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Early Pubertal Timing as a Vulnerability to Depression Symptoms: Differential Effects of Race and Sex

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Abstract

Robust evidence supports that girls and boys who experience early pubertal timing, maturing earlier than one's peers, are vulnerable to developing symptoms of depression. However, it has yet to be clarified whether early pubertal timing confers vulnerability to African American as well as to Caucasian adolescents and whether this vulnerability is specific to depressive symptoms or can be generalized to symptoms of social anxiety. In previous studies, one race or one sex was examined in isolation or sample sizes were too small to examine racial differences. Our longitudinal study consisted of a sample of 223 adolescents (Mean age = 12.42, 54.3% female, 50.2% African American, and 49.8% Caucasian). At baseline, depressive symptoms, social anxiety symptoms, and pubertal timing were assessed by self-report. Nine months later, we assessed depressive symptoms, social anxiety symptoms, body esteem, and stressful life events that occurred between baseline and follow-up. Analyses indicated that early pubertal timing interacted with stressful life events to predict increased symptoms of depression, but only for Caucasian girls and African American boys. Results were found to be specific to depressive symptoms and did not generalize to symptoms of social anxiety. Additionally, there was a significant positive indirect effect of pubertal timing on symptoms of depression through body esteem for Caucasian females.

Keywords

pubertal timing; life stress; depression; body esteem; adolescence

Robust evidence supports that maturing earlier than one's peers is a vulnerability factor for the development of depression symptoms during adolescence. Early-maturing girls and boys have consistently been found to have higher levels of depressive symptoms (e.g., Ge, Conger, and Elder, 2001; Ge et al., 2003; Mendle, Harden, Brooks-Gunn, and Graber, 2010; Negriff, Fung, and Trickett, 2008). The context in which puberty takes place may intensify the effects of early timing and much research supports a vulnerability-stress model (Ge and Natsuaki, 2009); stressful life events may trigger latent vulnerability conferred by early pubertal timing to result in increased depressive symptoms for early maturers. Early-

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maturing boys and girls who experienced high levels of family stress (Rudolph and Troop-Gordon, 2010) or peer stress (Conley and Rudolph, 2009) have been found to experience significantly more symptoms of depression. Girls may be more vulnerable to this exacerbation: early-maturing girls with high levels of stressful life events have been found to have the largest increases in depressive symptoms (Ge et al., 2001) and early-maturing girls with high levels of peer victimization have more depressive symptoms than later maturing peers who experienced the same level of victimization (Compian, Gowen, and Hayward, 2008).

Although the effect of early pubertal timing on boys' symptoms of depression has been well-documented, there have been reports that later maturing boys were more depressed than their peers (Conley and Rudolph, 2009) or that both early- and late-maturing boys were more vulnerable to increased symptoms of depression (Kaltiala-Heino, Kosunen, and Rimpelä, 2003). Boys have been understudied in pubertal timing research and the effect of pubertal timing on boys needs to be clarified (Negriff, Susman, and Trickett, 2011).

Racial Differences in the Effects of Pubertal Timing on Depressive Symptoms

Additionally, few studies have included sufficient numbers of youth of different races or ethnicities to examine race or ethnicity as a moderator of the relationship between pubertal timing and depressive symptoms. African American girls may undergo the pubertal transition earlier than Caucasian girls (Herman-Giddens, 2006) and so may be the first in their same-age peer group to develop physical pubertal characteristics. Although early-maturing African American girls have been found to experience higher levels of depressive symptoms (Ge et al., 2003; Nadeem and Graham, 2005; Negriff et al., 2008), a significant body of evidence suggests that early pubertal maturation may not predispose African American girls to depression. For example, in a sample consisting exclusively of African American girls, pubertal timing did not significantly predict depressive symptoms (Carter, Caldwell, Matusko, Antonucci, and Jackson, 2011). Similarly, DeRose, Foster, Shiyko, and Brooks-Gunn (2011) found that early-maturing Caucasian girls were more vulnerable to internalizing problems, but that this relationship did not hold for African American girls. Evidence supports that African American girls have higher body satisfaction than Caucasian girls do during adolescence, and this racial difference in body satisfaction may contribute to divergent perceptions of the pubertal transition (Franko and Striegel-Moore, 2002) that result in the lack of an association between pubertal timing and symptoms of depression for African American girls. In turn, the absence of a predictive association between pubertal timing and depressive symptoms for African American girls may be one factor contributing to the smaller gender gap in depression observed in African-Americans in adolescence (e.g., Hayward, Gotlib, Schradley, and Litt, 1999; Siegel, Aneshensel, Taub, Cantwell, and Driscoll, 1998). In the present study, we further examined gender and race effects on the pubertal timing – depressive symptom association in the context of life stress with equally sized numbers of Caucasian and African-American adolescents.

African Americans experience greater stress in adolescence (Boardman and Alexander, 2011), and greater exposure to stress in childhood and adolescence may directly lead to higher levels of depressive symptoms for African Americans throughout a lifetime (Walsemann, Gee, and Geronimus, 2009). In a large sample of African American youth across a 5-year period, Brody and colleagues (2006) found increases in perceived discrimination correlated with increased symptoms of depression. African American adolescents have reported being hassled by store personnel and by police, being perceived as dangerous and not intelligent, and being wrongly disciplined at school due to their race (Fisher and Wallace, 2000). Racial discrimination from teachers and classmates in seventh

grade predicted decreased self-esteem and increased symptoms of depression in eighth grade for African Americans (Wong, Eccles, and Sameroff, 2003). Similarly, in a sample of African Americans aged 10–12, racial discrimination (both self-reported and caretaker reported) had a strong association with depressive symptoms (Simons et al., 2002). As the impact of stressful life events may differ by race, measurement of racial differences in stress exposure may provide a more nuanced understanding of the effects of pubertal timing on African Americans.

Mechanisms of Sex Differences in Pubertal Timing as a Vulnerability Factor

Although early pubertal timing may function as a vulnerability factor to depression for both boys and girls, it may operate in each sex by different mechanisms; early pubertal maturation may predispose girls to depression through the mechanism of physical pubertal changes. Girls begin pubertal maturation an average of a year before boys so girls with early pubertal timing may feel set apart as they undergo physical changes before any of their peers (Mendle, Turkheimer, and Emery, 2007). The pubertal transition for girls results in increased body fat and weight gain; these physical changes move girls away from the pre-pubescent shape currently accepted as the beauty ideal in the industrialized world (Simmons, Burgeson, Carlton-Ford, and Blyth, 1987). Consequently, earlier maturing girls have been found to be more dissatisfied with their bodies (Michaud, Suris, and Deppen, 2006) and to have more weight concerns (Compian et al., 2008) than their peers. Poor body image that emerges after puberty may contribute to the elevated rates of depression found in post-pubertal girls (Stice, Hayward, Cameron, Killen, and Taylor, 2000). Vogt Yuan (2007) found that increased depressive symptoms in post-pubertal girls was accounted for by perceptions of being overweight and more physically developed than later maturing peers. Studies have found that body dissatisfaction predicts increased symptoms of depression in adolescents (e.g., Almeida, Severo, Araújo, Lopes, and Ramos, 2012; Bearman and Stice, 2008) or that early pubertal timing was associated with poor body image (e.g., Fonseca and Matos, 2011; Siegel, Yancey, Aneshensel, and Schuler, 1999). However, to our knowledge, body esteem has not been examined as a mediator between the interaction of pubertal timing and life stress in the prediction of depressive symptoms.

Specificity of Depression as an Outcome of Pubertal Timing and Elevated Stress

Many studies of pubertal timing have collapsed anxiety and depression into the broader category of internalizing symptoms. A small body of research has found associations between pubertal timing and symptoms of depression and anxiety as specific outcomes (Reardon, Leen-Feldner, and Hayward, 2009). Studies have found elevated symptoms of social anxiety for early-maturing girls (Deardorff et al., 2007; Blumenthal et al., 2011) or late maturing girls (Reynolds and Juvonen, 2011), and Ge and colleagues (2006) found early-maturing African American boys had increased symptoms of social anxiety disorder. Blumenthal and colleagues (2009) did not assess depressive symptoms, but found early-maturing adolescents who experienced high levels of peer stress had increased symptoms of social anxiety.

The Present Study

To date, we are aware of no prospective studies that have assessed whether pubertal timing interacted with stressful life events to predict increased symptoms of depression that evaluated both race and sex as moderators of these associations. Therefore, the primary goal of this study was to expand on prior research by examining race and sex differences in whether pubertal timing in the context of stressful life events prospectively predicted

depressive symptoms in a sample evenly divided between boys and girls and Caucasians and African-Americans. In light of the importance of body image during puberty, especially for girls, we also examined whether body esteem mediated the relationship between pubertal timing and depressive symptoms moderated by stress.

We hypothesized that: 1) early pubertal timing in interaction with stressful life events would predict increased symptoms of depression for boys and girls of both races, 2) the effect of pubertal timing in interaction with stress on depressive symptoms would be strongest for Caucasian females, and 3) there would be an indirect effect of pubertal timing in interaction with stressful life events on symptoms of depression through body esteem, but only for Caucasian females.

An exploratory goal of our study was to assess whether the interaction between pubertal timing and stressful life events specifically predicted symptoms of depression or whether this relationship generalized to symptoms of social anxiety.

Method

Participants

With Temple University IRB approval, Caucasian and African American adolescents, ages 12–13 (Mean age = 12.42, *SD* = 0.62) were recruited through newspaper advertisements and school mailings to area schools. To be eligible, participants had to be 12 or 13 years old, self-identify as Caucasian/White or African American/Black, and have a mother/primary female caregiver willing to participate. Exclusion criteria included: 1) the absence of a mother/primary female caregiver; 2) the mother or adolescent was psychotic, mentally retarded, or severely developmentally/learning disabled; and 3) the inability to complete study measures by the mother or adolescent for any other reason (e.g., due to the inability to read or speak English). Eligible mothers and adolescents were scheduled for a baseline assessment, at which time mothers provided written consent and adolescents provided written assent to participate in the study. The families of the adolescents exhibited a wide range of annual family income levels: 23.8% of participants' gross incomes fell below $30,000, 34.1% fell between $30,000 – $59,999, 17.0% fell between $60,000 – $89,999, and 25.1% fell above $90,000.

The adolescent sample for the present analyses consisted of 223 adolescents (54.3% female, 50.2% African American, and 49.8% Caucasian) who completed both a baseline assessment and a follow-up assessment approximately 9 months later. The 223 adolescents who completed both the baseline and follow-up assessments did not differ from those who completed only the baseline visit in race ($\chi^2(1) = 0.11$, $p = .74$) or gender ($\chi^2(1) = 1.27$, $p = .26$) distribution, pubertal status ($t = 1.09$, $p = .28$), or family income ($t = 1.69$, $p = .09$). The 223 adolescents who completed the two assessments required for the present study had lower symptoms of depression ($t = -3.10$, $p = .002$) and social anxiety ($t = -2.01$, $p = .05$) than those who did not complete the follow-up assessment.

Procedures

At baseline, adolescents completed measures of pubertal status, and symptoms of depression and social anxiety. Mothers of the adolescents also completed a measure of their child's pubertal status and a questionnaire about stressful events that occurred in the child's life from birth until participation in the study at baseline. At a follow-up visit 9 months later, adolescents completed a questionnaire assessing stressful life events experienced since baseline and were subsequently interviewed about these events. Nine months has been shown to be an adequate time frame in which to measure changes in symptoms of

depression in a community sample of this age group; studies have found significant changes in internalizing symptoms in a similar or shorter time frame (e.g., McLaughlin, Hatzenbuehler, and Hilt, 2009; Siegel, La Greca, and Harrison, 2009). Adolescents also completed measures of body esteem, and symptoms of depression and social anxiety at follow-up. Mothers completed a questionnaire regarding stressful life events experienced by their child between baseline and follow-up.

Measures

Pubertal timing—The Pubertal Development Scale (PDS; Petersen, Crockett, Richards, and Boxer, 1988) assesses pubertal development via self-report. The PDS rates five characteristics: growth spurt in height, body hair, skin change, breast change (girls only)/ voice change (boys only), and facial hair growth (boys)/menstruation (girls). Each characteristic (except menstruation) is rated on a 4-point scale (1 = *no development*, 2 = *development has barely begun*, *3 = development is definitely underway*, 4 = *development is complete*). Thus, higher scores indicate more mature pubertal status. The PDS has good psychometric properties and good convergent validity based on self- and physician-rated Tanner stages (Petersen et al., 1988). Similar psychometrics has been obtained in a multi-ethnic sample (Siegel et al., 1999). The mother's PDS report correlated $r > .80$ with the child's PDS report and for simplicity, we used the child's report only in our analyses. Separately for males and females, the PDS total score was regressed on age, and the residual obtained was used as a continuous measure of pubertal timing (Dorn, Susman, and Ponirakis, 2003; Susman et al., 2007). Internal consistency for the PDS in this sample was $\alpha = .66$ for girls and $\alpha = .74$ for boys at baseline.

Depressive symptoms—The Children's Depression Inventory (CDI; Kovacs, 1985) is a self-report measure designed to assess affective, behavioral, and cognitive symptoms of depression in youth. Each of the 27 items is rated on a 0 to 2 scale; total scores range from 0 to 54, with higher scores indicating more depressive symptoms. The CDI has good reliability and validity as a measure of depressive symptoms in adolescents (Klein, Dougherty, and Olino, 2005). Internal consistency in this sample was $\alpha = .86$ at baseline and $\alpha = .81$ at follow-up.

Anxiety symptoms—The Multidimensional Anxiety Scale for Children (MASC; March, Parker, Sullivan, Stallings, and Conners, 1997) is a 39-item self-report questionnaire assessing anxiety symptoms in youth. Factors include physical symptoms, social anxiety, harm avoidance, and separation anxiety. Adolescents responded to each item on a 4-point Likert scale with response options of *never*, *rarely*, *sometimes*, or *often*. Analyses for the current study were confined to the social anxiety subscale of the MASC as the prior literature suggests that pubertal timing effects have been found for social anxiety. The MASC and its subscales have been demonstrated to have excellent retest and internal reliability, and good convergent and discriminant validity (Baldwin and Dadds, 2007; March et al., 1997; March and Albano, 1998). There was adequate internal consistency in this sample at baseline ($\alpha = .82$) and follow-up for the MASC Social Anxiety subscale ($\alpha = .81$).

Childhood Stressful Life Events—The Children's Life Events Scale (CLES; Crossfield, Alloy, Gibb, and Abramson, 2002) is a checklist of 50 moderate to major negative events that children may experience in their lifetime. Crossfield and colleagues (2002) expanded upon the previously established Source of Stress Inventory (Chandler, 1981) to create the CLES. Mothers' reports were used because children may have been too young to recall all events independently. Items on the CLES include events in the following domains: negative emotional feedback, achievement failures, family difficulties, death of close family or friends, maltreatment (e.g., sexual, physical, emotional), and events

suggesting inadequacy (e.g., acquired a physical deformity). For each item, mothers were asked whether or not their child experienced that event in their lifetime and, if so, at what age the event occurred. Scores on the CLES range from 0–50, with higher scores indicating a greater number of negative events. There is limited information regarding the psychometric properties of the CLES; however, Crossfield and colleagues (2002) demonstrated its predictive validity. Internal consistency in this sample was $\alpha = .73$. The CLES was used in the present study to control for the effects of previous life stressors.

Life Events—The Adolescent Life Events Questionnaire (ALEQ; Hankin and Abramson, 2002) is a self-report checklist of 64 stressful events that typically occur in an adolescent's life. Adolescents answered 'Yes' or 'No' in response to whether an event occurred between baseline and follow-up (a period of approximately 9 months). Categories of events in the questionnaire include achievement (e.g., suspended or expelled from school), family (e.g., your parents got divorced), peer relationships (e.g., you didn't have as many friends as you would like), and romantic relationships (e.g., boyfriend or girlfriend broke up with you). Adolescents wrote in any stressful events not included in the questionnaire that occurred during the relevant period.

For each event endorsed by the adolescent on the ALEQ, trained interviewers (post-BA research assistants and clinical psychology graduate students) evaluated whether the event qualified according to a pre-determined set of event definition criteria. The semi-structured Life Events Interview (LEI; Safford, Alloy, Abramson, and Crossfield, 2007) serves as a reliability and validity check, allowing life events to be more objectively identified and reducing potential subjective report biases. The interviewer gathered detailed information about the event and disqualified events not meeting criteria. Mothers also completed a parent version of the ALEQ; events endorsed by the parent and not by the adolescent were probed in a general way to potentially cue the teen about the occurrence of an event without breaking confidentiality. Total scores were calculated by summing the number of qualifying life events. The ALEQ and LEI have demonstrated good reliability and test-retest reliability (Hankin and Abramson, 2002; Safford et al., 2007).

Body Esteem—The Body Esteem Scale (BES; Mendelson and White, 1982) measures beliefs about body shape, physical appearance, and weight in youth. The BES consists of 20 Yes/No items, such as "I wish I were thinner". The BES has been shown to have good internal consistency and concurrent validity (Mendelson and White, 1982). Internal consistency in this sample was $\alpha = .91$.

Results

Descriptive Analyses

Mean values for primary variables by sex and race are listed in Table 1. Compared to boys, girls had more advanced pubertal development and lower body esteem, and experienced more stressful events between baseline and follow-up, but did not differ on age or annual family income. According to the PDS, 6.6% of our sample had " no development", 39.8% had "development has barely begun", 42.7% had "development is definitely underway", and 10.8% had "development is complete". When we stratified by gender: for girls, 3.8% had " no development", 24.4% had "development has barely begun", 52.7% had "development is definitely underway", and 19.1% had "development is complete"; for boys, 10.0% had " no development", 58.2% had "development has barely begun", 30.9% had "development is definitely underway", and 0.9% had "development is complete".

There was no difference in the number of stressful events experienced between birth and baseline for boys and girls. Girls also did not differ from boys on symptoms of depression or

social anxiety at baseline but had significantly more symptoms of depression and social anxiety at follow-up. Compared to Caucasian adolescents, African American adolescents were slightly older, had lower annual family income, more advanced pubertal development, marginally higher body esteem, and lower social anxiety symptoms at baseline and follow-up. The average annual income for African American adolescents fell between $37,500 and $52,500; for Caucasian adolescents the average annual income fell between $60,000 and $75,000. African American and Caucasian adolescents did not differ on the number of stressful events that occurred from birth until baseline, the number of stressful events experienced between baseline and follow-up, or depressive symptoms at baseline or follow-up. Correlations between primary variables by sex and by race are displayed in Tables 2 and 3, respectively.

Means for depressive symptoms in our early adolescent sample were lower than that found in a meta-analysis of the CDI (Twenge and Nolen-Hoeksema, 2002), but are comparable to those reported in several recent studies conducted with early adolescents (Kouros and Garber, 2010; Tram and Cole, 2006). As expected from prior research, CDI and MASC scores for our sample were lower at follow-up than at baseline; this decrease has often been found on repeat administrations (Finch, Saylor, Edwards, and McIntosh, 1987; Twenge and Nolen-Hoeksema, 2002).

Prospective Analyses

To examine the specificity of the interaction of pubertal timing and stressful life events to the prediction of depressive and social anxiety symptoms, we conducted multiple hierarchical linear regressions predicting depressive or social anxiety symptoms while statistically controlling for overlap with the other type of symptoms (Epkins and Heckler, 2011; Starr and Davila, 2008). Thus, we controlled for initial levels of depressive and social anxiety symptoms when predicting depressive symptoms at follow-up, and we controlled for initial levels of social anxiety and depressive symptoms when predicting social anxiety symptoms at follow-up.

We first evaluated whether pubertal timing would moderate the relationship between stressful life events and depressive symptoms at follow-up and whether this relationship was further moderated by race and sex. Covariates (age, family income, time to follow up, stressful events from birth to baseline, and baseline depressive and social anxiety symptoms) were entered in Step 1. The main effects of pubertal timing, number of stressful life events, race and sex were entered in Step 2. All two-way interactions were entered in Step 3, three-way interactions were entered in Step 4, and the four-way interaction was entered in Step 5. Continuous predictor variables were centered at their means prior to analysis, and dichotomous variables (race and sex) were dummy-coded as 0 and 1. Analyses were then repeated with social anxiety symptoms at follow-up as the dependent variable.

As hypothesized, the pubertal timing × life events two-way interaction was significant in predicting depressive symptoms. However, this interaction was qualified by a significant 4-way interaction between pubertal timing, stressful life events, sex, and race predicting depressive symptoms at follow-up (Table 4). A significant 4-way interaction indicates that the pubertal timing × stressful life events interaction does differ by race and sex. Higher order interactions are best interpreted by decomposition into component lower-order interactions: to understand the form of the pubertal timing × life events interaction for adolescents of each race and sex, we probed the lower-order interactions within the significant 4-way interaction. Among Caucasians, there was a significant 3-way interaction between pubertal timing, life events, and sex, such that the 2-way interaction between pubertal timing and life events was significant for girls in predicting increased depressive symptoms at follow-up ($t = 2.94$, $p = .004$), but not for boys ($t = 0.41$, $p = .68$). Among

African Americans, there was a significant 3-way interaction between pubertal timing, life events, and sex, such that the 2-way interaction between pubertal timing and life events was significant for boys in predicting increased depressive symptoms at follow-up ($t = 2.09$, $p = .04$), but not for girls ($t = -0.75$, $p = .46$).

To probe the form of the significant two-way interactions for Caucasian girls and African-American boys (Figure 1), we plotted the interaction at one standard deviation above and below the mean levels of pubertal timing and stressful life events (Aiken and West, 1991). For Caucasian girls, consistent with hypotheses, earlier pubertal timing predicted increases in depressive symptoms among those who experienced more stressful life events ($t = 3.64$, $p < .001$), but not among those who experienced fewer stressful life events ($t = -0.27$, $p = .79$). Additionally, stressful life events predicted increases in depressive symptoms among Caucasian girls with earlier pubertal timing ($t = 5.09$, $p < .001$), but not among those with later pubertal timing ($t = 0.97$, $p = .33$). For African American boys, earlier pubertal timing predicted increases in depressive symptoms among those with more stressful life events ($t = 2.08$, $p = .04$), but not among those with fewer stressful life events ($t = -0.97$, $p = .33$). Additionally, stressful life events predicted increases in depressive symptoms among African American boys with earlier pubertal timing ($t = 4.03$, $p < .001$), but not among those with later pubertal timing ($t = 0.37$, $p = .71$).

We did not find a significant 4-way interaction between pubertal timing, stressful life events, sex and race in the prediction of social anxiety symptoms at follow-up ($t = 1.07$, $p = .29$), controlling for family income, time to follow-up and baseline symptoms of depression and social anxiety. Additionally, there were no significant lower-order 3-way or 2-way interactions predicting follow-up social anxiety symptoms (analyses available upon request).

Does Body Esteem Mediate the Relationship between the Pubertal Timing × Life Events Interaction and Symptoms of Depression?

We constructed a mediated moderation model (Figure 2) which proposed that early pubertal timing in the context of life stress predicted lower levels of body esteem, and lower body esteem then predicted increased symptoms of depression. Our model hypothesized a significant effect of pubertal timing on depressive symptoms directly as well as indirectly through body esteem, with both direct and indirect effects moderated by life events.

To test our model, we employed an SPSS macro (PROCESS) that uses a regression-based framework for moderation and mediation analysis as well as their integration as mediated moderation (Hayes, 2013). Using PROCESS, we estimated the effect of pubertal timing × life events on depressive symptoms directly as well as indirectly through body esteem. The macro produced the indirect effect of pubertal timing × life events on depressive symptoms through body esteem, along with a bias-corrected 95% bootstrap confidence interval for the indirect effect using 5,000 bootstrap samples. It also generated the direct effect of the interaction of pubertal timing and stressful life events on depressive symptoms when body esteem was included in the model. All analyses controlled for age, family income, time to follow up, stressful events from birth to baseline, and baseline symptoms of depression.

For Caucasian girls, we found a significant positive indirect effect of pubertal timing × life events on symptoms of depression through body esteem ($B = .04$, 95% CI [0.01, 0.12]); body esteem significantly mediated the relationship between pubertal timing and depressive symptoms among Caucasian girls who experienced higher levels of stress ($B = .72$, 95% CI [0.14, 1.84]) but not among Caucasian girls who experienced lower levels of life stress ($B = .10$, 95% CI [−0.20, 0.63]). For Caucasian girls, earlier pubertal timing and high stress predicted lower body esteem, which, in turn, predicted increased symptoms of depression. After accounting for the indirect effect through body esteem, there was still a significant

direct effect of pubertal timing × life events on depressive symptoms ($t = 2.45$, $p = .02$) for Caucasian girls, although the effect was reduced. For African American boys, we did not find moderated mediation: there was not a significant indirect effect of the pubertal timing × life events interaction on symptoms of depression through body esteem (analyses available upon request).

Discussion

Our results suggest that early pubertal timing serves as a vulnerability factor for increased depressive symptoms among Caucasian girls and African American boys who experienced high levels of stressful life events. Caucasian girls and African American boys who were more physically mature than peers at baseline and who encountered higher levels of stressful life events during the period between assessments experienced increases in depressive symptoms at follow-up. This relationship may help to explain why some, but not all, early-maturing adolescents experience increases in symptoms of depression. Additionally, we found some support for the interaction of early pubertal timing and stressful life events to specifically predict depressive symptoms as in contrast to several studies (e.g., Deardorff et al., 2007; Blumenthal et al., 2011), we did not find a relationship between pubertal timing and symptoms of social anxiety. These results provide further evidence for a vulnerability-stress relationship between pubertal timing and stressful life events in the prediction of symptoms of depression and suggest that these relationships may be specific to Caucasian girls and African American boys.

In the development of depressive symptoms, early pubertal timing triggered by stress might operate differently in Caucasian girls than in African American boys. Research supports an association between earlier physical development and lower levels of body satisfaction in girls. In our study, we found an indirect effect of pubertal timing on symptoms of depression through body esteem for Caucasian girls but not for African American boys; other evidence suggests early-maturing African American girls and boys of both races do not experience lower levels of body esteem (Franko and Striegel-Moore, 2002; Michaud et al., 2006; Vogt Yuan, 2007). Our findings suggest that the mechanism of early pubertal timing leading to lower body esteem and resulting in increased depressive symptoms may be specific to early-maturing Caucasian girls.

In the context of high stress, early pubertal maturation may lead to the development of low body esteem and other negative self-schemas in Caucasian girls. Negative self-schemas activated by life stress could influence girls to form negative self-attributions that contribute to increased symptoms of depression. The negative self-schemas of early-maturing Caucasian girls may extend to domains beyond body dissatisfaction as evidence supports that Caucasian girls may have lower self-esteem than Caucasian boys or African American boys and girls (Simmons and Rosenberg, 1975). Furthermore, after the age of 11, African American girls report consistently higher self-worth than Caucasian girls; African American girls experience increasingly higher self-worth from ages 11 to 14 when compared to their level of self-worth at age 9, but Caucasian girls experience lower self worth at ages 13 and 14 when compared to self-worth at age 9 (Brown et al., 1998). Additionally, self-schemas of early-maturing Caucasian girls may be influenced more by negative feedback from others: African American girls report more positive feedback from their mothers concerning the pubertal transition than do Caucasian girls; Caucasian girls also report more teasing from others and feelings of shame and embarrassment during the pubertal transition, especially regarding sex (Hayward, 2003). Lower global self-esteem and negative inferential feedback should both be explored as mediators in future research on the relationship between early pubertal timing and depressive symptoms.

It is more difficult to speculate why early-maturing African American boys would be more vulnerable to symptoms of depression in the context of high levels of stress. A meta-analysis found a strong relationship between racism and depressive symptoms among African Americans (Pieterse, Todd, Neville, and Carter, 2012) and the level of racial discrimination experienced by African Americans has been found to be inversely proportional to age (Kessler, Mickelson, and Williams, 1999). However, it is not yet understood if racism and discrimination affect African American girls and boys equally. Studies of racial discrimination and adolescents have not found gender differences but men have been found to report higher levels of racial discrimination than women (Kessler et al., 1999). Personal experiences of racism have been associated with increased internalizing symptoms, increased hopelessness, and decreased self-concept in African American boys (Nyborg and Curry, 2003). As early-maturing African American boys begin to physically resemble African American men, they may experience higher levels of racial discrimination (Cunningham, Swanson, Spencer, and Dupree, 2003). Early-maturing African American boys will likely be larger and more developed than their peers, and may be perceived as more of a threat by those around them (Coll et al., 1996), this may lead to more experiences of racial discrimination. Future studies would benefit by exploring racial discrimination as a mediator of the relationship between early pubertal timing and depressive symptoms for African American boys.

In our sample, we found the interaction of pubertal timing and life events predicted increased depressive symptoms only in Caucasian girls and African American boys. There is no clear explanation why early pubertal timing as a vulnerability factor did not predict increased depressive symptoms among the Caucasian boys and African American girls in our sample. Pubertal timing in the context of high levels of life stress may have had a negative effect on the Caucasian boys and African American girls that resulted in symptoms of another disorder, e.g., substance abuse (Ge et al., 2006) not assessed in the present study. It is also possible that Caucasian boys and African American girls were buffered from increased symptoms by a protective factor (e.g., peer prosocial behavior) not assessed in the current study.

Study Strengths and Limitations

This prospective study addresses a gap in the literature by evaluating pubertal timing in the context of stressful life events in a sufficiently sized sample evenly divided by race and sex. One strength of the study is that the age of the sample is just before the rise in depressive symptoms, particularly among girls, begins according to epidemiological studies (e.g., Hankin et al., 1998). A limitation of the current age range of our sample is that it may restrict the examination of late maturation effects. Although the range in maturation for our sample was large enough to allow a continuous measurement of pubertal timing, the present study should be replicated with samples at different chronological ages. Additionally, controlling for income in our analyses did not fully address differences in income distribution as SES and race are necessarily confounded (LaVeist, 2005); future studies should examine income versus race differences by enrolling African American and Caucasian samples with closely matched SES distributions.

Implications and Conclusions

This study extends evidence for pubertal timing as a vulnerability factor in the development of depressive symptoms to a sample evenly divided between boys and girls, Caucasians and African Americans. We found support for early pubertal timing as a vulnerability factor for prospective increases in depressive symptoms when Caucasian girls and African American boys experienced stressful life events. Results of the present study have implications for current knowledge about the role of pubertal maturation and potential mechanisms involved

in the development of depression. Evidence that early pubertal timing in the context of high levels of life stress specifically influences depressive symptoms in adolescents supports further study of pubertal timing, including the utility of pubertal timing in the prediction of the first diagnosis of a depressive disorder.

In addition, the literature on prevalence rates and correlates of depression across racial groups is inconsistent; dissimilar mechanisms may exist for depression onset in individuals of different races or ethnicities. To ensure the development of culturally sensitive assessments and interventions for depressive disorders, research should examine whether pubertal timing is a vulnerability factor for depression specific to Caucasian girls and African American boys and determine the effect of pubertal timing and stressful life events on adolescents of other ethnic groups. Furthermore, future study is needed to assess possible resilience factors that may buffer adolescents against the negative effects of early maturation in the face of stressful life events.

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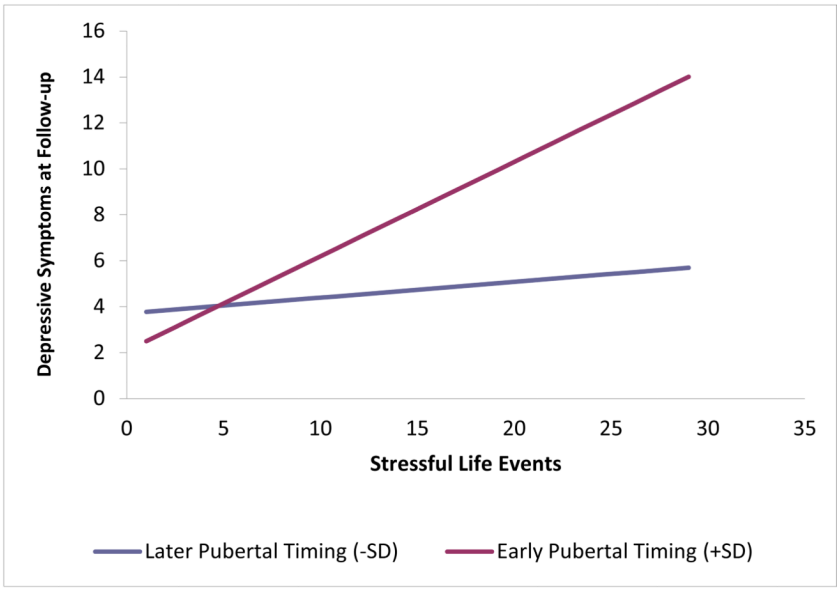
a)



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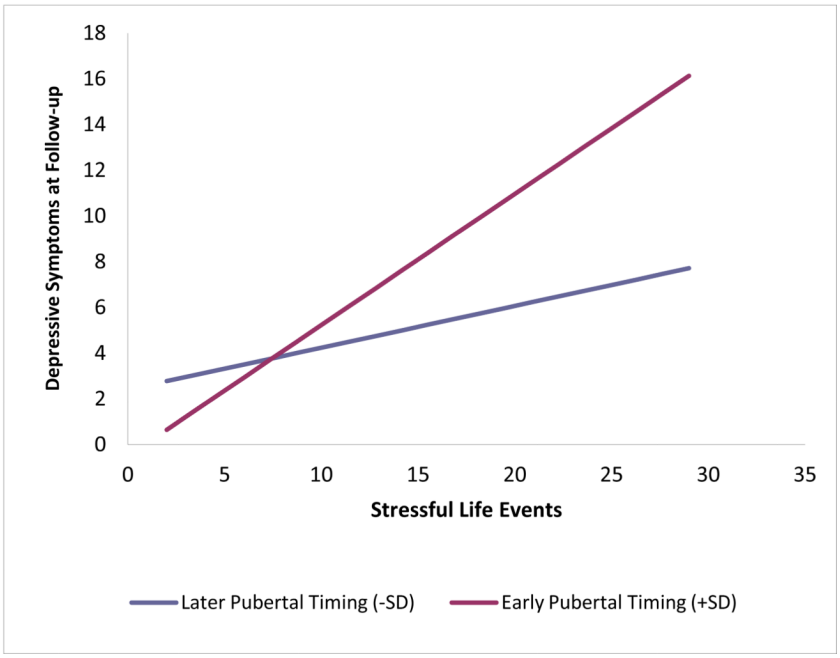

Figure 1.
Depressive symptoms at follow-up as a function of pubertal status and stressful life events for a) Caucasian girls and b) African American boys.

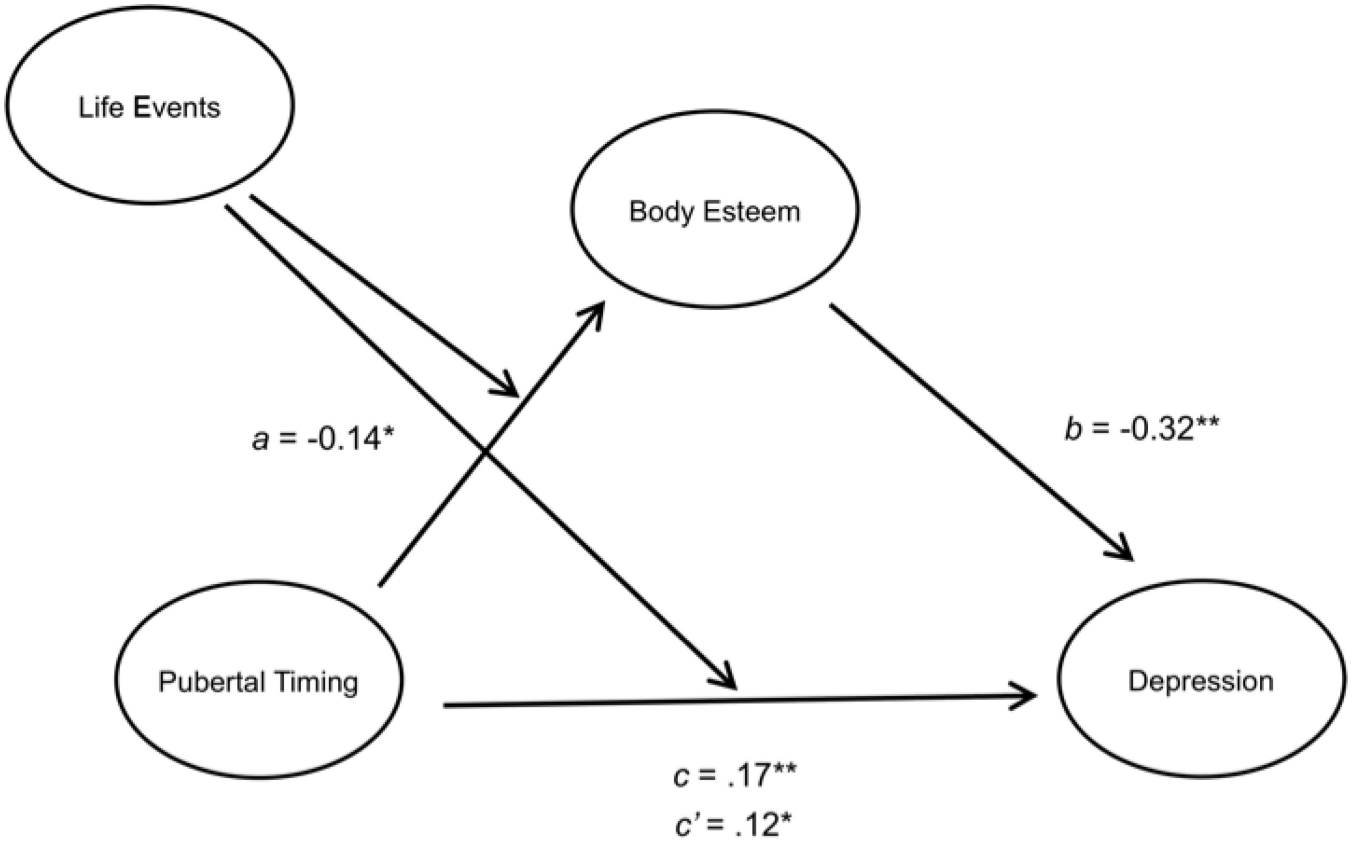

Figure 2.

Model coefficients for the indirect effect of pubertal timing moderated by life events through body esteem on depressive symptoms as well as the unconditional and conditional direct effects of pubertal timing moderated by life events on depressive symptoms for Caucasian girls.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 1

Participant Characteristics by Sex and Race

	Female	Male	*t*	*d*	Caucasian	African American	*t*	*d*
Variables:	*M (SD)*	*M (SD)*			*M (SD)*	*M (SD)*		
PDS	14.58 (3.31)	11.17 (2.93)	8.08***	1.08	12.48 (3.76)	13.54 (3.29)	2.24*	0.30
Age	12.44 (0.66)	12.39 (0.57)	0.55	0.08	12.29 (0.58)	12.54 (0.63)	3.17**	0.41
CLES	8.47 (3.82)	7.69 (3.95)	1.51	0.20	8.18 (3.78)	8.04 (4.00)	0.26	0.04
ALEQ	11.52 (6.99)	8.80 (5.23)	3.32***	0.45	9.96 (6.29)	10.59 (6.48)	0.73	0.09
CDI T1	6.71 (6.83)	5.76 (4.97)	1.20	0.17	6.06 (5.88)	6.48 (6.25)	0.52	0.06
CDI T2	5.47 (5.55)	4.15 (3.77)	2.10*	0.29	4.93 (4.66)	4.80 (5.05)	0.20	0.03
SOC T1	8.87 (5.45)	8.08 (5.13)	1.11	0.16	9.22 (5.53)	7.80 (5.00)	2.00*	0.27
SOC T2	7.89 (5.38)	6.39 (4.69)	2.20*	0.31	8.15 (5.44)	6.27 (4.62)	2.78**	0.38
BES	15.92 (4.74)	17.10 (3.54)	2.12*	0.28	15.96 (4.75)	16.95 (3.68)	1.74†	0.23

PDS = raw total score on Pubertal Development Scale; CLES = Children's Life Events Scale; ALEQ = Adolescent Life Events Questionnaire; CDI = total score on Children's Depression Inventory; SOC = total score on Multidimensional Anxiety Scale for Children: Social Anxiety subscale; BES = Body Esteem Scale; T1 = Baseline; T2 = Follow-up.

† $p < .10$,

* $p < .05$,

** $p < .10$,

*** $p < .001$.

Table 2

Correlations between Study Variables by Sex

	Measure	1	2	3	4	5	6	7	8	9
1.	PDS	---	.33***	.08	.07	.12	.15†	−.10	.04	−.17†
2.	Age	.49***	---	.17†	.13	.01	.09	−.05	.09	−.24**
3.	CLES	.10	.28**	---	.02	.01	.08	−.12	.03	−.08
4.	ALEQ	−.05	.06	.29**	---	.32**	.46***	.07	.19*	−.22**
5.	CDI T1	.06	−.01	−.05	−.17†	---	.62***	.41***	.22*	−.32***
6.	CDI T2	.14	.20*	.16	.26	.36***	---	.39***	.43***	−.60***
7.	SOC T1	−.04	−.06	−.11	−.01	.28**	.12	---	.63***	−.39***
8.	SOC T2	−.07	−.02	.03	.16	.10	.27**	.60***	---	−.41***
9.	BES	−.02	−.14	−.11	−.28**	−.14	−.45***	−.05	−.17†	---

Intercorrelations for girls are presented above the diagonal, and intercorrelations for boys are presented below the diagonal. PDS = raw total score on Pubertal Development Scale; CLES = Children's Life Events Scale; ALEQ = Adolescent Life Events Questionnaire; CDI = total score on Children's Depression Inventory; SOC = total score on Multidimensional Anxiety Scale for Children: Social Anxiety subscale; BES = Body Esteem Scale; T1 = Baseline; T2 = Follow-up.

† $p < .10$,

* $p < .05$,

** $p < .01$,

*** $p < .001$.

Table 3

Correlations between Study Variables by Race

	Measure	1	2	3	4	5	6	7	8	9
1.	PDS	---	.35***	.07	.14	.18†	.27**	.14	.21*	−.28**
2.	Age	.36***	---	.24*	.03	.03	.14	−.03	.08	−.27**
3.	CLES	.20*	.23*	---	.13	−.01	.05	−.09	.02	−.07
4.	ALEQ	−.03	.18†	.17†	---	.12	.43***	.15	.22*	−.22*
5.	CDI T1	.05	−.04	−.01	.12	---	.52***	.39***	.18†	−.26**
6.	CDI T2	.09	.15	.20*	.33***	.52***	---	.37***	.43***	−.55***
7.	SOC T1	−.18†	−.03	−.14	.02	.33***	.18†	---	.64***	−.32***
8.	SOC T2	−.02	.09	.09	.34***	.16†	.30**	.54***	---	−.40***
9.	BES	<.01	−.18†	−.16†	.18†	−.25**	−.53***	−.15	−.21*	---

Intercorrelations for Caucasian adolescents are presented above the diagonal, and intercorrelations for African American adolescents are presented below the diagonal. PDS = raw total score on Pubertal Development Scale; CLES = Children's Life Events Scale; ALEQ = Adolescent Life Events Questionnaire; CDI = total score on Children's Depression Inventory; SOC = total score on Multidimensional Anxiety Scale for Children: Social Anxiety subscale; BES = Body Esteem Scale; T1 = Baseline; T2 = Follow-up.

† $p < .10$,

* $p < .05$,

** $p < .01$,

*** $p < .001$.

Table 4

Interaction between Pubertal Timing, Stress, Sex and Race Predicting Depressive Symptoms at Follow-up.

	B	SE B	β	ΔR^2
Step 1				.40
CDI T1	.357	.041	.446***	
Age T1	.640	.397	.081	
SOC T1	.140	.047	.153**	
CLES	.049	.061	.039	
Days since T1	−.002	.003	−.032	
Income	−.049	.121	−.021	
Step 2				.13
Pubertal Timing (PT)	.791	.381	.168*	
Life Events (LE)	.235	.065	.310***	
Sex	−.385	.718	−.040	
Race	−.743	.670	−.077	
Step 3				.02
PT × LE	.146	.050	.201**	
Race × LE	.024	.092	.023	
Race × PT	−.882	.611	−.118	
Sex × LE	.035	.128	.026	
Sex × PT	−.804	.664	−.111	
Sex × Race	.800	.967	.071	
Step 4				.01
Sex × Race × LE	.008	.164	.005	
Sex × PT × LE	−.094	.136	−.061	
Race × PT × LE	−.194	.082	−.170*	
Sex × Race × PT	1.770	1.012	.159†	
Step 5				.01
Sex × Race × PT × LE	.383	.191	.180*	

CLES = Children's Life Events Scale; CDI = total score on Children's Depression Inventory; SOC = total score on Multidimensional Anxiety Scale for Children: Social Anxiety subscale; T1 = Baseline.

† $p < .10$,

* $p < .05$,

** $p < .01$,

*** $p < .001$.