Effects of Pubertal Timing and Pubertal Tempo on Social Physique Anxiety, Self-determined Motivation, and Exercise in Early Adolescent Girls

Abstract

Purpose: Research has shown that there is a decrease in physical activity levels during early adolescence, especially for girls. Previous studies have shown that the social physique anxiety (SPA) may be a controlling factor influencing exercise motivation and engagement in this behavior; however, the potential role that puberty plays in this decrease has not been considered until now. The objective of the present study was to examine the impact of pubertal timing and pubertal tempo on social physique anxiety (SPA) and exercise motivation and behavior. **Methods:** Data from 328 early adolescent girls, aged between 9-12 at the time of joining the study, were collected in three waves over a two-year period. Using structural equation modeling (SEM) techniques, different three-time-point growth models were estimated to examine if earlier maturing and compressed maturing in girls had differential effects on SPA and exercise motivation and behavior. **Results:** The results from growth analyses suggest that early maturing (according to all the pubertal indicators considered, except menstruation) tends to translate into (i) an increase in SPA levels, and (ii) a decrease in exercise - in the latter case, by reducing self-determined motivation. However, no differential effects from any of the pubertal indicators were found for compressed maturing in girls. **Discussion:** These results highlight the need for increased efforts toward developing programs aimed at helping early maturing girls to cope with the challenges of puberty with a particular focus on SPA experiences and exercise motivation and behavior.

Keywords: motivation, physical activity, body image, developmental stage termination hypothesis, maturation compression hypothesis.

Implications and Contribution

There are differential effects on SPA and exercise in early maturing girls, but not in compressed maturing girls. The Developmental Stage Termination Hypothesis is supported but not the Maturation Compression Hypothesis.

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Despite the well-documented health benefits of physical activity [1], research has highlighted a decline in exercise at the onset of early adolescence, especially in girls [2]. During puberty, important changes occur in body structure and shape (e.g., weight and height) that may lead to girls feeling social physique anxiety (SPA). This type of social anxiety results from excessive concern about the potential appraisal by others of one's body [3], which often leads to girls feeling pressure to control their body appearance and avoid the feeling of potential social disapproval [4]. Research evidence suggests that girls exhibit greater SPA than boys [5] and that this body-related negative emotion may compromise their level of participation in exercise [6].

In line with Self-determination Theory [7,8], many studies have shown that SPA is a controlling factor that can influence exercise motivation and engagement in exercise behavior [9–11]. Specifically, these studies have shown that SPA predicts a decrease in exercise engagement in adolescence by favoring controlling or non-self-determined forms of motivation (i.e., feeling forced or pressured into doing exercise, either by others or by oneself) and undermining autonomous or self-determined forms of motivation (i.e., a commitment to exercise behavior based on choice). Research suggests that experiencing SPA probably undermines autonomous motivation in exercise, given that this experience would reflect in the context being interpreted as controlling or pressuring because girls are trying to control the way their bodies looks [9,10,12]. However, the potential role of puberty in SPA has not so far been considered within this model, despite the proven relationship between pubertal development and social anxiety in early adolescent girls [13].

Adolescence may be a risk period for developing SPA in girls due to the significant bodily changes that can result from puberty (i.e., breast growth, growth spurt and pimples). The experience of puberty can differ dramatically depending on how early (timing of onset) and rapidly (tempo of puberty) girls begin and progress through these changes [14]. Psychological research has shown that individual differences in the maturation process are related to health and emotional well-being [15]. Nevertheless, the existing research has not examined whether these individual differences might explain body image concerns and the subsequent decrease in exercise in girls.

According to the Developmental Stage Termination Hypothesis [16], early pubertal timing may be problematic for body image because changes in body shape and weight would precede the psychological development necessary to adjust to the changes that come with puberty. Furthermore, given the disparity in maturation that early maturing girls would exhibit [14,17], it is to be expected that they would face more social pressures for which they are not cognitively and emotionally mature. Thus, early maturing girls may be unprepared to cope with the changes, with how they interpret their social environment, and with the expectations derived from others - resulting in SPA and less self-determined motivation toward exercise, which, in turn, leads to less engagement in this behavior.

In line with the Maturation Compression Hypothesis, an unusually rapid transition through puberty might contribute to a preoccupation with the body, triggering greater SPA and less engagement in exercise for girls. In other words, a faster than average pace of pubertal development may make body changes more obvious and visible, in a way that may provoke more reactions from family and peers, putting pressure on girls and increasing their perception of potential negative appraisal. In addition, an accelerated pace of body modification compresses the time available to

cope cognitively and emotionally with the demands of sudden body transformation. Conversely, a comparatively slower developmental progression than other girls, especially in those physical features that are more visible, may be less appreciated by significant others, putting less pressure on body image while allowing more time to assimilate these changes in body shape and weight.

While both the Developmental Stage Termination Hypothesis and the Maturation Compression Hypothesis focus on different aspects of variation in pubertal timing, both are similar and could support the hypothesis that atypical (either early or rapidly changing) pubertal development could be related to increased SPA and decreased exercise behavior in girls. Accordingly, this study extends the research on the relationship between puberty and adverse consequences and examines whether there is a relationship between a variation in pubertal maturation, SPA and exercise motivation and behavior. Specifically, the aim of the study is to determine whether there are differential effects on SPA and exercise motivation and behavior in earlier maturing and compressed maturing girls.

Methods

Participants

A convenience sample included 328 Spanish pre-adolescent girls who met the following inclusion criteria: (i) being female, (ii) being in the fifth or sixth grade of primary school at the time of joining the study, and (iii) completing the questionnaire at each of the data collection time points. The participants' age and BMI at the time of joining the study ranged from 9 to 12 years old (M = 10.42, SD = .65) and from 12.54 to 27.66 (M = 17.53, SD = 3.06), respectively. The participants' age and BMI at the time of study completion ranged from 11 to 14 years old (M = 12.36, SD = 0.68) and 13.24 to 31.95 kg/m^2 (M = 19.37, SD = 3.35), respectively. The sample were recruited from two public

schools (n = 48) and eight charter schools (n =280) in two urban areas in southern Spain; these were chosen based on the criteria of accessibility and willingness to cooperate. Charter schools, although privately owned, are non-selective state-funded schools in Spain, so they maintain the same access standards as public schools.

Measures

Sociodemographic Variables. Participants reported their age, height and weight, the last two being used to estimate the participants' BMI (kg/m^2).

Pubertal Development. A Spanish translation of the female version of the Pubertal Development Scale [18] was used. This instrument assesses the subjective degree of development of five physical characteristics associated with pubertal maturation. These include body hair (pubic hair) growth, breast growth, skin changes, growth spurt, and menarche. Each characteristic is rated using a 4-point scale ranging from 1 ("*no development*") to 4 ("*development completed*"). In the light of the present study's objectives, scores from individual indicators and an aggregate score reflecting subjective overall pubertal development were employed. Internal consistency values of α = .60 (Time 1), α = .71 (Time 2), and α = .76 (Time 3) were obtained in the present study for the summed score of the instrument.

Social Physique Anxiety. The Spanish version [19] of the one-dimensional Social Physique Anxiety Scale [SPAS-7; 20] was used. The original version of the instrument includes seven items (e.g., "*It would make me uncomfortable to know others were evaluating my physique or figure*"). Following recommendations provided in the validation study for the Spanish version of the instrument [19], the only reverse-worded item included in the instrument (item #5) was not used for calculating the overall score. The scale was preceded by the phrase: "*How often do you feel or think this way?*" The items were answered using a Likert scale ranging from 1 ("*never*") to 5 ("*always*").

Higher scores indicate higher SPA levels. Internal consistency values of α = .87 were obtained in the present study for the instrument's aggregate score.

Motivation to Exercise. The Spanish version of the Behavioral Regulation in Exercise Questionnaire-3 was used to measure self-determined motivation in exercise [21]. The questionnaire, headed by the sentence "Why do you engage or would you engage in exercise?", consisted of 23 items for assessing the different type of motivation. The items were answered using a Likert-type scale ranging from 0 (*not true for me*) to 4 (*very true for me*). In this study, internal consistency values of α =. 88 were obtained for intrinsic regulation, α =. 69 for identified regulation, α =. 77 for introjected regulation, α =.74 for external regulation, and α =. 65 for amotivation. These five scores were employed to obtain an index reflecting the degree of self-determined motivation (SDI). This index was calculated by assigning a weight to each type of motivation according to their position on the self-determination continuum. Hence, a weight of +3 was assigned to intrinsic regulation, +1 to identified regulation, −1 to introjected regulation, −2 to external regulation, and −3 for amotivation [22]. The final index score was calculated by adding all the results obtained from multiplying the score of each of the types of motivation by its corresponding weight. The SDI values ranged between −12 and 24 (mean [*M*] = 12.97; *SD* = 7.34).

Exercise Behavior. In the present study, exercise behavior was defined as engaging in physical activities aimed at improving or maintaining physical fitness, health and general well-being. According to this definition, this variable was operationalized as a latent variable consisting of two indicators [23]: (i) exercise frequency, which was assessed by the item "Over the past 7 days, on how many days did you do exercise for a total of at least 30 min per day?"; and (ii) stages of change, which was assessed following the procedure described elsewhere [24]. This involved presenting participants

with five sentences, reflecting each of the five phases of the exercise (i.e., precontemplation, contemplation, preparation, action, and maintenance), in order for them to select the one that most reflected their current situation [25]. The stages were coded from 1 (precontemplation) to 5 (maintenance).

Procedure

After obtaining approval from the bioethics committee of the host university, the principals and teachers at the schools were contacted to request their participation. At the beginning of the study, students in the fifth and sixth grade of primary education were invited to participate and were given an information letter for their parents or legal guardian, accompanied by a consent form. Two weeks later, members of the research team returned to the center to administer the questionnaire to the participants from whom informed consent had been obtained, these being 98.9% of those initially invited. The research survey was administered during regular class time at the beginning of each academic year over a three-year period. Both in the first (T1) and in the second (T2) data collection time points, participants completed information on the sociodemographic variables and the subjective degree of development of five physical characteristics associated with pubertal maturation. In the third data collection time point (T3), the participants additionally completed instruments that measured: (i) SPA, (ii) motivation to exercise, and (iii) exercise behavior. Of the 488 participants that completed the questionnaire at T1, 418 provided data at T2 and 328 provided data also at T3.

Statistical analysis

The preliminary analyses consisted of descriptive statistics and bivariate correlations between the study variables. The main analyses consisted of three-time-point growth models conducted in Mplus, Version 7 [28]. Growth factors allow flexible

modelling of the outcomes, such as differences in residual variances over time, correlated residuals over time, and regressions among the outcomes over time. The time scores for the growth factors were fixed at 0, 1, and 2 to define linear growth models with equidistant time points. The zero-time score for the slope growth factor at time point one defines the intercept growth factor as an initial status factor. The coefficients of the intercept growth factor are fixed at one as part of the growth model parameterization. The residual variances of the outcome variables are estimated and allowed to be different across time; also, the residuals are not correlated. Consequently, six different growth models were tested (see Figure 1) to assess (i) whether the timing (i.e., intercept) and tempo (i.e., slope) of the puberty indicators among girls (i.e., growth spurt, body hair, skin changes, breast growth, and the aggregate pubertal development score) influence SPA, and (ii) whether SPA influences self-determined motivation and, thus, exercise behavior. The age and BMI at Time 3 were included as covariates in the models. Taking into account the likely multivariate non-normality of the data, the models were tested using the robust maximum likelihood method (MLR) [27]. Values above or near to 0.95 for the comparative fit index (CFI), and 0.06 for both the root-mean-square error of approximation (RMSEA) and the standardized root-mean-square residual (SRMR) were considered to indicate adequate fit between the models and the data [28].

[FIGURE 1 HERE]

Results

The descriptive statistics for the pubertal development indicators by time point are shown in Table 1. Correlations between latent variables at Time 3 are shown in Table 2. The goodness-of-fit indices for the models (see Table 3) suggested adequate fit to the data. A summary of the standardized direct and indirect effects from the models

are shown in Table 4. In all of them, the intercept is significant at the initial time point, denoting girls vary significantly in the initial moment of puberty, as the significant mean of the intercepts also shows. The slope is not significant in any model. Therefore, over the 3 time points, girls do not differ in their individual growth patterns. With the exception of menstruation, the remaining intercept factors of the pubertal indicators were positively and statistically associated with SPA. These relationships were not statistically significant for any of the slope factors of the pubertal indicators. The variance on SPA explained by the models was 18% (growth spurt), 25% (body hair), 19% (skin changes), 19% (breast growth), 14% (menstruation), and 27% (summed indicators). The models explained 7.5 % of the variance on self-determined motivation in exercise, and 27% on exercise behavior. The negative relationships between the intercept factors of both summed and specific pubertal indicators (excluding menstruation) and exercise were found to be mediated by SPA and RAI.

[TABLE 1 HERE]

[TABLE 2 HERE]

[TABLE 3 HERE]

[TABLE 4 HERE]

Discussion

Extending previous research on the relationship between SPA and engagement in exercise behavior in early adolescent girls [10–12], the present study examines whether there are differential effects on SPA, and exercise motivation and behavior for earlier maturing and compressed maturing girls. The results of the present study support the controlling role of SPA in undermining autonomous motivation in girls toward exercise and their engagement in this behavior; however, only early pubertal timing, and not pubertal tempo, was shown to be a predictor of SPA. The results confirm the

relationship between SPA and exercise behavior, while showing that individual differences in the maturation process of girls play a role in this relationship.

On the one hand, in line with the postulates of SDT [7,8] and previous studies [10–12], the results support the idea that SPA may reflect an internal source of controlling influence (i.e., excessive concern about how others may be judging one's body), which favors low exercise engagement by undermining self-determined or autonomous forms of motivation in this behavior. Accordingly, the results support the implementation of strategies aimed at decreasing girls' social anxiety caused by the feeling that their bodies may be negatively appraised by others; insofar as this anxiety may undermine autonomous forms of motivation toward exercise, and the girls' engagement in this behavior.

Furthermore, the present study provides novel results showing that early pubertal timing in girls is a predictor of decreased exercise, through its influence on SPA. The results support the Developmental Stage Termination Hypothesis, suggesting that girls entering puberty early may not yet be sufficiently prepared to copy with the perceived internal and social pressures of the bodily changes they are experiencing [14,17]. This suggests that, given less cognitive and emotional development, early maturing girls are likely to experience their body changes as problematic and out of control, and, therefore, as a source of pressure on their body image and exercise engagement.

The results give quite robust support to the Developmental Stage Termination Hypothesis since early timing was shown to be a predictor of SPA in both the global model and in four of the five pubertal indicators. In the present study, menstruation was the only indicator that did not show a relationship with SPA. Previous research has shown relationships between this pubertal indicator and disordered eating attitudes, and with other body image-related behaviors [29]. However, two possible explanations may

account for why menstruation is the only indicator that does not show a relationship between early timing and SPA. First, in contrast to the other pubertal indicators considered in this study, menstruation is an indicator that is not externally visible. Given that SPA occurs because of the individuals' concern that a negative appraisal of their body may occur, it is plausible to think that body features that are visible to others acquire greater significance and cause more concern than non-visible ones. This may explain why the early timing of menstruation does not produce the same negative feelings about the body as does the early development of other pubertal indicators. Second, although menstruation is not a pubertal development indicator that is visible to others, another possible explanation could be the differential sequence in which the different indicators occur in girls [30,31]. In this sense, it is possible that some girls in the present study had not yet shown menstrual development at the time of the last data collection, so this indicator was not reflected with the same frequency and intensity as the other early-onset pubertal indicators.

Despite the strong evidence from the present study supporting the differential effects on SPA and exercise in early maturing girls, the results rule out pubertal tempo as a predictor of these outcomes. Thus, the study results do not appear to support differential effects on SPA and exercise for compressed maturing girls. Although there has been less research addressing the potential role of pubertal tempo on adverse outcomes compared to that of pubertal timing, it has shown that tempo may be a weaker predictor of mental health problems for girls than for boys [32–35]. One possible explanation is that timing and tempo differ significantly between girls and boys given their distinct maturational processes. Another possible explanation is that, in the present study, some of the girls with less maturational development in data collection 3 may still be experiencing a rapid period of developmental change, and so the study may not

have captured these pubertal changes. Future studies should confirm these results and examine whether compressed maturing girls show negative consequences in other conditions related to body image and exercise.

Understanding developmental processes and how they may affect girls is a challenge that needs to be addressed to help reduce the pressure they feel regarding their body image, and to encourage healthy behaviors such as exercise. Teachers, educators, and instructors working with girls in the exercise context should consider pubertal timing as a potentially salient factor in differentiating those girls who will be more likely to experience a decline in exercise behavior because of body-related negative emotions. Although the biological processes that occur in girls during puberty are difficult to alter, we can modify the responses that girls may have to this process. Hence, efforts should be directed towards developing programs that assist early timing girls to cope with the challenges of puberty without producing SPA or compromising their exercise motivation. Those early maturing girls who have strong internal resources are likely to cope more effectively with the stressors accompanying early maturation [36]. Coordinated efforts should be made between public health institutions, schools and parents to mitigate SPA and encourage greater commitment to exercise in early maturing girls.

Despite the novelty of these results, some limitations should be highlighted. First, the present study has been conducted using a convenience sample of early adolescent girls from public and charter schools in urban areas of southern Spain. Interestingly, pubertal tempo was shown not to be as significant a predictor as pubertal timing. Replication is needed with other samples, but also in other regions/countries and cultural contexts, to determine the role that pubertal timing has in explaining SPA and exercise behavior. In addition, the present study measured exercise behavior without

distinguishing between different exercising contexts (e.g., individual or group practice) or modalities, so this issue should be addressed by future studies. Second, the pubertal status was collected at each time point using self-reported responses. Third, the pubertal development of the girls in the present study was reported over three years, with participants ranging in age from 9 to 14 years. Finally, future studies should focus on examining potential moderators or mediators between pubertal timing and SPA since the relationship between pubertal timing and the psychosocial adjustment associated with body image may be affected by sociocultural and cognitive factors (e.g., perceived pressure from social agents to conform to certain body ideals, internalization toward body ideals) [37].

In summary, the results of the present study confirm that SPA is a controlling factor that predicts a decrease in exercise by it undermining autonomous forms of motivation. Furthermore, our results suggest that there are differential effects on SPA and exercise in early maturing girls, but not in compressed maturing girls. Although these results support the Developmental Stage Termination Hypothesis (but not the Maturation Compression Hypothesis), more work is needed to confirm this finding.

References

[1] Brusseau TA, Fairclough SJ, Lubans DR. The Routledge handbook of youth physical activity. London: Routledge; 2020.

[2] Dumith SC, Gigante DP, Domingues MR, et al. Physical activity change during adolescence: A systematic review and a pooled analysis. Int J Epidemiol 2011;40:685–698.

[3] Hart EA, Leary MR, Rejeski WJ. The measurement of social physique anxiety. J Sport Exerc Psychol 1989;11:94–104.

[4] Leary MR. Motivational and emotional aspects of the self. Annu Rev Psychol 2007;58:317–44.

[5] Hagger MS, Stevenson A, Chatzisarantis NLD, et al. Physical self-concept and social physique anxiety: Invariance across culture, gender and age. Stress Heal 2010;26:304–29.

[6] Gillison FB, Standage M, Skevington SM. Relationships among adolescents' weight perceptions, exercise goals, exercise motivation, quality of life and leisure-time exercise behaviour: a self-determination theory approach. Health Educ Res 2006;21:836–47.

[7] Deci EL, Ryan RM. Handbook of self-determination research. Rochester NY: University of Rochester Press; 2002.

[8] Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol 2000;55:68–78.

[9] Cox AE, Ullrich-French S, Sabiston CM. Using motivation regulations in a person-centered approach to examine the link between social physique anxiety in physical education and physical activity-related outcomes in adolescents. Psychol Sport Exerc 2013;14:461–7.

[10] Sicilia Á, Sáenz-Alvarez P, González-Cutre D, et al. Social physique anxiety and intention to be physically active: A Self-Determination Theory approach. Res Q Exerc Sport 2016;87:354–64.

[11] Brunet J, Sabiston CM. Social physique anxiety and physical activity: A self-determination theory perspective. Psychol Sport Exerc 2009;10:329–35.

[12] Cox AE, Ullrich-French S, Madonia J, et al. Social physique anxiety in physical education: Social contextual factors and links to motivation and behavior. Psychol Sport Exerc 2011;12:555–62.

[13] Deardorff J, Hayward C, Wilson KA, et al. Puberty and gender interact to predict social anxiety symptoms in early adolescence. J Adolesc Heal 2007;41:102–4.

[14] Ullsperger JM, Nikolas MA. A meta-analytic review of the association between pubertal timing and psychopathology in adolescence: Are there sex differences in risk? Psychol Bull 2017;143:903–938.

[15] Mendle J, Turkheimer E, Emery RE. Detrimental psychological outcomes associated with early pubertal timing in adolescent girls. Dev Rev 2007;27:151–171.

[16] Petersen AC, Taylor B. The biological approach to adolescence: biological change and psychological adaptation. In: Adelson J, editor. Handb. Adolesc. Psychol., New York, NY: John Wiley; 1980.

[17] Ge X, Natsuaki MN. In search of explanations for early pubertal timing effects on developmental psychopathology. Curr Dir Psychol Sci 2009;18:327–331.

[18] Petersen AC, Crockett L, Richards M, et al. A self-report measure of pubertal status: Reliability, validity, and initial norms. J Youth Adolesc 1988;17:117–33.

[19] Sáenz-Alvarez P, Sicilia Á, González-Cutre D, et al. Psychometric properties of the social physique anxiety scale (SPAS-7) in Spanish adolescents. Span J

Psychol 2013;16.

[20] Motl RW, Conroy DE. Validity and factorial invariance of the Social Physique Anxiety Scale. Med Sci Sports Exerc 2000;5:1007–17.

[21] González-Cutre D, Sicilia Á, Fernández A. Hacia una mayor comprensión de la motivación en el ejercicio físico: medición de la regulación integrada en el contexto español. Psicothema 2010;22:841–7.

[22] Vallerand RJ. Intrinsic and extrinsic motivation in sport and physical activity. A review and a look at the future. In (Eds.), (3rd ed., pp.). tle. In: Tenenbaum G, Eklund RC, editors. Handb. Sport Psychol. 3rd ed., New York, NY: John Wiley; 2007, p. 59–83.

[23] Anderson CB. Athletic identity and its relation to exercise behavior: Scale development and initial validation. J Sport Exerc Psychol 2004;26:39–56.

[24] Burkholder GJ, Nigg C. Overview of the Transtheoretical Model. In: Burbank PM, Riebe D, editors. Promot. Exerc. Behav. Chang. older adults Interv. with transtheoretical Model., Springer Publishing Co.; 2002, p. 57–84.

[25] Nigg CR, Harmon B, Jiang Y, et al. Temporal sequencing of physical activity change constructs within the transtheoretical model. Psychol Sport Exerc 2019;45:101557.

[26] Muthén LK, Muthén BO. Mplus user's guide (7th ed.). Los Angeles, CA: Muthén & Muthén; 2015.

[27] Wang J, Wang X. Structural equation modeling: Applications using mplus. Hoboken, NJ: John Wiley & Sons, Ltd; 2020.

[28] Brown TA. Confirmatory factor analysis for applied research (2nd ed.). New York, NY: The Guildford Press; 2015.

[29] O'Dea JA, Abraham S. Onset of disordered eating attitudes and behaviors in

early adolescence: Interplay of pubertal status, gender, weight, and age. Adolescence 1999;34:671–9.

[30] Mendle J. Beyond pubertal timing: New directions for studying individual differences in development. Curr Dir Psychol Sci 2014;23:215–9.

[31] Stubbs ML. Pubertal development and menarche. In: Ussher JM, Chrisler JC, Perz J, editors. Routledge Int. Handb. Women's Sex. Reprod. Heal., London: Routledge; 2019, p. 13–27.

[32] Mendle J, Harden KP, Brooks-Gunn J, et al. Development's tortoise and hare: Pubertal timing, pubertal tempo, and depressive symptoms in boys and girls. Dev Psychol 2010;46:1341–1353.

[33] Deardorff J, Marceau K, Johnson M, et al. Girls' pubertal timing and tempo and mental health: A longitudinal examination in an ethnically diverse sample. J Adolesc Heal 2021;68:1197–203.

[34] Beltz AM, Corley RP, Bricker JB, et al. Modeling pubertal timing and tempo and examining links to behavior problems. Dev Psychol 2014;50:2715–2726.

[35] Marceau K, Ram N, Susman EJ. Development and lability in the parent-child relationship during adolescence: Associations with pubertal timing and tempo. J Res Adolesc 2015;25:474–89.

[36] Caspi A, Moffitt TE. Individual differences are accentuated during periods of social change: The sample case of girls at puberty. J Pers Soc Psychol 1991;61:157–68.

[37] Thompson JK, Heinberg LJ, Altabe M, et al. Exacting beauty: Theory, assessment, and treatment of body image disturbance. Washington, DC: American Psychological Association; 1999.

Table 1

Descriptive Statistics for Indicators of Pubertal Development by Timepoint

Indicators of pubertal development	Time 1		Time 2		Time 3	
	M	*SD*	*M*	*SD*	*M*	*SD*
Spurt	2.23	0.86	2.35	0.89	2.38	0.86
Body air	1.65	0.78	2.06	0.91	2.46	0.96
Skin changes	2.02	1.04	2.18	1.00	2.58	1.00
Breast growth	2.07	0.80	2.27	0.80	2.55	0.78
Menstruation	1.20	0.69	1.79	1.19	2.59	1.43
Summed indicators	1.83	0.52	2.13	0.66	2.51	0.74

Note. Indicators of pubertal development ranged from 1 to 4.

E. Table

Table 2

Results of the Correlational Analysis

Variables (Pubertal indicator)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Age	-															
2. Body mass index	.231	-														
3. $PD_{Intercept}$ (Spurt)	.010	.149	-													
4. PD_{Slope} (Spurt)	.259	.095	-.142	-												
5. $PD_{Intercept}$ (Body hair)	.134	.139	n.a.	n.a.	-											
6. PD_{Slope} (Body hair)	.295	.166	n.a.	n.a.	-.001	-										
7. $PD_{Intercept}$ (Skin changes)	.260	.205	n.a.	n.a.	n.a.	n.a.	-									
8. PD_{Slope} (Skin changes)	.052	.028	n.a.	n.a.	n.a.	n.a.	-.131	-								
9. $PD_{Intercept}$ (Breast growth)	.292	.347	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-							
10. PD_{Slope} (Breast growth)	.099	-.097	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-.414	-						
11. $PD_{Intercept}$ (Menstruation)	.310	.163	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-					
12. PD_{Slope} (Menstruation)	.441	.171	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	.086	-				
13. $PD_{Intercept}$ (Summed indicators)	.282	.287	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-			
14. PD_{Slope} (Summed indicators)	.385	.137	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	.276	-		
15. Social Physique anxiety	.216	.304	.262	-.077	.418	.035	.361	-.041	.387	-.111	.220	.195	.468	.045	-	
16. Relative autonomy index	-.059	-.083	-.071	.021	-.115	.010	-.099	.011	-.106	.030	-.060	-.053	-.129	-.012	-.275	-
17. Exercise	-.031	-.043	-.037	.011	-.060	-.005	-.051	.006	-.055	.016	-.031	-.028	-.067	-.006	-.143	.521

Note. PD = Pubertal development, n.a. = Not applicable as the correlation refers to pairs of variables not being included in the same models. Variables other than pubertal development were assessed at Time 3.

E. Table

Table 3

Goodness-of-fit Indices for the Growth Models

Model (pubertal development indicator)	χ^2	*df*	χ^2/df	CFI	RMSEA				SRMR
					Est.	90% CI		*p*	
						LL	UL		
Model 1 (Spurt)	120.413	70	1.720	.963	.047	.032	.061	.627	.048
Model 2 (Body hair)	145.280	70	2.075	.947	.057	.044	.070	.174	.049
Model 3 (Skin changes)	143.621	70	2.052	.948	.057	.043	.070	.195	.055
Model 4 (Breast growth)	106.555	70	1.522	.973	.040	.023	.055	.864	.047
Model 5 (Menstruation)	153.799	70	2.197	.957	.054	.040	.067	.318	.048
Model 6 (Summed indicators)	135.695	70	1.939	.961	.053	.040	.067	.320	.047

Note. df = degrees of freedom, CFI = Comparative fit index, Est.= Estimate, RMSEA = Root Mean Square Error of Approximation, CI = Confidence interval, LL = Lower limit, UL = Upper limit, SRMR = Standardized root mean square residual.

E. Table

Table 4

Summary of Direct and Indirect Effects

	Model 1 Spurt					Model 2 Body hair					Model 3 Skin changes					Model 4 Breast growth					Model 5 Menstruation					Model 6 Summed indicators				
	β	95% CI		*SE*	*p*	β	95% CI		*SE*	*p*	β	95% CI		*SE*	*p*	β	95% CI		*SE*	*p*	β	95% CI		*SE*	*P*	β	95% CI		*SE*	*P*
		LL	UL				LL	UL				LL	UL				LL	UL				LL	UL				LL	UL		
Direct effects																														
Age→SPA	**.190**	**.015**	**.364**	**.089**	**.033**	.126	-.008	.259	.068	.065	.090	-.027	.207	.060	.133	.081	-.036	.198	.060	.177	.064	-.080	.208	.073	.387	.109	-.063	.282	.088	.215
BMI→SPA	**.240**	**.108**	**.372**	**.067**	**.000**	**.229**	**.072**	**.386**	**.080**	**.004**	**.224**	**.110**	**.337**	**.058**	**.000**	**.179**	**.056**	**.302**	**.063**	**.004**	**.245**	**.116**	**.374**	**.066**	**.000**	**.175**	**.063**	**.287**	**.057**	**.002**
$PD_{Intercept}$→SPA	**.207**	**.081**	**.333**	**.064**	**.001**	**.369**	**.062**	**.677**	**.157**	**.019**	**.290**	**.152**	**.428**	**.070**	**.000**	**.314**	**.139**	**.488**	**.089**	**.000**	.151	-.071	.373	.113	.183	**.426**	**.119**	**.732**	**.156**	**.006**
PD_{Slope}→SPA	-.119	-.421	.182	.154	.438	-.040	-.428	.349	.198	.841	-.014	-.376	.348	.185	.940	.028	-.128	.185	.080	.722	.112	-.081	.304	.098	.256	-.139	-.535	.258	.202	.493
SPA→RAI	**-.273**	**-.385**	**-.160**	**.057**	**.000**	**-.273**	**-.385**	**-.160**	**.057**	**.000**	**-.273**	**-.385**	**-.160**	**.057**	**.000**	**-.273**	**-.385**	**-.160**	**.057**	**.000**	**-.273**	**-.385**	**-.160**	**.057**	**.000**	**-.275**	**-.387**	**-.162**	**.057**	**.000**
RAI→Exercise	**.521**	**.414**	**.629**	**.055**	**.000**	**.521**	**.414**	**.629**	**.055**	**.000**	**.521**	**.414**	**.629**	**.055**	**.000**	**.521**	**.414**	**.629**	**.055**	**.000**	**.521**	**.414**	**.629**	**.055**	**.000**	**.521**	**.414**	**.629**	**.055**	**.000**
Indirect effects																														
Age→Exercise	**-.027**	**-.053**	**-.001**	**.013**	**.041**	-.018	-.038	.002	.010	.079	-.013	-.030	.004	.009	.140	-.012	-.029	.006	.009	.197	-.009	-.031	.013	.011	.417	-.016	-.041	.010	.013	.232
BMI→Exercise	**-.034**	**-.063**	**-.005**	**.015**	**.022**	**-.033**	**-.062**	**-.004**	**.015**	**.027**	**-.032**	**-.055**	**-.009**	**.012**	**.006**	**-.026**	**-.049**	**-.002**	**.012**	**.036**	**-.035**	**-.063**	**-.008**	**.014**	**.013**	**-.025**	**-.047**	**.003**	**.011**	**.027**
$PD_{Intercept}$→Exercise	**-.029**	**-.049**	**-.010**	**.010**	**.003**	**-.053**	**-.103**	**-.002**	**.026**	**.041**	**-.041**	**-.064**	**-.018**	**.012**	**.000**	**-.045**	**-.071**	**-.019**	**.013**	**.001**	-.022	-.054	.010	.016	.186	**-.061**	**-.109**	**.013**	**.024**	**.012**
PD_{Slope}→Exercise	-.017	-.026	.060	.022	.443	.006	-.050	.062	.029	.842	.002	-.049	.053	.026	.940	-.004	-.025	.017	.011	.710	-.016	-.041	.009	.013	.216	.020	-.038	.077	.029	.498

Note. SPA = Social physique anxiety, BMI = Body mass index, PD = Pubertal development, RAI = Relative autonomy index, β = Standardized regression coefficients, LL = Lower limit, UL = Upper limit, *SE* = Standardized error. Statistically significant effects ($p < .05$) appear highlighted in bold.

F. Figure

Figure 1. Hypothesized theoretical model. PD = Pubertal development, BMI = Body mass index, SPAS = Social physique anxiety scale, RAI = Relative autonomy index.