods (eg, fruits, vegetables, and whole-grain cereals), less leisure-time, and fewer opportunities for recreational exercise.[1–2] Furthermore, people living in circumstances of low SES may be more at the mercy of an obesogenic environment because their eating and activity are more likely the 'default choices' on offer.[24]

Regardless of the explanations underlying the shifting of obesity toward the poorest SES groups in part of the developing world, this phenomenon has important policy implications. First, for many developing countries (most or all upper-middle-income economies, and part of the lower-middle-income economies), obesity should be seen—at least among women—as a relevant booster of the already high health inequities generated by the exhaustively documented unequal social distribution of nutritional deficiencies, infectious diseases, and maternal and perinatal conditions. It should be noted that, in addition to being a disease in its own right, obesity substantially increases the risk of several

fatal and nonfatal, but highly debilitating, noncommunicable diseases—particularly cardiovascular diseases, non-insulin dependent diabetes mellitus, several endocrine and metabolic disturbances, sleep apnoea, osteoarthritis, certain types of cancer, and several psychological problems.[1] Second, in the absence of concerted national public actions to prevent obesity in the developing world, economic growth—a highly desirable and needed goal for any developing country—will tend to greatly expand the list of developing countries where obesity will fuel inequities in health.

Finally, our results make it most clear that public actions to prevent both obesity and obesity-related health inequities in the developing world should include population education strategies—not restricted to the elite—on the determinants and consequences of obesity as well as changes in the physical, economic, and sociocultural environment that make healthier choices concerning diet and physical activity behaviours feasible for all social classes.

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