The economic gradient of obesity in Mexico: Independent predictive roles of absolute and relative wealth by gender

Lucio Esposito, Adrián Villaseñor, Enrique Cuevas Rodríguez, Christopher Millett

PII: S0277-9536(20)30089-7

DOI: https://doi.org/10.1016/j.socscimed.2020.112870

Reference: SSM 112870

To appear in: *Social Science & Medicine*

Received Date: 9 September 2019

Revised Date: 3 January 2020

Accepted Date: 19 February 2020

CRediT author statement, Manuscript SSM-D-19-02873

The economic gradient of obesity in Mexico: independent predictive roles of absolute and relative wealth by gender

Lucio Esposito
Conceptualization, Methodology, Writing, Investigation, Original draft preparation, Reviewing and Editing

Adrián Villaseñor
Data curation, Methodology, Visualization, Investigation, Software, Writing, Reviewing and Editing

Enrique Cuevas Rodríguez
Data curation, Investigation, Visualization

Christopher Millett
Supervision, Writing, Reviewing and Editing

The economic gradient of obesity in Mexico:

independent predictive roles of absolute and relative wealth by gender

1st author and corresponding author
Lucio Esposito
School of International Development, University of East Anglia
Norwich Research Park, NR47TJ
Norwich, UK
lucio.esposito@uea.ac.uk
Tel. +44(0)1603591882

2nd author
Adrián Villaseñor
School of Environment and Geography, University of York, Your, UK
adrian.villasenor-lopez@york.ac.uk

3rd author
Enrique Cuevas Rodríguez
Department of Quantitative Methods, Universidad De Guadalajara, Guadalajara, Mexico
ecuevasr2@hotmail.com

4th author
Christopher Millett
School of Public Health, Imperial College, London, UK
c.millett@imperial.ac.uk

No conflict of interests.

No funding received for this research.

We are grateful to Thomas Hone, Ana Elisa Pineda, Davide Rasella and Sarah Tustin for useful comments.

The economic gradient of obesity in Mexico:

independent predictive roles of absolute and relative wealth by gender

Abstract

Despite the vast literature on the economic gradient of obesity, no study investigates the independent predictive roles of absolute and relative standards of living using a large nationally representative adult sample. This gap limits our ability to discern 'material' and 'psychosocial' pathways to obesity as well as our understanding of the role played by economic inequality in the growing obesity epidemic. Using a large and nationally representative Mexican dataset, we find that absolute wealth and relative deprivation are independently related to obesity, and that such relationships are patterned by sex. Absolute wealth predicts body mass index as well as abdominal obesity according to an inverted-U shape for both sexes, and more markedly so for females. Relative deprivation predicts higher body mass index for females and higher waist circumference for both sexes, with highly relatively deprived females being 24.29% (95% CI [24.26, 24.31]) more likely to be obese and 34.46% (95% CI [34.40,34.53]) more likely to be abdominal obese, and highly relatively deprived males being 14.91% (95% CI [14.88,14.93] more likely to be abdominal obese. Our results offer a new perspective on the economic gradient of obesity and highlight the potential impact of economic inequality, especially for women. Greater awareness of the independent and sex-specific roles of the absolute and relative facets of economic status is needed to better understand and address the obesity epidemic.

Keywords: Obesity, Inequality, Gender, Wealth, Relative Deprivation, Body Mass index, Waist Circumference, Mexico

1.Introduction

Obesity is a prominent feature of the rapid epidemiologic transition currently taking place in a large part of the world, resulting from new dietary habits and sedentary lifestyles (NCD, 2016; Ford et al., 2017). Obesity decreases health-related quality of life (de Hollander et al., 2013) and is a major health risk factor with associations to a number of issues including high blood pressure, type 2 diabetes, cardiovascular diseases, cancer, sleep disorders, pain, osteoarthritis and premature mortality

(Kopelman, 2007; Lementowski and Zelicof, 2008; Luppino et al., 2010). The problem of obesity is growing for a number of middle-income countries and is often neglected in major international development initiatives such as the United Nations Sustainable Development Goals (Murray, 2015).

Obesity figures in Mexico are particularly alarming, with prevalence reaching around one third of the population and being projected to rise to 54% and 57% for males and females, respectively, by 2050 (Rtveladze et al., 2014). The direct and indirect repercussions of excessive weight on the economy are considerable (Dee, 2014). A joint study by the Economic Commission for Latin America and the World Food Program estimated that Mexico will incur costs for USD 13 billion a year over the next six decades to deal with the negative consequences of excessive weight (Fernández et al., 2017). Mexico has implemented policies to counter the epidemic such as the one-peso-per-litre tax on sodas; while simulations studies predicted health benefits of this tax (Sánchez-Romero et al., 2016; Barrientos-Gutierrez et al., 2017), the mechanisms and wider effects of such taxes are yet to be fully understood (Popkin, 2017; Cornelsen and Smith, 2018; Quirmbach et al., 2018).

A large body of literature studied the economic gradient of obesity. The seminal work by Sobal and Stunkard (1989) indicated a consistent positive gradient in developing countries. This view was subsequently challenged by the evidence that obesity in developing countries was no longer restricted to the elites, but it gradually shifted to less wealthy groups in the process of economic development (Monteiro et al., 2004). More recent literature reviews found that the positive relationship between higher socioeconomic status and obesity tended to turn into a negative one for countries with higher Human Development Index (McLaren, 2007), and that a positive socioeconomic gradient of obesity existed in low-income countries but not in middle-income countries (Dinsa et al., 2012). However, a major shortcoming of nearly all existing research on this topic is the failure to disentangle the *absolute* and the *relative* aspects of the economic gradient of obesity. The former pertains to the standard of living a person enjoys and relates to material pathways to health (e.g. the effects of scarcity or abundance of resources), while the latter concerns her relative position in the economic hierarchy and relates to psychosocial pathways to health (e.g. physiological effects of chronic stress and behavioral risks triggered by psychosocial stress) – see Wilkinson (1997) and Marmot (2006).

No study provides evidence on the independent roles of objective indicators of absolute and relative standards of living as predictors of obesity using nationally representative adult data covering both males and females and different ages. The two existing studies are based on limited samples and provide contrasting results – relative deprivation was identified as a risk factor for obesity on the basis of US male adults (Eibner and Evans, 2005), while the opposite result was found using data on older adults (aged 50+) from China (Ling, 2009). The literature using subjective social status as a measure of relative standards of living is slightly larger; yet, a review of studies on the relationship between subjective social status and a range of health outcomes using adult samples finds no robust association in the case of obesity (Tang et al., 2016). The literature on adolescents seems instead more unisonous in indicating relative social standing as a significant factor. For Canadian adolescents, relative deprivation compared to schoolmates was found to be associated with obesogenic behaviours independently of absolute wealth (Elgar et al., 2016), echoing the findings for US adolescents on the association between subjective social status and obesity (Goodman et al., 2003) and adiposity (Lemeshow et al., 2008).

In this paper, we study the economic gradient of obesity in Mexico by jointly employing measures of absolute wealth and relative deprivation as covariates in multivariate regression analysis – for the first time using large nationally representative adult data and disentangling their independent roles as risk or protective factors by gender. We take into examination two obesity domains, Body Mass Index (BMI) and Waist Circumference (WC), which are known to exert independent impacts on health outcomes – BMI is more related to nonabdominal and subcutaneous abdominal fat and ignores fat distribution while WC is a better indicator of abdominal visceral fat (Janssen et al., 2004; Van Gaal et al., 2006; Seo et al., 2017). Mexico is an interesting context for studying the economic gradient of obesity not only given the extent of the epidemic, but also because of the major economic disparities existing in the country. Mexico is an upper middle-income country and OECD member, and yet around 44% of the population lives in absolute poverty according to official national statistics (CONEVAL, 2018). Economic inequality is also particularly high, placing Mexico at the very top of OECD countries for a range of national and sub-national indicators (OECD, 2016).

2.Methods

2.1.Data source and outcome variables

We use the 2012 wave of the Mexican National Health and Nutrition Survey (ENSANUT, 2012). This is a household survey compiled by the Mexican National Institute of Public Health, with one randomly chosen individual per household being interviewed, based on a stratified, multistage probability sample design and employing the 2010 National Census as a sampling frame. We retrieve data from the household, the anthropometry and the adult modules of the survey (individuals aged 20+). These provide a rich array of information, including data on BMI (standard kg/m^2, measured with 100gr-tolerance digital scales and 1mm-tolefance stadiometer) and WC (centimetres [cm], measured at the midpoint between the bottom of the ribs and the top of the iliac crest), collected by trained personnel. We follow the restrictions criteria previously applied to the analysis of ENSANUT 2012 (Barquera et al., 2013): we exclude observations where BMI>58 (46 observations) and BMI<13 (2 observations), and observations where WC>180cm (2 observations) and WC<50cm (18 observations). Regression analyses are carried out for 33,434 and 32,148 individuals for BMI and WC, respectively.

In addition to continuous BMI, we derive a dichotomous variable indicating the status of obesity (BMI>30), as well as an ordinal variable where ordered categories match the statuses of underweight, normal weight, overweight, obese and severely obese – based on customary BMI cut-off points of 18.5, 25, 30 and 40, respectively (Strum and Hattori, 2013). We use a continuous variable as well as two dichotomised measures for WC used to define abdominal obesity. The first is based on the widely used abdominal obesity thresholds proposed by Lean et al. (1995) – i.e. WC ≥88cm for women and WC ≥102cm for men, indicated as LHM cut-offs hereafter. These cut-off points are employed by the American Heart Associations and have proved useful in predicting diabetes and hypertension (Seo et al., 2017). Research has shown, however, that abdominal obesity thresholds able to predict illnesses such as metabolic syndrome, diabetes and hypertension differ highly across regions and ethnic groups (Misra et al., 2005; Qiao and Nyamdorj, 2010). With this in mind, we create a second dichotomous variable for abdominal obesity by averaging the thresholds identified by three papers using data from Mexican populations (Sánchez-Castillo et al., 2003; Alonso et al., 2008; Aschner et al., 2011) – in this way we derive thresholds of 91.5cm for women and 95.4cm for men, indicated as Mx cut-offs hereafter. Results for both definitions of abdominal obesity are presented.

2.2.Main explanatory variables of interest: absolute and relative wealth

Absolute standard of living is measured through an asset index. The use of wealth to explore economic gradients in health outcomes is advocated by Pollack et al. (2007), Laaksonen et al. (2009) and Sweet (2011). Our asset index is computed via principal component analysis (PCA) and using information on 38 indicators of the residential dwelling (e.g. walls, floors, roof quality of materials), access to basic services and utilities (e.g. source of water, rubbish disposal or electricity) and ownership of durable goods (e.g. computers, television, cars). Since customary PCA in the presence of numerous binary and cardinal variables (as in our data) may produce incorrect results, we calculate PCA using polychoric correlations (Kolenikov and Angeles 2009; Howe et al. 2012). More details on our asset index, including the list of raw indicators used and PCA weights are available in Section A of the supplementary online material. Given the hypothesis of an inverted-U relationship between resources and obesity formulated by Fernald (2007) and the results of Quezada and Lozada-Tequeanes (2015) partially supporting it, wealth is introduced in both linear and squared forms.

Relative standard of living is measured through indices of relative deprivation. These are calculated as a function of own wealth and the wealth of other individuals in the reference group (wealth being quantified through the asset index discussed above). The visible character of assets makes wealth particularly suitable for the construction of indices of relative economic status (Heffetz, 2011; Hicks and Hicks, 2014). We present results obtained using the Yitzhaki (1979) index of relative deprivation, which is based on the linear difference between individual *i*'s achievement and the achievements of better-off individuals. We define reference groups according to a criterion of geographic proximity, in line with Deaton's (2001) view that "people almost certainly compare themselves to their immediate geographical neighbours" (p. 21). We use municipality as the geographical identifier and in this way we are able to create 712 reference groups – with our data, using a narrower identifier would create groups with too few individuals to calculate meaningful measures of relative deprivation. Denoting individual *i*'s and individual *j*'s levels of wealth with y_i and y_j, respectively, for an increasingly ordered wealth vector $y = (y_1, \dots y_N)$ where N is the size of the reference group, we use the Yitzhaki index $RDY(y_i, y_j) = \sum_{j=i+1}^{N} \frac{y_j - y_i}{N}$. For more empirical and conceptual details on this index see a review of the use of this index see Adjaye-Gbewonyo and Kawachi (2012) and Côté-Lussier (2016). Robustness checks carried out with indices based on non-linear (concave) functional forms (Esposito, 2010, 2018) and reference groups defined according to additional demographic characteristics confirm our results and are available upon request.

2.3.Empirical analysis

We carry out regressions analyses for the different outcome variables described above using the software Stata 15.1. To study BMI, we estimate linear regressions using BMI as a continuous variable, ordered logit regressions using the derived ordinal variable and logit regressions using the dichotomous variable indicating obesity. In a similar fashion, we estimate linear regressions using continuous WC and logit regressions using the two dichotomous variables indicating abdominal obesity.

In all our models, we control for a range of socio-demographic characteristics as well as for the presence of other health problems or stressors which may be related to excessive BMI or WC. These are gender, education, age, civil status, household size, drinking habits, being a smoker, limitation in daily activities, presence of chronic illnesses, having been victim of violence in the past year and depressive symptoms – measured in the survey on the basis of a 7-item CES-D scale (Radloff, 1977). In all regressions we cluster standard errors at the municipal level (results from multilevel models confirm our results and are made available in the supplementary online material).

We are particularly interested in the interplay between gender and our standards of living indicators. In order to detect gender-based heterogeneities in the predictive role of absolute wealth and relative deprivation, we both introduce interaction terms between these economic indicators and gender in the pooled sample, and estimate our models using female and male subsamples separately. Analysis by subsamples enables us to see whether a certain pattern occurs within the subsamples or not; by contrast, the adoption of an interaction term in the pooled sample enables us to see whether there is a significant difference in the role of a certain predictor (in our case absolute wealth and relative deprivation) across the subsamples identified by the interacted variable (in our case the gender dummy).

3.Results

Table 1 describes the variables we used to estimate our models. Our sample is composed of adults from 20 to 101 years old (mean age is 44) who, on average, live in households of nearly 4 people. Around 60% are female, 17.8% are smokers and 51.5% do not drink. 48.8% of our sample has not studied beyond primary school, 28.4% studied up to secondary school 22.8% achieved a higher degree. More than half are married and 1.9% have been victim of physical violence. The correlation between BMI and WC is 84.36.

[Table 1 about here]

Table 2 presents summary results for BMI-based outcome variables – full regression output displaying all regressors can be found in Section B of the Supplementary Electronic Material (Table B2). Columns (1)-(4), (5)-(8) and (9)-(12) refer, respectively, to ordinary least squares models for continuous BMI, ordered logit models for categorical BMI statuses and logit models for the dichotomous status of being obese. For each of the three dependent variables, we estimated models for the full sample, by gender sub-samples and for the full sample with the addition of interaction terms between gender and wealth as well as gender and relative deprivation. We observe a strong quadratic relationship between wealth and BMI, irrespective of the empirical operationalisation, which holds for both genders but with stronger curvature for females. This indication is also confirmed by the models employing gender-based interaction terms. Figure 1 (top row) shows predicted values of the outcome variable along the wealth domain for models (4), (8) and (12) – left, centre and right figures, respectively. These graphs show a clear inverted-U pattern for both genders, and more markedly so for females. Whilst there is little gender difference in predicted BMI or predicted probability of being obese at low levels of wealth, at median wealth females are predicted to have on average a 1.388 (95% CI [1.382, 1.393])-point higher BMI and 8.50% (95% CI [8.46, 8.52]), and 11.18% (95% CI [11.14, 11.21]) higher probability of being obese for models (8) and (12), respectively. At high levels of wealth, however, this pattern is reversed and females are predicted to have, on average, around a 1.879 (95% CI [1.875,1.883])-point lower BMI and a lower probability of being obese – 12.36% (95% CI [12.33,12.40]) and 6.97% (95% CI [6.94,7.01]) lower according to models (8) and (12), respectively.

[Table 2 about here]

[Figure 1 about here]

While models (1), (5) and (9) suggest that relative deprivation is a significant risk factor, models estimated on gender subsamples indicate that this significance is in fact entirely driven by the female subsample – relative deprivation is never significant for models (3), (7) and (11) but is highly significant for models (2), (6) and (10) (p<0.001). A 0.1 increase in relative deprivation is associated to a 0.283 (95% CI [0.148, 0.423])-points increase in BMI, and according to model (10) relative deprivation is a risk factor for the probability of being obese (OR=3.20 (95% CI [1.86, 5.5]), p<0.001). The relevance of relative deprivation for females but not for males is also evident in our interaction models (4), (8) and (12) and in the corresponding graphs in Figure 1 (bottom row) depicting predicted values over the relative deprivation domain – curves are upward-sloped for females and essentially flat for males. For model (4), at low levels of relative deprivation the predicted difference in BMI across genders is below 1 (95% CI [0.607, 0.996]) point, but this increases to 3.602 (95% CI [2.316, 4.881]) BMI points at high relative deprivation. Similarly, for models (8) and (12), the difference in the probability of being obese for males and females goes from less than 1% at the lower end of the relative deprivation spectrum to around 23.95% (95% CI[13.70, 34.21]) and 30.68% (95% CI [17.30, 44.07]) (higher probability for females) at the higher end, respectively.

Table 3 presents summary results for WC-based dependent variables – full regression output can be found in Section B of the Supplementary Electronic Material (Table B3). Columns (13)-(16), (17)-(20) and (21)-(24) estimate, respectively, OLS for waist circumference in cm, logits for Mx and for LHM cut-offs As for Table 2, we estimate models with the full sample, by gender, and interacting gender with wealth and relative deprivation. The relationship between waist circumference and wealth is always significant and quadratic. The top row of Figure 2 plots predicted values over the wealth domain, based on interaction models (16), (20) and (24). After increasing in the first part of the graph, WC values level off for males and sharply decrease for females – with females having up to 15.61 (95% CI [13.02, 18.20]) cm smaller waist circumference for model (16) and up to 36.32% (95% CI [27.18, 45.47]) lower probability of abdominal obesity for model (20). This pattern changes for the graph derived using LHM cut-offs (top right), as these cut-offs, compared to the Mx ones, are not only further apart for the two genders but also more extreme (i.e. higher for males and lower for females). As a result, curves have similar shapes but shift along the vertical axis – for an illustration of how curves shift for different cut-offs, see Section C of the Supplementary Electronic Material (Figure C2W).

[Table 3 about here]

[Figure 2 about here]

Relative deprivation is always a risk factor, for both males and females and more strongly so for the latter. According to models (14) and (15), a 0.1-point increase in relative deprivation is associated to an increase in waist circumference by 1.20cm (95% CI [0.89, 1.51]) and 0.40cm (95% CI [0.11, 0.69]) for females and males, respectively. Our logit models display a similar gender pattern, with odds ratios higher for females compared to males – 5.70 (95% CI [3.52, 9.27]) vs 1.99 (95% CI

[1.15, 3.45]) for models (18) and (19); 4.30 (95% CI [2.56, 7.24]) vs 2.92 (95% CI [1.49, 5.69]) for models (22) and (23). Our interaction models show that gender differences are statistically significant for waist circumference and Mx obesity but not LHM obesity – see models (16), (20) and (24), respectively. We plot predicted values along the distribution of relative deprivation in the bottom row of Figure 2. At the lowest level of relative deprivation, model (16) predicts wider WC for males (94.91cm (95% CI [94.49, 95.31])) than females (91.48cm (95% CI [91.05, 91.92])). As we move along the distribution, predicted WC for females exceeds that of males and at the highest level of relative deprivation females are predicted to have a 4.12cm (95% CI [1.09,7.15]) wider waist than males. Model (20) shows a similar pattern. Females and males show similar probabilities of being obese at low levels of relative deprivation, but the two curves depart from each other to the point that, at the highest level of relative deprivation, the probability of being obese is almost 20% (95% CI [10, 30]) greater for females than for males. In line with the insignificance of the interaction term in model (24), the LHM-obesity graph shows parallel curves for females and males. The different results for models (20) and (24) with regard to gender heterogeneity roots in the choice of gender-specific cut-off points – for an illustration of how curves shift for different cut-offs, see Section C of the Supplementary Electronic Material (Figure C2RD).

4.Discussion

This paper provides new insights into the economic gradient of obesity in an important middle-income country setting. For the first time, the independent roles of objective indicators of absolute and relative standards of living as predictors of raised BMI and WC are disentangled using large nationally representative adult data. We find that in Mexico absolute wealth and relative deprivation are independently associated with excessive BMI and WC, and that for both facets of standards of living distinct gender-based patterns emerge. Results are confirmed for different manipulations of the outcome variable of interest and econometric specification: OLS for BMI or WC as continuous variables, ordered logit for standard BMI-based ordered categories (underweight, healthy weight, overweight, obese and severely obese) and logit for BMI and abdominal obesity. Results are also robust to a number of sensitivity checks, including the use of relative deprivation measures based on different functional forms and of different reference groups. The observed gender-based patterns emerge through both the introduction of a gender interaction term in the pooled sample and the study of female and male subsamples separately.

With regard to absolute wealth, we find a significant inverted-U relationship with raised BMI and WC. The shape of this relationship is visible for both females and males and is significantly more pronounced for the former. This indicates that the population in the middle of the wealth distribution bears the greatest risk of obesity. This evidence tallies with the conjecture made for Mexico by Fernald (2007) of a within-country inverted-U relationship between obesity and absolute standards of living: obesity would be low among the poor due to scarcity of resources and involvement in physically demanding jobs, it would peak for people in the middle of the distribution due to sufficient access to resources enabling them to maintain a positive energy balance, and would fall among the better off due to healthier diet and greater health awareness. The review by Mayén et al. (2014) finds indeed that in middle-income countries higher socioeconomic status is associated with a healthier diet. An inverted-U relationship in Mexico is also supported by the findings of Quezada and Lozada-Tequeanes (2015), although they found this pattern only for females, and of Levasseur (2015).

With regard to relative deprivation, we find that it is a risk factor for raised BMI (for females but not for males) as well as for and raised WC (for both females and males, and significantly more so for females in the case of continuous WC and for one of the chosen cutoffs for abdominal obesity). This evidence is in keeping with the idea that relative deprivation triggers chronic psychosocial stress (Wilkinson, 1997; Marmot, 2006), and chronic psychosocial stress is argued to be a driver of obesity (Siervo et al., 2009; Ford et al., 2017). Recent experimental evidence seems to confirm this causal link, showing that, independently of absolute standard of living, relative deprivation increases self-selected portion sizes and food intake (Sim et al., 2018a). Similar results are obtained by other experimental studies focusing on lower subjective economic status – which is a common direct implication of (objectively measured) relative deprivation, to the point of being often considered as a gauge for it (Kondo et al., 2008). Cardel et al. (2016) and Cheon and Hong (2017) show that subjective experience of lower socioeconomic status relative to others elicits obesogenic behaviors, and Sim et al. (2018b) found that low subjective social status not only decreases the sense of satiety but also has a direct influence on physiological responses by increasing the appetite-related hormone ghrelin. Taken together, these experimental findings lend support to the view that lagging behind others is a risk factor for obesity, by triggering obesogenic behaviours as well as more direct physiological effects.

Our finding of relative deprivation as a stronger risk factor for females compared to males can be seen in the light of the literature showing that females tend to have a more relativist attitude to wellbeing (Corazzini et al., 2012; Guven and Sørensen, 2012) and stronger inequality aversion (Croson and Gneezy, 2009). Females are also more affected by stress during their lives compared to males (Bale and Epperson, 2015; Maeng and Milad, 2015), which as we argued above is intensified by lower socioeconomic standing and is a risk factor for obesity – while we control for depressive symptoms, these may only partially account for stress. Lim et al. (2018) found that for females increased perceived stress predicted larger food portions and lowered expected satiety. Compared to males, females are also more intensely affected by the behaviour inhibition system and by negative emotions (Jorm et al., 1998; Becker et al., 2012), which can increase food intake (Canetti et al., 2002) and in particular sugar intake (Tapper et al., 2015). Furthermore, it is worth noting that Callan et al. (2011) show that relative deprivation increases delay discounting, which is known to be associated with obesity in women (Weller et al., 2008; Davis et al., 2010). Interestingly, the ecological study by Pickett et al. (2005) finds stronger and more consistent positive associations between income inequality and obesity for women.

The existence of a significant relationship between relative deprivation and obesity, and that this is particular strong for females, is interesting in its own right because it draws attention on the role of economic disparities and the fact that this role can be patterned by gender. In addition, it adds a new perspective on our current understanding of the socioeconomic gradient of obesity in women. A number of studies showed evidence of a negative gradient in females, in particular in middle- and high-income countries (Monteiro et al., 2004; Roskam and Kunst, 2008; Dinsa et al., 2012; Hirko et al., 2017; Newton et al., 2017). The negative gradient for females is consistent with the observation that wealthier women have a healthier diet, greater health awareness and more marked preferences for slenderness (Swami, 2015). However, beyond these plausible explanations, it is likely that the negative gradient for females observed in the literature is partly driven by the *relative* rather than the *absolute* facet of standards of living. In other words, the failure to explicitly control for relative standards of living in the existent literature leaves unclear the extent to which the observed negative gradient for females is due to being wealthier or to being wealthier *than others*. Dinsa et al. (2012) ask the question “Why does the within-country shift of obesity from the rich to the poor occur faster and at earlier levels of development for women than for men?” (p. 1076). Our results highlight an additional perspective on this question, emphasising the importance to consider the distributional changes occurring in the process of economic development because females may be more vulnerable to the adverse effects of an increase in economic inequality.

Addressing the rapid growth of obesity is an important priority in middle-income countries. This study based in Mexico provides potentially important insights into the complex socio-economic patterning of obesity in these settings. It highlights potentially important differences in socio-economic patterning between men and women, which should be considered in planning and evaluating interventions. For example, recent work modelling the reformulation of sugar-sweetened beverages in Mexico found larger associated reductions in obesity among males, young adults, and the middle socioeconomic status group (Basto-Abreu et al., 2018), which suggest that food policy interventions may not be sufficient to address the social patterning of obesity found here. Rather, addressing the economic gradient is key to not only reduce inequalities in health but overall health burden (Marmot et al., 2008) and may be especially advantageous for women. This is particularly important given the additional obesity-associated health problems suffered by women, such as increased likelihood of metabolic syndrome, polycystic ovary syndrome and specific cancers such as postmenopausal breast cancer and endometrial cancer (Hu, 2003). The gap between the haves and the have-nots should be seen as an important element of the fight to the obesity epidemic and of the quest towards better women's health.

Results for our control variables, available in the online supplementary material, are in line with previous findings. We observe a significant association of obesity with age (positive for linear age and negative for quadratic age); this reflects the inverted-U relationship between age and obesity commonly found in the literature (Cornelisse-Vermaat et al., 2006; Chung et al., 2016). Education is found to be a protective factor (Böckerman et al., 2017), and our results suggest that this is particularly the case for females, in line with other studies from Latin America including Mexico (Monteiro et al., 2001; Pérez-Ferrer et al., 2018). Limitation in physical activity and presence of chronic illnesses are significant risk factors for obesity as is typically found in the literature (e.g. Liou et al., 2005). Our negative and significant coefficients for civil status categories relative to the baseline 'married' are also is in keeping with previous results – entry into a romantic partnership was found to be associated with obesity (Averett et al., 2008; The and Gordon□Larsen, 2009), and transition into marriage was associated with weight gain whereas transition out of marriage is associated with weight loss (Dinour et al., 2012; Wilson, 2012). Our result that obesity is more prevalent in urban rather than rural areas is in line with the studies of Carrillo-Larco et al. (2016) and Sobngwi et al. (2016), which ascribe the phenomenon to a more sedentary lifestyle and unhealthier diet in urban areas. Finally, our result regarding depression is consistent with the evidence that depression may increase the likelihood of obesity (Blaine, 2008), and that in Mexico such relationship is more robust for women (Zavala et al., 2018).

Limitations of this study include that the data are now seven years old – although it has to be noted the one used here is the latest large ENSANUT dataset available, given that the 2016 'interim ENSANUT' is considerably smaller and less comprehensive. The data are cross-sectional, thus limiting causal inference, and restricted to one country, which limits the generalisability of our findings to other settings. Further research should be carried out with nationally representative datasets to explore the associations found in this paper, and understand in greater depth the role socioeconomic status plays in BMI and WC obesity – and how this is patterned by gender. Strengths of the study include the joint use absolute and relative wealth measures with a large nationally representative sample, objectively measured outcomes, multiple estimation techniques and robustness checks, and the rich array of outcomes and explanatory variables employed.

References

Adjaye-Gbewonyo, K., Kawachi, I., 2012. Use of the Yitzhaki Index as a test of relative deprivation for health outcomes: a review of recent literature. *Soc Sci Med*. *75*(1), 129-137.

Alonso, A. L., Munguía-Miranda, C., Ramos-Ponce, D., Hernandez-Saavedra, D., Kumate, J., Cruz, M., 2008. Waist perimeter cutoff points and prediction of metabolic syndrome risk. A study in a Mexican population. Arch Med Res. 39(3), 346-351.

Aschner, P., Buendía, R., Brajkovich, I., Gonzalez, A., Figueredo, R., Juarez, X. E., ... Ponte, C. I., 2011. Determination of the cutoff point for waist circumference that establishes the presence of abdominal obesity in Latin American men and women. Diabetes Res Clin Pract. 93(2), 243-247.

Averett, S. L., Sikora, A., Argys, L. M., 2008. For better or worse: relationship status and body mass index. *Econ Hum Biol*. *6*(3), 330-349.

Bale, T. L., Epperson, C. N., 2015. Sex differences and stress across the lifespan. *Nature Neurosci*. *18*(10), 1413-1420.

Barquera, S., Campos-Nonato, I., Hernández-Barrera, L., Pedroza, A., Rivera-Dommarco, J. A., 2013. Prevalence of obesity in Mexican adults 2000-2012. Salud Publica Mex. 55, S151-S160.

Barrientos-Gutierrez, T., Zepeda-Tello, R., Rodrigues, E. R., Colchero-Aragonés, A., Rojas-Martínez, R., Lazcano-Ponce, E., ... Meza, R., 2017. Expected population weight and diabetes impact of the 1-peso-per-litre tax to sugar sweetened beverages in Mexico. *PloS One*. *12*(5), e0176336.

Basto-Abreu, A., Braverman-Bronstein, A., Camacho-García-Formentí, D., Zepeda-Tello, R., Popkin, B. M., Rivera-Dommarco, J., ... Barrientos-Gutiérrez, T., 2018. Expected changes in obesity after reformulation to reduce added sugars in beverages: A modeling study. *PLoS Med*. *15*(10), e1002664.

Becker, J. B., Perry, A. N., Westenbroek, C., 2012. Sex differences in the neural mechanisms mediating addiction: a new synthesis and hypothesis. *Biol Sex Diff*. 3(1), 14.

Blaine, B., 2008. Does depression cause obesity? A meta-analysis of longitudinal studies of depression and weight control. *J Health Psychol*. *13*(8), 1190-1197.

Böckerman, P., Viinikainen, J., Pulkki-Råback, L., Hakulinen, C., Pitkänen, N., Lehtimäki, T., ...Raitakari, O. T., 2017. Does higher education protect against obesity? Evidence using Mendelian randomization. *Prev Med. 101*, 195-198.

Burkhauser, R. V., Cawley, J., 2008. Beyond BMI: the value of more accurate measures of fatness and obesity in social science research. *J Health Econ*. *27*(2), 519-529.

Callan, M. J., Shead, N. W., Olson, J. M., 2011. Personal relative deprivation, delay discounting, and gambling. *J Pers Soc Psychol*. *101*(5), 955-973.

Cardel, M. I., Johnson, S. L., Beck, J., Dhurandhar, E., Keita, A. D., Tomczik, A. C., ... Piff, P. K., 2016. The effects of experimentally manipulated social status on acute eating behavior: A randomized, crossover pilot study. *Physiol Behav*. *162*, 93-101.

Carrillo-Larco, R. M., Bernabé-Ortiz, A., Pillay, T. D., Gilman, R. H., Sanchez, J. F., Poterico, J. A., ... Miranda, J. J., 2016. Obesity risk in rural, urban and rural-to-urban migrants: prospective results of the PERU MIGRANT study. *Int J Obes*. *40*(1), 181-185.

Cheon, B. K., Hong, Y. Y., 2017. Mere experience of low subjective socioeconomic status stimulates appetite and food intake. *Proc Nat Acad Sci U S A*. *114*(1), 72-77.

Chung, W., Park, C. G., Ryu, O. H., 2016. Association of a new measure of obesity with hypertension and health-related quality of life. *PLoS One*. *11*(5), e0155399.

CONEVAL, 2018. *Pobreza y derechos sociales en México*. National Council for the Evaluation of Social Development Policy Mexico, Federal District.

Corazzini, L., Esposito, L., Majorano, F., 2012. Reign in hell or serve in heaven? A cross-country journey into the relative vs absolute perceptions of wellbeing. *J Econ Behav Organ*. *81*(3), 715-730.

Cornelisse-Vermaat, J. R., Antonides, G., Van Ophem, J. A., Van Den Brink, H. M., 2006. Body mass index, perceived health, and happiness: Their determinants and structural relationships. *Soc Ind Res*. *79*(1), 143-158.

Cornelsen, L., Smith, R. D., 2018. Soda taxes–Four questions economists need to address. *Food policy*. *74*, 138-142.

Côté-Lussier, C., 2016. Decomposing contributions of absolute, relative and subjective deprivation: A commentary on" Relative deprivation and risk factors for obesity in Canadian adolescents". *Soc Sci Med*. *155*, 12-14.

Croson, R., Gneezy, U., 2009. Gender differences in preferences. *J Econ Lit*. *47*(2), 448-474.

Davis, C., Patte, K., Curtis, C., & Reid, C., 2010. Immediate pleasures and future consequences. A neuropsychological study of binge eating and obesity. *Appetite*. *54*(1), 208-213.

Deaton, A., 2001. *Relative deprivation, inequality, and mortality*. NBER Working Paper No. w8099. National Bureau of Economic Research.

Dee, A., Kearns, K., O'Neill, C., Sharp, L., Staines, A., O'Dwyer, V., …Perry, I. J., 2014. The direct and indirect costs of both overweight and obesity: a systematic review. *BMC Res Notes*. *7*(1), 242.

de Hollander, E. L., Picavet, H. S. J., Milder, I. E., Verschuren, W. M., Bemelmans, W. J., de Groot, L. C., 2013. The impact of long-term body mass index patterns on health-related quality of life: the Doetinchem Cohort Study. *Am J Epidemiol*. *178*(5), 804-812.

Dinour, L., Leung, M. M., Tripicchio, G., Khan, S., Yeh, M. C., 2012. The association between marital transitions, body mass index, and weight: a review of the literature. *J Obes.* Article ID 294974.

Dinsa, G. D., Goryakin, Y., Fumagalli, E., Suhrcke, M., 2012. Obesity and socioeconomic status in developing countries: a systematic review. *Obes Rev*. *13*(11), 1067-1079.

Eibner, C., Evans, W. N., 2005. Relative deprivation, poor health habits, and mortality. *J Hum Res*. *40*(3), 591-620.

Elgar, F. J., Xie, A., Pförtner, T. K., White, J., Pickett, K. E., 2016. Relative deprivation and risk factors for obesity in Canadian adolescents. *Soc Sci Med*. *152*, 111-118.

Esposito, L., 2010. Upper boundedness for the measurement of relative deprivation. *Rev Income Wealth*. *56*(3), 632-639.

Esposito, L., 2018. Relative Deprivation and Relative Satisfaction: Theoretical Approaches, in: D'Ambrosio, C. (Ed.), *The Handbook of Research on Economic and Social Wellbeing*. Edward Elgar, London, pp. 339-355.

Fernald, L. C., 2007. Socio-economic status and body mass index in low-income Mexican adults. *Soc Sci Med. 64*(10), 2030-2042.

Fernández, A., Martínez, R., Carrasco, I., Palma, A., 2017. Impacto social y económico de la doble carga de la malnutrición: modelo de análisis y estudio piloto en Chile, el Ecuador y México. Economic Commission for the Latin America and the Caribbean and World Food Program.

Ford, N. D., Patel, S. A., Narayan, K. V., 2017. Obesity in low-and middle-income countries: burden, drivers, and emerging challenges. *Ann Rev Public Health. 38*, 145-164.

Goodman, E., Adler, N. E., Daniels, S. R., Morrison, J. A., Slap, G. B., Dolan, L. M., 2003. Impact of objective and subjective social status on obesity in a biracial cohort of adolescents. *Obesity*. *11*(8), 1018-1026.

Guven, C., Sørensen, B. E., 2012. Subjective well-being: Keeping up with the perception of the Joneses. *Soc Ind Res*. *109*(3), 439-469.

Heffetz, O.. 2011. A test of conspicuous consumption: Visibility and income elasticities. *Rev Econ Stat*. *93*(4), 1101-1117.

Hicks, D. L., Hicks, J. H., 2014. Jealous of the Joneses: conspicuous consumption, inequality, and crime. *Oxford Econ Papers*. *66*(4), 1090-1120.

Hirko, K. A., Lajous, M., Ortiz-Panozo, E. et al, 2017. Socioeconomic position and markers of adiposity among female teachers in Mexico. *J Epidemiol Community Health*. 71, 999-1004.

Howe, L. D., Galobardes B., Matijasevich A., et al., 2012. Measuring socio-economic position for epidemiological studies in low- and middle-income countries: a methods of measurement in epidemiology paper. *Int J Epidemiol*. 41(3), 871–886. doi:10.1093/ije/dys037.

Hu, F. B., 2003. Overweight and obesity in women: health risks and consequences. *J Womens Health*. *12*(2), 163-172.

Kolenikov, S., Angeles, G., 2009. Socioeconomic status measurement with discrete proxy variables: Is principal component analysis a reliable answer?. *Review Income Wealth*. *55*(1), 128-165.

Kondo, N., Kawachi, I., Subramanian, S. V., Takeda, Y., Yamagata, Z., 2008. Do social comparisons explain the association between income inequality and health?: Relative deprivation and perceived health among male and female Japanese individuals. *Soc Sci Med*. *67*(6), 982-987.

Janssen, I., Heymsfield, S. B., Allison, D. B., Kotler, D. P., Ross, R.. 2002. Body mass index and waist circumference independently contribute to the prediction of nonabdominal, abdominal subcutaneous, and visceral fat. *Am J Clin Nutr*. *75*(4), 683-688.

Janssen, I., Katzmarzyk, P. T., Ross, R., 2004. Waist circumference and not body mass index explains obesity-related health risk. *Am J Clin Nutr*. *79*(3), 379-384.

Jorm, A. F., Christensen, H., Henderson, A. S., Jacomb, P. A., Korten, A. E., Rodgers, B., 1998. Using the BIS/ BAS scales to measure behavioural inhibition and behavioural activation: factor structure, validity and norms in a large community sample. Pers Ind Dif. 26, 49–58.

Kopelman, P., 2007. Health risks associated with overweight and obesity. *Obes Rev*. *8*(s1), 13-17.

Laaksonen, M., Tarkiainen, L., Martikainen, P., 2009. Housing wealth and mortality: a register linkage study of the Finnish population. *Soc Sci Med. 69*(5), 754-760.

Lean, M. E., Han, T. S., Morrison C. E., 1995. Waist circumference as a measure for indicating need for weight management. BMJ. 311, 158–161.

Lementowski, P. W., Zelicof, S. B., 2008. Obesity and osteoarthritis. *Am J Orthop. (Belle Mead NJ). 37*(3), 148-151.

Lemeshow, A. R., Fisher, L., Goodman, E., Kawachi, I., Berkey, C. S., Colditz, G. A., 2008. Subjective social status in the school and change in adiposity in female adolescents: findings from a prospective cohort study. *Arch Pediatr Adolesc Med*. *162*(1), 23-28.

Levasseur, P., 2015. Causal effects of socioeconomic status on central adiposity risks: Evidence using panel data from urban Mexico. *Soc Sci Med*. *136*, 165-174.

Lim, E. X., Sim, A. Y., Forde, C. G., Cheon, B. K., 2018. The role of perceived stress and gender on portion selection patterns. *Physiol Behav*. 194, 205-211.

Ling, D. C., 2009. Do the Chinese "Keep up with the Jones"?: Implications of peer effects, growing economic disparities and relative deprivation on health outcomes among older adults in China. *China Econ Rev*. *20*(1), 65-81.

Liou, T. H., Pi-Sunyer, F. X., Laferrere, B., 2005. Physical disability and obesity. *Nutr Rev*. *63*(10), 321-331.

Luppino, F. S., de Wit, L. M., Bouvy, P. F., Stijnen, T., Cuijpers, P., Penninx, B. W., Zitman, F. G., 2010. Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. *Arch Gen Psychiatry*. *67*(3), 220-229.

Maeng, L. Y., Milad, M. R., 2015. Sex differences in anxiety disorders: interactions between fear, stress, and gonadal hormones. *Horm Behav*. *76*, 106-117.

Marmot, M. G., 2006. Status syndrome: a challenge to medicine. *Jama*. *295*(11), 1304-1307.

Mayén, A. L., Marques-Vidal, P., Paccaud, F., Bovet, P., Stringhini, S., 2014. Socioeconomic determinants of dietary patterns in low-and middle-income countries: a systematic review. *Am J Clin Nutr*. *100*(6), 1520-1531.

McLaren, L., 2007. Socioeconomic status and obesity. *Epidemiol Rev*. *29*(1), 29-48.

Misra, A., Wasir, J. S., Vikram, N. K., 2005. Waist circumference criteria for the diagnosis of abdominal obesity are not applicable uniformly to all populations and ethnic groups. Nutrition. 21(9), 969-976.

Marmot, M., Friel, S., Bell, R., Houweling, T. A., Taylor, S., Commission on Social Determinants of Health, 2008. Closing the gap in a generation: health equity through action on the social determinants of health. *Lancet*. *372*(9650), 1661-1669.

Monteiro, C. A., Conde, W. L., Popkin, B. M., 2001. Independent effects of income and education on the risk of obesity in the Brazilian adult population. *J Nutr*. *131*(3), 881S-886S.

Monteiro, C. A., Moura, E. C., Conde, W. L., Popkin, B. M., 2004. Socioeconomic status and obesity in adult populations of developing countries: a review. *Bull World Health Org*. *82*(12), 940-946.

Murray, C. J., 2015. Shifting to Sustainable Development Goals--Implications for Global Health. *N Engl J Med*. *373*(15), 1390-1393.

NCD Risk Factor Collaboration, 2016. Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19· 2 million participants. *Lancet*. *387*(10026), 1377-1396.

Newton, S., Braithwaite, D., Akinyemiju, T. F., 2017. Socio-economic status over the life course and obesity: Systematic review and meta-analysis. *PloS one*. *12*(5), e0177151.

OECD, 2016. *OECD Regions at a Glance 2016*. OECD Publishing.

Pérez-Ferrer, C., McMunn, A., Zaninotto, P., Brunner, E. J., 2018. The nutrition transition in Mexico 1988–2016: the role of wealth in the social patterning of obesity by education. *Pub Health Nutr*. *21*(13), 2394-2401.

Pickett, K. E., Kelly, S., Brunner, E., Lobstein, T., Wilkinson, R. G., 2005. Wider income gaps, wider waistbands? An ecological study of obesity and income inequality. *J Epidemiol Community Health*. *59*(8), 670-674

Pollack, C. E., Chideya, S., Cubbin, C., Williams, B., Dekker, M., Braveman, P., 2007. Should health studies measure wealth?: a systematic review. *Am J Prev Med*. *33*(3), 250-264.

Popkin, B. M., 2017. Mexican cohort study predates but predicts the type of body composition changes expected from the mexican sugar-sweetened beverage tax. *Am J Public Health*. *107*(11), 1702-1703.

Qiao, Q., Nyamdorj, R. 2010. The optimal cutoff values and their performance of waist circumference and waist-to-hip ratio for diagnosing type II diabetes. Eur J Clin Nutr. 64(1), 23-29

Quezada, A. D., Lozada-Tequeanes, A. L., 2015. Time trends and gender differences in associations between socioeconomic status indicators and overweight-obesity in Mexico (2006–2012). *BMC Public Health*. *15*(1), 1244

Quirmbach, D., Cornelsen, L., Jebb, S. A., Marteau, T., Smith, R., 2018. Effect of increasing the price of sugar-sweetened beverages on alcoholic beverage purchases: an economic analysis of sales data. *J Epidemiol Community Health*. 72(4), 324-330.

Roskam, A. J. R., Kunst, A. E., 2008. The predictive value of different socio-economic indicators for overweight in nine European countries. *Public Health Nutr*. *11*(12), 1256-1266

Rtveladze, K., Marsh, T., Barquera, S., Romero, L. M. S., Levy, D., Melendez, G., ... Brown, M., 2014. Obesity prevalence in Mexico: impact on health and economic burden. *Public Health Nutr*. *17*(1), 233-239

Sánchez-Castillo, C. P., Velázquez-Monroy, O., Berber, A., Lara-Esqueda, A., Tapia-Conyer, R., James, W. P. T., 2003. Anthropometric cutoff points for predicting chronic diseases in the Mexican National Health Survey 2000. *Obesity*. 11(3), 442-451.

Sánchez-Romero, L. M., Penko, J., Coxson, P. G., Fernández, A., Mason, A., Moran, A. E., ... Bibbins-Domingo, K., 2016. Projected impact of Mexico’s sugar-sweetened beverage tax policy on diabetes and cardiovascular disease: a modeling study. *PLoS medicine*. *13*(11), e1002158.

Seo, D. C., Choe, S., Torabi, M. R., 2017. Is waist circumference≥ 102/88 cm better than body mass index≥ 30 to predict hypertension and diabetes development regardless of gender, age group, and race/ethnicity? Meta-analysis. *Prev Med*. *97*, 100-108.

Siervo, M., Wells, J. C., Cizza, G., 2009. The contribution of psychosocial stress to the obesity epidemic: an evolutionary approach. *Horm Met Res*. *41*(4), 261-270.

Sim, A. Y., Lim, E. X., Forde, C. G., Cheon, B. K., 2018a. Personal relative deprivation increases self-selected portion sizes and food intake. *Appetite*. *121*, 268-274.

Sim, A. Y., Lim, E. X., Leow, M. K., Cheon, B. K., 2018b. Low subjective socioeconomic status stimulates orexigenic hormone ghrelin–a randomised trial. *Psychoneuroendocrinology*. 89, 103-112.

Sobal, J., Stunkard, A. J., 1989. Socioeconomic status and obesity: a review of the literature. *Psycho Bull*. *105*(2), 260.

Sobngwi, E., Mbanya, J. N., Unwin, N. C., Kengne, A. P., Fezeu, L., Minkoulou, E. M., ... Alberti, K. G. M. M., 2002. Physical activity and its relationship with obesity, hypertension and diabetes in urban and rural Cameroon. *Int J Obes*. *26*(7), 1009-1016.

Strum, R., Hattori, A., 2013. Morbid obesity rates continue to rise rapidly in the US. *Int J Obesity*. *37*(6), 889-891.

Sweet, E., 2011. Symbolic capital, consumption, and health inequality. *Am J Public Health. 101*(2), 260-264.

Tang, K. L., Rashid, R., Godley, J., Ghali, W. A., 2016. Association between subjective social status and cardiovascular disease and cardiovascular risk factors: a systematic review and meta-analysis. *BMJ open. 6*(3), e010137.

Tapper, K., Baker, L., Jiga-Boy, G., Haddock, G., Maio, G. R., 2015. Sensitivity to reward and punishment: Associations with diet, alcohol consumption, and smoking. Pers Individ Dif. 72, 79-84.

The, N. S., Gordon‐Larsen, P., 2009. Entry into romantic partnership is associated with obesity. *Obesity*. *17*(7), 1441-1447.

Van Gaal, L. F., Mertens, I. L., Christophe, E., 2006. Mechanisms linking obesity with cardiovascular disease. *Nature*. *444*(7121), 875-880.

Wang, Y. C., McPherson, K., Marsh, T., Gortmaker, S. L., Brown, M., 2011. Health and economic burden of the projected obesity trends in the USA and the UK. *The Lancet*. *378*(9793), 815-825.

Weller, R. E., Cook III, E. W., Avsar, K. B., Cox, J. E., 2008. Obese women show greater delay discounting than healthy-weight women. *Appetite*. *51*(3), 563-569.

Wilkinson, R.G., 1997. Health Inequalities: Relative or Absolute Material Standards? *BMJ*. 314, 591-595.

Wilson, S. E., 2012. Marriage, gender and obesity in later life. *Econ Hum Biol*. *10*(4), 431-453.

Zavala, G. A., Kolovos, S., Chiarotto, A., Bosmans, J. E., Campos-Ponce, M., Rosado, J. L., Garcia, O. P., 2018. Association between obesity and depressive symptoms in Mexican population. Soc Psychiatry Psychiatr Epidemiol. 53(6), 639-646.

Table 1. Descriptive statistics

Variable	Obs	Mean	SD	Min	Max
BMI	33,434	28.50	5.41	13.06	57.93
Waist Circumference	32,148	93.92	13.00	53	175.20
Wealth	33,434	6.74	2.15	0	13.99
RD	33,434	0.12	0.13	0	0.98
Depressive Symptoms	33,434	3.82	4.79	0	21
People in HH	33,434	3.92	1.86	1	19
Age	33,434	43.80	15.83	20	101
Chronic Illness	33,434	0.159	0.450	0	3
Daily Limitations	33,434	0.165	0.489	0	7
Variable	Obs	%			
Female	20,087	60.08			
Male	13,347	39.92			
Does not drink	17,208	51.5			
Drinks few times a year	8,188	24.5			
Drinks few times a month	5,061	15.1			
Drinks weekly-daily	2,977	8.9			
Does not smoke	27,477	82.2			
Currently smokes	5,957	17.8			
Not victim of violence	32,788	98.1			
Victim of Violence	646	1.9			
No Edu/Primary	16,316	48.8			
Secondary	9,493	28.4			
Post-Sec	7,625	22.8			
Single	4,792	14.3			
Free Union	6,055	18.1			
Married	17,441	52.2			
Divorced	2,615	7.8			
Widow	2,531	7.6			
Urban	21,541	64.4			
Rural	11,893	35.6			

Table 2. Results for BMI outcomes

	BMI				BMI CATEGORIES				BMI OBESITY (odds ratios)			
	(1) OLS	(2) OLS FEM	(3) OLS MALE	(4) OLS INTERACTION	(5) OLOGIT	(6) OLOGIT FEM	(7) OLOGIT MALE	(8) OLOGIT INTERACTION	(9) LOGIT	(10) LOGIT FEM	(11) LOGIT MALE	(12) LOGIT INTERACTION
Wealth	1.30***	1.56***	0.90***	0.90***	0.47***	0.51***	0.41***	0.39***	1.66***	1.76***	1.51***	1.56***
	(0.11)	(0.13)	(0.13)	(0.13)	(0.04)	(0.05)	(0.05)	(0.05)	(0.08)	(0.10)	(0.11)	(0.11)
Wealth²	-0.08***	-0.09***	-0.05***	-0.04***	-0.03***	-0.03***	-0.02***	-0.02***	0.97***	0.97***	0.98***	0.98***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Relative Dep	1.42*	2.80***	-0.37	-0.17	0.41*	0.83***	-0.14	-0.06	1.97**	3.20***	0.85	1.01
	(0.57)	(0.72)	(0.65)	(0.64)	(0.21)	(0.24)	(0.27)	(0.25)	(0.46)	(0.89)	(0.29)	(0.34)
Female	1.11***			-0.75	0.32***			0.04	1.54***			1.24
	(0.07)			(0.56)	(0.03)			(0.21)	(0.05)			(0.40)
Wealth*Female				0.68***				0.14**				1.12
				(0.14)				(0.05)				(0.09)
Wealth²* Female				-0.06***				-0.02***				0.99*
				(0.01)				(0.00)				(0.01)
RD*Female				2.79***				0.87**				2.83**
				(0.72)				(0.27)				(1.03)
N	33,434	20,087	13,347	33,434	33,434	20,087	13,347	33,434	33,434	20,087	13,347	33,434

* p<0.05, ** p<0.01, *** p<0.001. All models include the control variables described in Table 1. Standard errors clustered at the municipal level in parentheses.

Table 3. Results for WC outcomes

	Waist Circumference				Abdominal Obesity - Mx cut-offs (odds ratios)				Abdominal Obesity - LHM cut-offs (odds ratios)			
	(13) OLS	(14) OLS FEM	(15) OLS MALE	(16) OLS INTERACTION	(17) LOGIT	(18) LOGIT FEM	(19) LOGIT MALE	(20) LOGIT INTERACTION	(21) LOGIT	(22) LOGIT FEM	(23) LOGIT MALE	(24) LOGIT INTERACTION
Wealth	4.23***	4.68***	3.45***	3.39***	1.86***	1.93***	1.75***	1.73***	1.82***	1.91***	1.90***	1.88***
	(0.26)	(0.32)	(0.31)	(0.30)	(0.08)	(0.11)	(0.11)	(0.10)	(0.08)	(0.11)	(0.13)	(0.13)
Wealth2	-0.23***	-0.27***	-0.16***	-0.13***	0.97***	0.96***	0.97***	0.98***	0.97***	0.96***	0.97***	0.97***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Relative Dep	8.44***	12.01***	3.99**	4.43**	3.55***	5.70***	1.99*	1.99*	3.44***	4.30***	2.92**	3.27***
	(1.22)	(1.59)	(1.49)	(1.45)	(0.71)	(1.41)	(0.56)	(0.54)	(0.72)	(1.14)	(1.00)	(1.08)
Female	-2.59***			-4.80***	1.15***			1.13	4.75***			8.36***
	(0.18)			(1.45)	(0.04)			(0.31)	(0.16)			(2.72)
Wealth*Female				1.39***				1.13				1.01
				(0.37)				(0.08)				(0.08)
Wealth2* Female				-0.16***				0.98***				0.99*
				(0.03)				(0.00)				(0.01)
RD*Female				7.55***				2.93***				1.26
				(1.72)				(0.92)				(0.48)
N	32,148	18,822	13,326	32,148	32,148	18,822	13,326	32,148	32,148	18,822	13,326	32,148

* p<0.05, ** p<0.01, *** p<0.001. All models include the control variables described in Table 1. Standard errors clustered at the municipal level in parentheses.

Figure.1.Predicted BMI outcomes over the absolute wealth and relative deprivation domains

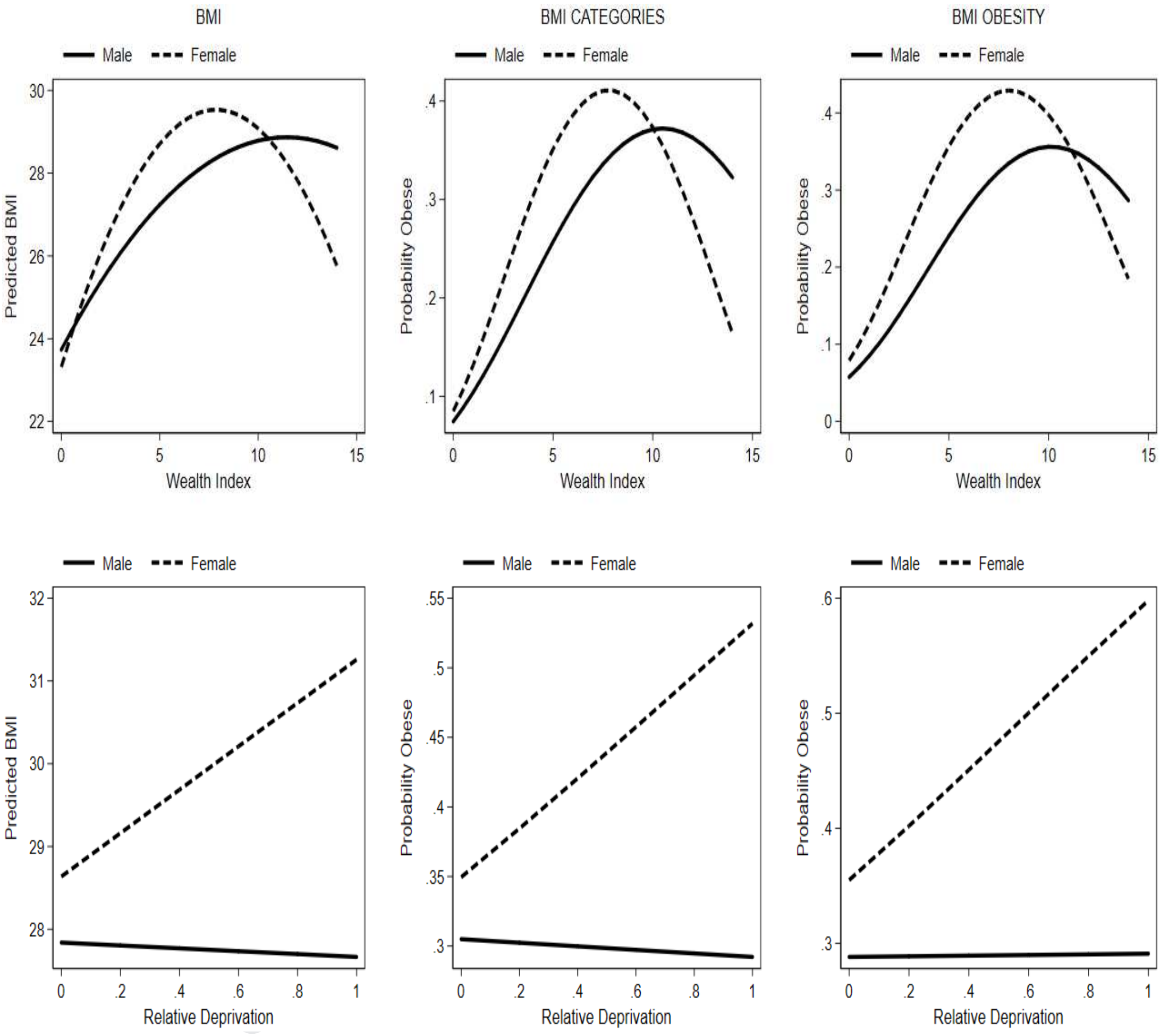
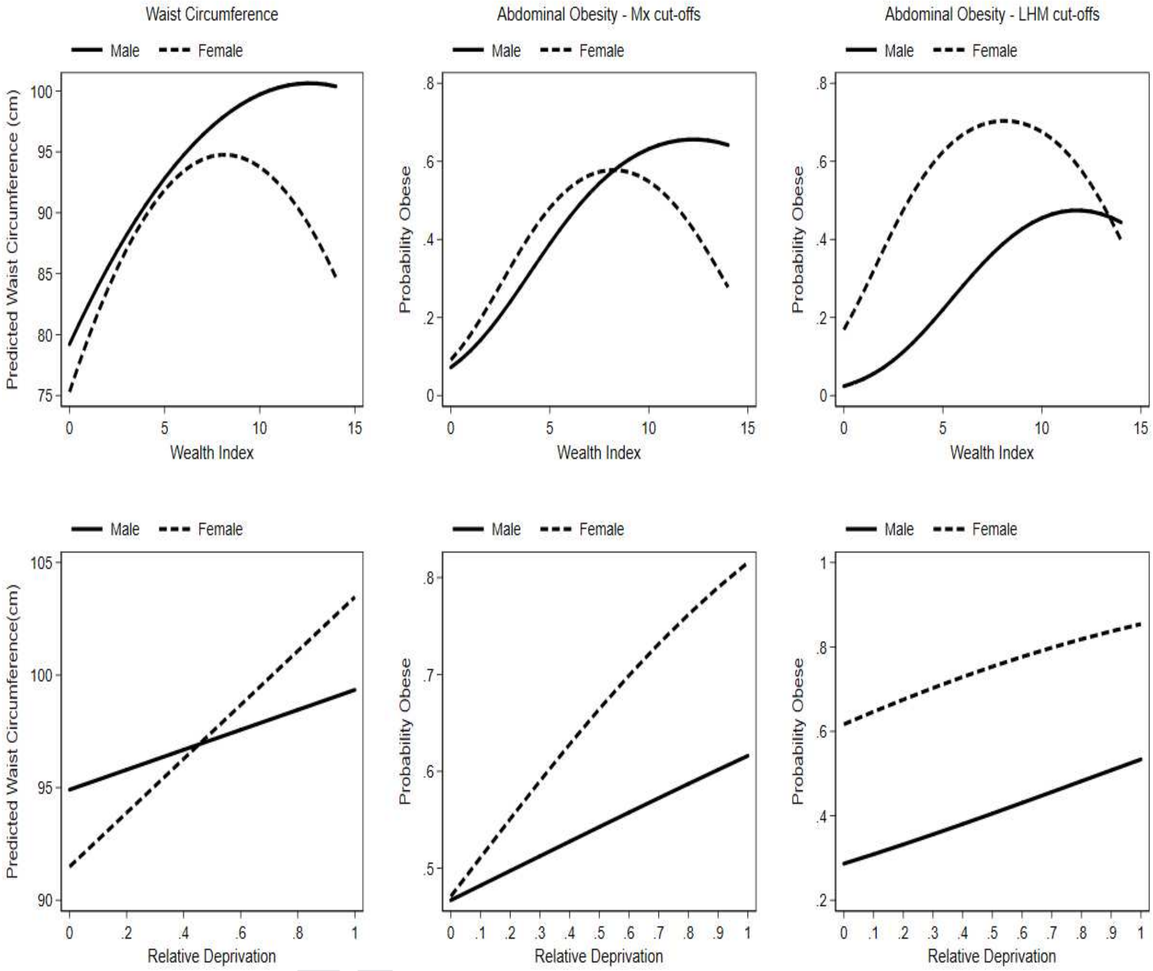


Figure.2.Predicted WC outcomes over the absolute wealth and relative deprivation domains



Highlights, Manuscript SSM-D-19-02873

The economic gradient of obesity in Mexico: independent predictive roles of absolute and relative wealth by gender

We provide novel results on the economic gradient of obesity in Mexico

We study the *absolute* and *relative* facets of economic status in relation to obesity

Wealth and relative deprivation are independently related to BMI and central obesity

BMI and central obesity exhibit an inverted-U pattern over the absolute wealth domain

Relative deprivation is a risk factor for both genders, in particular for women

.