Association of depression and obesity is mediated by weight perception

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Abstract

This study investigates whether the association between obesity and depression is mediated by the perception of body weight and verifies the combined effect of being obese and having a self-perception of being fat on depression in a population-based sample of 1238 individuals. Weight perception mediated the association between depression and obesity in 39.3 percent of participants. In stratified analysis, mediation occurred in the following groups: non-single, those with more schooling, non-alcohol abusers, non-smokers, and those who did not engage in physical activity. Being obese and having a self-perception of being fat produced a potentiating effect, significantly increasing the likelihood of depression.

Keywords

Brazil, depression, epidemiology, obesity, weight perception

Introduction

Obesity and depression are significant causes of disability and death worldwide (Murphy et al., 2009) and are relevant public health problems (Murphy et al., 2009; World Health Organization, 2017, 2018). By 2016, 1 in 10 adults worldwide was obese (World Health Organization, 2018). Depression, in turn, has already affected more than 300 million people (World Health Organization, 2017).

These conditions can occur simultaneously (Markowitz et al., 2008), generating immediate and long-term impacts on the health of the population (Murphy et al., 2009). There is a strong association between the conditions (Pereira-Miranda et al., 2017; Rajan and Menon, 2017; Robinson et al., 2017) showing that the more distant the individual is from the appropriate weight, the higher their probability of developing depression (Pereira-Miranda et al., 2017). A meta-analysis of epidemiological studies concluded that obesity increases the risk of depression and that the magnitude of this association did not change, regardless of the study design (Jung et al., 2017).

The evidence for this relationship is consistent, but little is known about the processes that explain this relationship (Robinson et al., 2017) and what variables connect these two health problems (Markowitz et al., 2008). Understanding the mechanisms linking obesity to depression

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becomes central to the treatment of individuals with both conditions (Markowitz et al., 2008).

A mediation approach has been recommended to investigate the association between obesity and depression and determine the possible mediating factors (Simon et al., 2006). A systematic review identified that individuals' perceptions, concerns, and dissatisfactions regarding their weights and shapes are associated with the relationship between obesity and depressive symptoms (Preiss et al., 2013). Studies have indicated that the association between obesity and depression may be mediated by body image (Preiss et al., 2013; Simon et al., 2006) or by weight perception (Gaskin et al., 2013; Roberts and Duong, 2013; Ter Bogt et al., 2006; Xie et al., 2010). The hypothesis for this mediation is based on the consequences generated by sociocultural ideals related to weight (Gaskin et al., 2013), where body dissatisfaction can lead to low self-esteem (Friedman et al., 2002) or to experiences of weight-related prejudice (Puhl and Heuer, 2009).

Much of the research investigating mediators of the relationship between obesity and depression has been conducted predominantly with adolescents in high-income countries. Nevertheless, it is important that further research identifies links between obesity and psychological outcomes for different ages, sexes, and ethnicities (Puhl and Heuer, 2009). Thus, this study aimed to investigate whether the association between obesity and depression is mediated by the perception of body weight, as well as to verify the combined effect of being obese and perceiving oneself as such on the occurrence of depression in a sample of Brazilian adults.

Methods

Data and participants

Data were collected in the "Health of the Rio Grande Population" study, developed by the Federal University of Rio Grande (FURG) and carried out in Rio Grande, located in the extreme south of Brazil. The target population consisted of individuals of both genders living in the urban area of the municipality with ages greater than or equal to 18 years. Individuals who were institutionalized in nursing homes, hospitals, or prisons and those with physical or mental impairments rendering them unable to respond to the questionnaire were not considered eligible.

Sample size calculation was performed considering a 95-percent confidence level, a 10-percent prevalence of the outcome, and a margin of error of two percentage points, resulting in 860 subjects. An additional 50 percent was added for sampling design and 10 percent for possible losses and refusals. Thus, 1420 individuals were required for the sample.

The sampling process was carried out in multiple stages based on data from the 2010 Demographic Census (Instituto Brasileiro de Geografia e Estatística, 2011). First, census tracts were selected, then the households, and finally the individuals. To sample 1420 individuals, it would be necessary to include 710 households, since each household had, on average, two residents aged 18 years or older (Instituto Brasileiro de Geografia e Estatística, 2011). A systematic selection of 72 census tracts was carried out, and then, the households were selected proportionally to the size of the sector. This research was approved by the Health Research Ethics Committee of FURG (opinion number 20/2016).

Data were collected in the first half of 2016. Trained interviewers visited the selected households, and after obtaining informed consent, they started administering the questionnaire. The instrument used was a single, precoded, standardized, and previously tested questionnaire. The information collected was double entered in EpiData 3.1 software. More details on sampling and fieldwork are published in another paper (Dumith et al., 2018).

Variable definitions and measurements

In the present study, the outcome consisted of screening for a major depressive episode, referred to throughout the text as depression. The Patient Health Questionnaire-9 (PHQ-9), validated for the Brazilian population (Santos et al., 2013), was used and consisted of 10 items that verified the frequency of depressive symptoms (depressed mood, anhedonia, sleeping troubles, fatigue or lack of energy, appetite or weight change, guilt or uselessness, concentration problems, feeling slow or agitated, and having recurring suicidal ideation or thoughts of death) in the 2 weeks preceding the interview. Responses were provided on a Likerttype scale from 0 to 3 (items 1-9 ranged from "not at all" to "nearly every day," and item 10 ranged from "not difficult at all" to "extremely difficult"). An algorithmic scale was used (Munhoz et al., 2016) to identify the individuals at most significant risk for a major depressive event, which complies with the criteria contained in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (American Psychiatric Association, 2013). This scale establishes that five or more symptoms are required for the test to be positive, provided that at least one is depressed mood or anhedonia and that each symptom lasts for at least a week or more, except suicidal ideation, which includes a frequency of less than 1 week. Cronbach's alpha of PHO-9 was 0.84.

Self-reported weight and height information were used to classify obesity according to the body mass index (BMI). Individuals were considered obese when the BMI was $\geq 30 \text{ kg/m}^2$, a cut-off point established by the World Health Organization (2004). Weight perception was evaluated from the answer to the question, "How do you feel today regarding your weight?", which was operationalized in two categories: (a) perceives himself or herself as fat (for very fat or fat responses) and (b) does not perceive himself or herself as fat (for answers a little bit fat, normal, lean, a little bit lean, very lean).

Intervening variables considered for stratification were gender (male/female), age in years $(18-39/40-59/\geq60)$, skin color (White/Black/ others), marital status (single/non-single), schooling in years of study (0–8/ \geq 9), per capita income tertiles, alcohol abuse (considered as five or more drinks for men or four or more drinks for women of alcoholic beverage in a single occasion in the 30 days prior to the study, no/yes), tobacco use (non-smoker/former or current smoker), and some leisure physical activity (no/yes).

Statistical analysis

Univariate analyses were performed to describe the sample according to socioeconomic, demographic, and behavioral aspects regarding absolute and relative frequency. Subsequently, we conducted a mediation analysis to verify whether the association between obesity and depression was mediated by weight perception.

The mediation assumptions were verified which occurs when (1) the independent variable (obesity) is significantly associated with the mediator (weight perception), (2) the independent variable is significantly associated with the dependent variable (depression) when the mediator does not exist, (3) the mediator has a unique and significant effect related to the dependent variable, and (4) the association between the independent variable and the dependent variable decreased with the addition of the mediator to the model (Karlson et al., 2012; Kohler et al., 2011).

This analysis was performed using the "khb" command. This method breaks down the overall effect of obesity on depression into direct and indirect effects, considering weight perception. It also provides estimates of the magnitude and level of statistical significance of the indirect effect and proportion of the total association accounted for by this pathway. Analyses were stratified for intervening variables described above and were adjusted for possible confounders. The results are shown as odds ratios (ORs) from the extraction of the exponential coefficient obtained.

After this step, we analyzed the combined effect of being classified as obese (or not) and self-perceiving as fat (or not) on depression. We created four categories with the possible combinations to achieve this goal: combination 1 (C1), non-obese and non-fat; combination 2 (C2), non-obese and fat; combination 3 (C3), obese and non-fat; and combination 4 (C4), obese and fat. Overall and stratified ORs were calculated for each combination through logistic regression, taking into account the sampling design effect.

Finally, we analyzed data to identify whether the OR of depression observed among those individuals positive for C4 (obese and fat) exceeded what would be expected at random. Thus, we first calculated the expected OR of depression by multiplying the discordant pairs (OR C2 * OR C3). Next, we calculated the odds ratio ratios (ORRs) by calculating the ratio of the OR of depression observed in the C4 group divided by the expected OR (ORR = $\frac{ORC4}{(ORC2 \times ORC3)}$). This calculation was conducted with the objective of quantifying, in a relative way, both potentiating and attenuating effects between weight perception and obesity in depression. In other words, this calculation verified whether the combination of weight perception with obesity intensified the odds of depression.

Analyses were not stratified by sex since there was no interaction (previously tested). All statistical procedures took into account the design effect and were conducted in Stata 13.1 software.

Results

A total of 1429 individuals were eligible for the study, and 1300 answered the questionnaire (91% response rate). Regarding non-responders (n=129), 77 percent (n=99) refused and 23 percent (n=30) were losses. Most of those who refused to respond were male (60%) and resided in the central district (20%); the response rate did not differ by age (p=0.64). Of the total number of respondents, 62 (4.8%)did not answer questions related to depression, weight perception, or obesity, and thus, 1238 individuals were included in the analysis. The prevalence of obesity was 23.7 percent (95% CI 21.3%–26.1%), 16.9 percent (95% CI 14.6%-19.2%) reported feeling "fat," and 11.2 percent (95% CI 9.3%-13.1%) were depressed (Table 1).

In the total sample, 39.3 percent of the association between depression and obesity was mediated by weight perception, as shown in Table 2. In the stratified analysis, weight perception mediated the effect of obesity on depression for the following groups: non-single, those with more than 8 years of schooling, non-alcohol abusers, non-tobacco users, and those with no leisure physical activity. After adjustment for possible confounders, the results were similar (not shown).

In the overall analysis of the associations between depression and the four possible categories from the combination of the variables weight perception and obesity (Table 3), we observed that the OR of depression was higher among those individuals who were obese and perceived themselves as fat (C4) when compared with those who were not obese and did not perceive themselves as fat (C1). A similar pattern could be observed for most of the groups, except among those with non-White skin color, single people, those with 0-8 years of schooling, those in the lowest tertile of income per capita, and those with alcohol abuse (Table 3). Only among individuals in the highest tertile of per capita income was a significant effect identified for one of the intermediate groups (C2: OR=5.11; 95% CI 1.43-18.21), equivalent to the C4 subgroup result (OR = 5.00; 95% CI 1.61-15.53). That is, for the richest individuals, it was not the fact that they were obese but that they perceived themselves as fat that led to depression.

Table 4 shows that there was an interactive potentiating effect (OR observed at least three times higher than expected) of the combination between the perception of weight and obesity in depression for the following groups: female, individuals aged 40–59 years, and those who were former smokers or current smokers. There was a robust attenuating effect for males, in which the observed OR was less than half of what would be expected, indicating that, for males, the effect of being obese and having a self-perception of being fat (C4) did not differ from showing only one of these characteristics (C2 or C3).

| Variable | N | % |
|-------------------------------------|-------------|---------|
| Gender (N=1238) | | |
| Male | 551 | 44.5 |
| Female | 687 | 55.5 |
| Age (years) (N=1238) | | |
| 18–39 | 490 | 39.6 |
| 40–59 | 457 | 36.9 |
| ≥60 | 291 | 23.5 |
| Skin color (N=1236) | | |
| White | 1030 | 83.3 |
| Black and other | 206 | 16.7 |
| Marital status (N=1238) | | |
| Single | 576 | 46.5 |
| Non-single | 662 | 53.5 |
| Schooling (years) (N=1236) | | |
| 0–8 | 506 | 40.9 |
| ≥9 | 730 | 59.1 |
| Income per capita (tertiles) (N | =1116) | |
| First tertile (lower) | 405 | 36.3 |
| Second tertile | 350 | 31.4 |
| Third tertile (upper) | 361 | 32.3 |
| Alcohol abuse (N=1235) | | |
| No | 1087 | 88.0 |
| Yes | 148 | 12.0 |
| Tobacco use (N=1238) | | |
| Non-smoker | 704 | 56.9 |
| Former or current smoker | 534 | 43.1 |
| Leisure physical activity $(N = 1)$ | 238) | |
| No | 822 | 66.4 |
| Yes | 416 | 33.6 |
| Obese $(N = 1238)$ | 0.1.1 | 74.2 |
| No | 944 | /6.3 |
| Tes | 294 | 23.7 |
| Perception of weight as fat/ver | ry fat (N = | = 1238) |
| No X | 1208 | 83.1 |
| Tes $(N = 1228)$ | 210 | 16.7 |
| | 1000 | 00 0 |
| Yos | 1077 | |
| 162 | 137 | 11.4 |

Table 1. Description of the characteristics of the sample of adults aged 18 years or older in Rio Grande, Brazil, 2016 (N = 1238).

N: absolute frequency; %: prevalence.

Discussion

This study demonstrated that almost half of the association between obesity and depression was

mediated by weight perception. This mediating effect was enhanced for the groups that were supposed to be less susceptible to depression: non-single, with more schooling (\geq 9 years), with no alcohol abuse, and with no tobacco use. An exception to this observed pattern occurred for individuals who were not engaged in leisure physical activity. On the other hand, the combined effect of being obese and having a selfperception of being fat under depression was more significant for the groups more susceptible to depression: women aged 40–59 years who were current smokers or former smokers (Gavin et al., 2010; Jackson et al., 2014).

The association between obesity and depression is well established in literature (Pereira-Miranda et al., 2017; Rajan and Menon, 2017), a finding that was also identified in this research. What is not as clear as the relation between obesity and depression are the factors that act as mediators of this association. While some research studies approach this subject using different methods and variables, they note that the relationship between individuals and their bodies can mediate this association (Eidsdottir et al., 2014; Friedman et al., 2002; Gaskin et al., 2013; Roberts and Duong, 2013). In this study, we identified that weight perception mediated the association between obesity and depression.

A study conducted with US adults concluded that the relationship between body weight and depression occurred through the mediation of weight perception (Gaskin et al., 2013). Being overweight was prospectively associated with an increase in depressive symptoms among American adults (Daly et al., 2017). The findings of one survey of Korean women support the hypothesis that body perception mediates the relationship between BMI and depressed mood (Kim et al., 2008). These results suggest that weight perception plays a crucial role, which is as important as weight itself in its relation to depression (Gaskin et al., 2013).

One hypothesis about this mechanism of mediation was proposed by Markowitz, Friedman, and Arent (Markowitz et al., 2008). The authors argue that dissatisfaction with body image mediates the

| | Ν | OR | 95% CI | þ value |
|--|------|-------|------------|---------|
| Overall | 1238 | | | |
| $Obesity \rightarrow depression$ | | 1.86 | 1.27-2.72 | 0.001 |
| Weight perception \rightarrow obesity | | 12.44 | 8.87-17.43 | <0.001 |
| Weight perception \rightarrow depression | | 2.21 | 1.48-3.30 | <0.001 |
| Direct effect | | 1.46 | 0.94-2.27 | 0.092 |
| Indirect effect | | 1.27 | 1.05-1.55 | 0.015 |
| % Mediation: 39.3 | | | 36.6–42.I | |
| Marital status | | | | |
| Married, separated, widower | 662 | | | |
| $Obesity \rightarrow depression$ | | 1.80 | 2.08-3.00 | 0.025 |
| Weight perception \rightarrow obesity | | 12.78 | 8.06-20.28 | <0.001 |
| Weight perception \rightarrow depression | | 3.05 | 1.83-5.08 | <0.001 |
| Direct effect | | 1.16 | 0.64-2.12 | 0.618 |
| Indirect effect | | 1.54 | 1.19-1.99 | 0.001 |
| % Mediation: 73.9 | | | 70.5–77.2 | |
| Schooling | | | | |
| 9 years or more | 730 | | | |
| $Obesity \rightarrow depression$ | | 2.92 | 1.68-5.00 | <0.001 |
| Weight perception \rightarrow obesity | | 14.19 | 9.18-21.92 | <0.001 |
| Weight perception \rightarrow depression | | 3.35 | 1.95-5.77 | <0.001 |
| Direct effect | | 1.99 | 1.04-3.82 | 0.037 |
| Indirect effect | | 1.46 | 1.07-1.99 | 0.017 |
| % Mediation: 35.6 | | | 32.1-39.0 | |
| Alcohol abuse | | | | |
| No | 1087 | | | |
| $Obesity \rightarrow depression$ | | 1.92 | 1.28-2.86 | 0.001 |
| Weight perception \rightarrow obesity | | 10.89 | 7.65-15.50 | <0.001 |
| Weight perception \rightarrow depression | | 2.08 | 1.37-3.15 | <0.001 |
| Direct effect | | 1.57 | 0.99–2.46 | 0.053 |
| Indirect effect | | 1.22 | 1.00-1.48 | 0.046 |
| % Mediation: 30.8 | | | 28.0-33.6 | |
| Tobacco use | | | | |
| Non-smoker | 704 | | | |
| $Obesity \rightarrow depression$ | | 2.20 | 1.32-3.67 | 0.003 |
| Weight perception \rightarrow obesity | | 13.00 | 8.37-20.20 | <0.001 |
| Weight perception $ ightarrow$ depression | | 2.56 | 1.53-4.29 | <0.001 |
| Direct effect | | 1.65 | 0.90-3.00 | 0.100 |
| Indirect effect | | 1.34 | 1.01-1.75 | 0.043 |
| % Mediation: 36.2 | | | 32.7–39.8 | |
| Leisure physical activity | | | | |
| No | 822 | | | |
| $Obesity \rightarrow depression$ | | 1.60 | 1.03-2.46 | 0.035 |
| Weight perception $ ightarrow$ obesity | | 13.06 | 8.75-19.51 | <0.001 |
| Weight perception $ ightarrow$ depression | | 2.21 | 1.43–3.43 | <0.001 |
| Direct effect | | 1.19 | 0.71-1.97 | 0.507 |
| Indirect effect | | 1.34 | 1.05-1.70 | 0.017 |
| % Mediation: 62.9 | | | 59.6–66. l | |

Table 2. Analysis of mediation of the sample of adults aged 18 years or older from the urban area of Rio
 Grande, Brazil, 2016.

N: absolute frequency; OR: odds ratio; CI: confidence interval.

| | Combination I (not obese + not fat) | Combination 2 (not obese + fat) | Combination 3 (obese + not fat) | Combination 4 (obese + fat) | |
|---------------------------|--|------------------------------------|------------------------------------|--------------------------------|--|
| | Reference | OR (95% CI) | OR (95% CI) | OR (95% CI) | |
| Overall | 1.00 | 1.31 (0.66–2.64) | 1.23 (0.68–2.24) | 2.79 (1.82-4.28) | |
| Stratified | | | | | |
| Gender | | | | | |
| Male | 1.00 | 3.46 (0.87–13.71) | 1.75 (0.75–4.07) | 2.37 (1.02–5.48) | |
| Female | 1.00 | 0.80 (0.31-2.08) | 0.96 (0.45-2.04) | 2.58 (1.50-4.44) | |
| Age (years) | | | | | |
| 18–39 | 1.00 | 1.86 (0.65–5.26) | 0.97 (0.33–2.88) | 2.50 (1.25-5.00) | |
| 40–59 | 1.00 | 0.76 (0.18–3.26) | 1.22 (0.49-3.04) | 3.49 (1.81–6.73) | |
| ≥60 | 1.00 | 1.53 (0.35-6.73) | 1.48 (0.52-4.24) | 2.09 (1.81-6.73) | |
| Skin color | | | | | |
| White | 1.00 | 1.41 (0.65–3.07) | 1.15 (0.55–2.39) | 3.29 (2.03-5.32) | |
| Black/other | 1.00 | 0.98 (0.13-7.70) | 1.38 (0.42-4.56) | 1.25 (0.43-3.62) | |
| Marital status | | | | | |
| Single | 1.00 | 0.90 (0.28–2.90) | 1.86 (0.91–3.80) | 1.90 (0.91–3.95) | |
| Non-single | 1.00 | 1.80 (0.72-4.49) | 0.84 (0.27-2.57) | 3.57 (2.11–6.06) | |
| Schooling (years) | | | | | |
| 0–8 | 1.00 | 0.81 (0.26-2.59) | 0.79 (0.37–1.67) | 1.85 (0.94–3.65) | |
| ≥9 | 1.00 | 2.23 (0.90-5.54) | 1.96 (0.87-4.44) | 4.53 (2.48-8.28) | |
| Income per capita | | | | | |
| First tertile | 1.00 | 1.13 (0.37–3.46) | 1.18 (0.55–5.24) | 1.57 (0.81–3.04) | |
| Second tertile | 1.00 | 1.00 (omitted) | 1.07 (0.38–3.05) | 2.59 (1.06-6.31) | |
| Third tertile | 1.00 | 5.11 (1.43–18.21) | 1.31 (0.26-6.54) | 5.00 (1.61-15.53) | |
| Alcohol abuse | | | | | |
| No | 1.00 | 1.19 (0.55–2.61) | 1.33 (0.72–2.45) | 2.76 (1.74–4.36) | |
| Yes | 1.00 | 3.47 (0.29-41.00) | I.00 (omitted) | 2.97 (0.91–9.67) | |
| Tobacco use | | | | | |
| Non-smoker | 1.00 | 1.83 (0.89–3.73) | 1.56 (0.85–2.87) | 3.08 (1.83-5.18) | |
| Former or current | 1.00 | 1.00 (omitted) | 0.59 (0.13-2.63) | 3.54 (1.18-10.65) | |
| smoker | | | | | |
| Leisure physical activity | / | | | | |
| No | 1.00 | 1.25 (0.57–2.75) | 0.87 (0.46–1.64) | 2.50 (1.51-4.14) | |
| Yes | 1.00 | 1.15 (0.14–9.29) | 2.85 (0.99–8.16) | 3.26 (1.24-8.53) | |

Table 3. Overall and stratified analyses of the association between depression and the categories of possible combinations between weight perception and obesity.

OR: odds ratio; CI: confidence interval.

Sample of adults aged 18 years or older from urban Rio Grande, Brazil, 2016 (N = 1238).

association between obesity and depression, which is due to the accompanying low selfesteem. Obese individuals are more likely to be dissatisfied with their bodies, leading to low selfesteem and consequently increasing the likelihood of developing depression (Flores-Cornejo et al., 2017; Markowitz et al., 2008). This means that as BMI increases, depressive symptoms also increase, but this relationship is a product of the effect of BMI on body image and the effect of body image on depression (Eidsdottir et al., 2014). In our study, this mediation occurred mainly for individuals who are presumably less susceptible to depression (non-single, more educated,

| | OR observed (combination 4) | OR expected (combination $2 \times$ combination 3) | OR ratio (OR observed ÷ OR expected) |
|---------------------------|--------------------------------|--|---|
| Overall | 2.79 | 1.61 | 1.73 |
| Stratified | | | |
| Gender | | | |
| Male | 2.37 | 6.06 | 0.39 |
| Female | 2.58 | 0.77 | 3.35 |
| Age (years) | | | |
| 18–39 | 2.50 | 1.80 | 1.39 |
| 40–59 | 3.49 | 0.93 | 3.75 |
| ≥60 | 2.09 | 2.26 | 0.92 |
| Skin color | | | |
| White | 3.29 | 1.62 | 2.03 |
| Black/other | 1.25 | 1.35 | 0.93 |
| Marital status | | | |
| Single | 1.90 | 1.67 | 1.14 |
| Married, separated, or | | 1.51 | 2.36 |
| widower | | | |
| Schooling (years) | | | |
| 0–8 | 1.85 | 0.64 | 2.89 |
| ≥ 9 | 4.53 | 4.37 | 1.04 |
| Income per capita | | | |
| First tertile | 1.57 | 1.33 | 1.18 |
| Second tertile | 2.59 | <u>_a</u> | a |
| Third tertile | 5.00 | 6.69 | 0.75 |
| Alcohol abuse | | | |
| No | 2.76 | 1.58 | 1.75 |
| Yes | 2.97 | a | a |
| Tobacco use | | | |
| Non-smoker | 3.10 | 4.01 | 0.77 |
| Former or current smoker | 2.66 | 0.45 | 5.91 |
| Leisure physical activity | | | |
| No | 2.50 | 1.09 | 2.29 |
| Yes | 3.26 | 3.28 | 0.99 |

Table 4. Results of the overall and stratified analysis of the observed and expected associations and the ratio between the associations (OR observed ÷ OR expected) for the combination four subgroup.

OR: odds ratio; OR observed: observed odds ratio; OR expected: expected odds ratio; OR ratio: odds ratio ratios. Sample of adults aged 18 years or older from the urban area of Rio Grande, RS, 2016 (N=1238). alnsufficient number of observations for the calculation.

non-alcohol abusers, and non-smokers). Thus, it can be assumed that this explanation (weight perception) for the association between obesity and depression occurs markedly when there is no set of factors and behaviors that are harmful to health.

Four possible combinations were established when we analyzed being obese and having a self-perception of being fat, of which two agreed (C1: not fat and not obese, C4: fat and obese) and two disagreed (C2: fat and not obese; C3: not fat and obese). Evaluating the association between these combinations and the probability of being depressed, we observed that this association was enhanced among those who perceived themselves as fat and were obese.

This combined effect occurred mainly among those presumably more susceptible to depression (women, middle-aged individuals, and current or former smokers). It is plausible that this occurred not because the path is causal but rather because there is potentiation among these subgroups. Thus, among current or former smokers, an unhealthy lifestyle can deteriorate self-esteem, increasing negative self-perception and susceptibility to depression (Friedman et al., 2002). Women and middleaged individuals culturally suffer greater social pressure concerning esthetics and appearance and are, therefore, more vulnerable to negative body perception and, thus, increasing psychological distress (Center for Disease Control and Prevention, 2011; Eidsdottir et al., 2014; Friedman et al., 2002). The opposite was found only among men, possibly because they were less subject to social pressure or esthetic aspects.

We emphasize that among the richest, weight perception alone (C2) was sufficient to increase the probability of showing depression, and the magnitude of the association was equivalent for those with both characteristics (C4). This result may be due to the impact exerted by the appearance (or perception of it) in this subgroup, possibly due to the social pressure and the peers of the same income range (McLaren and Kuh, 2004). Leanness serves as a social status indicator, where lean individuals are more likely to be socially accepted by those with a higher socioeconomic level, especially among women (Gavin et al., 2010; McLaren and Kuh, 2004).

Our study has some limitations due to the nature of epidemiological surveys. First, the cross-sectional design does not establish whether the associations (in this case, between obesity and depression) are causal. Therefore, the associations found are subject to reverse causality bias and should be interpreted with caution. In addition, the measurement of the main exposure variables (obesity and weight perception) has weaknesses. Obesity was measured from self-reported weight and height instead of from direct measures. However, this collection method is widely used in epidemiological studies (Gorber et al., 2007) and validated for Brazilian adults, despite its tendency to underestimate weight and overestimate height (Fonseca et al., 2004). The perception of weight was evaluated from a single question rather than being measured by the use of a validated instrument. Finally, eating disorders were not evaluated, which might constitute a possible source of confounding.

This study is innovative in its analyses of both the mediating role of weight perception in the association between obesity and depression and the combined effect of being obese and having a self-perception of being fat for this outcome. We did not find any other study in literature with the same approach. Thus, we consider that this work is useful both for health professionals in their clinical practice and for health managers in the implementation of public health measures and strategies.

Therefore, we conclude that obesity was a risk factor for depression and that this association was mediated by the perception of weight, especially in those individuals less susceptible to depression. Furthermore, we also observed that being obese and identifying as fat produced a potentiating effect, significantly increasing the probability of depression, especially for the groups most susceptible to this outcome. That is, this finding suggests that depression results both from obesity and the individual's perception of being fat.

Thus, it is estimated that approximately 40 percent of the depression among obese individuals was mediated by perceived weight. Thus, psychotherapeutic and psychosocial intervention targeting weight perception may reduce depression burden, an effect that will be observed mainly among the groups less susceptible to this outcome. However, respondents who are obese and consider themselves as fat are more likely to develop depression, an effect that was observed especially among most susceptible subgroups. In these occasions, multidisciplinary interventions to concomitantly address psychological, nutritional, and physical aspects are recommended. Finally, more studies

with this same approach are recommended to confirm the findings or to bring about new hypotheses in this field of knowledge.

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