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OBESITY, SES, AND ECONOMIC DEVELOPMENT: A TEST OF THE REVERSAL HYPOTHESIS

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Abstract

Studies of individual countries suggest that socioeconomic status (SES) and weight are positively associated in lower-income countries but negatively associated in higher-income countries. However, this reversal in the direction of the SES-weight relationship and arguments about the underlying causes of the reversal need to be tested with comparable data for a large and diverse set of nations. This study systematically tests the reversal hypothesis using individual- and aggregate-level data for 67 nations representing all regions of the world. In support of the hypothesis, we find not only that the body mass index, being overweight, and being obese rise with national product but also that the associations of SES with these outcomes shift from positive to negative. These findings fit arguments about how health-related, SES-based resources, costs, and values differ across levels of economic development. Although economic and social development can improve health, it can also lead to increasing obesity and widening SES disparities in obesity.

Keywords

obesity; body mass index; socioeconomic status; health disparities; economic development; World Health Survey

Introduction

Already serious problems in the United States (Flegal, Carroll, Ogden, & Curtin, 2010) and other high-income nations (Roskam et al., 2010), excess weight and obesity are increasingly common in lower- and middle-income nations (Caballero, 2007; Popkin, 2009). In 2000, for the first time in history, the number of overfed people across the world, 1.1 billion in total, equaled the number of underfed people (Gardner & Halweil, 2000). In a study of 36 low- and middle-income countries, the number of overweight persons exceeded the number of

Appendix. Supplementary data associated with this article can be found, in the online version.

underweight persons in well over half (Mendez, Monteiro, & Popkin, 2005). For example, sharp increases in obesity have occurred in Mexico, even among the poorest segments of the population (Monteverde, Noronha, Palloni, & Novak, 2010), and more than a fifth of the adult population is overweight in China, with levels rising particularly among the poor (Popkin, 2008). The global trend toward excess weight means that low- and middle-income countries face a dual health burden – they must grapple with acute and infectious diseases at the same time that chronic medical conditions associated with obesity such as diabetes, hypertension, metabolic syndrome, and disability are rising (Chopra, Galbraith, & Darnton-Hill, 2002; Kelishadi, 2007; Popkin, 2006).

The classic review of Sobal & Stunkard (1989) and two recent updates (McLaren, 2007; Monteiro, Moura, Conde, & Popkin, 2004a) illustrate the changes in obesity associated with social and economic development. Separate studies of individual nations show that high status persons tend to weigh more than others in poor countries but weigh less in rich countries. This apparent reversal in the relationship of SES and weight across levels of economic development highlights the importance of the national socioeconomic context of obesity.

Explanations of the Reversal

What might account for the changing influence of SES? Genetic predispositions, although related to individual weight, likely cannot explain differences in the direction of the SES gradient across regions, populations, and levels of economic development. Rather, the social environment is crucial (Caballero, 2007; Costa-Font, Fabbri, & Gi, 2010). One set of arguments focuses on how SES patterns of obesity, much like for cigarette smoking and other unhealthy behaviors (Cutler & Glaeser, 2009; Pampel, 2007), relate to the balance of the monetary costs of excess food with the health costs of excess weight for low and high SES groups in countries at different levels of economic development.

Consider first the monetary costs of excess food in poor countries. Food shortages in these countries (FAO 2006) make excess weight relatively uncommon, particularly for low SES groups. Whereas food insecurity in affluent nations often means lack of access to healthy food, it relates for many in poor countries to the lack of access to any food. Groups without physical access to food, the monetary resources to purchase food, and the social power to demand a share of available food suffer from undernourishment rather than obesity. The nature of food insecurity in poor countries should in turn affect the relationship between SES and body weight. Low SES limits the resources available for excess food consumption and increases physically demanding labor, whereas high SES increases both access to excess food and avoidance of physically demanding work. These conditions limit weight gain among low SES groups and encourage weight gain among the affluent in developing countries. In rich countries with economies based largely on service and technology industries, however, most can afford high-calorie foods and avoid physical labor (Brownson, Boehmer, & Luke, 2005). Crucial to rising obesity in high-income countries, particularly among low SES groups, are 1) the changing production and price structure of calorifically dense foods, stemming ultimately from technology that lowers cost per calorie (Bleich, Cutler, Murray, & Adam, 2008; Kumanyika, 2008), 2) the growth of restaurants with high-calorie selections (Chou, Grossman, & Saffer, 2004), and 3) reliance on easily prepared high calorie foods for home consumption (Cutler, Glaeser, & Shapiro, 2003).

High SES groups in high-income nations, however, counter the availability of excess food with concerns and motivations associated with the health costs of excess weight (Philipson & Posner, 2008). The relationship of obesity to mortality is the subject of some controversy – see Campos, Saguy, Ernsberger, Oliver, & Gaesser (2006) and Kim & Popkin (2006) for competing sides of the debate – but a conservative estimate is that obesity is associated with about 112,000 deaths a year in the United States alone (Flegal, Graubard, Williamson, & Gail, 2005). Given the longevity advantages of high SES groups (Link and Phelan 1995), they arguably have more to lose from excess weight and benefit the most from healthy behavior. As monetary costs of obesity decrease for low SES groups, health costs of obesity increase for high SES groups. Although obesity rises overall with economic development, it should do so less among high SES groups (Molarius, Seidell, Sans, Tuomilehto, & Kuulasmaa, 2000; Roskam et al., 2010). In contrast, excess weight among high SES groups in low-income countries may come with fewer health costs than in high-income countries. Weak public health infrastructures, shortages of medical doctors, dangerous cities with poor air quality, and the persistence of infectious diseases may limit the survival prospects of even high SES individuals in low-income nations. Thus, while the balance of monetary and health costs leads to a direct association of SES and weight in poorer countries, it leads to an inverse association in richer countries.

Knowledge and cultural values may also play roles in the reversal. In poor countries with less developed educational systems and less scientific nutritional knowledge, the presence of malnutrition makes excess weight seem unimportant or even healthy among all groups. In rich countries, high SES groups have educational advantages for understanding the health value of proper weight, diet, and exercise (Bleich, Blendon, & Adams, 2007; Kan & Tsai, 2004) and in more effectively applying knowledge about health to everyday behavior (Mirowsky & Ross, 2003). Public health programs in high-income nations may sponsor nutritional messages that contribute to knowledge about the health benefits of proper weight, much as messages about smoking contributed to knowledge of the harm of tobacco (Warner 2005). Again, however, these messages may most influence high SES groups and widen disparities in rich countries.

Cultural values can reinforce SES differences in obesity across levels of development. Preferences for thinness in high-income nations show in the stigma and bias faced by the obese, particularly those of lower SES (Bourdieu, 1984; Puhl, Heuer, & Brownell, 2010). However, excess weight in poorer countries symbolizes high status, and among men, large size can indicate power and physical prowess (McLaren, 2007). Such values may contribute to a positive association between SES and weight in low income countries.

Alternative Arguments

Plausible alternative arguments counter claims about the reversal of SES disparities in obesity. Although early studies may have demonstrated differences across levels of development, the global environment of food production and consumption may have changed enough to weaken both the positive relationship between SES and obesity in lower-income countries and the inverse relationship in higher-income countries.

In some low- and middle-income countries, low SES groups may now have sufficient access to cheap, calorie-dense, and processed food to put on excess weight (Drewnowski, 2007; Monteverde et al., 2010). A nutrition transition in developing societies has increased worldwide consumption of highly processed foods through exports, advertising, and the globalization of the agri-food system (Hawkes, 2006; Popkin, 2006). The globalization of the fast food industry similarly increases access to cheap, high-caloric food in low- and middle-income nations. Relying less on locally produced food, low SES residents of developing countries begin to adopt a diet more similar to low SES groups in richer nations and obesity rises. Conversely, through exposure to media, high SES groups in developing countries adopt Western ideals of thinness. These concurrent trends may considerably weaken the positive relationship between SES and obesity in some low- and middle-income countries.

In high-income countries, the obesity epidemic could be widespread enough to affect high as well as low SES groups. The obesogenic environment in the United States and other high-income nations (McLaren, 2007) makes it hard for any SES group to avoid obesity. Some support for this claim comes from findings that as weight has risen among all SES groups, inequality in obesity has declined in Sweden (Ljungvall & Gerdtham, 2010) and the United States (Harper & Lynch, 2007; Zhang & Wang, 2004). The pervasive pressures toward excess weight may weaken the inverse relationship between SES and obesity in higher-income nations.

Objectives

The objective of this study is to better test for a reversal in the relationship between SES and body weight with level of economic development by using an underutilized data resource. With recent data from the World Health Survey (WHS), we intend to determine if, as suggested by theories of the varied meanings of body weight across national contexts, body weight increases with SES in lower-income countries, but in higher-income countries, body weight decreases as SES increases. The WHS is particularly well suited for this task. It offers 1) comparable health measures, 2) representative samples of individuals, and 3) a large and diverse group of countries. The empirical approach we offer thus improves on studies that compile findings from separate studies of individual countries (Ball & Crawford, 2005; McLaren, 2007; Monteiro et al., 2004a; Sobal & Stunkard, 1989), that examine national differences for a single region such as Europe (Roskam et al., 2010; van der Wilk & Jansen, 2005), that use data for cities rather than national populations (Molarius et al., 2000), or that investigate the SES weight relationship across diverse countries but for women only (Monteiro, Conde, Lu, & Popkin, 2004b). The WHS allows for a better cross-national evaluation of the reversal and alternative hypotheses than is currently available.

We propose tests of the hypotheses based on the statistical interaction of measures of education, occupation, and income with national product. Support for the reversal hypothesis should show in interaction coefficients that indicate positive associations between SES and body weight in lower-income countries and negative associations in higher-income countries. However, it is important in these tests to allow for the potential reversal in the SES associations to vary by gender (McLaren 2007). Because socially constructed body weight norms and ideas often differ for men and women within the same society, the social disparities in body weight may also differ by sex. Thus, the same SES may translate into different body weight for men and women, and the interaction models to follow are estimated separately by gender.

Data and methods

Data

The data come from the World Health Survey (WHS), a World Health Organization (WHO) initiative aimed at collecting high-quality individual-level health data across all regions of the world (Üstün, Chatterji, Mechbal, & Murray, 2003). The survey took place in 70 countries during the 2002 and 2003 survey period (all downloadable for registered users at WHO, 2010a). Of those, 67 countries have sufficiently high quality data on height and weight to use in the analysis. Turkey and Zambia lack data on most variables, and Mali has a mean BMI score of 36.4 that appears implausibly large – higher by a substantial amount than the next largest national mean of 24.5 – and likely has invalid data. All three nations are excluded from the analyses. The countries cover all major regions of the world and range from poor countries of Africa (the Republic of the Congo has the lowest GDP per capita of $357) to wealthy countries of Western Europe and North America (Luxembourg has the highest GDP per capita of $61,861). For a list of countries and their gross domestic product per capita, see the appendix in the supplementary files that are available with the electronic version of the paper. Consistent question formats and interview techniques create a set of comparable health indicators for a range of countries at all levels of social and economic development and allow for combination of country-level contextual measures with individual-level health data. The Institutional Review Board of the University of Colorado has exempted this research from human subjects review, because it relies on publicly available, de-identified data.

The WHS uses a stratified multistage cluster sampling frame to select males and females aged 18 and over living in households or institutions during the survey period. The WHS includes in its sampling frame anyone in the dwelling who “is in an institution (hospital, after care home, home for the aged, hospice etc.) due to their health condition.” If the person in the institution is randomly selected as the person in the dwelling to interview, they are interviewed in the institution (if the condition is chronic) or upon return home (if the condition is acute). Only 0.7 percent of the respondents are reported as living in institutions. The WHS nations have response rates consistently over 80 percent across all regions and weights for most nations adjust for nonresponse as well as for oversampling (WHO, 2010a). However, 16 mostly high-income nations do not report weights, and older persons and females appear overrepresented in Eastern Europe.

Counting cases with valid data on all measures used in the model, the WHS has samples of 110,657 for women and 93,876 for men. On average for the 67 countries, there are 1,652 women and 1,401 men per country. The country with the smallest sample, Slovenia, has 314 women and 271 men; the country with the largest sample, Mexico, has 22,369 women and 16,377 men.

Measures

The body mass index (BMI) is computed from self-reported weight and height, but to prevent extremely small and large values from having undue influence, we recode all values below 10 (0.2 percent of the sample) as 10 and all values above 45 (1.7 percent of the sample) as 45. We also divide the BMI into four standard categories: underweight (<18.5), normal weight (18.5 to 24.9), overweight (25 to 29.9), and obese (30 or more). Of special concern is the potential misreporting of weight and height. If reporting tends to overstate weight (relative to height) in poorer countries and understate weight (relative to height) in richer countries, it will attenuate national differences. Lacking objectively measured weight and height, our main recourse to deal with this problem involves checks to ensure that relationships are meaningful and robust with respect to alternative specifications, measures, and outliers.

The individual-level predictors used in the BMI models include sociodemographic controls (gender, age, marital status, and residence) and three SES variables (education, occupational group, and income). Real gross domestic product (GDP) per capita is the key societal-level predictor.

Besides gender, the sociodemographic control variables include age in years (divided by 10 to make the coefficients larger), ranging from 1.8 to 9.0 and older, and an indicator of whether the individual is married or cohabiting versus the referent which includes never married, divorced, separated, and widowed. An indicator of area type distinguishes rural (the referent) from urban.

Education equals years of schooling completed (range: 0 to 20). An additional categorical education measure classifies education by highest level of schooling but both measures give nearly identical results, and years of schooling avoids some problems of comparability across nations in meanings of the education categories. Among cases with a score for the categorical measure of education, 10 percent lack the exact number of years of schooling. We use the categorical measure to estimate missing data for years of schooling. We also standardize years of schooling within each nation so that education is measured relative to those in the same nation rather than in absolute terms or in comparison to all other respondents across the world.

Occupation consists of dummy variables for no job, agricultural job, manual job, and nonmanual job. There are special challenges in collecting information on occupation in countries where subsistence living reigns: In some low-income WHS countries, as many as 70 percent of individuals report having no occupation. In addition, the distribution of occupations with the broad categories may differ enough across agricultural and industrial nations as to reduce the cross-national comparability of the classification. The measure has value but likely not as much as education.

Rather than measure income, the WHS asks about the ownership of a list of goods. The 11 goods available for nearly all nations in the survey include items such as a bucket, bicycle, refrigerator, and computer. Following Filmer and Pritchett (2001), we create a scale based on the weights from the first dimension of a principal components factor analysis. The factor weights avoid summations that attribute equal importance to each item (e.g., a bucket and a refrigerator) and instead reflect the contribution of each item to a linear index of household goods ownership. Because the divergent meanings of the goods across countries make comparisons of absolute levels potentially misleading, the scales are centered to have a mean of zero and a standard deviation of one within each country.

The WHS does not include a current pregnancy item. Since pregnancy distorts usual standards for body weight and height and since countries vary widely in fertility levels, the lack of adjustment may bias macro-level coefficients. We check on the potential bias by testing the hypotheses for women past childbearing ages.

GDP measures the value of goods and services and is used to reflect social and economic development. GDP is associated with greater disposable income and changes in the affordability and health costs of food consumption. The measure, available from the Penn World Table (Heston, Summers, and Aten, 2009) for 2003, uses purchasing power parities to make national currencies comparable. It is logged to reduce skew and focus on percentage differences.

Missing Data

The descriptive statistics in Table 1 show considerable missing data, especially for the BMI, due to missing height or weight data. Six nations (Bangladesh, Ethiopia, Burkina Faso, Nepal, Morocco, and Pakistan) lack BMI data for more than half the sample, and 33 nations have missing BMI data for more than 10 percent of the sample. At the aggregate level, countries with lower GDP and lower average levels of BMI have more missing data on the height and weight measures. At the individual level, younger, unmarried women in rural areas with low education and agricultural jobs are most likely to lack weight or height data. With more disadvantaged persons in low-income nations having less data and lower weight relative to height, the BMI scores are likely overstated in these nations which would attenuate differences with high-income nations. Other measures, including occupation and household goods, have substantial missing data as well.

Evidence from the relationships of missing data with aggregate and individual characteristics suggests the data are not missing completely at random (unconditional on the observed covariates), which makes typical approaches such as listwise deletion inappropriate (Allison, 2001). Because we cannot assume the missing data mechanism is ignorable, we use multiple imputation procedures (with the mi command in Stata 11) to estimate values for the missing data in the multivariate analyses. In the imputation phase, the procedures use a diverse set of predictors to estimate five sets of plausible values for each missing value. The imputed values in the five data sets include a random component based on draws from the posterior predictive distribution of the missing data under a posited Bayesian model and, under the missing-at-random assumption (a more plausible assumption than is made by listwise deletion), provide unbiased estimates of variance (Allison, 2001).

Estimation

The hypotheses specify cross-level interactions in which a measure of societal context (GDP) shapes the direction of influence of individual SES measures (education, occupation, and income). Models to test the hypotheses thus need to incorporate two levels of influence (individual and societal) and the interaction of measures at both levels (GDP by SES). Multilevel models are well suited for these goals. By treating level-1 individuals as nested within level-2 nations, they allow for estimation of coefficients for both individual and societal characteristics and also allow the individual slopes to vary across nations.

Under assumptions of multivariate normal distribution of errors, restricted maximum likelihood parameter estimates for the BMI models come from HLM 6.08 (Raudenbush et al. 2004). The estimates of random and fixed effects adjust for clustering by nation, different sample sizes for level-1 and level-2 units, heteroscedastic error terms, and varying numbers of cases within level-2 units – all problems that otherwise downwardly bias estimated standard errors (Raudenbush & Bryk, 2002). The linear regression estimates for the BMI can be extended in HLM to multinomial logistic regression estimates for the BMI categories. These categorical outcome models compare underweight, overweight, and obese categories relative to the base category of normal weight. Furthermore, the HLM procedures appropriately estimate coefficients, standard errors, and degrees of freedom for the data with imputed missing values.

Results

Table 2 lists results for the determinants of the BMI for women. Using the unimputed data with listwise deletion, the first column presents regression coefficients for the individual-level determinants plus logged GDP. The coefficients show the associations of the sociodemographic variables with the BMI when averaged across all nations. The positive coefficients for being married and living in cities mean these persons weigh more than their unmarried or rural counterparts. The positive coefficient for age and the negative coefficient for age squared mean that body weight increases with age until 63 and declines with age thereafter.

For the SES variables, increasing education and nonmanual work are associated with lower BMI values, while the household goods scale is associated with higher BMI values. However, nations differ in the direction and size of the SES-BMI relationships. The variance components in the second column indicate that the random coefficients vary significantly across nations. For example, the slopes for education have a variance of 0.36 around the average of −0.24.

The next column uses the imputed data to re-estimate the model for a considerably larger sample of women. The results prove quite similar. The last columns in Table 2, based on multinomial logistic regression of the BMI categories for the imputed data, reveal much the same pattern of results as the linear multilevel regression. With normal weight serving as the base category, variables associated directly with the BMI in the linear model generally are associated with lower logged odds of being underweight and higher logged odds of being overweight and obese relative to the normal weight category. Conversely, variables that are associated inversely with the BMI generally are associated with higher logged odds of being underweight and lower logged odds of being overweight and obese. For example, the household goods measure is associated with lower logged odds of being underweight and higher logged odds of being overweight and obese. However, education and nonmanual work are associated with higher logged odds of being normal weight and lower logged odds of being underweight, overweight, and obese.

The results in Table 3 include estimates for men and, again, are based on the raw and imputed data and on the BMI measure and its categories. In general, the results for men differ in several ways from those for women. Urban residence and increasing education have weaker associations with the BMI for men than women, while nonmanual work is associated with higher rather than lower BMI for men. The relationships of household goods are similar for men and women, but education and non-manual work have weaker associations with body weight for men than for women. However, as indicated by the significant variance coefficients, the SES-BMI relationships averaged across all nations hide diverse associations across nations.

Along with the individual-level determinants, Tables 2 and 3 include logged GDP as an aggregate-level determinant. The results show that, for both women and men, higher national income is associated with higher BMI and with increases in the logged odds of being overweight or obese.

Given that the SES variables on average are associated with lower body weight, while logged GDP is associated with higher body weight, the next step is to examine the cross-level interactions of these variables. This step in the analysis will test directly for differences in the slopes of the SES variables across levels of national income. Table 4 lists coefficients for interaction terms of education, nonmanual work, and household goods by either logged GDP or logged GDP and logged GDP-squared. Interactions involving both logged GDP and logged GDP squared allow the slopes of the SES variables to increase before declining, while interactions involving logged GDP alone indicate that the slopes of the SES variables steadily decrease. We exclude the logged GDP-squared term when it is insignificant. According to the reversal hypothesis, which posits increasing disparities at high levels of social and economic development, the slopes for SES should become more negative at higher levels of GDP. To minimize multicollinearity, we add interactions involving one SES variable at a time rather than all at once. The table thus reports results for women and men from a separate model with the education interactions, another model with nonmanual interactions, and a third model for the household goods interactions.

To summarize the results in Table 4, the interactions consistently confirm the reversal hypothesis. The slopes for education, being a nonmanual worker, and household goods become more negative at higher levels of national income. That is, the association of SES with the BMI shifts from positive in low-income nations to negative in high-income nations. For women, the negative coefficients for education by logged GDP in the equations for the BMI, being overweight, and being obese reflect an increasingly negative association – or increasing disparities – in high-income nations. The same negative interaction terms show for nonmanual work and household goods. The associations decline linearly for women but sometimes nonlinearly for men.

To help make sense of the patterns described by the interaction coefficients, Figure 1 graphs how the *slopes* of the SES variables vary with logged GDP. Figure 1a shows that the slopes for education on the BMI shift linearly from positive to negative for women and become increasingly negative at the highest levels of logged GDP for men (after rising from low to moderate levels). For both females and males, the association of education with the BMI becomes more strongly negative and the size of educational disparities in the BMI increase with GDP. The same shows in Figures 1b and 1c, which plot the logged odds coefficients for underweight, overweight, and obesity among females and then males. For females, the slopes for education on the logged odds of being overweight and obese shift from positive to negative. For males, the slopes on overweight and obesity shift from positive to negative after an initial rise. The graphs thus depict a clear reversal in the associations of education with body weight at higher levels of GDP. Note, however, that the education relationships are generally smaller for men than women.

Much the same patterns show for nonmanual work (Figures 1d–1f) and household goods (Figures 1g–1i). Females show near linear declines in the slopes of the SES variables on the BMI, overweight, and obesity, while males show either a decline or a rise and decline in the slopes.

The graphs highlight differences in patterns for men and women. Although results for both genders support the reversal hypothesis, the shifts are smaller and less linear for men than women. The difference produces a large gender gap in the slopes of SES at low levels of national income, but a small gender gap at high levels of national income. The tendency for high SES groups to be relatively overweight in low-income nations is particularly notable for women.

Since propensities for overweight and obesity vary across the life course, age may also modify the impact of SES. Moreover, the lack of a measure of pregnancy status requires tests at ages where pregnancy is rare. We therefore replicated the BMI models for women and men ages 18 to 40 and 41 and over (available on request). For women in particular, the results show stronger interaction coefficients for the older than the younger age group. The tendency for the relationship between individual-level SES and weight to change direction with increasing GDP emerges as strongly, or more strongly, among older adults than among younger adults. That both age groups and genders show the reversal suggests that pregnancy among women does not greatly bias the results. In addition, we checked for the influence of a measure of ever having given birth that is available only for women ages 18–49 in about 50 countries. Although the measure has a positive influence on the BMI, it does not change the interaction of education by GDP or weaken the evidence for the reversal hypothesis. Given missing data on this measure for men, older women, and a large subset of high-income nations, we do not include it in the reported results.

Discussion and conclusion

Increases in excess weight across the world may hinder improvements in the health of populations. Excess weight and especially obesity contribute to a host of chronic conditions and premature mortality in the developed world (Flegal et al., 2005) and threaten to do the same in the developing world (Popkin, 2009). This comes at a time when developing nations continue to suffer from morbidity and mortality risks from infectious diseases. Although economic and social development improves health, such progress can also create new concerns. At higher national income, problems of malnutrition are replaced by problems of over-consumption that differentially affect SES groups. Obesity disparities may widen, worsening health and mortality prospects most for the least advantaged.

A robust test of the reversal hypothesis among a diverse set of nations representing all regions of the world and using multiple measures of SES lends insight into the complex relationships between SES and excess weight. Our results show that higher SES (measured in several ways) has a positive relationship with BMI in low GDP nations, but the relationship becomes negative in high GDP nations. The patterns differed for men and women, with the shift from a positive to a negative relationship between SES and weight occurring more clearly for women than men, but both sexes showed larger SES disparities at higher levels of economic and social development.

Investigating changes in social patterns of obesity has been logistically difficult because of a lack of consistent data collection across regions of the world. Collating the findings of diverse studies (McLaren, 2007; Monteiro et al., 2004a) and combining different data sets (Monteiro et al., 2004b) have worked well to identify differences in the influence of SES across levels of development. Yet, the WHS provides a unique resource to both confirm and improve on previous estimates by gathering height and weight data in near identical ways for representative samples, for both men and women, and in countries that represent all regions of the world.

Although the data do not allow for precise tests of the causes of the reversal, several theoretical perspectives help make sense of our findings and drive policy considerations. In low-income nations, high SES may enable the consumption of high calorie foods, while allowing the avoidance of physically demanding tasks. In contrast, high SES individuals in high-income nations may have the most to lose from excess weight and may respond with healthy eating and regular exercise. Knowledge about the health consequences of excess weight and how to manage one’s weight may help drive the reversal, in part because it is most prevalent among high SES individuals in high-income societies. In contrast, low SES individuals in low-income countries who have strenuous lives and do not have access to excess calories are more concerned about the harm of malnutrition than excess weight. Finally, if thinness is valued by high status individuals in high-income countries and plumpness is valued among high status individuals in low-income countries, cultural values may shape the reversal.

Future research needs to examine the credibility of these arguments, but they suggest that policies need to focus on the different motivations for and meanings of excess weight of low and high SES groups across national levels of development. If obesity involves different socioeconomic groups in poor and rich countries, policy makers could design programs in each type of country to target groups most in need. Programs might focus on the affluent in poor countries and the poor in affluent countries.

Despite comparability of the WHS measures, these results should be interpreted with caution. The data face well documented biases in the use of self-reported weight and height (Deurenberg, Yap, & van Staveren, 1998). Any such biases may be exacerbated when making comparisons across nations with varied levels of national income and varied cultural ideals about weight. Thus, body weight preferences may, for example, lead high SES groups to overstate weight in low-income countries but understate weight in high-income countries. Such bias would exaggerate cross-country differences in the relationship of SES and weight. The difficulty of obtaining objective measures of weight and height in surveys of dozens of countries forces reliance on self-reports. A body of work documents that calculations based on self-reports may not be ideal, but they can be thought of as reliable (Spencer, Appleby, Davey, & Key, 2002; Denney, Krueger, Rogers, & Boardman, 2004). Self-reports are associated with overall and cause-specific mortality in ways that are similar to BMIs that come from objectively measured height and weight (Prospective Studies Collaboration, 2009; Rogers, Hummer, and Krueger, 2003), and studies have found similar results when using both self-reported and measured weight and height to make comparisons across nations at different levels of development (McLaren, 2007).

While misreporting is a well-documented problem, missing data on height and weight is an equally pressing concern. If understanding obesity on a global level is worthwhile, researchers are forced to deal with the problem of missing data using rigorous, though not flawless, techniques, such as multiple imputation. The missing data imputation gives unbiased estimates of coefficients and standard errors under the (largely untestable) assumption that the data are missing at random, conditional on observed variables. The ultimate goal should be consistently collected and accurate data on weight across the globe, particularly for developing countries where current economic and nutritional transitions may both help and in some ways harm their populations. The WHS does well in the span of countries and consistency of data gathering. The challenge for organizations charged with data collection is, and will continue to be, finding innovative ways to obtain these data, within budgetary constraints.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Research Highlights

- Studies of global patterns of obesity lack comparable data on nations across all world regions and levels of development.
- We examine unique data on socioeconomic status and weight for individuals in 67 diverse nations with the World Health Survey.
- We find that the influence of socioeconomic status on obesity shifts from positive to negative with national income.
- Economic and social development can both improve health and lead to widening SES disparities in obesity.

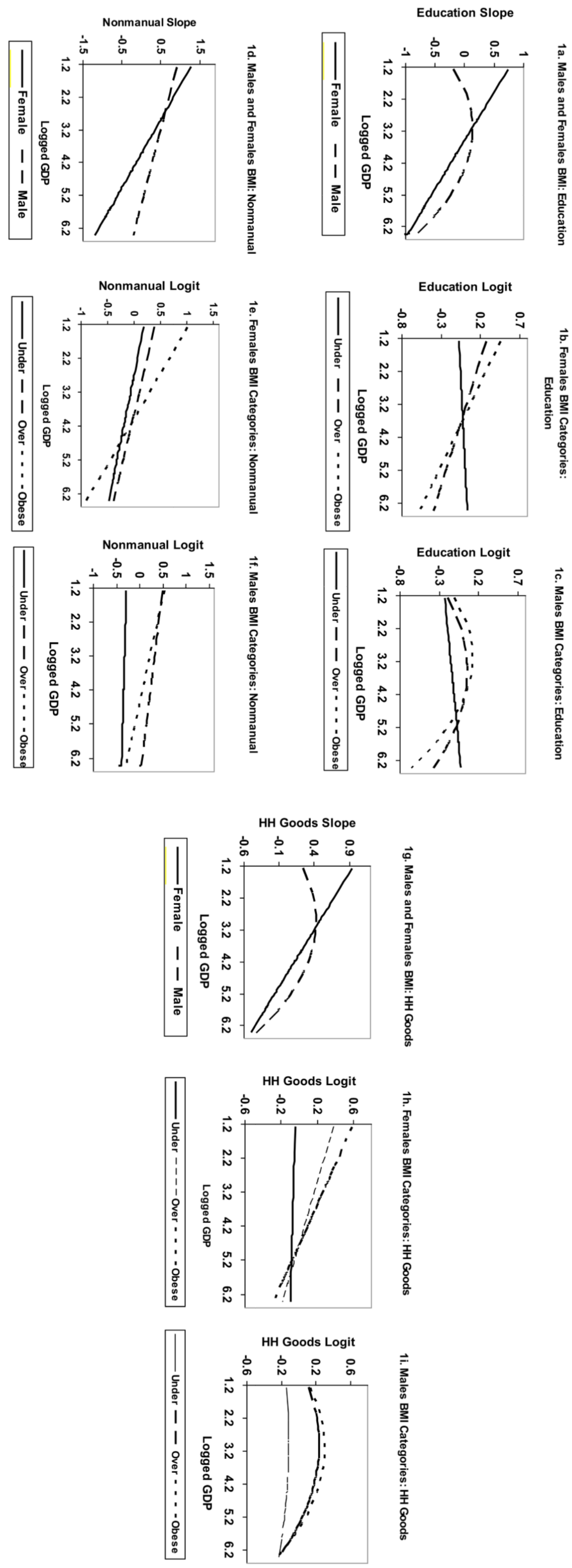
1a. Males and Females BMI: Education
Education Slope
1b. Females BMI Categories: Education
Education Logit
1c. Males BMI Categories: Education
Education Logit
1d. Males and Females BMI: Nonmanual
Nonmanual Slope
1e. Females BMI Categories: Nonmanual
Nonmanual Logit
1f. Males BMI Categories: Nonmanual
Nonmanual Logit
1g. Males and Females BMI: HH Goods
HH Goods Slope
1h. Females BMI Categories: HH Goods
HH Goods Logit
1i. Males BMI Categories: HH Goods
HH Goods Logit
Logged GDP
Female
Male
Under
Over
Obese

Figure 1.

SES Slope and Logit Coefficients on the BMI and BMI Categories by Logged GDP

Table 1

Descriptive Statistics: WHS Females and Males

	Females		Males			
Variables	**N**	**Mean**	**N**	**Mean**	**Min Value**	**Max Value**
BMI	125319	24.26	105177	24.17	10	45
Underweight	125319	0.09	105177	0.07	0	1
Normal	125319	0.55	105177	0.56	0	1
Overweight	125319	0.24	105177	0.27	0	1
Obese	125319	0.12	105177	0.09	0	1
Age	169455	4.03	132091	3.93	1.8	9.0
Married	168754	0.64	131441	0.66	0	1
Urban	160035	0.55	125356	0.53	0	1
Education	169238	−0.04	131779	0.17	−4.78	5.05
Not Working	163670	0.62	127152	0.28	0	1
Agriculture	163670	0.09	127152	0.22	0	1
Manual	163670	0.09	127152	0.27	0	1
Nonmanual	163670	0.20	127152	0.24	0	1
HH Goods	163980	0.06	127715	0.09	−6.54	10.40
GDP	169698	112.03	132243	106.30	3.58	618.61
Listwise N	110657		93876			

Table 2

Individual- and Nation-Level Coefficients (b listed above t value) for Multilevel Models of the BMI and BMI Categories: WHS Females

Predictors	Raw Data		Imputed Data	Imputed Data		
				Multinomial Logit of BMI Categories [b]		
	Linear BMI	Variance Components [a]	Linear BMI	Under	Over	Obese
Constant	24.36	2.80***	24.35	−2.06	−0.77	−1.67
Age	2.13***		1.71***	−0.37***	0.60***	0.94***
	10.03		10.76	−5.76	9.70	11.39
Age 2	−0.17***		−0.12***	0.03***	−0.04***	−0.07***
	−7.16		−7.19	4.44	−6.17	−8.03
Married	0.60***		0.65***	−0.29***	0.27***	0.20***
	8.94		10.65	−8.97	9.25	6.54
Urban	0.39***		0.37***	−0.08	0.15***	0.18**
	4.71		5.71	−1.91	4.68	3.47
Education	−0.24***	0.36***	−0.20***	−0.04	−0.11***	−0.16***
	−3.68		−3.85	−1.71	−5.05	−4.96
Agriculture	−0.67***		−0.67***	0.06	−0.25**	−0.41***
	−4.09		−5.72	1.01	−3.33	−3.76
Manual	0.26**		0.33***	−0.17*	0.09*	0.09
	2.96		4.12	−2.65	2.53	1.76
Nonmanual	−0.33**	0.85***	−0.32***	−0.17*	−0.12**	−0.27***
	−3.53		−4.02	−2.47	−3.31	−4.87
HH Goods	0.17**	0.29***	0.16**	−0.09***	0.05**	0.07*
	2.76		3.18	−5.27	2.97	1.98
Logged GDP	0.38**		0.44**	−0.31***	0.11*	0.23**
	2.85		3.29	−4.38	2.62	3.15
N Level 1	110657		169632	169632		
N Level 2	63		67	67		

*p < .05

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** $p < .01$

*** $p < .001$

[a] Without logged GDP

[b] Base category = normal weight

Table 3

Individual- and Nation-Level Coefficients (b listed above t value) for Multilevel Models of the BMI and BMI Categories: WHS Males

Predictors	Raw Data		Imputed Data	Imputed Data		
				Multinomial Logit of BMI Categories [b]		
	Linear BMI	Variance Components [a]	Linear BMI	Under	Over	Obese
Constant	24.42	3.15 ***	24.47	−2.74	−0.70	−2.01
Age	1.71 ***		1.45 ***	−0.41 ***	0.62 ***	1.02 ***
	13.35		13.42	−5.11	10.61	10.85
Age 2	−0.15 ***		−0.12 ***	0.04 ***	−0.05 ***	−0.08 ***
	−12.15		−11.95	5.14	−9.23	−9.04
Married	0.59 ***		0.64 ***	−0.22 **	0.31 ***	0.41 ***
	11.27		11.98	−3.38	7.54	9.49
Urban	0.05		0.03	0.02	0.07	0.02
	0.43		0.39	0.41	1.88	0.32
Education	−0.02	0.18 ***	−0.02	−0.09 **	−0.03	−0.08 *
	−0.50		−0.70	−3.23	−1.80	−2.46
Agriculture	−0.28 *		−0.23 *	−0.17 **	−0.07	−0.31 ***
	−2.24		−2.29	−3.01	−1.29	−4.39
Manual	0.13		0.26 **	−0.29 ***	0.14 ***	0.05
	1.49		3.34	−4.29	4.43	0.95
Nonmanual	0.22 *	0.50 ***	0.31 ***	−0.33 ***	0.21 ***	0.04
	2.53		4.19	−5.26	5.09	0.66
HH Goods	0.29 ***	0.20 ***	0.29 ***	−0.15 ***	0.13 ***	0.16 ***
	6.62		8.01	−4.28	8.18	6.03
Logged GDP	0.92 ***		0.87 ***	−0.57 ***	0.34 ***	0.49 ***
	6.48		6.21	−6.43	6.13	5.54
N Level 1	93876		132203	132203	132203	132203
N Level 2	63		67	67	67	67

* $p < .05$

** p < .01

*** p < .001

[a] Without logged GDP

[b] Base category = normal weight

Table 4

Individual- and Nation-Level Interaction Coefficients (b listed above t value) for Multilevel Models of the BMI and BMI Categories: WHS Females and Males

	Females				Males			
		Multinomial Logit of BMI Categories [b]				Multinomial Logit of BMI Categories [b]		
Interactive Predictors [a]	**Linear BMI**	**Under**	**Over**	**Obese**	**Linear BMI**	**Under**	**Over**	**Obese**
Education	−0.23***	−0.02	−0.11***	−0.13***	−0.07*	−0.12*	−0.03	−0.05
	−4.75	−0.76	−4.75	−4.37	−2.03	−2.64	−1.35	−1.65
Education × Logged GDP	−0.33***	0.02	−0.13***	−0.20***	0.57***	0.04	0.35**	0.43**
	−8.11	0.90	−8.13	−7.75	4.05	0.24	3.36	2.70
Education × Logged GDP^2					−0.09***	0.00	−0.05***	−0.07**
					−5.51	−0.21	−4.25	−3.74
Nonmanual	−0.13	−0.20**	−0.06	−0.08	0.27**	−0.36***	0.22***	0.05
	−1.35	−3.34	−1.32	−1.27	3.62	−4.22	5.40	0.85
Nonmanual × Logged GDP	−0.48***	−0.13*	−0.15***	−0.37***	−0.22**	−0.02	−0.09*	−0.16**
	−6.59	−2.15	−4.41	−6.77	−3.16	−0.34	−2.58	−2.82
HH Goods	0.12**	−0.08**	0.05*	0.09**	0.23***	−0.14***	0.13***	0.18***
	3.21	−3.55	2.53	3.29	6.60	−4.04	7.08	5.61
HH Goods × Logged GDP	−0.28***	−0.01	−0.11***	−0.17***	0.41*	0.06	0.24*	0.31*
	−9.18	−0.43	−7.27	−6.76	2.31	0.36	2.63	2.29
HH Goods × Logged GDP^2					−0.07**	−0.01	−0.04**	−0.05**
					−3.29	−0.35	−3.55	−3.24

* p < .05

** p < .01

*** p < .001

[a] Interactions of education, nonmanual work, and household goods are added separately to the models

[b] Base category = normal weight