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Beatriz Costa Vieira

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

Satisfação com a imagem corporal e sensibilidade a estímulos nocicetivos de pressão numa coorte de adolescentes de 13 anos

Abril, 2021

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Epidemiologia

TÍTULO DISSERTAÇÃO

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

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Ao meu pai, que me ensinou o valor da força de vontade e do trabalho,
me mostrou o lugar obrigatório do rir e do sorrir,
me faz falta e me inspira todos os dias.

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

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Abstract

Background: Adolescence is a crucial phase for the development of body image issues and for the expression of pain phenotypes. Associations between these traits are described in disease-specific cohorts but little is known on whether pain sensitivity changes with the level of body image satisfaction in adolescents.

Objectives: We aimed to quantify the associations between body image satisfaction and pain detection and tolerance thresholds in 13-year-old girls and boys.

Methods: We conducted an observational study in 1793 participants from the Generation XXI population-based cohort, recruited in 2005-06. Body image satisfaction was assessed using the Children's Figure Rating Scale and calculated as the difference between the silhouette selected as desired by the adolescent and the one representing his or her perception of the current body. Pain detection and tolerance thresholds were estimated using cuff pressure algometry with standardized stimuli. We express the results as linear regression coefficients (B) and as odds ratios (OR) and respective 95% confidence intervals. Crude models were computed and further adjusted to Tanner pubic hair stage and body mass index.

Results: Girls who were dissatisfied with their body silhouette had lower odds of achieving the highest quarter of pressure pain threshold ("prefers thinner silhouette" adjusted OR [95%CI] = 0.67 [0.46; 0.97; "prefers heavier silhouette" adjusted OR = 0.62 [0.39; 1.00]). Girls who preferred heavier silhouettes had lower average tolerance threshold compared with those who were satisfied (adjusted B [95%CI] = -4.43 [-8.76; -0.10]). Associations had lower magnitude among boys: "prefers thinner silhouette" adjusted B [95%CI] = -0.76 [-4.27; 2.74] and adjusted OR [95%CI] = 0.84 [0.55; 1.27]; "prefers heavier silhouette" adjusted B [95%CI] = -4.18 [-7.90; -0.46] and adjusted OR [95%CI] = 0.75 [0.49; 1.16].

Conclusion: Body image dissatisfaction was associated with lower tolerance to pain among 13-year-old adolescents, especially among girls. These findings may indicate a role of dissatisfaction with own body in the establishment of maladaptive pain phenotypes in healthy adolescents.

Keywords: quantitative sensory testing; cuff pressure algometry; pain sensitivity; body dissatisfaction; body image; adolescence.

1. Introduction

Adolescence is operationally defined as the life period between ages 10 and 19 years (Sawyer et al., 2012) and corresponds to the transition from childhood into adulthood. The onset of puberty marks the beginning of adolescence and physiologically is characterized by a steep increase in the production and secretion of several hormones, mainly adrenal androgens, gonadal steroids and growth hormone (Crone and Dahl, 2012), which together lead to changes in various dimensions of development such as physical, cognitive and social-emotional.

Physically, the maturation of the zona reticularis of the adrenal gland with the production of androgens leads to the first hallmark of puberty, the adrenarche. An increase in gonadal size and pubic hair along with a stature growth spurt are important changes during this phase, as well as the onset of breast development and menstrual bleeding in girls. Cognitive development occurs in parallel with physical growth: the capacity for abstract thought growths and evolves until adulthood, and there is progressive deepening of moral thinking together with the development of interest and concern for the future. A third main domain that matures during adolescence is the social-emotional one. In early adolescence, individuals struggle with their sense of identity, begin questioning parental models and giving more attention to their peers. Due to the extensive changes described above, youth can feel awkward about their bodies and start developing concerns about feeling “normal”, with an increasing focus on their body and appearance with sociocultural influences enhancing the development of a negative body image (Sawyer et al., 2012; Senín-Calderón et al., 2017).

Body image is the figuration of one’s body on his/her mind (Schilder and Wertman, 1994) and comprises two dimensions: perceptual and affective or attitudinal. The first, also called body perception, reflects the mental construct of own’s silhouette and its accuracy, including size, shape and appearance. The latter concerns the feelings, behavior and satisfaction about one’s body (Thompson, 2001). One of the components of the attitudinal dimension is the (dis)satisfaction with body (Henriques et al., 2015). Body dissatisfaction is the discrepancy between perceived current and desired silhouette. It may begin as early as five

years of age among female children (Flannery-Schroeder and Chrisler, 1996; Perez et al., 2018), but its prevalence increases progressively, especially among girls, during adolescence (Bucchianeri et al., 2013).

Like body dissatisfaction, pain experiences also increase in frequency during the course of adolescence and approximate adult levels by the age of 18 years (Jeffries et al., 2007). Sex differences in pain prevalence and experiences widen during adolescence, with girls typically reporting more symptoms than boys (King et al., 2011). Adverse pain experiences in adolescence can be considered predictors as well as intermediate steps toward chronic pain trajectories: for example, multisite pain is an early and strong predictor of prognosis and distress in youth (Auvinen et al., 2017; Kröner-Herwig et al., 2011) that extends into adulthood (Carnes et al., 2007). Quantitative Sensory Testing (QST) is a standardized set of tests of different sensory modalities, comprising calibrated physical and chemical stimuli that may be used to measure the pain detection and tolerance thresholds (Mücke et al., 2014), as well as pro- and anti-nociceptive mechanisms. Pressure pain QST seems useful to discriminate sensory responses in youth (Blankenburg et al., 2010) and it may add an important quantitative dimension to the characterization of pain phenotypes during adolescence.

Associations between body image and pain experiences are well described in disease-specific cohorts. In patients with fibromyalgia, body image is frequently disturbed and there is an association between body image satisfaction and reported pain (Akkaya et al., 2012). Overall, people with persistent pain have higher prevalence of appearance concerns, often related to reduced functioning and negative mood changes (Sundermann et al., 2018). Despite the evidence that sustains an association between body image and pain, the direction of a potential causal relationship is unclear, i.e., whether a misrepresentation of body image results from pain or the perception pain is somehow amplified by the dissatisfaction with one’s body. Alternatively, both body image and pain may share a common predisposition that accounts for their association. In any event, little is known about whether such an association is found before chronic conditions are established.

Therefore, using data from a 13-year-old population-based birth cohort, we aimed to quantify pressure pain thresholds according to body image satisfaction among adolescent girls and boys. We hypothesized that adolescents dissatisfied with their body image have less tolerance to pain than those who are satisfied.

2. Methods

2.1 Participants

We used data from the Generation XXI birth cohort, described in detail elsewhere (Alves et al., 2012; Larsen et al., 2013). Briefly, mothers who gave birth to live-born children with gestational age over 23 weeks, between April 2005 and August 2006, were recruited up to 72 hours after delivery from one of the five public level III maternities (units that comprise basic, specialty and subspecialty maternal care, providing care for complex maternal medical conditions, obstetric complications, and fetal condition (2019)) 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 (Alves et al., 2012; Larsen et al., 2013). The present investigation is a cross-sectional study implemented in the 13-year follow-up evaluation, which occurred between August 2018 and March 2020, and was interrupted due to the emergence of the COVID-19 pandemic.

We included all adolescents who had anthropometric data available at age 13, answered the body image satisfaction questionnaire, had their pubic hair stage evaluated, and agreed to undergo quantitative sensory testing (QST). Due to equipment availability, QST was performed on a subsample of adolescents, and our final analytical sample included 1793 adolescents. More detailed information on the selection criteria is depicted in Figure 1 and differences between those included (n=1793) and those not included (n=2840) regarding age, sex, anthropometric data and body image satisfaction are presented in Supplementary Material (Supplementary Table 1). Groups had similar distributions in all parameters except

for Tanner pubic hair stage, with participants being more frequently classified in the categories 4 and 5 in comparison to non-participants. The description of sample characteristics in the 13-year-old evaluation is presented in Table 1.

2.2. Evaluation

At the 13 years evaluation, adolescent's weight and height were measured using standard procedures (Gibson, 2005): 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 < + 1SD, ´overweight' as z-score ≥ + 1SD and < + 2SD and 'obesity' as z-score ≥ + 2SD (de Onis et al., 2007) (World Health, 2006).

Pubic hair development was evaluated by trained nurses using the Tanner Scale as reference (Marshall and Tanner, 1969, 1970), with stage 1 corresponding to pre-pubertal, stages 2 to 4 to pubertal and 5 to post-pubertal in both sexes.

Body Image Satisfaction at 13 years of age was assessed using the Children's Figure Rating Scale (Tiggemann and Wilson-Barrett, 1998). The scale consists of nine gender-specific figures of increasing size. Adolescents were asked first to select the figure they thought they looked the most with (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). Three categories were then defined: "Satisfied" (reference category) when the difference was equal to zero, "prefers thinner silhouette" when the difference was lower than zero and "prefers heavier silhouette" when the difference was greater than zero (López-Sánchez et al., 2018). The scale and questionnaire are presented in Supplementary Material.

2.2.1. 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) (Polianskis et al., 2002) to perform the evaluation. This equipment consists of a 13 cm-wide silicone high-pressure tourniquet cuff, a computer-controlled compressor, a 10cm electronic visual analog scale (VAS), and a stop-button for the immediate release of air in the tourniquet cuff (Lindskou et al., 2017). The tourniquet was tightly mounted around the widest part of the gastrocnemius, ensuring no cloths were present between the cuff and skin. For the measurements, we applied a ramp inflation pattern, with constant inflation of 1 kPa/s (Skou et al., 2013). Tests were conducted by trained examiners using a standardized protocol including oral instructions throughout the procedure. Children 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. Cuff was programmed to deflate instantaneously whenever the VAS reached 100 mm or the pressure reached a predefined maximum of 100 kPa or the 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 and that they remained in control of the procedures.

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) (Lemming et al., 2012). 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 higher due to a temporary malfunction in the left leg pressure outlet (Figure 1). Results for the left leg findings are presented as Supplementary Material.

2.3. Statistical analysis

Data analyses were stratified by sex at birth. Given the low number of participants in stage 1, Tanner stages 1 and 2 were grouped into the same category for statistical analysis purposes. 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, analysed using linear regression) and dichotomous (PDT and PTT at or above the 75th percentile in the sample vs. below the 75th percentile, analysed using binary logistic regression). Models were computed crude and adjusted to 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. Data were analysed using SPSS statistical software (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. IBM Corp.) and Stata (Statacorp, Version 15). Results were interpreted based on point estimates and confidence intervals and no null-hypothesis significance testing was conducted (Amrhein et al., 2019; Wasserstein et al., 2019).

3. Results

Table 1 presents the characteristics of participants in each sex, namely 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. By the time of the 13-year old follow-up, boys and girls had a mean age of 13.4 years. Mean BMI z-score was 0.52 for girls and 0.42 for boys. The weight status distribution was similar between sexes: 64.7% of girls and 63.0% of boys were classified has having normal weight, almost a quarter were overweight, 10% were obese and a minority were underweight (1.9% of girls and 3.0% of boys).

Tanner pubic hair stages showed more discrepant distribution between sexes: almost two-thirds of girls were in stage 4, 22.8% in stage 3, and 5.3% in stages 1 or 2, whereas boys were more evenly distributed between the first three categories, with 33.9% in stages 1 or 2,

30.3% in stage 3 and 26.6% in stage 4. The proportions of both sexes in stage 5 were similar (10.0% for girls and 9.2% for boys).

Regarding body image satisfaction, almost half of the adolescents preferred thinner silhouettes (48.5% of girls and 47.8% of boys). Among boys, 26.9% preferred a heavier silhouette, compared to 14.2% of girls. The remaining adolescents (37.2% of girls and 25.3% of boys) were satisfied with their current silhouette.

Table 2 and Table 3 present the results from the linear regression and binary logistic regression analyses, respectively, showing the crude and adjusted associations between body image satisfaction categories and the two QST outcomes (PDT and PTT).

3.1. Pain detection threshold (PDT)

Mean pressure pain detection thresholds for girls and boys were both 20.5 kPa and were similar among different body image satisfaction categories (Figure 2). Girls dissatisfied with their own body showed lower mean PDT and lower odds of achieving the highest quarter of PDT compared with the reference category (“Satisfied”), in both the “prefers thinner” group (adjusted B [95%CI] = -1.09 [-3.03; 0.84]; adjusted OR [95%CI] = 0.83 [0.55; 1.26]) and the “prefers heavier” group (adjusted B = -0.56 [-3.02; 1.91]; adjusted OR = 0.93 [0.55; 1.56]), but the differences were small.

Boys in the “prefers thinner” group had higher mean PDT and higher odds of achieving PDT 75th percentile compared with the “Satisfied” reference category (adjusted B [95%CI] = 2.35 [0.15; 4.55]; adjusted OR [95%CI] = 1.80 [1.13; 2.87]). Boys who preferred heavier silhouettes showed no differences compared to the reference group when PDT was analyzed continuously (adjusted B [95%CI] = -0.36 [-2.70; 1.91]). However, they were more likely to achieve the highest quarter of the PDT distribution (adjusted OR [95%CI] = 1.14 [0.69; 1.87]) (Tables 2 and 3).

3.2 Pain Tolerance Threshold (PTT)

Mean pressure pain tolerance thresholds for girls and boys were 53.0 and 51.6 kPa, respectively, with highest values among adolescents who were satisfied with their body image (54.8 kPa in girls and 54.2 kPa in boys) and lowest among those who preferred to have a heavier silhouette (50.8 kPa and 49.9 kPa) (Figure 3). Girls who preferred thinner silhouettes had lower mean PTT and lower odds of achieving the highest quarter when compared with girls who were satisfied with their own silhouette, although results using the continuous outcome lacked precision (adjusted B [95%CI] = -1.96 [-5.36; 1.45]; adjusted OR [95%CI] = 0.67 [0.46; 0.97]). Differences were more pronounced in the “prefers heavier” group, which also showed lower mean PTT and lower odds of achieving the highest quarter of PTT (adjusted B [95%CI] = -4.43 [-8.76; -0.10]; adjusted OR [95%CI] = 0.62 [0.39; 1.00], respectively). Boys who preferred thinner silhouettes showed lower mean PTT and lower odds of achieving the 75th PTT percentile, but both estimates were imprecise (adjusted B [95%CI] = -0.76 [-4.27; 2.74]; adjusted OR [95%CI] = 0.84 [0.55; 1.27], respectively). Boys who preferred heavier silhouettes showed lower mean PTT when compared with those who were satisfied (adjusted B [95%CI] = -4.18 [-7.90; -0.46]). This was also the case when the outcome was the highest quarter of PTT, although the estimate lacked precision (adjusted OR [95%CI] = 0.75 [0.49; 1.16]).

4. Discussion

In the present study, we investigated the association between body image satisfaction and experimental pressure pain sensitivity in 13-year-old adolescents. We hypothesized that adolescents dissatisfied with their body image have less tolerance for pain compared with those who are satisfied.

The proportion of adolescents that reported dissatisfaction with their own silhouette was similar between sexes, but a larger proportion of boys preferred heavier silhouettes compared to girls. The desire to develop a muscled body arises as a central issue in male body image (Jones and Crawford, 2005) and can explain the observed differences. Girls, on

the other side, have more frequently desire for a thinner body enhanced by the standardized model of beauty most accepted in current societies that favors slimness and thinness (Boschi et al., 2003).

We found that adolescents who were dissatisfied with their silhouettes showed lower mean pain tolerance thresholds as well as lower odds of achieving the highest quarter of pain tolerance. Lower pain tolerance was more evident among adolescents who preferred to have a heavier silhouette. There is very little in the literature about the relation between satisfaction with body image and tolerance to pain, and most existing evidence originates from disease-specific cohorts, such as patients with eating disorders. A study conducted in women with anorexia nervosa and bulimia nervosa showed that the more the patients desired to be thinner, the more pain-sensitive they were (Yamamotova et al., 2017) and experiments in healthy individuals revealed that their pain perception increased after being confronted with artificially distorted images of their own body (Osumi et al., 2014). Conversely, the association between pain sensitivity and body image distortion has been better explored: patients with chronic pain conditions like chronic back pain (Levenig et al., 2016; Levenig et al., 2019), fibromyalgia (Akkaya et al., 2012), rheumatoid arthritis (Boyington et al., 2015) and even pregnant-women with lumbopelvic pain (Wand et al., 2017) frequently report more negative body image. An approach focused on body perception improvement has been proposed as an intervention target for the treatment of patients with chronic pain conditions (Campo-Prieto and Rodríguez-Fuentes, 2018; Haggard et al., 2013; Sundermann et al., 2020; Wittkopf and Johnson, 2017).

Existing evidence supports common neural pathways for pain and body image perception. In particular, the amygdala seems to have an important role as a limbic brain region involved in emotional processing, neuropsychiatric disorders, and the emotional affective dimension of pain. The amygdala provides positive or negative emotional value to sensory information, modulating behavioral and affective responses (Simons et al., 2014). The central nucleus of the amygdala receives nociceptive and emotional inputs from several brain regions, allowing the modulation of pain and affect (Allen et al., 2021). Left and right amygdala appear to have

different importance on nociceptive function, with data suggesting a much more important role of the right amygdala in the context of pain, compared with the left one (Carrasquillo and Gereau, 2008). In parallel, Seeger et al. (2002) found an activation of the right amygdala in patients with anorexia nervosa when they were stimulated with digital pictures of their own body artificially distorted by a computer-based imaging technique. Thus, right amygdala is a circuit envolved in the processing of pain and also in the processing of negative emotions associated to body dissatisfaction, although our study does not explore the specific mechanisms involved in the lower pain tolerance found in adolescents dissatisfied with their bodies in the present study.

There was no clear association between body image satisfaction and pain detection thresholds in either sex. This could be because participants interpretation of the set of oral instructions that define pain detection can be even more heterogeneous than that of pain tolerance, in the context of a psychophysiological assessment such as cuff pressure algometry. One exception, however, was found in the “Prefers thinner” boys group, who showed higher pressure detection thresholds after adjustment, although this was not the case when pressure tolerance thresholds were analysed.

4.2. 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 cohorts, and our analytical sample may not be representative of the initial 8647 participants. However, a previous sensitivity analyses comparing participants included and excluded at ages 7 and 10 suggested little impact of attrition and missing data on pain history profiles (Lucas et al., 2020).

Regarding quantitative sensory testing, although it provides measurements of the responses to standardized stimuli in controlled environments (Arendt-Nielsen and Yarnitsky, 2009), it is still 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 performed an analysis on one sensory modality, deep tissue pressure pain, leaving out superficial

pressure pain and thermal nociception, as well as complementary dimensions of the 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 paediatric ages (Holden et al., 2020).

We should also note that the evaluation of satisfaction using the difference between self-reported desired and perceived silhouettes builds on predefined images and may not capture the body image satisfaction construct comprehensively or take into account the importance assigned by individuals to their physical appearance. However, from a public health perspective, this method is a simple and straightforward way of estimating body image dissatisfaction that can be particularly useful outside specialized centers (Henriques et al., 2013). Furthermore, this evaluation occurred at a single time point and the perception of one's own body, particularly among adolescents, is likely to vary over time.

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 perception and satisfaction.

4.3. 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 and findings have been largely inconclusive, with differences depending upon stimulus modality and population studied. 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 used in the satisfaction questionnaires is a validated scale for children (Tiggemann and Pennington, 1990; Tiggemann and Wilson-Barrett, 1998) and it is a more reliable technique to assess body image dissatisfaction than questionnaires that do not use figural scales (Gardner and Brown, 2010). Age-related confounding was minimized in our study, since adolescents of Generation XXI have approximately the same chronologic age.

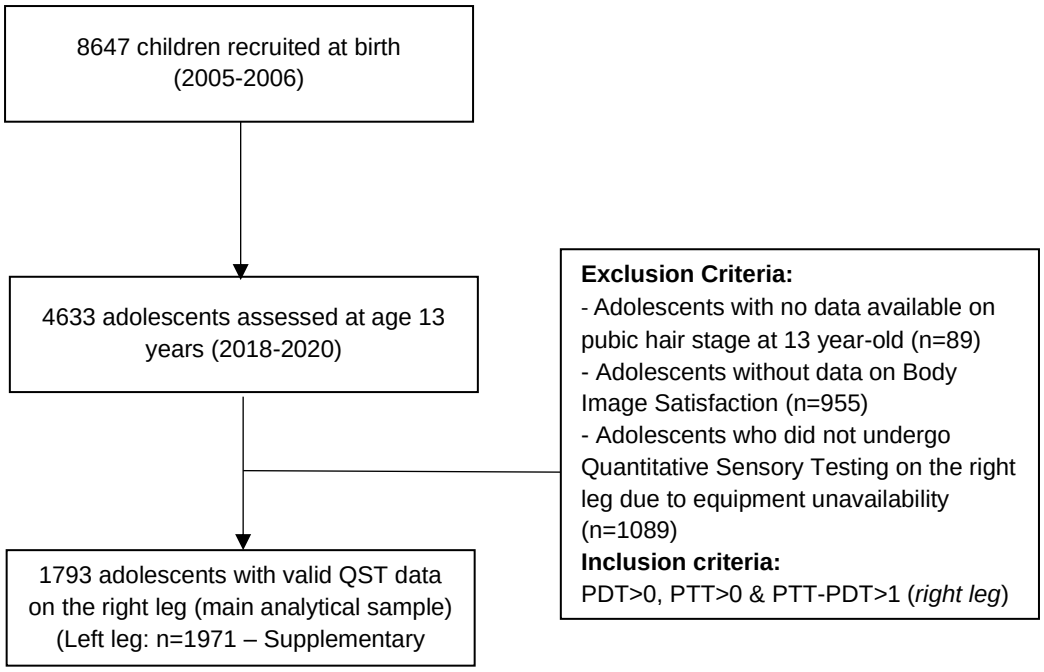
Additionally, at age 13, the vast majority of adolescents are unlikely to have established disease, either organic or mental, that could be an alternative explanation for the differences found. In summary, our study provides pioneering evidence on the association between satisfaction with one's own silhouette and pain detection and tolerance thresholds in adolescents from the general population.

5. Conclusion

Body image dissatisfaction was associated with lower tolerance to pain in boys and girls. Dissatisfaction with one's own body when building self body image may co-occur with decreased pain tolerance and ultimately be involved in the establishment of maladaptive pain phenotypes, indicating a possible shared populational burden between these two traits.

6. Figures and Tables

Figure 1. Selection of analytic sample from the Generation XXI birth cohort.



Legend:

QST – quantitative sensory testing; *PDT* – pressure detection threshold; *PTT* – pressure tolerance threshold.

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

		Girls (n=894)	Boys (n=899)
Age in years, mean (SD)		13.43 (0.31)	13.42 (0.31)
BMI z-score, mean (SD)		0.52 (1.11)	0.42 (1.21)
Weight status[1], n (%)			
	Underweight	17 (1.9%)	27 (3.0%)
	Normal weight	578 (64.7%)	566 (63.0%)
	Overweight	213 (23.8%)	215 (23.9%)
	Obesity	86 (9.6%)	91 (10.1%)
Tanner Pubic Hair stage[2], n (%)			
	1-2	47 (5.3%)	305 (33.9%)
	3	204 (22.8%)	272 (30.3%)
	4	554 (62.0%)	239 (26.6%)
	5	89 (10.0%)	83 (9.2%)
Body Image Satisfaction[3], n (%)			
	Satisfied	333 (37.2%)	227 (25.3%)
	Prefers thinner	434 (48.5%)	430 (47.8%)
	Prefers heavier	127 (14.2%)	242 (26.9%)
Pain detection threshold in kPa, mean (SD)		20.5 (11.6)	20.5 (12.2)
Pain tolerance threshold in kPa, mean (SD)		53.0 (20.4)	51.6 (19.6)

Legend:

BMI - Body Mass Index; *SD* – standard deviation

1.Child's weight status was defined based on the WHO growth references categories, as follows: Underweight: < − 2SD, Normal weight: ≥ − 2 and < + 1SD, Overweight: ≥ + 1 and ≤ + 2SD, Obesity: > + 2SD (de Onis et al., 2007; World Health, 2006)

2. 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 (Marshall and Tanner, 1969, 1970).

3. Body Image Satisfaction was calculated subtracting the silhouette indicated by the adolescent as the desired one from the silhouette representing his or her perception of the current body.

Figure 2. Pain Detection Threshold mean and 95% confidence interval, according to body image satisfaction.

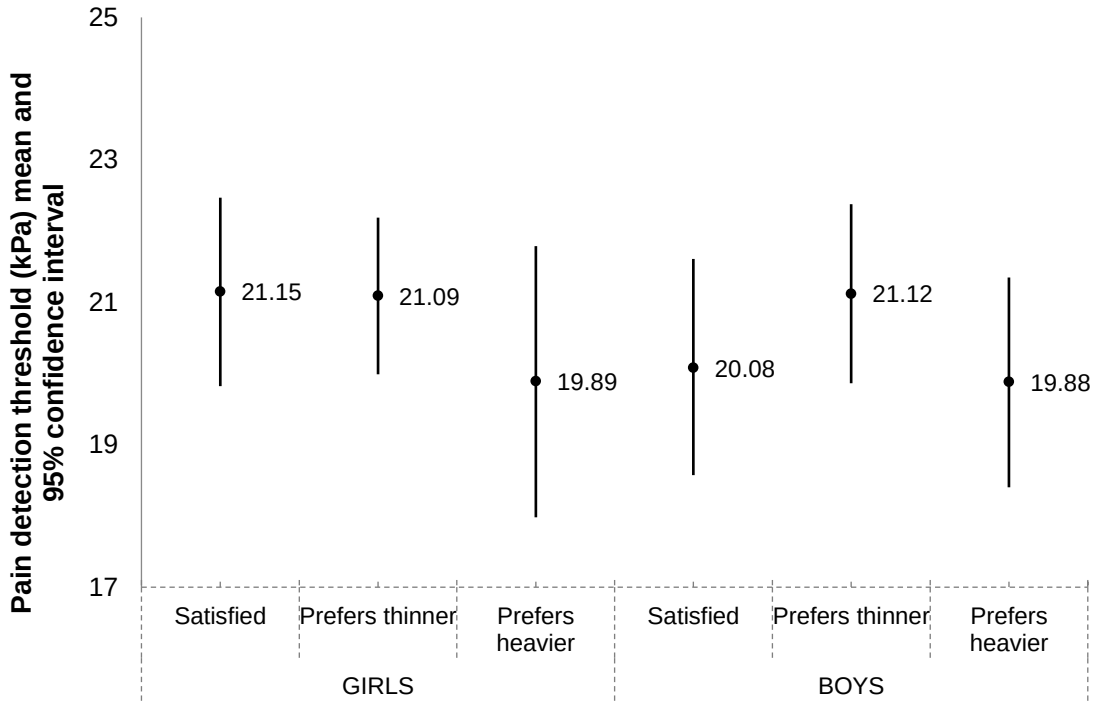


Figure 3. Pain Tolerance Threshold mean and 95% confidence interval by category of body image satisfaction.

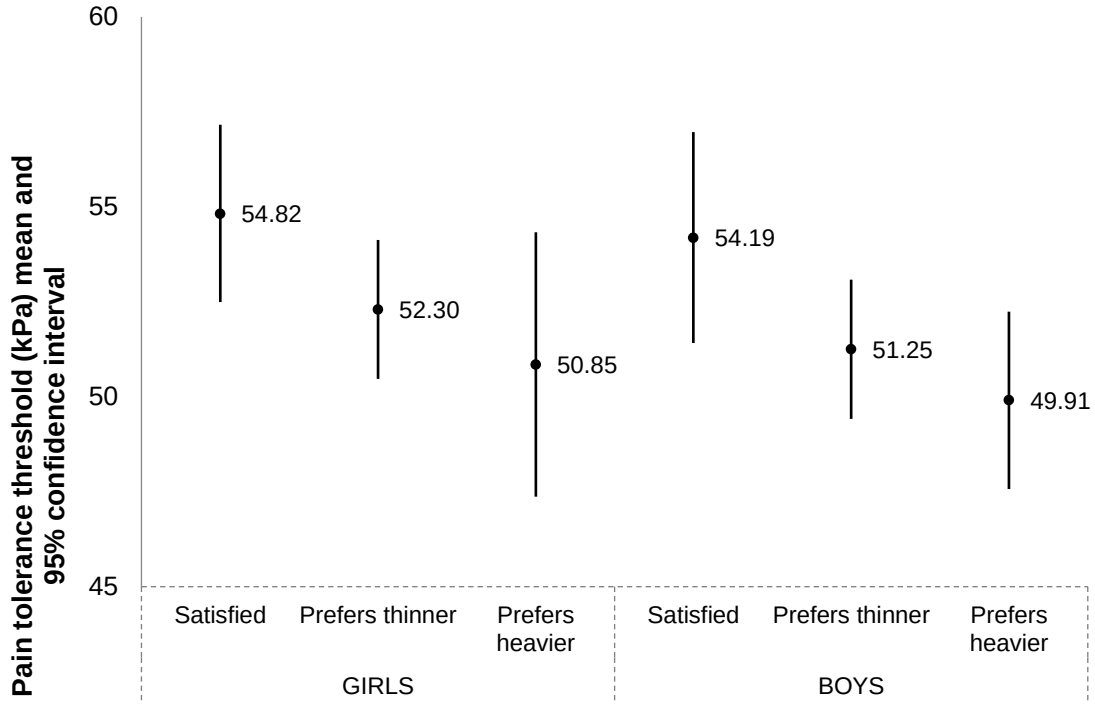


Table 2. Crude and adjusted linear regression coefficients between adolescent's satisfaction with own body and Quantitative Sensory Testing results for the right leg in Generation XXI cohort.

	Girls (n=894)				Boys (n=899)			
	PDT		PTT		PDT		PTT	
	Crude B (95% CI)	Adj. B (95% CI)	Crude B (95% CI)	Adj. B (95% CI)	Crude B (95% CI)	Adj. B (95% CI)	Crude B (95% CI)	Adj. B (95% CI)
Satisfied	0	0	0	0	0	0	0	0
Prefers thinner	-0.06 (-1.71; 1.60)	-1.09 (-3.03; 0.84)	-2.53 (-5.43; 0.37)	-1.96 (-5.36; 1.45)	1.05 (-0.92; 3.01)	2.35 (0.15; 4.55)	-2.94 (-6.09; 0.21)	-0.76 (-4.27; 2.74)
Prefers heavier	-1.26 (-3.63; 1.11)	-0.56 (-3.02; 1.91)	-3.97 (-8.12; 0.18)	-4.43 (-8.76; -0.10)	-1.2 (-2.41; 2.02)	-0.36 (-2.70; 1.91)	-4.28 (-7.83; -0.74)	-4.18 (-7.90; -0.46)

Legend:

PDT – pressure detection threshold; PTT – pressure tolerance threshold; B – regression coefficient; CI - Confidence Interval; Adj. – adjusted;

(Reference: ”Satisfied”)

Adj.B was adjusted for BMI z-score and Tanner pubic hair stage.

Table 3. Crude and adjusted odds ratios for the association between adolescent's satisfaction with own body and Quantitative Sensory Testing results for the right leg in Generation XXI cohort.

	Girls (n=894)				Boys (n=899)			
	PDT		PTT		PDT		PTT	
	Crude OR (95% CI)	Adj. OR (95% CI)	Crude OR (95% CI)	Adj. OR (95% CI)	Crude OR (95% CI)	Adj. OR (95% CI)	Crude OR (95% CI)	Adj. OR (95% CI)
Satisfied	1	1	1	1	1	1	1	1
Prefers thinner	0.93 (0.65; 1.33)	0.83 (0.55; 1.26)	0.69 (0.50; 0.95)	0.67 (0.46; 0.97)	1.48 (0.97; 2.27)	1.80 (1.13; 2.87)	0.73 (0.50; 1.05)	0.84 (0.55; 1.27)
Prefers heavier	0.89 (0.53; 1.50)	0.93 (0.55; 1.56)	0.63 (0.39;1.00)	0.62 (0.39; 1.00)	1.11 (0.68; 1.81)	1.14 (0.69; 1.87)	0.7 (0.46; 1.06)	0.75 (0.49; 1.16)

PDT – pressure detection threshold; PTT – pressure tolerance threshold OR - Odds Ratio and 95%; CI - Confidence Interval; Adj. – adjusted;

(Reference: ”Satisfied”)

Adj. OR was adjusted for WHO weight status and Tanner pubic hair stage.

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Declaration of Interest

The authors have no conflits of interests relevants to this article to disclose.

7. References

Akkaya, N., Akkaya, S., Atalay, N.S., Balci, C.S., Sahin, F., 2012. Relationship between the body image and level of pain, functional status, severity of depression, and quality of life in patients with fibromyalgia syndrome. Clinical Rheumatology 31, 983-988.

Allen, H.N., Bobnar, H.J., Kolber, B.J., 2021. Left and right hemispheric lateralization of the amygdala in pain. Progress in Neurobiology 196, 101891.

Alves, E., Correia, S., Barros, H., Azevedo, A., 2012. Prevalence of self-reported cardiovascular risk factors in Portuguese women: a survey after delivery. International journal of public health 57, 837-847.

Amrhein, V., Greenland, S., McShane, B., 2019. Scientists rise up against statistical significance. Nature 567, 305-307.

Arendt-Nielsen, L., Yarnitsky, D., 2009. Experimental and clinical applications of quantitative sensory testing applied to skin, muscles and viscera. J Pain 10, 556-572.

Auvinen, J., Eskola, P.J., Ohtonen, H.R., Paananen, M., Jokelainen, J., Timonen, M., Vahtera, J., Leino-Arjas, P., Karppinen, J., 2017. Long-term adolescent multi-site musculoskeletal pain is associated with psychological distress and anxiety. Journal of psychosomatic research 93, 28-32.

Blankenburg, M., Boekens, H., Hechler, T., Maier, C., Krumova, E., Scherens, A., Magerl, W., Aksu, F., Zernikow, B., 2010. Reference values for quantitative sensory testing in children and adolescents: developmental and gender differences of somatosensory perception. Pain 149, 76-88.

Boschi, V., Siervo, M., D'Orsi, P., Margiotta, N., Trapanese, E., Basile, F., Nasti, G., Papa, A., Bellini, O., Falconi, C., 2003. Body composition, eating behavior, food-body concerns and eating disorders in adolescent girls. Annals of nutrition & metabolism 47, 284-293.

Boyington, J.E., Schoster, B., Callahan, L.F., 2015. Comparisons of Body Image Perceptions of a Sample of Black and White Women with Rheumatoid Arthritis and Fibromyalgia in the US. The open rheumatology journal 9, 1-7.

Bucchianeri, M.M., Arikian, A.J., Hannan, P.J., Eisenberg, M.E., Neumark-Sztainer, D., 2013. Body dissatisfaction from adolescence to young adulthood: findings from a 10-year longitudinal study. Body image 10, 1-7.

Campo-Prieto, P., Rodríguez-Fuentes, G., 2018. Effectiveness of mirror therapy in phantom limb pain: A literature review. Neurologia (Barcelona, Spain).

Carnes, D., Parsons, S., Ashby, D., Breen, A., Foster, N.E., Pincus, T., Vogel, S., Underwood, M., 2007. Chronic musculoskeletal pain rarely presents in a single body site: results from a UK population study. Rheumatology (Oxford, England) 46, 1168-1170.

Carrasquillo, Y., Gereau, R.W.t., 2008. Hemispheric lateralization of a molecular signal for pain modulation in the amygdala. Molecular pain 4, 24.

Crone, E.A., Dahl, R.E., 2012. Understanding adolescence as a period of social-affective engagement and goal flexibility. Nature reviews. Neuroscience 13, 636-650.

de Onis, M., Onyango, A.W., Borghi, E., Siyam, A., Nishida, C., Siekmann, J., 2007. Development of a WHO growth reference for school-aged children and adolescents. Bulletin of the World Health Organization 85, 660-667.

Flannery-Schroeder, E.C., Chrisler, J.C., 1996. Body esteem, eating attitudes, and gender-role orientation in three age groups of children. Current Psychology 15, 235-248.

Gardner, R.M., Brown, D.L., 2010. Body image assessment: A review of figural drawing scales. Personality and Individual Differences 48, 107-111.

Gibson, R.S., 2005. Principles of Nutritional Assessment. Oxford University Press.

Haggard, P., Iannetti, G.D., Longo, M.R., 2013. Spatial sensory organization and body representation in pain perception. Current biology : CB 23, R164-176.

Henriques, A., Alves, E., Barros, H., Azevedo, A., 2013. Women's Satisfaction with Body Image before Pregnancy and Body Mass Index 4 Years after Delivery in the Mothers of Generation XXI. PLOS ONE 8, e70230.

Henriques, A., Alves, L., Alves, E., Silva, S., Barros, H., Azevedo, A., 2015. Social Trajectory and Body Image Satisfaction in Childbearing Women. Maternal and Child Health Journal 19, 1237-1244.

Holden, S., Rathleff, M.S., Thorborg, K., Holmich, P., Graven-Nielsen, T., 2020. Mechanistic pain profiling in young adolescents with patellofemoral pain before and after treatment: a prospective cohort study. Pain 161, 1065-1071.

Jeffries, L.J., Milanese, S.F., Grimmer-Somers, K.A., 2007. Epidemiology of adolescent spinal pain: a systematic overview of the research literature. Spine 32, 2630-2637.

Jones, D.C., Crawford, J.K., 2005. Adolescent Boys and Body Image: Weight and Muscularity Concerns as Dual Pathways to Body Dissatisfaction. Journal of youth and adolescence 34, 629-636.

King, S., Chambers, C.T., Huguet, A., MacNevin, R.C., McGrath, P.J., Parker, L., MacDonald, A.J., 2011. The epidemiology of chronic pain in children and adolescents revisited: a systematic review. Pain 152, 2729-2738.

Kröner-Herwig, B., Gassmann, J., van Gessel, H., Vath, N., 2011. Multiple pains in children and adolescents: a risk factor analysis in a longitudinal study. Journal of pediatric psychology 36, 420-432.

Larsen, P.S., Kamper-Jørgensen, M., Adamson, A., Barros, H., Bonde, J.P., Brescianini, S., Brophy, S., Casas, M., Devereux, G., Eggesbø, M., Fantini, M.P., Frey, U., Gehring, U., Grazuleviciene, R., Henriksen, T.B., Hertz-Picciotto, I., Heude, B., Hryhorczuk, D.O., Inskip, H., Jaddoe, V.W.V., Lawlor, D.A., Ludvigsson, J., Kelleher, C., Kiess, W., Koletzko, B., Kuehni, C.E., Kull, I., Kyhl, H.B., Magnus, P., Momas, I., Murray, D., Pekkanen, J., Polanska, K., Porta, D., Poulsen, G., Richiardi, L., Roeleveld, N., Skovgaard, A.M., Sram, R.J., Strandberg-Larsen, K., Thijs, C., Van Eijsden, M., Wright, J., Vrijheid, M., Andersen, A.-M.N., 2013. Pregnancy and Birth Cohort Resources in Europe: a Large Opportunity for Aetiological Child Health Research. 27, 393-414.

Lemming, D., Graven-Nielsen, T., Sorensen, J., Arendt-Nielsen, L., Gerdle, B., 2012. Widespread pain hypersensitivity and facilitated temporal summation of deep tissue pain in whiplash associated disorder: an explorative study of women. J Rehabil Med 44, 648-657.

Levenig, C.G., Hasenbring, M.I., Kleinert, J., Kellmann, M., 2016. [Body image and low back pain]. Schmerz (Berlin, Germany) 30, 437-443.

Levenig, C.G., Kellmann, M., Kleinert, J., Belz, J., Hesselmann, T., Hasenbring, M.I., 2019. Body image is more negative in patients with chronic low back pain than in patients with subacute low back pain and healthy controls. Scand J Pain 19, 147-156.

Lindskou, T.A., Christensen, S.W., Graven-Nielsen, T., 2017. Cuff Algometry for Estimation of Hyperalgesia and Pain Summation. Pain Med 18, 468-476.

López-Sánchez, G., Diaz Suarez, A., Smith, L., 2018. Analysis of body image and obesity by Stunkard's silhouettes in 3-to 18-year-old Spanish children and adolescents. Anales de Psicología 34, 167-172.

Lucas, R., Talih, M., Monjardino, T., Guimarães, S., Barros, H., 2020. Mother-reported pain experience between ages 7 and 10: A prospective study in a population-based birth cohort. Paediatric and perinatal epidemiology.

Marshall, W.A., Tanner, J.M., 1969. Variations in pattern of pubertal changes in girls. Arch Dis Child 44, 291-303.

Marshall, W.A., Tanner, J.M., 1970. Variations in the pattern of pubertal changes in boys. Arch Dis Child 45, 13-23.

Mücke, M., Cuhls, H., Radbruch, L., Baron, R., Maier, C., Tölle, T., Treede, R.D., Rolke, R., 2014. [Quantitative sensory testing]. Schmerz (Berlin, Germany) 28, 635-646; quiz 647-638.

Osumi, M., Imai, R., Ueta, K., Nobusako, S., Morioka, S., 2014. Negative body image associated with changes in the visual body appearance increases pain perception. PLoS One 9, e107376.

Perez, M., Kroon Van Diest, A.M., Smith, H., Sladek, M.R., 2018. Body Dissatisfaction and Its Correlates in 5- to 7-Year-Old Girls: A Social Learning Experiment. Journal of clinical child and adolescent psychology : the official journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53 47, 757-769.

Polianskis, R., Graven-Nielsen, T., Arendt-Nielsen, L., 2002. Pressure-pain function in desensitized and hypersensitized muscle and skin assessed by cuff algometry. J Pain 3, 28-37.

Sawyer, S.M., Afifi, R.A., Bearinger, L.H., Blakemore, S.J., Dick, B., Ezeh, A.C., Patton, G.C., 2012. Adolescence: a foundation for future health. Lancet (London, England) 379, 1630-1640.

Schilder, P., Wertman, R., 1994. Imagem do corpo: as energias construtivas da psique. Martins Fontes.

Seeger, G., Braus, D.F., Ruf, M., Goldberger, U., Schmidt, M.H., 2002. Body image distortion reveals amygdala activation in patients with anorexia nervosa -- a functional magnetic resonance imaging study. Neuroscience letters 326, 25-28.

Senín-Calderón, C., Rodríguez-Testal, J.F., Perona-Garcelán, S., Perpiñá, C., 2017. Body image and adolescence: A behavioral impairment model. Psychiatry Research 248, 121-126.

Shields, L.E., Wiesner, S., Fulton, J., Pelletreau, B., 2019. Obstetric Care Consensus No. 9: Levels of Maternal Care: Correction. 134, 883.

Simons, L.E., Moulton, E.A., Linnman, C., Carpino, E., Becerra, L., Borsook, D., 2014. The human amygdala and pain: evidence from neuroimaging. Hum Brain Mapp 35, 527-538.

Skou, S.T., Graven-Nielsen, T., Rasmussen, S., Simonsen, O.H., Laursen, M.B., Arendt-Nielsen, L., 2013. Widespread sensitization in patients with chronic pain after revision total knee arthroplasty. Pain 154, 1588-1594.

Sundermann, O., Flink, I., Linton, S.J., 2020. My body is not working right: a cognitive behavioral model of body image and chronic pain. Pain 161, 1136-1139.

Sundermann, O., Rydberg, K., Linder, L., Linton, S.J., 2018. "When I feel the worst pain, I look like shit" - body image concerns in persistent pain. Scand J Pain 18, 379-388.

Thompson, J., 2001. Body image, eating disorders, and obesity: An integrative guide for assessment and treatment. American Psychological Association.

Tiggemann, M., Pennington, B., 1990. The Development of Gender Differences in Body-Size Dissatisfaction. 25, 306-313.

Tiggemann, M., Wilson-Barrett, E., 1998. Children's figure ratings: relationship to self-esteem and negative stereotyping. Int J Eat Disord 23, 83-88.

Wand, B.M., Elliott, R.L., Sawyer, A.E., Spence, R., Beales, D.J., O'Sullivan, P.B., Smith, A.J., Gibson, W., 2017. Disrupted body-image and pregnancy-related lumbopelvic pain. A preliminary investigation. Musculoskelet Sci Pract 30, 49-55.

Wasserstein, R.L., Schirm, A.L., Lazar, N.A., 2019. Moving to a World Beyond “p < 0.05”. The American Statistician 73, 1-19.

Wittkopf, P.G., Johnson, M.I., 2017. Mirror therapy: A potential intervention for pain management. Revista da Associacao Medica Brasileira (1992) 63, 1000-1005.

World Health, O., 2006. WHO child growth standards : length/height-for-age, weight-for-age, weight-for-length, weight -for-height and body mass index-for-age : methods and development. World Health Organization, Geneva.

Yamamotova, A., Bulant, J., Bocek, V., Papezova, H., 2017. Dissatisfaction with own body makes patients with eating disorders more sensitive to pain. J Pain Res 10, 1667-1675.

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

Supplementary Material

I – Children's Figure Rating Scale and questionnaire used to assess Body Image Satisfaction.

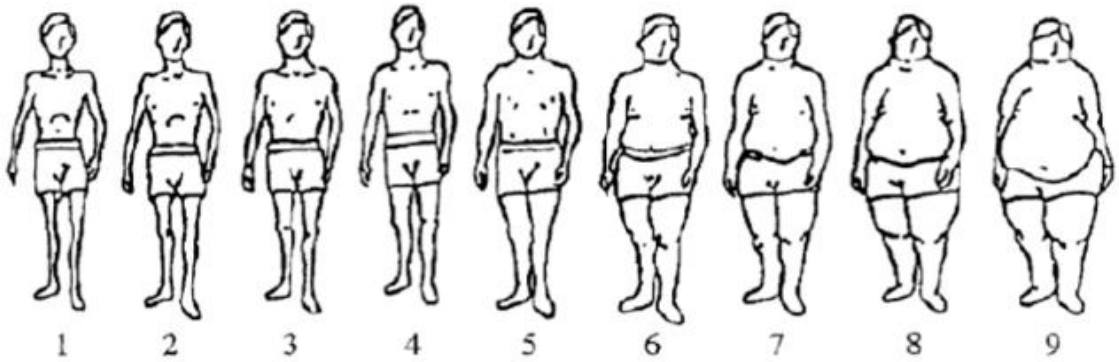
Adolescents were asked first to select the figure they thought they looked the most with (Q1) and then the figure they desired to look like the most (Q2). Body image satisfaction was calculated as the discrepancy between these two ratings (Q2-Q1).

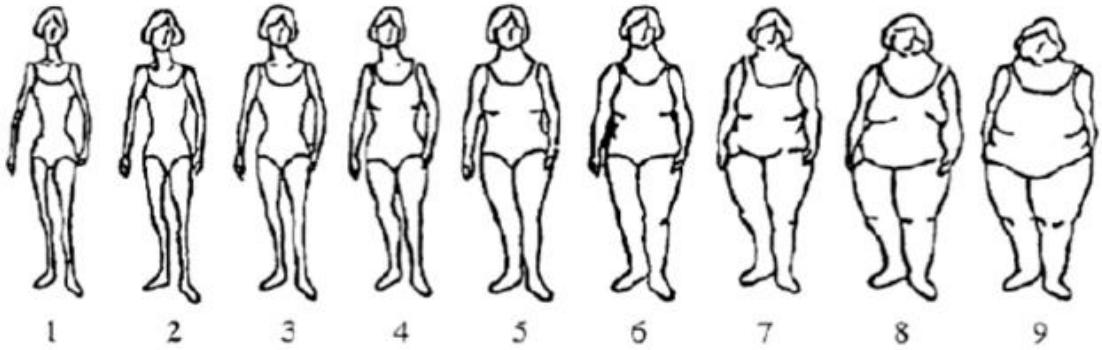
Children's Figure Rating Scale was addapted from Tiggemann and Wilson-Barrett, 1998.

ID

Imagem Corporal

Data de preenchimento – – (dd-mm-aaaa)





1. Das figuras acima, escolhe aquela com quem mais te identificas.

2. Com qual das figuras gostavas de te parecer?

II - Quantitative sensory testing in Generation XXI using cuff pressure algometry

Experimental set-up (CPAR Nocitech, Denmark)

III - Supplementary Results

Table 1. Comparison between included and not included participants regarding demographic and anthropometric characteristics and distributions by Pubic Hair Stage and Body Image Satisfaction.

		Included	**Not included**
		n=1793	**n=2840**
Age in years, mean (SD)		13.43 (0.30)	13.28 (0.23)
Sex, n(%)			
	Girls	894 (49.9)	1348 (47.4)
	Boys	899 (50.1)	1492 (52.5)
BMI z-score, mean (SD)		0.48 (1.16)	0.46 (1.20)
Weight status[1], n (%)			
	Underweight	44 (2.5)	61 (2.1%)
	Normal weight	1144 (63.8)	1800 (63.4%)
	Overweight	428 (23.9)	689 (24.3%)
	Obesity	177 (9.9)	290 (10.2%)
		n=1793	**n=2751**
Tanner Pubic Hair stage[2], n (%)			
	1-2	352 (19.6%)	705 (24.8%)
	3	476 (26.5%)	889 (31.3%)
	4	793 (44.2%)	969 (34.1%)
	5	172 (9.6%)	188 (6.6%)
		n=1793	**n=1855**
Body Image Satisfaction[3]			
	Satisfied	560 (31.2%)	626 (33.2%)
	Prefers thinner	864 (48.2%)	838 (44.5%)
	Prefers heavier	369 (20.6%)	421 (22.3%)

Left Leg Results

Table 2. Distribution of the characteristics of Generation XXI participants included.

		Girls (n=554)	**Boys (n=517)**
Age in years, mean (SD)		13,41 (0,3)	13,41 (0,29)
BMI z-score, mean (SD)		0,53 (1,09)	0,45 (1,18)
Weight status[1], n (%)			
	Underweight	10 (1,8%)	14 (2,7%)
	Normal weight	363 (65,3%)	327 (63,2%)
	Overweight	132 (23,8%)	120 (23,2%)
	Obesity	50 (9,0%)	56 (10,8%)
Tanner Pubic Hair stage[2], n (%)			
	1-2	30 (5,4%)	160 (30,9%)
	3	129 (23,3%)	157 (30,4%)
	4	343 (61,9%)	151 (29,2%))
	5	52 (9,4%)	49 (9,5%)
Satisfaction with own silhouette[3]			
	Satisfied	203 (36,6%)	131 (25,3%)
	Prefers thinner	268 (48,4%)	242 (46,8%)
	Prefers heavier	83 (15,0%)	144 (27,9%)
Pain detection threshold in kPa, mean (SD)		22,94 (13,99)	22,43 (13,44)
Pain tolerance threshold in kPa, mean (SD)		48,87 (21,23)	48,65 (19,67)

Legend:

BMI - Body Mass Index; *SD* – standard deviation

1.Child's weight status was defined based on the WHO growth references categories, as follows: Underweight: < − 2SD, Normal weight: ≥ − 2 and < + 1SD, Overweight: ≥ + 1 and ≤ + 2SD, Obesity: > + 2SD (de Onis et al., 2007; World Health, 2006)

2. Pubic Hair Stage was evaluated at the 13-year follow-up by trained nurses using the five Pubic Hair stages from Tanner Scale as reference (Marshall and Tanner, 1969, 1970).

3. Body Image Satisfaction was calculated subtracting the silhouette indicated by the adolescent as the desired one from the silhouette representing his or her perception of the current body.

Figure 2. Pain Detection Threshold mean and 95% confidence interval by category of body image satisfaction.

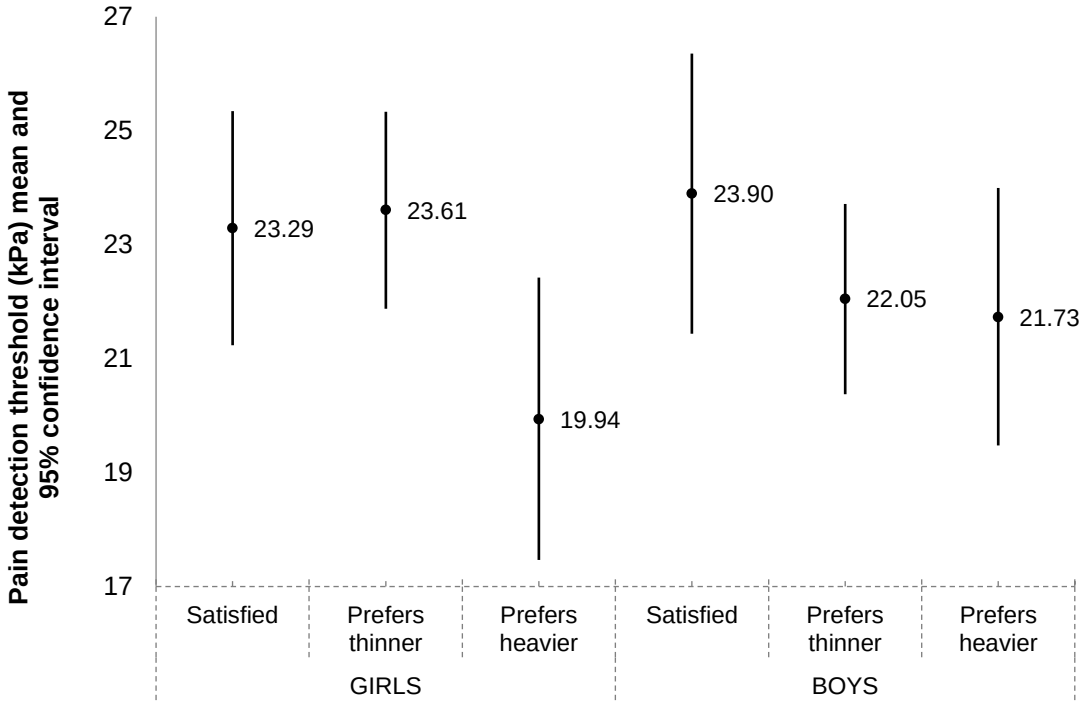


Figure 3. Pain Tolerance Threshold mean and 95% confidence interval by category of body image satisfaction.

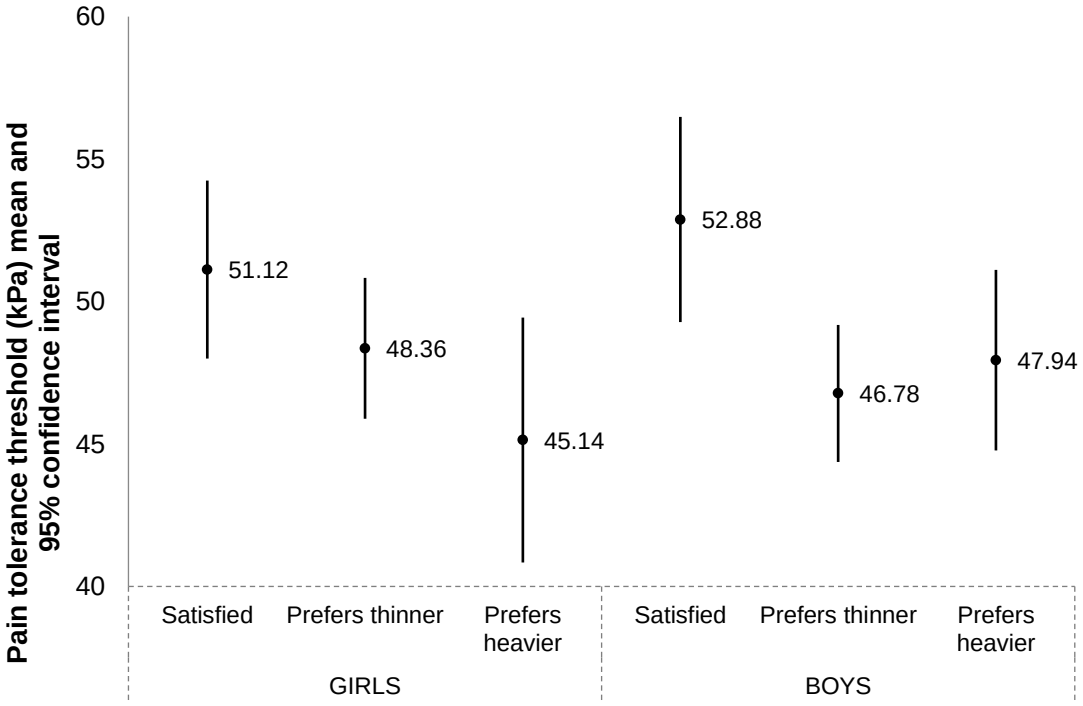


Table 3. Crude and adjusted linear regression coefficients between adolescent's satisfaction with own body and Quantitative Sensory Testing results for the right leg in Generation XXI cohort.

	Girls (n=894)				Boys (n=899)			
	PDT		PTT		PDT		PTT	
	Crude B (95% CI)	Adj. B (95% CI)	Crude B (95% CI)	Adj. B (95% CI)	Crude B (95% CI)	Adj. B (95% CI)	Crude B (95% CI)	Adj. B (95% CI)
Satisfied	0	0	0	0	0	0	0	0
Prefers thinner	0.32 (-2.22; 2.86)	-0.47 (-3.49; 2.56)	-2.77 (-6.62; 1.08)	-2.48 (-7.06; 1.08)	-1.85 (-4.70; 1.00)	-1.19 (-4.31; 1.94)	-6.10 (-10.25; -1.96)	-4.93 (-9.46; -0.39)
Prefers heavier	-3.35 (-6.90; 0.21)	-2.95 (-6.65; 0.75)	-5.98 (-11.37; -0.59)	-6.37 (-11.98; -0.76)	-2.16 (-5.33; 1.01)	-1.88 (-5.22; 1.47)	-4.94 (-9.56; -0.33)	-4.62 (-9.47; 0.24)

Legend:

PDT – pressure detection threshold; PTT – pressure tolerance threshold; B – regression coefficient; CI - Confidence Interval; Adj. – adjusted;

(Reference: self-body satisfied girls and boys)

Adj.B (linear regression) was adjusted for z-score BMI and pubic hair stage.

Table 4. Crude and adjusted odds ratios for the association between adolescent's satisfaction with own body and Quantitative Sensory Testing results for the right leg in Generation XXI cohort.

	Girls (n=894)				Boys (n=899)			
	PDT		PTT		PDT		PTT	
	Crude OR (95% CI)	Adj. OR (95% CI)	Crude OR (95% CI)	Adj. OR (95% CI)	Crude OR (95% CI)	Adj. OR (95% CI)	Crude OR (95% CI)	Adj. OR (95% CI)
Satisfied	1	1	1	1	1	1	1	1
Prefers thinner	1.05 (0.70; 1.59)	0.96 (0.59; 1.55)	0.76 (0.51; 1.15)	0.84 (0.52; 1.36)	0.83 (0.52; 1.33)	0.94 (0.56; 1.59)	0.55 (0.34; 0.88)	0.57 (0.33; 0.96)
Prefers heavier	0.47 (0.24; 0.93)	0.47 (0.23; 0.93)	0.69 (0.38; 1.25)	0.67 (0.36; 1.19)	1.12 (0.61; 2.07)	0.85 (0.49; 1.46)	0.56 (0.33; 0.96)	0.60 (0.34; 1.04)

PDT – pressure detection threshold; PTT – pressure tolerance threshold OR - Odds Ratio and 95%; CI - Confidence Interval; Adj. – adjusted;

(Reference: self-body satisfied girls and boys)

Adj. OR (logistic regression) was adjusted for WHO weight status and Pubic Hair Stage.

de Onis. M.. Onyango. A.W.. Borghi. E.. Siyam. A.. Nishida. C.. Siekmann. J.. 2007. Development of a WHO growth reference for school-aged children and adolescents. Bulletin of the World Health Organization 85. 660-667.

Marshall. W.A.. Tanner. J.M.. 1969. Variations in pattern of pubertal changes in girls. Arch Dis Child 44. 291-303.

Marshall. W.A.. Tanner. J.M.. 1970. Variations in the pattern of pubertal changes in boys. Arch Dis Child 45. 13-23.

Tiggemann, M., Wilson-Barrett, E., 1998. Children's figure ratings: relationship to self-esteem and negative stereotyping. Int J Eat Disord 23, 83-88.

World Health. O.. 2006. WHO child growth standards : length/height-for-age. weight-for-age. weight-for-length. weight -for-height and body mass index-for-age : methods and development. World Health Organization. Geneva.

PSYCHONEUROENDOCRINOLOGY

An International Journal

AUTHOR INFORMATION PACK

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Psychoneuroendocrinology publishes papers dealing with the interrelated disciplines of **psychology**, **neurobiology**, **endocrinology**, **immunology**, **neurology**, and **psychiatry**, with an emphasis on multidisciplinary studies aiming at integrating these disciplines in terms of either basic research or clinical implications. One of the main goals is to understand how a variety of psychobiological factors interact in the expression of the stress response as it relates to the development and/or maintenance of **neuropsychiatric illnesses**. The journal is international and comprises original research papers, reviews of an area of the literature, or at an appropriate stage in the development of the author's own work, commentaries in areas of current interest, short communications and book reviews. Although reviews, editorials and commentaries are usually by invitation, interested authors can contact one of the Co-Editors-in-Chief to discuss the suitability of topics for either category of manuscripts.

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Psychoneuroendocrinology publishes papers dealing with the interrelated disciplines of psychology, neurobiology, endocrinology, immunology, neurology, and psychiatry, with an emphasis on multidisciplinary studies aiming at integrating these disciplines in terms of either basic research or clinical implications. One of the main goals is to understand how a variety of psychobiological factors interact in the expression of the stress response as it relates to the development and/or maintenance of neuropsychiatric illnesses. The journal is international and comprises original research papers, reviews of an area of the literature, or at an appropriate stage in the development of the author's own work, commentaries in areas of current interest, short communications and book reviews.Other forms of publication (e.g., editorial, opinion, news, perspective) are up to the editors' discretion.

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Becker JB, Arnold AP, Berkley KJ, Blaustein JD, Eckel LA, Hampson E, Herman JP, Marts S, Sadee W, Steiner M, Taylor J, Young E, Strategies and methods for research on sex differences in brain and behavior, Endocrinology, 2005, 146, 1650-1673, doi: 10.1210/en.2004-1142. Poromaa IS, Gingnell M, Menstrual cycle influence on cognitive function and emotion processing ? from a reproductive perspective, Front Neurosci, 2014, https://doi.org/10.3389/fnins.2014.00380

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	**(a) Indicate the study's design with a commonly used term in the title or the abstract** "We conducted an observational study in 1973 participants from the Generation XXI population-based cohort, recruited in 2005-06."	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found "Body Image Satisfaction was assessed using a self-administered questionnaire with the Children's Figure Rating Scale. Pain detection and tolerance thresholds were estimated using cuff pressure algometry with standardized stimuli. We express the results as linear regression coefficients (B) and as odds ratios (OR) and their 95% confidence intervals. Models were computed crude and adjusted to Tanner pubic hair stage and body mass index. (…) Dissatisfaction with own body image was associated with lower tolerance to pain in this cohort of 13-year-old adolescents, especially among girls."	2
Introduction			
Background/rationale	2	**Explain the scientific background and rationale for the investigation being reported** "Body dissatisfaction may begin as early as five years of age among female children (Flannery-Schroeder and Chrisler, 1996; Perez et al., 2018), but its prevalence increases progressively, especially among girls, during adolescence (Bucchianeri et al., 2013). Like body dissatisfaction, also pain experiences increase in frequency during the course of adolescence and approximate adult levels by age 18 years (Jeffries et al., 2007). Sex differences in pain prevalence and experiences widen during adolescence, with girls typically reporting more symptoms than boys (King et al., 2011). (…) Adolescence is simultaneously a crucial phase for the development of body image issues and also for the expression of pain phenotypes. (…) Despite the evidence that sustains an association between body image and pain, the direction of a potential causal relationship is unclear, i.e., whether a misrepresentation of body image results from pain or the perception pain is somehow amplified by the dissatisfaction with one's body. Alternatively, both body image and pain may share a common predisposition that accounts for their association."	5
Objectives	3	**State specific objectives, including any prespecified hypotheses** "Therefore, using data from a 13-year-old population-based birth cohort, we aimed to assess pressure pain thresholds according to body image satisfaction among adolescent girls and boys. We hypothesized that adolescents dissatisfied with their body image have less tolerance for pain compared with those who are satisfied."	6

Methods

Study design	4	**Present key elements of study design early in the paper** "We used data from the Generation XXI birth cohort, described in detail elsewhere (…). The present investigation is a cross-sectional study implemented in the 13-year follow-up evaluation, which occurred between August 2018 and March 2020."	6
Setting	5	**Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection** "The 13 years evaluation took place between August 2018 and March 2020." "Adolescents underwent quantitative sensory testing to assess responses to standardized pressure stimuli. Tests were conducted by trained examiners using a standardized protocol including oral instructions throughout the procedure"	7
Participants	6	***(*a**) **Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up** "We included all children who had anthropometric data available at age 13, answered the body image satisfaction questionnaire, had their pubic hair stage evaluated, and agreed to undergo quantitative sensory testing (QST). Due to equipment availability, only a subsample of adolescents was eligible for QST, and our final analytical sample included 1793 adolescents. More detailed information on the selection criteria is depicted in Figure 1, and the description of sample characteristics in the 13-year-old evaluation is presented in Table 1." **(*b*) For matched studies, give matching criteria and number of exposed and unexposed**	7
Variables	7	**Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable** "Body Mass Index (BMI) was calculated and age- and sex-specific BMI z-scores and categories were established according to the World Health Organization: 'underweight' was defined as z-score < − 2 standard deviations (SD), ´normal weight' as z-score ≥ − 2SD and < + 1SD, ´overweight' as z-score ≥ + 1 and < + 2 and 'obesity' as z-score ≥ + 2SD" "Body Satisfaction was calculated using the difference between the answers to question two and question one (Q2-Q1). We then defined three categories: "satisfied" (reference category) when the difference was equal to zero, "prefers thinner" when the difference was inferior to zero and "prefers heavier" when the difference was superior to zero." "Pubic hair development was evaluated by trained nurses using the Tanner Scale as reference (Marshall and Tanner, 1969, 1970), with stage 1 corresponding to pre-pubertal, stages 2 to 4 to pubertal and 5 to post-pubertal in both sexes." "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"	8-9

		"Data analyses were stratified by sex at birth. Categorical variables are described as counts and proportions and continuous variables as means and standard deviations. 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, analysed using linear regression) and dichotomous (PDT and PTT at or above the 75th percentile in the sample vs. below the 75th percentile, analysed using binary logistic regression). Models were computed crude and adjusted to pubic hair stage and BMI z-score. Results are expressed as linear regression coefficients (B) and 95% confidence intervals (95% CI) or as odds ratios (OR) and 95% confidence intervals (95% CI)."	
Data sources/ measurement	8*	**For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group** "Children's weight and height were measured using standard procedures (…). Body Mass Index (BMI) was calculated and age- and sex-specific BMI z-scores and categories were established according to the World Health Organization." "Pubic hair development was evaluated by trained nurses using the Tanner Scale as reference (…)". "Body Satisfaction at 13 years of age was assessed using a self-administered questionnaire with the Children's Figure Rating Scale" "Adolescents underwent quantitative sensory testing to assess responses to standardized pressure stimuli. We used a computer-controlled cuff pressure algometer (Nocitech, Denmark) (Polianskis et al., 2002) to perform the evaluation."	7-8
Bias	9	**Describe any efforts to address potential sources of bias** "Models were computed crude and adjusted to pubic hair stage and BMI z-score."	9
Study size	10	**Explain how the study size was arrived at** "We included all children who had anthropometric data available at age 13, answered the body image satisfaction questionnaire, had their pubic hair stage evaluated, and agreed to undergo quantitative sensory testing (QST). Due to equipment availability, only a subsample of adolescents was eligible for QST, and our final analytical sample included 1793 adolescents. More detailed information on the selection criteria is depicted in Figure 1."	7
Quantitative variables	11	**Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why** "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, analysed using linear regression) and dichotomous (PDT and PTT at or above the 75th percentile in the sample vs. below the 75th percentile, analysed using binary logistic regression)." "Figure 1. Selection of analytic sample from the Generation XXI birth cohort."	9; 16

Statistical methods	12	**(*a*) Describe all statistical methods, including those used to control for confounding** "2.3. Statistical analysis Data analyses were stratified by sex at birth. Categorical variables are described as counts and proportions and continuous variables as means and standard deviations. (…) Models were computed crude and adjusted to pubic hair stage and BMI z-score. Results are expressed as linear regression coefficients (B) and 95% confidence intervals (95% CI) or as odds ratios (OR) and 95% confidence intervals (95% CI). Data were analysed using SPSS statistical software (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. IBM Corp.) and Stata (Statacorp, Version 15). Results were interpreted based on point estimates and confidence intervals and no null-hypothesis significance testing was conducted (Amrhein et al., 2019; Wasserstein et al., 2019)."	9
		(*b*) Describe any methods used to examine subgroups and interactions "Data analyses were stratified by sex at birth."	9
		(*c*) Explain how missing data were addressed "Figure 1. Selection of analytic sample from the Generation XXI birth cohort."	16
		(*d*) If applicable, explain how loss to follow-up was addressed "Figure 1. Selection of analytic sample from the Generation XXI birth cohort."	16
		(*e*) Describe any sensitivity analyses "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, analysed using linear regression) and dichotomous (PDT and PTT at or above the 75th percentile in the sample vs. below the 75th percentile, analysed using binary logistic regression)."	9
Results			
Participants	13*	**(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed** "Due to equipment availability, only a subsample of adolescents was eligible for QST, and our final analytical sample included 1793 adolescents. More detailed information on the selection criteria is depicted in Figure 1(…)." "Figure 1. Selection of analytic sample from the Generation XXI birth cohort."	7; 16
		(b) Give reasons for non-participation at each stage "Due to equipment availability, only a subsample of adolescents was eligible for QST, and our final analytical sample included 1793 adolescents." "Figure 1. Selection of analytic sample from the Generation XXI birth cohort."	7;16
		(c) Consider use of a flow diagram "Figure 1. Selection of analytic sample from the Generation XXI birth cohort."	16

Descriptive data	14*	**(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders** "In each sex, mean age, BMI z-score and QST outcomes, as well as the distributions of the participants according to weight status categories, pubic hair stages and satisfaction with their own silhouette, can be seen in Table 1." "Table 1. Distribution of the characteristics of Generation XXI participants included."	9; 17
		(b) Indicate number of participants with missing data for each variable of interest "Figure 1. Selection of analytic sample from the Generation XXI birth cohort."	16
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	**Report numbers of outcome events or summary measures over time** "By the time of the 13-year old follow-up, boys and girls had a mean age of 13.4 years. Mean BMI z-score was 0.52 for girls and 0.42 for boys. The weight status distribution was similar between sexes: 64.7% of girls and 63.0% of boys had normal weight, almost a quarter were overweight, 10% were obese and a minority was underweight (1.9% of girls and 3.0% of boys). Tanner pubic hair stages showed more discrepant distribution between sexes: almost two-thirds of girls were in stage 4, 22.8% in stage 3, and 5.3% in stages 1 or 2, whereas boys were more evenly distributed between the first three categories, with 33.9% in stages 1 or 2, 30.3% in stage 3 and 26.6% in stage 4. The proportions of both sexes in stage 5) were similar (10.0% for girls and 9.2% for boys). Regarding the satisfaction with their silhouettes, almost half of the children preferred thinner silhouettes (48.5% of girls and 47.8% of boys). Among boys, 26.9% preferred a heavier silhouette, compared to 14.2% of girls. The remaining adolescents (37.2% of girls and 25.3% of boys) showed satisfaction with their own body. Mean pressure pain detection thresholds for girls and boys were both 20.5 kPa and mean pressure pain detection thresholds were 53.0 and 51.6 kPa, respectively."	9-10

Main results	16	**(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included** "Table 2 and Table 3 present the results from the linear regression and binomial logistic regression analyses, respectively, showing the associations between body image satisfaction categories and the two QST outcomes (PDT and PTT), crude and adjusted for Tanner stage and body mass index. 3.1. Pain detection threshold (PDT) (…) 3.2 Pain Tolerance Threshold (…)" "Table 2. Crude and adjusted association between child's satisfaction with own body and Quantitative Sensory Testing results for the right leg in Generation XXI cohort (results from linear regression models)." "Table 3. Crude and adjusted association between child's satisfaction with own body and Quantitative Sensory Testing results for the right leg in Generation XXI cohort (results from logistic regression models)." **(*b*) Report category boundaries when continuous variables were categorized** "The distribution of QST parameters means by body image satisfaction categories can be seen in Figures 2 (pain detection threshold) and 3 (pain tolerance threshold). While PDT was similar among different body image satisfaction categories and in both sexes, PTT was highest among adolescents who were satisfied with their body image (54.8 kPa in girls and 54.2 kPa in boys) and lowest among those who prefered to have a heavier silhouette (50.8 kPa and 49.9 kPa)." "Figure 2. Pain Detection Threshold mean and 95% confidence interval by category of body image satisfaction." "Figure 3. Pain Tolerance Threshold mean and 95% confidence interval by category of body image satisfaction." **(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period**	10-11; 19-20 10; 19
Other analyses	17	**Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses**	
Discussion			
Key results	18	**Summarise key results with reference to study objectives** "We found that adolescents who preferred thinner or heavier bodies had lower mean pain tolerance thresholds as well as lower odds of achieving the highest quarter of pain tolerance. Lower pain tolerance was clearer among adolescents who preferred to have a heavier silhouette."	11-12
Limitations	19	**Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias** "4.2. Limitations of data and methods Due to attrition and missing data, the final sample differs from the initial cohort of children recruited (…). Regarding quantitative sensory testing, although it provides measurements of the responses to standardized stimuli in controlled environments (Arendt-Nielsen and Yarnitsky, 2009), it is still a test of subjective (…). Moreover, we only performed an analysis on one sensory modality, deep tissue pressure pain (…). We should also note that the evaluation of satisfaction using the difference between self-reported desired and perceived silhouettes builds on predefined images and may not capture the body image satisfaction construct	13-14

		comprehensively. Furthermore, this evaluation occurred at a single time point and the perception of one's own body, particularly among children, is likely to vary over time. Finally, the results may not be directly applicable to in children in other populations or settings (…)."	
Interpretation	20	**Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence** "There is very little in the literature about the relation between satisfaction with body image and tolerance to pain, and most existing evidence originates from disease-specific cohorts, such as patients with eating disorders. (…) The association of pain sensitivity with body image distortion has been better explored. (…) Existing evidence supports common neural pathways for pain and body perception. (…). Body dissatisfaction is associated with negative emotions that share common circuits with pain processing systems, although more evidence is needed to explain the specific mechanisms involved in the lower pain tolerance found in the children dissatisfied with their bodies in the present study." "Body image dissatisfaction was associated with lower tolerance to pain in boys and girls. Dissatisfaction with one's own body when building self-body image may indicate decreased pain tolerance and ultimately be involved in the establishment of maladaptive pain phenotypes."	12-15
Generalisability	21	**Discuss the generalisability (external validity) of the study results** "the results may not be directly applicable to in children in other populations or settings, given the wealth of sociocultural factors that can influence one's body perception and satisfaction." "Age-related confounding was minimized in our study, since children of Generation XXI have approximately the same chronologic age. Additionally, at age 13, the vast majority of adolescents are unlikely to have established disease, either organic or mental, that could be an alternative explanation for differences found."	14
Other information			
Funding	22	**Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based** "Funding sources were not involved in the design, conduct, analysis or writing of the present results."	22

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