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Interaction of hormonal and social environments in understanding body image concerns in adolescent girls

K. Jean Forney[a], Pamela K. Keel[a,*], Shannon O'Connor[b], Cheryl Sisk[c], S. Alexandra Burt[b], Kelly L. Klump[b]

[a] Department of Psychology, Florida State University, 1107 W Call St, Tallahassee, FL, 32306, USA
[b] Department of Psychology, Michigan State University, 316 Physics Rd #262, East Lansing, MI, 48824, USA
[c] Neuroscience Program, Michigan State University, 293 Farm Ln, East Lansing, MI, 48825, USA

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ABSTRACT

During adolescence, peer approval becomes increasingly important and may be perceived as contingent upon appearance in girls. Concurrently, girls experience hormonal changes, including an increase in progesterone. Progesterone has been implicated in affiliative behavior but inconsistently associated with body image concerns. The current study sought to examine whether progesterone may moderate the association between perceived social pressures to conform to the thin ideal and body image concerns. Secondary analyses were conducted in cross-sectional data from 813 girls in early puberty and beyond (ages 8–16) who completed assessments of the peer environment, body image concerns, and progesterone. Models for mediation and moderation were examined with BMI, age, and menarcheal status as covariates. Belief that popularity was linked to appearance and the experience of weight-related teasing were both positively associated with greater body image concerns, but neither was associated with progesterone once adjusting for covariates. Progesterone significantly interacted with perceived social pressures in predicting body image concerns. At higher progesterone levels, appearance-popularity beliefs and weight-related teasing were more strongly related to body image concerns than they were at lower progesterone levels. Findings support a moderating role for progesterone in the link between social pressures and body image concerns in girls. This study adds to a growing literature examining how girls' hormonal environments may modulate responses to their social environments. Longitudinal and experimental work is needed to understand temporal relations and mechanisms behind these associations.

Body image concerns are prevalent in adolescence (Saunders and Frazier, 2017) and may set the stage for later problems, such as disordered eating and eating disorders, depressive symptoms, and overweight status (Goldschmidt et al., 2016; Holsen et al., 2001; Jacobi et al., 2004; Stice et al., 2002). Both social and biological changes during adolescence are theorized to contribute to these body image concerns. Peer approval and acceptance become increasingly important (Crockett et al., 1984), and peer influences are thought to play causal roles in the development of body image concerns (Thompson et al., 1999; Webb and Zimmer-Gembeck, 2014). Similarly, girls go through many physiological and hormonal changes during this time. Pubertal development is posited to play a role in body image concerns through the rapid increase of fat tissue (Halpern et al., 1999; Thompson and Chad, 2000). Additionally, puberty is marked by an increase in ovarian hormones (Lee et al., 1976). One of these hormones, progesterone, has been inconsistently associated with body image concerns (Racine et al., 2012; Hildebrandt et al., 2015), but more consistently implicated in affiliative goals and behavior (Schultheiss et al., 2003; Wirth and Schultheiss, 2006; Maner et al., 2010). These social and hormonal changes may interact to explain individual differences in body image concerns. Thus, the current study seeks to explore how progesterone interacts with the peer environment in understanding body image concerns.

The importance of peer acceptance increases during early adolescence (Crockett et al., 1984), and adolescent girls report that appearance is an important factor in being accepted and popular (Carey et al., 2011; Crockett et al., 1984). If being thin is an important aspect of appearance and peer approval, then body image concerns will be

* Corresponding author.
E-mail address: keel@psy.fsu.edu (P.K. Keel).

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greater for girls who experience greater peer pressure to be thin for acceptance. Supporting this assertion, body image concerns are greatest in girls who report that being thin is important for acceptance (Lieberman et al., 2001; Shroff and Thompson, 2006a) and who report increased pressures from peers to be thin (Gondoli et al., 2011; Hutchinson and Rapee, 2007; Hutchinson et al., 2010). Peer pressures to be thin also prospectively predict body image concerns (Gondoli et al., 2011; Stice and Whitenton, 2002). Weight-related teasing represents a behavioral means to communicate the importance of thinness for peer acceptance and can be conceptualized as an indicator of social rejection. Similar to peer pressure to be thin, peer teasing about weight and shape is associated with body image concerns both cross-sectionally (Hutchinson et al., 2010; Lieberman et al., 2001; Menzel et al., 2010) and longitudinally (Cattarin and Thompson, 1994; Menzel et al., 2010).

In addition to the increasing importance of peers in their social environment, adolescent girls experience numerous physiological changes during puberty, including an increase in ovarian hormones, such as progesterone (Lee et al., 1976). Experimental studies that administer progesterone suggest that progesterone may have a direct effect on affiliative behavior. Specifically, progesterone administration increases amygdala reactivity to emotion faces in humans (Van Wingen et al., 2008), and the progesterone product allopregnanolone acts in the ventral tegmental area to influence social behavior between female rats (Frye and Paris, 2011; Frye et al., 2008). Although the relationship between progesterone and affiliation is not always replicated (Gaffey and Wirth, 2014; Gangestad and Grebe, 2017), evidence from the social psychology literature supports a potential causal link between progesterone and affiliative goals and behavior, particularly in women (Brown et al., 2009; Duffy et al., 2017; Maner et al., 2010; Schultheiss et al., 2003; Seidel et al., 2013; Wirth and Schultheiss, 2006). Studies have observed higher progesterone levels in those assigned to a task designed to increase closeness relative to a neutral social task (Brown et al., 2009). In experimental manipulations of social rejection, social rejection causes increases in progesterone (Seidel et al., 2013), with the greatest increases observed in those who are more sensitive to rejection (Maner et al., 2010). The seemingly contradictory findings of increased progesterone following closeness induction and social rejection may reflect the tendency to attempt to re-affiliate with others after rejection. Indeed, following rejection, progesterone levels are highest among those more sensitive to rejection and given the opportunity to re-affiliate compared to those who are simply rejected (Duffy et al., 2017). Finally, between-subjects differences in progesterone are associated with increased sensitivity to social stimuli (Maner and Miller, 2014), and individual differences in implicit affiliation are positively correlated with progesterone levels in women (Schultheiss et al., 2003; Wirth and Schultheiss, 2006).

Taken together, evidence supports a link between progesterone and affiliation, indicating that progesterone levels are highest in those most motivated to affiliate. As such, progesterone may play a key role in influencing susceptibility to social pressures to adhere to a cultural ideal of thinness as a means of ensuring social acceptance. Specifically, the link between perceived social importance of being thin and weight-based teasing may be more closely related to body image concerns in the presence of high versus low progesterone levels.

The current study sought to test progesterone as a moderator of the association between perceived social pressures to adhere to the thin ideal and body image concerns in adolescent girls. Specifically, we tested the hypothesis that these associations are stronger at higher progesterone levels. We focused on individual differences in the belief that thinness is important for acceptance (appearance-popularity beliefs) and peer teasing about weight and shape because both have been linked to body image concerns (Gondoli et al., 2011; Menzel et al., 2010; Shroff and Thompson, 2006a), and both relate to social acceptance or rejection by peers. Given prior theories regarding the influence of puberty on body image concerns (Killen et al., 1992; Striegel-Moore et al., 1986), we included BMI percentile, menarcheal status, and age as covariates in analyses.

1. Materials and methods

1.1. Participants

Data represent a secondary analysis of 813 female twins (n = 450 families)[1] from the Michigan State University Twin Registry (Burt and Klump, 2013; Klump and Burt, 2006) who were enrolled in the study "Twin Study of Mood, Behavior, and Hormones during Puberty" (MBHP). Prior reports from the parent study have demonstrated that twins were representative of the broader population from which they were recruited (Burt and Klump, 2013; Klump et al., 2017; O'Connor et al., 2016). Racial and ethnic identity of those included in analyses were as follows: 79% Caucasian (n = 644), 9% African American (n = 73), and less than 1% Asian (n = 6) and American Indian or Alaska Native (n = 2). Additionally, 9% (n = 70) identified as more than one race, and 2% (n = 18) were missing data on race. Four percent of the sample identified as Hispanic (n = 35); ethnicity data were missing for 1% (n = 14). Because of limited variability in progesterone prior to puberty (Elmlinger et al., 2002), only girls who were in early puberty and beyond (i.e., puberty status score 2 or above on the Pubertal Development Scale (Petersen et al., 1988)) were included in analyses. The distribution of pubertal development was as follows: 17.1% early pubertal, 41.2% mid-pubertal, 34.6% late pubertal, and 7.1% post-pubertal. Girls' ages ranged from 8 to 16 years, mean (SD) = 12.18 (1.95) years. All twins were free from medications that may influence progesterone levels (e.g., oral contraceptive use).

1.2. Procedures

All procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All parents provided informed consent, and all twins provided assent prior to participation. All study procedures were approved by the Michigan State University Institutional Review Board, and secondary data analyses were approved by the Florida State University Institutional Review Board. Twins came to the lab accompanied by a parent to complete questionnaire and interview assessments. Twins provided saliva samples on each of the two days before the scheduled study visit and during their in-person assessment.

1.3. Measures

Appearance-Popularity Beliefs The Peer Attribution Scale (Lieberman et al., 2001) assessed the extent to which girls endorsed beliefs that they would be more popular and more well-liked by their friends if they were thinner and better looking. The modified version comprises four items rated on a six-point scale, ranging from "false" to "true." These items refer to any friend rather than same-sex or opposite-sex friends (Shroff and Thompson, 2006a). Internal consistency was good in the current sample, Cronbach's alpha = .80.

Weight-Related Teasing History of peer teasing was assessed with the Perception of Teasing Scale for Friends, a measure adapted from the Perception of Teasing Scale (Thompson et al., 1995). The Perception of Teasing Scale for Friends consists of two items assessing history of comments and teasing from friends about appearance and weight on a five-point scale, ranging from "never" to "very often" (Shroff and Thompson, 2006b). Previous research supports its psychometric

[1] Because the twin design was not central to the current study, only twins who were in early puberty or beyond were included in analyses; thus, some families contributed only one twin to analyses.

properties (Thompson et al., 2007). The Spearman Brown coefficient was 0.63 in this sample (Eisinga et al., 2013), supporting sufficient internal consistency.[2]

Progesterone Salivary progesterone was assayed using commercially available kits (Salimetrics, Carlsbad, CA) and measured in pg/mL. Girls provided samples one and two days prior to their study visit and on the day of the visit. Samples from the three days were averaged to minimize measurement error and establish a stable estimate of individual differences in progesterone levels. The interassay CV ranged from 9.78 to 13.05. Previous research indicates comparable results between salivary and blood progesterone assessments (Edler et al., 2007). Postmenarcheal twins were scheduled during the follicular phase whenever possible to minimize the influence of ovulation on individual differences in progesterone levels. Premenarcheal twins and postmenarcheal twins with irregular menstrual periods (operationalized as missing the last two projected menstrual periods) participated without regard to menstrual cycle phase. In total, 47.8% (n = 129) of postmenarcheal girls were in the menstrual or follicular phase at the time of assessment.

Body Image Concerns Body image disturbance was assessed using a composite variable from three measures of body image concerns due to the high correlations among these conceptually related assessments and to decrease measurement error and Type 1 error: the Body Dissatisfaction subscale from the Minnesota Eating Behavior Survey (MEBS) (von Ranson et al., 2005),[3] the Weight Preoccupation subscale from the MEBS, and the combined Shape Concerns and Weight Concerns subscales from the Youth Eating Disorder Examination Questionnaire (Goldschmidt et al., 2007). Scores for each variable were standardized before averaging the three scales.[4] Internal consistency was good, alpha = .85.

Covariates Height and weight were objectively measured using a scale and wall-mounted ruler and used to calculate body mass index (BMI) percentile for age and sex (Kuczmarski et al., 2000). Pubertal status was measured using the Pubertal Development Scale (Petersen et al., 1988). Girls completed four items about physical pubertal changes on a four-point scale ranging from development has not yet begun (1) to development seems complete (4). Additionally, a dichotomous item was used to assess menarche. Previous research supports the convergent validity of the self-report scale with physician assessments (Petersen et al., 1988). The Pubertal Development Scale categorical measure was used as an inclusion criterion for the present study (i.e., in early puberty or beyond). Menarcheal status was derived from the Pubertal Development Scale and used as a dichotomous covariate given evidence that progesterone increases after menarche (Lee et al., 1976) and because progesterone levels were higher in postmenarcheal girls, $p < .001$.[5] Mothers also completed the Pubertal Development Scale, and mother report was used to fill in missing data from girls (e.g., menarcheal status) and to correct any implausible reports from girls. Mother and child reports of pubertal stage have previously show high correspondence (Laberge et al., 2001).

1.4. Statistical analyses

Within a given family, twins were assigned as Twin 1 and Twin 2 based upon birth order. Zero-order correlations between variables were calculated within each twin set and combined using z transformations. Correlations were calculated using pairwise deletion. Moderation analyses were conducted using hierarchical linear modeling with full maximum likelihood estimates in SPSS 22.0. Individual differences in twins (Level 1) were nested within families (Level 2) to adjust for the non-independence of the twin data. All individual differences were treated as fixed effects, and the intercept was included as a random effect in models; thus, an identity matrix was used. Age, BMI percentile, and menarcheal status were included as covariates. Pubertal development was considered as an additional covariate but was rejected given its high correlations with age ($r = 0.77$) and menarcheal status ($r = 0.85$). Due to significant skew, progesterone values, Peer Attribution Scale scores, and Perception of Teasing scores were log-transformed. All predictor variables were standardized and centered prior to multilevel modeling. Interactions were probed at one standard deviation above and below the mean. The pattern of results did not differ meaningfully when using raw data or with outliers brought in; data reported in tables represent the log-transformed values.

2. Results

2.1. Descriptive analyses and Bivariate associations

Table 1 displays correlations among study variables. Age, BMI percentile, and menarcheal status were positively associated with body image concerns. Both peer attributions and teasing were positively associated with body image concerns, such that girls with stronger appearance-popularity beliefs and with a greater history of weight-related teasing had the highest body image concerns. Progesterone was positively associated with appearance-popularity beliefs, but progesterone was not associated with weight-related teasing or body image concerns. Appearance popularity beliefs were no longer associated with progesterone in a model adjusting for age, BMI percentile, and menarcheal status ($p = .22$).

2.2. Moderation analyses

The interaction of progesterone and appearance-popularity beliefs was tested by first entering covariates, progesterone, and appearance-popularity beliefs as predictors of body image concerns as fixed effects in the multilevel model. Appearance-popularity beliefs ($p < .001$), but not progesterone ($p = .18$), were significantly positively associated with body image disturbance. With the addition of the interaction term, AIC decreased from 1644.10 to 1638.07, and BIC decreased from 1681.46 to 1680.10. Review of the likelihood-ratio test indicated that model fit improved significantly with the addition of the interaction term, $X^2(1) = 8.03$, $p = .005$. The progesterone by appearance-popularity beliefs interaction was statistically significant (see Table 2). Probing the interaction revealed that at higher levels of progesterone, appearance-popularity beliefs were more strongly associated with body image concerns (Estimate = 0.39; SE = 0.03, $p < .001$) than at lower levels of progesterone (Estimate = 0.26, SE = 0.04, $p < .001$) (see Fig. 1).

In the multilevel model including covariates, progesterone, and weight-related teasing as predictors of body image concerns, weight-related teasing ($p < .001$), but not progesterone ($p = .38$), was significantly positively associated with body image concerns. With the

[2] Given the lower reliability of the scale, analyses were repeated using the two single items that make up the Perception of Teasing for Friends scale. The interaction results remained unchanged. Results are presented with the total scale for simplicity.

[3] The Minnesota Eating Behavior Survey (MEBS; previously known as the Minnesota Eating Disorder Inventory [M-EDI]) was adapted and reproduced by special permission of Psychological Assessment Resources, Inc., 16204 North Florida Avenue, Lutz, Florida 33549, from the Eating Disorder Inventory (collectively, EDI and EDI-2) by Garner, Olmsted, Polivy, Copyright 1983 by Psychological Assessment Resources. Further reproduction of the MEBS is prohibited without prior permission from Psychological.

[4] We also ran analyses looking at each scale separately. The pattern of results remained unchanged when using the combined Shape Concerns and Weight Concerns subscale and Body Dissatisfaction subscale. When examining the Weigh Preoccupation subscale, the interaction between progesterone and appearance-popularity beliefs and progesterone and weight-related teasing was in the same direction but failed to reach significance, $p = .26$ and $p = .12$, respectively.

[5] The three-way interactions between the Peer Attribution Scale, progesterone, and menarcheal status ($p = .56$) and between the Perception of Teasing for Friends Scale, progesterone, and menarcheal status($p = .22$) did not reach statistical significance, suggesting results did not differ by menarcheal status.

Table 1
Means, standard deviations, and correlations of study variables (N = 789–813).

	1.	2.	3.	4.	5.	6.	7.
1. Age	–						
2. BMI Percentile	.06	–					
3. Menarcheal Status	.74***	.23***	–				
4. Progesterone	.28***	.02	.27***	–			
5. Peer Attribution Scale	.15***	.19***	.15***	.09*	–		
6. Perception of Teasing Scale for Friends	.12***	.09*	.12***	.06	.43***	–	
7. Body Image Concerns	.13***	.41***	.19***	.03	.48***	.37***	–
Mean/%	12.18	58.01	41.7%	77.99	6.08	2.60	-.001
(SD)/N	(1.95)	(29.78)	(339)	(145.87)	(3.45)	(1.08)	(.88)

Note: Means and standard deviations are from untransformed data; correlations use log-transformed values for progesterone, Peer Attribution scale, and Perception of Teasing Scale for Friends. Progesterone is measured in pg/mL; BMI = body mass index. *$p < .05$; **$p < .01$; ***$p < .001$.

Table 2
Multilevel model examining the interaction of appearance-popularity beliefs and progesterone in the cross-sectional prediction of body image concerns in girls.

Fixed Effects	Estimate	Standard Error	df	*t*	*p*-value
Intercept	-.19	.12	779.82	−1.63	.10
Age	.01	.04	650.39	.14	.89
BMI Percentile	.26	.03	718.56	9.30	< .001
Menarcheal Status	.13	.08	786.31	1.60	.11
Progesterone	-.03	.03	779.84	−1.17	.24
Appearance-Popularity Beliefs	.33	.03	784.50	12.77	< .001
Progesterone X Appearance-Popularity Beliefs	.07	.02	655.93	2.84	.005
Co-Variance	Estimate	Standard Error		Wald Z	*p*-value
Within Family	.22	.03		7.56	< .001
Residual	.28	.02		13.16	< .001

Note: BMI = body mass index. Appearance-popularity beliefs were measured with the Peer Attribution Scale.

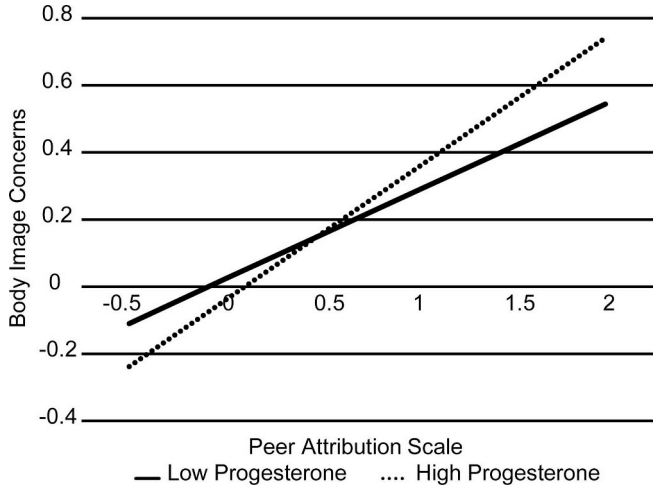

Fig. 1. Appearance-popularity beliefs interact with progesterone levels to cross-sectionally predict body image concerns in girls. Low and high levels of progesterone indicate the relationship between appearance-popularity beliefs and body image concerns for girls with progesterone values one standard deviation below and above the sample mean, respectively. Values represent z-scores.

addition of the interaction term, AIC decreased from 1727.29 to 1720.60, and BIC decreased from 1764.69 to 1762.67. Review of the likelihood-ratio test indicated that model fit improved significantly with the addition of the interaction term, $X^2(1) = 8.70$, $p = .003$. The progesterone by weight-related teasing interaction was significant (see Table 3). Probing the interaction revealed that at higher levels of progesterone, teasing was more strongly associated with body image concerns (Estimate = 0.30; SE = 0.03, $p < .001$) than at lower levels of progesterone (Estimate = 0.16, SE = 0.04, $p < .001$).

Due to the moderate correlation between progesterone and age, analyses were run to determine if age, rather than progesterone, and the social environment interacted to explain body image concerns. Age did not interact with either peer popularity beliefs ($p = .18$) or history of weight-related teasing ($p = .13$) to explain body image concerns.

Table 3
Multilevel model examining the interaction of weight-related teasing and progesterone in the cross-sectional prediction of body image concerns in girls.

Fixed Effects	Estimate	Standard Error	df	*t*	*p*-value
Intercept	-.19	.12	776.45	−1.52	.13
Age	.02	.04	640.04	.41	.68
BMI Percentile	.30	.03	704.33	10.41	< .001
Menarcheal Status	.13	.08	785.88	1.53	.13
Progesterone	-.02	.03	778.10	-.77	.44
Weight-Related Teasing	.23	.03	780.25	8.80	< .001
Progesterone X Weight-Related Teasing	.07	.02	667.35	2.96	.003
Co-Variance	Estimate	Standard Error		Wald Z	*p*-value
Within Family	.22	.03		7.09	< .001
Residual	.32	.02		13.11	< .001

Note: BMI = body mass index. Weight-Related Teasing was measured with the scale Perception of Teasing for Friends.

3. Discussion

The current study examined the interaction between social and physiological factors for understanding body image concerns in girls during adolescence, a period of peak risk for eating disorder onset (Smink et al., 2012). Results support a moderating role of progesterone in the relationship between the social environment and body image concerns. The highest body image concerns were observed in girls with the highest progesterone levels and greatest endorsement of social pressures to adhere to the thin ideal. We did not observe an association between progesterone and body image concerns, nor was progesterone associated with the social environment after adjusting for key covariates. This may reflect our study's focus on individual differences in basal

progesterone levels by assessing premenarcheal girls and postmenarcheal girls in the menstrual and follicular phases, when progesterone is low and relatively stable (Schumacher et al., 2014). Previous literature linking progesterone and body image concerns examined within-subject changes in progesterone across the menstrual cycle (Racine et al., 2012).

Based on prior studies implicating progesterone in affiliative motivation, progesterone may increase girls' motivation to adhere to perceived norms required for social acceptance, making them more susceptible to the influence of these social pressures on internalization of the thin ideal. Due to the cross-sectional design, we were unable to examine temporal or causal relationships among variables. Some have hypothesized that progesterone's association with affiliation is mediated by progesterone's role in regulating emotions around interpersonal scenarios (Milivojevic et al., 2014); indeed, progesterone administration increases amygdala reactivity to emotion faces (Van Wingen et al., 2008). Progesterone's metabolites may have a direct role in affiliative behavior, as subcutaneous administration of progesterone in ovariectomized mice facilitates social interaction (Koonce and Frye, 2013). This finding suggests that the peripheral progesterone measured in this study has implications for the effects of progesterone and its products in the brain and supports that progesterone may increase affiliative motivation.

The source of salivary progesterone in the current study is unknown as both the ovaries and adrenal glands secrete this hormone (Schumacher et al., 2014). Our progesterone assessment may represent a more basal assessment of adrenally-sourced progesterone given our inclusion of premenarcheal girls and efforts to sample postmenarchael girls during the menstrual or follicular phases, when progesterone levels are low (Schumacher et al., 2014). Progesterone secreted by the adrenal glands has been implicated in the stress response (Schumacher et al., 2014), and findings may reflect progesterone's role in increasing susceptibility to a stress response in reaction to a social stressor rather than susceptibility to increased affiliative motivations (Herrera et al., 2016; Maner et al., 2010; Seidel et al., 2013; Wirth and Schultheiss, 2006). Thus, an alternative interpretation of our findings is that girls who experience more stress and/or are more stress responsive are also more sensitive to acceptance and rejection-related cues in the social environment. However, differences in progesterone are observed in experimental manipulations that do not involve rejection and are not inherently stressful (i.e., a social closeness task; Brown et al., 2009). More work is needed to understand how the link between progesterone and affiliation may be related to the stress response, affiliative motivations, or both. Indeed, motivation to gain acceptance from peers may be an adaptive means to reduce social threats and rejection.

Even at lower levels of progesterone, the social environment remained associated with body image concerns. In addition to understanding progesterone-related mechanisms, it is important to understand how girls develop appearance-popularity beliefs in order to prevent the development of body image concerns. A moderate correlation between appearance-popularity beliefs and weight-related teasing suggests that girls may develop these beliefs through experiences with teasing. These beliefs may also be learned through socialization processes, such as appearance-related conversations with friends ("fat talk") (Sharpe et al., 2013; Tzoneva et al., 2015). Indeed, exposure to appearance-related conversations causally influences body dissatisfaction (Salk and Engeln-Maddox, 2012; Stice et al., 2003). Teaching girls to challenge unhelpful beliefs about appearance propagated by peers may help in maintaining a healthy body image. The cognitive dissonance-based *Body Project* provides exercises that may assist girls in critically evaluating and challenging their own beliefs and messages from peers (Becker et al., 2006; Stice et al., 2008).

The current study had several strengths that contributed to our ability to demonstrate a novel interaction between progesterone and perceived peer pressures in explaining individual differences in body image concerns. We benefited from the use of a large sample of girls across the range of pubertal development and the use of self-report and physiological assessments. We internally replicated an interaction between progesterone and peer environment using two assessments of the peer environment, importance of appearance for popularity and weight-related teasing. Moreover, findings were largely replicated when examining the individual body image scales.[4] We adjusted for relevant covariates and ruled out the possibility that interactions with age, rather than progesterone, were driving findings. However, there were limitations as well. Given our reliance on secondary analyses of existing data, we were only able to examine between-subjects associations cross-sectionally. Longitudinal designs are needed to test temporal associations over the course of development, and experimental manipulations of progesterone are needed to confirm that progesterone causes changes in the strength of associations between social pressures and body image concerns. Future work should examine within subject variability in progesterone and its associations with perceptions of the social environment and body image concerns. Such analyses would extend current findings regarding who is most susceptible to peer influences to examine when they are most vulnerable. Although the overall study design sought to minimize the between subjects variability in progesterone due to menstrual cycle phase, we were unable to assess progesterone during the same part of the menstrual cycle in all postmenarcheal girls. Importantly, the pattern of results remains the same when limiting analyses among postmenarcheal girls to those in the follicular or menstrual phases at the time of data collection. Finally, we were limited to the examination of hormones that are measurable in saliva (Horvat-Gordon et al., 2005). Thus, we were unable to examine oxytocin despite its association with social behaviors such as bonding (Gangestad and Grebe, 2017). Future research should examine the interplay of oxytocin with peer influences for body image concerns, given recent evidence that oxytocin may be dysregulated in eating disorders (Culbert et al., 2016).

Taken together, the current study provides preliminary evidence that progesterone may increase vulnerability to body image concerns in response to the perceived importance of appearance for social acceptance. These findings add to a growing literature that seeks to understand individual differences in responses to ovarian hormones (Kiesner, 2017). In addition, these findings address for whom the social environment imparts the most risk. This larger question remains essential to answer, as all girls are exposed to Western ideals of thinness, but only a small minority develop clinically significant body image concerns and eating pathology. This and similar work may enhance identification of who will benefit most from interventions as well as inform the content of interventions to reduce body image concerns and risk for developing eating pathology.

Declarations of interest

None.

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