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Running Title: Weight stigma processes and physical activity.

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Abstract

A growing body of research identifies weight stigma as a motivational barrier to physical activity (PA) participation. The purpose of this study was twofold: (1) to better understand the motivational processes involved in the associations between weight stigma and PA (motivation to avoid exercise and self-control resources); and (2) to examine this question in a White, Educated, Industrialized, Rich, and Democratic (WEIRD) country, and a non-WEIRD country with different obesity prevalence: France and Mexico. French (N=200) and Mexican (N=153) participants completed an online questionnaire measuring weight stigma constructs (perceived discrimination, weight stigma concerns, and weight bias internalization), motivational processes, and PA. Main results showed that motivation to avoid exercise and self-control resources operated as two independent processes of the weight stigma – PA relationship: The higher weight stigma, the higher their motivation to avoid exercise, and the lower their self-control resources, both resulting in lower PA. Results also showed both differences (in the levels of weight stigma constructs) and similarities (in the weight stigma processes) between France and Mexico, suggesting the importance of investigating weight stigma in both WEIRD and non-WEIRD countries.

Keywords: Weight stigma, Physical Activity, Avoidance motivation, Self-control resources, Cross-cultural comparison.

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Obesity is a leading risk of mortality worldwide, with body mass index (BMI) being associated with diabetes, cancer, arthritis, and cardiovascular diseases (GBD 2015 Obesity Collaborators, 2017). These relations have been attributed to multiple factors, such as richness of gut microbiome, genetics, and lifestyle (Cannon & Kumar, 2009; Choquet & Meyre, 2011; Le Chatelier et al., 2013). Substantial evidence shows that physical activity (PA) combined with dietary restriction lead to greater weight loss in the long term, compared with diet alone (Johns et al., 2014). In addition, regular PA has many health benefits for obese individuals (Warburton et al., 2006): it is associated with improvements in maximum oxygen consumption and muscle strength, and with decreases in depressive symptoms and type-two diabetes (Lee et al., 2005; Sarsan et al., 2006). Despite these benefits, many cross-sectional, longitudinal, and experimental studies show that PA decreases with increasing body mass index (BMI) (see Ekkekakis et al., 2016 for a review). It is therefore crucial to identify the specific barriers faced by overweight people in the PA domain.

In recent years, increasing attention has been paid to the impact of weight stigma on health behaviors (e.g., maladaptive eating behaviors and physical inactivity) and outcomes (e.g., ill-being, mortality) (e.g., Hayward et al., 2018; Pearl et al., 2015; Puhl & Suh, 2015; Tomiyama et al., 2018; Vartanian & Novak, 2011). Defined as “the pervasive social devaluation and denigration of people who are perceived to carry excess weight” (Major et al., 2018, p. 2), weight stigma may affect health through three major constructs: perceived discrimination, weight stigma concerns, and weight bias internalization (Major et al., 2018). *Perceived discrimination* refers to individual experiences of teasing and negative treatment based on one’s weight. *Weight*

stigma concerns, or social identity threat, refers to one's anticipation of encountering weight-based rejection, avoidance, and devaluation (Major et al., 2018). Finally, *weight bias internalization*, or self-stigma, is the tendency to accept and blame oneself for negative weight-based stereotypes (Hilbert et al., 2014).

The existing literature suggests that these three constructs are related in a serial manner (Major et al., 2018). First, there is evidence that perceived discrimination predicts weight stigma concerns (Hunger & Major, 2015; Major et al., 2012; Major et al., 2020). In other words, the more people think they are being discriminated against, the more they anticipate being discriminated against. Although these two constructs seem similar, they are distinct, as weight stigma concerns have been shown to undermine self-regulation even in the absence of interpersonal discrimination (Major et al., 2012; Major et al., 2014). Second, past research suggests that weight stigma concerns may predict weight bias internalization (Pearl & Dovidio, 2015): the more people are concerned of being discriminated against, the more they tend to internalize negative weight-based stereotypes.

While a growing literature provides support to the role of these weight stigma constructs in health, the processes through which they affect PA remain unclear (Puhl et al., 2020). The primary goal of the present study was to better understand the motivational processes through which weight stigma predict PA. One process that has captured interest is motivation to avoid exercise (Vartanian & Novak, 2011; Vartanian & Shaprow, 2008). For example, Vartanian and Novak (2011) showed that the more participants experienced discrimination, the more they felt uncomfortable or embarrassed to do physical activity in public places -- a motivation that could reflect a desire to avoid stigmatization (Major et al., 2020). In turn, motivation to avoid exercise was associated with less frequent exercise (Vartanian & Shaprow, 2008).

Although exercise avoidance may be an important weight stigma process, other mechanisms are likely to be involved. Research on eating behaviors has notably shown that weight stigma may reduce people's capacity for weight control (e.g., Major et al., 2020; Major et al., 2014; Salvy et al., 2011), leading them to eat more calories (Major et al., 2014; Schvey et al., 2011). Indeed, coping with the stress induced by weight stigma may consume self-control resources (Major et al., 2018), preventing people from inhibiting subsequent temptations such as eating junk food. Although self-control resources (i.e., one's perception of the mental resources or energy available to the self, Clarkson et al., 2016) have been shown to predict physical activity (Forestier et al., 2018), no study to our knowledge has examined the role of self-control in the weight stigma – physical activity relationship. The present study investigated whether self-control resources mediate the association between weight stigma and physical activity independently from motivation to avoid exercise.

A second goal was to test if weight stigma processes are similar in higher-income and lower-income countries (France and Mexico). To date, weight stigma has been viewed as a specific issue to people from Western, Educated, Industrialized, Rich and Democratic (WEIRD) societies, like the US and Western Europe (Brewis et al., 2018). There is limited evidence on the extent to which weight stigma affects populations across the Global South (i.e., lower income countries). Adopting a cross-cultural approach is important given the growing awareness in psychological science of the limitations of conducting studies on people from WEIRD societies. In social and behavioral science studies, such samples represent as much as 80 percent of study participants, but only 12 percent of the world's population, whereas they are outliers on many phenomena (Henrich et al., 2010). With regard to weight stigma more particularly, obesity represents an issue not only in WEIRD countries but also in non-WEIRD ones. For example,

Mexico is ranked second highest in obesity prevalence out of the 45 countries in the Organization for Economic Co-operation and Development (OECD) (32.4% of the population; OECD, 2017). This prevalence is higher than in a WEIRD country such as France, which is ranked 27th in obesity prevalence (15.3% of the population).

With regard to weight stigma, two questions can be raised: first, are there differences in the level of weight stigma between countries with different incomes and obesity prevalence? Second, do the processes through which weight is negatively related to PA differ in both countries? Given the exploratory nature of this comparison, we did not formulate specific hypotheses.

Present Research

We investigated the motivational processes (i.e. motivation to avoid exercise and self-control resources) of the weight stigma – physical activity relationships and their cultural invariance in a cross-sectional study conducted on French and Mexican participants. More particularly, the model presented on Figure 1 tested using structural equation modeling the hypotheses that: (1) perceived weight (i.e., the extent to which an individual perceives him or herself as overweight versus average weight or underweight) positively predicts perceived discrimination. We operationalized weight as perceived weight as it seems to be more related to weight stigma than BMI (Major et al., 2014); (2) perceived discrimination positively predicts weight stigma concerns, which in turn are positively associated with weight bias internalization; (3) weight bias internalization positively predicts motivation to avoid exercise and self-control resources; (4) these two motivational constructs independently predict physical activity participation, with motivation to avoid exercise negatively predicting it, and self-control resources positively predicting it.

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Overall, this study is likely to extend the literature by better understanding the motivational processes involved in weight stigma in the physical activity domain, and by examining these processes in WEIRD as well as in non-WEIRD countries with different obesity prevalence.

Methods

Participants and procedure

A-priori sample size calculator for structural equation models was used to calculate the required sample size (Soper, 2019). With the following parameters: anticipated effect size =.20, desired statistical power level = .80, Number of latent variables = 5, Number of observed variables = 29, Probability level = .05, the recommended minimum sample size is 376 participants (Soper, 2019). In total, 552 people were contacted to participate in an anonymous on-line questionnaire between June and July 2016. A total of 417 people agreed to answer. This convenient sample was recruited in France and Mexico. The questionnaire was distributed to participants in the form of a weblink with the help of one hospital, 13 private practitioning physicians and dietitians, a national research center on dieting and health, and an association promoting health in overweight people, which in turn sent the invitation to their members and associated clinicians. All recruiters were instructed to send the questionnaire to their patients and contacts' network. A document explaining the goals of the study as an investigation of the psychosocial determinants of physical activity was sent to each site. They gave permission to recruit participants from among their patients and helped spread the questionnaire via e-mail and social media. All participants signed the study consent form approved by the Ethics Committee

of the institution where the research was conducted. The questionnaire had an average duration of 19.5 minutes.

Outliers, underage participants, and those with substantial missing data were excluded (see Data screening section), yielding a final sample of 353 participants (200 French participants and 153 Mexican participants). Out of the French participants, 80 were males and 120 were females, and the sample had a mean age of 34.71 (*SD*=16.08, range = 18-77)). The Mexican sample was composed of 64 males and 89 females, with a mean sample age of 29.75 (*SD*=10.80, range = 18-65).

Measures

Based on the transcultural validation methodology (Hambleton, 2005), the scales measuring perceived discrimination, weight stigma concerns, weight bias internalization, and exercise avoidance motivation, were translated from English to the concerned language by native speakers (French or Spanish) and back-translated by a professional translator to English, then both English versions were compared.

The questionnaire included a demographic section in which participants reported their height and weight, allowing us to calculate their BMI.

Perceived weight was assessed by asking participants to answer the stem, "currently I am…" using seven possible answers: 'extremely thin', 'moderately thin', 'a little thin', 'neither thin nor overweight', 'a little overweight', 'moderately overweight', 'extremely overweight'. This question is part of the self-reported measures assessed in the online version of the IAT for weight-related stigma (Greenwald et al., 1998; Teachman & Brownell, 2001).

Perceived discrimination was assessed using a modified version of the everyday discrimination scale (Hunger & Major, 2015; Williams et al., 1997). The scale consists of five

items (e.g., “In the past 12 months, how often have you been treated differently than others because of your weight?”) rated on a scale ranging from 1 (never) to 7 (all the time) (α_{France}=.91; α_{Mexico}=.93).

Weight stigma concerns were measured with the scale developed by Hunger and Major (2015), which consists of three items (e.g., “I am afraid of being excluded because of my weight”) rated on a Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) (α_{France}=.91; α_{Mexico}=.90).

Weight bias internalization was measured with the Modified Weight Bias Internalization Scale *(WBIS-M*; Pearl & Puhl, 2014), which consists of 11 items (e.g., “I am less attractive than other people because of my weight”) rated on a Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) (α_{France}=.91; α_{Mexico}=.91).

Motivation to avoid exercise was measured with a three-item measure (e.g., “I avoid going to the gym when I know there will be plenty of thin people there”; Vartanian & Novak, 2011). For each item, participants responded on a seven-point scale from 1 (not at all) to 7 (totally agree) (α_{France}=.81; α_{Mexico}=.73).

Self-control resources were measured using the Subjective Vitality Scale (Ryan & Frederick, 1997), consisting of five items (e.g., “I feel alive and full of vitality”) rated on a Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) (α_{France}=.92; α_{Mexico}=.90). Self-control resources were indexed by subjective vitality, namely the energy one can regulate for purposive actions (Ryan & Deci, 2008), because this construct corresponds closely to the definition of self-control resources as the perceived mental resources or energy available to the self (Clarkson et al., 2016). Several studies have confirmed that perceived subjective vitality

(Emile et al., 2015; Forestier et al., 2018) or perceived energy (Major et al., 2020) are valid measures of self-control resources.

Physical activity was assessed with the short-form of the International Physical Activity Questionnaire (IPAQ; Booth, 2000). Participants were asked to report the amount of moderate (e.g. biking calmly, doubles tennis match) and vigorous (e.g. mountain cycling, playing football, long distance running) physical activity they engaged in, indicating for each category how many days in the last seven days they engaged in such activities, and how much time they usually spent in those activities per day. Frequency and duration were multiplied to obtain an average of total minutes of moderate to vigorous physical activity (MVPA) per week.

Data analysis strategy

Structural equation modeling (SEM) was the main analysis strategy of the data. To ensure that the underlying assumptions of SEM were met, participants were screened for missing data and outliers. Then, univariate histograms, skewness, and kurtosis scores were used to check for normality. Next, measurement invariance of the questionnaire across the two countries was tested to ensure that items functioned similarly across cultural contexts. We followed a previously recommended procedure (Millsap, 2011) by conducting hierarchical tests for invariance of measurement parameters. We first carried out a confirmatory factor analysis (CFA) to check for the expected relationships between each item and their subscale (factor), with all cross-loadings constrained to zero. This model was taken as the configural model and was used as the baseline model for the test of factor loadings (metric) invariance, and the factor loadings plus intercepts (scalar) invariance. Model fit was determined by comparing multiple fit indices (Hu & Bentler, 1999): the χ^2, the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA) and its Confidence Interval (CI) of 90%.

CFI and TLI values ≥ 0.90 and RMSEA ≤ 0.08 are considered as indicators of acceptable fit (Hair et al., 2010). To test the different types of invariance, we looked for changes in fit across the nested models of .015 or less for RMSEA (ΔRMSEA) and of .01 or less for CFI (ΔCFI) to establish invariance (Cheung & Rensvold, 2002).

SEM was then used to test the hypothetical model. The goodness-of-fit index, completed by the Akaike information criterion (AIC), and the Bayes information criterion (BIC) were used to test model fit to the data. For AIC and BIC, the smaller the index are, the better the model is. Indirect effect was computed using bootstrapping (1,000 bootstrapped samples) procedures with 95% confidence intervals determining the indirect (mediated) relationships between variables. Finally, a multigroup SEM was run to test the invariance of the model within the French and Mexican samples. Specifically, the fits of the model with constrained structural paths across groups were compared to those of an unrestricted model in which the structural paths were allowed to vary across the two countries. If the fit of the model degraded significantly, this was evidence that the relationships between the variables of the model differed significantly by country.

R-studio and its package LAVAAN (Rosseel, 2012) were used for all the analyses described in this section.

Results

Data screening

We excluded from analyses participants who were under 18 years old (France=2; Mexico=6) or who had over 70% of missing data (France=25; Mexico=18). Outliers were handled via the Mahalanobis distance with a critical chi-squared value of 24.32 assessed using a $p<.001$, which resulted in seven participants being eliminated from the French sample and six

from the Mexican one. In total, 30 participants were excluded from the Mexican sample, and 34 participants were excluded from the French sample, leaving 353 participants in the final sample. To ensure the additional missing data were missing at random the distribution by question was estimated. Forty-five participants had 1.15% missing data and eight participants had 2.3% missing data. Data were missing over 15 different questions, indicating that they were completely at random Multivariate imputation by chained equations was used to impute the rest of the missing data (Buuren & Groothuis-Oudshoorn, 2011). All measured variables had a skewness and kurtosis between -1.0 and 1.0 and were normally distributed.

The average BMI for the combined sample is 24.33 (*SD*=4.91) with 4.25% of participants being underweight, 61.19% within normal weight, 22.66% overweight and 11.90% obese, according to the weight categories determined by the Center for Disease Control (2016). The average BMI in the Mexican sample was 25.34, which is in the overweight range, while the average BMI in the French sample was 23.55, which is within the normal range. This coincides with the underlying populations of Mexico and France (Kuri Morales et al., 2016; Saint Pol, 2007). Two-tailed t-tests and χ^2 tests were carried out in order to check possible differences between the two countries on the measured variables. Results revealed significant differences between the two countries for BMI, perceived weight, perceived discrimination, weight stigma concerns, which were higher in the Mexican sample. The Mexican participants are also younger than the French ones. No statistically significant differences were found for self-control resources, motivation to avoid exercise, and PA. The sample characteristics and the difference tests between the two countries can be found in Table 1.

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Measurement model Analyses and Measurement Invariance

Results from the CFA indicated that the model fits the data correctly [$\chi^2(314)= 873.33$, CFI= .922, TLI= .913, RMSEA= .071, CI=.066 - .077]. Due to a low and non-significant factor loading we decided to remove the first item of the WBIS-M scale. Moreover, based on the Lagrange multiplier (LM) test, we added covariance relationships within two perceived discrimination items and two weight bias internalization items. This re-specified model improved the fits of the data in the pooled sample [$\chi^2(287)=782.50$, CFI=.931, TLI=.922, RMSEA=.070, CI=.064 -.076], the French [$\chi^2(287)=638.917.30$, CFI=.914, TLI=.9023, RMSEA=.078, CI=.070 -.087] or Mexican [$\chi^2(287)= 492.33$, CFI=.925, TLI=.916, RMSEA=.068, CI=.058 - .079] sub-samples as well. As a result, it was used as baseline (configural) model. Means, standard deviations, Cronbach's alpha and correlation matrix of the variables of interest can also be found in the Table 2.

Compared to the configural model, the changes in fit for the metric model (loadings constrained across countries) exceeded the requirements for invariance on the CFI statistic (ΔCFI=.014 and ΔRMSEA=.005). The constraint of equal loading across countries had to be relaxed for the eighth item of the WBIS-M scale ("I don't feel that I deserve to have a really fulfilling social life, because of my weight") to attain partial metric invariance (ΔCFI=.007 and ΔRMSEA=.002). Compared to the metric model, the scalar model did not worsen the fit to the data (ΔCFI=.006 and ΔRMSEA=.001), thus showing partial scalar invariance across countries given that the item 8 of the WBIS-M scale has to be unconstrained in the preceding model (i.e., metric invariance model). Table 3 shows the goodness of fit indices for all models tested.

Structural Models Analyses

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The model showed good fit to the data [$\chi^2(330)=915.264$, CFI=.92, TLI=.91, RMSEA=.071, CI=.066 - .076, AIC=26882, BIC=27172]. However, the modification indices suggested to add two paths, namely perceived weight → weight stigma concerns and perceived weight → weight bias internalization. This revised model resulted in an improvement in the fit of the model to the data [$\chi^2(341)=933.930$, CFI=.92, TLI=.91, RMSEA=.070, CI=.065 - .076, AIC=26878, BIC=27126; $\Delta\chi^2 = 18.66$, $\Delta df = 11$, $p < .001$]. All the paths were significant and in the expected direction. More particularly, the three weight stigma constructs were related in a serial manner, with perceived discrimination positively predicting weight stigma concerns, which positively predicted weight bias internalization. In turn, weight bias internalization significantly predicted self-control resources and motivation to avoid exercise, which were both associated with PA. This model explained between 10 and 62% of the variance of the variables. The standardized path coefficients of the final model are shown in Figure 2.

Indirect effect Analyses

Bootstrapped testing of indirect effects in the final model revealed that all indirect pathways were significant (see Table 4). The results indicated that perceived weight was negatively related to PA through six specific indirect effects: (a) via the sequence perceived weight → perceived discrimination → weight stigma concerns → weight bias internalization → self-control resources (β=-.01, $p<.05$, 95% CI = -.01, -.004), (b) via the sequence perceived weight → perceived discrimination → weight stigma concerns → weight bias internalization → motivation to avoid exercise (β=-.01, $p<.05$, 95% CI = -.01, -.001), (c) via the sequence perceived weight → weight stigma concerns → weight bias internalization → self-control resources (β=-.01, $p<.01$, 95%CI = -.02, -.003), (d) via the sequence perceived weight → weight stigma concerns → weight bias internalization → motivation to avoid exercise (β=-.01, $p<.05$,

95% CI = -.02, -.001), (e) via the sequence perceived weight → weight bias internalization → self-control resources (β=-.02, p<.001, 95% CI = -.03, -.01), and (f) via the sequence perceived weight → weight bias internalization → motivation to avoid exercise (β=-.02, p<.05, 95% CI = -.03, -.003). However, the total indirect effect is small (β=-.07, p<.001, 95% CI = -.10, -.04).

Cultural invariance of the final model

The final structural model had adequate fit in French [$\chi^2(341)=756.79$, CFI= .901, TLI= .891, RMSEA= .078, CI= .071-.085] and Mexican [$\chi^2(341)=588.25$, CFI= .913, TLI= .904, RMSEA= .069, CI= .059-.078] participants. In order to test for cross-cultural invariance of the final model between the two countries, we ran two multigroup models, one where the structural paths were allowed to vary across the two countries, and another with the loadings of the structural and measurement models constrained to be the same (with the same item freed as in the measurement invariance test). Both models show satisfactory (Table 3, last two lines) and comparable fits (ΔCFI=.006 and ΔRMSEA=.001). This result indicates that the regression coefficients could be held equal across the country, indicating a similarity in the way the predictors influence the outcome variables across both countries.

Discussion

The main goals of this study were to better understand the motivational processes involved in the associations between weight stigma and PA, and to examine this question in WEIRD and non-WEIRD countries with different obesity prevalence. Results add to the existing literature in two important ways. First, we identified motivation to avoid exercise and self-control resources as two independent processes of the weight stigma – PA relationship. In other words, the more participants internalized weight stigma, the higher their motivation to avoid exercise, and the lower their self-control resources, both resulting in lower PA. These findings

extend previous studies on eating behaviors showing that weight stigma may reduce people's capacity for weight control (e.g., Major et al., 2020; Major et al., 2014; Salvy et al., 2011), and research showing that self-control resources significantly predict physical activity (Forestier et al., 2018). It also corroborates past studies showing significant positive relationships between weight stigma and motivation to avoid exercise (Vartanian & Novak, 2011; Vartanian & Shaprow, 2008). Importantly, our results indicate that these two motivational processes operate independently from one another, providing an empirical answer to Hunger et al. (2015) who pointed out that: "Although findings highlight the important role of weight stigma in physical activity, it is unclear if these effects emerged as a result of diminished self-regulation, increased motivation to avoid stigma, or some combination thereof" (p. 260).

Second, results corroborate the importance of investigating weight stigma in both WEIRD and non-WEIRD countries, as they show both differences and similarities between France and Mexico. On the one hand, significant differences in the levels of weight stigma variables were observed between the two countries: perceived weight, perceived discrimination, and weight stigma concerns were higher in the Mexican sample than in the French one. These results reveal that weight stigma is present not only in WEIRD countries, but also in non-WEIRD ones (Brewis et al., 2018). Moreover, these result do *not* support the visual normalization theory (Robinson, 2017), which holds that weight status is judged according to visual body size norms. When larger body sizes are common, there is a recalibration of what is perceived to be a 'normal' or 'overweight' body size. In other words, an increased exposure to obesity (like in Mexico) could have resulted in an increase in the size at which a body is categorized as normal or overweight. As in a recent study with New Caledonian adolescents (Frayon et al., 2019), our data do not support this theory. Perhaps with globalization, images of

slender people are invading the media in most of the world's countries, and these pervasive images have a greater influence in shaping the canons of beauty than do visual observations of the body sizes of people seen in the close environment. However, further studies are needed to test this hypothesis more specifically.

Importantly, while levels of weight stigma differed in France and Mexico, weight stigma processes were cross-cultural invariant. In other words, the processes through which weight stigma predicted PA did not differ in the two countries. Furthermore, both samples were partially invariant in measurement, as the scales measured the same latent constructs in both countries. These findings suggest that the anti-fat norms prevailing in the northern countries (Brewis et al., 2018) are as psychologically damaging in non-WEIRD countries such as Mexico. Future studies could also test whether weight stigma processes are gender invariant or not. Although our data indicate that there were non-significant gender differences in mean levels of all variables (except weight bias internalization, with females scoring higher than males, see supplemental materials, Table 2), this is not sufficient to conclude about the gender invariance of the model, and this question could be investigated in the future.

Finally, our findings provide support to the existing literature by showing that the three weight stigma constructs operate in a serial manner, with perceived discrimination predicting weight stigma concerns (Hunger & Major, 2015; Major et al., 2012; Major et al., 2020), which in turn predict weight bias internalization (Pearl & Dovidio, 2015). However, the modification indices of the SEM analysis indicated that perceived weight was significantly and positively associated with each of these three constructs, and not just with perceived discrimination. This suggests that weight stigma constructs could also partially operate in a parallel manner. In addition, although we examined the mediating role of self-control resources and motivation to

avoid exercise in the relationship between weight bias internalization and PA, it is possible that these motivational constructs also mediated the relationships between the three weight stigma phenomena. This question could be examined in future research.

This study is subject to some limitations that should be kept in mind when interpreting the results. First, our research design is cross-sectional in nature, and thus causal inferences cannot be drawn. The associations found between weight stigma, motivational processes, and PA warrant further investigation in longitudinal or experimental studies. More ecologically valid methodologies, such as experiencing sampling, could also provide interesting additional information (e.g., Seacat et al., 2016). Secondly, while the sample might be sufficient in terms of power, it might still be limited because we used a convenient sample, which was therefore not completely representative of the populations of each country. Indeed, obesity rates in our samples were inferior to those of the Mexican and French populations. This may limit the generalizability of our findings concerning the mean level of weight stigma variables. In particular, it is possible that these results underestimate weight stigma perceptions that exist at the level of each population. However, we believe that this imperfect representativeness is unlikely to have biased the relationships between the constructs of interest. Indeed, we observed that while mean level of weight stigma differed in the two countries, weight stigma processes were cross-cultural invariant. This suggests that variations in mean level of these constructs do not have implications on their relationships. Finally, the use of a self-reported PA measure, although a highly validated one such as IPAQ, may provide an overestimate of PA due to recall and social desirability biases (Tucker et al., 2011).

In conclusion, despite these limitations, the present study provides empirical data on the complex mechanisms of weight stigma in the PA domain. It adds to the existing literature in

several ways, by identifying two independent motivational processes of the weight stigma – PA relationship (i.e., motivation to avoid exercise and self-control resources), and by revealing both cultural variance (in the levels of weight stigma) and invariance (in the processes involved) in two countries with different obesity prevalence and income. Future research could extend this work by examining other motivational processes. For example, the role of motivation to *escape* stigma suggested by Hunger et al. (2015) would be worthy of study. According to these authors, in the face of pervasive weight stigma, obese or overweight people sometimes attempt to diet and/or engage in unhealthy behaviors (e.g., skipping meals, taking diet pills) in order to rid themselves of their stigma. In the area of PA, it is possible that the motivation to escape stigma may lead individuals to temporarily engage in inappropriate PA behaviors (e.g., too much PA to the point of severe muscle or joint pain) instead of long-term healthy PA. In the same vein, future studies could examine the mediating role of the *quality* of motivation for PA, as assumed by the theory of self-determination (Ryan & Deci, 2017). According to this theory, the quality of motivation is as important to examine as its quantity in order to predict health behaviors. It is possible that weight stigma, predicts controlled forms of motivation such as external or introjected regulations, which are forms of motivation that are not, or only weakly, related to sustained PA behavior.

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Data availability statement

Data and materials supporting the findings of this study are available from the first author [ARJ], upon reasonable request.

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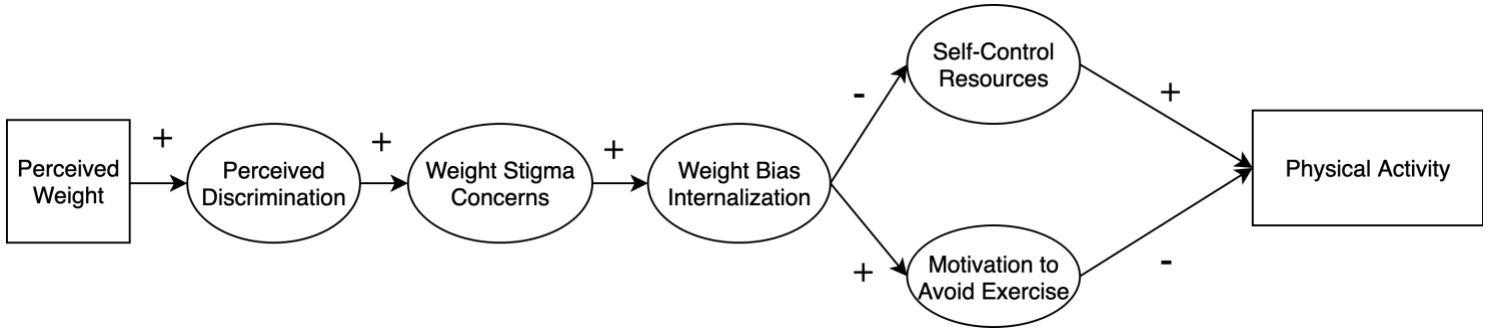
Footnotes

[1]Given that Vartanian and Novak (2011) observed that weight bias internalization moderated the relationship between perceived discrimination and motivation to avoid exercise, preliminary analyses were carried out to check whether weight stigma processes moderated each other. Results revealed no significant interactions (see Table 1 of the online supplemental materials).

Running Title: Weight stigma processes and physical activity.

Figure 1. Hypothetical model of the relationships between weight stigma phenomena, motivational processes, and physical activity.



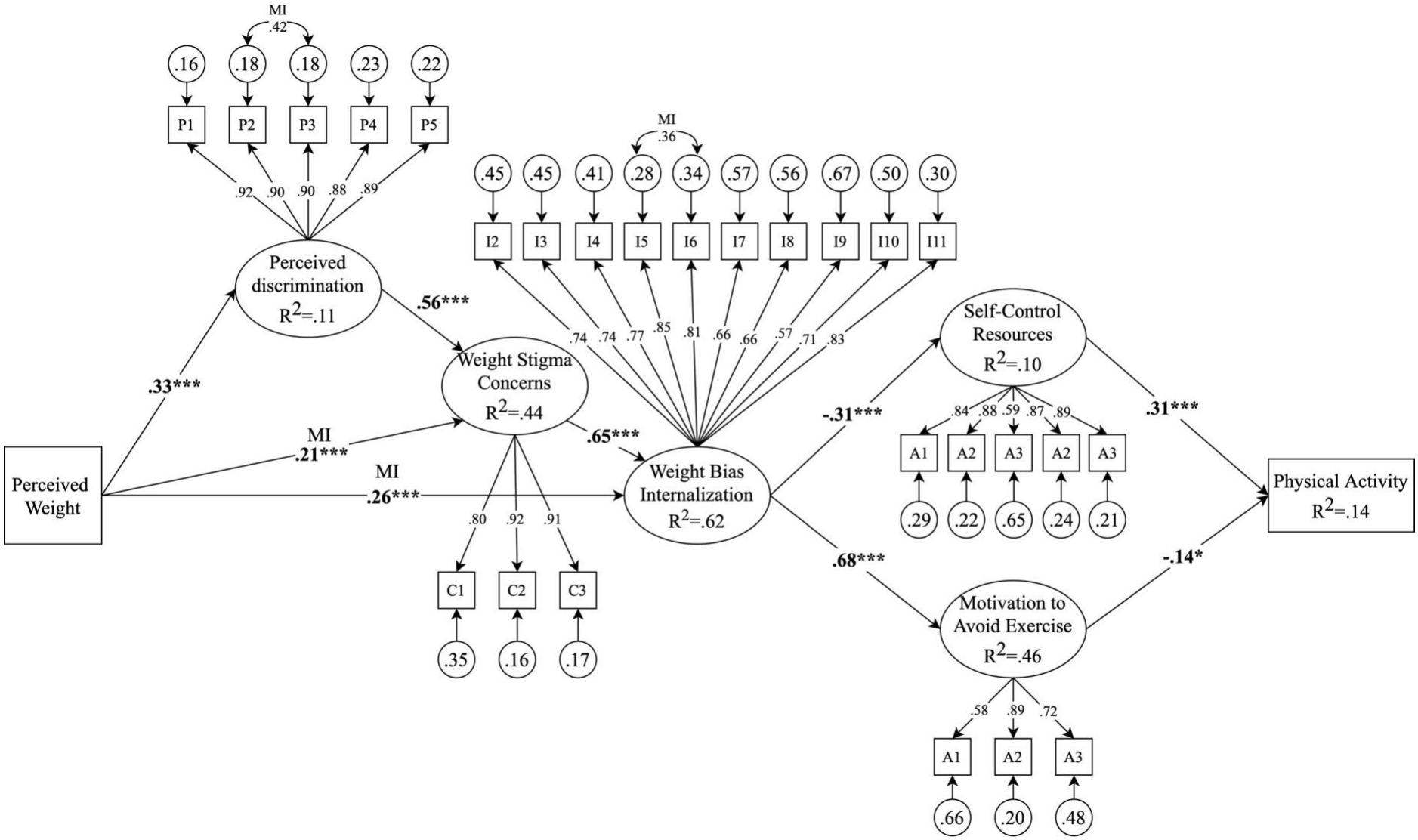


Figure 2. Final model testing the relationships between weight stigma phenomena, motivational processes, and physical activity.

Weight stigma processes and physical activity.

Note: The arrows labeled MI correspond to the additional relationships suggested by modification indices. The path coefficients of the structural model which can be interpreted as standardized beta weights in a regression model are shown next to each arrow. *p<.05, **p<.01, ***p<.001.

Table 1.
Sample characteristics and scores with mean (SD) or % (N) as well as two-tailed t-tests and Chi-squared tests.

	French sample	Mexican sample	t-test/χ^2test
Sex			$\chi^2(1)=0.73$
Male	40% (80)	42.83% (64)	
Female	60% (120)	58.17% (89)	
BMI	23.55 (4.86)	25.34 (4.81)	3.45***
Weight range			$\chi^2(3)=14.37$**
Underweight	6% (12)	1.96% (3)	
Normal weight	67% (134)	53.59% (82)	
Overweight	16.50% (33)	30.72% (47)	
Obese	10.50% (21)	13.72% (21)	
Age	34.71 (16.08)	29.75 (10.80)	3.29*
Physical activity	301.54 (216.49)	286.18 (256.6)	-0.61
Subjective vitality	4.30 (1.18)	4.31 (1.31)	0.08
Motivation to Avoid Exercise	2.59 (1.65)	2.71 (1.44)	0.72
Perceived Weight	3.24 (1.4)	3.56 (1.33)	2.18*
Weight Stigma Concerns	2.00 (1.4)	2.35 (1.64)	2.16*
Perceived discrimination	1.30 (0.56)	2.47 (0.73)	17.04***
Weight Bias Internalization	2.55 (1.29)	2.77 (1.25)	1.60
N	200	153	-

Note: * $p<.05$, ** $p<.01$, *** $p<.001$. Weight range was classified based on the categories determined by the World Health Organization: underweight (BMI < 18.5), normal weight (18.5-24.9), overweight (25-29.9) and obese (> 30).

Table 2.
Means, standard deviations, Cronbach's alpha, and correlation matrix (N = 353).

	Mean	SD	α	1	2	3	4	5	6	7
1. BMI	24.37	4.92	-							
2. Physical Activity	296.39	226.79	-	-.16**						
3. Subjective Vitality	4.30	1.25	0.90	-.14**	.37***					
4. Motivation to Avoid Exercise	2.64	1.55	0.77	.25***	-.28***	-.33***				
5. Perceived Weight	4.42	1.41	-	.72***	-.20***	-.23***	.31***			
6. Weight Stigma Concerns	2.15	1.53	0.91	.33***	-.10	-.21***	.47***	.39***		
7. Perceived Discrimination	1.82	0.88	0.95	.36***	-.07	-.11*	.31***	.32***	.60***	
8. Weight Bias Internalization	2.66	1.29	0.91	.38***	-.13*	-.30***	.54***	.50***	.68***	.48***

Note: * p<.05, ** p <.01, *** p <.001.

Table 3
Factorial invariance tests across countries for the measurement model.

	df	χ^2	CFI	ΔCFI	TLI	RMSEA	CI RMSEA	ΔRMSEA
Configural invariance	574	1129.62	.919	NA	.908	.074	.067-.081	NA
Metric invariance	594	1195.40	.912	.007	.904	.076	.070-.082	.002
Partial metric invariance	615	1258.14	.906	.006	.901	.077	.070-.083	.001
Scalar invariance	638	1351.07	.896	.010	.894	.080	.074-.086	.003
Model invariance								
Free betas	736	1446.12	.904	NA	.893	.074	.068-.080	NA
Constrained betas	764	1516.63	.898	.006	.891	.075	.070-.080	.001

Note: df: degrees of freedom; CFI: Comparative fit index; TLI: Tucker-Lewis Index; RMSEA: Root mean square error; CI: Confidence interval; NA: Not Applicable.

Table 4
Standardized parameter estimates of indirect effects

Parameters	β	95% CI	
		LL	UL
Specific Indirect Effects			
BMI→PW→PD→WSC→WBI→SV→PA	-.01*	-.01	-.004
BMI→PW→PD→WSC→WBI→SV	-.03***	-.04	-.01
BMI→PW→PD→WSC→WBI	.09***	.06	.12
BMI→PW→PD→WSC	.13***	.09	.18
BMI→PW→PD	.24***	.17	.31
BMI→PW→PD→WSC→WBI→MAvE→PA	-.01*	-.02	-.001
BMI→PW→PD→WSC→WBI→MAvE	.06***	.04	.08
BMI→PW→WSC→WBI→SV→PA	-.01**	-.02	-.003
BMI→PW→WSC→WBI→SV	-.03***	-.05	-.01
BMI→PW→WSC→WBI	.10***	.06	.14
BMI→PW→WSC	.15***	.09	.22
BMI→PW→WSC→WBI→MAvE→PA	-.01*	-.02	-.001
BMI→PW→WSC→WBI→MAvE	.07***	.04	.10
BMI→PW→WBI→SV→PA	-.02***	-.03	-.01
BMI→PW→WBI→SV	-.06***	-.08	-.03
BMI→PW→WBI	.19***	.13	.24
BMI→PW→WBI→MAvE→PA	-.02*	-.03	.003
BMI→PW→WBI→MAvE	.13***	.08	.17
PW→PD→WSC→WBI→SV→PA	-.01***	-.02	-.005
PW→PD→WSC→WBI→SV	-.04***	-.06	-.02
PW→PD→WSC→WBI	.12***	.08	.16
PW→PD→WSC	.19***	.13	.25
PW→PD→WSC→WBI→MAvE→PA	-.01*	-.02	-.002
PW→PD→WSC→WBI→MAvE	.08***	.05	.11
PW→WSC→WBI→SV→PA	-.01**	-.02	-.005
PW→WSC→WBI→SV	-.04***	-.07	-.02
PW→WSC→WBI	.14***	.08	.20
PW→WSC→WBI→ MAvE→PA	-.01*	-.03	-.002

PW→WSC→WBI→ MAvE	.09***	.05	.14
PW→WBI→SV→PA	-.03***	-.04	-.01
PW→WBI→SV	-.08***	-.12	-.04
PW→WBI→MAvE→PA	-.03*	-.05	-.005
PW→WBI→MAvE	.17***	.12	.23
PD→WSC→WBI→ SV→PA	-.04***	-.05	-.02
PD→WSC→WBI→ SV	-.11***	-.16	-.07
PD→WSC→WBI	.36***	.30	.43
PD→WSC→WBI→MAvE→PA	-.04*	-.06	-.01
PD→WSC→WBI→MAvE	.25***	.19	.30
WSC→WBI→SV→PA	-.06***	-.09	-.03
WSC→WBI→SV	-.20***	-.27	-.13
WSC→WBI→ MAvE→PA	-.06*	-.11	-.01
WSC→WBI→ MAvE	.44***	.37	.51
WBI→SV→PA	-.10***	-.14	-.05
WBI→ MAvE→PA	-.10**	-.17	-.02
Total Indirect effects			
BMI→ PA	-.07***	-.10	-.04
PW→ PA	-.10***	-.15	-.06
PD→ PA	-.07***	-.10	-.04
WSC→ PA	-.13***	-.18	-.07
WBI→ PA	-.20***	-.27	-.12

Notes: BMI=Body Mass Index, PW= Perceived Weight, PD= Perceived Discrimination, WSC= Weight Stigma Concerns, WBI= Weight Bias Internalization, SV= Subjective Vitality, MAvE=Motivation to Avoid Exercise, PA= Physical Activity, β = standardized parameter estimate; 95% CI = 95% confidence intervals; LL = Lower limit of 95% CI; UL = Upper limit of 95% CI; BMI = Body Mass Index. *p<.05, **p<.01, ***p<.001.

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