Evaluating social and gender differences in excess weight in the Iberian Peninsula: a multilevel analysis in urban settings

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Background and theoretical focus

Obesity is a major contributor to the burden of non-communicable diseases and related disabilities (Haththotuwa et al., 2020). Many countries have experienced alarming increases in the prevalence of excess weight in the last four decades (Hruby & Hu, 2015). Globally, obesity has almost tripled from 1975 to 2016 (Haththotuwa et al., 2020), reaching epidemic proportions (Hruby & Hu, 2015). In 2016, approximately 13% of adults (11% of men and 15% of women) were obese worldwide (WHO, 2018).

Several factors (social, environmental, behavioral and biological), and levels (including individual and contextual) interact to determine the burden of overweight and obesity. Given the high velocity in the increment of excess weight, studies suggested that behavioral and environmental factors have contributed much more to the epidemic than the biological factors (Stein and Colditz, 2004; Haththotuwa et al., 2020). From a macro-level perspective, economic growth, industrialization, globalization, increases in income, rapid urbanization, and the nutritional transition are among the main drivers of the rising trends in excess weight (Hruby & Hu, 2015; Malik et al., 2013).

Previous studies showed a positive association between obesity and urbanization (Mendez and Popkin, 2004; Subramanian et al., 2011), and some mechanisms were proposed to explain this association. On the one hand, living in urban settings may lead to a less energy expenditure (because of less physically demanding occupations, less opportunities to exercise, and more sedentary leisure activities). On the other hand, living in cities might lead to a faster transition to the "Western" diets high in calories, fat and sugar, and low in vegetables and fruits (Popkin et al., 2012). Several factors may underly the former, such as the increased affordability of processed and high in calories foods due to rising incomes and advances in food technologies (Goryakin & Suhrcke, 2014).

The nutrition transition –i.e. the process of shifts in the diet and in the physical activity patterns that result in changes in nutritional status (Popkin., 1994)- is faster in urban settings (Hawkes et al., 2017). Urban food environments with supermarkets, high density of food stores, restaurants and street sellers, facilitate the access to unhealthy and high dense calorie diets. However, the urban environment also offers considerable opportunities to access healthy food for those who can afford it (Hawkes et al., 2017). Since healthy and low dense calorie food is often more expensive than unhealthy and high dense food, the urban poor are more likely to have access to the latter (Ruel et al., 2008; Hawkes et al., 2017). Thus, living

in urban areas might have different impact in overweight and obesity, depending on the social position of individuals.

In Europe, 53% of adults are overweight or obese (De Schutter et al., 2020; Marques et al., 2014). In line with that, in the Iberian Peninsula (Spain and Portugal), excess weight affects more than half of the adult population (Busutil et al., 2017; Carreira et al., 2012). Janssen et al. (2020) estimated an age standardized prevalence of obesity in adult population of 22.7% in men and 24.9% in women of Portugal, and 27.5% in men and 27.2% in women of Spain in 2016. They also projected for 2060 a decrease in the obesity prevalence and in the existing gender gap in Portugal (18% and 17.7% in men and women, respectively), but an increase in the prevalence of obesity among men in Spain as well as in the gender gap (30% for men and 27% for women).

Numerous studies suggested that social position and gender are related to the excess weight in the Iberian Peninsula (Ortíz-Moncada et al., 2011; Merino Ventosa & Urbano-Garridos, 2016; Gaio et al., 2018; Hernández-Yumar et al., 2018; García-Goñi & Hernández-Quevedo, 2012; Oliveira et al., 2018; Rodríguez-Caro et al., 2016; Costa-Font & Gil, 2008). In Portugal, higher prevalence of overweight and obesity were found among individuals with lower educational background and women (Gaio et al., 2018; Oliveira et al., 2018). Moreover, in Spain Rodríguez-Caro et al. (2016) showed a large and rising social gradient in obesity (especially with respect to educational attainment), more noticeable among women. However, scarce evidence exists on the effect of urban social determinants beyond individual social position on excess weight, and even less about the interplay between individual- and city-level social factors in these associations in Spanish and Portuguese cities. Thus, the aims of this study are to evaluate the association between urban social indicators and excess weight by gender in cities of the Iberian Peninsula, and to analyze to what extent these associations vary by individual education.

Data

Data sources for this study will be the Second European Health Interview Survey for Spain and Portugal - carried out between 2013 and 2015, and the 2011 population censuses of these countries. We will include in the study individuals living in cities of more than 100,000 inhabitants.

Three dichotomous outcomes at the individual level related to excess weight (based on anthropometric measures of weight and height) will be considered:

- Overweight: defined if BMI is ≥25 kg/m^2
- Pre-obesity: defined if BMI is ≥25 kg/m^2 and <30 kg/m^2
- Obesity: defined if BMI is ≥30 kg/m^2

We might end up selecting one single outcome, but initially we will explore potential differences in the distribution and associations between the exposures and these outcomes.

As exposure variables, we will consider city-level social indicators, such as the percentage of population with secondary education, and the Per-capita Gross Domestic Product (GDP) of cities. In addition, we will include a city-level social context index as an exposure variable in a sub-set of models, calculated by factorial analysis on social census indicators. We will also consider the individual education (less than primary, primary, secondary, and university) as potential modifier of the association between city social indicators and excess weight.

We will adjust the analyses by individual age, city population size and country, and all analyses will be stratified by gender (technically self-reported sex female/male).

Methods

We will estimate gender-stratified two-level logistic mixed models, with a random intercept for cities. Four models of increasing complexity will be explored:

- Model 1: including age, individual education and age as fixed effects, and a random variance component for city.
- Model 2: adding the city population size and city social indicators -alternatively, in different models.
- Model 3: adding interaction terms to evaluate to what extent the association between city social indicators and excess weight variables are modified by individual education.

Final models will be fitted, based on the following:

$$logit\ of\ P_{ij} = \gamma_{00} + \gamma_{10}E_{ij} + \gamma_{20}A_{ij} + \gamma_{01}S_j + \gamma_{02}P_j + \gamma_{03}C_j + \gamma_{11}E_{ij}S_j + \vartheta_j$$

where P_{ij} is the probability of overweight/pre-obesity/obesity in the *ith* individual, living in the *kth* city; γ_{10} is the estimate of individual education; γ_{20} is the estimate of age; γ_{01} is the estimate of the city social indicators (alternatively, in different models); γ_{02} is the estimate of the total population of cities; γ_{03} is the fixed effects of country; γ_{11} is the interaction between individual education and city social indicators; and ϑ_j is the random intercept for cities.

Continuous variables will be standardized in all models. Analyses will be performed using Stata v15.

Expected findings

We expect to find a higher probability of excess weight outcomes in individuals living in cities with lower socioeconomic status, compared to those living in cities with higher socioeconomic status. We also expect that these associations will be stronger in women, compared to men. In addition, we think the individual education will modify the excess weight-city social indicators associations. Specifically, we expect that the inverse association between excess weight and city socioeconomic level will be stronger among individuals from lower educational background.

Overall, we expect to provide knowledge on how the social features of large cities are related to adult excess weight in the Iberian Peninsula, and to what extent individual education might act as a buffer of these associations.

References

Aranceta-Bartrina, J., Pérez-Rodrigo, C., Alberdi-Aresti, G., Ramos-Carrera, N., & Lázaro-Masedo, S. (2016). Prevalence of general obesity and abdominal obesity in the Spanish adult population (aged 25–64 years) 2014–2015: the ENPE study. *Revista Española de Cardiología*, *69*(6), 579-587.

Costa-Font, J., & Gil, J. (2008). What lies behind socio-economic inequalities in obesity in Spain? A decomposition approach. *Food policy*, *33*(1), 61-73.

De Schutter, O., Jacobs, N., & Clément, C.W. (2020). A 'Common Food Policy' for Europe: How governance reforms can spark a shift to healthy diets and sustainable food systems. *Food Policy, 96*, 101849.

Gaio, V., Antunes, L., Namorado, S., Barreto, M., Gil, A., Kyslaya, I., ... & INSEF Research group. (2018). Prevalence of overweight and obesity in Portugal: results from the first Portuguese Health Examination Survey (INSEF 2015). *Obesity research & clinical practice*, *12*(1), 40-50.

García-Goñi, M., & Hernández-Quevedo, C. (2012). The evolution of obesity in Spain. *Eurohealth*, *18*(1), 22-25.

Goryakin, Y., & Suhrcke, M. (2014). Economic development, urbanization, technological change and overweight: what do we learn from 244 Demographic and Health Surveys?. *Economics & Human Biology*, *14*, 109-127.

Haththotuwa, R. N., Wijeyaratne, C. N., & Senarath, U. (2020). Worldwide epidemic of obesity. In *Obesity and obstetrics* (pp. 3-8). Elsevier.

Hawkes, C., Harris, J., Gillespie, S. (2017). Urbanization and the Nutrition Transition. In Global Food Policy Report, (4): 34-41.

Hruby, A., & Hu, F. B. (2015). The epidemiology of obesity: a big picture. *Pharmacoeconomics*, *33*(7), 673-689.

Kelly, T., Yang, W., Chen, C. S., Reynolds, K., & He, J. (2008). Global burden of obesity in 2005 and projections to 2030. *International journal of obesity*, *32*(9), 1431-1437.

Malik, V., Willett, W. & Hu, F. (2013). Global obesity: trends, risk factors and policy implications. *Nat Rev Endocrinol* **9,** 13–27.

Marques, A., Peralta, M., Naia, A., Loureiro, N., & de Matos, M. G. (2018). Prevalence of adult overweight and obesity in 20 European countries, 2014. *The European Journal of Public Health*, *28*(2), 295-300.

Mendez M.A., Popkin B.M. (2004). Globalization, Urbanization and Nutritional Change in the Developing World. *Electronic Journal of Agricultural and Development Economics,* 1:220–241.

Merino Ventosa, M.; Urbano-Garridos, R. (2016). Disentangling effects of socioeconomic status on obesity: a cross-sectional study of the Spanish adult population. *Economics & Human Biology*, *22*, 216-224.

Oliveira, A., Araújo, J., Severo, M., Correia, D., Ramos, E., Torres, D., & Lopes, C. (2018). Prevalence of general and abdominal obesity in Portugal: Comprehensive results from the National Food, nutrition and physical activity survey 2015–2016. *BMC public health*, *18*(1), 1-9.

Popkin, B. M. (1994). The nutrition transition in low-income countries: an emerging crisis. *Nutrition reviews*, *52*(9), 285-298.

Popkin, B. M., Adair, L. S., & Ng, S. W. (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition reviews*, *70*(1), 3-21.

Rodriguez-Caro, A., Vallejo-Torres, L., & Lopez-Valcarcel, B. (2016). Unconditional quantile regressions to determine the social gradient of obesity in Spain 1993–2014. *International journal for equity in health*, *15*(1), 1-13.

Stein, C.J., Colditz, G.A. The epidemic of obesity. *J Clin Endocrinol Metab*, *89*, 2522-5.

Subramanian S., Perkins J.M., Özaltin E., Smith G.D. (2011). Weight of nations: a socioeconomic analysis of women in low-to middle-income countries. *American Journal of Clinical Nutrition*; 93:413–421.

World Health Organization (2018). Noncommunicable diseases country profiles. Geneva: World Health Organization.