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Abstract

The origin of the obesity epidemic in developing countries is still poorly understood. It has been prominently argued that economic development provides a natural interpretation of the growth in obesity. This paper tests the main aggregated predictions of the theoretical framework to analyze obesity: Average female body weight is associated with economic development. In relatively poor countries, obesity is a phenomenon of the socioeconomic elite. With economic development, obesity shifts towards individuals with lower socioeconomic status.

Keywords

Obesity, socioeconomic inequality, economic development.

JEL Classification

I1.

1 Introduction

The obesity epidemic has attracted considerable attention in recent years. Much of the related research has focused on obesity in developed countries (see for example French et al. (2010), Baum (2009); Baum & Ruhm (2009); Chou, Grossman, & Saffer (2008); Gruber & Frakes (2006) among others), where the emerging epidemic in developing countries has attracted less attention (Abdulai, 2010; Sahn, 2009; Doak & Popkin, 2008; Asfaw, 2007).

Philipson and co-authors (Lakdawalla & Philipson, 2009; Lakdawalla, Philipson, & Bhattacharya, 2005; Philipson & Posner, 2003) provide a theoretical framework to analyze the obesity epidemic. They argue that economic development provides a natural interpretation for the emerging obesity epidemic and that on the individual level, a non-monotonic relationship between income and weight arises, with obesity concentrated among the socio-economic elite in poor countries and among the poor in more developed countries.

Empirical evidence supporting the theoretical predictions comes mainly from single country studies analyzing socioeconomic inequality in body weight (such as in Tafreschi (2011) for example), whose results are difficult to generalize, or from literature reviews. These reviews document that in developing countries obesity was initially a disease of the rich (McLaren, 2007; Sobald & Stunkard, 1989). More recently, obesity shifted from the socioeconomic elite to people with a relatively lower socioeconomic status (SES) (Monteiro, Moura, Conde, & Popkin, 2004). However, the number of reviewed studies is relatively small, included studies use very different indicators to measure socioeconomic status (such as education, income, wealth, etc.) and reviews are based on a great variety of study populations (general population, immigrants, populations from selected areas, etc.).

This paper is, to the best of our knowledge, the first systematic overview of the SES-obesity gradient in developing countries. We contribute to the literature from four angles: We use (1) comparable micro-data (Demographic Health Surveys), (2) comparable samples (women drawn from the general population), (3) similar indicators for SES-rank, and (4) data from more than 50 developing countries. Our results confirm the main predictions of the theoretical contribution of Philipson and co-authors.

2 Theoretical background

Philipson and co-authors (Lakdawalla & Philipson, 2009; Lakdawalla, Philipson, & Bhattacharya, 2005; Philipson & Posner, 2003) analyze the long-run rise in obesity in a standard micro-economic framework, where body weight is a commodity produced with chosen inputs (calorie consumption and physical exercise). In their theoretical framework, body weight is influenced by three exogenous factors, i.e. (1) the relative food price, (2) the calories expended per hour of work, and (3) the individual wage rate.

Economic development is likely to affect all of these three factors. First, with economic development, relative food prices decline. Second, technological change alters the industry structure. Fewer people are needed for food production, while other sectors, particularly the service sector, become more relevant. Work becomes more sedentary and, hence, individuals need fewer calories to perform in their jobs. Third, technological progress increases productivity and with this also wages. These three factors would lead to a higher demand for calories and higher body weight, particularly among wealthier people. On the other hand, individuals have preferences for an ideal weight. If an ideal weight is a normal good, the marginal disutility of deviating from this ideal weight is higher for higher income groups. This results in a negative association between socio-economic status and body weight.

Whether or not one observes a positive or negative income gradient of overweight in a population depends largely on the level of economic development. In relatively poor countries, the first effect dominates and one would expect a positive relationship between SES and body weight. In more advanced countries, the second (disutility) effect dominates for at least some proportion of the population and the relation between SES and weight is inverted U-shaped.

Ideally one would like to empirically test this theory by estimating the causal impact of absolute SES on body weight, either on different parts of the income distribution to analyze effect heterogeneity within a country, or across different countries to compare effects. This is, however, difficult for two reasons: (1) Measuring incomes (as a measure for absolute SES) is problematic (Pyatt, 2003) and many household surveys include measures for relative SES-rank but not for absolute SES. (2) A creditable identifying strategy is needed to isolate the impact of SES on body weight, but exogenous variations of SES are rare. We therefore test for two predictions at the aggregate level that follow from the micro-economic predictions.

Proposition 1: Average body weight is associated with economic development.

Denote the relationship between body weight and income with $W = g(x)$ and the probability density function of income with $f(x)$. Economic development shifts the income distribution function to $f^{*}(x)$ such that the average income increases $\int x\, f(x)dx < \int x\, f^{*}(x)dx$. As long as $g(x)$ is a strictly positive transformation (or in other words, if higher incomes lead to higher body weight), economic development should be associated with higher average weight (i.e. $\int g(x)\, f(x)dx < \int g(x)\, f^{*}(x)dx$). The disease is self-limiting, however, if the disutility effect dominates for at least a some share of the population. If this is the case, economic development can be associated with constant or even declining average weight (i.e. $\int g(x)\, f(x)dx \geq \int g(x)\, f^{*}(x)dx$). We, thus, expect a non-linear (and maybe even non-monotonic) relationship between average weight and economic development.

One should notice that with a non-linear individual level relationship between body weight and SES, aggregate cross-section studies may be subject to the aggregation problem (see the discussion on the Wilkinson hypothesis such as in Wildman (2001) for example). It may thus be difficult to infer on individual behavior from aggregated data. We therefore combine micro-level (i.e., the SES-related inequality within a country) and macro-level evidence.

Proposition 2: SES-related health inequality is associated with economic development.

Denote the cumulative proportion of body weight with $q_W(x) = \frac{1}{E[g(X)]}\int_0^x g(X)f(X)dX$ and the cumulative income distribution with $p(x)$. The concentration curve $L_W(p)$ denotes the relationship between $q_W(x)$ and $p(x)$, and indicates the proportion of weight in individuals with incomes less than or equal to x. The concentration index is twice the area between the concentration curve and the line of equality (Wagstaff, Paci, & van Doorslaer, 1991). If the relationship between body weight and income is differentiable, the resulting second derivate of the concentration curve is equal to (Podder & Tran-Nam, 1994):

$$L''_W(p) = \frac{g'(x)}{E[g(X)]f(x)}$$

Suppose that on the individual level, higher incomes lead to higher body weight (i.e. $g'(x) > 0$ for all plausible incomes), the concentration curve is convex (the concentration index takes positive values). If in contrast, higher incomes would lead people to lose weight (i.e. $g'(x) < 0$ for all plausible incomes), the concentration curve is concave (the concentration index takes negative values). In the intermediate case, where the relationship between income and weight is inverted U-shaped, the concentration curve crosses the equality line (see Figure 1).

[Figure 1: HERE]

Note that in standard applications, concentration index is often used to rank countries. Concentration curves that cross the line of equality make it difficult to judge which country has a more unequal health distribution. In this application, concentration indices are used to test the implication of a theoretical model, where crossing concentration curves are part of this theory. We expect a negative association between the concentration index and economic development, with concentration indices close to zero in more advanced economies.

3 Empirical analysis

3.1 Data

To test the two propositions outlined above, we use the Demographic and Health Surveys (DHS), which are nationally representative household surveys. These cross-sectional surveys typically include 5,000 to 30,000 households, and provide anthropometric measurement (weight and height) for a selected sample of women. We use DHS data from 52 different countries from 1990 to 2008 (in total 115 different surveys, including information from 943'605 women).

To test proposition 1, average Body Mass Index ($BMI = kg/m^2$), proportion of the population being overweight or obese ($BMI \geq 25$) or obese ($BMI \geq 30$) is used as dependent variable. The concentration index (Kakwani, Wagstaff, & van Doorslaer, 1997) based on the DHS wealth index (Rutstein, 2008; Filmer & Pritchett, 2001) is used as dependent variable to test proposition 2. Our main independent variable approximating economic development is per capita GDP, which ranges between US$ 125 and 5'155. Descriptive statistics of all dependent and independent variables are provided in the appendix.

3.2 Results

We run a regression of per capita GDP on average BMI (alternatively the share with overweight or obesity) to test for proposition 1. A squared term of per capita GDP is included to capture a potential non-linear relationship. Controlling for a linear time trend (Table 1, column 1) shows that average BMI, as well as overweight or obesity rates significantly increase with economic development. The results are robust to controlling for confounding variables on the aggregated level (see columns 2-4).

[Table 1: HERE]

To test for proposition 2, we a run a regression of per capita GDP, its squared term and a linear time trend on the concentration indices for BMI (alternatively, concentration indices for overweight or obesity). As predicted by the theory, our results indicate a significantly negative association between the concentration indices for overweight and obesity and per capita GDP (Table 2). The association between the concentration indices for BMI and per capita GDP is also negative but not significant on standard levels (p=0.15). The results are robust to including control variables on the aggregated level (see columns 2-4). This sustains to the second hypothesis that obesity shifts from the socioeconomic elite to people with a relatively low socioeconomic status with ongoing economic development.

[Table 2: HERE]

Several sensitivity checks are performed to support our main findings. The results are not reported but available from the authors upon request. First, we run a demographic standardization (Kakwani, Wagstaff, & van Doorslaer, 1997) to account for the heterogeneity in the population structure. Included variable in this standardization are age, pregnancy status, marital status, type of residence, number of children aged below 5 and total number of children ever born. All of these factors are very likely associated with body weight for women, and may be also associated with the development status of the country. Second, DHS surveys for more than one year are available for 35 countries allowing estimating time fixed effects panel models. This allows controlling for any time-fixed confounders, such as for cultural differences. Third, we address for the fact that overweight and obesity are binary variables. This is particularly a problem since concentration indices are bounded by the mean of the health variable with binary variables. Since the theory predicts increasing average obesity levels with ongoing economic development for developing countries, lower concentration indices could simply reflect higher average obesity levels and may not portray lower SES-related inequality. We therefore normalize the concentration index by dividing it by its feasible minimum or maximum (Wagstaff A. , 2011). And finally, we use alternative measures for the relative SES-rank to adjust for the fact that our results may be sensitive to the choice or our measure for SES (Wagstaff & Watanabe, 2003). The DHS wealth index does not use the same asset types in all countries. We thus construct an alternative asset index that uses the same types of asset. This, however, does not solve the incomparability problem (i.e. the ownership of certain assets may not correspond to a similar SES-rank in different countries). We also use the highest education of the household head as an indicator for SES-rank (even in culturally and economically diverse countries, higher education should lead to higher incomes and thus higher SES-rank). Our results are robust to all these sensitivity checks.

4 Conclusions

This paper analyses the socioeconomic gradient in obesity in developing countries. Our results indicate that economic development is positively associated with average body weight, and that economic development also determines the distribution of body weight within countries. These results are consistent with a theoretical model that supports ideal weight preferences.

Nonetheless, the results are worrisome. If the observed trend continues, the obesity epidemic may further burden health systems in developing countries, which are already challenged by the spread of communicable diseases. Further research should outline the effectiveness of public health prevention campaigns in schools, communities and beyond.

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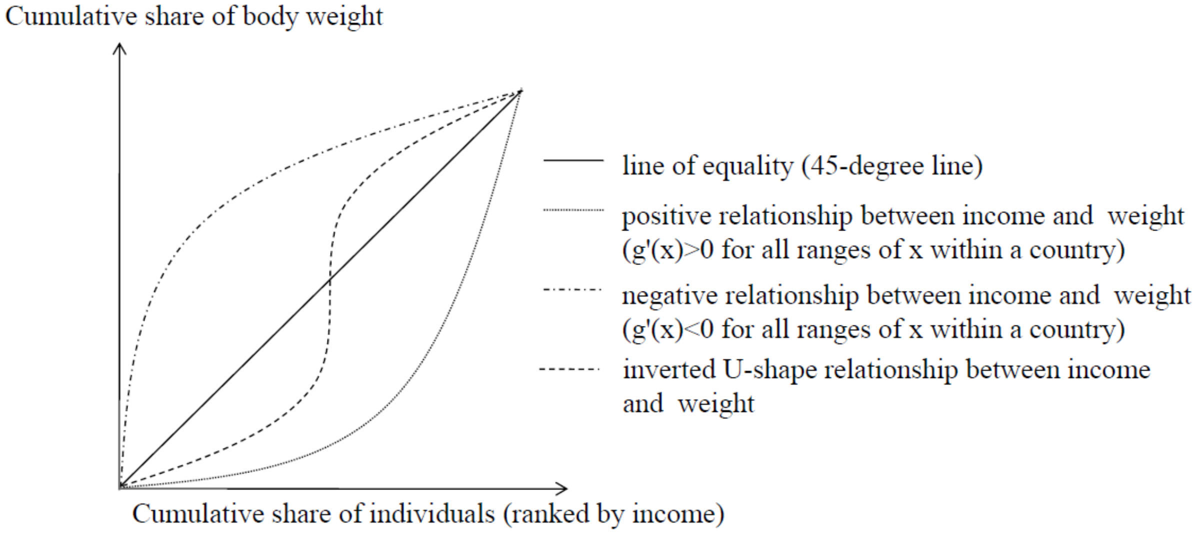
Figures

Figure 1: Concentration curves



Tables

Table 1: Estimation results for proposition 1 (per capita GDP in thousands).

		Model 1		Model 2		Model 3		Model 4	
Body mass	GDP	4.13770	***	3.67630	***	3.61730	***	3.83820	***
		(0.46460)		(0.50190)		(0.52040)		(0.53640)	
	GDP SQ	-0.00074	***	-0.00065	***	-0.00063	***	-0.00068	***
		(0.00012)		(0.00012)		(0.00013)		(0.00013)	
% Overweight	GDP	0.35660	***	0.31360	***	0.31460	***	0.33140	***
		(0.03720)		(0.03970)		(0.04100)		(0.04160)	
	GDP SQ	-0.00006	***	-0.00005	***	-0.00005	***	-0.00006	***
		(0.00001)		(0.00001)		(0.00001)		(0.00001)	
% Obesity	GDP	0.15440	***	0.13270	***	0.13340	***	0.13660	***
		(0.02320)		(0.02390)		(0.02540)		(0.02620)	
	GDP SQ	-0.00003	***	-0.00002	***	-0.00002	***	-0.00002	***
		(0.00001)		(0.00001)		(0.00001)		(0.00001)	
Control variables		Time trend		Time trend Urbanization		Time trend Urbanization Population		Time trend Urbanization Population CPI	
Obs.		115		115		115		108	

Note: Robust standard errors clustered at the country level in brackets. Star levels denote significant levels at (*) 10%, (**) 5% and (***) 1%.

Table 2: Estimation results for proposition 2 (per capita GDP in thousands).

		Model 1		Model 2		Model 3		Model 4	
Body mass	GDP	-0.00432		-0.00150		-0.00070		-0.00287	
		(0.00273)		(0.00325)		(0.00318)		(0.00335)	
	GDP SQ	0.00000		0.00000		0.00000		0.00000	
		(0.00000)		(0.00000)		(0.00000)		(0.00000)	
Overweight	GDP	-0.21340	***	-0.17010	***	-0.15940	***	-0.18880	***
		(0.02790)		(0.03430)		(0.03280)		(0.03360)	
	GDP SQ	0.00003	***	0.00003	***	0.00002	***	0.00003	***
		(0.00001)		(0.00001)		(0.00001)		(0.00001)	
Obesity	GDP	-0.31610	***	-0.23410	***	-0.22520	***	-0.26010	***
		(0.03850)		(0.04440)		(0.04390)		(0.04570)	
	GDP SQ	0.00005	***	0.00003	***	0.00003	***	0.00004	***
		(0.00001)		(0.00001)		(0.00001)		(0.00001)	
Control variables		Time trend		Time trend Urbanization		Time trend Urbanization Population		Time trend Urbanization Population CPI	
Obs.		100		100		100		93	

Note: Robust standard errors clustered at the country level in brackets. Star levels denote significant levels at (*) 10%, (**) 5% and (***) 1%.

Appendix

Table A1: Descriptive statistics for dependent variables

	Obs	Mean	Std. Dev.	Min	Max
Average BMI	115	23.067	2.164	18.92	29.846
Concentration index (BMI)	100	0.0197	0.0107	-0.0064	0.0388
Share with BMI>25 (overweight)	115	0.256	0.1809	0.0195	0.7899
Concentration index (overweight)					
Share with BMI>30 (obese)	115	0.0811	0.0881	0.001	0.4469
Concentration index (obese)	100	0.35	0.2061	-0.0409	0.8332

Table A2: Descriptive statistics for independent variables at the aggregated level

Variable	Obs	Mean	Std. Dev.	Min	Max
Time (year)	115	2000	5	1991	2008
Per capita GDP ($)	115	930.96	1020.5	124.85	5115.1
Urbanization (rates)	115	3.4348	1.9170	-2.5251	14.993
Population (thousands)	115	37,500	106,000	497	1,090,000
Consumer Price Index	108	73.634	32.38366	0.0501	143.11