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Anti-fat bias in secondary school teachers: Are physical education teachers more biased than mathematics teachers?

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Abstract

It has been suggested that physical education (PE) teachers hold strong anti-fat attitudes and that these can have an impact on the health of their students. In this study, we compare the attitudes and stereotypes towards obesity of PE teachers with those of their colleagues who teach mathematics. In addition, we evaluated the association between the teachers' anti-fat biases and the level of physical activity (PA) of their students. The sample consisted of 81 PE teachers and 75 mathematics teachers. The adolescent sample consisted of 1792 secondary school students. The assessment of attitudes and stereotypes was conducted with the Implicit Association Test and the Anti-Fat Attitudes questionnaire. The PA level of the adolescents was determined by a self-administered instrument. PE and mathematics teachers showed similar biases, except for the automatic obesity–laziness association, which was stronger for PE teachers than for mathematics teachers. These distinctive implicit stereotypes of PE teachers were also significant predictors of the lack of PA in adolescents. We recommend the use of interventions aimed at reducing non-traditional forms of prejudice in teachers.

Keywords

Anti-fat bias, secondary school teachers, physical education, physical activity, multilevel regression

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Introduction

In spite of the increasing incidence of obesity in childhood and adolescence, there does not appear to be an increase in social acceptance of young people who are overweight or obese. On the contrary, these young people are frequently subjected to situations of discrimination due to their appearance (Latner and Stunkard, 2003; Puhl et al., 2016). While the stigmatization of young people who are overweight/obese is common in many environments, it is particularly prevalent in schools (Puhl et al., 2011). In fact, both students and teachers believe that bullying for weight reasons is the most common form of bullying experienced by young people in schools (Bradshaw et al., 2013; Bucchianeri et al., 2013; Puhl et al., 2015).

Students' peers are the most frequent perpetrators of weight-based teasing and bullying at school (Puhl et al., 2011). However, teachers are not exempt from involvement in these processes of victimization (Glock et al., 2016; Neumark-Sztainer et al., 1999). Neumark-Sztainer et al. (1999), for example, found that approximately a quarter of high school teachers surveyed held the belief that obese people were more impulsive, less organized, and had more family problems than non-obese people. In the same study, 28% of teachers felt that becoming obese is the worst thing that could happen to a person. When the perspective of the potential victims of these discriminatory acts was investigated, it was found that 27% of a sample of adolescents undergoing treatment to lose weight claimed to have been victimized by their own teachers (Puhl et al., 2013).

Do physical education (PE) teachers have an anti-fat bias?

Most research on teacher biases towards overweight/obese individuals has been carried out with PE teachers, usually trainees (Alameda and Whitehead, 2015; Fontana et al., 2013; Gago et al., 2012; Lynagh et al., 2015; O'Brien et al., 2007), and to a lesser extent with practicing teachers (Fontana et al., 2013; Greenleaf and Weiller, 2005; Peterson et al., 2012).

In general, the results of these studies show that most PE teachers maintain implicit obesity biases (Alameda and Whitehead, 2015; Gago et al., 2012; Gobbi et al., 2017; Fontana et al., 2013; Lynagh et al., 2015; O'Brien et al., 2007). For example, Fontana et al. (2013), using a pencil and paper version of the Implicit Association Test (IAT) to measure the automatic associations between the concepts thin/fat with the attributes good/bad and lazy/active, found, both in teachers and trainee teachers, that the fat–bad and fat–lazy associations were much stronger than the fat–good and fat–active associations. However, studies that have investigated the explicit obesity bias of PE teachers have yielded mixed results, depending on which component of bias (affective, cognitive, or behavioral) was evaluated.

The Dislike subscale of the Anti-Fat Attitudes (AFA; Crandall, 1994) questionnaire and the Disparagement subscale of the Anti-Fat Attitudes Test (AFAT; Lewis et al., 1997) have been used to measure the affective component of PE teachers' explicit anti-fat bias. Research using these measures has shown that PE teachers have a sympathetic attitude toward overweight/obese individuals (Alameda and Whitehead, 2015; Gago et al., 2012; Gobbi et al., 2017; O'Brien et al., 2007; Rukavina et al., 2019). For instance, O'Brien et al. (2007) administered the AFA to a sample of trainee PE teachers and found that the mean (M) score obtained on the Dislike subscale was 1.5 standard deviation (SD) below the midpoint of the scale, indicating a pro-fat attitude of the trainees in the sample. Similar results have been found by Gago et al. (2012) and Gobbi et al. (2017) using the same measure (1.3 and 1.2 SD below the midpoint, respectively) and by Alameda and

Whitehead (2015) and Rukavina et al. (2019) using the Disparagement subscale of the AFAT (2.0 and 1.8 *SD* below the midpoint, respectively).

The cognitive component of explicit anti-fat bias has been assessed through the measurement of PE teachers' stereotypical beliefs. Most of these studies have shown that PE teachers endorsed stereotypes that represent overweight/obese individuals as lazy, incompetent, and weak-willed (Gago et al., 2012; Gobbi et al., 2017; Greenleaf and Weiller, 2005; Greenleaf et al., 2008; O'Brien et al., 2007; Peterson et al., 2012; Tingstrom and Nagel, 2017). For example, Greenleaf and Weiller (2005) surveyed 105 PE teachers and found that they had lower expectations of overweight students than healthy-weight students, both in terms of their physical abilities and their reasoning, cooperative, and social interaction skills. Similar findings have been reported by Peterson et al. (2012) using an experimental task in which PE teachers had to rate the expected abilities and performance of overweight and non-overweight students depicted in photographs. Greenleaf et al. (2008), applying a modified version of the Fat Stereotypes Questionnaire (Davison and Birch, 2004) to a sample of trainee PE teachers, discovered that overweight children, in comparison with non-overweight children, were thought to be lazier and less socially adept, among other common stereotypes. Research using the Willpower subscale of the AFA questionnaire has also found that trainee PE teachers considered that overweight/obese children lack the willpower required to control their weight (Gago et al., 2012; Gobbi et al., 2017; O'Brien et al., 2007).

Some evidence in the literature suggests that overweight/obese students are often discriminated against by PE teachers. This evidence has been obtained indirectly through retrospective reports by overweight/obese individuals of their experiences in PE classes. Puhl et al. (2013), for example, found that 42% of a sample of 361 adolescents enrolled in a weight loss camp reported that they had been bullied or teased about their weight by PE teachers or sports coaches. Trout and Graber (2009) interviewed 12 overweight high school students about their experiences in PE, including questions about how they were treated by PE teachers. Most of them described inappropriate teaching practices, such as encouraging overweight students to sit out certain activities or punishing the whole class when overweight students failed. Bauer et al. (2004) ran several focus groups with high school students, in which they discussed how PE teachers sometimes made negative comments about the athletic abilities of some students, and how these comments could affect participation of those students in PE classes.

Stigmatization due to weight and physical activity (PA)

As suggested by the work of Bauer et al. (2004), some studies have found evidence for a relationship between the stigmatization of overweight/obese students and engagement in PA. For example, DeSmet et al. (2014) found that, in a sample of obese adolescents, experiences of bullying were associated with greater avoidance and less enjoyment of PA along with lower motivation to engage in such activities. Similarly, Hayden-Wade et al. (2005) found that the frequency of weight-related teasing was linked to a higher preference for sedentary/solitary activities and a lower preference for physical/social activities. An inverse relationship has also been found between the level of PA and the frequency with which overweight youths are victimized by their peers (Storch et al., 2007). The results reported by Losekam et al. (2010), in a sample of overweight and non-overweight youngsters, were however, somewhat less clear, since they found that an inverse relationship between PA levels and frequency of weight-related teasing was only evident for the males in the sample.

According to Faith et al. (2002), the effects of the criticism or ridicule aimed at overweight adolescents depends on the context in which such acts occur. When the adolescents were criticized while engaging in PA, this criticism was associated with less PA and less enjoyment of sports activities. When they were criticized in other contexts, however, this was associated with an increase in PA and greater enjoyment of sports. Considering the fact that weight-based stigmatization is very frequent in the educational context, particularly in PE classes (Puhl et al., 2011, 2013), it is unsurprising that some studies have found an association between the use of avoidance of PA as a coping strategy and the frequency of incidents of victimization in the gymnasium of the educational center (Puhl and Luedicke, 2012).

The current study

In summary, with the exception of research carried out with explicit measures of attitudes, previous research has consistently shown that anti-fat biases are prevalent among PE teachers. However, given the pervasive nature of anti-fat bias in the teaching profession (Nutter et al., 2019), it is worth exploring whether anti-fat biases are particularly high in PE teachers when compared with teachers of other subjects. Some studies provide evidence supporting this hypothesis in the case of trainee teachers (Gago et al., 2012; Lynagh et al., 2015). Furthermore, it has been found that trainee PE teachers near completion of their training showed a stronger anti-fat bias than first-year trainees (Gago et al., 2012; O'Brien et al., 2007), giving support to the idea that trainee PE teachers could be socialized into having anti-fat biases (O'Brien et al., 2007). However, no previous study has investigated if this difference in bias between PE teachers and other teachers also exists in the case of practicing teachers.

We chose practicing mathematics teachers as a contrast group for two reasons. First, the training received by mathematics teachers is clearly distinct from the body-centered training received by PE teachers. If, as has been suggested (O'Brien et al., 2007), overinvestment in physical attributes is associated with anti-fat biases, we might expect to find that practicing mathematics teachers show less anti-fat bias than their PE colleagues. Second, since Spanish PE teachers are, together with their biology colleagues, the main role models responsible for health education in schools, their obesity bias could potentially have a notable impact on students' health. Mathematics teachers, in contrast, are not usually responsible for delivering health education. If the elevated level of obesity bias observed in trainee PE teachers is confirmed in practicing PE teachers, this could have potentially harmful consequences for the health of students, particularly in the area of PA. Hence, the primary objective of this work was to compare the anti-fat attitudes and stereotypes of practicing PE teachers with those of their colleagues who teach mathematics.

Further, since many of the instances of victimization suffered by overweight youngsters occur in the context of PE classes, it is likely that those who experience these episodes of discrimination may acquire an aversion to PA, which may subsequently decrease their enjoyment of and motivation to take physical exercise. If the attitudes toward obesity held by PE teachers are particularly negative, it would be unsurprising if these had some influence on the extent to which their students engage in PA, as the comments of some adolescents suggest (Bauer et al., 2004). Since no previous research has directly analyzed this relationship, our second objective was to assess whether the anti-fat attitudes and stereotypes of PE teachers are associated with the level of PA of their students.

Finally, since PE teachers can play an important role in modeling protective health behaviors (Cardinal, 2001), it is possible, as Yager and O'Dea (2010) suggest, that they may also be transferring to their students, even inadvertently, biased views and negative attitudes towards

obesity. Therefore, our third objective was to assess whether the anti-fat attitudes and stereotypes of PE teachers are associated with the attitudes and stereotypes of their students.

Method

Participants

A total of 156 Compulsory Secondary Education (ESO in its Spanish acronym) teachers participated in this study, of which 81 were PE teachers and 75 mathematics teachers. First, all PE teachers from the public centers of the province of Huelva, Spain, who taught ESO were asked to take part in the study. The participation rate was 83%. Subsequently, mathematics teachers who taught the same class groups as the PE teachers were then contacted. Information on 1792 of their students was also collected. To recruit the sample of students, a class group was randomly selected from among those taught by each of the PE teachers.

The average age of the teaching staff was 38.27 years ($SD = 8.43$), with an average length of teaching experience of 11.87 years ($SD = 8.80$). While most of the PE teachers were male (82.7%), in the mathematics group there was a slight majority of female teachers (54.7%). In addition, it was found that the average body mass index (BMI) of the PE teachers ($M = 24.40$, $SD = 3.26$) was lower than the average BMI of the mathematics teachers ($M = 25.76$, $SD = 4.09$), this difference being statistically significant ($t = 2.30$, $df = 154$, $p = 0.02$, $d = 0.37$). Using the World Health Organization classification criteria (World Health Organization, 1995), the percentage of teachers who were classified as overweight or obese was 37.0% in the case of PE teachers and 56.1% in the case of mathematics teachers.

The adolescents that took part in this study were aged between 12 and 16 years ($M = 14.00$, $SD = 1.41$) and were distributed homogeneously throughout the four years of ESO. Just over half of the students were male (51.1%). The mean BMI was 21.64 ($SD = 3.83$) for males and 21.22 ($SD = 3.48$) for female students. Using the cut-off points established by Cole et al. (2000, 2007), the percentages of adolescents classified as underweight and obese were 4.2% and 3.2%, respectively. Most of the adolescents were classified as being within the healthy weight range (81.1%).

Instruments

Measures for teachers and students

BMI. Students and teachers were asked to verbally report their weight and height, but only if they could provide this information with certainty. Otherwise, a member of the research team offered to measure the weight and height with a balanced scale and a standardized stadiometer. BMI was calculated as the weight in kilograms divided by the height in meters squared.

AFA (Crandall, 1994). Two subscales of the AFA were administered, one as an explicit measure of attitudes (AFA-D: Dislike or antipathy towards fat people) and another as an explicit measure of stereotypes (AFA-W: Willpower or individuals' beliefs in the controllability of weight/fat). The AFA-D subscale is composed of seven items (e.g. "Fat people make me somewhat uncomfortable"). The AFA-W subscale is composed of three items (e.g. "It is people's own fault if they are overweight"). The response format of the items is a Likert-type scale with nine options, ranging from 1 "Totally disagree" to 9 "Totally agree". High scores on the AFA-D and AFA-W subscales are taken to indicate negative attitudes or stereotypes towards obese people, respectively. Cronbach's alpha values indicate moderate levels of internal consistency in the student sample

($\alpha = 0.73$ and $\alpha = 0.80$, for AFA-D and AFA-W, respectively) with these values being somewhat lower in the sample of teachers ($\alpha = 0.60$ for AFA-D and $\alpha = 0.71$ for AFA-W). Evidence of construct validity of the Spanish version of the AFA has been reported elsewhere (Carmona et al., 2015; Magallares and Morales, 2014).

Measures for teachers only

IAT. The IAT is a widely-used measure of implicit attitudes and stereotypes in weight bias research. Although there is an ongoing debate with regard to the meaning and use of IAT scores, the most recent and extensive meta-analysis of IAT data provides strong support for the predictive and incremental validity of the IAT (Kurdi et al., 2019). More specifically, evidence of the predictive validity of the weight IAT has also been provided by Agerström and Rooth (2011). The IAT is a procedure that measures the speed with which a series of stimuli (in our case, words) are sorted into categories. There are four stimulus categories: two target concepts (obesity versus thinness) and two attributes (positive versus negative). The names of a target concept and an attribute are presented on each side of a computer screen. The task of the participants is to classify stimuli by quickly pressing a key on either the left or the right side of the keyboard. The words for each category and attribute were selected according to the proposal of Teachman and Brownell (2001), ensuring that the length of the words was counterbalanced between categories and attributes. Two versions of the IAT were administered.

IAT Attitudes. To evaluate the implicit attitudes toward obese people, we tested the associations of “fat people” and “thin people” with “good” and “bad”. The IAT for measuring attitudes consists of a number of trials on which “fat people” are paired with “bad” and “thin people” with “good” (anti-fat congruent trials), and others on which “fat people” are paired with “good” and “thin people” with “bad” (anti-fat incongruent trials). The difference in reaction times between the two types of trials is taken as an indicator of implicit attitude.

IAT Stereotypes. The associations of “fat people” and “thin people” with “lazy” and “motivated” were evaluated in the version of the IAT designed to assess implicit obesity stereotypes. The pairings of targets and attributes in the IAT stereotypes were as follows: “fat people” with “lazy” and “thin people” with “motivated” on the anti-fat congruent trials, and “fat people” with “motivated” and “thin people” with “lazy” on the anti-fat incongruent trials. As in the case of implicit attitudes, implicit stereotypes were inferred from the difference in reaction times between congruent and incongruent trials.

The two versions of the IAT were programmed in INQUISIT 3.0 following the standard procedure described in Nosek et al. (2005). D scores (Greenwald et al., 2003), a standardized measure of the difference in reaction times between congruent and incongruent trials, were used as a measure of implicit attitudes and stereotypes. The higher the absolute value of the D score, the greater the bias. Values higher than 0.15 are taken as indicators of negative attitudes or stereotypes; values below -0.15 are taken to indicate positive attitudes or stereotypes, and values between -0.15 and 0.15 are indicators of neutral attitudes or stereotypes (Nosek et al., 2007). The cut-off points |0.15|, |0.35|, and |0.65| were used to classify the D scores as indicators of a weak, moderate, and strong bias.

The reliability of the implicit measures was estimated by correlating the D score obtained on the practice tests with that obtained on the test trials (Nosek et al., 2005). Spearman–Brown adjusted correlation coefficients were used to evaluate the internal consistency of these measures. The

results obtained revealed acceptable internal consistency estimates, both in the implicit measure of attitudes (0.79), and in the implicit measure of stereotypes (0.83)

Measures for students only

Measurements of Physical Activity. To assess the PA of the students, a previously validated checklist of children's PA was administered (Tercedor et al., 2007). The students had to indicate the PA carried out in four time periods: Yesterday; Saturday; Sunday; and summer. This questionnaire is an adaptation of the self-administered PA checklist (Sallis et al., 1996) and was validated for the Spanish population by Tercedor and López (1999). Based on the activities carried out, the energy expenditure in metabolic equivalents (METs) for each of these time periods was calculated, using the tables provided by Ainsworth et al. (2000). A physical activity index (PAI) was calculated from the sum of MET scores obtained for the four activity periods.

Procedure

During the planning phase of data collection, we contacted the ESO centers of the province of Huelva and their PE teachers. They were informed in detail about the objectives of the investigation and asked if they wished to collaborate. Once the PE teachers agreed to participate, and a group of students was selected for each of them, we then contacted the mathematics teachers who taught these groups, to request their collaboration. Written informed consent was obtained from all the participants in the study and from the adolescents' parents/guardians.

We administered a questionnaire to the students that contained, among other instruments, the AFA and the checklist of PA. The administration of the questionnaire took place in the classrooms, with a member of the research team in charge of briefly explaining the objectives of the study, informing them how to complete the instrument, and answering any questions that may have arisen during the process. This member of the research team ensured the anonymity of the answers and the collective treatment of the information.

The teachers received a questionnaire that included, among other instruments, Crandall's AFA. In addition, they completed the two versions of the IAT on a laptop computer. The instruments were administered in one of the school offices. A researcher was always present in the room to provide clarification and to answer questions if needed.

Data analysis

To determine if the teachers had negative attitudes or biased stereotypes, Student's *t*-tests were used, comparing the average scores observed on the explicit and implicit measures with the points that theoretically indicated a neutral attitude or an unbiased stereotype: 0 on the D scores for the implicit measures, and the midpoints of the AFA scales for the explicit measures. To establish the differences between PE teachers and mathematics teachers, Student's *t*-tests were also used. The effect sizes were evaluated using Cohen's *d*.

Regression techniques were employed to evaluate the effects of PE teachers' attitudes and stereotypes. Given that the participants were selected by cluster sampling, the data obtained have a hierarchical structure—that is, students grouped into classes—which violates the assumption of independence of the observations. In these circumstances, the usual minimum-quadratic regression techniques may not be adequate, and multilevel regression techniques need to be considered. To assess the suitability of multilevel modeling, we computed the intraclass correlation coefficients

(ICC) and the corresponding design effects (DE) in null models. The ICC represents the proportion of variance that could potentially be explained by group factors (e.g. teacher attitudes and stereotypes). As a general rule, DE values greater than 2 are taken to indicate that clustering should not be overlooked, and multilevel modeling should be used (Muthén and Satorra, 1995).

The PE teachers' scores on the AFA and the IAT were included as the predictor variables in all the models. The indicators of the students' attitudes (AFA-D), stereotypes (AFA-W) and PA (PAI) were the criterion variables to be predicted. Given the higher levels of PA usually reported by adolescent boys compared with girls, and the well-known decline in PA throughout adolescence (Dumith et al., 2011), gender and grade level were included as control variables when PA was the criterion variable. BMI was also used as a control variable, since most studies have found a negative association between PA and BMI in children and adolescents (Jiménez-Pavón et al., 2010). BMI, gender, and grade level were also considered as control variables in the prediction of anti-fat attitudes, since previous research has found associations between these variables in adolescent samples (Klaczynski and Felmban, 2019; Puhl et al., 2011).

We used multilevel linear regression as our modeling approach. When modeling PA, however, the inspection of the residuals of the linear model revealed a markedly skewed distribution and, therefore, violation of the assumption of normality. This led to the exploration of the applicability of some generalized linear multilevel models. Given the characteristics of the data (positive skewness and the presence of a relatively high number of 0 scores—physically inactive students), a multilevel model was applied consisting of two parts: logistic regression to model the presence/absence of activity; and Gamma regression to model the amount of activity (Baldwin et al., 2016).

All the multilevel analyses were conducted in STATA 14, specifying a maximum likelihood estimation method without restrictions. For the statistical comparison between nested models, the difference between the deviation indices of the models was used. For the comparison of non-nested models, the Akaike information criterion was used.

Results

Implicit attitudes and stereotypes

The teachers' average score on the IAT Attitudes was 0.52 ($SD = 0.51$). Taking the value 0 as an indicator of the absence of bias, the results reveal that, on average, the teachers showed significant implicit anti-fat attitudes ($t = 12.57$, $df = 155$, $p < 0.01$). No statistically significant differences were found in the implicit attitudes between PE teachers and mathematics teachers. Almost 80% of the teachers showed implicit negative attitudes, with 42% displaying strong implicit anti-fat attitudes. Only 10.7% of the teachers showed implicit positive attitudes, which were strong for only 3.3% of teachers.

The PE teachers obtained an average score on the IAT Stereotypes ($M = 0.32$, $SD = 0.58$) that was significantly greater than 0 ($t = 4.89$, $df = 80$, $p < 0.01$). Of the PE teachers, 67.1% automatically associated obesity with laziness, this anti-fat bias being strong in 27 of these teachers (34.2%), while 19% automatically associated obesity with diligence, this association being strong in five cases (6.3%). The implicit stereotypes of the mathematics teachers, however, were not biased ($t = 1.57$, $df = 74$, $p = 0.12$, $d = 0.42$). The differences between mathematics teachers and PE teachers were statistically significant (Table 1). These differences remained statistically significant when controlling for the effect of BMI ($F(1,153) = 5.09$, $p = 0.03$) and marginally significant when the effect of gender was controlled ($F(1,152) = 3.87$, $p = 0.05$).

Table 1. Teachers' implicit and explicit attitudes and stereotypes.

	Teachers		t	df	p	d
	Physical education	Mathematics				
	M (SD)	M (SD)				
IAT Implicit Attitudes	0.57 (0.54)	0.46 (0.49)	1.33	154	0.18	0.21
IAT Implicit Stereotypes	0.32 (0.58)	0.09 (0.51)	2.57	154	0.01	0.42
AFA-D Explicit Attitudes	1.80 (0.90)	1.58 (0.79)	1.68	154	0.09	0.26
AFA-W Explicit Stereotypes	6.09 (1.77)	5.96 (1.84)	0.47	154	0.64	0.07

Notes: IAT, Implicit Association Test; AFA-D, Dislike subscale of the Anti-Fat Attitudes questionnaire; AFA-W, Willpower subscale of the Anti-Fat Attitudes questionnaire; M, mean; SD, standard deviation; t, Student's t-test; df, degrees of freedom; p, p-value; and d, Cohen's d.

Explicit attitudes and stereotypes

Taking the midpoint of the scale as a neutral attitude indicator, the teachers' mean score on the AFA-D ($M = 1.69$, $SD = 0.85$) was significantly lower than this midpoint ($t = -48.37$, $df = 155$, $p < 0.01$, $d = -3.87$), indicating explicit positive attitudes toward overweight/obese people. The attitudes of the mathematics and PE teachers did not differ significantly (Table 1).

Further, both mathematics and PE teachers explicitly showed the stereotyped belief that overweight/obese people have little willpower. Their mean AFA-W score ($M = 6.03$, $SD = 1.80$) was significantly and moderately higher than the midpoint of the scale ($t = 7.16$, $df = 155$, $p < 0.01$, $d = 0.57$). No statistically significant differences were found between the mathematics and PE teachers in terms of the AFA-W scores.

Effects of PE teachers' attitudes and stereotypes

Suitability of multilevel modeling. Low ICCs were found for AFA-D ($ICC = 0.04$) and AFA-W ($ICC = 0.03$). Moreover, given that the corresponding DEs were below 2, it was considered that the models that included group factors were not adequate to explain the variability observed in these characteristics. When attempting to predict the PAI, however, the percentage of variability potentially explained by the group factors ($ICC = 0.06$) and the DE (2.35) were large enough to analyze whether the characteristics of the PE teachers could explain part of that variability.

Multilevel modeling of PA. A two-part multilevel regression model was used to test the effects of PE teachers' obesity bias on students' PA, while controlling for the effects of the students' gender, BMI, and school year.

The model presented a significantly better fit than the null model ($\chi^2 = 438.81$, $df = 18$, $p < 0.001$). The estimates of the parameters of the model are presented in Table 2. Gender and school year are significant predictors of both the presence/absence of activity and activity level. Specifically, it was found that the odds of being physically inactive were much higher in the case of female adolescents (odds ratio (OR) = 11.50, 95% confidence interval (CI): 8.14–16.24) and that their level of activity, when they were active, was 40% lower than that of active male adolescents. In addition, the odds of being physically inactive were higher in the ninth grade (OR = 2.68, 95% CI: 1.26–5.71) and in the tenth grade (OR = 2.30, 95% CI: 1.08–4.90) in comparison with the

Table 2. Two-part multilevel model estimates.

	Logistic regression (active/not active) odds ratios	Gamma regression (amount of physical activity) incidence-rate ratios
Fixed effects		
Intercept	0.05** (0.04)	44.96** (7.00)
Gender		
Female	11.50** (2.03)	0.60** (0.02)
Body mass index	1.00 (0.02)	1.00 (0.01)
Secondary education		
Year 9	1.05 (0.39)	0.90 (0.06)
Year 10	2.68* (1.03)	0.76** (0.05)
Year 11	2.30* (0.89)	0.81** (0.06)
IAT Attitudes	0.65 (0.21)	1.00 (0.06)
IAT Stereotypes	1.90* (0.60)	1.03 (0.06)
AFA Dislike	0.96 (0.16)	1.00 (0.03)
AFA Willpower	0.92 (0.07)	1.00 (0.01)
Random effects variance components		
Logistic regression intercept	0.93** (0.26)	
Gamma regression intercept		0.02* (0.01)
Covariance between intercepts		−0.06* (0.03)

Notes: * $p < 0.05$, ** $p < 0.01$, standard error is shown in parentheses below each effect estimate; IAT, Implicit Association Test; and AFA, Anti-Fat Attitudes Test.

eighth grade. Likewise, the amount of PA of the active ninth and tenth graders was, respectively, 24% and 19% lower than that of the active students of the eighth grades.

With regard to the effects of teacher attitudes and stereotypes on the amount of PA of active students, none of the corresponding regression coefficients were statistically significant. Instead, it was found that each additional point that PE teachers scored on the implicit stereotype scale implied a 90% increase in the odds of the students being inactive (OR = 1.90, 95% CI: 1.02–3.52).

Discussion

The aims of this study were to examine whether practicing PE teachers had stronger anti-fat biases than their mathematics colleagues, and whether those biases had an impact on the obesity-related attitudes and behaviors of their students. Our results provide partial support for this proposal.

When PE teachers were explicitly evaluated on their opinions on obesity, our findings were seemingly contradictory. While they showed an explicit sympathetic attitude towards overweight/obese people, their beliefs about the unwillingness of those same people reflected moderately negative explicit stereotypes about obesity. When we evaluated their implicit anti-fat biases, it was found that the obesity–bad association was rather strong and the obesity–laziness association was of medium intensity. With the exception of the findings obtained with the explicit measure of attitudes, our results appear to confirm the existence of an anti-fat bias in practicing PE teachers. This is consistent with the results of previous research (e.g. O’Brien et al., 2007) that has revealed a

number of manifestations of anti-fat bias in trainee PE teachers, but no explicit anti-fat attitude. One possible explanation for the discrepancy between explicit and implicit measures of anti-fat bias could be that the responses to the explicit measures were affected by the participants' tendencies to respond in a socially desirable manner. However, the coexistence of openly expressed pro-fat attitudes and anti-fat stereotypes does not fit well with an interpretation of these findings based solely on social desirability. An alternative explanation, derived from the integrative prejudice framework (Brochu et al., 2011), is that the observed biases were due to a type of prejudice known as aversive. Unlike what occurs in traditional forms of prejudice, in aversive prejudice overt negative evaluations of the overweight/obese people only emerge when they can be justified on non-prejudicial grounds. According to this view, our PE teachers genuinely believe that they have no prejudice against fat people. They think that they like overweight/obese individuals (explicit measure of attitudes), but, at the same time, they believe that overweight/obese people are not strong enough to change their eating and PA habits (explicit measure of stereotypes). Although aversive-prejudiced people may be convinced that these controllability beliefs are not biased, they are, in fact, an important component of a culture that blames overweight/obese individuals for their condition (Crandall, 1994) and that advocates the ideology of healthism (Alfrey et al., 2019).

To determine if the anti-fat biases of PE teachers were particularly strong, these biases were compared with those of their mathematics colleagues. Unlike what was found when trainee PE teachers were compared with students of other degree subjects (Gago et al., 2012; Lynagh et al., 2015; O'Brien et al., 2007), differences between PE teachers and their non-PE colleagues were generally small. PE teachers only showed a significantly greater bias than mathematics teachers in their implicit stereotypes, with the automatic association between obesity and laziness being of moderate size in the case of PE teachers and absent in the case of mathematics teachers.

Taken together, the results obtained seem to indicate that, in terms of anti-fat prejudices, PE teachers and their mathematics colleagues are more similar than different. If trainee PE teachers are socialized in anti-fat prejudice, as suggested by O'Brien et al. (2007), it is possible that the effect of this socialization becomes weaker with increased practical experience of teaching. This explanation is compatible with the results of previous investigations with a range of health professionals showing that the greater the professional experience and contact with overweight/obese people, the weaker the anti-fat biases (Bagley et al., 1989; Puhl et al., 2014; Schwartz et al., 2003). Similarly, within the field of PE, Fontana et al. (2013) found that practicing PE teachers had explicit pro-fat biases that were not present in trainee teachers.

Contrary to our expectations, we found no evidence of the effect of class characteristics on students' anti-fat biases, which indicates that the explicit attitudes and stereotypes of the students were determined by individual factors or by other contextual factors (e.g. factors related to family or their circle of friends). Thus, it does not appear to be the case that teachers are directly transferring their anti-fat biases to students. It should be noted, however, that we did not measure students' implicit biases, and that it is possible that the PE teachers' implicit biases could have a more direct impact on students' implicit anti-fat biases than their explicit anti-fat biases. In fact, previous research has shown that intergenerational transmission of biases operates through the implicit-implicit channel in other domains, from teachers to students in the case of racial prejudice (Vezzali et al., 2012), and from parents to children in reference to attitudes toward smoking (Sherman et al., 2009) or in the case of ethnic prejudice (Pirchio et al., 2018).

The most relevant finding of this work is the association between the implicit anti-fat stereotypes of the PE teachers and the PA of their students. The results of the multilevel analysis revealed an association between PE teachers' stereotypes and whether or not the students engaged in PA,

but not with the amount of exercise taken by the active students. Specifically, the probability of students being inactive was found to be higher when PE teachers had strong implicit anti-fat stereotypes. This is consistent with previous qualitative research that supports the important role of PE teachers in fostering or hindering physically active lifestyles in students during their school years (Martins et al., 2015), and even later during adulthood (Thompson et al., 2003). Quantitative studies on this issue, however, have yielded mixed results. Although some studies seem to indicate the importance of PE teachers (McDavid et al., 2012), others have found that the impact of PE teachers on the sport and PA habits of students is somewhat limited (Seabra et al., 2011). A possible explanation for these contradictory findings is that in the majority of these studies, the impact of PE teachers on students' PA was not assessed directly, but was evaluated by asking students how they perceive the influence of their teachers. The ability of students to objectively evaluate the effects of PE teachers is debatable, but, in any case, it would be difficult for them to discern which specific characteristics of their teachers have affected them. In this regard, the strength of our study is that both teacher characteristics and student outcomes were independently measured. This has allowed us to examine the role of those characteristics of PE teachers that students are unable to discern, such as implicit bias.

To the best of our knowledge, this is the first study to provide quantitative evidence of an association between the weight bias of PE teachers and the physical inactivity of their students, adding support to the notion that PE teachers may in some cases act as a barrier to the promotion of physically active lifestyles in children and adolescents (Li and Rukavina, 2012). If our findings are confirmed in further studies, the mechanisms underlying the association between PE teachers' bias and students' physical inactivity should be investigated. We believe that the Youth Physical Activity Promotion (YPAP) model (Welk, 1999) might be well suited to this purpose. According to the YPAP model, PA can be considered a consequence of the combined influences of predisposing factors (e.g. outcome and efficacy expectations), enabling factors (e.g. availability of resources or physical skills), and reinforcing factors (e.g. social influences of parents, peers, and teachers). While the reinforcing factors can have a direct impact on PA in young people, these can also operate through their effects on certain predisposing factors (Hilland et al., 2018; Zhang et al., 2015). Chen et al. (2017), for example, have shown that the relationship between peer support and PA in adolescents is mediated by two common predisposing factors, namely self-efficacy and enjoyment of PA. In the same vein, it would be unsurprising if the obesity bias held by PE teachers had a negative impact on certain predisposing factors (e.g. reducing enjoyment and self-efficacy), which in turn resulted in the students showing reduced levels of PA. Further research is clearly needed to explore these potential mediating mechanisms.

The association between the implicit stereotypes of PE teachers and the physical inactivity shown by their students is particularly relevant if we consider the role of PE teachers in health promotion. Therefore, it would be advisable to design intervention programs that make PE teachers aware of the existence of implicit biases that could shape—even if inadvertently through their non-verbal language (Perugini et al., 2010)—their behavior towards overweight students. Some promising intervention programs aimed at changing PE teachers' anti-fat biases have been proposed in the literature (for a review, see Nutter et al., 2019). Tingstrom and Nagel (2017), for instance, found that a short awareness intervention program based on emphasizing noncontrollable causes of obesity and positive teaching strategies ameliorated anti-fat biases among trainee PE teachers. Furthermore, since anti-fat biases generally appear to be shared by other colleagues, interventions could be aimed at modifying those biases in the faculty as a whole, not only by reducing

stereotypes but also by addressing some well-intentioned, but potentially damaging, views of obese students (Kenney et al., 2017).

The present study has a number of strengths, including the fact that it is the first to compare the anti-fat biases of practicing PE teachers with those of their peers, while directly assessing the potential effects of these biases. However, some limitations of this study are also worth noting. One limitation involves certain measurement issues. In particular, the relatively low Cronbach's alpha value of the AFA-D in the teacher sample (0.60) indicates that the findings regarding teachers' explicit attitudes should be viewed with some caution. Furthermore, we did not include implicit measures of student biases or objective measures of PA. The well-known problems associated with the exclusive use of subjective measures of PA (Shephard, 2003) or explicit measures of bias (Paulhus, 1984), make it necessary for future studies to include objective measures of PA and implicit measures of bias. Moreover, there are some potential moderators and/or mediators of the association between the teachers' stereotypes and students' PA that were not taken into account in the present study. Given the multifactorial nature of PA, future research should explore the possibility that this relationship is moderated by other reinforcing factors, such as the influence of peers or parents, or mediated by particular predisposing factors, such as those mentioned above (i.e. self-efficacy and enjoyment of PA).

Conclusions

In conclusion, the findings of this study show that while practicing PE teachers are likely to have an anti-fat bias, this bias is not markedly different from that shown by their mathematics colleagues. The only difference found was the stronger implicit stereotypes of PE teachers, and it is precisely these biases that appear to be associated with the lack of PA shown by their students. Therefore, given the likely impact of teachers' implicit biases on the health of their students, we strongly recommend the implementation of intervention programs that consider the likely existence of non-traditional forms of prejudice in order to modify the anti-fat biases of teachers.

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