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Overweight and obesity in low- and middle income countries: A panel-data analysis

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Abstract

The rather small literature on obesity in developing countries mainly uses descriptive statistics and cross section analysis to focus on rising income levels as the source of rapidly increasing obesity rates. This paper uses a new panel dataset comprised of WHO and World Bank data for 126 low- and middle income countries to focus on rapid and urbanization as the main driver of rising obesity levels. The results of the fixed effects estimation suggest that urbanization and lifestyle changes associated with the "Nutrition Transition" are responsible for the phenomenon. Moreover, time invariant effects such as tradition and culture account for the differences in overweight and obesity rates across countries. These findings raise new questions and open up paths for further research and can also lead to direct policy implications drawn from the "Urban Agriculture" literature.

1. Introduction

Rising obesity rates in recent years and the health risks associated with the phenomenon have been well documented in the literature. High body fat exposes individuals to health risks such as diabetes, hypertension and cardiovascular disease (Mokdad et al., 2001). While this phenomenon is mostly encountered in industrialized countries, developing countries are closing in and in many cases overtaking them in the prevalence of overweight and obesity. According to the World Health Organization (WHO) obesity is the epidemic of the 21st century. This seems to affect especially women in adulthood (Martorell et al., 1998; Marini and Gragnolati, 2006). As a result they and also their children are exposed to the aforementioned health risks[1] (Anderson, Butcher and Levine, 2003). Therefore, it is crucial to target women and especially mothers and caregivers, so as to prevent the spread to future generations.

Many researchers refer to the "nutrition transition" hypothesis as the main source of rising obesity rates. This hypothesis states that innovations in the food industry have made high-fat food cheaper in relation to traditional food and that societies in developing countries move towards more sedentary lifestyles (Lakdawalla and Philipson, 2002; Popkin, 1999; Popkin, 2003). However, empirical evidence that cover this hypothesis is scarce. So far the literature focuses on income levels (Martorell et al., 2000, Popkin, 2003; Monteiro et al., 2004), arguing that higher incomes drive obesity rates. However, these studies are conducted at the cross sectional level and mainly rely on descriptive statistics. The nutrition transition hypothesis itself is taken as granted and very little empirical evidence is provided. This paper aims at diverting attention from income levels and highlighting other factors such as urbanization, structural changes in the economy, health provision and cultural factors as potential sources of the phenomenon.

Although these rising trends are clearly based on individual choices and behaviors, country level data may offer valuable insight on the mechanisms behind it. Furthermore, the use of panel data (which are extremely rare on the micro-level) allows us to control for unobserved heterogeneity and time invariant characteristics, in order to focus on the real effect of changes in income and urbanization levels. This also allows us to take genetic and cultural differences into account. Several studies argue that the phenomenon is viewed differently in various regions and societies and may even be

[1] Children are heavily dependent on their mother's care and also adapt to certain obesogenic behaviors. Thus, a link between obese mothers and obese children has been established in the literature (Anderson, Butcher and Levine, 2003; Fertig, Glomm and Tchernis, 2009; and others).

regarded as a positive outcome in some cultures (Brown, 1991; Ulijaszek and Lofink, 2006; Case and Menendez, 2009). The views of a society changes rather slowly and can therefore be captured by the fixed effects component. Moreover, one can safely assume that cultural factors can be correlated with GDP levels, through institutions for instance (Tabellini, 2010). This provides another argument for the use of panel data instead of cross sectional, in order to account for this as well and overcome some of the shortcomings of cross section analyses (Wooldridge, 2002a).

In 2010 the WHO completed a database on global obesity rates starting in 2002 (Ono, Guthold and Strong, 2010). To our knowledge, these data have not been used yet for examining the drivers of global obesity rates. Therefore, this study uses the Global Obesity Infobase to present the case, that rapid and uncontrolled urbanization and the underlying factors associated with it, should be considered among the main drivers of the sharply rising obesity shares and that cultural differences across regions and other time invariant characteristics account for a very large part of the differences observed across the globe.

The remainder of the paper introduces a conceptual framework and a literature review in Section 2. Section 3 provides an overview of the dataset and some descriptive statistics, whereas the results of the analysis are presented in Section 4. Finally, Section 5 summarizes and gives some policy implications.

2. Conceptual Framework and Literature Review

This paper follows a simple framework, where aggregate welfare is function of income and health. The health status is in turn determined and affected negatively by a high body weight.

$$\boldsymbol{W = f(Income, Health\,(Obesity^{-}))}$$

Obesity is caused by a chronic imbalance between daily caloric intake and expenditure. If the intake exceeds expenditure over longer periods of time, body weight increases:

$$\boldsymbol{CI_t > CE_t}$$

where CI denotes caloric intake and CE stands for caloric expenditure. It is also assumed that a high imbalance in period t_o will lead to increased body weight in the

next period t_1. Increasing body weight leads in turn to overweight and eventually obesity.

Although the BMI ($Body\ Mass\ Index = \frac{Weight}{Height^2}$) is far from perfect as a measure of overweight and obesity among adults[2], it is widely used in the literature, because of its simplicity and ease of measurement. In general, a BMI>25 indicates overweight, while a BMI >30 indicates obesity (WHO/ FAO (2003)).

Most studies argue that obesity rates in developing countries are driven by rising income levels (Martorell et al., 2000). This holds especially for middle-income countries. The mechanism behind this fact is connected to generally lower prices of high-fat food and a clear preference towards it (Cutler et al., 2003). Moreover, higher income levels allow increased imports or production of such food types, since the demand is there. It is safe to assume that the availability of various food types has an impact on dietary habits. On the other hand, higher income is also linked to preferences towards a "healthier" lifestyle. In most developed countries the higher income groups tend to avoid sedentary lifestyles and are therefore less obese compared to the lower income groups (Lakdawalla and Philipson, 2002). Furthermore, the income level at which obesity among women occurs is getting lower, which is in line we the picture we obtain in industrialized countries (Monteiro et al., 2004).

In micro-level studies conducted for individual developing countries, the effects of household income levels differ across countries. Abdulai (2010), for instance, finds a positive non-linear relationship between household expenditures and obesity rates among women. This suggests that at the higher end of the income distribution, obesity may even decline. Moreover, Wittenberg (2013) reveals a mixed picture between household income and the mean BMI across population groups in South Africa, whereas Römling and Qaim (2012) find a clear positive relationship between household expenditures and the BMI. Fernald (2007) on the other hand presents the case that the socioeconomic status is only positive among the poorest households in Mexico.

A part of the literature also argues that obesity in developing countries can be mostly found in urban areas (Popkin, 1999; Subramanian et al., 2011). The reasons behind this, is that, first of all, high-fat food is available in higher quantities and lower prices in large cities. Besides that, higher urbanization is also a result of a development process and rising incomes. Moreover, lack of space in large cities prohibits -especially among the

[2] See Cawley and Burkhauser (2008) for more on the subject

poorer groups- the production and consumption of own-produced fruits and vegetables. Furthermore, living in urban areas raises the probability to be employed in the service sector, in an occupation, that requires less physical activity. Finally, overall changes to a more sedentary lifestyle are closely linked to residing in urban areas (shorter distances and means of transportation, availability of television or radio, or staying at home due to higher crime rates). Therefore, rapid and uncontrolled urbanization is linked with both, higher calorie intake and lower calorie expenditure.

The role of education is not that clear. Part of the literature argues that education has positive externalities[3] and raises awareness on the health risks connected with obesity. On the other hand, it might be the case that higher education leads to higher income levels and also higher employment in the service sector, which in turn requires less physical activity.

The situation is clearer, when we look at medical provision. One can safely assume that higher medical provision raises awareness on the health risks associated with obesity and also encourages recreational physical activity.

Finally, we expect that structural changes in the economy have an effect on nutritional outcomes through both, caloric intake and expenditure. An economy that moves from agricultural production towards services can arguably lead to lower physical activity levels, on the one hand, and to rising incomes on the other.

Many of the economic studies cited tend to neglect a very important factor in their empirical analyses. Cultural differences are essential in explaining the differences in obesity rates around the globe. Many authors from other fields have focused on this issue and have argued that obesity is regarded differently in various cultures (Brown, 1991; Ulijaszek and Lofink, 2006) and thus socioeconomic variables may also have varying impacts through different channels across regions and cultures. This is especially the case, if a higher body weight is seen as a positive outcome in some cultures and a negative one in others.

[3] Gibson (2001) and Monteiro et al. (2004)

3. The Data

This study uses a dataset for 126 low- and middle-income countries, constructed by using WHO and World Bank data. The variables for overweight and obesity are provided by the World Health Organization for 2002, 2005 and 2010 (Ono, Guthold and Strong, WHO Global Comparable Estimates, 2010). All other variables are taken from the World Bank databases[4] for the years 1996-2009. They have been aggregated into period averages (1996-2001, 2002-2004 and 2005-2009), in order to deal with missing observations and to balance the panel.

The dependent variable is the prevalence of overweight or obesity for female adults aged over 30 in each country. The main explanatory variables are income, given by the natural logarithm of the Gross Domestic Product per capita, PPP, in constant 2005 US$, and urbanization, given by the share of the population living in urban areas. Controls for education levels and health care are also used. For education, the secondary school enrollment rates are included. Furthermore, health care provision is proxied by the number of hospital beds per thousand people and for robustness checks by the number of physicians per thousand people. Finally, the value added of services as a share of GDP[5] and the food imports as a share of GDP are used to account for structural changes in the economies.

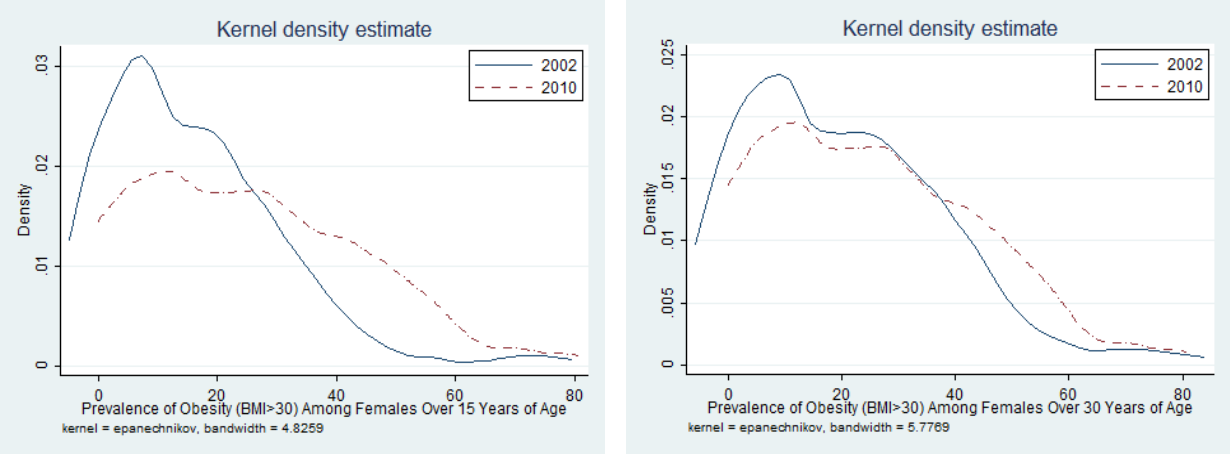
Further robustness checks include the same specifications for females aged over 15, as well as regressions for men of both age groups. Additionally, we run Pooled OLS regressions with the inclusion of the lagged share of overweight and obesity. Moreover, this paper uses a few other control variables, which include the Gini Index of Inequality and the KOF Index of Globalization[6]. However, they are dropped from the final specifications, because the number of observations drops substantially due to missing values and the main results do not really change. A final robustness check is to drop Oceania as a region, because it exhibits extremely high shares of overweight and obesity and may bias the results. All of these can be seen in the Appendix A1.

4 http://data.worldbank.org/indicator
5 For robustness we also use the share of agriculture in GDP
6 Dreher (2006). Available at: http://globalization.kof.ethz.ch/

3.1 Stylized Facts

In the period between 2002 and 2010 obesity among women aged over 30 rose by 21.4% to average almost 25% in the sample. The same trend occurs for both sexes. On average, overall prevalence of obesity in 2010 for men and women made its mark at 17.8%. The Kernel density estimations in Figure 1 show a very clear shift to the right. A similar pattern is observed, when the younger population is included (aged over 15). It is a clear indication that body weight increases rapidly all over the developing world.

Figure 1: Prevalence of female obesity 2002-2010



Note: Own calculation using the WHO Global Infobase. The prevalence of obesity among females aged 15+ and 30+ in the sample

In Table 1 we present the overweight and obesity rates for each age group across regions. It can be seen that the regions with the highest rates are Latin America and the Caribbean, Oceania and the MENA region. However, the prevalence of obesity increased across all regions at an alarming rate. In SSA for instance, the rates increased by over 33% among females aged over 30. In LAC on the other hand, obesity rose by 25-30% in both age groups.

During the same period, the urban population also increased. In 2001 about 45% of the total population in these 126 countries lived in urban areas. This figure rose by 3 percentage points in 2009. In very few countries did the share of urban population stagnate or retreat and in most cases a sharp rise could be observed. Especially in some South and Southeast Asian countries the share increased by more than 8 percentage points[7].

[7] World Bank Data

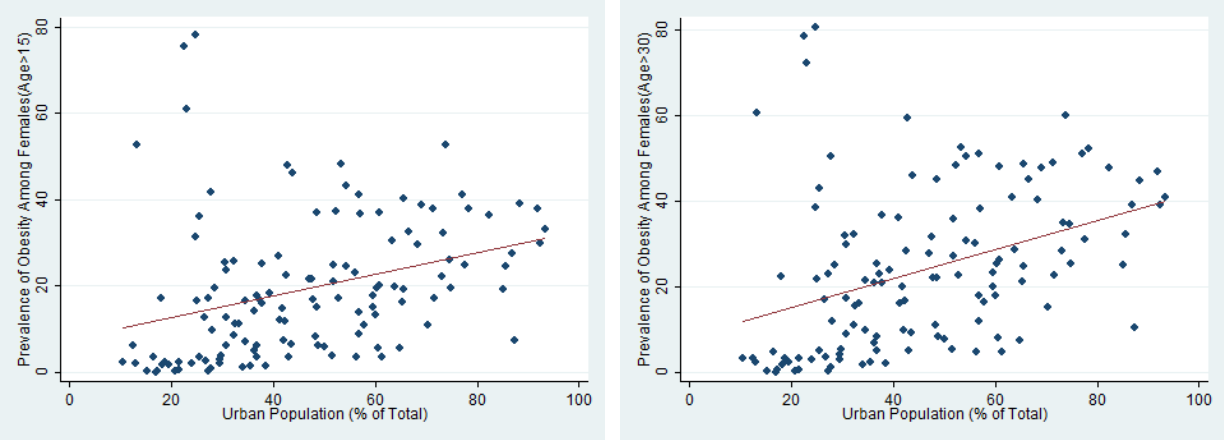
Table 1: Prevalence of overweight and obesity across regions

Region	Year	Overweight 30+ Years	Overweight 15+ Years	Obese 30+ Years	Obese 15+ Years
Sub- Saharan Africa	2002	36.91%	30.94%	9.72%	7.32%
	2005	38.98%	32.90%	10.91%	8.28%
	2010	42.24%	36.02%	12.94%	9.91%
Latin America and Caribbean	2002	66.41%	58.79%	30.35%	23.56%
	2005	68.63%	61.30%	33.34%	26.26%
	2010	72.20%	65.54%	38.70%	31.23%
East- and Southeast Asia	2002	32.42%	25.98%	5.92%	4.18%
	2005	35.07%	28.36%	7.01%	4.97%
	2010	40.18%	33.00%	9.29%	6.68%
South Asia	2002	25.18%	20.03%	6.89%	4.85%
	2005	26.81%	21.44%	7.63%	5.40%
	2010	29.83%	24.16%	9.01%	6.41%
Central Asia	2002	58.20%	47.20%	20.22%	14.93%
	2005	59.48%	48.57%	21.65%	16.20%
	2010	60.87%	50.00%	23.35%	17.83%
Middle East and North Africa	2002	64.01%	54.02%	31.51%	23.39%
	2005	65.28%	55.41%	32.95%	24.68%
	2010	67.55%	57.91%	35.69%	26.98%
Oceania	2002	67.87%	64.11%	40.86%	35.89%
	2005	69.44%	65.90%	42.79%	37.82%
	2010	71.92%	68.79%	45.92%	41.02%

Note: Own calculations using the WHO Global Infobase. Overweight is defined as BMI>25 and Obesity as BMI>30

Figure 2 shows the correlation in the cross section between the share of the population living in urban areas in 2009 and the overweight and obesity rates in 2010.

Figure 2: Correlation between obesity and urbanization



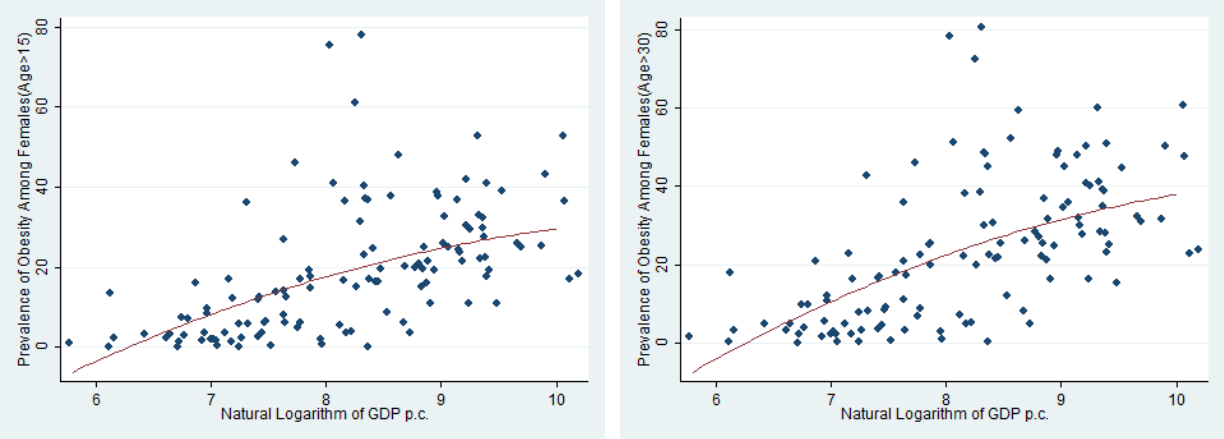
Note: Own calculation using the WHO Global Infobase and World Bank data. The prevalence of obesity among females aged 15+ and 30+ and the share of people living in urban areas.

A clear positive correlation can be identified. The outliers correspond to Pacific-Island countries that have high obesity rates and low levels of urbanization[8]. Heteroscedasticity may also be of some concern, but we use robust standard errors in the regressions. Furthermore, the same pattern emerges, when the data for 2001-2002 and 2004-2005 are used. The same picture, if not even clearer, is obtained, when overweight is used on the Y-Axis.

Figure 3 shows the correlation between obesity rates and the natural logarithm of per capita income, expressed by the GDP per capita, PPP, 2005 US$ (2010). In the cross section, a clear positive relationship can be confirmed. This is in line with the findings of Popkin (2003). The outliers are again countries located in Oceania. Removing them provides a better fit, but does not change the overall picture.

[8] Removing them will provide a better fit for the line, but the main point remains unchanged.

Figure 3: Correlation between obesity and income (2010)



Note: Own calculation using the WHO Global Infobase and World Bank data. The prevalence of obesity among females aged 15+ and 30+ and the natural logarithm of GDP per capita adjusted for PPP, in constant 2005 US dollars

However, a cross section analysis neglects unobserved heterogeneity between countries and time invariant factors that may have driven obesity rates for years. The real question is what the net effects of rising incomes look like. In order to provide an answer, a simple regression with fixed effects is considered, in order to also take a look at the within variation. Therefore, the following equation is estimated[9]:

$$\boldsymbol{Y_{it} = \alpha + \beta X_{it} + \gamma Z_{it} + T_t + u_i + v_{it}}$$

where u_i is the fixed effect component, X_{it} are the main variables of interest (GDP and Urbanization), Z_{it} are control variables, T_t are time dummies and v_{it} is the error term.

Since obesity can take some time to develop, it is assumed that any influence each parameter has, occurs in the next period. This effectively means that the period average of income between 2001 and 2004 is associated with the obesity rate of 2005. With this technique the model gains a dynamic component and some missing observations are filled in. All equations are estimated for females aged over 30 and report t-statistics derived from heteroscedasticity robust standard errors, clustered at the country level.

[9] The analysis follows the guidelines provided by Wooldridge (2002a; 2002b) and McCaffrey et al. (2012).

4. Empirical Results

The analysis is based on the results of the fixed effects panel regression with robust standard errors, in order to correct for heteroscedasticity. The fixed effects account for time-invariant characteristics across countries, such as culture, tradition, genetic differences or the acceptance of obesity in each society.

A first glance at the results in Table 2 reveals that there is a positive and significant relationship between per capita income and overweight rates. Since a non-linear relationship is not confirmed in the first specification we drop the squared term for all other specifications. Changes in the level of a country's per capita income seem to positively affect female overweight in Column 2. However, adding further controls in Column 3 renders the coefficient insignificant. Furthermore, the inclusion of year dummies in the final specification turns the coefficient of the natural logarithm of GDP per capita to be negative and significant. This suggests that despite common belief, increasing income levels result in lower overweight rates among females for both age groups, after controlling for country- and time fixed effects. Urbanization on the other hand is positive and significant for all specifications. The size of the coefficient is also relative high. However, adding the year dummies causes the coefficient to drop sharply. This finding suggests that there are unobserved factors that vary over time, are common for all countries and are associated with the share of the population residing in urban areas. Further research that focuses on urban areas is required to identify these factors, in order to draw policy implications.

Better health provision is negatively correlated with overweight in Column 3. However, the coefficient is not significant. What female education is concerned, the coefficient is positive and significant, but this may be a spurious correlation, since the coefficient turns insignificant in Column 4 when the year dummies are added. On the other hand, the share of services in GDP and food imports are insignificant for all specifications. Finally, the year dummies are highly significant at the 1% level. This fact might provide evidence that a worldwide transition, such as the “Nutrition Transition”, takes place and leads to increasing body weights. Further research is required to determine what factors drive obesity rates and turn the sign of income levels negative.

Table 2: Fixed effects estimation for the share of overweight women aged over 30

	(1)	(2)	(3)	(4)
ln(GDP p.c.)	3.3114	4.0459***	1.3331	-3.9185**
	(0.482)	(3.650)	(0.798)	(-2.103)
ln(GDP p.c.) squared	0.0441			
	(0.109)			
Urban	0.8814***	0.8801***	0.7602***	0.3946***
	(11.025)	(11.146)	(5.374)	(3.123)
Female Schooling			0.1014***	0.0317
			(2.773)	(0.962)
Hospital Beds			-0.3219	-0.1361
			(-1.418)	(-0.524)
Services			0.0719	-0.0096
			(1.328)	(-0.212)
Food Imports			-0.0813	-0.0096
			(-1.113)	(-0.158)
Year 2005				1.4120***
				(3.317)
Year 2010				4.2880***
				(5.569)
Observations	369	369	200	200
Countries	124	124	103	103
R-squared (within)	0.588	0.588	0.643	0.782
Rho	0.9911	0.9911	0.9902	0.9953

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

These results hold, when alternate samples, specifications or variable definitions are estimated[10]. Therefore, the results are considered robust. It is also worth noting, that adding the control variables reduces the number of observations, since they are not available for all countries and time periods. Still, there is no reason to believe that any systematic bias occurs.

The situation changes when considering obesity (BMI>30) in Table 2. In these regressions income shows a clear non-linear negative relationship with obesity rates among females. The turning point is well outside of the sample and lies at over 20,000$ per capita. Urbanization, on the other hand, is positive and highly significant in the first two specifications. However, the coefficient becomes negative and also turns insignificant, when the time dummies are added. This leads to the conclusion that factors associated with large populations in urban areas that are common for all countries and vary over time lead to increasing obesity rates. However, there are

[10] See Appendix.

significant regional differences what the effects of urbanization on obesity rates is concerned, as shown in Column 4. The interaction terms show that the impact of higher share in urban population varies across regions (or cultures), with East- and Southeast Asia being the left out category.

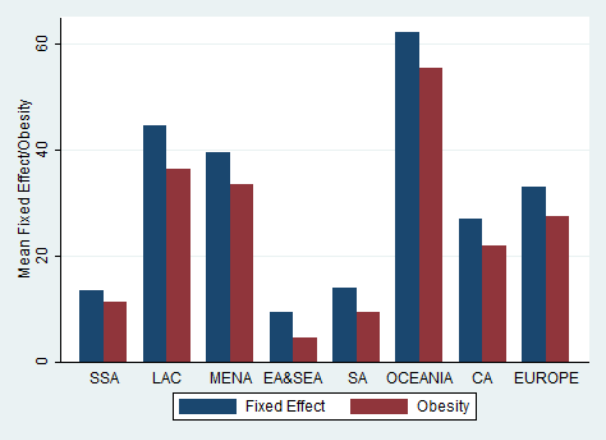
Table 3: Fixed effects estimation for the share of obese women aged over 30

	(1)	(2)	(3)	(4)
ln(GDP p.c.)	-24.8980***	-50.3940***	-49.3305***	-48.3553***
	(-2.763)	(-3.276)	(-4.082)	(-5.133)
ln(GDP p.c.) squared	1.7421***	3.0668***	2.5018***	2.5499***
	(3.099)	(3.173)	(3.282)	(4.690)
Urban	0.7147***	0.5842***	0.0058	-0.0105
	(7.187)	(3.147)	(0.042)	(-0.106)
Female Schooling		0.1442***	0.0305	0.0281
		(2.716)	(0.670)	(0.872)
Hospital Beds		-0.5767**	-0.2969	-0.0930
		(-1.991)	(-0.962)	(-0.330)
Services		0.0435	-0.0991	-0.1071**
		(0.540)	(-1.660)	(-2.255)
Food Imports		-0.1480	-0.0322	-0.1175
		(-1.344)	(-0.441)	(-1.287)
Year 2005			2.2798***	2.1641***
			(4.562)	(4.623)
Year 2010			6.8788***	6.2605***
			(7.614)	(6.779)
Urban*SSA				-0.2378
				(-0.806)
Urban*LAC				0.6712**
				(2.293)
Urban*MENA				-0.6800**
				(-2.380)
Urban*EUR				-1.4426***
				(-8.305)
Urban*SA				-0.0180
				(-0.148)
Urban*CA				-4.3676***
				(-3.384)
Urban*OCEANIA				0.6877***
				(2.722)
Observations	369	200	200	200
Countries	124	103	103	103
R-squared	0.421	0.503	0.763	0.850
Rho	0.9857	0.9789	0.9954	0.9993

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Furthermore, it is noticeable that most of the variance comes from the fixed effects[11]. The α_i accounts for more than 97% of the variance as indicated by rho. This practically means that the largest part of the deviation from the estimated mean is due to country specific characteristics that do not vary over time. An interpretation of this could be that time invariant factors such as culture or the standing of obesity in a society explain the largest part of the differences in overweight and obesity rates around the globe. In that regard, Figure 4 shows the mean of the fixed effects component across regions.

Figure 4: The average fixed effect per region



Note: Own calculation. The mean of the predicted $\alpha_i = const + u_i$ estimated from a modified version of the 3rd specification of Table 1.2. The GDP p.c. was used instead of its natural logarithm.

We clearly observe large differences in the fixed effects component across regions. An implication of this finding may be that policy should target each country individually. There does not seem to be a recipe that can be applied to all countries or regions. This suggests that the phenomenon should be further investigated using micro-level household data for individual countries. However, it is undeniable, that higher urbanization rates and other related factors are to some extent responsible for the rapidly spreading global obesity epidemic and also that economic development and increasing income levels seem to reduce the share of obesity.

[11] The fixed effects model performs better, than a random effects model (as expected), as the Hausman test suggests for all specifications.

5. Concluding Remarks

This paper used a new panel dataset on overweight and obesity in low- and middle-income countries to identify some of the drivers behind the rising global obesity trends. The results suggest that, contrary to common belief, the net effect of rising per capita income seems to be negative, when we account for fixed effects. These time invariant factors (tradition, culture) etc. explain the largest part of the differences in obesity rates across countries. This component varies largely across regions, indicating that either genetic or cultural differences clearly play a much larger role compared to the level of economic development. Regardless, economic development and increasing income levels do not seem to further increase obesity rates in the developing world as previously suggested by cross sectional studies.

Nevertheless, some economic factors seem to be associated with the increasing prevalence rates. Higher urbanization is a possible source of increasing weight and its effects also vary substantially across regions. The implications of these findings are twofold. First, it gives researchers the incentive to further investigate the phenomenon on the micro-level in individual countries focusing mainly in urban areas. Secondly, direct policy implications can be drawn. There exists a large literature supporting and promoting urban and peri-urban agriculture (UPA). Policymakers could look into this concept, in order to deal with problems in the nutritional status of urban populations and the provision of low price, low calorie food items. Moreover, the fact that cultural aspects and a positive view of obesity in several societies clearly play an important role renders health education programs essential in changing these perceptions and effectively reducing obesity rates. Finally, new paths for research are opened, due to the fact that the year dummies have a positive and significant impact on obesity rates. This finding suggests that factors common to all countries that changed over time have driven the weight gain of the world population.

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APPENDIX

Table A1: Descriptive statistics

	2002			2005			2010		
	Mean	S.E	Obs.	Mean	S.E.	Obs.	Mean	S.E.	Obs.
Overweight 15+	42.78	19.65	126	44.67	19.83	126	47.88	20.03	126
Overweight 30+	49.74	21.18	126	51.64	21.13	126	54.75	20.92	126
Obesity 15+	15.25	13.98	126	16.65	14.69	126	19.15	16.02	126
Obesity 30+	19.66	16.64	126	21.28	17.32	126	24.14	18.56	126
GDP p.c., PPP, 2005 US$	4275.1	4173.8	122	4656.2	4512.6	123	5503.9	5349.1	124
Urbanization	42.73	20.49	126	44.00	20.67	126	45.74	20.86	126
Female Schooling	52.11	31.02	105	56.98	31.67	111	62.85	30.35	117
Schooling	51.01	27.01	100	56.04	28.12	106	61.67	26.99	111
Hospital Beds per 1000	2.884	2.454	59	2.483	2.111	79	2.129	1.795	117
Physicians per 1000	1.071	1.101	95	1.143	1.257	64	0.906	1.128	107
Services in GDP	50.41	13.63	120	50.73	13.93	123	51.39	14.59	119
Agriculture in GDP	21.52	14.28	120	19.74	13.86	123	17.12	12.24	119
Food Imports	17.13	7.82	111	16.77	8.34	108	15.40	7.58	109
KOF Index	43.07	11.54	123	45.38	11.43	124	48.38	11.33	124
GINI	45.07	9.13	70	44.47	8.80	64	42.44	8.62	80

Note: Own calculations using WHO, World Bank and KOF Data.

Table A2: List of countries

Afghanistan
Algeria
Angola
Antigua and Barbuda
Argentina
Armenia
Azerbaijan
Bangladesh
Belarus
Belize
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Brazil
Burkina Faso
Burundi
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
Chile
China
Colombia
Comoros
Dem. Rep. of Congo
Rep. of Congo
Costa Rica
Cote d'Ivoire
Djibouti
Dominica
Dominican Rep.
Ecuador
Egypt
El Salvador
Eq. Guinea
Eritrea
Ethiopia
Fiji
Gabon
Gambia
Georgia
Ghana
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Honduras
India
Indonesia
Iran
Jamaica
Jordan
Kazakhstan
Kenya
Kiribati
Kyrgyz Rep.
Lao PDR
Lebanon
Lesotho
Liberia
Libya
Madagascar
Malawi
Malaysia
Maldives
Mali
Mauritania
Mauritius
Mexico
Micronesia Fed. St.
Moldova
Mongolia
Morocco
Mozambique
Myanmar
Namibia
Nepal
Nicaragua
Niger
Nigeria
Oman
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Rwanda
Samoa
Sao Tome and Principe
Saudi Arabia
Senegal
Seychelles
Sierra Leone
Solomon Islands
South Africa
Sri Lanka
St. Kitts and Nevis
St. Lucia
St. Vincent and Grenadines
Sudan
Suriname
Swaziland
Syria
Tajikistan
Tanzania
Thailand
Timor Leste
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkmenistan
Uganda
Uruguay
Uzbekistan
Vanuatu
Venezuela
Vietnam
Yemen
Zambia
Zimbabwe

Table A3: Fixed effects estimation for the share of overweight females over 15 years of age

	(1)	(2)	(3)	(4)
ln(GDP p.c.)	-3.3882	4.3356***	1.6601	-4.7037**
	(-0.488)	(3.794)	(0.893)	(-2.446)
ln(GDP p.c.) squared	0.4639			
	(1.120)			
Urban	0.8817***	0.8685***	0.7587***	0.3152**
	(10.352)	(10.476)	(4.949)	(2.465)
Female Schooling			0.1117***	0.0269
			(2.727)	(0.751)
Hospital Beds			-0.4090*	-0.1812
			(-1.677)	(-0.683)
Services			0.0542	-0.0449
			(0.855)	(-0.880)
Food Imports			-0.0909	-0.0040
			(-1.089)	(-0.060)
Year 2005				1.7351***
				(3.838)
Year 2010				5.2092***
				(6.208)
Observations	369	369	200	200
Countries	124	124	103	103
R-squared	0.567	0.565	0.613	0.791
Rho	0.9905	0.9903	0.9881	0.9951

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Table A4: Fixed effects estimation for the share of obese females over 15 years of age

	(1)	(2)	(3)	(4)
ln(GDP p.c.)	-24.1831***	-49.4325***	-48.3343***	-45.7794***
	(-2.760)	(-3.185)	(-3.995)	(-4.851)
ln(GDP p.c.) squared	1.6785***	3.0324***	2.4793***	2.4292***
	(3.032)	(3.135)	(3.279)	(4.464)
Urban	0.5916***	0.4952***	-0.0689	-0.1083
	(6.508)	(2.727)	(-0.522)	(-1.041)
Female Schooling		0.1177**	0.0054	0.0067
		(2.381)	(0.130)	(0.222)
Hospital Beds		-0.5626*	-0.2795	-0.0865
		(-1.972)	(-0.999)	(-0.348)
Services		0.0242	-0.1161**	-0.1206**
		(0.316)	(-2.090)	(-2.550)
Food Imports		-0.1131	-0.0006	-0.0790
		(-1.081)	(-0.009)	(-0.936)
Year 2005			2.3169***	2.1646***
			(4.821)	(4.722)
Year 2010			6.7413***	6.0542***
			(7.675)	(6.607)
Urban*SSA				-0.2077
				(-0.777)
Urban*LAC				0.6967**
				(2.361)
Urban*MENA				-0.6080**
				(-2.267)
Urban*EUR				-1.2219***
				(-6.987)
Urban*SA				0.0068
				(0.054)
Urban*CA				-3.6548***
				(-2.786)
Urban*OCEANIA				0.7821***
				(3.321)
Observations	369	200	200	200
Countries	124	103	103	103
R-squared	0.384	0.459	0.747	0.837
Rho	0.9844	0.9754	0.9951	0.9992

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Table A5: Fixed effects estimation for the share of overweight males over 30 years of age

	(1)	(2)	(3)	(4)
ln(GDP p.c.)	-2.1300	5.0283***	3.8074	0.4637
	(-0.240)	(3.648)	(1.403)	(0.134)
ln(GDP p.c.) squared	0.4299			
	(0.827)			
Urban	0.7128***	0.7005***	0.4084**	0.1677
	(6.504)	(6.591)	(2.018)	(0.695)
Schooling			0.1611***	0.1036*
			(3.181)	(1.940)
Hospital Beds			-0.0682	0.0330
			(-0.270)	(0.129)
Services			0.0288	-0.0176
			(0.401)	(-0.260)
Food Imports			0.0124	0.0962
			(0.101)	(0.840)
Year 2005				0.5982
				(0.799)
Year 2010				2.8907**
				(1.992)
Observations	369	369	189	189
Countries	124	124	98	98
R-squared	0.467	0.465	0.541	0.606
Rho	0.9864	0.9861	0.9783	0.9877

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Table A6: Fixed effects estimation for the share of obese males over 30 years of age

	(1)	(2)	(3)	(4)
ln(GDP p.c.)	-20.6801***	-32.3151***	-36.2450***	-27.2026***
	(-2.897)	(-2.728)	(-3.512)	(-2.946)
ln(GDP p.c.) squared	1.4038***	2.0008***	1.9425***	1.4599***
	(3.099)	(2.793)	(3.148)	(2.751)
Urban	0.3700***	0.2512*	-0.1128	-0.2260
	(4.754)	(1.710)	(-0.797)	(-1.225)
Schooling		0.1364**	0.0427	0.0304
		(2.610)	(0.786)	(0.755)
Hospital Beds		-0.3667	-0.1596	-0.0283
		(-1.282)	(-0.697)	(-0.125)
Services		-0.0572	-0.1327**	-0.1255**
		(-0.805)	(-2.081)	(-2.307)
Food Imports		0.0582	0.1717**	0.0385
		(0.593)	(2.013)	(0.462)
Year 2005			1.3884**	1.4262***
			(2.457)	(2.759)
Year 2010			4.5142***	3.9053***
			(4.210)	(3.889)
Urban*SSA				-0.1240
				(-0.556)
Urban*LAC				0.9855***
				(3.115)
Urban*MENA				-0.6228**
				(-2.159)
Urban*EUR				-0.6693***
				(-2.875)
Urban*SA				0.1698
				(0.848)
Urban*CA				-1.3341
				(-1.041)
Urban*OCEANIA				0.8113***
				(2.999)
Observations	369	189	189	189
Countries	124	98	98	98
R-squared	0.287	0.405	0.594	0.736
Rho	0.9809	0.9615	0.9905	0.9986

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Table A7: Fixed effects estimations for females over 30 years of age

	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity
ln(GDP p.c.)	-4.1107**	-43.7109***	-5.5836***	-49.2110*	-4.3594**	-52.7836***
	(-2.039)	(-2.955)	(-2.711)	(-1.857)	(-2.341)	(-5.210)
ln(GDP p.c.) squared		2.2069**		2.3154		2.8107***
		(2.493)		(1.416)		(4.341)
Urban	0.3851***	-0.0195	0.4217*	-0.1902	0.3394***	-0.1460
	(3.093)	(-0.141)	(1.931)	(-0.791)	(2.694)	(-1.002)
Female Schooling	0.0268	0.0247	0.1299*	0.1619**	0.0562	0.0623
	(0.824)	(0.565)	(1.881)	(2.087)	(1.188)	(1.060)
Hospital Beds	-0.1523	-0.3565	-0.1324	-0.7473*		
	(-0.553)	(-1.093)	(-0.375)	(-1.843)		
Physicians					-0.8019	-0.6060
					(-1.407)	(-0.749)
Services	-0.0084	-0.0870	0.0184	-0.1146**		
	(-0.183)	(-1.462)	(0.363)	(-2.088)		
Agriculture					-0.0148	0.0108
					(-0.171)	(0.115)
Food Imports	0.0190	-0.0168	0.0134	-0.0375	-0.0644	0.0478
	(0.346)	(-0.233)	(0.082)	(-0.174)	(-1.041)	(0.673)
Globalization	-0.0098	-0.1106				
	(-0.102)	(-0.805)				
GINI			0.0600	-0.0095		
			(0.993)	(-0.107)		
Year 2005	1.5430***	2.4616***	1.2177	1.7510*	1.3991***	2.5050***
	(3.749)	(5.046)	(1.515)	(1.946)	(3.442)	(4.864)
Year 2010	4.5962***	7.3954***	4.7133***	7.4583***	4.3886***	6.5228***
	(6.168)	(8.058)	(3.319)	(4.765)	(5.743)	(7.134)
Observations	197	197	123	123	201	201
Countries	102	102	75	75	100	100
R-squared	0.791	0.771	0.799	0.796	0.783	0.705
Rho	0.9953	0.9952	0.9914	0.9956	0.9944	0.9943

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Table A8: Fixed effects estimations for females over 30 years of age, excluding Oceania

	Overweight	Obesity	Obesity
ln(GDP p.c.)	-4.3314**	-49.7382***	-48.4067***
	(-2.246)	(-4.114)	(-5.123)
ln(GDP p.c.) squared		2.5464***	2.5402***
		(3.343)	(4.644)
Urban	0.3873***	-0.0312	-0.0146
	(3.203)	(-0.230)	(-0.142)
Female Schooling	0.0220	0.0451	0.0237
	(0.583)	(0.881)	(0.686)
Hospital Beds	-0.2105	-0.2906	-0.1173
	(-0.821)	(-0.921)	(-0.398)
Services	-0.0114	-0.0999	-0.1047**
	(-0.261)	(-1.660)	(-2.152)
Food Imports	0.0377	0.0059	-0.1295
	(0.526)	(0.067)	(-1.156)
Year 2005	1.5895***	2.0998***	2.2280***
	(3.218)	(3.587)	(4.520)
Year 2010	4.7499***	6.7114***	6.4240***
	(5.441)	(6.265)	(6.698)
Urban*SSA			-0.2683
			(-0.865)
Urban*LAC			0.6532**
			(2.205)
Urban*MENA			-0.7088**
			(-2.310)
Urban*EUR			-1.4268***
			(-7.964)
Urban*SA			-0.0159
			(-0.123)
Urban*CA			-4.4114***
			(-3.457)
Observations	186	186	186
Countries	98	98	98
R-squared	0.783	0.750	0.839
Rho	0.9949	0.9947	0.9993

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Table A9: Pooled OLS estimations for females over 30 years of age

	Overweight	Obesity
Obesity (lagged)		1.0497***
		(54.728)
Overweight (lagged)	0.9909***	
	(94.237)	
ln(GDP p.c.)	0.2507	2.0015
	(0.749)	(0.733)
ln(GDP p.c.) squared		-0.0917
		(-0.576)
Urban	0.0170**	0.0195*
	(2.311)	(1.745)
Female Schooling	0.0003	0.0037
	(0.038)	(0.369)
Hospital Beds	-0.3041***	-0.3663***
	(-3.429)	(-3.434)
Services	-0.0022	0.0062
	(-0.179)	(0.382)
Food Imports	0.0067	-0.0137
	(0.305)	(-0.539)
Globalization	-0.0055	-0.0212
	(-0.280)	(-0.787)
Year 2010	1.3602***	1.4124***
	(6.419)	(4.722)
Constant	0.3052	-8.9918
	(0.150)	(-0.852)
Observations	153	153
Countries	100	100
R-squared	0.996	0.991

*significant at 10%; ** significant at 5%; *** significant at 1%
Pooled OLS estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Year 2002 removed.