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Body image dissatisfaction and experimental pressure pain sensitivity in a cohort of 13-year-old adolescents

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ABSTRACT

Objective: We aimed to quantify the associations between body image (dis)satisfaction and pressure pain thresholds in adolescents, using data from Generation XXI, a population-based cohort study in Portugal.
Methods: We assessed 1785 13-year old adolescents cross-sectionally. Body image satisfaction was measured using the Children's Figure Rating Scale. Pain detection and tolerance thresholds were assessed using cuff pressure algometry. We quantified the associations between body image categories (satisfied, prefers slightly thinner, prefers much thinner, and prefers heavier) and pain detection and tolerance thresholds using linear and logistic regression for continuous and binary (odds of achieving the highest distribution quarter) outcomes, respectively. Models were adjusted to pubertal stage and body mass index.
Results: Adolescents who desired a heavier silhouette had lower pressure pain tolerance thresholds when compared to those who were satisfied (linear regression coefficient: −3.95; 95% confidence interval: −6.68, −1.21), which was more precise in boys (−3.51; −7.17, −0.08). Those adolescents also had lower odds of achieving the highest quarter of pressure pain tolerance threshold (odds ratio: 0.66; 0.48, 0.90), especially girls (0.58; 0.35, 0.98). Adolescents who desired much thinner silhouettes had lower odds of achieving the highest quarter of pressure pain tolerance (0.68; 0.46, 1.00), and this was clearer in girls (0.66; 0.48, 0.90). Pain detection thresholds did not show robust associations with body image dissatisfaction.
Conclusion: Our study suggests an association between satisfaction with one's silhouette and pain tolerance in adolescents from the general population, arguing for an integrated approach to the assessment of body image and pain sensitivity.

1. Introduction

Body image is typically defined by how individuals experience their embodiment, including cognitive-affective, perceptual and behavioral components [1,2]. Although most research addresses appearance-related domains, body image encompasses a range of experiences related also to physical functioning as well as biological integrity [3]. This broad psychological understanding of body image resonates with a sensorimotor definition of body image as "the way one's body feels to its owner" [4], which is of particular relevance in the context of chronic pain conditions.

One's body image can be seen as the result of interactions between contextual influences, such as cultural norms and interpersonal relations, and individual physical traits and development (e.g. body size and sexual development), organic disease, personality traits (e.g. neuroticism), and psychological distress, including depression and anxiety [3]. For instance, body image seems to mediate the maintenance of psychosocial maladjustment among patients with post-traumatic stress disorder [5], whereas neuroticism is associated with body image dissatisfaction [6]. Those influences also play a major role in the establishment and maintenance of chronic pain, which can be modelled in terms of a multilevel matrix of increasing complexity, from a

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nociceptive to a perceptive-attentional level, and finally to a reappraisal-emotional level, which form a cognitive-affective basis for the maintenance of pain experiences [7]. An individual's interpretations of pain are seen as the key to understanding their responses to painful stimuli (behaviors, coping and affect), and several mutual maintenance mechanisms are common between long-term pain and chronic psychological distress, including attentional and reasoning biases, avoidant coping styles, depression and anxiety [8]. Personality traits are also thought to play a role, with neuroticism being associated with increased reactivity to pain and greater pain-related anxiety [9].

The relation between body image and pain is well-documented from a neurological perspective, e.g. exposure to chronic physical pain contributes to cortical reorganization, leading to body image distortions and sensory inaccuracy in different chronic pain patient populations [4,10]. The psychological literature also supports this relation, with empirical associations being found between body image dissatisfaction, appearance concerns, reported pain, reduced functioning and negative mood in disease-specific cohorts [11–13]. Conversely, pain acceptance is associated with a positive body image [14].

Much less is known on whether different body image experiences are related to pain sensitivity subclinically, in the absence of chronic pain conditions, body image disturbances, or psychological distress states. In particular, little is known on how they relate in pediatric ages, even though some studies suggest that body image dissatisfaction - a negative attitude towards one's body that contributes to the cognitive-affective component of body image - may trace back to the first decade of life [15,16]. The prevalence of body image dissatisfaction increases progressively during adolescence [17], which seems to be a sensitive period for shaping body image, with its profound changes in various dimensions of development such as physical, cognitive and social-emotional. Like body image dissatisfaction, adverse pain experiences also increase during adolescence and are seen as intermediate steps towards chronic pain trajectories [18–20]. Although most evidence on pain profiles originates from questionnaires, quantitative sensory testing (QST) adds a psychophysiological understanding of the embodiment of pain phenotypes. QST comprises standardized calibrated stimuli used to measure pain detection and tolerance thresholds [21], as well as pro- and anti-nociceptive mechanisms. Pressure pain QST seems useful to discriminate sensory responses in youth [22].

Body image and chronic pain share psychological and neurological mechanisms, and adolescence is a key build-up period for both experiences. Yet, little is known on whether they are associated in the general adolescent population. This knowledge may be useful to provide evidence for an integrated understanding and management of body image and bodily pain from a young age. Therefore, we aimed to quantify pressure pain sensitivity according to body image dissatisfaction among girls and boys from the general population, by using data from a 13-year-old population-based birth cohort. We hypothesized that adolescents dissatisfied with their body image have a lower sensitivity to experimental pain compared to those who report to be more satisfied with their body image.

2. Methods

2.1. Participants

We used data from the Generation XXI birth cohort, described in detail elsewhere [23,24]. Briefly, mothers who gave birth to live-born children with a gestational age over 23 weeks, between April 2005 and August 2006, were recruited up to 72 h after delivery from one of the five public level III maternities [25] that covered the metropolitan area of Porto, Portugal. These maternities were responsible for 91.6% of the deliveries in the whole catchment population in 2004. A total of 91.4% of the invited mothers agreed to participate, yielding an initial cohort of 8647 children. Follow-up evaluations were conducted at 4, 7, 10 and 13 years of age [23,24]. The present investigation is a cross-sectional study implemented in the 13-year follow-up evaluation, which occurred between August 2018 and March 2020. Evaluations have focused on a wide set of research areas related to the biological and psychosocial aspects of growth and development, including the assessment of pain experiences [26]. Ethical approval was obtained for each cohort evaluation. Specifically, the 13-years-old wave study protocol, including the evaluation of quantitative sensory responses using cuff pressure algometry, was approved by the Ethics Committee of the Institute of Public Health of the University of Porto with the reference 1932CE. The study conforms to the Helsinki Declaration and the Oviedo Convention. Participation was voluntary and written informed consent was obtained from legal guardians and oral assent from children, after one team member informed families about the objectives and methods of the study.

Of the cohort recruited at birth, we were able to reassess 4633 adolescents in the 13 years wave of age up until March 2020, when in-person evaluations were interrupted due to the COVID-19 pandemic. Due to equipment availability and questionnaire design, data on our outcome (quantitative sensory responses) and exposure (body image satisfaction) were collected from a consecutive subsample of 1785 adolescents who constitute our final analytical sample in the present paper. More detailed information on the selection criteria is depicted in Fig. 1, and differences between those included and the remaining cohort participants assessed at age 13 ($n = 2848$) regarding age, sex, anthropometric data and body image satisfaction are presented in Supplementary Table 1. Groups had similar distributions in all parameters except for Tanner stage, with participants included being more frequently classified in categories 4 and 5 than those not included.

3. Evaluation

3.1. Body image satisfaction

Body Image Satisfaction at 13 years of age was assessed using the Children's Figure Rating Scale [27]. The scale consists of nine gender-specific figures of increasing size (Supplementary material). Adolescents were asked first to select the figure they thought they looked the most like (Q1) and then the figure they desired to look like the most (Q2). Body image satisfaction was calculated as the discrepancy between these two ratings (Q2-Q1). Four categories were then defined: “Satisfied” (reference category) when the difference was zero, “prefers much thinner silhouette” when the difference was between −4 and − 2, “prefers slightly thinner silhouette” when the difference was −1 and “prefers heavier silhouette” when the difference was greater than zero [28]. The “prefers heavier” category was not further subdivided due to a smaller sample size ($n = 363$).

3.2. Quantitative sensory testing

Adolescents underwent quantitative sensory testing to assess responses to standardized pressure stimuli. We used a computer-controlled cuff pressure algometer (Nocitech, Denmark)[29,62] to perform the evaluation. This equipment consists of a 13 cm-wide silicone high-pressure tourniquet cuff, a computer-controlled compressor, a 100 mm electronic visual analog scale (VAS), and a stop-button for immediate cuff deflation [30]. The tourniquet was tightly mounted around the widest part of the gastrocnemius, ensuring no clothes were present between the cuff and skin. For the measurements, we applied a ramp inflation pattern, with constant inflation of 1 kPa/s [31]. Tests were conducted by trained examiners using a standardized protocol, including oral instructions throughout the procedure. Adolescents were asked to continuously move the electronic visual analog scale (VAS) to rate perceived pain intensity. VAS extremes “0” and “100” mm were defined as “no pain” and “maximal pain”, respectively. The cuff was programmed to deflate instantaneously whenever the VAS reached 100 mm, or the pressure reached a predefined maximum of 100 kPa, or the

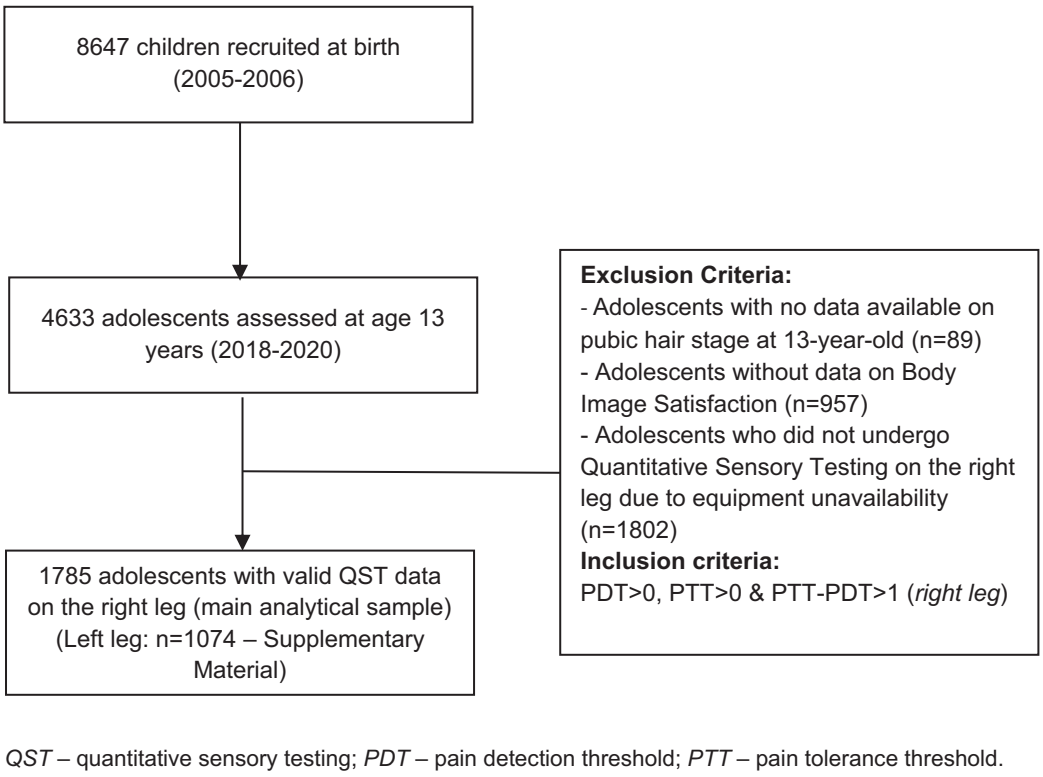

Fig. 1. Selection of analytic sample from the Generation XXI birth cohort.
QST – quantitative sensory testing; *PDT* – pain detection threshold; *PTT* – pain tolerance threshold.

adolescent pressed a safe key on the VAS peripheral, whichever occurred first. Adolescents were informed that they could stop the examination verbally or by pressing the safe key whenever they wished.

Pain detection threshold (PDT) was defined as the pressure exerted the first time the VAS score exceeded 10 mm. Pain tolerance threshold (PTT) was defined as the pressure exerted when the VAS reached 100 mm or the adolescent pressed the safe key. If none of those happened, PTT was set at 100 kPa (750 mmHg) [32]. The test was conducted on both legs. Given that results were very similar between legs, we present results for the right leg, for which our sample size was larger (Fig. 1). Results for the left leg findings are presented as Supplementary Material.

3.3. Confounders

It is likely that current body size and sexual development influence pain sensitivity and body image satisfaction simultaneously. Therefore, we used body mass index and pubertal stage as confounders in our models. At the 13 years evaluation, adolescents' weight and height were measured using standard procedures [33]: participants were weighed in underwear and without shoes, using a digital scale, and the measure was recorded to the nearest 0.1 kg. Height was also measured without shoes, using a fixed stadiometer to the nearest 0.1 cm. Body mass index (BMI), age- and sex-specific BMI z-scores were calculated, and weight status categories were established according to the World Health Organization (WHO), as follows: 'underweight' was defined as z-score < -2 standard deviations (SD), 'normal weight' as z-score ≥ -2SD and $< +1$SD, 'overweight' as z-score $\geq +1$SD and $< +2$SD and 'obesity' as z-score $\geq +2$SD [34]. Pubic hair stage was evaluated by trained nurses using the Tanner Scale as reference [35, 36], with stage 1 corresponding to pre-pubertal, stages 2 to 4 to pubertal, and 5 to post-pubertal in both sexes.

3.4. Statistical analysis

Tanner stages 1 and 2 were grouped for analysis. To estimate the association between pain detection and tolerance thresholds and adolescents' body image satisfaction, outcomes were used as continuous (PDT and PTT in kPa, analyzed using linear regression) and dichotomous measures (PDT and PTT at or above the 75th percentile in the sample vs. below the 75th percentile, analyzed using binary logistic regression). Crude models were computed and subsequently adjusted for pubic hair stage and BMI z-score. Results were expressed as linear regression coefficients (B) and 95% confidence intervals (95% CI) or as odds ratios (OR) and 95% CI. Due to the documented heterogeneity in the frequency of adverse body image and pain experiences between girls and boys [2,37], we tested interaction terms between body image satisfaction categories and sex at birth in regression models. Data were analyzed using SPSS version 26.0 (IBM Corp.) and Stata version 15.1 (Statacorp). Results were interpreted based on point estimates and confidence intervals.

4. Results

Table 1 presents the characteristics of participants in the sample, including mean age, BMI z-score and QST outcomes, as well as their distributions according to weight status categories, pubic hair stages and satisfaction with their own silhouette. Age and weight status distributions were similar between sexes. Tanner pubic hair stages showed a more discrepant distribution with almost two-thirds of girls in stage 4, whereas boys were more evenly distributed between pubertal development stages. The proportions in stage 5 were similar between sexes. Regarding body image satisfaction, a little over a third of girls and a quarter of boys were satisfied with their current silhouette, whereas almost half of the adolescents preferred thinner silhouettes. Among those, a higher proportion of girls preferred a slightly thinner silhouette. Similar proportions of boys preferred slightly and a lot thinner silhouettes. More boys than girls preferred a heavier silhouette. Tables 2 and 3 present the results from the linear regression and binary logistic regression analyses, respectively, showing the crude and adjusted

Table 1
Distribution of the characteristics of Generation XXI participants included in the analysis.

	Whole sample (n = 1785)	Girls (n = 890)	Boys (n = 895)
Age in years, mean (SD)	13.42 (0.30)	13.43 (0.31)	13.42 (0.30)
BMI z-score, mean (SD)	0.48 (1.16)	0.53 (1.11)	0.43 (1.21)
Weight status[a], n (%)			
Underweight	44 (2.5%)	17 (1.9%)	27 (3.0%)
Normal weight	1138 (63.8%)	576 (64.6%)	562 (62.8%)
Overweight	426 (23.9%)	211 (23.8%)	215 (24.0%)
Obesity	177 (9.9%)	86 (9.7%)	91 (10.2%)
Tanner Pubic Hair stage[b], n (%)			
1–2	350 (19.6%)	47 (5.3%)	303 (33.9%)
3	474 (26.6%)	203 (22.8%)	271 (30.3%)
4	790 (44.3%)	551 (61.9%)	239 (26.7%)
5	171 (9.6%)	89 (10.0%)	82 (9.1%)
Body Image Satisfaction[c], n (%)			
Satisfied	560 (31.4%)	333 (37.4%)	227 (25.4%)
Prefers slightly thinner silhouette	539 (30.2%)	306 (34.3%)	233 (26.0%)
Prefers much thinner silhouette	323 (18.1%)	127 (14.3%)	196 (21.9%)
Prefers heavier silhouette	363 (20.3%)	124 (13.9%)	239 (26.7%)
Pain detection threshold in kPa, mean (SD)	20.7 (11.9)	20.9 (11.6)	20.5 (12.3)
Pain tolerance threshold in kPa, mean (SD)	52.4 (20.0)	53.1 (20.4)	51.6 (19.7)

BMI - body mass index; *PDT* – pain detection threshold; *PTT* – pain tolerance threshold; *SD* – standard deviation.

[a] Adolescent's weight status was defined based on the WHO growth reference categories, as follows: Underweight: < -2SD, Normal weight: ≥ -2 and $< +1$SD, Overweight: $\geq +1$ and $\leq +2$SD, Obesity: $> +2$SD [34].

[b] Pubic hair stage was evaluated at the 13-year follow-up by trained nurses using the five pubic hair stages according to the Tanner Scale [35,36].

[c] Body image satisfaction was calculated by subtracting the silhouette indicated by the adolescent as the desired one from the silhouette representing his or her perception of the current body.

associations between body image satisfaction categories and the two QST outcomes (PDT and PTT). No statistical interaction was found when multiplicative interaction terms between sex at birth and body image satisfaction categories were tested for the prediction of QST outcomes. This was also generally supported by our estimates of associations, which are presented below in the whole sample as well as stratified by sex.

4.1. Pain detection threshold (PDT)

In the whole sample, crude mean pressure pain detection thresholds (PDT) were similar across body image satisfaction categories (Fig. 2). After adjustment for BMI and pubertal development, there were no differences in mean PDT between adolescents who were dissatisfied with their own body and those who were satisfied, in the whole sample or in either sex. Adolescents who preferred much thinner silhouettes had higher odds of achieving the highest quarter of PDT compared with the reference category ("Satisfied"), but these differences were present only among boys and they were not replicated when the contralateral leg was analyzed (Supplementary Table 4).

4.2. Pain tolerance threshold (PTT)

Mean pressure pain tolerance thresholds were highest among adolescents who were satisfied with their body image and lowest among those who preferred to have much thinner or heavier silhouettes (Fig. 3). After adjustment for BMI z-score and sexual development, adolescents in all dissatisfied categories ("prefers much thinner", "prefers slightly thinner", and "prefers heavier") had lower mean PTT, but the differences were significant only among those who preferred to have a heavier silhouette. This was observed in both sexes in terms of point estimates, but the association was more precise among boys. Lower odds of achieving the highest PTT quarter were found among adolescents who were dissatisfied with their silhouette, across all three different dissatisfaction categories. After adjustment for BMI z-score and sexual development, adolescents in the "prefers much thinner silhouette" and "prefers heavier silhouette" categories remained less likely to achieve the highest PTT quarter. This was partly due to the contribution of the stronger associations found among girls in both dissatisfaction categories.

5. Discussion

In the present study, we investigated the association between body image satisfaction and experimental pressure pain sensitivity in 13-year-old adolescents, and found that adolescents dissatisfied with their body image had on average lower tolerance to pressure pain than those who were satisfied, whereas this was not the case for pain detection thresholds.

The proportion of adolescents who reported dissatisfaction with their own silhouette was similar between sexes, but a larger proportion of boys preferred heavier silhouettes than girls. Even though we did not

Table 2
Crude and adjusted associations between adolescents' satisfaction with their own body image and pain sensitivity (continuous outcome: PDT or PTT in kPa) in Generation XXI cohort.

			Satisfied	Prefers much thinner silhouette	Prefers slightly thinner silhouette	Prefers heavier silhouette
Boys (n = 895)	**PTT**	**Adj. B (95% CI)**	0	−1.98 (−6.44; 2.48)	−0.45 (−4.20; 3.31)	−3.51 (−7.17; −0.08)
		Crude B (95% CI)	0	−4.34 (−8.10; −0.59)	−1.82 (−5.41; 1.77)	−4.18 (−7.75; −0.61)
	PDT	**Adj. B (95% CI)**	0	1.98 (−0.82; 4.78)	2.39 (−0.28; 4.75)	−0.12 (−2.42; 2.19)
		Crude B (95% CI)	0	0.45 (−1.90; 2.80)	1.55 (−0.70; 3.79)	−0.27 (−2.50; 1.96)
Girls (n = 890)	**PTT**	**Adj. B (95% CI)**	0	−3.33 (−8.41; 1.76)	−1.25 (−4.75; 2.24)	−4.09 (−8.40; 0.23)
		Crude B (95% CI)	0	−4.23 (−8.40; −0.06)	−1.81 (−4.97; 1.36)	−3.71 (−7.91; 0.50)
	PDT	**Adj. B (95% CI)**	0	−0.67 (−3.57; 2.23)	−0.79 (−2.79; 1.20)	−0.89 (−3.35; 1.58)
		Crude B (95% CI)	0	0.45 (−1.93; 2.84)	−0.29 (−2.10; 1.52)	−1.22 (−3.62; 1.18)
Whole sample (n = 1785)	**PTT**	**Adj. B (95% CI)**	0	−2.55 (−5.84; 0.74)	−0.98 (−3.52; 1.56)	−3.95 (−6.68; −1.21)
		Crude B (95% CI)	0	−4.43 (−7.16; −1.69)	−1.83 (−4.20; 0.53)	−4.18 (−6.82; −1.54)
	PDT	**Adj. B (95% CI)**	0	0.57 (−1.40; 2.54)	0.60 (−0.93; 2.12)	−0.65 (−2.29; 0.99)
		Crude B (95% CI)	0	0.24 (−1.40; 1.87)	0.48 (−0.94; 1.89)	−0.86 (−2.44; 0.72)

PDT – pain detection threshold; *PTT* – pain tolerance threshold; *B* – regression coefficient; *CI* - Confidence Interval; *Adj.* – adjusted; (Reference: girls and boys satisfied with their own body image)
Adj. B (linear regression) was adjusted for body mass index z-score and pubic hair stage.

Table 3
Crude and adjusted associations between adolescents' satisfaction with their own body image and pain sensitivity (binary outcome: PDT or PTT above vs. below the 75th percentile in the sample) in Generation XXI cohort.

			Satisfied	Prefers much thinner silhouette	Prefers slightly thinner silhouette	Prefers heavier silhouette
Boys (n = 895)	**PTT**	**Adj. OR (95% CI)**	1	0.82 (0.49; 1.39)	0.94 (0.60; 1.45)	0.74 (0.48; 1.14)
		Crude OR (95% CI)	1	0.67 (0.43; 1.04)	0.81 (0.54; 1.22)	0.73 (0.48; 1.11)
	PDT	**Adj. OR (95% CI)**	1	2.18 (1.28; 3.73)	1.98 (1.26; 3.10)	1.04 (0.66; 1.64)
		Crude OR (95% CI)	1	1.46 (0.93; 2.27)	1.60 (1.05; 2.45)	1.09 (0.70; 1.69)
Girls (n = 890)	**PTT**	**Adj. OR (95% CI)**	1	0.52 (0.28; 0.95)	0.75 (0.50; 1.11)	0.58 (0.35; 0.98)
		Crude OR (95% CI)	1	0.56 (0.34; 0.92)	0.77 (0.54; 1.09)	0.58 (0.35; 0.95)
	PDT	**Adj. OR (95% CI)**	1	1.15 (0.65; 2.04)	1.05 (0.74; 1.57)	0.89 (0.53; 1.47)
		Crude OR (95% CI)	1	1.16 (073; 1.84)	1.05 (0.73; 1.50)	0.88 (0.54; 1.44)
Total sample (n = 1785)	**PTT**	**Adj. OR (95% CI)**	1	0.68 (0.46; 1.00)	0.82 (0.62; 1.10)	0.66 (0.48; 0.90)
		Crude OR (95% CI)	1	0.58 (0.42; 0.80)	0.77 (0.59; 1.00)	0.65 (0.48; 0.88)
	PDT	**Adj. OR (95% CI)**	1	1.50 (1.03; 2.17)	1.31 (0.98; 1.76)	0.91 (0.66; 1.27)
		Crude OR (95% CI)	1	1.29 (0.94; 1.75)	1.23 (0.94; 1.61)	0.90 (0.66; 1.23)

PDT – pain detection threshold; *PTT* – pain tolerance threshold; *OR* - Odds Ratio; *CI* - Confidence Interval; *Adj.* – adjusted; (Reference: girls and boys satisfied with their own body image)
Adj. OR (logistic regression) was adjusted for body mass index z-score and pubic hair stage.

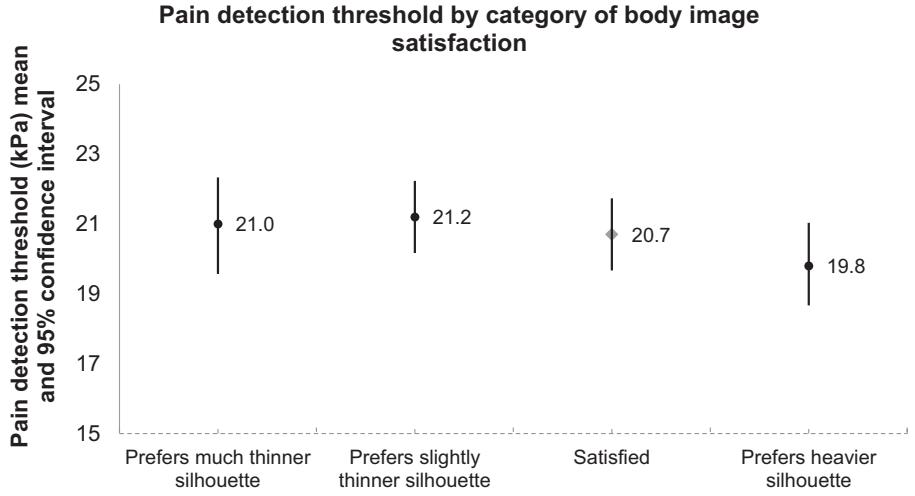

Fig. 2. Pain detection threshold means and 95% confidence intervals, according to body image satisfaction categories.

Fig. 3. Pain tolerance threshold means and 95% confidence intervals, according to body image satisfaction categories.

specifically assess if this was the reason for dissatisfaction, the desire to develop a muscled body arises as a central issue in male body image [38–41] and weight gain attempts in the context of muscle-enhancing goals and behaviors are common among adolescent boys and young men, including those considered normal weight, overweight or obese [42]. On the other hand, girls had a more frequent desire for a thinner body, consistent with a standardized model of beauty that favors slimness and thinness [3,43]. However, recent evidence suggests that a drive

for muscularity is also a current concern among girls [41].

In our study, adolescents who were dissatisfied with their silhouettes showed lower mean pressure pain tolerance thresholds. After adjustment for pubertal development and body mass index, a lower average pain tolerance remained clear among adolescents who preferred to have a heavier silhouette, and a lower odds of achieving the highest quarter of pain tolerance was observed among those who preferred to have much thinner or heavier silhouettes. Our observation that adolescents who desired to be larger had lower tolerance to pressure pain is consistent with a broad concept of body image, encompassing not only an esthetic/appearance dimension but also other domains related to physical competences, fitness and function, which are in turn related to sensory responses to mechanical stimuli [44].

Existing evidence supports common pathways to link pain experiences and body image constructs, but most research focuses on the effect of chronic pain conditions on body image distortions [4]. Patients with longstanding pain conditions such as chronic back pain [45,46], fibromyalgia [11], rheumatoid arthritis [47], and even pregnancy-related lumbopelvic pain [48] report a negative body image more frequently. Chronic pain states and associated loss of physical function and impaired sensory functioning are documented to change body image experiences, namely through cortical reorganization and distortion of neural representations of body image [4]. The amygdala also seems to play an important role, since it provides positive or negative emotional value to sensory information, modulating behavioral and affective responses to pain [49,50], and the right amygdala appears to have an important role in nociceptive function [51]. Those neurological findings are also consistent with psychological models of the relation between body image, psychosocial distress and chronic physical pain. Adverse pain-related cognitions and affect likely lead to maladaptive pain coping strategies that contribute to a negative experience of body image [10].

Conversely, evidence on the effect of body image on pain sensitivity is still scarce. Pain detection thresholds for heat stimuli seem to be influenced by body image constructs, as in a study conducted in women with anorexia nervosa and bulimia nervosa that showed that the more the patients desired to be thinner, the more pain-sensitive they were [52]. An experiment in healthy individuals also revealed that pain perception increased after being confronted with artificially distorted images of their own body [53]. Both of those studies found differences in pain detection thresholds, whereas in our study this was not the case. In fact, adolescents in our “Prefers thinner silhouette” groups had higher odds of reaching the highest pain detection threshold quarter, although this was not the case when the continuous measure was analyzed, when pain tolerance was the outcome or when the contralateral leg was examined. A dissociation between pain detection and tolerance thresholds has been long documented by Gelfand [54], and interpreted as a higher susceptibility of pain tolerance to be influenced by psychological circumstances, likely including the set of oral instructions provided in the context of a subjective psychophysiological assessment such as cuff pressure algometry. This may imply that our measurements of pain tolerance are more susceptible to the influence of negative affect and cognitions that are also associated with body image dissatisfaction and could thus partly explain our heterogeneous results between detection and tolerance thresholds.

The present study does not aim to explore the specific mechanisms that may explain the lower pain tolerance found in adolescents dissatisfied with their silhouettes, and causal inference is limited by design. Specifically, associations such as those found would be expected if there is a uni- or bidirectional causal relationship between body image and pain sensitivity, or if both higher pain sensitivity and body image dissatisfaction result from a common predisposition. In any case, clear distinctions between those interpretations seem somewhat artificial and counterproductive. Sündermann et al. [10] recently proposed a cognitive behavioral model that builds on a bidirectional relation between body image and chronic pain to explain the interplay between those constructs. According to the model, negative affect with regard to body image leads to unhelpful coping strategies that interfere with appearance and physical function, and adversely affect pain experiences. In turn, negative affectivity towards pain experiences drives ineffective pain coping strategies, which have an adverse impact on body image. This model seems particularly well-suited to interpret our results if we admit that, in adolescents who are building a cognitive-affective basis for body image and pain experiences, heightened pain sensitivity can negatively affect one's body image and, in turn, dissatisfaction with body image can contribute to lower pain thresholds.

5.1. Limitations of data and methods

Due to attrition and missing data, the final sample differs from the initial cohort of children recruited, as happens in most longitudinal studies. Thus, our analytical sample is likely not representative of the initial 8647 participants. However, a previous sensitivity analysis comparing participants included and excluded at ages 7 and 10 suggested little impact of attrition and missing data on pain history profiles [55].

Regarding quantitative sensory testing, although it provides reproducible measurements of responses to standardized stimuli in a controlled environment [56], it remains a test of subjective experiences, where the roles of the examiner and the specific set of oral instructions may be undesired sources of variability. Moreover, we only analyzed one sensory modality, leaving out superficial pressure pain and thermal nociception, as well as complementary dimensions of pain experiences like pro- and anti-nociceptive mechanisms. Nevertheless, there is evidence that deep-tissue pressure pain responses are useful to study pain experiences since pediatric ages [57].

We should also note that the evaluation of satisfaction using the difference between self-reported desired and perceived silhouettes builds on predefined images of body shapes. From a population perspective, this method is a simple and straightforward approach useful outside specialized centers [58]. However, it may not capture the body image satisfaction construct comprehensively or take into account other cognitive-affective and behavioral aspects of body image, or the importance assigned by individuals to their physical appearance. Nevertheless, body dissatisfaction was found to be a specific but strong predictor of a range of negative health outcomes [59]. This evaluation occurred at a single time point and the perception of one's own body, particularly among adolescents, is labile and likely to vary over time. The cross-sectional nature of our study also hinders considerations on the temporal relation between body image satisfaction and pain sensitivity, and only future evaluations waves will allow us to assess whether (and how) they co-evolve in the future. Finally, the results may not be directly applicable to adolescents in other populations or settings, given the wealth of sociocultural factors that can influence one's body satisfaction and/or pain experiences.

5.2. Strengths

To our knowledge, there are no population-based studies that have applied cuff pressure algometry in large-scale samples of adolescents. Most of the existing data are from small studies in cohorts of children with specific medical conditions. In addition, we were able to address confounding by collecting and adjusting for direct measures of weight, height and pubertal development status. Also, the Children's Figure Rating Scale is validated in children [27,60], and it is more reliable than non-figural questionnaires [61]. Age-related confounding was minimized in our study since adolescents of Generation XXI have approximately the same chronologic age. Additionally, at age 13, the vast majority of adolescents were unlikely to have established disease, either organic or mental, that could modify our effect estimates.

6. Conclusion

Our study provides current evidence on the association between satisfaction with one's own silhouette and pressure pain sensitivity in adolescents from the general population. It shows that 13-year-old adolescents who were dissatisfied with their body image had lower tolerance to pressure pain. While our study was not designed to assess specific intervention targets, its results argue for an integrated understanding of body image and pain experiences in a life stage of rapid and profound biological and psychosocial changes. It adds evidence that this relation is observable outside clinical settings and before most chronic pain conditions are established, which may be useful for further investigations on planning interventions that bring together body image and pain experiences since the first decades of life.

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Declaration of Competing Interest

The authors have no conflicts of interest relevant to this article to disclose.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychores.2022.110912.

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