HHS Public Access

Author manuscript

J Early Adolesc. Author manuscript; available in PMC 2016 January 13.

Published in final edited form as:

J Early Adolesc. 2012 December ; 32(6): 824–850. doi:10.1177/0272431611429945.

Other-Sex Relationship Stress and Sex Differences in the Contribution of Puberty to Depression

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Abstract

Research suggests that the pubertal transition, particularly when experienced earlier than age-matched peers, is associated with heightened depression in girls but less depression in boys. This study examined whether stress within other-sex relationships serves as one process through which puberty differentially contributes to depression for girls and boys. Youth (51 girls, 34 boys; *M* age = 12.68) and their caregivers reported on pubertal status and age of menarche. Semistructured interviews were conducted to assess youths' depression and exposure to chronic other-sex stress. As anticipated, more advanced status and earlier timing were associated with more depression in girls and less depression in boys. More advanced status and earlier timing were associated with less other-sex stress in boys; earlier age of menarche was associated with more other-sex stress in girls. Other-sex stress partially mediated the early menarche-depression association in girls, suggesting one process through which puberty promotes risk for depression in girls.

Keywords

depression; peer relationships; puberty/pubertal development; stress

Ample research documents sex differences in how adolescents negotiate the pubertal transition, particularly with regard to the onset of depression. Before puberty, boys and girls share a similar risk for depression but trajectories begin to diverge at the onset of puberty with a sharp rise in girls (Angold, Costello, & Worthman, 1998; Wade, Cairney, & Pevalin, 2002). In particular, earlier-maturing girls (Ge, Conger, & Elder, 2001) and later-maturing boys (Graber, Lewinsohn, Seeley, & Brooks-Gunn, 1997) are at the greatest risk for depression. This study examined whether chronic stress in the context of other-sex relationships helps to explain this sex difference in depression. Specifically, we examined whether three indexes of puberty—pubertal status (absolute level of maturation), pubertal timing (level of maturation relative to peers), and age of menarche (an index of pubertal timing in girls) contribute to sex differences in depression through their impact on chronic other-sex relationship stress.

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Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Puberty is characterized by developmentally unprecedented transitions within physical, psychological, and social contexts. Physical changes include alterations in body shape, fluctuating hormone levels, and significant brain reorganization (Romeo, 2003). Psychological changes include maturation of executive function and shifts in cognitions (Blakemore & Choudhury, 2006; Mezulis, Hyde, & Abramson, 2006). Social changes abound within the family and the peer group; for many youth, the adolescent transition is accompanied by entrance into middle school, which involves a new level of autonomy, responsibility, and social disruption (Simmons, Burgeson, Carlton-Ford, & Blyth, 1987).

It is clear that the pubertal transition represents a sensitive period in development when associated changes could lead to the destabilization that underlies susceptibility for depression. If girls and boys both face such vast changes at this stage, why is the onset of puberty associated with higher levels of depression in girls but not in boys? Answering this question requires a consideration of the differences in the way that adolescents experience this transition. Some evidence suggests that varying characteristics of pubertal development make more advanced status and earlier timing a social disadvantage for girls but a social advantage for boys (Mendle, Turkheimer, & Emery, 2006).

Pubertal Status and Social Stress

For girls, the onset of puberty is accompanied by increases in estrogen (which has been posited to have a biochemical link to depression; Cutter, Norbury, & Murphy, 2003), the emergence of secondary sex characteristics, and the onset of menstrual cycles. These physical transformations of puberty can manifest in the form of personal and psychological discomfort, undesirable changes in body shape, and weight gain. Increased body fat can have an adverse effect on girls' self-image in societies where slenderness is idealized (Blyth, Simmons, & Zakin, 1985); indeed, more advanced maturation is associated with weight concerns in girls (Compian, Gowen, & Hayward, 2009). This and other physical-maturational changes also may lead to ongoing stressful social conditions such as persistent harassment or negative attention from other-sex peers (McMaster, Connolly, Pepler, & Craig, 2002). Moreover, advancing puberty may trigger increased interest in romantic relationships and onset of dating; these experiences may, in turn, create heightened chronic stress and feelings of rejection or unhappiness if such relationships fail to materialize, become conflictual, or end prematurely (Friedlander, Connolly, Pepler, & Craig, 2007). Menarche may have a particularly salient meaning in the context of other-sex relationships given its implications for reproductive maturity, potentially creating heightened stress as girls enter into mature sexual relationships.

For boys, however, advancing pubertal status is associated with some changes that may reduce social stress. In males, puberty is characterized by increases in testosterone, which, in turn, can result in increased height and muscle mass gain. These changes, in conjunction with the onset of secondary sex characteristics such as deepening voice and hair growth, can actually boost social status and self-esteem, perhaps due to increased athleticism and a more adult appearance. Muris, Meesters, van de Blom, and Mayer (2005) found that adolescent boys made more attempts to become muscular than girls, whereas adolescent girls made more attempts to lose weight than boys; for boys, more advanced status was associated with

less social pressure to gain muscle mass. Moreover, more pubertally advanced boys are developmentally in sync with their female peers, who undergo pubertal changes at earlier ages. Thus, advancing maturation in boys may lead to more prestige in the context of other-sex relationships, thereby reducing social pressure, teasing, and other chronic stressors.

Pubertal Timing and Social Stress

Beyond these effects of puberty itself, the timing of youths' maturation has been implicated as a contributor to depression. According to the stage-termination hypothesis (Petersen & Taylor, 1980), adolescents with earlier timing are insufficiently prepared for the cognitive and emotional demands of puberty and may not have had the opportunity to progress through prior developmental stages at a normal rate or order. Earlier maturers also may suffer as trailblazers who lack the support structures afforded to on-time peers. Moreover, earlier timing can lead to a risky social environment in which adolescents affiliate with older peers, perhaps due to their more mature appearance and interests (Weichold, Silbereisen, & Schmitt-Rodermund, 2003). For girls, this tendency may spur earlier other-sex romantic attractions and relationships with older boys (Stroud & Davila, 2008). Not only such affiliations (and their disintegration) are likely to be fraught with psychological and social risk, but also this ongoing stress in other-sex relationships is experienced by girls with less developmental preparation than their on-time or later-maturing peers, potentially leaving them with less peer support. As girls begin puberty earlier than do boys and complete the transition more quickly (Parent et al., 2003), girls with earlier pubertal timing experience the earliest timing overall, while boys with later timing experience the latest timing overall. Thus, girls with earlier timing may experience the most chronic stress whereas boys with earlier timing may benefit from being one of the first members of their mixed-sex peer group to attain the socially desirable characteristics of puberty and to attract positive attention from the other sex. Indeed, earlier pubertal timing is linked to lower body image and self-esteem in girls (Williams & Currie, 2000) but more positive other-sex social outcomes (marital satisfaction) into adulthood for boys (Taga, Markey, & Friedman, 2006).

Other-Sex Stress and Depression

Negative experiences with the other sex, such as habitual teasing, stressful dating experiences, and conflict in romantic relationships, are in turn linked to depression (Compian, Gowen, & Hayward, 2004; Natsuaki, Biehl, & Ge, 2009; Rizzo, Daley, & Gunderson, 2006). Research reveals that more physically mature girls who experienced more frequent relational victimization, and girls who reported more romantic activities, are at greater risk for depression (Compian et al., 2009; Steinberg & Davila, 2008.). The stress-depression link may be especially pronounced for girls who are particularly prone to depression in the face of interpersonal stress during adolescence (Hankin, Mermelstein, & Roesch, 2007; Rudolph & Hammen, 1999).

Study Overview

In sum, advancing pubertal maturation, particularly early menarche and earlier timing overall, may be related to more other-sex chronic stress in girls but less in boys; in turn, other-sex chronic stress may be more strongly linked with depression in girls than in boys.

However, few studies directly examine the network of associations among puberty, other-sex stress, and depression, making it difficult to determine the precise role of other-sex stress. This study examined whether chronic stress within other-sex relationships helps to account for sex differences in the puberty-depression link. We investigated stressful conditions in both other-sex platonic and romantic relationships. Specifically, we tested four hypotheses: (a) More advanced pubertal maturation and earlier pubertal timing would be associated with more depression in girls but less depression in boys, (b) More advanced pubertal maturation and earlier pubertal timing would be associated with more other-sex chronic stress in girls but less other-sex chronic stress in boys, (c) Other-sex chronic stress would be associated with more depression, especially in girls, and (d) Other-sex chronic stress would partly account for the Puberty × Sex contribution to depression and for the association between earlier age of menarche and depression in girls.

Method

Participants

Participants were 85, fourth to eighth graders, (51 girls, 34 boys; *M* age = 12.68, *SD* = 1.28; 96.5% ages 10–14) participating in a study of the adolescent transition. Participants were diverse in ethnicity (72.9% White, 17.7% African American, 9.4% Other) and income level (19.5%: <US$30,000; 57.3%: 30,000–75,000; 23.2%: >US$75,000). Youth were selected from a larger sample of 167 youth based on the availability of other-sex stress data. Youth with and without the relevant data did not significantly differ in ethnicity (White vs. minority), $\chi^2(1; N = 167) = 2.41$, *ns*, income, $t(160) = .38$, *ns*, pubertal timing, $t(156) = .23$, *ns*, age of menarche, $t(43) = .40$, *ns*, or depression, $t(165) = 1.08$, *ns*. Compared to youth without relevant data, those with data were more likely to be girls, $\chi^2(1; N = 167) = 5.01$, $p < .05$, older, $t(165) = 3.03$, $p < .01$, and more pubertally advanced, $t(156) = 2.12$, $p < .05$. These differences did not result from self-selection, availability of other-sex stress data was due to procedural issues (i.e., the study was expanded to include other-sex stress part way through its implementation). In no cases did youth decline completion of this interview.

Participants in the original sample of 167 were recruited via schoolwide screenings for depressive symptoms using the Children's Depression Inventory (CDI; Kovacs, 1992). We selected youth with a range of CDI scores, oversampling slightly for those with scores above 18. Participants and nonparticipants in the larger study did not differ in sex, χ^2 (1, $N = 468$) = .39, *ns*, ethnicity, χ^2 (1, $N = 468$) = .02, *ns*, or CDI scores, $t(280) = 1.11$, *ns*. Participants (*M* age = 12.41 years, *SD* = 1.19) were slightly younger than non-participants (*M* age = 12.65 years, *SD* = 0.89), $t(275) = 2.28$, $p < .05$.

Procedures

Families provided written consent (caregivers) and assent (youth). Youth and caregivers independently completed the puberty questionnaires and diagnostic interview, and youth completed the other-sex chronic stress interview. To avoid contamination of the diagnostic and life stress information, two different staff members conducted the interviews. Diagnostic interviews were conducted by a faculty member in clinical psychology, psychology graduate students, or a post-BA-level research assistant. Diagnoses were made through consultation

with the clinical psychology faculty member. Life stress interviews were conducted by psychology graduate students, post-BA-level research assistants, or advanced undergraduate students. Consensual Diagnoses and Life Stress Scores were assigned using a best estimate approach (Klein, Ouimette, Kelly, Ferro, & Riso, 1994), in which the team uses their best clinical judgment to combine and reconcile any disparate youth and caregivers reports.

Measures

Pubertal development—Youth and caregivers completed the Pubertal Development Scale (PDS; Petersen, Crockett, Richards, & Boxer, 1988) which includes five questions assessing growth spurt, hair growth, skin changes, voice change and facial hair (boys), and breast development and menarcheal status (girls). Items were rated on a 4-point scale (1 = *no development*, 2 = *development has just begun*, 3 = *development is definitely underway*, 4 = *development is complete*). The menarche item uses a dichotomous response (1 = *No*, 4 = *Yes*). The PDS has been validated across several studies (Brooks-Gunn, Warren, Rosso, & Gargiulo, 1987; Petersen et al., 1988). Scores are moderately correlated with physician ratings of the Tanner stages (Brooks-Gunn et al., 1987). As strong correlations were found between youth and caregiver reports in the overall sample ($r[68] = .88$, $p < .001$, for girls, $r[58] = .72$, $p < .001$ for boys), composites were formed for each of the five items by averaging across informants (within this subsample, $\alpha = .89$ for girls, .80 for boys). When information was available from only one informant, this information was used.

Youth and caregivers also rated youths' stage of development using the Udry line drawings of the five Tanner stages (Morris & Udry, 1980). Girls' drawings depict breast and pubic hair development and boys' drawings depict genital and pubic hair development. Caregivers and youth checked which of the drawings most closely matched youths' current stage of maturation. Validity has been established through significant associations with physician ratings on physical exams (Schlossberger, Turner, & Irwin, 1992). In the overall sample, strong correlations were found between girls' and caregivers' reports ($r[65] = .83$, $p < .001$, for breast development; $r[62] = .69$, $p < .001$, for pubic hair development) and between boys' and caregivers' reports ($r[40] = .47$, $p < .01$, for genital development; $r[37] = .65$, $p < .001$, for pubic hair development). Composites were formed for each of the two items by averaging across informants. When information was available from only one informant, this information was used. Within this subsample, the two items were strongly correlated in girls, $r(50) = .84$, $p < .001$, and in boys, $r(31) = .92$, $p < .001$. Of the 85 youth, 32% were in Tanner Stages 1or 2 (less advanced), 23% were in Tanner Stage 3 (average), and 45% were in Tanner Stages 4 or 5 (more advanced).

Confirmatory factor analyses in this sample (Conley & Rudolph, 2009) yielded well-fitting measurement models using the seven items (five PDS and two Tanner) as indicators for a latent variable. Thus, a composite score was created by averaging the seven items, standardized within sex. Composite scores were calculated for youth with at least five of the seven indicators. As prior research has used the Tanner stages alone as an index of pubertal development (Dorn, Susman, Nottelmann, Inoff-Germain, & Chrousos, 1990), scores also were calculated for youth with Tanner data only, or Tanner data plus one to two PDS items. When information on all of the items was available from only one informant (9.4% of

families), this information was used. Using scores along a continuum, higher scores reflect more advanced pubertal status.

Two indexes of pubertal timing were used. First, residualized scores were computed separately for girls and boys by regressing pubertal status onto chronological age (Dorn, Susman, & Ponirakis, 2003). Using scores along a continuum, higher scores reflect earlier maturation relative to one's age-mates. Second, age of onset of menarche was used as an additional index of pubertal timing in girls who had reached menarche, averaging across youth and caregiver reports ($n = 29$, $r[28] = .96$, $p < .001$; 3.5% based on single report). To facilitate interpretation of effects involving this variable, the effects are presented such that higher scores on this variable reflect earlier age of menarche.

Other-sex stress—The Youth Life Stress Interview (Rudolph & Flynn, 2007) was administered to youth to assess chronic stress within other-sex relationships. We focused on chronic rather than episodic stress because specific acute events in other-sex relationships were infrequent in this early adolescent sample (50.6% had no other-sex episodic events) whereas only 3.5% of youth received an other-sex chronic stress score of 1 (*no stress*). This semi-structured interview uses the contextual threat method (Brown & Harris, 1978) to assess the occurrence and severity of chronic stress experienced in the previous year. Interviewers used specific probes to elicit information about ongoing stressful experiences within other-sex platonic relationships (e.g., teasing) and romantic relationships (e.g., unreciprocated interest, conflict). Follow-up questions were asked to establish the overall severity of stress. Interviewers presented narrative summaries to a team of coders with no prior knowledge of youths' experience of depression or their subjective response to the stress. Coders assigned an objective stress rating reflecting the degree of chronic stress experienced on a scale from 1 (*no negative stress*) to 5 (*severe negative stress*). Interrater reliability for both platonic and romantic other-sex stress was high (ICCs = .86). As ratings for other-sex platonic and romantic stress were highly correlated ($r = .72$, $p < .01$), a composite index was created by averaging the two ratings.

Depression—Interviewers individually administered the Schedule for Affective Disorders and Schizophrenia for School-Age Children-Epidemiologic Version-5 (Orvaschel, 1995) to youth and their caregivers to assess youth depression. Based on *Diagnostic and Statistical Manual of Mental Disorders criteria* (American Psychiatric Association, 2000) regarding the number, severity, frequency, and duration of symptoms and resulting impairment, ratings of depressive symptoms were assigned on a 5-point scale: 0 = *no symptoms*, 1 = *mild symptoms*, 2 = *moderate symptoms*, 3 = *diagnosis with mild to moderate impairment*, and 4= *diagnosis with severe impairment*. Separate ratings were assigned for each category of depression (e.g., major depression, dysthymia) and each period of depression during the year preceding the interview. Ratings were then summed to create continuous scores. Higher scores reflected more severe symptoms within a single diagnostic category, the presence of symptoms from multiple categories, and/or multiple episodes of depression (for a similar approach, see Rudolph et al., 2000).

Providing evidence for concurrent validity, these scores were significantly correlated with scores on the CDI (Kovacs, 1992) and the Youth Depression Inventory (Rudolph, 2002) in

the overall sample (*r*s = .46–.57, *p*s < .01). Consistent with the use of this continuous index, contemporary conceptualizations of depression suggest that depression is best represented on a dimensional continuum (Hankin, Fraley, Lahey, & Waldman, 2005). Based on independent coding of 25% of the original sample, strong reliability (one-way random-effects intraclass correlation coefficient [ICC] = .95, $p < .001$) was found for the Continuous Depression Scores. Of the 85 youth, 11.8% met diagnostic criteria for major depression or dysthymia within the past year (i.e., a rating of 3 or 4 for at least one episode). An additional 14.1% had subthreshold symptoms of major depression, dysthymia, or other depressive disorders within the past year (i.e., a rating of 1 or 2 for at least one episode).

Results

Preliminary Tests of Sex Differences

T tests were conducted to provide descriptive information about sex differences (Table 1). Based on the Pubertal Development Scale, girls were significantly more developed than were boys, $t(83) = 2.63$, $p < .05$. No other significant sex differences were found. The absence of a sex difference in depression is likely due to the fact that this difference emerges during middle adolescence (about age 13; e.g., Costello, Mustillo, Erklani, Keeler, & Angold, 2003), and 51.8% of the present sample was younger than 13 years old.

Overview of Analytic Approach

First, zero-order correlations were calculated to investigate the general pattern of associations. Second, regressions were conducted to investigate whether sex moderated the contribution of puberty to depression. Third, regression analyses were conducted to examine whether other-sex stress mediated the Pubertal development × Sex contributions to depression. Regressions also were conducted to examine whether other-sex stress mediated the association between age of menarche and depression in girls. In light of the fact that we had specific, theoretically driven directional hypotheses, one-tailed significance levels are reported (Rosnow, Rosenthal, & Rubin, 2000).

Correlational Analyses

As expected, more advanced pubertal status, earlier pubertal timing, and earlier age of menarche were positively correlated with depression in girls; more advanced pubertal status and earlier pubertal timing were negatively correlated with depression in boys (Table 1). Comparison of the correlations using Fisher's *r*-to-*z* transformations revealed that the correlations between puberty and depression differed significantly between girls and boys, *z*s > 3.38, *p*s < .001. Also as expected, earlier age of menarche was positively correlated with other-sex stress in girls, and more advanced pubertal status was negatively correlated with other-sex stress in boys. The correlation between pubertal status and other-sex stress differed significantly between girls and boys, $z = 2.26$, $p < .05$. The correlation between earlier pubertal timing and other-sex stress significantly differed in girls and boys, $z = 1.82$, $p < .05$, as reflected in a positive but nonsignificant correlation in girls and a marginally significant negative correlation in boys. Other-sex stress was correlated with more depression in girls (significantly) and boys (marginally); the difference was not significant, $z = 1.07$, *ns*.

Regression Analysis of Sex Differences

Hierarchical multiple regression analyses were conducted to examine sex differences in the contribution of pubertal status and timing to depression. Sex and the mean-centered main effects of puberty were entered in the first step; the two-way interaction was entered in the second step. Significant interactions were interpreted by solving the regression equation in girls and in boys. For pubertal status, analyses revealed nonsignificant main effects of pubertal status and sex but a significant Pubertal status × Sex interaction (Table 2). Deconstruction of this interaction (Figure 1a) revealed that more advanced pubertal status was significantly associated with more depression in girls ($\beta = .36$, $p < .05$) and less depression in boys ($\beta = -.38$, $p < .05$). For pubertal timing, analyses again revealed nonsignificant main effects of pubertal timing and sex but a significant Pubertal timing × Sex interaction (Table 2). Deconstruction of this interaction (Figure 1b) revealed that earlier pubertal timing was significantly associated with more depression in girls ($\beta = .35$, $p < .01$) and less depression in boys ($\beta = -.45$, $p < .01$).

Mediation by Other-Sex Stress: Pubertal Status and Pubertal Timing

The next set of analyses examined whether the Pubertal status × Sex and Pubertal timing × Sex contributions to depression were accounted for by other-sex stress (i.e., tests of mediated moderation). Several conditions must be satisfied to support mediated moderation (Muller, Judd, & Yzerbyt, 2005). Condition 1 requires that the magnitude of the overall effect of the independent variable (puberty) on the dependent variable (depression) depends on the moderator (sex); Condition 1 was previously satisfied for pubertal status and timing (Table 2). Condition 2 requires that the mediator (other-sex stress) accounts for the overall moderation effect. For this to be the case, either the effect of puberty on other-sex stress depends on sex and the average partial effect of other-sex stress on depression is significant and/or the partial effect of other-sex stress on depression depends on sex and the average effect of puberty on other-sex stress is significant. As a result, the moderation of the residual direct effect of puberty on depression is reduced compared to the overall moderated effect. To investigate Condition 2, two regression analyses were conducted. The first regression examined whether the path from puberty to other-sex stress was moderated by sex (Condition 2a). The second regression examined whether other-sex stress or the Other-sex stress × Sex interaction predicted depression after adjusting for the main and interactive effects of puberty and sex (Condition 2b), and whether the overall interactive effect of puberty and sex on depression was reduced upon inclusion of other-sex stress and the Other-sex stress × Sex interaction (Condition 2c).

First, hierarchical multiple regressions were conducted to examine whether sex moderated the association between puberty and other-sex stress (Condition 2a). Sex and the mean-centered main effects of puberty (status or timing) were entered in the first step; the Puberty × Sex interaction was entered in the second step. These analyses revealed nonsignificant main effects of sex and pubertal timing, but a marginally significant main effect of pubertal status. Specifically, more advanced pubertal status predicted less other-sex stress. These analyses also revealed significant Pubertal status × Sex and Pubertal timing × Sex interactions (see Table 2). As displayed in Figure 2a, more advanced pubertal status was significantly associated with less other-sex stress in boys ($\beta = -.47$, $p < .01$) but was not

significantly associated with other-sex stress in girls (β = .01, *ns*). Similarly, as displayed in Figure 2b, earlier pubertal timing was marginally associated with less other-sex stress in boys (β = −.28, $p < .06$) but was not significantly associated with other-sex stress in girls (β = .13, *ns*).

Next, hierarchical multiple regressions were conducted to examine whether other-sex stress or the Other-sex stress × Sex interaction predicted depression after adjusting for the main and interactive effects of puberty and sex (Condition 2b). Sex and the mean-centered main effects of puberty (status or timing) were entered in the first step; the Puberty × Sex interaction, the mean-centered main effect of other-sex stress, and the Other-Sex Stress × Sex interaction were entered in the second step.

For both pubertal status and pubertal timing, analyses revealed nonsignificant main effects of other-sex stress and a significant Other-sex stress × Sex interaction (Table 3). Deconstruction of these interactions (Figure 3) revealed that other-sex stress was significantly associated with more depression in girls (βs = .48, *p*s < .001) and marginally associated with more depression in boys (βs = .27, *p*s < .07). The residual effects of the Puberty × Sex interactions on depression were smaller than the overall moderated effect (Table 3; Condition 2c) but remained significant after adjusting for other-sex stress and the Other-sex stress × Sex interaction (Table 3), suggesting that other-sex stress may partially mediate the Puberty × Sex contribution to depression.

We therefore examined whether other-sex stress mediated the association between puberty and depression in girls and in boys. We examined two indexes to quantify the strength of mediation: the size and significance of the indirect effect (IE; Sobel, 1982) and the effect proportion (indirect effect/total effect; Shrout & Bolger, 2002). In girls, we found nonsignificant indirect effects (pubertal status: IE = .01, $Z = .07$, *ns*; pubertal timing: IE = .06, $Z = .90$, *ns*) and small effect proportions (other-sex stress accounted for 1.4% of the total effect of pubertal status on depression and 16.8% of the total effect of pubertal timing on depression). In boys, we also found nonsignificant indirect effects (pubertal status: IE = −.06, $Z = -.57$, *ns*; pubertal timing: IE = −.04, $Z = -.81$, *ns*) and small effect proportions (14.4% for pubertal status and 9.6% for pubertal timing).

Mediation by Other-Sex Stress: Age of Menarche

Finally, we conducted a series of hierarchical multiple regressions to examine whether other-sex stress mediated the association between earlier age of menarche and depression in girls (Baron & Kenny, 1986; Table 4). First, the effect of earlier age of menarche on other-sex stress was significant. Second, the effect of other-sex stress on depression, after adjusting for age of menarche, was significant. Consistent with partial mediation, the association between age of menarche and depression was reduced to marginal significance after including other-sex stress. Also, the indirect effect of age of menarche on depression was marginally significant (IE = .15, $Z = 1.60$, $p < .07$) and other-sex stress accounted for 35% of the total effect of age of menarche on depression. These findings provide support for partial mediation by other-sex stress.

Discussion

This study examined the hypothesis that other-sex stress would partially account for the differential association between pubertal development and depression in girls and boys. Evidence was obtained for the anticipated moderating influence of sex on the associations between puberty and depression, puberty and other-sex stress, and other-sex stress and depression. Other-sex stress did not account for the contribution of pubertal status or timing to depression; however, other-sex stress partially accounted for the association between earlier age of menarche and depression in girls.

Pubertal Development and Depression

As expected, more advanced status and earlier timing were associated with heightened depression in girls. This pattern supports the stage-termination hypothesis (Petersen & Taylor, 1980), which suggests that an earlier transition into puberty creates psychological risk, and is consistent with the relatively well-established effect of puberty on depression in girls (e.g., Ge, Conger, et al., 2001). Conversely, less advanced status and later timing were associated with more depression in boys. This finding is consistent with some prior research (Graber et al., 1997), but evidence is mixed with regard to the link between pubertal development and depression in boys. Indeed, some research indicates that earlier timing in boys is associated with more internalizing symptoms (DeRose, Wright, & Brooks-Gunn, 2006) and with more depression over time, even though it may be associated with less concurrent depression (Conley & Rudolph, 2009). Earlier puberty in boys also may lead to other kinds of negative developmental outcomes, such as aggression, conduct problems, and substance abuse (Huddleston & Ge, 2003); both earlier and later timing have been linked to risk for antisocial and delinquent behaviors (Williams & Dunlop, 1999). It may be that the detrimental effects of earlier timing manifest over longer time periods and are not captured in concurrent studies or studies of younger boys. Alternatively, the maturational-deviance hypothesis (e.g., Petersen & Taylor, 1980; Williams & Dunlop, 1999) posits that simply being off time (earlier or later compared to peers) is a key risk factor for psychological adjustment. Thus, earlier-maturing boys may not necessarily be as vulnerable to concurrent depression as girls, but this does not mean that the pubertal transition is without risk.

Pubertal Development and Other-Sex Stress

Consistent with our expectations, significant Puberty × Sex interactions supported differential associations between puberty and other-sex stress in girls and boys. In boys, pubertal status was associated with significantly less other-sex stress, and earlier pubertal timing was associated with marginally less other-sex stress. In girls, earlier age of menarche was positively and significantly associated with other-sex stress; the results for earlier pubertal timing were in the expected direction but nonsignificant. The fact that these associations were significantly different and in opposite directions in girls and boys, supports the premise that puberty is associated with differing sex-linked other-sex relationship experiences.

However, these results also highlight the importance of considering the differential impact of various indexes of puberty on adjustment. Each of the three indexes—status, timing, and

age of menarche—had the predicted associations with depression in both girls and boys. However, only status had the expected significant negative association with other-sex stress in boys, and only age of menarche had the expected significant positive association with other-sex stress in girls. This pattern suggests that different indexes of puberty carry varying psychological and social meanings and may influence the experience of depression through different pathways.

Secondary sexual characteristics carry a high "social stimulus value" (Brooks-Gunn & Warren, 1989, p. 41) because they are readily apparent to youth and others in their social contexts. Yet, merely undergoing these changes was not associated with more other-sex stress in girls. It may be that emerging secondary sexual characteristics lead to psychological changes (e.g., concerns about weight and body image) or to harassment from same-sex peers and more general peer group stress), which in turn create a risk for depressive symptoms (Compian et al, 2009; Conley, Rudolph, & Bryant, 2010). It also is possible that although some physical manifestations of puberty (e.g., weight gain) are viewed as undesirable, others (e.g., more feminine/adult appearance, breast development) are viewed as desirable (Brooks-Gunn & Warren, 1988; Tobin-Richards, Boxer, & Petersen, 1983), creating differential associations with adjustment (Carter, Jaccard, Silverman, & Pina, 2009). In the domain of other-sex stress, the onset of menarche may be a particularly salient sign of the entry into adolescence, as well as an explicit signal of reproductive maturity, and therefore may be more strongly associated than other indicators of puberty with engagement in mature other-sex experiences and relationships that can lead to stress. In boys, however, more advanced pubertal status did suppress exposure to other-sex stress. The physical manifestations of puberty in boys, such as increased muscle mass and athleticism, seem to translate into a social advantage by protecting them from negative experiences within other-sex relationships.

It is important to note that this specific pattern of findings may apply only to concurrent associations between puberty and other-sex stress. It may be that the link between advanced pubertal status and other-sex stress in girls is driven by slowly accumulating changes in physical, emotional, and social development that were not captured in this study. Likewise, boys who mature early relative to their peers engage in riskier behavior and romantic relationships (Weichold et al., 2003), possibly accounting for research suggesting links between earlier pubertal timing and heightened depression in boys over time (Natsuaki et al., 2009). A longitudinal examination of pubertal development, long-term trajectories of other-sex stress, and depression could help elucidate these temporal issues.

Other-Sex Stress and Depression

As anticipated, higher levels of other-sex stress were associated with more depression, and this association held more strongly for girls than it did for boys. The moderated associations between puberty and depression were not significantly mediated by other-sex stress, but the addition of other-sex stress to the statistical model did reduce the interactive effect of puberty and sex on depression. This suggests that other-sex stress may account for a small portion of this association. Further, other-sex stress did partly mediate the association between earlier age of menarche and depression, suggesting one process through which

puberty is associated with vulnerability to depression for girls. However, it is likely, given the modest evidence for mediation, that other factors also play a significant role in mediating or moderating the puberty-depression link. For example, there is evidence that peer stress, abuse, and heightened reactivity to rejection are associated with increases in depression across the pubertal transition (Brendgen, Wanner, Morin, & Vitaro, 2005; Conley et al., 2010; Hayward & Sanborn, 2002). Given evidence that puberty has differential effects on self-esteem and depressive symptoms across ethnic groups (Ge, Elder, Regnerus, & Cox, 2001; Hayward, Gotlib, Schraedley, & Litt, 1999), race or ethnicity may also moderate the association between puberty and depression.

Strengths and Limitations

This is one of the first studies to investigate sex differences in the association between puberty and depression as mediated by other-sex stress. Beyond this novel conceptual contribution, this study has several methodological strengths. First, stress and depression were assessed with rigorous semistructured interviews and coding systems to reduce responder bias and to obtain nuanced, detailed descriptions of youths' ongoing stressful experiences. Second, both parent and youth reports were used to assess depression and puberty, providing a comprehensive, dual-informant perspective. Third, we assessed multiple indexes of pubertal development, including absolute status, timing relative to peers, and age of menarche. However, it should be noted that the cross-informant reliability of pubertal status was lower in boys than in girls, perhaps affecting the strength of the results in boys. The study also was limited by a relatively small sample size, which reduced power to detect significant mediation, and by the fact that many girls in our cohort had not yet reached menarche at the time of data collection. Moreover, the age range of the participants, boys in particular, may have limited our ability to detect certain effects. Although later pubertal timing may be an important source of vulnerability to both depression and other-sex stress, our sample of boys may not have been sufficiently old enough to capture the strongest negative effects of later timing. Future research in this area should endeavor to obtain data from a larger sample and a broader age range while maintaining methodological rigor. In such a sample, it would be informative to examine the effects of other individual differences, such as rejection sensitivity or ethnic group, which may moderate or mediate the association between puberty and depression.

Another notable limitation of this study was the concurrent design, which prevented us from detecting changes in other-sex stress and depression subsequent to the onset and progression of puberty. Pertinent to this, some researchers have speculated that stressful interpersonal experiences may themselves lead to earlier pubertal timing as an evolutionary strategy that takes advantage of extended childhood in supportive environments and accelerates maturation in stressful environments (Belsky, Steinberg, & Draper, 1991; Belsky, Steinberg et al., 2007). Indeed, Tither and Ellis (2008) found that family disruption and paternal absence predict earlier age of menarche. For girls, this concept may manifest as a reciprocal relationship wherein interpersonal stress in the familial context may lead to earlier pubertal timing, which may, in turn, lead to still more interpersonal stress in other-sex relationships. Longitudinal examination of stress and puberty would be required to elucidate this potential cycle.

Conclusion

Overall, this study contributes important information regarding the network of associations among puberty, other-sex stress, and depression. Though only modest evidence was found for mediation in this small sample, the pattern of effects was consistent with our guiding conceptual framework. More advanced and earlier pubertal maturation were associated with more depression in girls but less depression in boys. Puberty was differentially associated with other-sex stress across sex: It conferred an advantage for boys and (for earlier menarche) a disadvantage for girls. Also, other-sex stress was associated with significantly more depression in girls than in boys. These findings support the premise that girls and boys face distinctly different experiences in the context of other-sex relationships as they progress through puberty and these experiences confer distinctly different vulnerabilities to depression. The fact that girls, particularly those who mature earlier relative to their peers, begin to outnumber boys in their rates of depression during the pubertal transition may be due, in part, to their heightened vulnerability in other-sex relationships. Further evidence in this direction may have implications for preventative and ameliorative strategies targeted at improving mental health during this developmental stage.

Acknowledgments

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the National Institute of Mental Health (MH59711); a William T. Grant Foundation Faculty Scholars Award; and a University of Illinois Arnold O. Beckman Research Award to Karen D. Rudolph.

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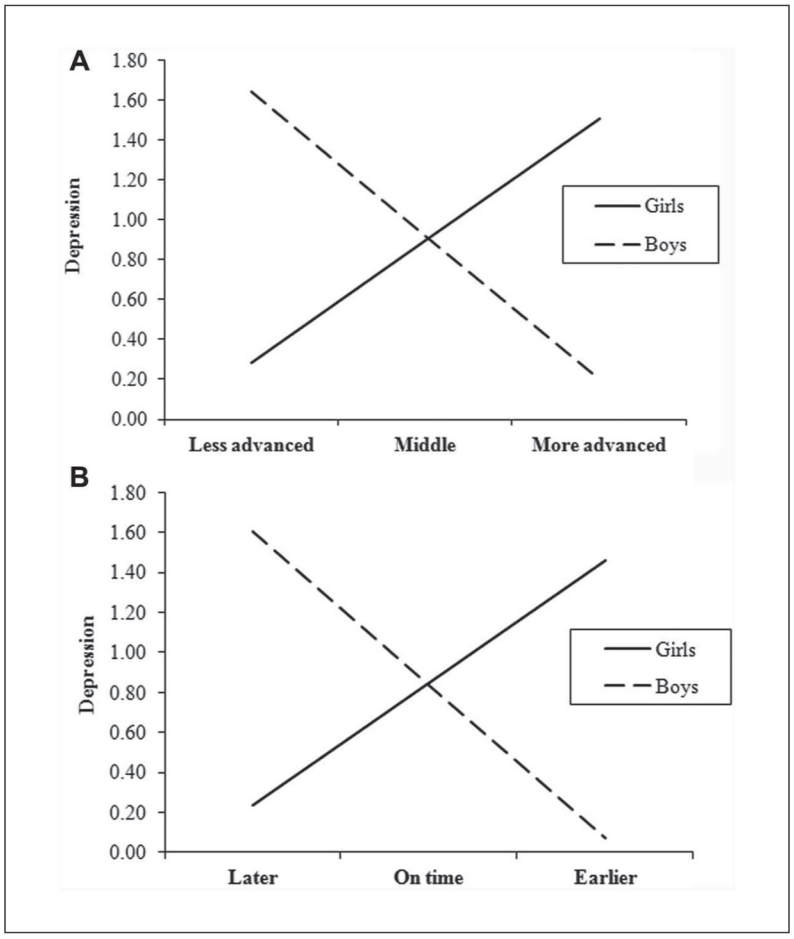

Figure 1.
Puberty × Sex contributions to depression for (a) pubertal status and (b) pubertal timing

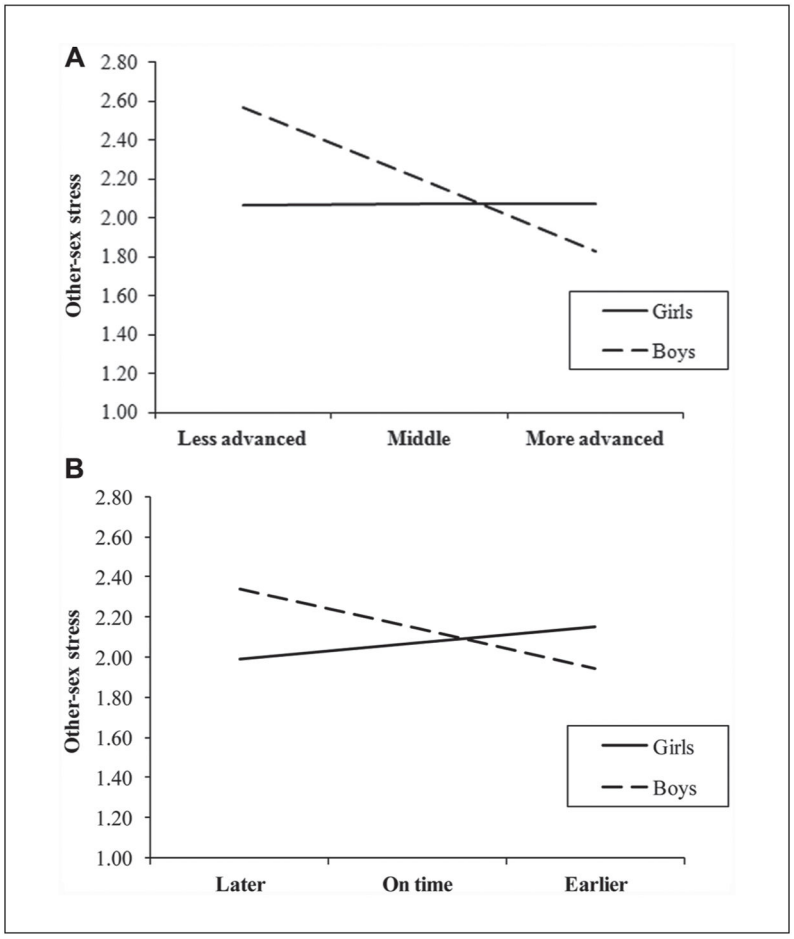

Figure 2.
Puberty × Sex contributions to other-sex stress for (a) pubertal status and (b) pubertal timing

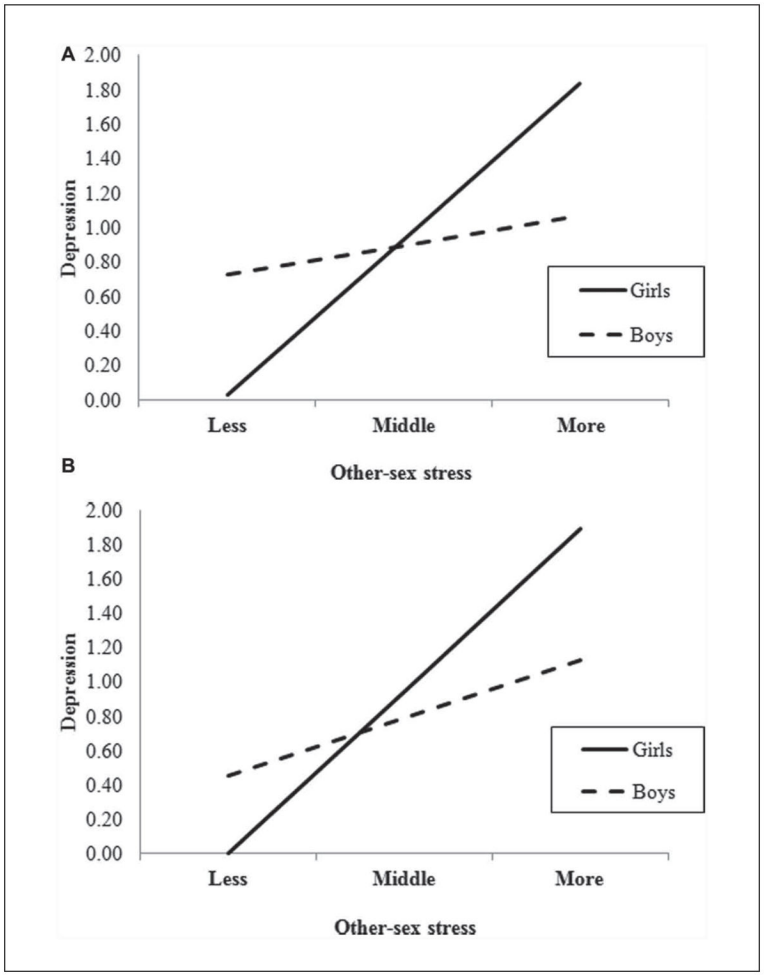

Figure 3.

Other-sex stress × Sex contributions to depression for (a) pubertal status and (b) pubertal timing

Table 1

Descriptive Information and Intercorrelations Among the Variables

	Descriptive information				Intercorrelations				
	Boys		Girls						
Measures	**Range**	***M* (*SD*)**	**Range**	***M* (*SD*)**	**1**	**2**	**3**	**4**	**5**
1. Pubertal status					—	.71****	.25*	.01	.36***
Pubertal Development Scale	1.10–3.40	2.16 (0.56)	1.00–3.80	2.56 (0.84)					
Udry line drawings	1.00–5.00	3.06 (1.13)	1.00–5.00	3.01 (1.29)					
2. Pubertal timing					.76****	—	.51***	.13	.35***
3. Age of menarche	—	—	10.00–14.13	11.83 (1.05)	—	—	—	.39**	.43**
4. Other-sex stress	1.00–4.00	2.13 (0.69)	1.00–4.25	2.07 (0.63)	−.47***	−.28*	—	—	.48****
5. Depression	0.00–8.00	0.79 (1.67)	0.00–9.00	0.82 (1.82)	−.38**	−.45***	—	.27*	—

Note: Intercorrelations presented above the diagonal are for girls; intercorrelations presented below the diagonal are for boys. For correlation analyses, higher scores on age of menarche variable reflect earlier onset of menarche.

* $p < .10$.

** $p < .05$.

*** $p < .01$.

**** $p < .001$.

Table 2

Predicting Depression and Other-Sex Stress From Pubertal Development, Sex, and Pubertal Development × Sex Interactions

	Status			Timing		
Predictors	**β**	***t***	**ΔR^2**	**β**	***t***	**ΔR^2**
Predicting depression						
Step 1						
Pubertal development	.11	0.97		.06	0.50	
Sex	.02	0.22		.01	0.1	
Step 2						
Pubertal development × Sex	.62	3.39****	.12	.62	3.72****	.15
Predicting other-sex stress						
Step 1						
Pubertal development	−.17	−1.58*		−.04	−0.33	
Sex	−.07	−0.67		−.05	−0.45	
Step 2						
Pubertal development × Sex	.47	2.51***	.07	.34	1.90**	.04

Note: βs and *t*s represent standardized coefficients and *t* statistics at each step; ΔR^2represents percentage of variance accounted for at each step.

* $p < .10$.

** $p < .05$.

*** $p < .01$.

**** $p < .001$.

Table 3

Tests of Mediated Moderation to Predict Depression: Pubertal Status and Timing

	Status			Timing		
Predictors	**β**	***t***	**ΔR^2**	**β**	***t***	**ΔR^2**
Step 1						
Pubertal development	.11	0.97		.06	0.50	
Sex	.02	0.22		.01	0.10	
Step 2						
Pubertal development × Sex	.57	3.10***	.27	.54	3.38***	.28
Other-sex stress	.10	0.61		.14	0.93	
Other-sex stress × Sex	.31	2.02**		.25	1.73**	

Note: βs and *t*s represent standardized coefficients and *t* statistics at each step; ΔR^2 represents percentage of variance accounted for at each step.

* $p < .10$.

** $p < .05$.

*** $p < .01$.

**** $p < .001$.

Table 4

Test of Mediation: Age of Menarche

	Other-sex stress			Depression		
Predictors	**β**	***t***	**ΔR^2**	**β**	***t***	**ΔR^2**
Step 1						
Earlier age of menarche	.39	2.22**	.15	.43	2.45**	.18
Step 2						
Earlier age of menarche				.28	1.56*	
Other-sex stress				.39	2.22**	

Note: βs and *t*s represent standardized coefficients and *t* statistics at each step; ΔR^2 represents percentage of variance accounted for at each step.

* $p < .10$.

** $p < .05$.

*** $p < .01$.

**** $p < .001$.