Do income inequality and women empowerment predict obesity in Latin American cities?

1. Background and theoretical focus

Obesity, urbanization, and social and gender inequalities are three closely related growing global issues. Approximately 55% of the world's population lives in urban areas[1], and about 50% of the world's adult population has excess weight[2]. Moreover, obesity as well as social inequalities are higher in more urban areas[3-5]. In addition, social and gender inequalities are one of the most important problems in population health[6]: more unequal societies have worse health outcomes[3]. Indeed, obesity is more prevalent among more unequal societies[7], and income gradients and gender inequalities in obesity have been noted[8,9]. Even though obesity is associated with multiple comorbidities and it is the leading cause of preventable mortality, no country has so far succeeded in reducing its rates[10,11].

Two of the most prevalent theories proposed to explain rising obesity rates are the "dependency and world systems theory" and the "modernization theory". The former argues that external structural forces drive the obesity epidemic, posing that factors related to globalization processes flood markets with inexpensive high caloric density food and diffuse Western-style fast food outlets in lower income countries[12,13]. The "modernization theory" refers that economic development leads to domestic nutrition transitions (from low caloric to high caloric diet), and relates the greater unhealthy food intake to increasing income and higher participation of women in the labor force[13-15].

Previous empirical evidence shows that income inequality is related to the obesity epidemic, as inequality may determine obesogenic environments that influence individuals´ choices towards less healthy dietary patterns and lifestyles[3,16]. In addition, obesity shows a gendered patterning: globally, its prevalence is higher and more heterogeneous among women than in men, and some evidence suggests that gender-based inequality might explain these differences[8,17]. Gender patterned norms may also drive some well-known social and behavioral factors associated to obesity, such as dietary intake and physical activity[8,18,19]. However, other research showed that increasing women's empowerment appears to be associated with increases in adiposity over time, especially among women[13].

The rising prevalence of obesity and related risk behaviors has not been uniformed between and within regions and countries[20, 21]. In high-income countries the prevalence began to attenuate in the past decade, while rising trends are likely to be continued in low- and middle-income countries, where more than half of people with obesity live[20,22]. Furthermore, research shows that as country's development increases, the burden of obesity shifts toward the lower socioeconomic groups and that this pattern is more noticeable among women[20,22]. However, less is known about how social and gender inequalities shape the pattern of obesity between and within countries, especially in low- and middle-income countries.

Weight excess affects approximately 50% of adult Latin American population, and increasing trends are projected mainly among women[23,24]. However, there is considerable heterogeneity across and within countries, since the most populated countries of the region (Brazil, Mexico and Colombia) are reducing both the gender gap and the socioeconomic differences in the prevalence obesity among women[25]. Additionally, Latin America is among the most urbanized regions worldwide, with fast growing rates: urban population grew from 40% in 1950 to 80% in 2015[1]. Moreover, several large Latin American cities are projected to become megacities by 2030[26]. At the same time, this is one of the most unequal regions, including more than half of the most unequal cities[27,28]. Gender inequalities also characterize the region: poverty, difficulties in schooling and low levels of participation in the labor force affect women predominantly, among others[29,30]. Evidence from Latin America shows that obesity is more prevalent among women, however individual education and city-level socioeconomic development may influence the risk[31]. In women, there are large educational inequalities in obesity independently of city-level socioeconomic development while in men education gradients were observed only in cities with lower socioeconomic development[31].

Given the concomitant features of high urbanization rates, high levels of social and gender inequalities, and high prevalence of obesity, Latin America is a unique scenario for studying the urban social and gender

inequalities in obesity. However, to the best of our knowledge, no prior study has assessed the association between income inequality and women empowerment indicators with obesity in Latin American cities. Thus, the aims of this study are to analyze: 1) the association between city-level income inequality, women empowerment indicators and obesity by gender in Latin America; 2) how these associations vary by individual education or subcity socioeconomic conditions (SEC).

2. Data and research methods

Sample

Data was compiled by SALURBAL (Urban Health in Latin America), a collaborative multinational project that examines drivers of health in Latin American cities[28]. For this study we will analyze a total of 81,878 adults living in 187 cities of more than 100,000 inhabitants and 538 subcities (defined as administrative units nested within cities), from the following countries: Argentina, Brazil, Chile, Colombia, El Salvador, Guatemala, Mexico and Peru. We will use harmonized data from population census and health surveys collected from 2002 to 2016.

Outcome variables

Obesity at the individual level, defined as body mass index (BMI) ≥30 kg/m^2 based on anthropometric measures of weight and height (except for Argentina with self-reported weight and height).

Exposure variables

Exposures:

-City-level income inequality: we will use income-based Gini measure as indicator of city-level inequality.
-City-level women empowerment: A score of women´s labor force participation (WLFP) will be used as a proxy of women empowerment. The WLFP score was constructed by considering the following census measures: the ratio of the female to male proportion of the population aged 25 or older who completed secondary education or above; the ratio of the female to male proportion of the population aged 25 or older who completed university or above; the labor force participation rate among the female population 15 years or above; the ratio of the labor force participation rate among females to the labor force participation rate among males (15 years or older)[32]. Higher score values indicates greater WLFP.

Modifiers:

-Subcity SEC: we will use a composite indicator of poverty level and general living conditions at the subcity level, obtained by considering the percentage of households with piped water inside the dwelling, the percentage of households with overcrowding (3 or more people per room, inverted), and the percentage of population aged 15-17 attending school[33]. Higher score values correspond to better living conditions.
-Individual SEC: we will use the individual educational attainment as proxy of individual SEC, categorized as less than primary, primary, secondary, and university.

Other covariates

All analyses will be stratified by gender (technically self-reported sex female/male). We will adjust the analyses by the following covariates:
-Age: given that obesity is associated with age[34].
-Population size: since previous studies showed links between population size and obesity[35].
-Social environment index (SEI): in order to test to what extent income inequality and WLFP are associated with obesity beyond city SEC. The SEI is obtained by averaging the z-scores of the percentage of households with sewage connection, percentage of households with connection to water, percentage of households with overcrowding (inverted), and percentage of individuals aged 25 or older with primary education completed or above[36]. Higher SEI indicates better city SEC.
-Country: we will adjust analysis for country (Argentina, Brazil, Chile, Colombia, El Salvador, Guatemala, Mexico, Peru) in order to control for unmeasured confounding effects.

Statistical analysis

We will estimate gender-stratified three-level logistic mixed models, with random intercepts for subcities and cities. Four models of increasing complexity will be explored.

First, we will test a null model (model 0) with country and age as fixed effects and a random variance component for city and subcity levels. Second, we will add the city income inequality/WLFP -alternatively- to the empty model (model 1). Third, we will add population size and city SEI to model 1 (model 2). Last, we will include interaction terms to evaluate whether the association between city income inequality/WLFP and obesity are modified by subcity or by individual SEC (model 3). Continuous variables will be standardized in all models.

Final models will be fitted, based on the following:

$$logit\ of\ P_{ijk} = \gamma_{000} + \gamma_{001} I_k + \gamma_{002} P_j + \gamma_{003} S_j + \gamma_{004} C_j + \gamma_{010} L_{jk} + \gamma_{100} E_{ijk} + \gamma_{200} A_{jk} + \gamma_{011} L_{jk} I_k + \gamma_{101} E_{jk} I_k + \vartheta_{jk} + \vartheta_k$$

where $P_{ijk}$is the probability of obesity in the *ith* individual, living in the *jth* subcity and the *kth* city; γ_{001} is the estimate of city income inequality/WLFP score; γ_{002} is the estimate of the total population of cities; γ_{003} is the estimate of the city SEI; γ_{004} is the fixed effects of country; γ_{010} is the estimate of subcity SEC; γ_{100} is the estimate of individual SEC; γ_{200} is the estimate of age; γ_{011} is the interaction between subcity SEC and city income inequality/WLFP; $\gamma_{101}$is the interaction between individual SEC and city income inequality/women WLPF; ϑ_{jk} and ϑ_k are random intercepts for subcity and city, respectively (both normally distributed with variances τ_{00}^2 and τ_0^2).

3. Expected findings

We expect that individuals living in cities with greater income inequality will have higher probability of obesity compared to those from less unequal cities. In addition, the association between city income inequality and higher probability of obesity will be stronger among individuals from lower subcity and individual SEC. In regards to women empowerment, we expect that individuals living in cities with greater WLPF will have lower probability of obesity compared to those from cities with lower WLFP. Further, the association between WLFP and lower probability of obesity will be stronger among individuals from higher subcity and individual SEC. All the associations are expected to be stronger among women than in men. Overall, we expect to generate evidence on how social and gender inequalities shape obesity, and obesity-related health outcomes in Latin American cities.

4. References

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