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Is a 'culture of plus-size women' the independent effect of neighborhood disadvantage on female BMI? A cross-sectional study in two Chilean Municipalities

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ABSTRACT

Research has shown that neighborhood disadvantage has an effect on BMI that is independent of individual disadvantage, much more pronounced in women than in men. The mechanisms that explain this gender-specific effect are not yet clear. Since women's body size dissatisfaction is closely linked to gender differences in BMI inequalities, the independent effect of neighborhood disadvantage on female BMI may relate to a local culture of acceptance of female large bodies, that could influence women's parameters for body size dissatisfaction. This study explored how the relation between female BMI, neighborhood income, individual income and education is influenced by body size dissatisfaction in a random sample of 882 women aged 20–60 that reside in two Chilean Municipalities. Data have a two level structure (women nested in 17 neighborhoods); it was collected by direct survey, height and weight were measured with portable instruments. Disadvantaged neighborhoods house mainly poor and low educated women, whereas the wealthier ones were inhabited mostly by affluent women with postsecondary education. The proportion of women without a husband/partner and with more than three children in disadvantaged neighborhoods was higher than better off areas. Multilevel linear regression showed that neighborhood disadvantage had an effect on female BMI that was independent of women's income and education, which was explained by body size dissatisfaction. The mean BMI for body size satisfaction among women in disadvantaged neighborhoods was 2 kg/m^2 higher than in affluent areas, which suggests that a 'culture of plus-size women' would emerge in urban clusters of poverty. The findings signal that neighborhood effects on BMI would relate to the socioeconomic polarization of urban areas, with marked concentrations of poverty and wealth, and might be explained by the psychosocial pathways associated to social disadvantage that act in addition to the effects of material conditions to influence people's health.

1. Introduction

The global prevalence of obesity has reached epidemic proportions, overburdening women in most populations (Jaacks et al., 2019; Popkin and Reardon, 2018; Garawi et al., 2014). Being overweight or obese (a body mass index (BMI) $\geq$ 25 and $\geq$30 kg/m2, respectively) has a profound impact on the length and quality of life of women (Muennig et al., 2006). Relative to men, women shoulder a disproportionate burden of weight-based discrimination in life domains of crucial importance for personal wellbeing (Spahlholz et al., 2016; Puhl and Heuer, 2009), and suffer also a greater burden of disease attributable to excess weight (Kulie et al., 2011; Muennig et al., 2006).

Female obesity rates in Chile are among the highest in Latin America, one of the world regions most affected by the obesity epidemic (Ng et al., 2014; Popkin and Reardon, 2018). The sustained growth of the Chilean economy during the last decades was concomitant with a rapid increase in obesity prevalence, which disproportionally affected socioeconomically disadvantaged women (Vio and Kain, 2019; Mujica-Coopman

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et al., 2020). The mean body mass index (BMI) of women with less than 8 years of education (elementary) reaches 30 kg/m^2, whereas in women with more than 12 years of education (beyond high school) is 26.8 kg/m^2 (Ministerio de Salud de Chile, 2010).

Research has shown that as societies transit to higher income levels, the burden of excess weight progressively clusters among disadvantaged populations, and an inverse pattern of association between socioeconomic status (SES) and BMI becomes evident in women but not in men (Jaacks et al., 2019; McLaren, 2007; Sobal and Stunkard, 1989). Even though the female excess in obesity prevalence is linked to women's reproductive role, the effects of reproduction on female BMI are largely driven by socioeconomic factors (Brooks and Maklakov, 2010; Kim et al., 2007). Addressing the factors that may underlie female BMI inequailiets in obesity-related research is relevant from both a social and a health equity perspective, because obese women's offspring face an increased obesity risk (Patro et al., 2018; Whitaker et al., 1997), so the disadvantage-obesity binding might perpetuate in time.

The evidence suggests that the socioeconomic context of neighborhoods could have an impact on the female excess in obesity burden. Studies about neighborhoods and overweight/obesity show that the association between the socioeconomic conditions of residential areas and BMI is much more pronounced in women than in men (Harrington and Elliott, 2009; Matheson et al., 2008; Rundle et al., 2008). Research has shown as well that neighborhood disadvantage has an effect on BMI that is independent of individual disadvantage, which could be at least as important as individual SES in explaining individual differences in excess weight; however, this effect is observed mainly in women (Feng and Wilson, 2015; Rachele et al., 2019; King et al., 2006).

In identifying potential mechanisms to explain how neighborhoods affects BMI, research has focused mainly on the effects that the material conditions of residential areas could have on people's eating and physical activity behaviors. Disadvantaged neighborhoods provide residents with limited access to healthy food shops, functioning sidewalks and parks (Diez Roux and Mair, 2010; Lovasi et al., 2009). Nevertheless, such environmental features might not be able to explain the gender-specific effect of neighborhood disadvantage on BMI (Ford and Dzewaltowski, 2011; Harrington and Elliott, 2009).

Neighborhoods' social dynamics may exert an important influence on people's weight-related behaviors (Cannuscio et al., 2014; Macintyre, 2007), so directing research attention towards the influence of social contextual features may contribute to explain the independent effect of neighborhood disadvantage on women's BMI. The literature often mentions that studying cultural features of the social context may help to understand why women's overweight and obesity rates are so high in disadvantaged neighborhoods (Harrington and Elliott, 2009; Matheson et al., 2008; McLaren and Gauvin, 2002). Nonetheless, within the potential mechanisms by which the socioeconomic circumstances of places could affect people's health, neighborhoods' culture is amongst the most widely discussed but least developed, theoretically or empirically (Harding and Hepburn, 2014).

Cultural views towards women's body size arising from western media representations of female thinness as an ideal of bodily beauty might play an important role in explaining the social stratification of women's BMI in affluent societies (McLaren, 2007; Sobal and Stunkard, 1989). Evidence from both quantitative and qualitative studies signals that the impact of the 'thin ideal' is rather modest in disadvantaged contexts but quite considerable in higher socioeconomic strata, where women's pursuit of thinness and body size dissatisfaction are commonplace (Mclaren and Kuh, 2004; Paquette and Raine, 2004; Robinovich et al., 2018; Swami et al., 2010). Although researchers often mention that societal attitudes towards female body size might play a part in explaining neighborhood-driven BMI inequalities (Harrington and Elliott, 2009; Matheson et al., 2008; Rundle et al., 2008), only a handful of studies have explored the link between neighborhood affluence, women's body size dissatisfaction and BMI (McLaren and Gauvin, 2002, 2003). McLaren and Gauvin (2002, 2003) found that, independently of individual income, both neighborhood affluence and the average BMI of female residents affects women's body size dissatisfaction for a given BMI. They suggested that women's high rates of excess weight in disadvantaged neighborhoods may relate to a 'local culture' of acceptance of female large bodies (McLaren and Gauvin, 2002), and that body size dissatisfaction is more common in affluent neighborhoods because these areas house a larger proportion of thin women, who may double the value granted to thinness by comparing themselves with a slim 'local ideal' as well as with the 'thin ideal' held by the broader sociocultural context (McLaren and Gauvin, 2003). Consistently, research has shown that people's exposure to a larger proportion of either 'thin' or 'fat' others within geographical areas may instill under or over perception of self-body size by 'visual adaptation' to other's bodies (Brooks et al., 2016; Stephen et al., 2018). Visual adaptation refers to the influence of the size of a stimulus (e.g. body size) a person is used to see in their environment on his or her perceptions of normality (Robinson et al., 2016). This process would lead to misperceptions of self-body size by influencing people's judgments about the size of a 'normal' or desirable body and, consequently, would affect their body size (dis)satisfaction. Visual adaptation affects female body size dissatisfaction to a greater extent, possibly by the heightened visual attention of women to other women's bodies (Brooks et al., 2019; Robinson, 2017; Stephen et al., 2018). While women's visual adaptation to a high proportion of larger women in poor areas shall explain how the composition of neighborhoods affects female body size dissatisfaction, exploring if there is a female body size 'local ideal' in poor areas may help to understand how the social context of disadvantaged neighborhoods could influence women's BMI. If a larger body size ideal prevails in poor neighborhoods, overweight and obese women shall experience lower levels of dissatisfaction with self-body size compared to better off areas. Body size dissatisfaction is very influential on fostering female weight control practices, particularly by dieting, and can boost overweight and obese women's attempts to lose weight (Anderson et al., 2002; Millstein et al., 2008). A female 'normal BMI' appears to be the product of restrictive behavioral patterns (Wardle and Griffith, 2001), whose adoption might depend on the (dis)satisfaction with self-body size that the 'neighborhood culture' instills in women. According to Swinburn (2011), obesity results from people responding normally to the obesogenic environments they find themselves in, and the differences in prevalence rates observed between world regions may reflect how cultural body-size preferences would shape the effect of an increased food access on populations' obesity levels. Thus, the same might occur between neighborhoods.

Aiming to expand current knowledge regarding the influence of body size dissatisfaction on place-related inequalities in female BMI, this work explored how neighborhood disadvantage impacts women's BMI according to their income, education, parity and marital status, and how these associations could be influenced by body size dissatisfaction. The study of McLaren and Gauvin (2003, 2002) reported results based on income as indicator of individual SES; however, among SES indicators, education appears to be best predictor for both women's BMI and body size dissatisfaction (Cohen et al., 2013; Devaux et al., 2011; Mclaren and Kuh, 2004). Therefore, the exposure to a local 'culture of plus-size women' in disadvantaged neighborhoods would influence female parameters for dissatisfaction with self-body size mainly according to women's education; consequently, low educated women would feel less dissatisfied with a large body size than their neighbors with a higher educational attainment. Hence, this work hypothesizes that low educated women's susceptibility to overweight and obesity (a higher BMI) is increased when they live in disadvantaged neighborhoods by experiencing satisfaction with self-body size at a higher BMI than low educated women living in less disadvantaged areas. Fig. 1 shows a visual representation of the analytical framework proposed by this study to analyze the influence of neighborhood disadvantage on female BMI. Parity and marital status were not included in the schematic framework because the evidence suggests that their effect on female BMI is shaped

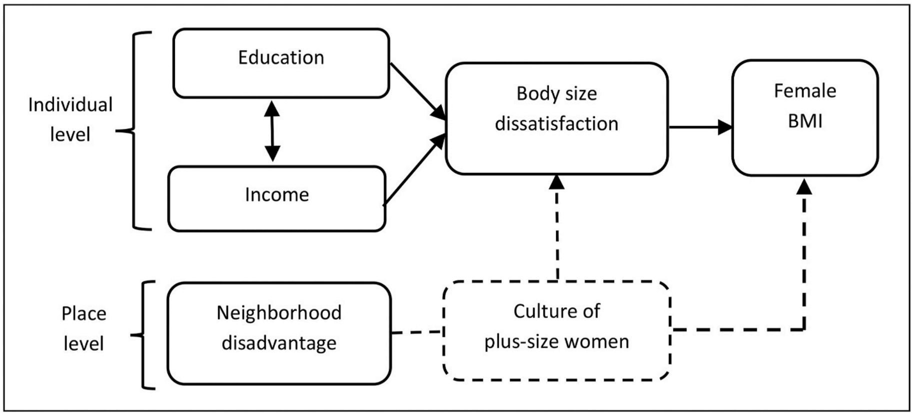

Fig. 1. Visual representation of the influence of neighborhood disadvantage and individual indicators of socioeconomic position on female BMI.

by SES (Averett et al., 2008; Brooks and Maklakov, 2010; Kim et al., 2007; Sobal et al., 2003), and would be conditioned by women's need to comply with the 'thin ideal' (Paquette and Raine, 2004; Robinovich et al., 2018). Thereby, the influence of parity and marital status on BMI at neighborhood level would depend on how the social context affects women's parameters for body size (dis)satisfaction and BMI by SES.

2. Method

This work used data from a cross-sectional study carried out between 2012 and 2014 that explored individual and contextual factors related to female obesity in urban areas of two Chilean Municipalities, Macul and Temuco. Macul is one of the 37 Municipalities of Santiago de Chile, the national capital city; Temuco is one of the two Municipalities of the Araucanía Region capital city, also named Temuco, located at 700 km south from Santiago. Municipalities were chosen based on their similar proportions of population by SES segments (Adimark, 2004). This socioeconomic segmentation is made by the Chilean Association of Market Research Companies (Asociación de Investigadores de Mercado, AIM) for marketing purposes upon a class-based concept of social stratification, given that people's consumption patterns manifest social class differences in lifestyles (AIM-Chile, 2008). It is widely used in Chile for various purposes, including academic research, because it identifies several parameters to distinguish social strata that are periodically updated, being income ranges one of them.

2.1. Sampling

Participants were selected using multistage random sampling procedures. Within census tracts (CTs) with exclusively urban population, blocks and households were selected by systematic random sampling (Kish, 1965). The population in Macul is 100% urban; in Temuco, the 12 CTs with 100% urban population (out of 19) were included. Nonresidential blocks corresponding to public infrastructure (parks, hospitals, schools, etc.) were excluded. Within each household, one woman was randomly selected to be invited to take part in the study, considering the total number of women that met the eligibility criteria (Kish, 1965). These were age between 20 and 60, living in the household for at least 6 months, capacity to read, absence of physical disability and not being pregnant or during postpartum. The age range considered that BMI tends to increase due to metabolic conditions in women over 60 years old (Goodpaster et al., 2005), which may mask the influence of social and economic factors. Exclusion criteria were defined taking into account a minimum time of exposure to neighborhood conditions, the potential difficulties that physical disability might represent to directly measure height and weight, participants' incapacity to read self-administered questionnaires due to visual impairment or illiteracy (CIA reported a 97% adult female literacy rate in Chile in 2015), and that pregnancy and postpartum may temporarily distort women's weight and body size dissatisfaction (Rallis et al., 2007; Skouteris et al., 2005). This study was approved and monitored during its execution by the Scientific Ethics Committee of Universidad de La Frontera, a state-funded University located in Temuco. Each participant voluntarily agreed to participate and signed an informed consent form.

2.2. Data collection

Data were collected through direct survey by female university students trained as pollsters. Standardized procedures were utilized for field work and inter-observer reliability was assessed for selecting the team of pollsters. Sociodemographic data was gathered using a structured survey form designed for the study. Body weight and height were measured using a portable digital scale (Beurer; 0.1 kg accuracy) and a portable stadiometer (Seca 213; 0.1 cm precision). Body size dissatisfaction was assessed through The Contour Drawing Figure Rating Scale (CDFRS), developed by Thompson and Gray (1995). As most silhouette scales, the CDFRS consists of nine figures arranged from very thin to obese from where participants chose those corresponding to ideal and self-perceived body size. Dissatisfaction corresponds to the numerical difference between self and ideal figures. The CDFRS presents a high range of test-retest reliability for both the silhouette measures and the ideal-self difference score (Cafri et al., 2010; Wertheim et al., 2004), and has been previously used in Chile by Swami (2010). Silhouette faces were covered with opaque boxes, as Swami (2010) did, because facial features may distort body size assessment when using figure drawing scales (Pull and Aguayo, 2011).

2.3. Sample size

Sample size (1656) was calculated upon the detection of a statistically significant difference in morbid obesity between women with low and high education, based on figures of the 2010 National Health Survey (Ministerio de Salud de Chile, 2010). It considered a 15% loss, a 5% significance level and a statistical power of 80%. Morbid obesity figures were used as reference due to budget constraints that compromised the feasibility of the study, which could not be carried out with the larger sample size that estimations based upon obesity figures showed. The overall response rate was 54% (n=896). In Temuco, 476 women participated (57.5%), 200 declined the invitation (24.2%), and 152 households (18.3%) were non-respondents. In Macul, 420 women participated (50.7%), 125 declined the invitation (15.1%), and 283 households were non-respondents (34.2%). A household was recorded as non-respondent after being visited up to three times at different day time hours. Due to the low response rate observed, pollsters were asked to roughly visually rank, when possible, age range (20-40/40-60) and body size of women rejecting to participate, using the CDFRS. Most of them lived in the less disadvantaged urban areas; were ranked by pollsters as aged 40-60 (56%) and, on average, had a body size regarded as large (B 6.9) by Swami (2010). The socioeconomic distribution of the sample was consistent with reports from Temuco and Macul that estimated population's SES upon the AIM segmentation criteria using census data (Adimark, 2004). The proportion of women for BMI categories of nutritional status (underweight, normal, overweight, obese) was consistent with the nationally representative health survey (Ministerio de Salud de Chile, 2010).

This work includes a subset of 882 participants. Women whose dissatisfaction with self-body size was in the direction of wanting to gain weight (n = 14) were excluded because they do not represent the population of interest for this work. Since they correspond to a 1.56% of the sample, their exclusion did not affect the results significantly (analyses were run with and without those 14 women).

2.4. Individual level variables

- BMI represents the outcome variable, estimated as weight (kg) divided by height squared (m^2).
- Age corresponds to the difference between birth date and survey date.
- Education considers completed stages: elementary, high school, technical and university.
- Household income levels for this work were grouped into three categories: high-medium, low and very low, to better estimate the effect of economic disadvantage on BMI by comparing low and very low income women to high/medium income ones. Income levels were measured by presenting nine income ranges to participants for them to select the category corresponding to the total household earnings of the last month. Among methods for measuring income in surveys, this offers very little net bias in reports (Moore et al., 2000). Income categories are based on the amounts described for each social stratum by the AIM report closest to the data collection period (AIM-Chile, 2015). (AIM-Chile, 2008, 2015) distinguishes four social class strata (AB, C, D and E) and seven income ranges (C is subdivided in C1, C2 and C3). To avoid misestimating income, this study added an upper and a lower category to include amounts over and below the reported value ranges. To ease interpretation, strata were labeled as high (AB), medium (C), low (D), and very low (E).
- Parity considers all children that women gave birth. Those that had three or more children (30.3% of the sample) were collapsed into one category.
- Marital status includes four categories: single, married/with partner, widow and divorced/separated. The survey form included alternatives for distinguishing whether women lives with their husband/partner or not, because it can make a difference on household income levels.
- Body size satisfaction was estimated as an ideal-self difference ranging from −1 to 1, instead of the zero difference that usually reflects satisfaction (Cafri et al., 2010), to account for under and over perceptions of self-body size that may arise by the clustering of either 'thin' or 'fat' women in neighborhoods, as explained above. The ideal-self difference of the sample ranged between −8 and 4. Values ranging between −2 and −8 were classified as dissatisfied due to a desire to be thinner, and those ranging from 2 to 4 as dissatisfied by wanting to gain weight.

2.5. Neighborhood level variable

CTs were selected as geographical areas representing neighborhoods because block grouping and CT-area grouping did not show the minimum of 10 individuals per cluster that, according to the 'rule of thumb', is required to obtain acceptable estimates of clustering effects (Lai and Kwok, 2015). The 882 women of the sample were distributed across 17 neighborhoods; each had, on average, 52 women (SD 17.4).

Income was selected as area level indicator of socioeconomic conditions because it can reflect how residents might self-select into neighborhoods. Given the existing market-based housing policies in Chile, neighborhood of residence depends mainly on people's income (Beswick et al., 2019). Three categories of neighborhood income were estimated by aggregating the individual income categories at CT level, representing the most common income category among households in the neighborhood (mode): medium-high, low, and very low. This estimation of neighborhood affluence, based on the categorical nature of individual income data, could reflect the relative income of a woman with respect to the income level of the majority of women in the neighborhood. The latter is relevant for this work because psychosocial factors, like body size dissatisfaction, could be influenced by the relative position of an individual within a given social environment (Marmot and Wilkinson, 2001). This work used the same income categories at both individual and area level. This was based on the accurate assessment of a contextual effect that controlling stringently for an equivalent measure of neighborhood income at individual level permits, by excluding the possibility of an effect of neighborhood disadvantage on female BMI fully based on poorer women living in poorer neighborhoods (Bosma et al., 2001).

2.6. Data analysis

Data had a two-level structure (individuals nested within neighborhoods). Exploratory analyses were carried out to assess the composition of neighborhoods. The mean age and mean BMI for each category of individual-level variables were estimated for each neighborhood income category. These results are presented in Table 1.

Multilevel linear regression models were used to assess the association between BMI, neighborhood income and individual-level variables. Six models were built: model 1 tested the age-adjusted association between BMI and neighborhood income; model 2 tested the associations of model 1 plus individual income; women's education was introduced to the analysis in model 3, parity in model 4, marital status in model 5, and body size dissatisfaction in model 6. Cross-level interactions were tested between neighborhood income and each individual level variable. Model fit was assessed using Wald chi-square test. The intra-class correlation (ICC) coefficient for BMI was estimated for a null model (not shown) and the subsequent ones to decompose the variance in the dependent variable across levels of analysis. The estimated fixed effects coefficients, random effects variances, and the ICC are presented in Table 2. Linear regression coefficients are presented unstandardized and can be interpreted as the average difference in BMI between the category of interest and the reference group. Data were analyzed using Stata SE, version 15.

3. Results

In this sample of women, 47.4% had either a technical or university degree; however, only 24.8% were within the high-medium income category. Most women (72%) live in areas where low income households predominate. These neighborhoods house 65.7% of the women with a university degree and a 63% of the women with high-medium incomes. High-medium income neighborhoods house 15.8% of the women; 76.3% of them have postsecondary education and 58.3% had high-medium income levels. Disadvantaged neighborhoods (very low income) house 12.2% of the women; 85.2% of them did not have postsecondary education, and 99.1% had either low or very low household incomes. The proportion of single and married/with partner women in high-medium and low income neighborhoods slightly differs and, on average, was 31.2% and 55.8%, respectively; however, in disadvantaged neighborhoods 35.2% were single and 50.9% lived with a partner/husband. Likewise, the poorest neighborhoods house a greater percentage of women with children (93.5%) than the better off (79.1%). While in disadvantaged neighborhoods 39.8% of the women had three

Table 1
Descriptive statistics by neighborhood income category.

Individual level variables	Neighborhood income											
	Medium-high (n = 139)				Low (n = 635)				Very low (n = 108)			
Income	n	(%)	BMI (B)	SD	n	(%)	BMI (B)	SD	n	(%)	BMI (B)	SD
Medium-high	81	58.3	25.9	4.44	137	21.6	26.6	4.66	1	0.9	26.4	–
Low	53	38.1	27.1	4.67	370	58.3	28.0	5.49	44	40.8	29.7	4.74
Very low	5	3.6	27.9	3.38	128	20.2	29.0	5.38	63	58.3	30.9	6.34
Educational level												
University	58	41.7	25.6	4.11	124	19.5	26.9	4.99	8	7.4	27.2	3.49
Technical	48	34.5	26.2	3.78	175	27.6	26.8	4.54	8	7.4	27.3	3.22
High School	30	21.6	27.7	5.76	261	41.1	28.4	5.27	60	55.6	31.1	6.30
Elementary	3	2.2	31.8	4.88	75	11.8	30.3	6.82	32	29.6	30.6	5.14
Marital status												
Single	44	31.7	26.2	5.52	203	32.0	27.6	5.82	38	35.2	29.3	5.05
Married/with partner	78	56.1	26.6	4.10	352	55.4	28.1	5.14	55	50.9	30.4	4.79
Widow	4	2.9	25.3	3.15	20	3.1	29.0	3.91	8	7.4	35.0	11.34
Divorced/separated	13	9.4	26.3	3.79	60	9.4	27.6	5.27	7	6.5	30.5	5.94
Parity												
No Children	31	22.3	25.2	4.21	124	19.5	26.6	5.29	7	6.5	30.1	4.85
One child	35	25.2	27.2	5.55	129	20.3	28.2	6.31	27	25.0	30.1	6.58
Two children	37	26.6	27.1	4.04	193	30.4	27.8	5.06	31	28.7	30.7	6.61
Three or more children	36	25.9	25.9	3.97	189	29.8	28.7	4.80	43	39.8	30.4	4.70
Body size (dis)satisfaction												
Satisfied with self-body size	51	36.7	24.4	3.74	203	32.0	24.7	3.87	17	15.7	26.6	4.47
Unsatisfied with self-body size	88	63.3	27.5	4.56	432	68.0	29.4	5.30	91	84.3	31.1	5.67
Age (mean and SD)			41.3	11.37			40.9	12.12			40.5	11.67

or more children, this figure averages 27.9% in the other areas.

Within each category of neighborhood income, women's BMI increased as their income and education decreased. Female BMI increased as well for each level of individual income and educational attainment as neighborhood income decreased, except for elementary educated women, whose mean BMI was around 30 kg/m^2 across neighborhoods. The largest BMI differences between neighborhoods were observed among low income and high school educated women, whose mean BMI in disadvantaged neighborhoods was, respectively, 3 kg/m^2 and 3.4 kg/m^2 higher than that of their peers from high-medium income neighborhoods (Table 1). The mean BMI at which women from high-medium and low income neighborhoods experienced satisfaction with self-body size differed only in 0.3 kg/m^2 and was, on average, 24.6 kg/m^2. However, the mean BMI for body size satisfaction among women in disadvantaged neighborhoods was 26.6 kg/m^2.

Regression models (Table 2) show that a higher BMI is associated with living in disadvantaged neighborhoods, aging and low education. The association between living in low income neighborhoods and BMI was explained by women's individual income (model 2), and the association between individual income and BMI was explained women's educational attainment (model 3). Model 3 shows an association between neighborhood disadvantage and BMI that is independent of women's education and income, which is explained by body size dissatisfaction (model 6). Parity and marital status were not positively associated to female BMI (models 4 and 5). Cross-level interactions did not show statistically significant results (not shown). Random effects parameters show that in all regression models, except model 1, there were statistically significant level 1 variances (women) but not level 2 variances (neighborhoods). The ICC for BMI reduced from 5.8% in the null model to 1.5% and 1.1% in models 2 and 3, respectively, which shows that BMI differences between neighborhoods are mainly due to individual income.

A sensitivity analysis was performed for the observed association between BMI, neighborhood income, individual income and education. Regression was run for BMI and neighborhood income as dummy, including age plus six interaction variables built upon dummies of three educational categories (postsecondary, high school and elementary) plus two income categories (low and very low), to establish comparisons with the high-medium income group. For all neighborhoods, associations were positive only for the education-income interaction variables including high school and elementary education; those including postsecondary education showed non statistically significant associations.

4. Discussion

This study found that neighborhood disadvantage has an effect on female BMI that is independent of individual disadvantage, as previous research reported (Feng and Wilson, 2015; Rachele et al., 2019; King et al., 2006). Unlike preceding studies, in this sample of Chilean women, the independent effect of neighborhood disadvantage on BMI is explained by body size dissatisfaction. The mean BMI at which women experience satisfaction with self-body size in disadvantaged neighborhoods is 2 kg/m^2 higher than in other urban areas, which suggests that a 'culture of plus-size women' prevails in the social context of poorest neighborhoods.

According to Jargowsky (1997, 2015), cultural practices at variance with mainstream values and social norms, such as teenage pregnancy and drug and alcohol use, appears to be common rule in the social context of neighborhoods that concentrate urban poverty. Likewise, a 'neighborhood culture' at variance with the 'thin ideal' that the broader societal context embraces might exist in cities' poorest areas. Researchers have suggested that the high rates of female obesity in disadvantaged neighborhoods may not relate solely to adverse socioeconomic conditions but to women's exposure to urban concentrated poverty (Boardman et al., 2005; Kershaw and Albrecht, 2014).

Neighborhood effects are "… properties of groups that can influence the behavior of individuals, independently of their individual characteristics" (Oakes et al., 2015), and emerge from the composition of neighborhoods by residents' social interactions (Oakes, 2004). The composition of the neighborhoods in this study would accurately reproduce the socioeconomic polarization of Chilean cities that urban researchers describe for the sampled locations (Beswick et al., 2019; Garin et al., 2009; Sabatini et al., 2001). Disadvantaged neighborhoods are inhabited mostly by poor women without postsecondary education, whereas high-medium income areas house mainly university-educated and affluent women. Thus, a 'culture of plus-size women' may emerge from the social interaction of poor and low educated women living in the disadvantaged extreme of a polarized urban area. Urban social polarization can affect the magnitude of spatial health inequalities, probably by fostering inequitable relationships between societal groups (Krieger,

Table 2
BMI regressed on neighborhood income, age, individual income, education and body size dissatisfaction.

Neighborhood level variable	Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
Neighborhood income	Coef	SE	p	Coef	SE	p	Coef	SE	p	Coef	SE	p	Coef	SE	p	Coef	SE	p
Medium-high	ref			ref			ref			ref			ref			ref		
Low	1.597	0.709	0.024	0.979	0.655	0.135	0.724	0.619	0.242	0.715	0.617	0.246	0.765	0.636	0.229	0.682	0.584	0.243
Very low	3.996	0.980	0.000	2.841	0.928	0.002	2.248	0.886	0.011	2.177	0.884	0.014	2.180	0.910	0.017	1.411	0.838	0.092
Individual level variables																		
Age	0.079	0.015	0.000	0.076	0.014	0.000	0.065	0.015	0.000	0.071	0.016	0.000	0.077	0.017	0.000	0.092	0.016	0.000
Income																		
Medium-high				ref			ref			ref			ref			ref		
Low				1.216	0.443	0.006	0.759	0.467	0.104	0.778	0.469	0.097	0.748	0.467	0.110	0.567	0.427	0.184
Very low				2.039	0.566	0.000	1.141	0.612	0.062	1.178	0.623	0.059	1.157	0.622	0.063	1.047	0.567	0.065
Educational level																		
University							ref			ref			ref			ref		
Technical							0.137	0.518	0.792	0.137	0.517	0.791	0.239	0.518	0.645	0.016	0.473	0.973
High School							1.455	0.517	0.005	1.448	0.518	0.005	1.506	0.526	0.004	1.226	0.480	0.011
Elementary							2.303	0.691	0.001	2.339	0.696	0.001	2.468	0.709	0.001	2.089	0.648	0.001
Marital status																		
Single										ref			ref			ref		
Married/with partner										−0.127	0.414	0.758	−0.011	0.458	0.980	−0.046	0.417	0.912
Widow										0.203	0.995	0.838	0.344	1.005	0.732	0.901	0.917	0.326
Divorced/separated										−1.210	0.681	0.076	−1.081	0.708	0.127	−0.670	0.646	0.300
Parity																		
No children													ref			ref		
One child													0.917	0.571	0.108	0.726	0.521	0.163
Two children													−0.003	0.606	0.996	−0.073	0.553	0.895
Three or more children													−0.126	0.651	0.847	0.048	0.594	0.935
Body size (dis)satisfaction																		
Satisfied with self-body size																ref		
Unsatisfied with self-body size																4.567	0.343	0.000
Random effects																		
Level 2 variance (neighborhoods)	0.621	0.401	0.030	0.387	0.321	0.057	0.283	0.275	0.076	0.280	0.275	0.077	0.336	0.295	0.064	0.291	0.242	0.057
Level 1 variance (women)	26.265	1.263	0.000	25.996	1.251	0.000	25.564	1.229	0.000	25.457	1.224	0.000	25.277	1.216	0.000	21.033	1.011	0.000
Intraclass correlation (ICC)	0.023	0.015		0.015	0.012		0.011	0.011		0.011	0.011		0.013	0.011		0.014	0.011	

2016, 2018).

4.1. Can gender income inequalities influence the neighborhood-BMI association?

In this study, disadvantaged neighborhoods house a lower percentage of married/with partner women, and a greater proportion of singles and women with three or more children than better off areas (Table 1). This may signal that female household headship, an important contributor to the feminization of poverty (Bradshaw et al., 2017; Christensen, 2019), tends to concentrate in poorest neighborhoods. The term 'feminization of poverty' was coined by Pearce (1978), after documenting how women and children were disproportionately represented among low-income populations in developed societies.

Single parenthood expose women to an important income vulnerability in developing and developed countries (OECD, 2017); thereby, neighborhhods' composition in this work may be demonstrating how women self-select into poor places by economic vulnerability. Rundle (2008) found that the neighborhood socioeconomic context influences how education and income interact to affect BMI, and that these interactions differ by gender. It is possible that the relation of these two common SES indicators with the BMI of men and women at neighborhood level is shaped by the influence that gender-related income inequalities may have on people's distribution across urban areas. Although economic affluence is highly dependent on an individual's education, in most western societies there are marked disparities in the affluence-education relation between men and women (Krieger et al, 1997, 1999). Even though the cross-sectional nature of this study precludes to determine the influence of women's economic circumstances on their housing decisions, urban research highlights that under the Chilean neoliberal housing policy system, both neighborhood of residence and housing quality are mainly determined by people's socioeconomic conditions (Beswick et al., 2019; Sabatini et al., 2001).

This work found that, at neighborhood level, education explains the effect of individual income on women's BMI. The latter appears to be in conflict with evidence that shows that both education and income influence female BMI (Chung et al., 2017; Devaux el at., 2011; Ogden et al., 2017); however, if neighborhoods house women with similar income levels, the observed BMI differences would be mainly given by their education. The income-education interaction with female BMI observed in this study is consistent with the work of Jokela (2014), who stresses that most neighborhood-health relations may develop via selective residential mobility. Income categories in this work reflect social class stratification (AIM-Chile, 2008, 2015), so the results are likely showing how, in Chile, residential segregation patterns are shaped by class-derived income inequalities (Garreton et al., 2020; Méndez and Otero, 2018; Beswick et al., 2019; Sabatini et al., 2001).

A growing body of evidence suggests that, at neighborhood level, most associations between individual SES and health outcomes mirrors how people self-select into places by economic circumstances and social class (Glass and Bilal, 2016; Jokela, 2014, 2015). Population distribution across neighborhoods is not random but largely influenced by macro-level social and economic factors; if social mobility is low, disadvantaged groups have limited options about where to live (Arcaya et al., 2015). Evidence from cross-country studies stresses that the gendered patterning of obesity inequalities would be primarily related to wealth disparities between men and women, and largely influenced by the lower status held by women at societal level (Ameye and Swinnen, 2019; Garawi et al., 2014; Wells et al., 2012). Therefore, the gender-specificity of the neighborhood-BMI association may arise from the interaction of inequalities in gender and income.

4.2. The influence of socioeconomic status on women's BMI

The results of this work show that, for a given level of education and income, women's BMI gradually increases as neighborhood affluence decreases. As well, within neighborhoods, BMI steadily rises as women's education and income lessens (Table 1). These findings are consistent with the work of Rachele (2019), who suggested that neighborhood disadvantage adds to individual disadvantage to influence female BMI. However, this study found that the BMI of elementary educated women, unlike women with high school education or beyond, slightly varied across neighborhoods, revealing also that most of them were obese. This may indicate that the social disadvantage that an elementary education entails for women is such that it influences their BMI regardless of their socioeconomic context.

This work agrees with evidence that shows that the influence of education on female BMI is greater compared to income; research signals as well that the education-BMI association is stronger in women than in men (Chung et al., 2017; Devaux et al., 2011; Ogden et al., 2017). It has been suggested that education and income could affect individual's BMI by the extent to which these indicators act as markers of social status (Chung et al., 2017; Devaux et al., 2011); nonetheless, household incomes may not signal the status of women as much as their education. Bourdieu's social theory addresses that individuals manifest their status by different symbols, and education is by far one of the most important; however, its symbolic value is particularly relevant for women, partly because the production of economic capital is linked to masculinity (Bourdieu, 1984, 2002). In rich countries, obesity overburdens elementary educated women, and the main differences in obesity rates are observed between women that did and did not attain postsecondary education (Chung et al., 2017; Devaux et al., 2011; Kinge et al., 2015). It is thus possible that in societal contexts where most people complete secondary studies, an education beyond high school marks a difference regarding women's 'place' in the social hierarchy, and an elementary education may position women near its lower end.

4.3. Limitations and strengths

The cross-sectional design of this study constitutes a limitation to posit that body size dissatisfaction is to blame for the high BMI of women in disadvantaged neighborhoods, because a high BMI could be both a cause and a consequence of female body size dissatisfaction (Weinberger et al., 2017). Notwithstanding, a longitudinal Australian study including nationally representative data showed that people who lived in disadvantaged neighborhoods were less dissatisfied with their weight status and were more likely to gain weight (Feng and Wilson, 2016, 2019), which suggests that the body size dissatisfaction-BMI association established in this work would be in the right direction. Another limitation imposed by the cross-sectional design is the possibility of reverse causality on the association between women's BMI and neighborhood disadvantage. The income-BMI association among women is not unidirectional; a higher BMI may cause women to have lower incomes (Kim and Von Dem Knesebeck, 2018), which would influence how they self-select into neighborhoods. However, the high proportion of low educated women in disadvantaged neighborhoods may reduce the likelihood of reverse causality, because education is a more stable indicator of socioeconomic position among women than household income (Krieger et al., 1999), and appears to be the stronger socioeconomic predictor of female obesity (Cohen et al., 2013; Devaux et al., 2011). It should be acknowledged as well that defining neighborhoods as CTs, as it is done in most place-health studies, could affect the magnitude of the effect of neighborhood disadvantage on female BMI that is reported in this work, because census boundaries may not accurately reflect the processes occurring within neighborhoods (Arcaya et al., 2016).

Despite the aforementioned limitations, an important strength of this study is the quality of data, since it was collected by direct survey, and BMI was estimated upon measuring weight and height. Self-reported measurements of anthropometric data are often used in research (Engstrom et al., 2003). However, having accurate estimations is particularly relevant in studying female BMI inequalities, because women tend to overestimate height and underestimate weight (Engstrom et al., 2003), and these misestimations vary by educational level (Boström and Diderichsen, 1997).

4.4. Final remarks and considerations for further research

Review studies highlight the importance of disentangling whether neighborhoods influence health or health and neighborhood outcomes are both governed by prior common causes, and make also a call to concert efforts around understanding the complex and reciprocal neighborhood-health interaction (Arcaya et al., 2016; Oakes et al., 2015). Geographic health inequalities often reflect unjust social structures (Arcaya et al., 2015), so analyzing how structural inequalities affect people's distribution across neighborhoods, and how this repercutes on social relations, may contribute to understand the effect of residence place on people's health. As Singh-Manoux and Marmot (2005) argue, socialization seems to be the mechanism that links social selection, material and behavioral explanations for social inequalities in health. Urban territorial divisions are not culturally neutral spaces but are imbued with social power relations and a resource-related symbolic meaning (Cummins et al., 2007).

Self-selection has been a major concern in longitudinal research, the only study design that would allow to establish neighborhood-BMI causal associations (Letarte et al., 2020). Nonetheless, people appear to choose (or not) neighborhoods according to their economic capacity to afford a place where they can experience a sense of belongingness that relies mainly on cultural constructs built upon social class identity (Savage, 2005, 2010). Thus, most neighborhood effects would, indeed, arise from social selection, as Jokela (2014, 2015) reports.

Scholars have stressed that, together with improving studies' methodological aspects, neighborhood effects research should reconsider current perspectives towards places, which often approach neighborhoods as 'containers', or static entities, defined by what is within (Oakes et al., 2015; Macintyre, 2007; Prior et al., 2018). Even though this study, as cross-sectional, cannot answer whether neighborhood disadvantage causes female overweight/obesity, it signals that the 'independent effect of neighborhood disadvantage' on women's BMI might be explained by the psychosocial pathways associated to social disadvantage that act in addition to the effects of material conditions to influence people's health (Marmot and Wilkinson, 2001). In this regard, social sciences' evidence has long revealed that people's lifestyles, including preferences for food, body size and shape concerns, plus cultural views towards women's social roles (e.g. workers, mothers, mates), are not born out of a conscious act of following rules but are 'naturally' incorporated (embodied) from the social context (Bourdieu, 1984, 2002, 2002; Williams, 1995; Robinovich et al., 2018). Therefore, analyzing how the socially homogeneous contexts that result from cities' concentration of poverty and wealth could impact population's BMI (and other health outcomes), plus charting *who* lives in neighborhoods where disadvantage and advantage are clustered and *why*, might yield useful insights for policy making. Economic-based residential segregation results from a cyclical interaction between the labor market and the housing market (Jargowsky, 1996). Establishing a causal association in a cyclic dynamic would be rather 'difficult', not to say impossible, unless structural inequalities are properly addressed in interpreting research findings.

Jargowsky (2015) refers to 'the architecture of segregation' as a market-driven public policy system that tends to concentrate urban poverty in peripheral neighborhoods with scarce work placement, and inadequate access to good quality education, public transport and services, which structurally cuts off residents' opportunities for upward social mobility. Income inequalities arising from the labor market are thus distributed across urban spaces by the housing market (Jargowsky, 1996). An extreme social and economic segregation can foster the emergence of 'urban slums', poor neighborhoods where cultural practices at variance with mainstream values are common, and usually become normative for the children that grow up there. Although these practices may reflect people's adaptation to structural conditions, societal attitudes towards the inner-city poor often locate the causes of their misery on their behaviors rather than on the organization of economies or societies (Jargowsky, 1997, 2015).

As a final remark, it is worth mentioning that integrating the knowledge from sociological urban research (e.g. the work of Jargowsky and Savage) into theoretical approaches towards data analysis in place-health studies may contribute with evidence for policy making. Understanding the neighborhood-health relation may require, on the one hand, to account for the influence of structural inequalities on societal cultural constructs around poverty and wealth. On the other hand, it might be necessary to keep in mind that, in framing plausible explanations for place-driven health inequalities, epidemiology and public health can contribute importantly to social justice (Marmot, 2017). As Marmot (2017) argues, in establishing associations in health inequalities research, it should be acknowledged that, almost invariably, the arrow runs "from wealth to health".

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Author contributions

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Declarations of competing interest

None.

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