Does Social Globalization Through Access to Information Communication Technologies Drive Obesity Among Youth? An Empirical Analysis, 1990-2013

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Abstract

Scholars debate the effects of globalization on obesity. Using the latest data on access to ICTs and the Global Burden of Disease data on excess weight gain and obesity, we find that both social globalization and access to ICTs lower the overweight and obese share among the global youth cohort aged 15-19. Previous studies report mixed results, which are hard to evaluate because of the use of different data, sample sizes, and estimating strategies. Using fixed effects analyses on a global sample of over 160 countries spanning 24 years, we show that "social globalization" reduces the obesity share of youth when fixed effects are estimated. Greater access to ICTs also independently lowers youth obesity rates. We speculate that greater access to information and knowledge about current trends, the benefits of physical activity and diet, and trends in healthy consumption spreading through ICTs might be a boon despite risks associated with greater consumption from increasing wealth and democracy. These results are robust to several estimating methods, including instrumental variables analysis. Our results suggest that increased access to ICTs does not increase obesity and that policy might even usefully target youth via ICTs for encouraging better health.

Keywords: ICTs, social globalization, overweight, obesity

Introduction

Scholars of public health debate the effects of globalization and the liberalization of markets on human health, often highlighting the "lifestyle" and "habit" formation aspects of the global transformation of culture (Delpeuch, Maire, Monnier, & Holdsworth, 2009; Kawachi & Wamala, 2007; Maud, Martens, & Hilderink, 2005; Schrecker & Bambra, 2015). Exposure to global markets, many argue, changes life styles, food systems, and habits of consumption because corporate capitalism apparently peddles bad products and habits that come at the expense of health (de Vogli, Kouvonen, Elovainio, & Marmot, 2014; Delpeuch et al., 2009). The fast-food industry, advertising, car culture, as well as the adoption of technology and sedentary lifestyles are all likely to contribute to excess weight gain through a simple model explaining weight gain, which is calorie consumption over energy expenditure (Cutler, Glaeser, & Shapiro, 2003; Malik, Willett, & Hu, 2013). Some studies report that "social globalization" associates with excess weight gain and obesity (de Vogli et al., 2014). One very real way in which people become connected across the world is through the information and communications revolution associated with globalization. It is likely, thus, that harmful effects of globalization are transmitted across space faster and more robustly the more connected a society is to ICTs? Indeed, some make the claim that access to ICTs increases sedentariness and encourages excess calorie intake, an issue that is relatively less discussed than the availability of fast food (Chatterjee & DeVol, 2012). We examine this issue systematically by using the latest available data on access to ICTs among roughly 160 countries across the globe and overweight and obese shares of the population between the ages of 15 and 19 obtained from the Global Burden of Disease database (GBD). We expect arguments about ICTs and obesity to be manifested most strongly in a youth cohort because of the recency of this new technology and the susceptibility of youth to be harbingers of cultural change through more rapid adoption of technology.

Our results are easily summarized. Previous research on social globalization show positive effects on obesity only because they either fail to control for unmeasured country heterogeneity (de Vogli et al., 2014) or because they estimate fairly limited spatial and temporal domains (Costa-Font & Mas, 2016; Goryakin, Lobstein, James, & Suhrcke, 2015). Our fixed effects estimations, the workhorse technique for inferring causality, using roughly 160 countries over a 24-year period, show that social globalization decreases the share of obese youth as do access to both internet and mobile phones for a significantly extended sample of countries. These results are robust to a host of alternative models and estimating techniques. Substantively, the negative effects of access to ICTs are several times as large as the impact of increasing wealth and democracy. Our results support others that find that it is "modernization" (wealth and democracy) not globalization (connectivity and open borders), that predicts weight gain. Conditional effects between access to ICTs and increasing wealth show that access to ICTs along the wealth dimension increases obesity mostly at the bottom end of the income scale but has no discernible effect at the richer end of the income scale. A similar effect is observed for the conditional effect of access to ICTs and democracy, suggesting that ICT access might even mitigate some of the calorie-in/calorie-out balance associated with wealth and the personal freedoms associated with democracy. These results hold across many alternative specifications, estimating techniques, and a sample of only "non-Western" countries. The use of a unique instrument for ICT use, namely the density of lightning strikes, in 2-stage least-square IV estimations also show that mobile phone use lowers obesity rates, which is added evidence in support of a causal claim.

Theory

The change in a population´s physical appearance in terms of body size is a robust indicator of culture change carrying health consequences because body size indicates changes to the social

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environment, habits, tastes and consumption choices. Many argue that the trends in the transformation of body size might be associated with the diffusion of homogenizing values across the world (Appadurai, 1996; Ritzer, 2000). The incidence of excess weight gain and resultant diseases, such as heart disease and diabetes, are growing across the world (WHO, 2016). Currently, obesity related deaths in the developing world have overtaken the incidence of undernutrition-related morbidity (Loureiro & Nayga, 2005). The World Health Organization defines overweight and obesity as an abnormal or excessive accumulation of fat. The Body Mass Index (BMI) is usually applied to classify overweight and is defined as a person's weight divided by the square of height in meters (kg/m^2) (M. Ng et al., 2014; WHO, 2016). BMI equal to, or greater than 25, is classified as being overweight, while obesity is defined as a BMI greater than or equal to 30. A BMI between 20 and 25 is considered a "healthy" weight while a BMI below 20 is considered underweight (Cutler et al., 2003).

While gaining weight has historically been viewed as a sign of increasing health and wellbeing associated with increases in wealth, in the past decades the average body size in the West has risen so much that it is considered a health problem of epidemic proportion. Today, two-thirds of Americans and over 60% of the British population are overweight, leading to increased disease and loss of productivity at a time of soaring health-care costs (Economist, 2016). The same goes for all the member nations of the Organization for Economic Co-operation and Development (OECD), where the prevalence of obesity is rising rapidly. Asian countries with a traditionally low prevalence of overweight and obesity are catching up with the Western countries. China´s obesity rate doubled from 2002 to 2008 and went from 2.5 percent to 5.7 percent. India's obesity rate went from 0.7 percent in 1998 to 1.9 percent in 2008. This is a significant increase considering the large populations of these nations (Chatterjee & DeVol, 2012). For developing states especially these trends are an added burden on already overstretched resources.

The WHO (2016) reports that low- and middle-income countries might be facing a double burden of disease. In addition to the continuous fight against infectious diseases, these countries now experience burdens related to malnutrition and overweight and obesity. One longitudinal study of 166 males and 181 females conducted by Guo, Wu, Chumlea, and Roche (2002) shows that adolescents suffering from overweight and obesity are also at great risk of maintaining this condition also in adulthood. Adolescence is, therefore, a critical period which lays the foundations of future health levels of individuals (Guo et al., 2002). Yang and Hall (2008) found that the cost of assisting the obese or overweight elderly in need of medical care could amount to 4 hundred billion dollars in the US. The male overweight and obese cohort had respectively a 6 and 12.5 percent higher health care cost than the normal weight male cohort. Life quality among the elderly will also suffer, as obese 70-year-olds will live through 40 percent more time in disability compared to their normal-weight counterparts. While ICTs are now an intricate part of the economic success of states and permeate every aspect of our lives across the world, can these trends be related somehow to how lifestyle are being altered by access to the ICT revolution sweeping the globe? Can it be that the positive effect of "social globalization" on obesity rates reported by others is based on the spread of ICTs?

As countries integrate with the global market through a plethora of international trade agreements and diverse political commitments, governments´ ability to impose effective public policy combating over-consumption might be compromised as suggested by critic of globalization, such as John Gray (Ghosh, 1999). Grey argues that Multinational Corporations strive to change the preferences of the ruling political classes so that their interests are likely to reflect the interests of capital over communitarian values. Even several mainstream economists, such as Joseph Stiglitz and Dani Rodrik, argue that greater openness threatens the public interest because governments will be constrained from acting in the interests of social preferences due to pressures for conforming with market dictates (Rodrik, 1997; Stiglitz, 2002). Indeed, the

public health literature argues that increased globalization may affect health by increasing income and other inequalities between people (Kawachi & Wamala, 2007; Wilkinson & Pickett, 2009). Apparently, public "demoralization" due to inequality, the spread of unhealthy diets and lifestyles, and the privatization of services may all apparently add up to creating "obesogenic" environments (Delpeuch et al., 2009; Hawkes, 2006; Swinburn et al., 2011). If one takes the simple model of excess weight gain to be a function of the ratio between consumption of calories and energy expenditure, then these arguments would explain how globalization promotes excess weight gain.

Raine (2012) depicts this global development using a model made by Popkin and Gordon-Larsen (2004), where the obesity epidemic has gone through several stages with distinct characteristics. The process of excess weight gain is driven by rapid urbanization, economic growth, and cultural change. In stage 3, countries move from suffering from food shortages caused by traditional food supplies to diets high in sugars and fats, while at the same time people experience a lowered level of physical activity. At stage 4, there is an increase in non-communicable diseases before entrance to stage 5 when behavioral changes contribute to a healthier lifestyle with nutritious food and frequent physical activity. Popkin and Gordon-Larsen (2004) thereby draws a picture of globalization as homogenizing food cultures more rapidly than in the past, a phenomenon referred to as McDonaldization (Hawkes, 2006). Moreover, others provide a simple schema to understand growing obesity, which is that technological change has increased access to food (calories) while reducing the need to burn off excess energy, without the commensurate development of mechanisms that prevent a higher calorie-in/calorie-out ratio (Cutler et al., 2003).

There are a number of studies that have addressed the question of whether and to what extent globalization and the liberalization of economic policies matter for excess weight gain and obesity above the effects of wealth (Costa-Font, Mas, & Navarro, 2013; de Soysa & de

Soysa, 2017; de Vogli et al., 2014; Goryakin et al., 2015). Unfortunately, these studies cannot be directly compared because some of them study the issue at the individual level with fairly limited coverage across countries. Some use the actual BMI values while others use the percentage of the population above the BMI value of 30 etc. (Fox, Feng, & Asal, 2019; Garcia-Dorada, Cornselsen, Smith, & Walls, 2019). Others, while showing that economic globalization does not matter for obesity, show that social and political globalization do. Lawson, Murphy, and Williamson (2016) find that economic liberalization per se does not lead to increased BMI on the aggregate level, but the increase is related to economic development over time. Economic freedom and growth increases life expectancy in both men and women, although we see an increase in BMI over time which can result in preventable lifestyle diseases (Lawson et al., 2016; WHO, 2016). Poor countries also benefit from trade liberalization in many other ways, particularly reducing poverty. Economic growth through trade with richer nations might increase public health in these nations (Rayner, Hawkes, Lang, & Bello, 2006). de Soysa and de Soysa use fixed effects estimation and find globalization, particularly economic globalization and an index of economic freedom to be negatively associated with obesity (de Soysa & de Soysa, 2017). They also report that the unmeasured country-level fixed factors, such as culture, explain much of the variance relative to large macro-level factors. Others, such as Goryakin et al. (Goryakin et al., 2015) and Costa-Font and Mas (Costa-Font & Mas, 2016) report positive effects between social globalization and obesity, even in fixed effects analyses, but the data they use as well as the sample of countries covered are much smaller than our study. Thus, this study will re-examine the question of social globalization and obesity using the widely-available GBD data for a long period of time (24 years) for roughly 160 countries. We test specifically if the positive results on social globalization are due to culturally transmitted values working through access to ICTs. Importantly, we rely on fixed-effects estimations in

order to avoid bias from omitted variables, which many other studies, using only random effects, are likely to be biased by (de Vogli et al., 2014).

If economic globalization is being driven by the reduction in barriers to trade and financial flows, social globalization is mostly a feature of the spread of ICTs that are binding people ever more closely to one another, often giving people instantaneous access to information and communication across vast geographic distances (Dreher, Gaston, & Martens, 2008). Indeed, some speak of the "death of distance" (Cairncross, 2001). The spread of social media products, such as Facebook, Twitter and YouTube bring other people and their cultures directly to diverse regions and peoples instantaneously. Habits, ideas and trends, thus, diffuse across space (Simmons & Elkins, 2004). Moreover, the use of electronics have changed the nature of work, travel, and how we spend our leisure hours, particularly as advanced economies are now dominated by the service sector. Through instant contact with other cultures, people may pick up habits and values that they did not have before. Some argue that the cause of the increase of overweight and obesity to be a "worldwide transition toward an 'information/knowledge-based society' that has led to changes in work habits and lifestyle" (Chatterjee & DeVol, 2012, p. 2). The indirect result of these trends, as many argue, is that people across the world are becoming more exposed to unhealthy diets and lifestyles where excess calorie intake and increased sedentariness drive obesity. Chatterjee and DeVol (2012, p. 2) highlight three factors contributing to weight gain:

• Changes in the pattern and portion size of food consumption

• A more sedentary lifestyle at home

• Less strenuous work-related physical activity

These researchers also finds that technological change, greater consumption and access to processed foods and dual-income households are changing our eating habits as "Families began dining out more, buying more processed foods, and exercising less as their use of cars

and public transit increased" (Chatterjee & DeVol, 2012, p. 2). Urbanization following modernization also makes us reliant on motorized transport, making us even more sedentary. This notion is supported by Baillie (2008) who observes that an increase in government facilitated sedentary forms of transportations has reduced exercise. People rely more and more on fast food for daily meals due to modern housing in urban environments. The nature of our labor has also changed in the last century. Service sector jobs require long hours in front of screens and most people do not have physically-demanding jobs in the modern economy because of automation and artificial intelligence (Chatterjee & DeVol, 2012). The question is, thus, how forces of wealth, such as urbanization and technological advancements, which generate forces for higher calorie consumption, and the underutilization of energy relate directly to the availability of ICTs.

The evidence for a relationship between ICT use and obesity, including the watching of TV, is highly mixed and contentious. Researchers find both direct and indirect effects of the use of ICTs. Shensa et al. (2017) find that frequent social media use is associated with symptoms of depression among young adults in the US. A number of studies find that depression in youth increase the odds of obesity in both adolescence and adulthood due to a variety of reasons including binge eating and less physical activity (Blaine, 2008; Goodman & Whitaker, 2002; Luppino et al., 2010). Rey-López, Vicente-Rodríguez, Biosca, and Moreno (2008) find that there is, in general, a positive but delayed association between watching TV and obesity in young children. "Watching TV during family meals was associated with lower intake of vegetables, grains, and dairy food, and higher intakes of soft drinks and fried food" (Feldman, Eisenberg, Neumark-Sztainer, & Story, 2007, p. 4). They speculate that advertisements for high-calorie food influence consumers of different age groups (Feldman et al., 2007; Harrison & Marske, 2005; Story & Faulkner, 1990). However, Swami et al. (2010) report that exposure to Western media increase the desire for slimmer figures. Thus, ICTs might

just as well transfer good cultural practices, such as promoting health and physical fitness, as much as promote the bad ones; i.e. fast food.

Another large N study conducted by Kautiainen, Koivusilta, Lintonen, Virtanen, and Rimpelä (2005) examining the use of ICTs and the prevalence of obesity among Finnish youth aged 14, 16 and 18 years report an association between the use of ICT and weight gain. However, this only applied to certain types of ICTs. They report that time spent on watching TV led to unhealthy diets and time spent on computers correlated positively with obesity, but only among 16-year-old girls. Playing video games on computers was in general not correlated with obesity, nor related to gender differences. It is worth mentioning that other studies have found associations between the risk of overweightness and obesity and leisure time spent on the internet in people aged 20-65 in Adelaide, Australia (Vandelanotte, Sugiyama, Gardiner, & Neville, 2009). While others report weaker correlations between cell phone use and increased BMI among Finnish twins aged 11-12, 14 and 17.5 years of age (Lajunen et al., 2007). How such effects in rich countries can be separated from the wealth effects, however, remains a thorny question given that education and rising awareness can easily limit the harm from ICT use.

On this score, it is worth noting that some studies report that playing computer games is not associated with obesity, decreased academic performance or social impairment in college-aged men. College-aged men might even rely on electronic gameplay as a source of socialization and relaxation during their college education (Wack & Tantleff-Dunn, 2009). Moreover, Cutler et al. (2003) present data contradicting the notion that society is getting more sedentary. In 1980 84% of workers drove to work, 3 percent walked, and 5 percent commuted by public transport. In the year 2000, the numbers had not changed much—it still remained that 87 percent drive, 3 percent walk and 5 percent use public transportation. Cutler et al. (2003) conclude that this change is too small to explain the increase of overweight and obesity in the

American population. Cutler et al. (2003) also discredit the hypothesis of Chatterjee and DeVol (2012), who postulate an association between dual-income households and the growth of obesity by showing that obesity has increased across all groups, including single households, thus, it is simply not more access to money. Cutler et al. (2003) conclude that an increased rate of sedentariness in peoples' leisure time is not the cause of the dramatic increase of overweight and obesity since activity levels, especially amongst the elderly, has risen at the same time as people are getting heavier. Thus, it is still uncertain how cultural transmission of sedentary lifestyles through access to ICTs matter for explaining excess weight gain and obesity across the world, apart from the greater ease of access to calories.

As in most complex phenomena, there are potentially a number of factors working in tandem to both reinforce and counteract the effects of economic and social life that affects obesity rates. Personal agency working through human capital (knowledge) can also mitigate the assumed negative effects of easy access to calories because people can learn both good and bad habits. If adolescents are to find good information on what foods they should eat, they have to be rational and know how to make intelligent choices to maximize health gains from what they eat. Mirowsky and Ross (1998) argue that the concept of human capital can explain how young people develop the skills to adapt healthy habits. More educated people have higher levels of human capital and are more inclined to participating in healthy activities and value a "better" quality of life. Individuals with higher levels of education are better agents of choices for improving their lives. This could be a key element for both developing and developed nations in handling the nutrition transition (Popkin & Gordon-Larsen, 2004). Access to ICTs can empower both citizens and governments to promote healthier choices even as becoming wealthy may drive over consumption and higher sedentariness, which might be viewed as an unwanted cost of development. Managing input and output of calories is critical to the balance of good health outcomes versus ill-health. To summarize, we address this issue by first

examining the effect of social globalization on excess weight gain and obesity levels and then examine how access to ICTs might explain how social globalization may affect these outcomes.

Methods

Our study design uses cross country data over a long period of time on obesity shares of the youth population and variables measuring globalization and the use of ICTs. We use appropriate statistical methods for analyzing these data. Our main dependent variables are the population share of overweight (BMI>25) and population share of obese (BMI>30) in the age-group cohort 15-19 years for both sexes as presented by the Global Burden of Disease data (S. W. Ng, Zaghloul, Ali, Harrison, & Popkin, 2011). We test both categories as a share of the age cohort rather than use BMI as others have done because rising BMI does not necessarily mean people are becoming unhealthy if they are moving from under-nourished category to normal weight. A growing share of an age cohort into a problematic body weight is a better indicator of general change in a society. The GBD data are the most comprehensive cross-sectional, time-series (TSCS) data on overweight and obesity. The GBD data collection effort involved hundreds of researchers from across the world that estimated obesity rates by looking at all available studies on individual countries, household surveys, hospital records etc. in order to gather the most accurate, age-standardized estimates. These data are available for the years 1990 to 2013 for most countries in the world. Our study includes roughly 160 countries for which we have complete data on all variables covering the years 1990 to 2013 (24 years).[i] As seen in Figure 1, the trend in overweight and obesity shares among youth in the rich, Western, industrialized countries outpace that of the poorer, non-western, mostly non-industrialized countries.[ii] The gaps between them, however, seem to be closing just very slightly. Overweightness clearly outpaces the prevalence of obesity, but since overweightness is the first stage to reaching obesity, its growth is rightly cause for worry.

**********FIGURE 1 ABOUT HERE**********

Our main independent variables are; 1) the KOF Globalization Index´s social globalization component, which includes indicators capturing internet and mobile call traffic between countries as well as subscriptions, the sale of English books, the number of letters exchanged with foreigners, the number of McDonalds restaurants, and the number of tourist arrivals (Dreher, 2006; Gygli, Haelg, & Sturm, 2018). Each of the areas of measurement are designed to capture the intensity of association of a country with the outside world 2) we add the rate of internet users as well as mobile users (per 1000 inhabitants) to capture the extent of ICT access within a population. We obtain these variables from the World Bank´s World Development Indicators (WDI) online data portal (World Bank, 2018). We take the natural log of both variables to reduce skewness. The correlation between internet user rates and mobile user rates is very high as expected ($r = 0.82$), and these variables correlate with social globalization only moderately ($r = 0.50$). Thus, we test the effects of ICT use holding social globalization constant, which then allows us to assess the partial effects of ICT access relative to all the other aspects of social globalization plus the controls. Figure 1 shows the global trend in social globalization, internet and mobile user rates since 1990.

**********FIGURE 2 ABOUT HERE**********

As seen there, mobile use clearly outpaces internet use, which is not surprising, but both trends move with the trend in social globalization.

Naturally, we include a few controls in order to eliminate spurious findings. First, we account for the level of development. Richer societies should have greater access to ICTs as well as have higher consumption possibilities through technological improvements that may

increase obesity (Cutler et al., 2003; Egger, Swinburn, & Amirul Islam, 2012). We use per capita income (GDP per capita) in constant 2010$ obtained from the WDI. This variable is logged to reduce skewness. Secondly, we use total trade to GDP to measure the overall exposure to the outside world through access to goods and services. Closed economies may have less access to ICTs and have lower consumption possibilities. Trade to GDP is obtained from the WDI. Finally, we enter a term capturing political democracy measured as the election of government in free and fair elections without coercion or violence. This variable is obtained from the Varieties of Democracy Project and is coded as "Polyarchy", or electoral democracy (Coppedge & Reinicke, 1990). Greater democracy is associated with greater freedoms of access to media and ICTs and greater democracy may also be associated with less shortage of consumption possibilities. We limit our models to these variables in order not to overfit our models and allow our main variables of interest to "speak" (Achen, 2005).

As discussed above, some studies reporting positive effects of globalization on obesity estimate random effects regressions and cross-sectional analyses from which inferring causality is often perilous (de Vogli et al., 2014). Thus, we estimate a time-series, cross-section dataset (TSCS) examining the variance in the share of overweight and obese youth. The countries in our sample are limited to countries with populations above 500,000 inhabitants. TSCS data are known to be plagued by complicated correlation patterns within and across units. One such issue is temporal dependence, or autocorrelation. Standard ordinary least squares linear regression is biased in the presence of these problems (Beck & Katz, 1995). We test for autocorrelation by using the Wooldridge test for first-order serial correlation and were unable to reject the null of no first-order serial correlation. Therefore, we use the Newey-West method, which produces standard errors robust to both serial correlation and heteroscedasticity (Newey & West, 1987). Apart from temporal dependence, we also account for spatial dependence since factors that determine body size may cluster in space. To account for fixed effects robust to

spatial and temporal dependence, we estimate Driscoll-Kraay standard errors in additional tests (Hoechle, 2007). Moreover, we enter a time trend in all the models to capture any effects of trending data and unit fixed effects for accounting for unit-level heterogeneity, an effective method for eliminating omitted variables bias (Wilson & Butler, 2007). In robustness tests, we follow Costa-Font and Mas and implement the Panel-Corrected Standard Error (PCSE) method, but our basic results do not change. The PCSE method, however, is optimal when T is relatively large compared with N. Importantly, accounting for unit heterogeneity is important even if PCSEs are estimated (Wilson & Butler, 2007). Table 1 presents the summary statistics associated with our main variables.

**********TABLE 1 ABOUT HERE**********

Results

Table 2 presents the results of our replication of previous studies on social globalization and overweightness and obesity among youth.

**********TABLE 2 ABOUT HERE**********

As seen in columns 1 and 2, when estimating random effects regression, the effect of social globalization on overweight share and obese share of the 15-19 age cohort is positive and statistically significant, results consistent with those reported by others using individual-level data and others using country-level data (Costa-Font & Mas, 2016). Notice, however, that in columns 3 and 4, when country-fixed effects are estimated, the sign on social globalization completely changes, and it becomes statistically highly significant in the case of obesity. In other words, an increase in social globalization reduces the share of the population that is

"obese" among youth after all the cross-sectional heterogeneity is accounted. Substantively, keeping each of the other control variables at their mean values, increasing globalization by a standard deviation (within variance) reduces the obese share of the youth population by 20% of a standard deviation (within) in the obese share of the youth population.[iii] This result, therefore, is substantively quite large.

In columns 5 and 6, the effects of internet access on both overweight and obese are negative and statistically highly significant. Holding the other control variables at their means, raising access to internet by a standard deviation reduces the overweight share of the youth population by roughly 19% of a standard deviation in the share of the overweight youth population. Substantively, a standard deviation increase in internet users reduces the obese share by roughly 45% of a standard deviation in the obese share, which is substantively a large effect. In columns 7 and 8 the extent of access to mobile phones shows a similar picture with very similar substantive effects. Access to internet and mobiles, thus have statistically significant effects that are negative on excess weight gain, and these effects are substantively large and independent of gains in wealth, democracy, and other aspects of social globalization.

Finally, in the last two columns, we drop all countries that are industrialized, mostly from Western Europe, North America and Oceania, including Japan, but in general these countries are largely inhabited by European populations (see footnote 2). Despite dropping these 22 countries, the effects of internet access and mobile access is negative. Notice, however, that the negative effect of social globalization on the obese share of the population is no longer statistically significant, suggesting that social globalization´s negative effect seems to be driven mostly by the Western countries that have begun to reverse their obesity rates. These tests do not show in any way that social globalization or access to ICTs drive obesity. Indeed, the opposite seems to be true, particularly when omitted variables are accounted in fixed effects estimations, which allows us to infer causality. In this case, the danger of reverse causality—

i.e. that obesity rates drive lower ICT use is theoretically untenable. Moreover, the results of the control variables are also more intuitive in the FE estimations, where income per capita and democracy independently increase excess weight gain, while trade openness reduces it, but these effect are a lot less robust since they drop in and out of significance dependent on specification.

Table 3 shows the results of our basic equations estimated using fixed effects estimations with standard errors robust to cross-sectional dependence and temporal dependence.

**********TABLE 3 ABOUT HERE**********

As seen there, the results from the previous table are confirmed. Both internet access and mobile access reduce the share of overweight and obese among youth. The coefficients are barely changed. Again, both income and democracy predict higher overweight and obesity, while trade remains statistically not significant. Clearly, a great deal of excess weight gain is predicted by both income and democracy. Substantively, a standard deviation increase in democracy, holding all other variables at their mean values, increases the share of obesity by roughly 8% of a standard deviation in obesity among youth, which suggests that globalization´s negative impact is almost 3 times the positive effect of democracy. The same is true roughly when comparing the substantive effect of income per capita. This means that the effects on obesity from democracy and increases in wealth is negated by greater access to ICTs, which is a significant impact given all the attention to increased wealth and democracy as facilitators of over consumption and over indulgence (Fox et al., 2019).

We ran several tests of robustness. First, we ran alternative models, by dropping democracy, which is only available for countries with over 500,000 inhabitants. Our sample of

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countries increase from 156 to 181. Dropping trade from the model made no difference to the basic results. The results on social globalization and internet users remain negative and statistically highly significant even when all controls are dropped. Since much has been made of rising inequality and increasing excess weight gain, we estimated a variable obtained from the Varieties of Democracy Project measuring the access of the poorest people to quality health care comparable with that available to the rich (VDEM, 2017). The independent effect of "health equality" on higher overweight and obesity is negative and statistically significant, results that seem to contradict a relationship between structural conditions of social inequality and excess weight gain.

By observing how ICT access behaves under conditions of higher consumption possibilities predicted by wealth, we test the conditional effects between them on the obese share. Thus, we interact internet access with income per capita holding the controls constant. Increase in ICT access in increasing income raise the share of obesity, but the effect is statistically not significant at the highest levels of income, suggesting again that the consumption effects of income are moderated by access to ICTs at the highest levels of income, not exacerbated (results not shown but available on request). To see this effect visually, one needs to examine the margins plots. See Figure 3.

**********Figure 3 About Here**********

As seen there, access to ICTs increase the obesity rate to about the middle levels of income and then lose statistical significance at the 95% confidence interval. A similar effect is observed when we test a conditional effect between internet access and democracy. As figure 4 shows,

**********Figure 4 About Here***********

as ICT access increases with rising democracy, the effect on obesity is positive but is small and statistically not significant. Contrarily, when wealth increases with rising democracy (see figure 5), the effect on obesity share of the youth population increases strongly, results that are statistically highly significant. These results taken together suggest that it is wealth (and perhaps democracy) that increases obesity, independently of the level of social globalization through access to ICTs, which may indeed reduce the tendency.

**********Figure 5 About Here**********

Next, we conduct several post estimation tests to ascertain the veracity of the basic results. Running the basic models and testing for multicollinearity using the variance inflation factor (VIF) showed no reason to be concerned about multicollinearity. Moreover, tests for influence using the cook´s D statistic showed no change to the basic results when running our models after excluding roughly 200 data points with cooks´ D values above the cutoff value of $4/n$. Indeed, the statistical significance on social globalization and the ICT measures became stronger. Next, we tested our main variables for non-stationarity using the augmented dickey fuller test, but in all cases, we are able to reject the null hypothesis that our panels were nonstationary and contained unit roots. Moreover, we also test our models using the feasible generalized least square (FGLS) method, and the results remain largely unaltered. Running our basic models with the PCSE method yielded very similar results. The results, thus, are robust to alternative models, estimating techniques, alternative data, and to potential bias from unusually influential observations and any violations of critical regression assumptions.

Finally, while the fixed effects estimations allow us to infer causality because omitted variables bias is generally accounted, we still cannot be sure that endogeneity bias due to reverse

causality is not present. For some reason, if the obesity rate among youth also drove the demand for ICTS, then we might be finding that the "cart is before the horse." To overcome this problem, we follow several other studies by instrumenting for ICT use with density of lightning strikes. Lightning strikes hamper the development of infrastructure vital for the growth of mobile phone access, namely transmission towers, and it explains ICT development well (Andersen, Bentzen, Dalgaard, & Selaya, 2011). The density of lightning strikes, however, while explaining access to ICTs, should not directly explain obesity. We know of no real reason why density of lightning would explain obesity rates among youth. The data are measured as lightning strikes per square kilometer and are collected by NASA.[iv] Instrumenting mobile phone use with lightning strike density in a two-stage least square (2SLS) estimation shows a strong statistically significant negative effect of mobile phone density on the obesity rate. The Paap-Kleibergen and Cragg-Donald tests show F values way above the threshold value of 10, signifying that the instrument passes the "relevance" test (Bound, Jaeger, & Baker, 1995). The Hansen-J statistic was not significant, which means that the instrument passes the instrument exclusion criteria. The same test using internet access showed a negative effect that just misses statistical significance at the 10% level, but the instrument failed the instrument relevance test as the F stats did not reach the 10 threshold, signifying that lightning strike density is not a valid instrument for internet access. These results demonstrate further that one might make strong causal claims about the effects of ICTs and the growth of obesity among youth.

Conclusion

Scholars of public health debate the effects of globalization on human health, with many arguing that globalization transfers the worst practices from the rich to poor, driving conditions of ill-health across the globe. One area of particular concern is the global spread of excess weight gain and obesity commensurate with the ICT revolution. Since a simple but elegant

explanation for rising obesity rates is that technological change, first manifested in countries such as the US, drives over consumption of excess calories without increases in energy expenditure, it is highly plausible that ICTs exacerbate the weight problem. This simple schema allows us to think through how social globalization occurring through the tighter connection of people to the outside world might be transforming cultural habits and values, leading to worse health due to excess weight gain. The evidence for a connection between globalization and weight gain, however, remains highly mixed (Fox et al., 2019; Garcia-Dorada et al., 2019).

Using the instance of social globalization, we use fixed effects analyses on a large sample of countries over two decades since 1990 and find that both social globalization and the intensity of ICT use independently lower the incidence of obesity among youth. The results suggest that the transmission of values through greater connectivity is not a negative factor in so far as weight gain is concerned. Rather, like others, we find that it is "modernization," identified usually as income growth and associated social change because of changing work life conditions, for example, that increases obesity, not connectivity via ICTs *per se* (Fox et al., 2019). Moreover, as economies transition from agriculture and manufacturing to services, people´s sedentariness increases, regardless of how dependent people become on mobile phones or computers. These tools on their own might encourage both healthy outcomes as well as unhealthy ones. On balance, our data show that independently of income and democracy, as well as other factors explaining social globalization, access to ICTs reduce the population share of youth suffering excess weight gain and obesity. Further study is needed to fully understand how processes of globalization and the spread of technology affect the conditions that produce obesity, and which ways ICTs might be leveraged by policy to drive better health outcomes.

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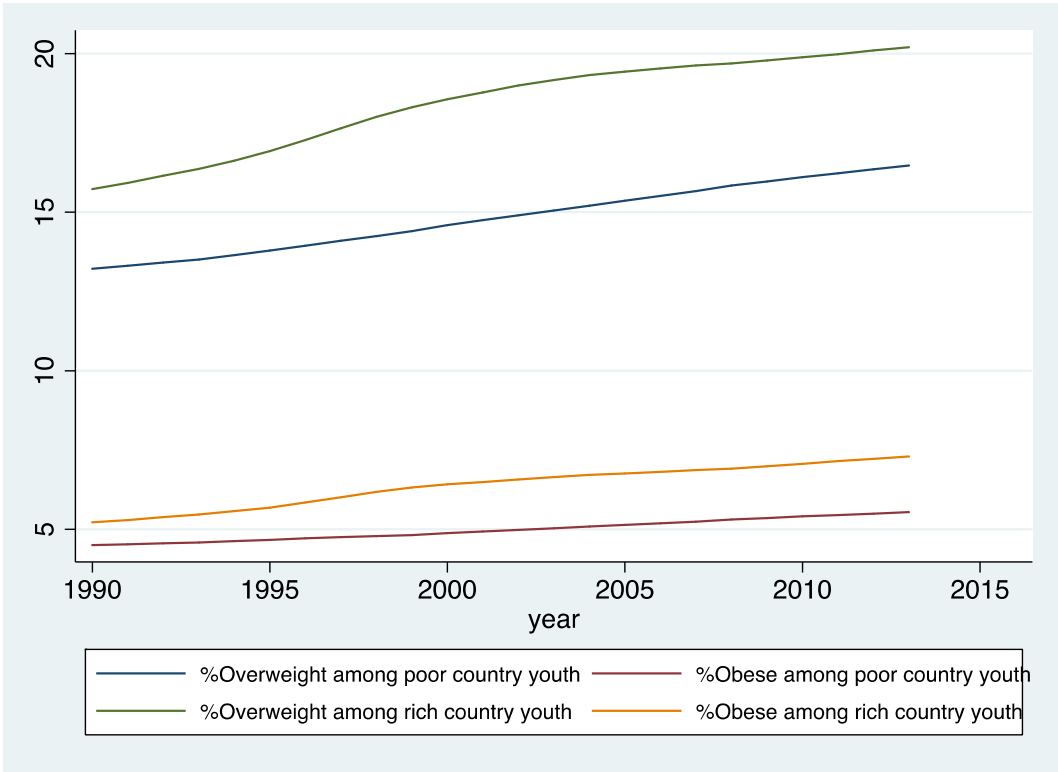Figure 1. Overweight and obese share of the youth population across the world by wealth status, 1990-2013

%Overweight among poor country youth	%Obese among poor country youth
%Overweight among rich country youth	%Obese among rich country youth

Figure 2. Social globalization and ICT access trends, 1990-2015

Trends in Internet & Mobile Users per 1000 against Social Globalization Trend, 1990-2015

Social globalization	Internet Users
Mobile users	
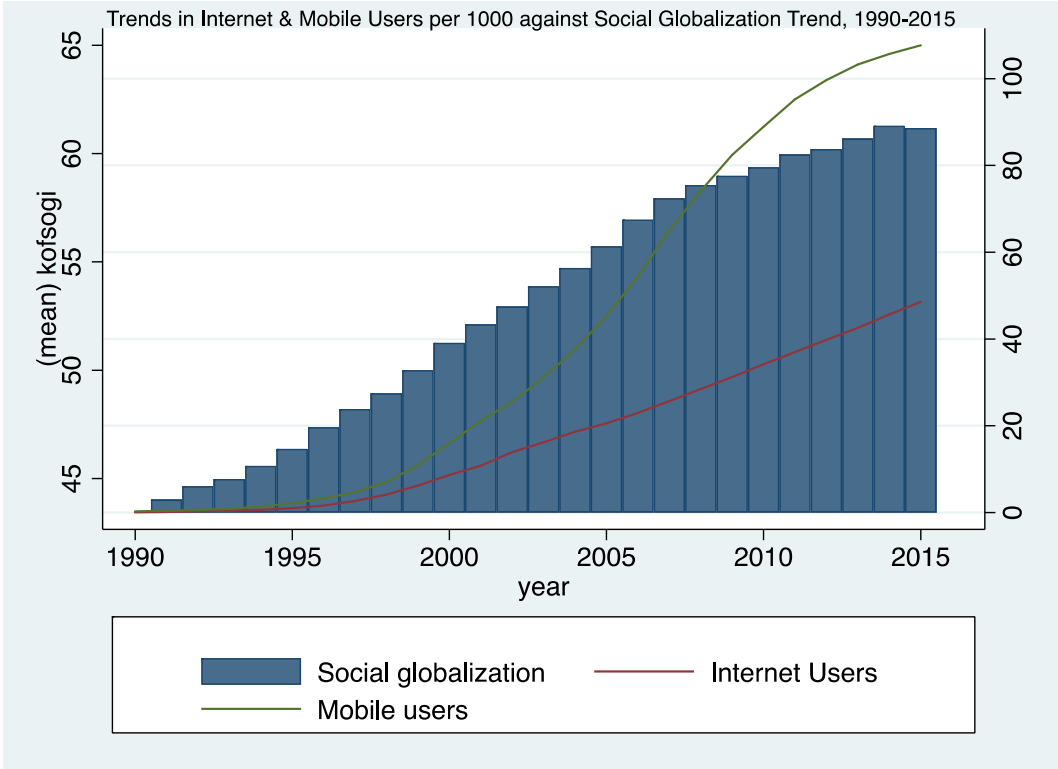
Table 1. Summary statistics of main variables (pooled variation)

	Obs	Mean	Std. Dev.	Min	Max
Internet users per 1000 pop	3049	-.0473039	5.255531	-20.72327	4.566531
Mobile users per 1000 pop	3496	-.8303314	7.891502	-20.72327	5.342029
Overweight	3496	14.18704	7.283485	1.2	38.8
Obese	3496	4.438444	2.857688	.8	18.7
GDP per capita (log)	3496	8.168336	1.505177	5.077179	11.42512
Trade/GDP (log)	3496	4.23276	.5507661	.0207818	5.776512
Democracy	3496	.5487289	.2632896	.0176478	.9584104
Social globalization	3487	50.2	20.2	9.4	90.7

Table 2. The effects of social globalization and ICT access on the share of overweight and obese youth, 1990-2013

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Estimation method	RE	RE	FE	FE	FE	FE	FE	FE	FE	FE
Country sample	All	All	All	All	All	All	All	All	non-West	non-West
Dep. Variable	%overweight	%obese	%overweight	%obese	%overweight	%obese	%overweight	%obese	%obese	%obese
Internet users per 1000 inhabitants (log)					-0.10***	-0.06***			-0.04***	
					(0.02)	(0.01)			(0.01)	
Mobile users per 1000 inhabitants (log)							-0.06***	-0.03***		-0.02***
							(0.01)	(0.00)		(0.00)
Social Globalization Index	0.08***	0.02*	-0.01	-0.02***	-0.00	-0.02***	-0.01	-0.02***	-0.00	-0.00
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Income per capita (log)	2.34***	1.13***	0.83***	0.21**	0.91***	0.21**	0.71***	0.15*	0.13	0.08
	(0.25)	(0.13)	(0.22)	(0.09)	(0.23)	(0.08)	(0.21)	(0.08)	(0.08)	(0.08)
Total Trade / GDP (log)	-0.78***	-0.19	0.13	0.02	-0.06	-0.11*	0.10	0.01	-0.10*	0.03
	(0.30)	(0.12)	(0.10)	(0.05)	(0.13)	(0.06)	(0.11)	(0.06)	(0.06)	(0.06)
Electoral democracy (vdem)	-4.32***	-2.31***	1.05***	0.57***	0.86**	0.54***	1.52***	0.81***	0.48***	0.77***
	(0.82)	(0.35)	(0.35)	(0.15)	(0.35)	(0.15)	(0.34)	(0.15)	(0.14)	(0.14)
Constant	-4.41**	-4.05***	7.42***	2.61***	5.66***	2.05***	7.10***	2.47***	2.65***	2.93***
	(1.96)	(0.92)	(1.24)	(0.53)	(1.36)	(0.58)	(1.21)	(0.55)	(0.54)	(0.54)
Countries	156	156	156	156	156	156	156	156	134	134
Observations	3,487	3,487	3,487	3,487	3,041	3,041	3,474	3,474	2,525	2,954

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3. The effects of ICT access on overweight and obesity accounting for spatial correlation with Driscoll-Kraay standard errors

	(1) overweight	(2) obese	(3) overweight	(4) obese
Social globalization	-0.01	-0.02***	-0.00	-0.01***
	(0.01)	(0.00)	(0.01)	(0.00)
Internet users per 1000 inhabitants(log)	-0.02**	-0.02***		
	(0.01)	(0.01)		
Mobile users per 1000 inhabitants (log)			-0.04***	-0.02***
			(0.01)	(0.00)
Per capita income (log)	0.67***	0.11*	0.50***	0.08
	(0.17)	(0.06)	(0.15)	(0.06)
Total trade / GDP (log)	0.07	-0.05	0.14	0.03
	(0.10)	(0.04)	(0.10)	(0.04)
Electoral democracy	0.71***	0.48***	1.46***	0.77***
	(0.27)	(0.13)	(0.27)	(0.13)
Year	0.17***	0.08***	0.17***	0.08***
	(0.01)	(0.01)	(0.01)	(0.00)
Constant	-329.13***	-157.36***	-334.18***	-147.45***
	(20.62)	(11.50)	(18.33)	(8.72)
Observations	3,041	3,041	3,474	3,474
Countries	156	156	156	156

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Fixed effects estimated in all tests

Figure 3. Margins plot of the conditional effect between income per capita and access to internet on the obese share of the youth population
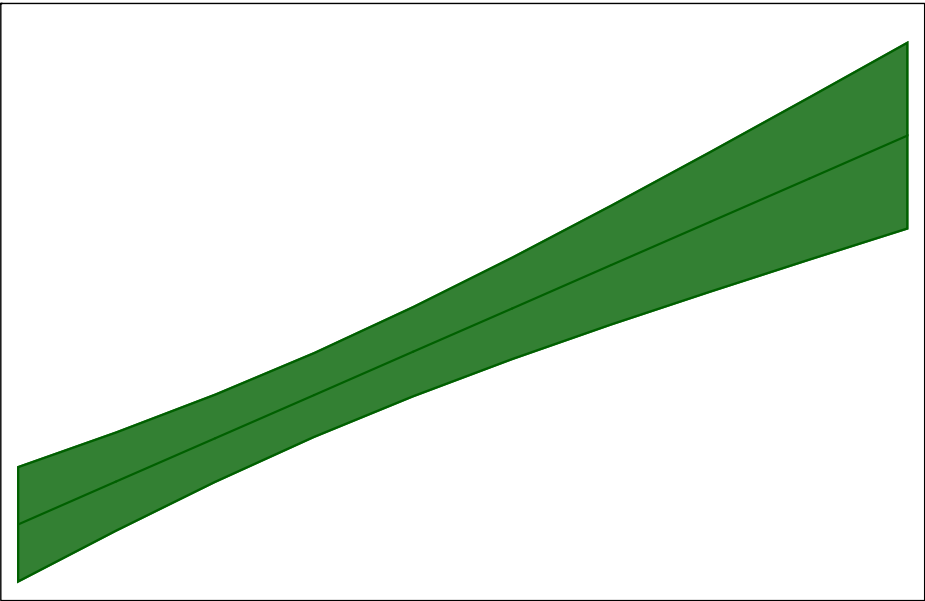

Figure 4. Margins plot of the conditional effect between electoral democracy and access to internet on the obese share of the youth population
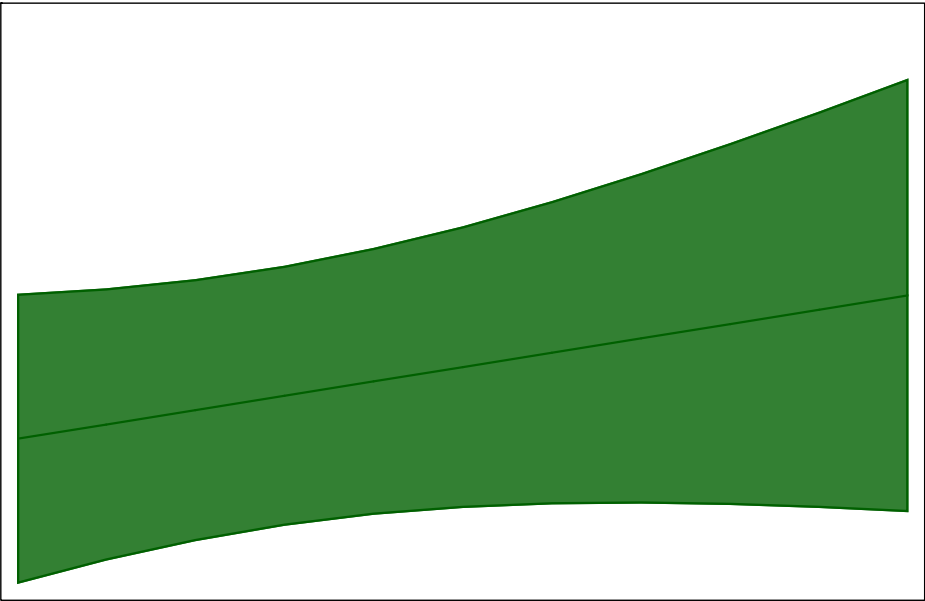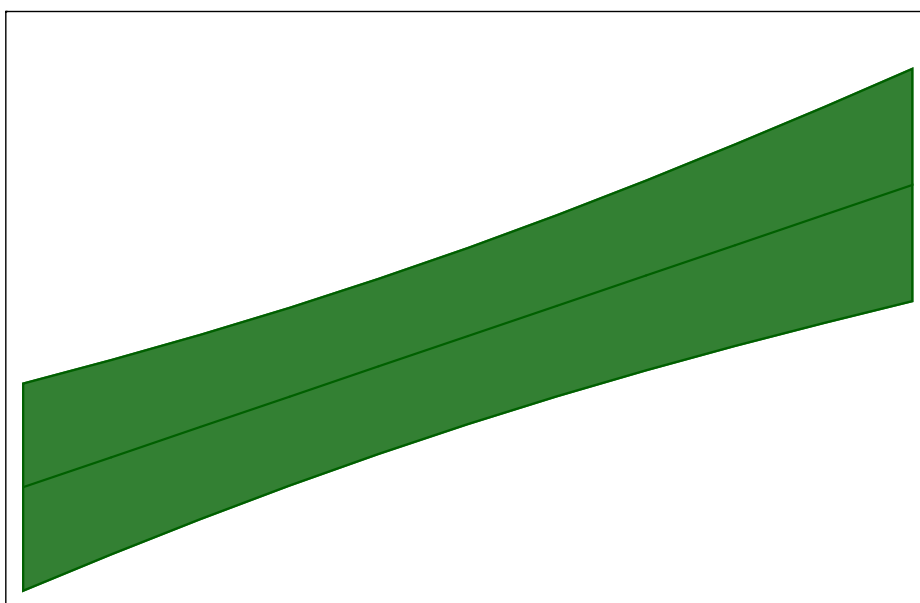
Figure 5. Margins plot of the conditional effect between income per capita and electoral democracy on the obese share of the youth population

ENDNOTES

[ii] The following make up the list of 22 "Western" industrialized countries: United States, Canada, Great Britain, Ireland, France, Netherlands, Germany, Luxembourg, Belgium, Switzerland, Italy, Spain, Portugal, Denmark, Norway, Sweden, Finland, Greece, Austria, Australia, New Zealand, and Japan.