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Exploring the mediating role of motivational regulations in the relationship between body image and physical activity by sex: a structural equation modelling approach

Sergio Navas-León[1,2], Ana Tajadura-Jiménez[3,4], Luis Morales[1], Mercedes Borda-Mas[5], María Luisa Avargues-Navarro[5] and Milagrosa Sánchez-Martín[1*]

Abstract

Background This study investigates how motivational regulation mediates the relationship between body image satisfaction and physical activity participation, considering sex differences.

Methods The study used a cross-sectional design and involved 1012 participants stratified by sex of the Spanish adult population. Body image satisfaction was assessed using the Multidimensional Body Self-Relations Questionnaire (MBSRQ), motivational regulation using the Behavioural Regulation Exercise Questionnaire (BREQ-3), and total weekly minutes of moderate-vigorous PA with the International Physical Activity Questionnaire Short Form (IPAQ-SF). Structural equation modelling was used to test the hypothesised relationships.

Results The findings showed that satisfaction with physical appearance and physical shape had both direct and indirect associations with moderate-vigorous PA and motivational regulation. The relationship between body image satisfaction and moderate-vigorous PA was mainly mediated by intrinsic, integrated, and introjected regulations for men and integrated, identified, and amotivated regulations for women.

Conclusion These findings suggest that motivational regulation may play a crucial role in the relationship between body image satisfaction and PA participation. Promoting intrinsic and integrated motivation in men and women, respectively, rather than appearance-based goals, may foster more sustainable PA. The findings can provide valuable insights for policymakers and practitioners seeking to promote healthy PA behaviour.

Keywords Body image, Exercise psychology, Motivational theory, Physical inactivity, Self-determination theory, Structural equation modelling

*Correspondence:
Milagrosa Sánchez-Martín
msanchez@uloyola.es
[1]Department of Psychology, Universidad Loyola Andalucía, Avda. de las Universidades s/n, Dos Hermanas, Sevilla 41704, Spain
[2]Centro de Investigación Nebrija en Cognición (CINC), Facultad de Lenguas y Educación, Universidad Nebrija, Madrid 28043, Spain
[3]UCL Interaction Centre, University College London, London WC1E 6BT, UK
[4]DEI Interactive Systems Group, Department of Computer Science, Universidad Carlos III de Madrid, Madrid 28911, Spain
[5]Departamento de Personalidad, Evaluación y Tratamiento Psicológicos, Universidad de Sevilla, Sevilla 41018, Spain

Background

Numerous health benefits are associated with participation in physical activity (hereafter, PA) [1]. However, approximately 1.4 billion people are still insufficiently active according to a new global survey [2]. More specifically, in Spain, physical inactivity affects 27% of the adult population [2]. Physical inactivity is a leading global risk factor for both morbidity and mortality; it also imposes a significant economic burden [3]. Considering this evidence, PA promotion has become a critical public health goal for policymakers and practitioners.

Recent research aims to understand and motivate people to engage in regular PA by using health behaviours and behavioural change theories as a framework for intervention [4]. Evidence suggests that theory-based interventions are more effective in promoting adherence to PA than those that are not [5]. However, some studies have reported only small to moderate effect sizes for theory-based interventions (e.g., Cohen's d = 0.120-0.156 [6]; d = 0.357 [7]), leading to debates about their appropriateness [8–10]. Improving the effectiveness of theory-based interventions requires identifying mediators. These are key variables that explain how and why such interventions are associated with PA participation. In PA interventions, Rhodes et al. [11] conducted a systematic review and meta-analysis of 51 studies. They identified key mediators such as beliefs about capabilities (d = 0.26) and motivational regulations (d = 0.29) as important for increasing PA participation. Rhodes et al. [11] suggested that mediators with low effect sizes might not be as crucial to increase PA participation.

Identifying which mediatorsare associated with changes in PA allows for theoretical integration. It helps reduce redundancy and makes better use of each theory's strengths [12–14]. More innovative studies are needed to focus on key mediators of PA to improve future interventions [15–18]. For example, body image has received significant attention as a potential factor associated with PA behaviour [19]. In this regard, extensive research highlights the significant associations of psychological constructs on individuals' participation in PA [16, 20], as these constructs have been shown to account for a larger portion of the variance in PA behaviour compared to other factors, such as biological or environmental factors [21–27].

Body image and physical activity

The term "body image" refers to a multidimensional construct that consists of three components: (1) a behavioural component involving body-related behaviours (i.e., checking behaviours such as fixating on body parts in the mirror); (2) a perceptual component involving the perception of body characteristics (i.e., estimates regarding the size and shape of their body and body parts); and (3) a cognitive-affective component (i.e., how people think and feel about their bodies) [28]. Body image dissatisfaction is a related concept defined as a person's persistent negative attitudes and feelings regarding his or her physical appearance [28]. Body image dissatisfaction is widespread. For example, in the US, prevalence ranges from 11% to 72% in women and 8% to 61% in men, according to a review of epidemiological studies conducted between 1973 and 2009 [29]. More recently, in the UK, a survey found that 20% of adults experienced shame, 34% felt down or low, and 19% felt dissatisfied with their body image [30]. The adult population in Spain reports a prevalence of 22.20%. Significant differences were found between men and women, with 10.2% of men and 32.0% of women reporting body dissatisfaction [31]. Prevalence rates vary by country, demographics, and methodology. Still, the overall trend suggests that body image disturbance is a global mental health concern [32].

Furthermore, being overweight or obese is a significant factor that increases the risk of body image dissatisfaction [29]. On the other hand, it is strongly associated with impaired health-related quality of life [33]. Therefore, it raises concerns due to its increasing prevalence and potentially severe effects on human health [34]. Body image disturbance is strongly associated with unhealthy lifestyle behaviours (e.g., smoking or risky sexual behaviours) [35, 36]; depression, anxiety, and low self-esteem [37]; and an increased risk for eating disorders [29, 38].

Given the above, to implement interventions to reduce the prevalence of body image dissatisfaction, a large body of research in the PA domain exists. In this regard, several systematic reviews and meta-analyses have concluded that PA can significantly improve physical self-perceptions and increase self-esteem, both of which contribute to greater body image satisfaction [39, 40]. Most research has examined how PA interventions affect body image. Far less attention has been given to the reverse—how body image is associated with the onset or maintenance of PA—even though the relationship is considered bidirectional [41–44]. Importantly, recent reviews have highlighted a notable gap in this direction of the association. For instance, a review covering the period from 1990 to 2019 (N = 155) identified only one intervention study that explicitly tested the impact of body image on PA adherence [44]. In that study, Silva et al. [45] conducted a controlled trial involving 239 women, with one group receiving a self-determination theory-based intervention including body image components. Although PA increased in the intervention group, the lack of pre–post assessments of body image made it impossible to determine its specific role.

This lack of evidence is consistent with findings from other systematic reviews [e.g., 39, 46–48], which collectively emphasise that body image has rarely been

investigated as a predictor or as a factor associated with PA behaviour. Similarly, a review of over 210 studies between 2008 and 2018 concluded that "this focus precludes an understanding of body image as a predictor of PA and/or sports participation" [19] (p. 6). Sabiston et al. [19] noted this is a critical but underexplored area in sport and exercise psychology. It could offer promising targets for intervention. They argue that the limited evidence may stem from a lack of theoretical frameworks supporting this direction of the association. Fernández-Bustos et al. [40] similarly emphasised the absence of conceptual clarity regarding the bidirectional nature of these relationships, highlighting that no solid theory exists to explain when and how body image might act as a barrier or facilitator of PA. Thus, while it is plausible that body dissatisfaction may hinder PA participation and body satisfaction may encourage it, the current evidence is scarce, fragmented, and lacks robust theoretical grounding. More empirical and theory-driven research is needed to clarify whether body image functions as a barrier, a motivator, or both—depending on individual and contextual factors [19, 49–51].

Despite theoretical frameworks being crucial for PA research, as previously stated, research on the relationship between PA and body image has tended to be less grounded in theory. For example, Martin-Ginis, Basset and Conlin [51] pointed out that only half of the revised studies ($N = 12$) employed a theoretical framework. Similarly, Sabiston et al. [19] reported that only 33.5% of the studies were guided by an identifiable theoretical framework, limiting any "understanding of mechanisms that could be targeted in interventions" [19] (p.6). In this context, it has been argued that a person's motivation could be particularly informative for explaining the relationship between body image and PA and hence serve as a mediating variable framework [50]. To this end, self-determination theory is a prominent theoretical framework of human motivation that is particularly valuable in the field of body image. It specifies the various motivational regulations that underpin PA behaviour, thereby identifying potential targets for tailored PA interventions [19, 39, 44, 50].

Self-determination theory and physical activity

In brief, a fundamental tenet of self-determination theory is that humans are growth-orientated organisms inclined to form a unified sense of self and to integrate themselves in each context [52–54]. Within this framework, self-determination theory includes a sub-theory called organismic integration, often used to explain the motivational dynamics underlying human behaviours [52–54]. Adopting a multidimensional approach, the organismic integration theory states that six different motivational regulations are placed on a continuum based on their degree of self-determined (or autonomous) motivation, which reflects the extent of the internalisation process [52–54] (see Fig. 1). Amotivation (the absence of motivation or intention to act) falls on the lowest end of the continuum, and intrinsic motivation (performing an activity for its own sake) is on the other end of the continuum. Between these two, extrinsic motivation comprises four motivational regulations differing in their relative

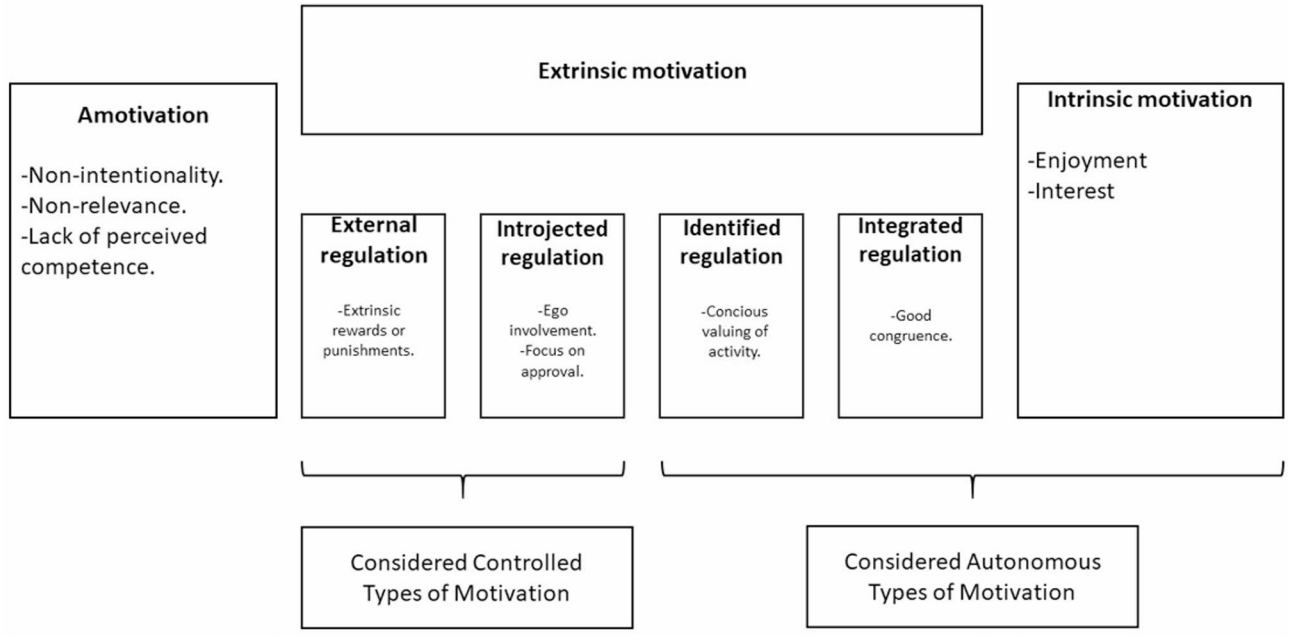

Fig. 1 Continuum of Motivation. Adapted from [53]

autonomy and implies participating in PA behaviour to acquire a result that is unrelated to the action per se. The least self-determined form of extrinsic motivation is external regulation, wherein behaviour is controlled and guided by an external demand or to obtain a reward (e.g., "I exercise because my friends and family say I should"). Next, introjected regulation involves behaviour that is partially internalised but not fully accepted as one's own, controlled by emotions or self-perceptions (e.g., "Because I feel guilty when I don't practise it"). A more autonomous form is identified regulation and reflects a behaviour that is valued and deemed important even though the behaviour may not be enjoyable (e.g., "Because I value the benefits of physical exercise"). Finally, the most self-determined form of extrinsic regulation, is integrated regulation in which a behaviour is part of an individual's values and broader goals (e.g., "Because physical activity is in accordance with my way of life"). External and introjected regulations are controlling forms of extrinsic motivation. Integrated and identified regulations are autonomous forms.

Self-determination theory has been extensively investigated in the PA domain. A prominent systematic review of more than 60 studies from 1960 to 2011 found a positive association between more *autonomous* forms of motivation (i.e., intrinsic, identified, and integrated regulations) and PA behaviours, in terms of frequency, duration, and intensity, in a variety of populations and settings [55]. In contrast, they found no association or a negative association between PA behaviour and the *controlled* forms of regulation (i.e., external and introjected regulations). Additionally, variables such as sex, BMI, and age have been shown tobe associated with motivational regulations. Regarding sex, some authors suggest that more controlled regulations predict PA behaviour for women, whereas more autonomous regulations predict PA behaviour for men [56–58]. These findings highlight the need to consider individual differences, such as sex assigned at birth, when studying self-determination theory in PA research [55].

Body image and self-determination theory

As previously mentioned, our modern societies perpetuate body image dissatisfaction. Women are thought to adopt a self-objectified view of themselves and to be evaluated based on their appearance [28, 59, 60]. In contrast, body image dissatisfaction in men tends to focus more on functionality—what the body can do—aligned with ideals such as the "bodybuilder-thin ideal" rather than concerns about being overweight or body shape akin to the "supermodel ideal" [60–64].

When individuals fail to meet these societal standards and expectations, whether related to appearance and/or functionality, they often experience negative thoughts and emotions rooted in the belief that others are judging their bodies negatively [65]. This aligns with social comparison theory, which posits that people inherently compare themselves to similar others to evaluate their self-worth [60, 66]. Such comparisons canbe associated with social physique anxiety—a fear of being negatively evaluated based on one's physique [67].

Empirical evidence supports this link. Lower body satisfaction, often worsened by social physique anxiety, is associated with reduced enjoyment of PA [65, 68, 69]. These conditions can diminish intrinsic motivation and increase reliance on controlled forms of motivation, such as exercising out of guilt or external pressure [65, 68, 69]. Conversely, higher levels of body satisfaction are linked to greater intrinsic motivation for exercise, fostering consistent and enjoyable PA participation (see [39] for a recent review).

Thus, from a self-determination standpoint, this anxiety acts as an internal source of controlling forms of regulation, undermining intrinsic motivation for engaging in PA [66]. This situation can be associated with both men and women to engage in compulsory or inconsistent PA [37, 69, 70]. This has important consequences on people's physical and mental wellbeing and can be associated with to drastic strategies such as extreme dietary restraint and ultimately eating disorders [71]. However, despite their importance, very few studies have tested motivational regulations as a mediating variable framework for the associations of body image with the onset/maintenance of PA [72].

Relationship between body image, self-determination theory, and physical activity

In one of the first studies on this topic, Markland [73] aimed to test the mediating role of motivational regulations in the relationship between body size discrepancies (i.e., the difference between how individuals perceive their body size and their actual size) and PA participation among 102 women (18–55 years). According to the findings, bivariate correlations indicated that body size discrepancies were negatively associated with intrinsic and identified regulations and were positively related to external regulation. Furthermore, the mediation analysis reflected that self-determined motivation regulations (i.e., identified and intrinsic) mediated the relationship between self-discrepancy and PA behaviour. Specifically, the decrease in self-determined motivation regulations mediated a negative association between body size discrepancies and PA. These findings suggest that body size discrepancies decreased people's perception that PA is worthwhile and enjoyable and made them feel more externally regulated in their PA behaviour.

In a similar study, Brunet et al. [72] also aimed to test the mediating role of motivational regulations in the

relationship between body size discrepancies and PA participation among 205 women (16–28 years). Bivariate correlations showed a positive association between greater agreement with actual and ideal body size and intrinsic motivation [72]. Alternatively, they found negative associations between body size discrepancies and introjected and external regulations. Furthermore, motivational regulations partially mediated the relationship between the agreement with the actual and ideal body and PA behaviour. Overall, the findings suggest that weight management motives and pressure to meet beauty standards are associated with young women's PA. These motives are linked to less self-determined reasons for participation. The authors concluded that theory-based interventions integrating body image and self-determination should promote a healthy and realistic body image in young women. This can help foster self-determined motivational regulations and, as a result, adjusted PA participation [72].

More recently, More and Phillips [74] aimed to test the mediating role of motivational regulations in the relationship between body image dissatisfaction and PA type (cardiovascular vs. strength-based activity) and elucidate the role of sex in this relationship among a mixed sample of 334 individuals (18–41 years; 71% female). Mediation analysis yielded that, for males and females, body image dissatisfaction was related to less frequent cardiovascular and strength-based activity due to lower levels of intrinsic regulation. Specifically, in women, the relation between body image dissatisfaction and PA (cardiovascular and strength-based) was partially mediated by controlled regulations (i.e., external and introjected). In the words of More and Philipps [74], "women who were dissatisfied exercised more because they were more likely to feel that they had to appease others or themselves" (p. 10).

Overall, the body of research that tests explicit hypotheses derived from self-determination theory has recently been described as a 'cutting edge' [75] and 'emergent' topic in the body image field [39]. Despite its importance and the potential implications for evidence-based practice, it is important to highlight some limitations. First, most of the studies relied on body size discrepancies as a proxy for body image dissatisfaction. However, some authors have argued that body size discrepancies do not always reflect body image dissatisfaction, nor do they indicate the magnitude of any dissatisfaction [76]. Therefore, it is recommended to evaluate body image dissatisfaction with a special focus on characteristics such as body appreciation and the value of appearance [77]. Nevertheless, a recent study suggests that body dissatisfaction and body appreciation could be interpreted as dimensions of a single construct rather than separate concepts [78]. Second, it has recently been argued that the mediating role of motivational regulations in the relationship between body image and PA has not been explicitly tested and is therefore "a potential avenue for further research" [50] (p.161). Relatedly, it has been recommended that function-related aspects of body image are also important to measure since evidence suggests that some people place greater emphasis on function (what the body can do) than appearance (how the body looks) [51]. Third, most studies in the field had nonrepresentative samples that mostly focused on young women, discarding other subpopulations. This trend is consistent with prior epidemiological research that reports body image dissatisfaction to be an 'epidemic' among young women [29]. Nonetheless, more study focusing on diverse samples, such as men, is required because body image dissatisfaction affects these subpopulations as well [72]. And finally, research on this topic has relied on standard regression methods for mediation analysis [72, 73, 74]. Future research would benefit from adopting a structural equation modelling framework as a multivariate statistical technique [79].

The present study

Considering the evidence, within a structural equation modelling framework, this study aimed to elucidate the relationship between body image and PA, considering the possible mediating role of motivational regulations using a large representative sample of the Spanish adult population. To better capture the nature of body image, we focused on two key components: Satisfaction with Physical Appearance (hereafter, SPA) and Satisfaction with Physical Shape (hereafter, SPS). These two constructs, derived from the Spanish version of the Multidimensional Body-Self Relations Questionnaire (MBSRQ), reflect body image satisfaction. This distinction allows us to examine specific relationships through which each component may be associated with PA. As a secondary aim, given the importance of individual differences, and in particular sex (assigned at-birth), as previously stated, we conducted a moderation analysis to elucidate whether the proposed model is similar for men and women (see Fig. 2). Given the above, the following hypotheses were proposed:

Hypothesis 1 *(H1)*: SPA and SPS will show significant positive direct associations with PA participation, with these associations expected to be weaker in men than in women.

Hypothesis 2 *(H2)*: More autonomous forms of motivation (i.e., intrinsic, integrated, and identified) and lower levels of controlled regulations (i.e., external and introjected) will show significant positive and negative indirect associations between SPA/SPS and PA participation.

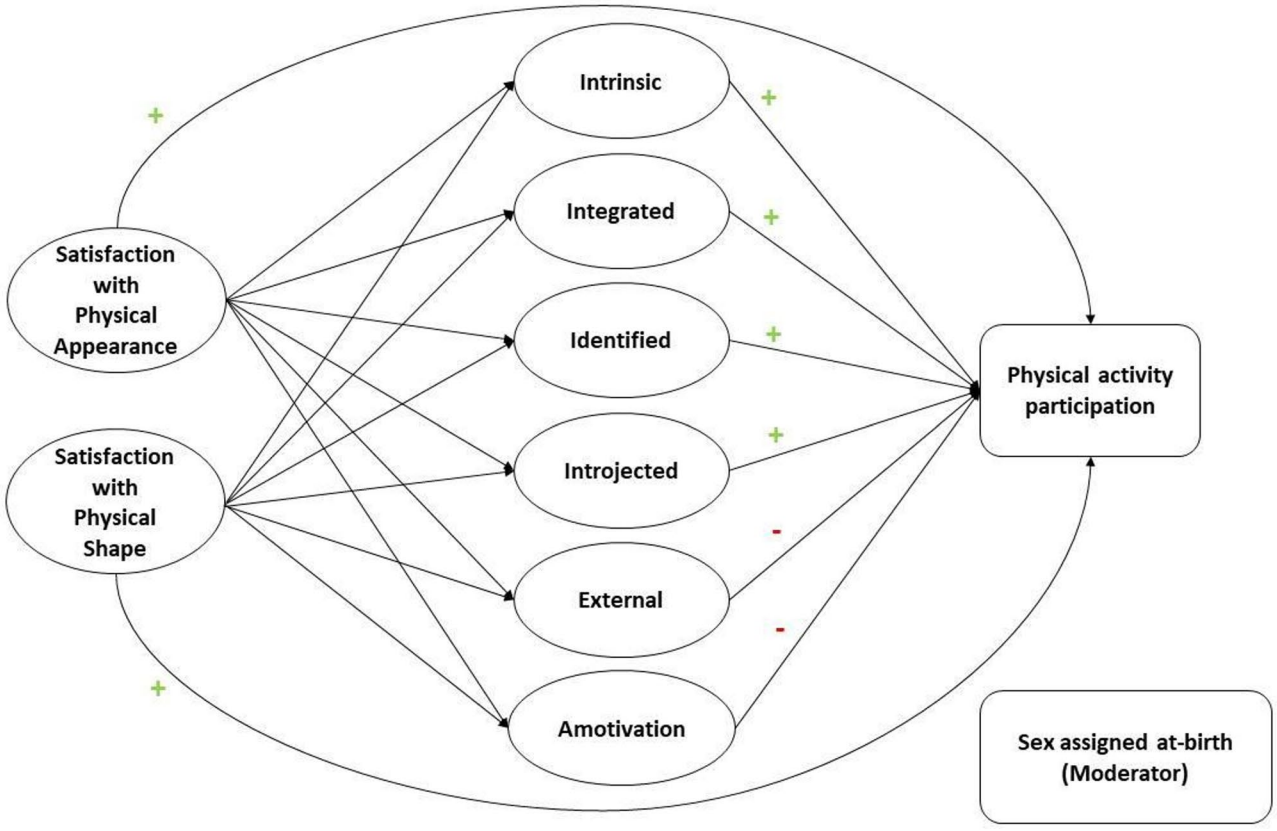

Fig. 2 Hypothesised model with motivational regulations as mediator of the relationship between body image and moderate-vigorous PA. Note. Solid lines are used to represent hypothesised direct associations

Hypothesis 3 *(H3)*: Body image, particularly SPA for men and SPS for women, will be associated with PA participation through motivational regulations, with men relying on autonomous motivation and women on controlled motivation.

Materials and methods

This study was approved by the Research Ethics Committee of the Autonomous Region of Andalucía (Code: ULA-PSI2016-350105. Approval no. 20181241335, 24 January 2018) and the Ethics Committee of the Loyola Andalucía University. Data collection in this study followed the ethical standards laid down in the Declaration of Helsinki of 1964 and its subsequent amendments. Before participation, written informed consent was obtained from all participants after a comprehensive explanation of the study procedures. A cross-sectional study was conducted in 2018. Data for this analysis was collected through a dedicated online panel.

Participants

A total of 1012 adults, representative of the Spanish population and stratified by sex, provided sociodemographic data allowing us to characterise the population, and they completed a battery of questionnaires (see *Measures* section). Eligible participants were (a) to be ≥ 18 years; (b) not to have medical issues for which PA was contraindicated; and (c) to provide informed consent.

The existence of univariate outliers was controlled through the Short International Physical Activity Questionnaire (IPAQ-SF) [80]. The total moderate-vigorous PA participation was calculated based on the minutes dedicated to moderate and vigorous activity over the past 7 days. According to the IPAQ-SF scoring protocol, 57 outliers were excluded (subjects reporting at least 960 min/week or greater of activity) [81]. Two additional participants were removed due to data entry errors. Thus, at this stage, the sample comprised 953 participants (482 men and 471 women).

Measures

Physical activity

Short Form International Physical Activity Questionnaire (IPAQ-SF [80]): The IPAQ-SF assesses PA levels. The participants were asked to report on the number of days and duration of several activities that they undertook during the last 7 days. The IPAQ-SF comprises six items that provide separate scores on walking, moderate

and vigorous PA. Our IPAQ analysis included both the total duration and the number of days. With these data, a score of cumulative total weekly minutes of moderate/vigorous PA was calculated as a continuous variable. Moderate-vigorous PA is considered the most valid and reliable PA outcome [82]. The IPAQ-SF has been found to be a reliable and valid tool for Spanish adults [83]. A way to increase reliability is to combine it along with direct measures such as speedometers or accelerometers [84]. However, like other studies, the large sample prevented this recommendation [85].

Motivational regulations

The Behavioural Regulation Exercise Questionnaire (BREQ-3 [77, 86]): The BREQ-3 assesses motivational regulations in PA. For this study, we used the Spanish version of the BREQ-3, translated, and preliminarily validated by González-Cutre, Sicilia and Fernández [87]. It is composed of 24 Likert-type 4-point response items ranging from 0 ("Strongly disagree") to 4 ("Strongly agree"), with higher scores reflecting higher levels of motivation. Six subscales are measured: amotivation (Item 14: *"I don't see the point in exercising"*), external (Item 1: "*Because others tell me that I should do it"*), introjected (Item 2: "*Because I feel guilty when I don't practice it"*), identified (Item 3: "*Because I value the benefits of physical exercise"*), integrated (Item 5: "*Because it is in accordance with my way of life*") and intrinsic motivation (Item 4: "*Because I think exercise is fun"*), and these items reflect the motivational continuum of self-determination theory [87]. The BREQ-3 has been found to be a reliable and valid tool for the Spanish population [87]. The Cronbach's alpha value for the BREQ-3 ranged between 0.91 and 0.75, and item-total correlations were more than 0.4, indicating a good level of internal consistency.

Body image

Multidimensional Body Self Relations Questionnaire (MBSRQ [88]): We employed the two-dimensional factor structure proposed by Ornelas et al. [89], as the four-dimensional structure suggested by del Cid et al. [89] did not fit our data well based on goodness-of-fit indices. This version consists of 14 items, rated on a 5-point Likert scale ranging from 0 ("strongly disagree") to 5 ("strongly agree"), with total scores ranging from 0 (minimum) to 70 (maximum). Following the validated Spanish-language scoring procedure of Ornelas et al. [90] and del Cid et al. [91], we reverse-coded negatively worded items so that higher scores consistently reflect greater satisfaction. Accordingly, we refer to the two subscales as Satisfaction with Physical Appearance (SPA, e.g., Item 4: "*I am physically attractive*") and Satisfaction with Physical Shape (SPS, e.g., Item 5: "*I am not involved in a regular exercise program*" [reverse-coded]). SPA refers to the evaluation of one's physical attractiveness, while SPA denotes the evaluation regarding one's physical capabilities or fitness level. High scorers feel mostly positive and satisfied with their appearance and shape; low scorers have a general unhappiness with their physical appearance and shape. In our sample, SPA and SPS were positively correlated, replicating the pattern reported by Ornelas et al. [90] and Ornelas et al. [91], supporting their shared conceptual basis in satisfaction-related evaluations. Internal consistency was high for both subscales—SPA (α = 0.861) and SPS (α = 0.866)—as well as for the global score (α = 0.887), with item–total correlations above 0.40.

Data analysis

Preliminary analysis

Following descriptive statistics (means, standard deviations, mean comparison and bivariate correlations), assumptions of multicollinearity were examined by correlation coefficients with the items of the scales, as high bivariate correlations (>0.90) could signal potential problems for structural equation modelling analysis [92, 93]. Multicollinearity was assessed by examination of correlation matrices, as well as by variance inflation factor (VIF) and tolerance scores. These were obtained by using a regression analysis, with moderate-vigorous PA as the dependent variable. Therefore, the presence of multicollinearity could be disregarded. Additionally, in structural equation modelling analysis, acceptable values of skewness fall between − 3.00 and + 3.00, and kurtosis is appropriate from a range of − 10.00 to + 10.00 [94]. Regarding multivariate normality, if Mardia's coefficient is lower than p(p + 2) (p = number of variables), then the combined distribution of the variables is multivariate normal [95].

Furthermore, the sample size of 1014 was initially chosen to meet the minimum requirements for model identification, reduce the likelihood of convergence problems, and ensure unbiased estimates or standard errors [96]. On the other hand, the final sample size of 953 participants was evaluated through a post hoc power analysis using the ShinyApp tool (https://sempower.shinyapps.io/sempower/) based on Moshagen and Bader [97]. With 37 manifest variables and 599 degrees of freedom, the power analysis yielded a power estimate of >0.90 at an alpha level of 0.05 and an acceptable model fit, as indicated by the RMSEA value of 0.06, confirming that our sample size was sufficient to detect significant effects.

IBM SPSS Statistics version 28.0 [98] was used for data management, data inspection, and descriptive statistics. Student's t-tests and bivariate correlations were used to examine sex differences in the main study variables. All statistical procedures adopted a significance level of ≤ 0.05.

Measurement and structural model

Following a two-step approach to structural equation modelling [94, 95], the analyses were conducted in two stages. First, we assessed the measurement models to verify that the latent constructs were adequately represented by their observed indicators. Once satisfactory measurement properties were confirmed, we estimated the structural model to test the hypothesised relationships. In this regard, structural equation modelling offers a flexible framework for testing mediation and estimating latent constructs based on theory [15]. Within the PA field, reviews have noted that SEM is still less frequently employed [11, 12], with regression analyses often preferred despite their limitations in testing multiple associations simultaneously [99].

In our study, we applied a trimming model process [100], starting with a complex model and progressively simplifying it through backward elimination, removing nonsignificant associations ($p > 0.05$) to obtain the most parsimonious model. Moreover, in case of disagreement between *p*-value indirect associations and indirect CI intervals (range of values within which the true effect is likely to lie), we considered the latter since *p* values are computed assuming the Z-statistic comes from a standard normal distribution [101, 102]. Finally, non-meaningful relationships (i.e., standardised beta coefficients (β) < 0.10) were considered nonrelevant in the model, as such small effects are unlikely to have practical significance or meaningful explanatory value. Standardised beta coefficients (β) indicate the expected change in the outcome (in standard deviation units) for a one standard deviation change in the predictor [66]. For instance, β = 0.50 means that a one SD increase in x is associated with a 0.50 SD increase in y. The proposed initial model and subsequent models included cumulative total weekly minutes of moderate-vigorous PA as an observable variable, while motivational regulations and body image were considered latent variables with the items of the scales as their estimators.

At a global level, following standard confirmatory factor analysis and structural equation modelling procedures [103] to evaluate model fit, we used the following goodness-of-fit indices: Comparative Fit Index (CFI) (≥ 0.90), Tucker and Lewis Index (TLI) (≥ 0.90), root mean square error of approximation (RMSEA) (≤ 0.080), Test of Approximate Fit of RMSEA (nonsignificant), and Standardised Root Mean Square Residual (SRMR) (≤ 0.080) with the utilised cut-off values for a good fit provided in parentheses. To minimise the impact of sample size on the χ2 model, we used the relative/normed chi-square (χ^2/df). A $\chi^2/df < 5$ is considered permissible [104]. We also reported for each variable the squared multiple correlations (SMC) (the regression R^2) for the measurement model that indicates the size of the variation explained by the latent variables. Additionally, we evaluated the AIC for model comparison, using a criterion of < 5 for comparison between models.

At a local level, we reported standardised regression coefficients for each proposed direct, indirect, and total association. A direct association links two variables directly, while an indirect association is mediated by a third; the total association combines both. Positive coefficients indicate that increases in the predictor correspond to increases in the outcome, whereas negative coefficients indicate the opposite. To examine associations, considering the non-normal distribution and to ensure methodological rigour, the analyses were conducted using a bias-corrected (BC) bootstrap method to test the significance of the standardised indirect associations [105]. We used a bootstrap of 5,000 resamples with 1,000 iterations (repeatedly sampling from the data), as recommended by Cheung and Lau [106]. If the confidence interval (95% CI) does not contain zero, these indirect associations are considered statistically significant [107]. The resampling procedure called 'bootstrapping' used in the current study has shown valid results [99]. The structural models provided the methodological basis for testing hypothesis 1 and 2. Specifically, they allowed us to assess the direct associations of SPA and SPS with PA participation (H1), as well as the mediating role of motivational regulation types (autonomous and controlled) in the relationship between body image satisfaction (SPA/SPS) and PA participation (H2).

CFA/SEM and invariance analyses were carried out using MPLUS 8.4 [108]. Mardia's coefficient was calculated using 'FACTOR' software Version 10.10.03 [109]. All statistical procedures adopted a significance level of ≤ 0.050.

Structural model invariance

Prior to the moderation analysis, we first assessed invariance by examining an increasingly restrictive set of models with respect to sex assigned at-birth (women vs. men). Invariance was tested using the ML estimator through the following models, from the least to the most restrictive: Test 1, configural (same structure across groups: factor loadings and thresholds free across groups, residual variances fixed at 1 in all groups and factor means fixed at 0 in all groups); Test 2, metric (factor loadings fixed to be equal, thresholds free across groups, factor means fixed at 0 and residual variances fixed at 1 in both groups); Test 3, scalar (factor loadings and thresholds fixed to be equal, residual variances fixed at 1 in one group and free in the other one, and factor means fixed at 0 in one group and free in the other one). Invariance between models was evaluated using (a) a change in ΔCFI (≤ 0.01) and (b) a change in ΔRMSEA (0.015) [68]; (c) a change in ΔTFI (≤ 0.010); and (d) a change in ΔSRMR (≤ 0.030) [107]. The

invariance testing provided the methodological basis for testing Hypothesis 3 and allowed for a meaningful comparison of these pathways, ensuring that the relationships hypothesised in the structural model may reflect sex-based differences rather than discrepancies in factor structure, factor loadings, or item thresholds.

Results

Preliminary analysis

No missing values were detected in the dataset, as the survey was administered electronically and designed to ensure that participants could not skip any questions. The correlations between explanatory variables were not sufficiently strong to warrant any exclusions (rs < 0.90) [110]. Furthermore, the VIF and tolerance values indicated the absence of multicollinearity (VIF < 5 and tolerance >0.20 [98]). Our data exhibited moderate levels of skewness (absolute value of 1.631) and kurtosis (absolute value of 1.972) for all variables, suggesting that there were no issues of univariate nonnormality [94]. In relation to this, the mean scores for each item were around the middle response option, suggesting that the results were probably not influenced by floor or ceiling effects. Mardia's coefficient (1831.794) was greater than the cut-off point of 1520 (38 variables). Considering this, although the data were within the normal threshold in the univariate analysis, the multivariate critical ratio and kurtosis indicated a violation of the normality assumptions. Therefore, to assess the parameter estimates, we used maximum likelihood ML [108] with the bootstrapping procedure to address non-normality. ML is robust to the non-normality, especially since the sample size is large [110].

Descriptive statistics

The characteristics of the participants are shown in Table 1. They had an age range of 18 to 74 years, with a mean age of 44.91 (SD = 16.05). The BMI of the women was greater than that of the men (M_w = 26.45, SD = 4.28; M_m = 24.36, SD = 4.34; $p < 0.001$). The mean age of the women was greater than that of the men (M_w = 47.01, SD = 15.79; M_m = 42.86, SD = 16.11; $p < 0.001$). Integrated motivation was high among women and significantly greater than among men (M_w = 3.41, SD = 1.02; M_m = 3.32, SD = 1.01; $p < 0.001$). There was a nonsignificant tendency for intrinsic motivation, which was higher among the women than among the men (M_w = 3.51, SD = 0.98; M_m = 3.32, SD = 0.98; $p = 0.053$). The SPA of the women was greater than that of the men (M_w = 3.14, SD = 0.67; M_m = 2.95, SD = 0.75; $p < 0.001$). Similarly, the SPS of the women was greater than that of the men (M_w = 3.37, SD = 0.96; M_m = 3.18, SD = 0.87; $p < 0.001$). Table 2 shows bivariate correlations among the variables of interest. Age was positively correlated with BMI, integrated, identified, and external motivations and negatively correlated with SPS. BMI was negatively correlated with moderate-to-vigorous PA, the most self-determined forms of motivation (i.e., intrinsic, integrated, and identified), SPA and SPS, whereas it showed positive correlations with external motivation and amotivation). Moderate-to-vigorous PA was positively correlated with the most self-determined forms of motivation, SPA and SPS, while it showed a negative correlation with the less self-determined forms of motivation. Intrinsic, integrated, identified, and introjected motivations showed positive correlations among them and negative correlations with external motivation. Except for BMI, external motivation and amotivation, SPA and SPS showed positive correlations with the variables of interest.

Table 1 Characteristics of the participants

	All (*n* = 953)		Men (*n* = 482)		Women (*n* = 471)		*p*
	M	SD	M	SD	M	SD	
Age[a]	44.91	16.05	42.86	16.11	47.01	15.79	0.000***
BMI[a]	25.39	4.28	24.36	4.34	26.45	3.95	0.000***
MVPA per week[a]	653.98	674.25	650.63	686.38	657.41	662.32	0.626
Intrinsic[a]	3.66	0.98	3.60	0.98	3.71	0.98	0.053
Integrated[a]	3.41	1.02	3.32	1.01	3.51	1.03	0.000***
Identified[a]	4.07	0.88	4.03	0.89	4.11	0.86	0.123
Introjected[a]	2.37	0.90	2.35	0.90	2.38	0.91	0.509
External[a]	1.83	0.89	1.79	0.87	1.88	0.91	0.095
Amotivation[a]	1.75	0.90	1.79	0.90	1.72	0.91	0.135
SPA[a]	3.04	0.72	2.95	0.75	3.14	0.67	0.000***
SPS[a]	3.28	0.92	3.18	0.87	3.37	0.96	0.001**

Note. BMI: Body Mass Index; MVPA: Moderate-to-vigorous Physical Activity; SPA: Satisfaction with Physical Appearance; SPS: Satisfaction with Physical Shape. The number of asterisks indicates the level of significance, with *** indicating $p < 0.001$, ** indicating $p < 0.01$, and * indicating $p < 0.05$

Table 2 Bivariate correlations

Variable	1	2	3	4	5	6	7	8	9	10
1.-Age[a]	1									
2.-BMI[a]	0.308**	1								
3.-MVPA per week[a]	-0.037	-0.138**	1							
4.-Intrinsic motivation[b]	0.007	-0.195**	0.251**	1						
5.-Integrated motivation[b]	0.109**	-0.156**	0.266**	0.777**	1					
6.-Identified motivation[b]	0.075*	-0.153**	0.244**	0.696**	0.713**	1				
7.-Introjected motivation[b]	0.022	0.017	0.065*	0.220**	0.301**	0.187**	1			
8.-External motivation[b]	0.086**	0.199**	-0.076*	-0.243**	-0.175**	-0.300**	0.400**	1		
9.-Amotivation[b]	-0.011	0.113**	-0.164**	-0.561**	-0.517**	-0.638**	0.023	0.457**	1	
10.-SPA[b]	0.052	-0.376**	0.190**	0.358**	0.352**	0.288**	-0.044	-0.189**	-0.184**	1
11.-SPS[b]	0.083*	-0.215**	0.357**	0.618**	0.673**	0.598**	0.158**	-0.227**	-0.501**	0.488**

Note. BMI: Body Mass Index; MVPA: Moderate-to-vigorous Physical Activity; SPA: Satisfaction with Physical Appearance; SPS: Satisfaction with Physical Shape. [a] Pearson correlation coefficient; [b] Spearman Rho correlation coefficient. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Measurement models

Following the recommended two-step approach [94, 95], we first evaluated the measurement models of the two instruments included in the study: the Multidimensional Body-Self Relations Questionnaire (MBSRQ) and the Behavioural Regulation in Exercise Questionnaire-3 (BREQ-3).

For the MBSRQ, the model yielded a good fit to the data, χ^2 (71) = 365.80, $p < 0.001$, RMSEA = 0.066, 90% CI [0.059, 0.073], CFI = 0.951, TLI = 0.937, and SRMR = 0.046. Likewise, for the BREQ-3, the model yielded a good fit to the data, χ^2 (238) = 892.31, $p < 0.001$, RMSEA = 0.054, 90% CI [0.050, 0.057], CFI = 0.952, TLI = 0.945, and SRMR = 0.073.

Overall, the results suggested that the measurement models were adequately specified, thereby justifying the subsequent assessment of the structural model.

Structural models

The initial model (A1) had a poor fit, with nonsignificant associations. Model A2 showed no improvements, and after removing the nonsignificant associations, Model A3 also did not improve, revealing introjected motivation as irrelevant (β < 0.10). Thus, a fourth model (Model A4) was tested, showing improvements from Model A3 (χ^2/df = 3.730; CFI = 0.919; TLI = 0.911; RMSEA = 0.052; SRMR = 0.0680; AIC = 89858.96). After comparing the last two models, we accepted Model A4, as it showed significant direct associations for all the included variables (see Fig. 3). The elimination of the associations from introjected and external motivation was supported theoretically by the systematic review by Teixeira et al. [55], which found a tendency for these associations to show nonsignificant associations with PA participation. Additional path diagrams for Models A1, A2, and A3, as well as a table detailing the trimming process, are provided in the supplementary materials [see Additional File 1].

Standardised regression coefficients for each proposed direct association in the final model (A4) reached significance at the $p < 0.050$ level. SPA to moderate-vigorous PA had a negative total association [(β = -0.115, $p < 0.050$; SE = 0.048; 95% CI: -0.213 to -0.025)] and a positive total indirect association [(β = 0.545, $p < 0.010$; SE = 0.192; 95% CI: 0.262 to 0.978)]. The relationship between SPA and moderate-vigorous PA had an indirect and positive association with moderate-vigorous PA through intrinsic motivation [(β = 0.119, $p < 0.050$; SE = 0.058 95% CI: 0.038 to 0.270)], integrated motivation [(β = 0.171, $p < 0.050$; SE = 0.079; 95% CI: 0.058 to 0.366)], and identified motivation [(β = 0.169, $p < 0.050$; SE = 0.095; 95% CI: 0.034 to 0.400)]. The models also included the indirect association of amotivation, whose coefficient was almost relevant [(β = 0.087, $p < 0.010$; SE = 0.034; 95% CI: 0.027 to 0.164)]. SPS to moderate-vigorous PA had a positive total association [(β = 0.464, $p < 0.010$; SE = 0.046; 95% CI: 0.375 to 0.557)] and a negative total indirect association [(β = -1.406, $p < 0.010$; SE = 0.397; 95% CI: -2.450 to -0.736)]. The relationship between SPS and moderate-vigorous PA had an indirect and negative association with moderate-vigorous PA through intrinsic motivation [(β = -0.342, $p < 0.010$; SE = 0.137; 95% CI: -0.650 to -0.111)], integrated motivation [(β = -0.480, $p < 0.010$; SE = 0.189; 95% CI: -0.910 to 0.181)], identified motivation [(β = -0.414, $p < 0.050$; SE = 0.208; 95% CI: -0.897 to -0.090)] and amotivation [(β = -0.171, $p < 0.010$; SE = 0.062; 95% CI: -0.298 to -0.054)]. It should be noted that some of the CI indirect associations were close to the level of non-significance. The final model explained 79% of the variance in intrinsic motivation, 83% of the variance in integrated motivation, 83% of the variance in identified motivation and 49% of the variance in amotivation.

Factorial invariance

The fit indices of configural, metric, and scalar invariance models indicated that the three models achieve

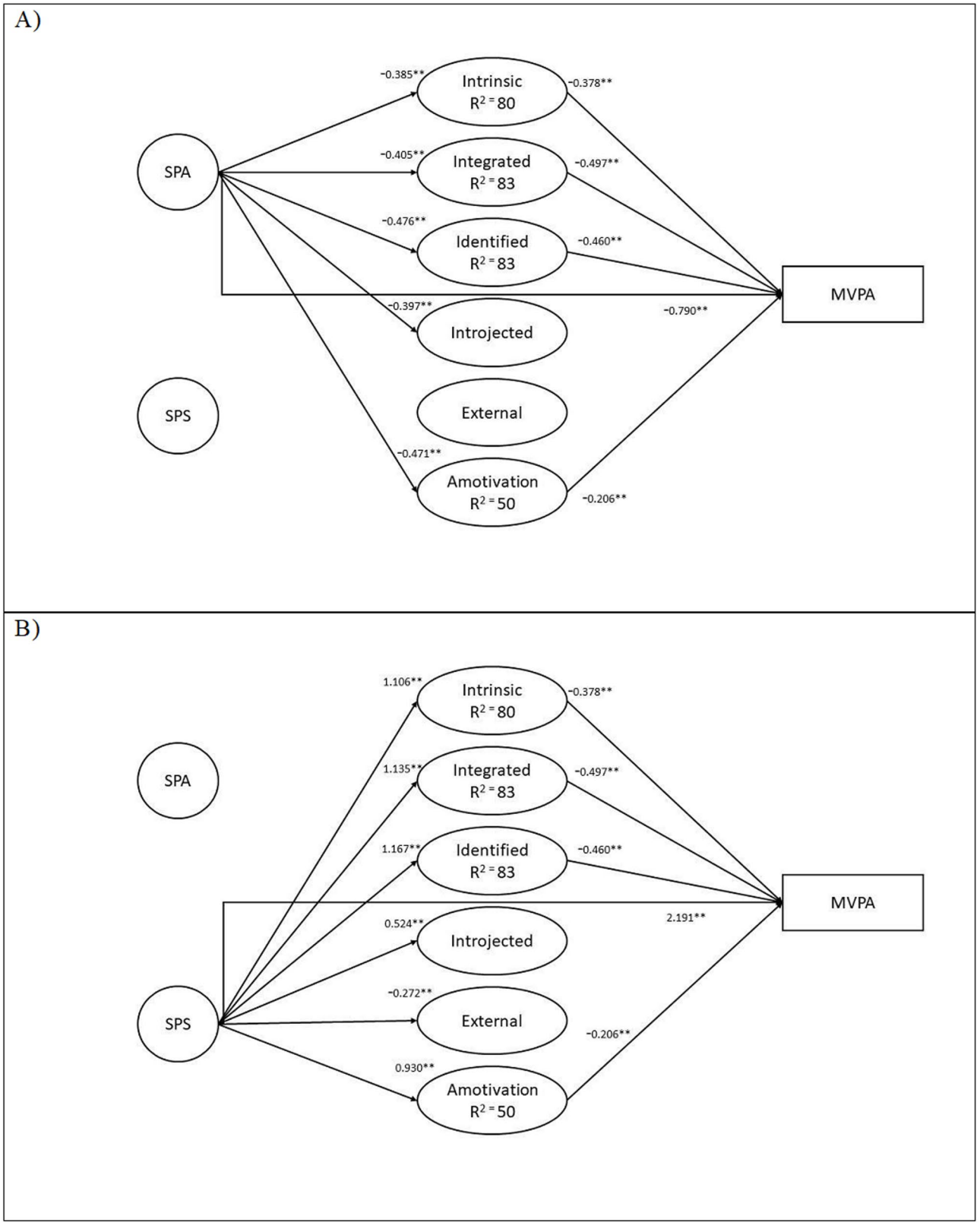

Fig. 3 (See legend on next page.)

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Fig. 3 Final theoretical model (model A3) with standardised regression coefficients (β). Panel **A**: Satisfaction with Physical Appearance (SPA). Panel **B**: Satisfaction with Physical Shape (SPS). B). *Note.* MVPA: Moderate-to-vigorous Physical Activity. Solid lines are used to represent direct associations. *$p <$ 0.050; **$p <$ 0.010. Some direct associations showed beta values greater than 1, which can occur in certain situations when the relationships between variables are highly correlated. Additionally, some motivational regulations showed unexpected negative associations with moderate-to-vigorous PA participation. This pattern may reflect a suppression effect, which occurs when predictors share substantial variance, such that controlling for one alters the apparent direction or strength of the association between the other and the outcome. Such effects are permissible and often occur in the context of high correlations between latent variables [110, 111]

good model fit. In addition, ΔCFI and ΔRMSEA values proposed by Chen [107] indicated that changes caused by sex assigned at-birth have only a slight impact on the measurement structure and can be neglected. An additional table provides a detailed account of the results of the measurement invariance test conducted between the two groups (men and women) [see Additional File 1, Table 3].

Structural models by sex

The same procedure was followed from the initial model, but the samples of men (Model M1; hereafter, M for men) and women (Model W1; hereafter, W for women) were considered separately (Table 4).

Regarding the sample of men, different models were designed following a procedure like the one used with the total sample (see Additional File 1 to see the nonsignificant associations). Among them, the Model M5 showed a better fit (see Fig. 4). An additional table presents a more detailed view of the nonsignificant associations and fit indices for each model [see Additional File 1, Table 1].

SPA to moderate-vigorous PA had a negative total association [(β = -0.137, $p < 0.05$; SE = 0.067; 95% CI: -0.283 to -0.016)] and a positive total indirect association [(β = 0.423, $p > 0.050$; SE = 0.260; 95% CI: 0.129 to 1.120)]. The relationship between SPA and moderate-vigorous PA had an indirect and positive association with moderate-vigorous PA through intrinsic motivation [(β = 0.200, $p > 0.050$; SE = 0.131; 95% CI: 0.053 to 0.552)]. This model also included the positive and indirect associations with moderate-vigorous PA through integrated [(β = 0.169, $p > 0.050$; SE = 0.141; 95% CI: 0.020 to 0.556)] and introjected motivations [(β = 0.054, $p > 0.050$; SE = 0.036; 95% CI: -0.004 to 0.140)], with associations close either to the level of non-significance and/or relevance. SPS to moderate-vigorous PA had a positive total association [(β = 0.460, $p < 0.010$; SE = 0.069; 95% CI: 0.336 to 0.612)] and a negative total indirect association [(β = -1.174, $p < 0.010$; SE = 0.502; 95% CI: -2.362 to -0.471)]. The relationship between SPS and moderate-vigorous PA had an indirect and negative association with moderate-vigorous PA through intrinsic motivation [(β = -0.624, $p < 0.050$; SE = 0.262; 95% CI: -1.243 to -0.253)] and integrated motivation [(β = -0.478, $p > 0.050$; SE = 0.305; 95% CI: -1.619 to -0.054)]. We retained the relationship between the indirect and negative associations with moderate-vigorous PA through introjected motivation, whose coefficient was close to the level of relevance [(β = -0.072, $p > 0.050$; SE = 0.046; 95% CI: -0.174 to -0.008)]. The final model explained 79% of the variance in intrinsic motivation, 83% of the variance in integrated motivation, and 24% of the variance in introjected motivation.

Regarding the sample of women, different models were designed following a procedure like the one used with the total sample. Among them, Model M5 showed a good fit (see Fig. 5). An additional table presents a more detailed view of the nonsignificant associations and fit indices for each model [see Additional File 1, Table 1].

SPA to moderate-vigorous PA had a nonrelevant negative nonsignificant total association [(β = -0.074, $p > 0.050$; SE = 0.072; 95% CI: -0.222 to 0.061)] and a positive total indirect association [(β = 0.602, $p < 0.010$; SE = 0.322; 95% CI: 0.181 to 1.363)]. The relationship between SPA and moderate-vigorous PA had an indirect and positive association with moderate-vigorous PA through integrated motivation [(β = 0.233, $p > 0.050$; SE = 0.193; 95% CI: 0.036 to 0.771)] and amotivation [(β = 0.110, $p > 0.050$; SE = 0.060; 95% CI: 0.15 to 0.255)]. This model also included the positive and indirect associations with moderate-vigorous PA through identified motivation [(β = 0.259, $p > 0.050$; SE = 0.189; 95% CI: 0.034 to 0.779)], whose CI was close to the level of non-significance. SPS to moderate-vigorous PA had a positive total association [(β = 0.456, $p < 0.010$; SE = 0.066; 95% CI: 0.328 to 0.590)] and a negative total indirect association [(β = -1.401, $p < 0.010$; SE = 0.635; 95% CI: -2.797 to -0.438)]. The relationship between SPS and moderate-vigorous PA had an indirect and negative association with moderate-vigorous PA through integrated motivation [(β = -0.625, $p > 0.050$; SE = 0.421; 95% CI: -1.727 to -0.094)], identified motivation [(β = -0.564, $p > 0.050$; SE = 0.369; 95% CI: -1.503 to -0.065)] and amotivation [(β = -0.213, $p > 0.050$; SE = 0.109; 95% CI: -0.447 to -0.230)]. The final model explained 86% of the variance of integrated motivation, 84% of the variance of identified motivation and 54% of the variance of amotivation.

Discussion

This study examined the link between body image and PA, considering the mediating role of motivational regulations using data from a large, representative Spanish sample. For the design of the initial theoretical model, we considered previous literature on the association between of body image on PA behaviour through motivational

Table 3 Factorial invariance test

Variables	χ2 (df)	*p*-value	CFI	TLI	RMSEA	SRMR	Contrast	χ2 Diff		Δ		Decision
								χ2 (df)	*p*	CFI	RMSEA	
Sex: 1 = Women (*n* = 471); 2 = Men (*n* = 482).												
Model 1. Configural	2545.479 (1264)	0.000	0.938	0.931	0.046 (0.042–0.0477)	0.069	-	-	-	-	-	-
Model 2. Metric	2571.506 (1293)	0.000	0.939	0.933	0.046 0.042–0.0477)	0.070	2 vs. 1	26 (29)		0.001	0.000	Accept
Model 3. Scalar	2593.781 (1322)	0.000	0.939	0.935	0.046 0.042–0.0477)	0.070	3 vs. 2	22 (29)		0.000	0.000	Accept

Note. CFI = Comparative Fit Index; Contrast χ^2 Diff = Chi-square difference test between nested models; Decision = Model comparison outcome; Δ = Change in fit index between models; df = Degrees of freedom; p / *p*-value = Probability value; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; TLI = Tucker-Lewis Index; χ^2 = Chi-square statistic; χ^2 (df) = Chi-square value with corresponding degrees of freedom

Table 4 Summary of the overall fit indices for each CFA model

	χ2	df	χ2/df	RMSEA	CFI	TLI	SRMR
Model M1	1816.011	640	2.41	0.0062	0.888	0.877	0.085
Model M2	1816.018	641	2.41	0.062	0.888	0.877	0.085
Model M3	1816.018	641	2.41	0.062	0.888	0.878	0.085
Model M4	1805.979	640	2.41	0.061	0.889	0.878	0.085
Model M5	1624.074	638	2.33	0.053	0.906	0.896	0.075
Model W1	1521.070	640	2.18	0.054	0.914	0.906	0.079
Model W2	1524.021	641	2.18	0.054	0.914	0.905	0.080
Model W3	1524.010	641	2.18	0.054	0.914	0.905	0.080
Model W4	1396.654	639	2.18	0.050	0.926	0.919	0.080
Model W5*	1395.975	638	2.18	0.050	0.926	0.918	0.067

Note. CFI = Comparative Fit Index; df = Degrees of freedom; χ^2 = Chi-square statistic; χ^2/df = Chi-square divided by degrees of freedom (normed chi-square); RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; TLI = Tucker-Lewis Index. M, men; W, women. *Final model

regulations [74–76]. To better interpret the mediation effects, we tested all six motivational regulations, as recommended [114, 115]. We hypothesised: (i) SPA and SPS would predict higher PA; (ii) autonomous and controlled regulations would have positive and negative indirect links between body image and PA; and (iii) men would show more autonomous motivation, while women would show more controlled motivation. Body image is composed in our study of two key elements. SPA refers to the evaluation of one's physical attractiveness, while SPS denotes the evaluation regarding one's physical capabilities or fitness level. High scorers feel mostly positive and satisfied with their appearance and shape; low scorers have a general unhappiness with their physical appearance and shape. Several alternative models were tested. The final ones were chosen for their best fit and theoretical coherence. While key theoretical aspects aligned, the final models differed by sex. Overall, the findings partially supported all three hypotheses.

Our first hypothesis, suggesting that more body imagesatisfaction would be associated with more PA participation, was partially supported. More body image satisfaction, specifically in terms of satisfaction with physical shape, generally associated with increased PA. However, more body image satisfaction, specifically in terms of satisfaction with physical appearance, was associated with lower PA participation. The unexpected negative link between satisfaction with appearance and moderate-vigorous PA was slightly stronger in women. This aligns with epidemiological data: women are more driven by aesthetic concerns, while men focus more on muscle-oriented goals [116]. Additionally, previous studies on the topic have found similar findings, although these studies were based on data from female samples [73, 74]. Otherwise, our results differ from those by More and Phillips [75], who only reported a direct association between body image and cardiovascular activity for women. One explanation is that people satisfied with their appearance see less need to engage in moderate-vigorous PA to alter or maintain it [117]. However, literature also suggests that appearance-based goals may sometimesbe associated with overvaluation of shape and weight. For example, Siegling and Delaney [118] noted this phenomenon particularly in non-clinical samples, where appearance-basedgoals are often associated with excessive body change behaviours (i.e., excessive PA participation). On the other hand, an expected direct positive association of satisfaction with physical shape with moderate-vigorous PA was found. These associations may reflect that PA is often "triggered" by functional motives, like weight loss or maintaining fitness [50]. Furthermore, the results revealed that it was slightly more relevant in women than in men, which is in line with previous studies. Men often participate for enjoyment or social reasons, while women more often aim to improve physical condition [119]. With regard to the direct association

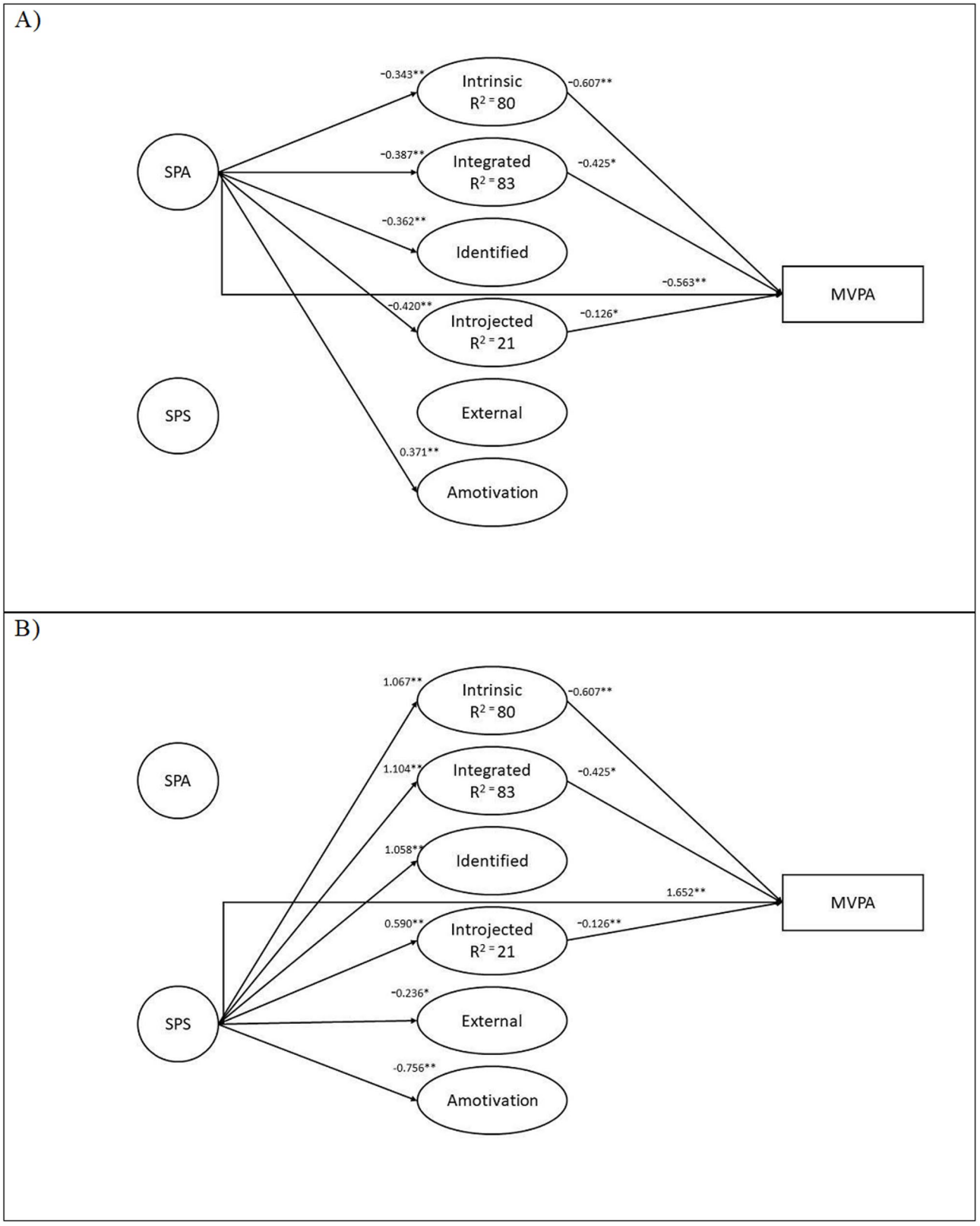

Fig. 4 (See legend on next page.)

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Fig. 4 Final theoretical model (model M5) with standardised regression coefficients (β) for the men subsample. Panel **A**: Satisfaction with Physical Appearance (SPA). Panel **B**: Satisfaction with Physical Shape (SPS). *Note.* MVPA: Moderate-to-vigorous Physical Activity. Solid lines are used to represent direct associations. $p < 0.050$; $^{**}p < 0.010$. Some direct associations showed beta values greater than 1, which can occur in certain situations when the relationships between variables are highly correlated. Additionally, some motivational regulations showed unexpected negative associations with moderate-to-vigorous PA participation. This pattern may reflect a suppression effect, which occurs when predictors share substantial variance, such that controlling for one alters the apparent direction or strength of the association between the other and the outcome. Such effects are permissible and often occur in the context of high correlations between latent variables [112, 113]

between motivational regulations with moderate-vigorous PA, except for introjected motivation among men, nonsignificant associations were found between controlled forms of motivation (introjected and external) and moderate-vigorous PA. Similar results were also reported in previous studies on the topic [74, 75], which is reinforced by the systematic review carried out by Teixeira et al. [56] on self-determination theory within the domain of PA, which also found weak evidence regarding this relationship. These results contrast with Brunet et al. [73], who found significant direct associations for controlled forms of motivation (introjected and external). Furthermore, our results revealed that, compared to women, men tended to be slightly more associated with autonomous forms of motivation (intrinsic, integrated, and identified). As mentioned above, beauty standards, which are an external demand or a socially constructed contingency, can diminish autonomous motivation in women [56]. Except for the nonsignificant relationships for controlled regulations, our findings partially support the hypothesis on the associations of autonomous forms of motivations with sex assigned at-birth.

Our second and third hypotheses were partially supported. In terms of mediation, men tended to be more associated with autonomous forms of motivation compared to women. The relationship between satisfaction with physical appearance and moderate-vigorous PA was clearly positively mediated by intrinsic motivation for men and by integrated motivation for women. These autonomous forms of motivational regulations may be important targets that can be used to develop interventions to promote PA behaviour in dissatisfied individuals. It should be noted that these indirect associations cannot be directly compared to previous studies, as they either relied on body size discrepancies as a proxy for body image dissatisfaction or considered different PA subtypes, such as cardiovascular or strength-based activity [75]. However, the relationship between satisfaction with physical shape and moderate-vigorous PA was clearly negatively mediated by intrinsic and integrated motivation for men and integrated and identified motivation for women [56]. Promoting autonomous motivation can enhance enjoyment in PA. This may be related to lower reliance on functional motives, which are linked to poorer long-term PA maintenance [56]. This finding also has preventive value. High PA participation is linked to poorer treatment outcomes in women with ED [120]. Amotivation showed a significant indirect effect for women. However, given it is a negative bivariate correlation with moderate-to-vigorous PA and the high reliability of the BREQ-3 amotivation subscale, it is unlikely that measurement error accounts for this finding. The most plausible explanation is a statistical suppression effect. Furthermore, other motivational regulations showed indirect associations for satisfaction with physical appearance and satisfaction with physical shape. Some effects were near non-significance or had wide confidence intervals, even after bootstrapping for robustness (e.g., amotivation in women, amotivation in the total model, introjected in men, and integrated/identified in women). These should be interpreted cautiously.

Practical recommendations might be drawn from the results of the presentvstudy. Our findings revealed that in both sexes, satisfaction with physical appearance was associated with lower PA participation. Thus, appearance-focused messaging in fitness-based interventions may be counterproductive. For example, Kerner et al. [121], in a review of body image programmes and interventions in physical education, found that fitness-based interventions primarily targeted the physical attractiveness domain of physical self-perceptions. These interventions were somewhat effective. However, promoting enjoyment (intrinsic) and personal relevance (integrated) could make them even more effective.

At a practical level, to foster these two types of motivation, strategies that emphasise autonomy support, competence satisfaction, and relatedness satisfaction are associated with more favourable outcomes [122, 123]. Autonomy support—allowing individuals control over decisions—has the greatest positive impact on motivation. Competence satisfaction (feeling capable) and fostering social connections also enhance relatedness, which sustains long-term change. Integrating these principles can be associated with to more sustainable and impactful sport programmes. Furthermore, our study revealed that intrinsic and integrated motivations played distinct and meaningful mediating roles in these relationships, particularly in promoting increased PA participation. Thus, in practical terms, for men, intervention-based studies might focus on fostering intrinsic motivation. Likewise, in women, promoting integrated motivation by aligning PA participation with their personal interests and values could be more effective.

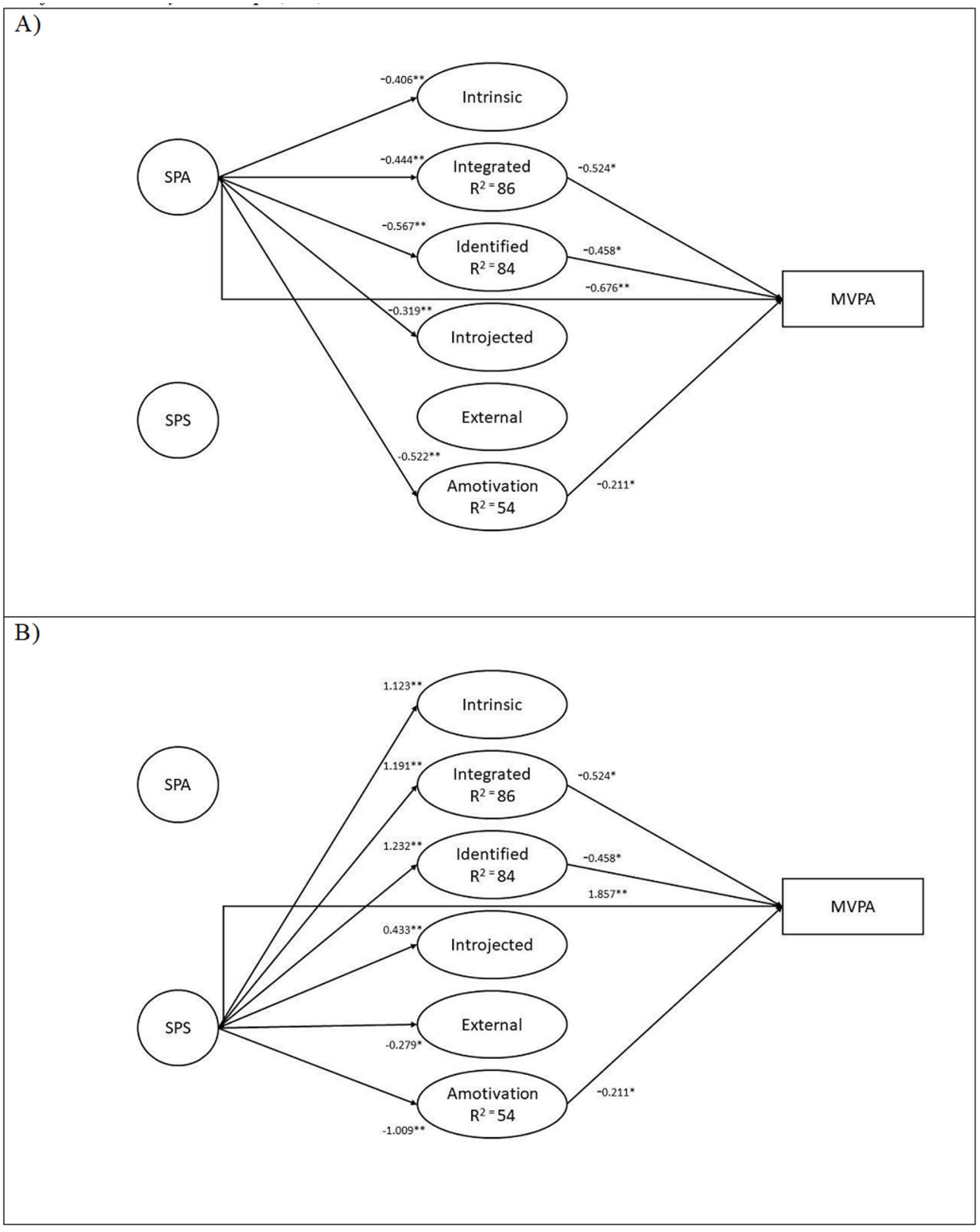

Fig. 5 (See legend on next page.)

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Fig. 5 Final theoretical model (model W5) with standardised regression coefficients (β) for the women subsample. Panel **A**: Satisfaction with Physical Appearance (SPA). Panel **B**: Satisfaction with Physical Shape (SPS). *Note.* MVPA: Moderate-to-vigorous Physical Activity. Solid lines are used to represent direct associations. $p < 0.050$; $^{**}p < 0.010$. Some direct associations showed beta values greater than 1, which can occur in certain situations when the relationships between variables are highly correlated. Additionally, some motivational regulations showed unexpected negative associations with moderate-to-vigorous PA participation. This pattern may reflect a suppression effect, which occurs when predictors share substantial variance, such that controlling for one alters the apparent direction or strength of the association between the other and the outcome. Such effects are permissible and often occur in the context of high correlations between latent variables [112, 113]

Future research could also explore targeting need-supportive practices, as outlined by Ahmadi et al. [124], where educators and trainers suggested self-determination-based strategies, such as offering choices and rationales, to foster autonomous motivation (i.e., intrinsic, or integrated) to enhance PA participation. This view is supported by Gillison et al. [122], who, in their meta-analysis of 74 studies examining techniques to promote autonomous motivation from a self-determination perspective, found that "providing rationales" and "use of non-controlling language" were some of the most important variables. This complementary approach could help balance external demands or socially constructed contingencies with more autonomous forms of motivation, ultimately enhancing PA participation in educational settings, where body image dissatisfaction is relatively prevalent among students [125–127]. In this regard, illustrative examples of need-supportive, autonomy-focused initiatives include the Body Project [128], a peer-led intervention that promotes body acceptance and encourages physical activity for enjoyment rather than appearance-related motives, and FitSpirit [129], a Canadian programme that combines body acceptance workshops with non-competitive activities to foster autonomy, enjoyment, and social connection. Both show how theory-based strategies can be applied to foster intrinsic and integrated motivation. A key strength of our study is the reliance on structural equation modelling, which offers several key advantages over multiple regression [130]. Structural equation modelling accounts for measurement error, tests multiple relationships simultaneously, models both direct and indirect (mediated) associations, and integrates latent and observed variables [130]. Additionally, structural equation modelling allows for iterative model refinement through nested model re-specification, enabling a robust framework for theory-driven analysis [130]. Despite these strengths, SEM is underused in PA theory research (see reviews [10, 11] on the topic). Prior studies noted its advantages but could not apply it due to small samples ($N = 102$; Markland et al. [74]).

The present study could be affected by some limitations that must be acknowledged. First, the cross-sectional design restricts the ability to establish causal relationships between the examined variables. Our findings are theoretically grounded, but longitudinal or experimental studies are needed to replicate them and rule out confounders [75, 131]. Second, we used the Spanish version of the MBSRQ [93]. The findings of the study suggest that the factorial structure of the instrument may not generalise well to English-speaking populations, limiting the generalisability of the results. However, further research is needed to determine if the structure can be replicated and improved in other populations. Third, we did not include PA types (i.e., cardiovascular, or strength-based). As More and Phillips [75] noted, this is crucial since different PA behaviours are mediated by different motivational regulations, and this relationship is markedly moderated by sex assigned at-birth. Fourth, we observed a negative statistical suppression effect in some associations, likely caused by multicollinearity [132]. Specifically, the direct associations of autonomous motivations (intrinsic, integrated, and identified) with PA participation showed a sign flip, a common occurrence with the BREQ-3 due to high intercorrelations among subscales [115]. These negative paths in the model should not be interpreted as indicating that autonomous motivations decrease PA participation. Instead, they may reflect statistical suppression arising from overlapping variance among motivational regulations, rather than theoretical effects. Nevertheless, multicollinearity levels in our dataset were acceptable (correlations < 0.90; VIF < 10) [95, 109]. Finally, although different reviews have shown that the IPAQ questionnaire is well validated [133, 134], IPAQ overestimation of an individual's activity is common because it is a self-reported measure [84]. A way to increase reliability is to combine self-report questionnaires with direct measures such as speedometers or accelerometers [85]. As in other studies, the large sample made this recommendation unfeasible [135].

Conclusion

The suggested model highlights the relationship between body image, particularly SPA and SPS, and PA participation. Motivational regulations, framed within the self-determination theory, appear to play a mediating role in these relationships, with distinct patterns observed between men and women—men showing a stronger association with intrinsic motivation, and women with integrated motivation. Fitness programmes should move away from appearance-based goals. Instead, they should foster autonomous motivation (enjoyment and personal relevance) which is associated with higher PA engagement, lower internalisation of beauty ideals, and better self-esteem. Additional research in varied populations,

including samples segmented by gender identity and sexual orientation, could provide stronger evidence. These insights may offer key targets for interventions that incorporate body image in the context of PA promotion. By using a large, representative sample and examining six motivational regulations, our study contributes to a deeper understanding of the complex relationship between body image and PA. However, given the cross-sectional design of the study, the findings cannot be interpreted as evidence of causality. Studies adopting a longitudinal design may offer a clearer understanding of the directionality of these associations.

Abbreviations

PA Physical activity
SPA Satisfaction with physical appearance
SPS Satisfaction with physical shape

Supplementary Information

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Supplementary Material 1: **Additional file 1**. SEM results expanded.

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Author contributions

SNL: Conceptualization, Data curation, Formal analysis, Investigation, Writing - Original draft; ATJ: Funding acquisition, Supervision, Writing - Review & Editing; LM: Supervision, Writing - Review & Editing, Resources; MBM: Writing - Review & Editing; MAN: Writing - Review & Editing; MSM: Conceptualization, Investigation, Methodology, Project administration, Software, Supervision, Writing - Review & Editing.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the Research Ethics Committee of the Autonomous Region of Andalucía (Code: ULA-PSI2016-350105. Approval no. 20181241335, 24 January 2018) and the Ethics Committee of the Loyola Andalucía University. Data collection in this study followed the ethical standards laid down in the Declaration of Helsinki of 1964 and its subsequent amendments.

Consent for publication

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Competing interests

The authors declare no competing interests.

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References

1. Reiner M, Niermann C, Jekauc D, Woll A. Long-term health benefits of physical activity - A systematic review of longitudinal studies. BMC Public Health. 2013;13(1):1–9. https://doi.org/10.1186/1471-2458-13-813
2. World Health Organization (WHO). Global status report on alcohol and health. Geneva. Switzerland: World Health Organization; 2023.
3. Ding D, Lawson KD, Kolbe-Alexander TL, Finkelstein EA, Katzmarzyk PT, van Mechelen W, Pratt M. The economic burden of physical inactivity: a global analysis of major non-communicable diseases. Lancet. 2016;388(10051):1311–24. https://doi.org/10.1016/S0140-6736(16)30383-X
4. Hagger MS, Moyers S, McAnally K, McKinley LE. Known knowns and known unknowns on behaviour change interventions and mechanisms of action. Health Psychol Rev. 2020;14(1):199–212. https://doi.org/10.1080/17437199.2020.1719184
5. Rhodes RE, McEwan D, Rebar AL. Theories of physical activity behaviour change: A history and synthesis of approaches. Psychol Sport Exerc. 2019;42:100–9. https://doi.org/10.1016/j.psychsport.2018.11.010
6. Conn VS, Hafdahl AR, Mehr DR. Interventions to increase physical activity among healthy adults: meta-analysis of outcomes. Am J Public Health. 2011;101(4):751–8. https://doi.org/10.2105/AJPH.2010.194381
7. Gourlan M, Bernard P, Bortolon C, Romain AJ, Lareyre O, Carayol M, Ninot G, Boiché J. Efficacy of theory-based interventions to promote physical activity. A meta-analysis of randomised controlled trials. Health Psychol Rev. 2016;10(1):50–66. https://doi.org/10.1080/17437199.2014.981777
8. Brand R, Cheval B. Theories to explain exercise motivation and physical inactivity: ways of expanding our current theoretical perspective. Front Psychol. 2019;10(MAY):1–4. https://doi.org/10.3389/fpsyg.2019.01147
9. de Souto Barreto P. Why are we failing to promote physical activity globally? Bull World Health Organ. 2013;91(6):10–1. https://doi.org/10.2471/BLT.13.120790
10. Hagger MS, Weed M. DEBATE: do interventions based on behavioural theory work in the real world? Int J Behav Nutr Phys Act. 2019;16(1). https://doi.org/10.1186/s12966-019-0795-4
11. Rhodes RE, Boudreau P, Josefsson KW, Ivarsson A. Mediators of physical activity behaviour change interventions among adults: a systematic review and meta-analysis. Health Psychol Rev. 2021;0(0):1–58. https://doi.org/10.1080/17437199.2019.1706614
12. Baranowski T, Anderson C, Carmack C. Mediating variable framework in physical activity interventions: how are we doing? how might we do better? Am J Prev Med. 1998;15(4):266–97. https://doi.org/10.1016/S0749-3797(98)00080-4
13. Bauman AE, Sallis JF, Dzewaltowski DA, Owen N. Toward a better Understanding of the influences on physical activity: the role of determinants, correlates, causal variables, mediators, moderators, and confounders. Am J Prev Med. 2002;23(2):5–14. https://doi.org/10.1016/s0749-3797(02)00469-5
14. Rhodes RE, Nigg CR. Advancing physical activity theory: A review and future directions. Exerc Sport Sci Rev. 2011;39(3):113–9. https://doi.org/10.1097/JES.0b013e31821b94c8
15. Noar SM, Mehrotra P. Toward a new methodological paradigm for testing theories of health behaviour and health behaviour change. Patient Educ Couns. 2011;82(3):468–74. https://doi.org/10.1016/j.pec.2010.11.016
16. Cortis C, Puggina A, Pesce C, et al. Psychological determinants of physical activity across the life course: A determinants of diet and physical activity (DEDIPAC) umbrella systematic literature review. PLoS ONE. 2017;12(8):1–25. https://doi.org/10.1371/journal.pone.0182709
17. Hagger MS. Theoretical integration in health psychology: unifying ideas and complementary explanations. Br J Health Psychol. 2009;14(2):189–94. https://doi.org/10.1348/135910708X397034
18. Rhodes RE, Pfaeffli LA. Mediators of physical activity behaviour change among adult non-clinical populations: A review update. Int J Behav Nutr Phys Act. 2010;7. https://doi.org/10.1186/1479-5868-7-37
19. Sabiston CM, Pila E, Vani M, Thogersen-Ntoumani C. Body image, physical activity, and sport: A scoping review. Psychol Sport Exerc. 2019;42(December):48–57. https://doi.org/10.1016/j.psychsport.2018.12.010
20. Rick P, Sánchez-Martín M, Singh A, Navas-León S, Borda-Mas M, Bianchi-Berthouze N, et al. Investigating psychological variables for technologies promoting physical activity. Digit Health. 2022;8:20552076221116559. https://doi.org/10.1177/20552076221116559

21. Bauman AE, Bull FC, National Institute of Health and Clinical Excellence. Environmental correlates of physical activity and walking in adults and children: A review of reviews. ; 2007. [consultado el 26 de febrero de 2020]. Disponible en: https://www.nice.org.uk/guidance/ng90/evidence/environmental-correlates-of-physical-activity-review-pdf-4787281408
22. De Bourdeaudhuij I, Sallis JF, Saelens BE. Environmental correlates of physical activity in a sample of Belgian adults. Am J Health Promot. 2003;18(1):83–92. https://doi.org/10.4278/0890-1171-18.1.83
23. De Bourdeaudhuij I, Teixeira PJ, Cardon G, Deforche B. Environmental and psychosocial correlates of physical activity in Portuguese and Belgian adults. Public Health Nutr. 2005;8(7):886–95. https://doi.org/10.1079/phn2005735
24. Giles-Corti B, Donovan RJ. The relative influence of individual, social and physical environment determinants of physical activity. Soc Sci Med. 2002;54(12):1793–812. https://doi.org/10.1016/s0277-9536(01)00150-2
25. Owen N, Cerin E, Leslie E, duToit L, Coffee N, Frank LD, et al. Neighborhood walkability and the walking behaviour of Australian adults. Am J Prev Med. 2007;33(5):387–95. https://doi.org/10.1016/j.amepre.2007.07.025
26. Pan SY, Cameron C, DesMeules M, Morrison H, Craig CL, Jiang X. Individual, social, environmental, and physical environmental correlates with physical activity among canadians: A cross-sectional study. BMC Public Health. 2009;9:21. https://doi.org/10.1186/1471-2458-9-21
27. Wendel-Vos W, Droomers M, Kremers S, Brug J, Van Lenthe F. Potential environmental determinants of physical activity in adults: A systematic review. Obes Rev. 2007;8(5):425–40. https://doi.org/10.1111/j.1467-789X.2007.00370.x
28. Cash TF, Smolak L, editors. Body image: A handbook of science, practice, and prevention. Guilford Press; 2011.
29. Fallon EA, Harris BS, Johnson P. Prevalence of body dissatisfaction among a united States adult sample. Eat Behav. 2014;15(1):151–8. https://doi.org/10.1016/j.eatbeh.2013.11.007
30. Mental Health Foundation. Report. https://www.mentalhealth.org.uk/explore-mental-health/articles/body-image-report-executive-summary. Published 2019.
31. Latorre Roman PA, Lopez Munera R, Izquierdo Rus T, Garcia Pinillos F. Body satisfaction in Spanish Adults, influence of Sex, age and weight state. Rev Iberoam Diagn Eval Psicol. 2018;47(2):83–94. https://doi.org/10.21865/RIDEP47.2.06
32. Rodgers RF, Laveway K, Campos P, de Carvalho PHB. Body image as a global mental health concern. Camb Prisms Glob Ment Health. 2023;10:e9. https://doi.org/10.1017/gmh.2023.2
33. Liu W, Lin R, Guo C, Xiong L, Chen S, Liu W. Prevalence of body dissatisfaction and its effects on health-related quality of life among primary school students in Guangzhou, China. BMC Public Health. 2019;19(1):1–8. https://doi.org/10.1186/s12889-019-6519-5
34. Bucchianeri MM, Neumark-Sztainer D. Body dissatisfaction: an overlooked public health concern. J Public Ment Health. 2014;13(2):64–9. https://doi.org/10.1108/JPMH-11-2013-0071
35. Granner ML, Black DR, Abood DA. Levels of cigarette and alcohol use related to eating-disorder attitudes. Am J Health Behav. 2002;26(1):43–55. https://doi.org/10.5993/ajhb.26.1.5
36. Littleton H, Breitkopf CR, Berenson A. Body image and risky sexual behaviours: an investigation in a tri-ethnic sample. Body Image. 2005;2(2):193–8. https://doi.org/10.1016/j.bodyim.2005.02.003
37. Fiske L, Fallon EA, Blissmer B, Redding CA. Prevalence of body dissatisfaction among united States adults: review and recommendations for future research. Eat Behav. 2014;15(3):357–65. https://doi.org/10.1016/j.eatbeh.2014.04.010
38. Cash TF, Deagle EA 3rd. The nature and extent of body-image disturbances in anorexia nervosa and bulimia nervosa: A meta-analysis. Int J Eat Disord., Gunter R, McEwan D, Kamarhie A. Physical activity and body image among men and boys: A meta-analysis. *Body Image*. 2017;22:114–128. doi:10.1016/j.bodyim.2017.06.007.
39. Panão I, Carraça EV. Effects of exercise motivations on body image and eating habits/behaviours: A systematic review. Nutr Dietetics. 2020;77(1):41–59. https://doi.org/10.1111/1747-0080.12575
40. Fernández-Bustos JG, Infantes-Paniagua Á, Cuevas R, Contreras OR. Effect of physical activity on self-concept: theoretical model on the mediation of body image and physical self-concept in adolescents. Front Psychol. 2019;10(JULY). https://doi.org/10.3389/fpsyg.2019.01537
41. Fernández-Bustos JG, Infantes-Paniagua Á, Gonzalez-Martí I, Contreras-Jordán OR. Body dissatisfaction in adolescents: differences by sex, BMI and type and organisation of physical activity. Int J Environ Res Public Health. 2019;16(17). https://doi.org/10.3390/ijerph16173109
42. Gilchrist JD, Pila E, Castonguay A, Sabiston CM, Mack DE. Body pride and physical activity: differential associations between fitness- and appearance-related pride in young adult Canadians. Body Image. 2018;27:77–85. https://doi.org/10.1016/j.bodyim.2018.08.010
43. Srismith D, Wider L-M, Wong HY, et al. Influence of physical activity interventions on body representation: A systematic review. Front Psychiatry. 2020;11(March). https://doi.org/10.3389/fpsyt.2020.00099
44. Beadle ES. Published. Body shame, body compassion and physical activity. http://uhra.herts.ac.uk/handle/2299/22613. 2020.
45. Silva MN, Vieira PN, Coutinho SR, Minderico CS, Matos MG, Sardinha LB, et al. Using self-determination theory to promote physical activity and weight control: a randomized controlled trial in women. J Behav Med. 2010;33:110–22. https://doi.org/10.1007/s10865-009-9239-y
46. Alleva JM, Sheeran P, Webb TL, Martijn C, Miles E. A meta-analytic review of stand-alone interventions to improve body image. PLoS ONE. 2015;10(9):e0139177. https://doi.org/10.1371/journal.pone.0139177
47. Campbell A, Hausenblas HA. Effects of exercise interventions on body image: A meta-analysis. J Health Psychol. 2009;14(6):780–93. https://doi.org/10.1177/1359105309338977
48. Añez E, Fornieles-Deu A, Fauquet-Ars J, López-Guimerà G, Puntí-Vidal J, Sánchez-Carracedo D. Body image dissatisfaction, physical activity and screen-time in Spanish adolescents. J Health Psychol. 2018;23(1):36–47. https://doi.org/10.1177/1359105316664134
49. Brudzynski LR, Ebben W. Body image as a motivator and barrier to exercise participation. *Int J Exerc Sci*. 2010;3(1):3. Available at: https://digitalcommons.wku.edu/ijes/vol3/iss1/3
50. Vani M, Murray R, Sabiston C. Body image and physical activity. In: Essentials of Exercise and Sport Psychology: An Open Access Textbook. Published 2021. https://doi.org/10.51224/b1007
51. Ginis KM, Bassett-Gunter RL, Conlin C. Body image and exercise. In: Oxford handbook of exercise psychology. 2012:55–75.
52. Deci EL, Ryan RM. The general causality orientations scale: Self-determination in personality. J Res Pers. 1985;19(2):109–34. https://doi.org/10.1016/0092-6566(85)90023-6
53. Deci EL, Ryan RM. The what and why of goal pursuits: human needs and the self-determination of behaviour. Psychol Inq. 2000;11(4):227–68. https://doi.org/10.1207/S15327965PLI1104_01
54. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol. 2000;55(1):68–78. https://doi.org/10.1037/0003-066X.55.1.68
55. Teixeira PJ, Carraça EV, Markland D, Silva MN, Ryan RM. Exercise, physical activity, and self-determination theory: A systematic review. Int J Behav Nutr Phys Act. 2012;9. https://doi.org/10.1186/1479-5868-9-78
56. Najera RJ, Mondaca F, Jimenez C, Conchas M, Aguirre SI, Rangel Y, et al. Motives for male and female university students engaging in physical exercise. Eur Sci J. 2019;15(32):32–40. Disponible en:. https://eujournal.org/index.php/esj/article/view/12521
57. Sáez I, Solabarrieta J, Rubio I. Motivation for physical activity in university students and its relation with gender, amount of activities, and sport satisfaction. Sustainability. 2021;13(6):3183. https://doi.org/10.3390/su13063183
58. Romero-Parra N, Solera-Alfonso A, Bores-García D, Delfa-De-La-Morena JM. Sex and educational level differences in physical activity and motivations to exercise among Spanish children and adolescents. Eur J Pediatr. 2023;182(2):533–42. https://doi.org/10.1007/s00431-022-04742-y
59. Franzoi SL. The body-as-object versus the body-as-process: gender differences and gender considerations. Sex Roles. 1995;33:417–37. https://doi.org/10.1007/BF01954577
60. Mulgrew KE, Tiggemann M. Form or function: does focusing on body functionality protect women from body dissatisfaction when viewing media images? J Health Psychol. 2018;23(1):84–94. https://doi.org/10.1177/1359105316655471
61. Brown TA, Forney KJ, Pinner D, Keel PK. A randomized controlled trial of the body project: more than muscles for men with body dissatisfaction. Int J Eat Disord. 2017;50(8):873–83. https://doi.org/10.1002/eat.22724
62. Fletcher J. Applying self-determination theory to college students' physical-activity behaviour: Understanding the motivators for physical (in) activity. Commun Stud. 2016;67(5):489–508. https://doi.org/10.1080/10510974.2016.1212911
63. Grogan S. Body image: Understanding body dissatisfaction in men, women and children. 3rd ed. London: Routledge; 2021.

64. Quittkat HL, Hartmann AS, Düsing R, Buhlmann U, Vocks S. Body dissatisfaction, importance of appearance, and body appreciation in men and women over the lifespan. Front Psychiatry. 2019;10:864. https://doi.org/10.3389/fpsyt.2019.00864
65. Brunet J, Sabiston CM. Social physique anxiety and physical activity: A self-determination theory perspective. Psychol Sport Exerc. 2009;10(3):329–35. https://doi.org/10.1016/j.psychsport.2008.11.002
66. Festinger L. A theory of social comparison processes. Hum Relat. 1954;7(2):117–40. https://doi.org/10.1177/001872675400700202
67. Hart EA, Leary MR, Rejeski WJ. The measurement of social physique anxiety. J Sport Exerc Psychol. 1989;11(1):94–104. https://doi.org/10.1123/jsep.11.1.94
68. Sabiston CM, Pila E, Pinsonnault-Bilodeau G, Cox AE. Social physique anxiety experiences in physical activity: a comprehensive synthesis of research studies focused on measurement, theory, and predictors and outcomes. Int Rev Sport Exerc Psychol. 2014;7(1):158–83. https://doi.org/10.1080/1750984X.2014.904392
69. Thøgersen-Ntoumani C, Ntoumanis N. A self-determination theory approach to the study of body image concerns, self-presentation and self-perceptions in a sample of aerobic instructors. J Health Psychol. 2007;12(2):301–15. https://doi.org/10.1177/1359105307074267
70. Reinboth MS, Sundgot-Borgen J, Bratland-Sanda S. Exercise dependence and body image concerns amongst group fitness instructors: A self-determination theory approach. Front Psychol. 2022;12:816287. https://doi.org/10.3389/fpsyg.2021.816287
71. Freire GLM, da Silva Paulo JR, da Silva AA, Batista RPR, Alves JFN, do, Nascimento Junior JRA. Body dissatisfaction, addiction to exercise and risk behaviour for eating disorders among exercise practitioners. *J Eat Disord*. 2020;8(1):1–9. https://doi.org/10.1186/s40337-020-00300-9
72. Brunet J, Sabiston C, Castonguay A, Ferguson L, Bessette N. The association between physical self-discrepancies and women's physical activity: the mediating role of motivation. J Sport Exerc Psychol. 2012;34(1):102–23. https://doi.org/10.1123/jsep.34.1.102
73. Markland D. The mediating role of behavioural regulations in the relationship between perceived body size discrepancies and physical activity among adult women. Hell J Psychol. 2009;6:169–82.
74. More KR, Phillips LA. The influence of body dissatisfaction on cardiovascular and strength-based physical activity by gender: A self-determination theory approach. Psychol Health. 2019;34(12):1437–50. https://doi.org/10.1080/08870446.2019.1614587
75. Cash TF. Body image: A joyous journey. Body Image. 2017;23(October):A1–2. https://doi.org/10.1016/j.bodyim.2017.11.00
76. Kling J, Kwakkenbos L, Diedrichs PC, et al. Systematic review of body image measures. Body Image. 2019;30:170–211. https://doi.org/10.1016/j.bodyim.2019.06.006
77. Markland D, Tobin V. A modification to the behavioural regulation in exercise questionnaire to include an assessment of amotivation. J Sport Exerc Psychol. 2004;26(2):191–6. https://doi.org/10.1123/jsep.26.2.191
78. More KR, Hayes NL, Phillips LA. Contrasting constructs or continuum? Examining the dimensionality of body appreciation and body dissatisfaction. Psychol Health. 2024;39(3):336–57. https://doi.org/10.1080/08870446.2022.2055025
79. Gunzler D, Chen T, Wu P, Zhang H. Introduction to mediation analysis with structural equation modeling. Shanghai Arch Psychiatry. 2013;25(6):390–4. https://doi.org/10.3969/j.issn.1002-0829.2013.06.009
80. Hallal PC, Hallal, Victora CG. Reliability and validity of the international physical activity questionnaire (IPAQ). Med Sci Sports Exerc. 2004;36(3):556–556. https://doi.org/10.1249/01.mss.0000117161.66394.07
81. IPAQ Research Committee. Guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ)-short and long forms. http://www.ipaq.ki.se/scoring.pdf. Published 2005.
82. Sember V, Meh K, Sorić M, Starc G, Rocha P, Jurak G. Validity and reliability of international physical activity questionnaires for adults across EU countries: systematic review and meta analysis. Int J Environ Res Public Health. 2020;17(19):7161. https://doi.org/10.3390/ijerph17197161
83. Viñas BR, Barba LR, Ngo J, Majem LS. Validación En población Catalana Del cuestionario internacional de actividad física. Gac Sanit. 2013;27(3):254–7. https://doi.org/10.1016/j.gaceta.2012.05.013
84. Wilson PM, Rodgers WM, Loitz CC, Scime G. It's Who I Am… Really!'The importance of integrated regulation in exercise contexts. J Appl Biobehav Res. 2006;11(2):79–104. doi:10.1111/j.1751-9861.2006.tb00021.x.
85. González-Cutre D, Sicilia Á, Fernández A. Hacia Una mayor comprensión de La motivación En El ejercicio físico: medición de La regulación integrada En El contexto español. Psicothema. 2010;22(4):841–7. https://www.redalyc.org/articulo.oa?id=72715515047
86. Cash TF. Users' manuals for the Multidimensional Body-Self Relations Questionnaire, the Body-Image Ideals Questionnaire, the Appearance Schemas Inventory, the Situaional Inventory of Body-Image Dysphoria, and the Appearance Schemas Inventory. (Available from the author at www.body-images.com)s. 2000.
87. del Cid LBG, Rabert ER, Ruiz JB. Evaluación psicométrica de La imagen corporal: Validación de La versión española Del multidimensional body self relations questionnaire (MBSRQ). Rev Argent Clin Psicol. 2009;18(3):253–64. https://www.redalyc.org/articulo.oa?id=281921775006
88. Ornelas LHB, Ramírez JV, Chávez JF, Enríquez MDZ, Pando EVB. Composición factorial Del multidimensional body self relations questionnaire (MBSRQ) En universitarios Mexicanos. Rev Psicol Deport. 2017;26(2):113–8. https://doi.org/10.19044/esj.2020.v16n29p14
89. Ornelas JR, Martínez RP, Tiznado CJR, Del Cid J. Influencia de La insatisfacción corporal y La actividad física En El bienestar psicológico de jóvenes Mexicanas. Retos. 2022;45:259–67. https://dialnet.unirioja.es/descarga/articulo/8413106.pdf
90. Tarka P. An overview of structural equation modeling: its beginnings, historical development, usefulness and controversies in the social sciences. Qual Quant 2018;52:313–54. https://doi.org/10.1007/s11135-022-01326-8
91. Brown TA. Confirmatory factor analysis for applied research. Guilford; 2015.
92. Bollen KA. Structural equations with latent variables. New York: Wiley; 1989.
93. Kline R. Principles and practice of structural equation modeling. New York: The Guilford Press; 2011.
94. Hair JF, Black WC, Babin BJ, Anderson RE, Tatham RL. Multivariate data analysis. 7th ed. New York: Pearson; 2010.
95. Moshagen M, Bader M, semPower. General power analysis for structural equation models. Behav Res Methods. 2024;56(4):2901–22. https://doi.org/10.3758/s13428-023-02254-7
96. IBM Corp. IBM SPSS statistics for windows (version 28). Armonk, NY: IBM Corp; 2021.
97. Cheng EW. SEM being more effective than multiple regression in parsimonious model testing for management development research. J Manag Dev. 2001;20(7):650–67. https://doi.org/10.1108/02621710110400564
98. Hayes AF. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. Guilford; 2017.
99. Hayes AF, Scharkow M. The relative trustworthiness of Inferential tests of the indirect effect in statistical mediation analysis: does method really matter? Psychol Sci. 2013;24(10):1918–27. 10.1177/0956797613480187.
100. Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct Equ Model. 1999;6(1):1–55. https://doi.org/10.1080/10705519909540118
101. HooperD CJ, Mullen M. Structural equation modelling: guidelines for determining model fit. Electron J Bus Res Methods. 2008;6(1):53–60. https://doi.org/10.21427/d7cf7r
102. Muthén LK, Muthén BO. Mplus User's Guide. Sixth Edition. Los Angeles, CA: Muthén & Muthén. Statmodel; 2017. https://www.statmodel.com/download/usersguide/MplusUserGuideVer_8.pdf
103. Preacher KJ, Hayes AF. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behav Res Methods. 2008;40(3):879–91. https://doi.org/10.3758/brm.40.3.879
104. Cheung GW, Lau RS. Testing mediation and suppression effects of latent variables: bootstrapping with structural equation models. Organ Res Methods. 2008;11(2):296–325. 10.1177/1094428107300343.
105. Chen FF. Sensitivity of goodness of fit indexes to lack of measurement invariance. Struct Equ Model. 2007;14(3):464–504. https://doi.org/10.1080/10705510701301834
106. Muthén BO, Muthén LK, Asparouhov T. Regression and mediation analysis using Mplus. Los Angeles, CA: Muthén & Muthén; 2017.
107. Lorenzo-Seva U, Ferrando PJ. FACTOR: A computer program to fit the exploratory factor analysis model. Behav Res Methods. 2006;38(1):88–91. https://doi.org/10.3758/bf03192753
108. Tabachnick BG, Fidell LS, Ullman JB. Using multivariate statistics. Volume 5. Boston, MA: Pearson; 2007.
109. Iacobucci D. Structural equations modeling: fit indices, sample size, and advanced topics. J Consum Psychol. 2010;20(1):90–8. https://doi.org/10.1016/j.jcps.2009.09.003
110. Jöreskog KG. How large can a standardized coefficient be? Struct Equ Modeling. 1999;6(4):335–41. Available from: http://www.statmodel.com/download/Joreskog.pdf

111. Schreiber JB. Core reporting practices in structural equation modeling. Res Social Adm Pharm. 2008;4(2):83–97. https://doi.org/10.1016/j.sapharm.2007.04.003
112. Ryan RM, editor. The Oxford handbook of self-determination theory. Oxford: Oxford University Press; 2023.
113. Howard JL, Gagné M, Van den Broeck A, Guay F, Chatzisarantis N, Ntoumanis N, et al. A review and empirical comparison of motivation scoring methods: an application to self-determination theory. Motiv Emot. 2020;44:534–48. https://doi.org/10.1007/s11031-020-09831-9
114. Murray SB, Nagata JM, Griffiths S, et al. The enigma of male eating disorders: A critical review and synthesis. Clin Psychol Rev. 2017;57:1–11. https://doi.org/10.1016/j.cpr.2017.08.001
115. Peng B, Ng JY, Ha AS. Barriers and facilitators to physical activity for young adult women: a systematic review and thematic synthesis of qualitative literature. Int J Behav Nutr Phys Act. 2023;20(1):1–17. https://doi.org/10.1186/s12966-023-01411-7
116. Siegling AB, Delaney ME. Toward Understanding body image importance: individual differences in a Canadian sample of undergraduate students. Eat Disord. 2013;21(2):117–29. https://doi.org/10.1080/10640266.2013.761083
117. Molanorouzi K, Khoo S, Morris T. Motives for adult participation in physical activity: type of activity, age, and gender. BMC Public Health. 2015;15(1):1–12. https://doi.org/10.1186/s12889-015-1429-7
118. Guemmer R, Giel KE, Schag K, et al. High levels of physical activity in anorexia nervosa: a systematic review. Eur Eat Disord Rev. 2015;23(5):333–44. 10.1249/MSS.0000000000000912.
119. Kerner C, Prescott A, Smith R, Owen M. A systematic review exploring body image programmes and interventions in physical education. Eur Phys Educ Rev. 2022;28(4):942–67. https://doi.org/10.1177/1356336X221097318
120. Gillison FB, Rouse P, Standage M, Sebire SJ, Ryan RM. A meta-analysis of techniques to promote motivation for health behaviour change from a self-determination theory perspective. Health Psychol Rev. 2019;13(1):110–30. https://doi.org/10.1080/17437199.2018.1534071
121. Teixeira PJ, Marques MM, Silva MN, Brunet J, Duda JL, Haerens L, et al. A classification of motivation and behaviour change techniques used in self-determination theory-based interventions in health contexts. Motiv Sci. 2020;6(4):438. https://doi.org/10.1037/mot0000172
122. Ahmadi A, Noetel M, Parker P, Ryan RM, Ntoumanis N, Reeve J, et al. A classification system for teachers' motivational behaviours recommended in self-determination theory interventions. J Educ Psychol. 2023. https://doi.org/10.1037/edu0000783
123. Bornioli A, Lewis-Smith H, Slater A, Bray I. Body dissatisfaction predicts the onset of depression among adolescent females and males: a prospective study. J Epidemiol Community Health. 2021;75(4):343–8. https://doi.org/10.1136/jech-2019-213033
124. Ferrari EP, Petroski EL, Silva DAS. Prevalence of body image dissatisfaction and associated factors among physical education students. Trends Psychiatry Psychother. 2013;35:119–27. https://doi.org/10.1590/s2237-60892013000200005
125. Liu W, Lin R, Guo C, Xiong L, Chen S, Liu W. Prevalence of body dissatisfaction and its effects on health-related quality of life among primary school students in Guangzhou, China. BMC Public Health. 2019;19:1–8. https://doi.org/10.1186/s12889-019-6519-5
126. Stice E, Rohde P, Shaw H, Gau J. An effectiveness trial of a dissonance-based eating disorder prevention program for high-risk adolescent girls. J Consult Clin Psychol. 2019;87(6):529–42. https://doi.org/10.1037/a0016132
127. Sabiston CM, Brunet J, O'Loughlin E, et al. The fitspirit program: a school-based physical activity intervention for adolescent girls. J Phys Act Health. 2014;11(7):1393–9. https://doi.org/10.1186/s12889-021-10200-5
128. Nunkoo R, Ramkissoon H. Structural equation modelling and regression analysis in tourism research. Curr Issues Tour. 2012;15(8):777–802. https://doi.org/10.1080/13683500.2011.641947
129. Spector PE. Do not cross me: optimizing the use of cross-sectional designs. J Bus Psychol. 2019;34(2):125–37. https://doi.org/10.1007/s10869-018-09613-8
130. Martinez Gutierrez N, Cribbie R. Incidence and interpretation of statistical suppression in psychological research. Can J Behav Sci. 2021;53(4):480. https://doi.org/10.1037/cbs0000267
131. Healy GN, Clark BK, Winkler EAH, Gardiner PA, Brown WJ, Matthews CE. Measurement of adults' sedentary time in population-based studies. Am J Prev Med. 2011;41(2):216–27. https://doi.org/10.1016/j.amepre.2011.05.005
132. Silsbury Z, Goldsmith R, Rushton A. Systematic review of the measurement properties of self-report physical activity questionnaires in healthy adult populations. BMJ Open. 2015;5(9):1–10. https://doi.org/10.1136/bmjopen-2015-008430
133. Biernat E, Piątkowska M. Overestimation of physical activity by the long IPAQ in a Polish nationwide study. Hygeia Public Health. 2016;51(1):87–95. https://doi.org/10.13140/RG.2.1.1448.7445
134. Ahmad MH, Salleh R, Mohamad Nor NS, et al. Comparison between self-reported physical activity (IPAQ-SF) and pedometer among overweight and obese women in the MyBFF@home study. BMC Womens Health. 2018;18(Suppl 1). https://doi.org/10.1186/s12905-018-0599-8
135. Gobbi S, Sebastião E, Papini CB, et al. Physical inactivity and related barriers: A study in a community dwelling of older Brazilians. J Aging Res. 2012. https://doi.org/10.1155/2012/685190

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