Early pubertal timing and adult adjustment outcomes: Persistence, attenuation, or accentuation?

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Introduction

Adolescents who experience puberty earlier than their same-sex and same-age peers (i.e. early pubertal timing) report higher rates of depression, anxiety, hostility, delinquency, substance use, and precocious sexual activity than their later maturing peers (e.g., Baams, Dubas, Overbeek, & van Aken, 2015; Brooks-Gunn, Warren, Rosso, & Gargiulo, 1987; Dimler & Natsuaki, 2015; Flannery, Rowe, & Gulley, 1993; Ge, Kim, Brody, Conger, Simons, Gibbons, & Cutrona, 2003; Mendle & Ferrero, 2012; Mendle, Turkheimer, & Emery, 2007; Negriff & Susman, 2011; Ullsperger & Nikolas, 2017; White, Deardorff, & Gonzales, 2012). Although recent work has questioned whether the effect sizes associated with early timing are large enough to warrant public concern (Smith-Woolley, Rimfeld, & Plomin, 2017), there is consistent evidence that early pubertal timing is associated with a range of negative outcomes in adolescence. Important remaining questions concern whether early puberty primarily accentuates tendencies toward problematic behavior (e.g., Caspi & Moffitt, 1991) and whether the correlates of early pubertal timing persist across the life span (e.g., Boden, Fergusson, Horwood, 2011; Copeland, Shanahan, Miller, Costello, Angold, & Maughan, 2010; Natsuaki, Biehl, & Ge, 2009; Stattin & Magnusson, 1990). This paper addresses these questions using data from the Iowa Youth and Families project, a longitudinal study that has followed focal participants from approximately ages 13 to 35 (e.g., Conger & Conger, 2002; Ge, Conger, & Elder, 1996, 2001).

Early Pubertal Timing and Adolescent Development

Although a number of perspectives attempt to account for the association between early pubertal timing and adolescent outcomes (e.g., Caspi & Moffitt, 1991; Ge & Natsuaki, 2009; Smith-Woolley et al., 2017; Ullsperger & Nikolas, 2017), the developmental readiness hypothesis appears to have the strongest support. This account posits a linear association between early pubertal timing and negative outcomes. The gist of this explanation is that adolescents who experience puberty earlier compared to their later maturing peers are not as prepared for the social and emotional demands that accompany this transition.

One modification to the developmental readiness hypothesis is the possibility that the experience of early puberty is primarily problematic for youth who are already showing signs of distress (e.g., Caspi & Moffitt, 1991). This is known as the *accentuation* hypothesis (see also Ge & Natsuaki, 2009), which asserts that early pubertal timing is a stressful transition that reinforces and magnifies existing behavioral and emotional tendencies. The first evidence for the accentuation hypothesis was provided by Caspi and Moffitt (1991) who found that early maturing girls with a history of childhood behavior problems at age 9 experienced the most adjustment difficulties throughout adolescence. Further tests of the accentuation hypothesis have been limited due to data requirements needed to test this idea including the need for earlier measures of distress (see Ge & Natsuaki, 2009). Nonetheless, the accentuation hypothesis is an important qualifier of the developmental readiness hypothesis.

Gender is often considered important when evaluating the impact of early pubertal timing on developmental outcomes (e.g. Ullsperger & Nikolas, 2017). Many classic studies focused exclusively on girls and popular discussion often emphasizes the impact of early puberty on girls (Deardorff & Greenspan, 2014). However, studies that have evaluated the impact of early pubertal timing in boys and mixed-sex samples tend to find that early maturation is problematic for boys as well (e.g., Ge et al., 2001; Smith-Woolley et al., 2017). Indeed, recent meta-analytic studies found no evidence for gender differences in the association between early pubertal timing and adolescent externalizing problems (Dimler & Natsuaki, 2015) as well as adolescent psychopathology more broadly (Ullsperger & Nikolas, 2017). Thus, the general findings about the negative correlates of early pubertal timing appear to apply to both girls and boys; and, we test this issue in the current study. Indeed, Cohen, Cohen, and Brook (1995) suggest that researchers should directly test for gender differences rather than separately analyze data for males and females in the absence of statistical evidence for gender differences.

Long-term Impact of Early Pubertal Timing

When compared to the evidence that early pubertal timing is associated with negative outcomes during adolescence, relatively little is known about long-term impacts of early puberty beyond adolescence and young adulthood. Stattin and Magnusson (1990) remarked about a shortage of studies on the long-term impact of puberty and little has changed in the last quarter-century (see Copeland et al., 2010). For example, Dimler and Natsuaki (2015) noted there was "limited knowledge regarding the long-term effect of early pubertal timing"

(p. 162). Copeland et al. (2010) outlined two hypotheses about the long-term effects of early puberty – the *attenuation* and *selective persistence* hypotheses.

The attenuation hypothesis predicts that the impact of early puberty weakens in adulthood, likely because of general developmental trends toward increases in psychological health and personality maturity during the transition to adulthood (e.g., Caspi, Roberts, & Shiner, 2005; Galambos, Barker, & Krahn, 2006). In contrast, the selective persistence hypothesis predicts that early maturation has lasting general effects that pervades multiple areas of functioning. The idea behind this hypothesis is that early puberty increases the likelihood that adolescents encounter so-called snares (e.g., Moffitt, Caspi, Harrington, & Milne, 2002) such as addiction, teen parenthood, school drop-out, and arrest that decrease the probability of a successful transition to adulthood and heightens risks for adjustment difficulties across multiple outcomes.

The bulk of studies in the literature seem to support the attenuation hypothesis. For example, Boden and colleagues (2011) examined associations between age of menarche and psychosocial outcomes in early adulthood including antisocial behaviors, educational attainment, mental health outcomes, and sexual behaviors in a birth-cohort sample of New Zealand women. Aside from their finding that earlier menarcheal age was associated with an increased risk of pregnancy and sexually transmitted infections by age 18, Boden and colleagues (2011) suggested that links between age of menarche and risks of adverse outcomes by age 30 are small to nonexistent. Copeland and colleagues (2010) tested associations between pubertal timing and psychosocial outcomes at age 21 for women including crime, substance use, peer problems, family relationships, sexual behavior, mental health, and education/SES. Early puberty was not associated with any negative outcomes with the exception of a significant interaction between pubertal timing and adolescent conduct disorder predicting depression during young adulthood.

These recent findings about longer-term outcomes associated with early pubertal timing are consistent with the classic work by Stattin and Magnusson (1990) who studied a sample of Swedish women and examined outcomes regarding family life, education, work, social support, personality, criminal offenses, and substance use measured when their sample participants were at about 25 years of age. Aside from noting that only 2% of the early maturing women (those whose menarcheal age was before 11) entered college or university compared to 12-15% of the later maturing women, there were few indications of lasting effects. Stattin and Magnusson remarked that "no convincing relationship between menarcheal age and adult social maladjustment was established" (Stattin & Magnusson, 1990, p. 340).

Boden et al. (2011), Copeland et al. (2010), and Stattin and Magnusson (1990) are notable for the breadth of constructs they assessed but their focus was limited to women. The longer-term studies that have used mixed-sex samples tend to find mixed results. Natsuaki et al. (2009) found evidence of attenuation for outcomes like depression whereas Graber, Seeley, Brooks-Gunn, & Lewinsohn (2004) found more complicated results. They reported evidence consistent with attenuation for males followed to age 24 (with the exception of tobacco use) but evidence for persistence for women in terms of rates of psychological disorders and

relationship problems. One concern is that both Graber et al. (2004) and Natsuaki et al. (2009) were limited in their follow-up period to the early to mid-20s which makes it unclear whether early pubertal timing effects persist past young adulthood for both men and women.

The Current Study

The current study revisits the Iowa Youth and Families Project (IYFP; see Conger & Conger, 2002) sample used by Ge and his colleagues to investigate the association between early puberty and adolescent emotional outcomes (e.g., Ge et al., 1996, 2001). Ge et al. (1996) found that 7th grade girls who experienced menarche at younger ages reported higher symptoms of psychological distress than their on-time and late-maturing peers. A later study demonstrated that early-maturing boys experienced more hostile feelings and internalized distress symptoms relative to their on-time and later maturing peers (Ge et al., 2001). The IYFP participants have now been followed well into adulthood, and the most recently available wave was taken in 2010 when participants were 35 years of age, on average. Thus, the current study addresses two gaps in the literature – we test for accentuation and evaluate the long term correlates of early pubertal timing using a mixed-sex sample followed into their fourth decade of life.

We extend the earlier work by Ge and colleagues by focusing on adolescent outcomes beyond just emotional problems including delinquency, GPA, health variables, substance use, and early sexual behaviors. We also measure pubertal development for both boys and girls using a continuous measure rather than dividing the female sample into pubertal groups (e.g., early, on-time, late as in Ge et al., 1996). This continuous variable or individual differences approach is recommended by current investigators (see Smith-Woolley et al., 2017) because it minimizes information loss and avoids the arbitrariness associated with creating pubertal development categories. We also explicitly investigate whether correlates of early pubertal timing differ by gender.

Method

Participants

Data come from the Iowa Youth and Families Project (IYFP), an ongoing longitudinal study of a cohort first assessed in 1989 when target participants were in 7th grade (N = 451; 52% women; M age = 12.7 years). Data were originally collected annually from 1989 through 1992. These assessments were used to form our composites for adolescent outcomes. In 1994, families from the IYFP were included with data from another project and renamed, the Family Transitions Project (FTP; see Conger & Conger, 2002) and participants were assessed approximately every two years. However, we focus only on IYFP participants given the need to use an assessment of early pubertal timing from the 1989 wave and to make our results comparable to the earlier papers by Ge and colleagues.

Participants were recruited from public and private schools in eight rural Iowa counties. Due to the rural nature of the sample and the fact that there were few racial/ethnic minority families in Iowa at the beginning of the study, all of the participants were Caucasian. Seventy–eight percent of the eligible families agreed to participate. Families were primarily

economically lower-middle or middle–class. In 1989, parents averaged 13 years of schooling and had a median family income of $33,700. Families ranged in size from 4 to 13 members, with an average size of 4.94 members. The current sample includes those targets who provided data from at least one of the two most recent assessments. These occurred in 2007 and 2010 when targets were an average age of 32 and 35 years of age respectively.

Measures

Means, standard deviations, minimum and maximum scores, and alpha reliabilities are provided in Table 1.

Early Pubertal Timing (Adolescence)—Pubertal status was assessed in grade 7 using the Pubertal Development Scale (PDS; Petersen, Crockett, Richards, & Boxer, 1988). On a 4-point scale ranging from 1 = *has not yet started* to 4 = *has completed*, both boys and girls rated their body hair development, height growth spurt, and skin changes. Boys also rated their development of facial hair and voice change. Girls also rated their breast development and one yes/no question about the onset of menstruation. Menarche was rated as absent (1) or completed (4). The PDS yields a composite score by averaging the five items within each sex to maintain the original metric. PDS scores were then standardized within each age category at grade 7 (i.e., age 12, 13, or 14) and biological sex (girls and boys) to create a measure of early puberty. Higher scores indicate more advanced pubertal development relative to same sex and same age members of the sample and conversely lower scores indicate less advanced pubertal development relative sample norms. In other words, a high score on this measure is an index of early puberty. This was the same approach to assess early puberty used by Ge et al. (2001) for boys.

Outcomes

Adolescent outcome measures were assessed in 7th, 8th, 9th, and 10th grade, unless otherwise indicated. The adolescent composites were the average of the respective variables across the relevant occasions (grades 7 to 10 unless otherwise noted). Adulthood composites were the average of variables taken from the two most recent waves of data collection when participants were in their early to mid-30s.

Psychological Distress (Adolescence and Adulthood)—Psychological distress was assessed through self-report using the depression, anxiety, hostility, somatization (for adolescents only), and additional symptom subscales from the SCL-R-90 (Derogatis, 1994). Response categories assessed how distressed or bothered the participant felt during the past week, ranging from 1 = *not at all* to 5 = *extremely*. For the depression scale, adolescents were asked 12 questions (omitting "loss of sexual interest or pleasure") and adults were asked 13 questions regarding depressive symptoms such as "crying easily" or "feelings of worthlessness." The anxiety subscale included 10 questions assessing behavior such as "nervousness or shakiness inside" and "feeling fearful." The hostility subscale included 6 items asking questions related to "getting into frequent arguments" and "having urges to break or smash things." The additional items subscale included 8 items asking questions related to "trouble falling asleep" and the "idea that something is wrong with your mind." The somatization subscale was assessed for adolescents only and included 12 items asking

questions related to "nausea or upset stomach" and "heavy feelings in your arms or legs." Scores on individual scales were averaged together to create an overall psychological distress score, with higher scores indicating greater psychological distress.

Body Mass Index (Adolescence and Adulthood)—Body mass index (BMI) was based on self-reported height and weight measures and calculated with the formula: weight (lb) / [height (in)]^2 × 703. Higher scores indicate greater body mass.

Self-Rated Physical Health (Adolescence – 9th & 10th grade and Adulthood)—Participants rated their overall physical health with responses ranging from 1 = *excellent* to 5 = *poor*. For our adolescent measure, scores were averaged across grade 9 and 10, because the measure was not assessed in grade 7 and 8. Items were recoded so that higher scores indicate higher perception of overall physical health.

Self-Rated Mental Health (Adolescence – 9th & 10th grade and Adulthood)—Participants rated their overall mental health with responses ranging from 1 = *excellent* to 5 = *poor*. For our adolescent measure, scores were averaged across grade 9 and 10, because the measure was not assessed in grade 7 and 8. Items were recoded so that higher scores indicate higher perception of overall mental health.

Delinquency (Adolescence)—Delinquency was measured using an adapted instrument from the National Youth Survey (Elliott, Huizinga, & Ageton, 1985). Adolescents reported 23 delinquent behaviors related to laws and rules in the last year. Sample delinquent behaviors include: "run away from home" and "cut classes, or stayed away from school without permission." Responses ranged from 0 = *never* to 4 = *6 or more times in the last year*. Higher scores indicate greater delinquency.

Substance Use (Adolescence and Adulthood)—During adolescence, participants were assessed on 13 items regarding their substance use behavior during the past 12 months. Sample substance use behaviors included: smoking cigarettes, using chewing tobacco, drinking beer, wine, or wine coolers, having 3 or 4 drinks in a row, smoking marijuana, using some other illegal drug, and/or using prescription drugs without a doctor's prescription. Responses ranged from 0 = *never* to 4 = *three or more times per week*, with higher scores indicating greater substance use. In adulthood, participants were assessed on 11 items regarding their substance use behavior during the past 12 months. Responses ranged from 1 = *never* to 7 = *every day*. Higher scores indicate greater substance use.

Number of Sexual Partners (Adolescence – 8th, 9th, & 10th grade and Adulthood)—Participants reported the number of people they have had sexual intercourse with during the past 12 months. During adolescence, responses were a continuous variable, and were averaged across grade 8, 9, and 10, as this was not assessed in grade 7, with higher scores indicating more sexual partners. During adulthood, responses ranged from 0 = *no one* to 7 = *ten or more*, with higher scores indicating more sexual partners.

Frequency of Sexual Intercourse (Adolescence – 8th, 9th, & 10th grade and Adulthood)—Participants reported how often they had sexual intercourse during the past

12 months. During adolescence, responses were a continuous variable, and were averaged across grade 8, 9, and 10, as this was not assessed in grade 7, with higher scores indicating greater frequency of sexual intercourse. During adulthood, responses were coded as 0 = *never* to 5 = *every day*, with higher scores indicating greater frequency of sexual intercourse.

Grade Point Average (Adolescence)—Adolescents reported their grade point average (GPA) on a scale from 00 = *F* to 10 = *A*. Higher scores indicate higher GPA.

Workplace Deviancy (Adulthood)—Participants were given a list of 19 behaviors related to workplace deviancy (Bennett and Robinson, 2000) and asked if they have ever done any of these things, and if so, how often. Sample items include behaviors such as: "acted rudely toward someone at work," and "discussed confidential company information with an unauthorized person." Responses ranged from 1 = *never* to 7 = *daily*. Higher scores indicate greater frequency of workplace deviancy.

Sexual Satisfaction (Adulthood)—Participants were asked to indicate how they feel about each of the following statements. Sample statements include, "My partner and I do not have time for affection and intimacy" and "Sex isn't very important to me." Responses ranged from 1 = *strongly agree* to 5 = *strongly disagree*. Higher scores indicate greater sexual satisfaction.

Relationship Quality (Adulthood)—Relationship quality was assessed using a modified form of the Quality Marriage Index (QMI; Norton, 1983). The QMI is a six-item scale asking respondents to report the extent to which they agree or disagree with general statements about their romantic relationships. The first question asks, "How happy are you, all things considered with your relationship?" Responses ranged from 0 = *extremely unhappy* to 5 = *extremely happy.* The other five questions ask participants to rate their relationship with their partner. Sample questions include, "We have a good relationship" and "I really feel like part of a team with my partner." Responses ranged from 1 = *strongly agree* to 5 = *strongly disagree.* Since the response options were different, these items were standardized, averaged together, and coded so that higher scores indicate higher relationship quality.

Educational Attainment (Adulthood)—Participants were asked to indicate their highest level of educational attainment. Responses ranged from 1 = *less than high school*, 2 = *high school degree/GED*, 3 = *degree from junior, vocational, or community college*, 4 = *degree from 4-year college*, 5 = *master's degree*, 6 = *PhD or professional degree.*

Covariates

Given concerns over possible third variable explanations, we also conducted a set of analyses controlling for mother's age at menarche and indicators of parental SES.

Mother's age at menarche—In 1991 (when adolescent was in grade 9), mothers were asked to indicate their age at menarche. The answers were then converted into months of age at menarche, with responses available for 223 (94.5%) mothers. Mother's later age at menarche was correlated with less advanced target pubertal development at grade 7 ($r = .14$).

Parent's education—In 1989 (when adolescent was in grade 7), mothers and fathers reported their highest level of educational attainment. Responses ranged from 1 = *less than high school*, 2 = *high school degree/GED*, 3 = *degree from junior, vocational, or community college*, 4 = *degree from 4-year college*, 5 = *master's degree*, 6 = *PhD or professional degree*. Mother and father education was averaged together to create an average parent education variable.

Family income—In 1989 (when adolescent was in grade 7), mothers and fathers reported their family income for the previous year from all sources. This was obtained from an extensive reporting of family finances and then divided by the number of household members to create per capita income. It should be noted that family per capita income included negative values because some families had negative net farm income.

Results

Table 2 provides the correlational results. We tested whether correlation coefficients were different for males/females using tests of independent correlations. No significant gender differences were obtained so we report the results for the combined sample. We also report partial correlations controlling for family income, education, and maternal age at menarche in Table 2 along with Spearman's rho correlations in case of concerns about the distributions of the variables (see de Winter, Gosling, & Potter, 2016). The interpretation of the results was consistent across all three coefficients. Additional analyses including Bayesian hypothesis tests are presented in the Supplementary Material.

Early Pubertal Timing and Outcomes in Adolescence and Adulthood

As seen in Table 2, pubertal timing at grade 7 was correlated with greater overall psychological distress in adolescence. That is, early pubertal timing was correlated with greater depressive symptoms, anxiety, hostility, somatization, and additional symptoms of psychological distress assessed from grade 7 to 10. These findings replicate previous published results for this sample during adolescence (see Ge et al., 1996, 2001). Extending these prior studies, we also found that earlier pubertal timing at grade 7 was correlated with greater BMI, delinquency, substance use, higher number of sexual partners, and greater frequency of sexual intercourse assessed from grades 7 to 10. There was no evidence that early pubertal timing in grade 7 was associated with self-ratings of physical health, self-ratings of mental health, or GPA.

In contrast to the adolescent outcomes, there was no evidence that early pubertal timing at grade 7 was correlated with any of the adult outcomes we investigated. This is consistent with predictions from the attenuation perspective and counter to the selective persistence hypothesis. In short, we found no evidence for the persistence of the negative correlates of early pubertal timing when considering a wide range of adult adjustment outcomes. Including the covariates of maternal age at menarche, parent education, or family income had no impact on our conclusions about the correlates of pubertal timing.

Testing the Accentuation Hypothesis

As noted by Ge and Natsuaki (2009), tests of the accentuation hypothesis are challenging because of the data requirements including the need for good indicators of problems prior to adolescence (i.e., existing difficulties). Although far from a perfect solution, we used grade 7 variables as our proxy of these existing problems. A moderated multiple regression framework (Aiken & West, 1991) was used to test the accentuation hypothesis. For adolescent outcomes, we created outcome composites using the average of the assessments at the other grades (i.e., we dropped the 7th grade assessment from the calculation). The adult outcome variables were naturally unchanged.

Tests in adolescence—The outcome variables were regressed on six predictor variables – the standardized 7th grade early pubertal timing score, the standardized 7th grade score, the product of the standardized early pubertal timing score and standardized 7th grade score (i.e., the focal interaction), maternal age at menarche, parent education, and family income in a series of simultaneous regression models (i.e., all predictors were entered in a single step). Results were unchanged when the covariates were dropped from the model. As seen in Table 3, early pubertal timing in grade 7 was significantly ($p < .05$) associated with future psychological distress, depressive symptoms, anxiety, hostility, additional symptoms of distress, somatization, delinquency and substance use. This provides evidence that early pubertal timing at grade 7 is associated with future difficulties controlling for current levels of the respective outcomes.

The critical test of the accentuation hypothesis, however, is the interaction between early pubertal timing and the 7th grade variables. Interactions were positive and statistically significant at $p < .05$ in models predicting depression, hostility, additional symptoms of distress, and substance use. In other words, 4 tests of the accentuation hypothesis were supported. The PROCESS macro for SPSS (Hayes, 2012) was used to graph the interactions and it was evident that early pubertal timing accentuated the predictive power of the grade 7 problem behavior score. Figure 1 shows how pubertal development at grade 7 interacts with substance use at grade 7 to predict substance use behaviors at grades 8, 9, and 10. As shown in the graph, the prediction of substance use for grade 8 to grade 10 from grade 7 scores, was strongest (i.e. the slope was steepest) for those individuals who matured earlier relative to their peers of the same age and sex. Additional graphs for depression, hostility, and additional symptoms of distress are reported in the Supplementary Material and have this same form.

Adult outcomes—We used the same moderated multiple regression framework to test the accentuation hypothesis for adult outcomes as shown in Table 3. The main challenge when conceptualizing and conducting these analyses was to make sure our 7th grade variable was an acceptable way to operationalize existing individual tendencies for predicting adult outcomes. There were changes in the ways certain variables were measured over time that may attenuate overtime associations. For example, the response categories for our substance use variables were not the same in adulthood and adolescence. In addition, we were limited to using early GPA to predict adult educational attainment and adolescent delinquency to predict adult workplace deviancy. We believed the grade 7 GPA serves as a measure of early

academic problems that might be accentuated by early pubertal timing when predicting long term educational attainment. Likewise, we thought grade 7 delinquency was a reasonable indicator of early externalizing problems that might be accentuated by early pubertal timing and thus manifest as workplace deviancy in adulthood. As shown in Table 3, however, there was little evidence of accentuation when predicting adult outcomes as none of the interaction terms were positive and statistically significant.

Discussion

Consistent with prior work about the negative correlates of early pubertal timing in adolescence, we found that early pubertal development in grade 7 was correlated with greater psychological distress, BMI, deviancy, substance use, and sexual behaviors during adolescence. In general, early maturing adolescents report greater maladjustment during the adolescent years relative to their on-time and later maturing peers. There were no gender differences in these results. We also found some evidence for accentuation of early pubertal timing effects when statistically predicting a few adolescent outcomes. These results suggest that the negative effects of early pubertal timing might be more easily detectable in those adolescents with existing problems (see Caspi & Moffitt, 1991), especially when considering psychological distress and substance use.

In addition to testing the accentuation hypothesis, the current study provides important new data for both men and women testing whether the associations between early pubertal timing and problematic outcomes persist into adulthood. Consistent with the attenuation hypothesis, there was little evidence that early pubertal timing in adolescence was associated with adult outcomes for either sex. Moreover, there was no evidence that accentuation effects persisted into adulthood. Our findings are therefore consistent with previous studies that have suggested that the associations between early pubertal timing and risks of adverse outcomes in early adulthood are small, at best (see Boden et al., 2011; Copeland et al., 2010; Graber et al., 2004; Najman et al., 2009; Natsuaki et al., 2009; Stattin & Magnusson, 1990).

The possibility that the effects of early pubertal timing dissipate into adulthood is an interesting phenomenon that needs greater attention in the literature. Results from the current study should be replicated and we hope that there is no prejudice against null results given the importance of this issue. To be sure, additional higher powered tests are needed given the fact that our sample size was constrained by the design of the study that was initiated in 1989. It is also important to emphasize that elevated levels of psychological symptoms and other problems during adolescence are unpleasant and potentially distressing for youth and their families, regardless of whether these effects persist past age 30. At the same time, recent work by Smith-Woolley et al. (2017) has suggested that even the effect sizes for early puberty when considering adolescent outcomes in non-clinical samples are too small to warrant major concern. This is ultimately an issue for the field to deliberate and we think it important for researchers to place the effect sizes in context of other correlates of adolescent problems to avoid overstating (or understating) concerns about early pubertal timing. Given that adolescent outcomes are multiply influenced, large effects are likely to be rare (see e.g., Strube, 1991 for a methodological discussion of this point). Thus, early puberty might not be an especially powerful correlate of adolescent adjustment problems but

perhaps this generalization applies to many of the variables that are implicated in adolescent psychopathology. We also note that the accentuation hypothesis suggests that early pubertal timing might be more of a concern for adolescents who are already distressed. Thus, we think there is value in framing the discussion about the impact of early puberty in terms of thinking about which adolescents are most at risk for distress.

The current findings should be interpreted within the context of at least five limitations of this work. First, the sample is limited in ethnic and racial diversity, geographic location, and family structure; therefore, our findings may not be generalizable to other populations. Second, measures are based on self-reports of constructs. Third, our test of the accentuation hypothesis was limited to using 7th grade data, the same year we assessed early pubertal timing. Measures taken prior to adolescence would provide a stronger test of the accentuation hypothesis as those assessments would more clearly capture pre-existing individual differences. Fourth, some of the analyses testing accentuation for adults outcomes were less than ideal because our adolescent measure was a controversial operationalization of the pre-existing individual difference in question (e.g. we used adolescent delinquency when statistically predicting adulthood workplace deviancy). Last, we adopted an analytic approach of considering two developmental periods (i.e. adolescence and adulthood) because we were interested in testing the long-term outcomes of early pubertal timing as opposed to the correlates of trajectories of pubertal development in terms of tempo. Questions about tempo are an important consideration for future studies, especially those that assess pubertal development in more frequent intervals than annual assessments.

These limitations notwithstanding, our results suggest that any negative effects of early pubertal timing are attenuated by the fourth decade of life. Moreover, tests of the accentuation hypothesis suggest that the negative impact of early maturation may be most pronounced for the subset of early maturing youth who have existing behavioral difficulties. Future research should continue to evaluate both short-term and long-term consequences of early pubertal timing and to test the accentuation hypothesis. Such additional research will help increase knowledge about the psychological and behavioral correlates of early puberty and who is most at risk for problems related to pubertal timing. Likewise, additional work will provide further evidence for or against the idea that impact of early puberty dissipates across the lifespan.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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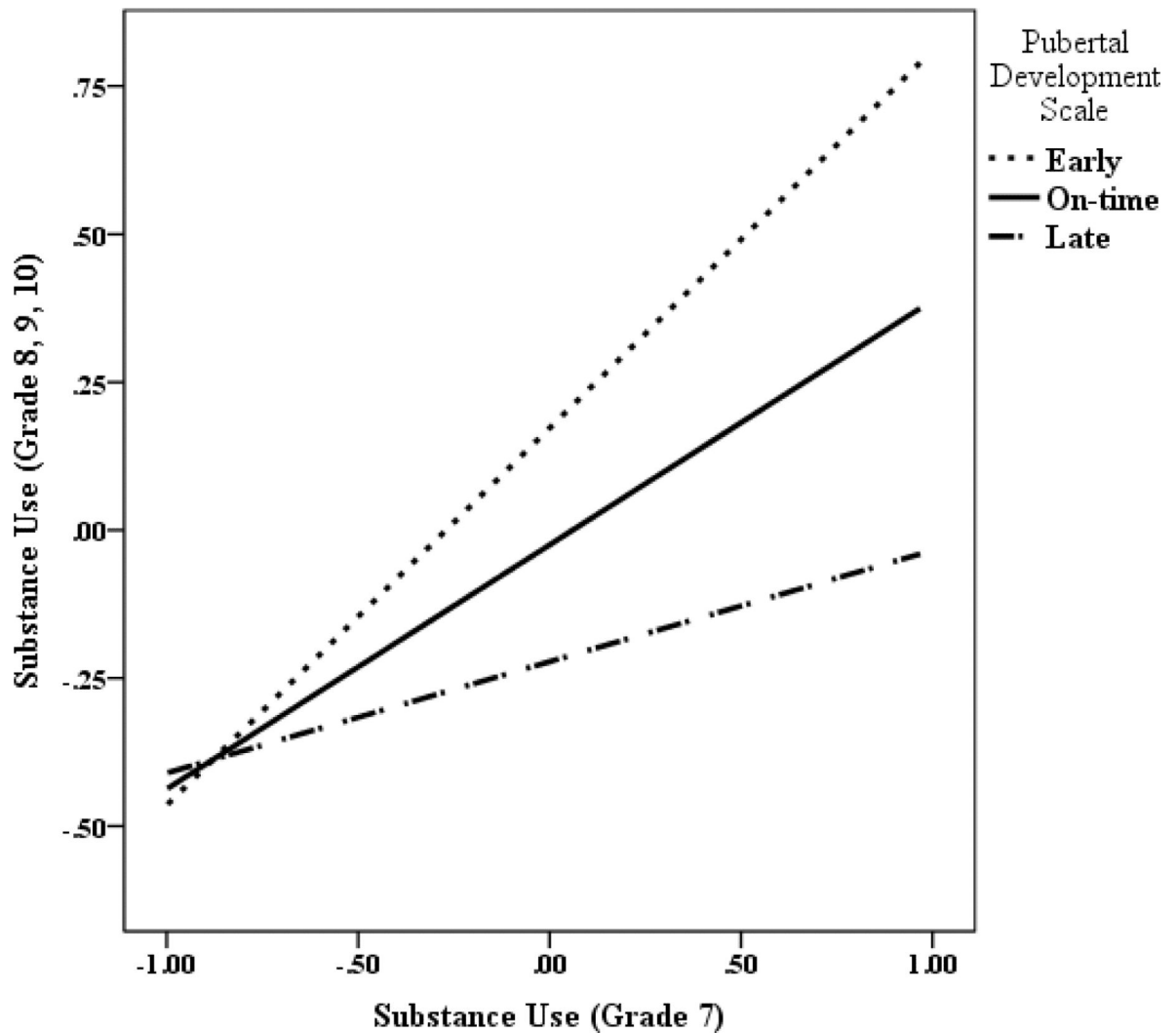
Figure 1. The Association Between Substance Use in Grade 7 and Subsequent Substance Use is Moderated by Pubertal Timing

Notes. Illustration of the interaction between the standardized early pubertal timing score and the standardized substance use score at grade 7 to predict the standardized substance use scores across grades 8, 9, and 10. Early, on-time, and late refer to one standard deviation above the mean, at the mean, and one standard deviation below the mean of early pubertal timing in grade 7. Higher scores indicate more advance pubertal development relative to same sex and same age members of the sample.

Table 1

Descriptive Statistics for Study Variables

Variables	N	Minimum	Maximum	M	SD	α range
Adolescent Measures						
Early Pubertal Timing	451	−2.39	2.12	.00	.99	.71 – .74
Psychological Distress	451	1.00	3.25	1.49	.37	.94 – .96
Depression	451	1.00	3.77	1.55	.45	.85 – .91
Anxiety	451	1.00	3.50	1.42	.38	.83 – .90
Hostility	451	1.00	3.92	1.53	.47	.79 – .87
Additional Symptoms	451	1.00	3.41	1.51	.42	.72 – .80
Somatization	451	1.00	3.33	1.46	.36	.79 – .84
Body Mass Index	451	12.13	34.26	20.88	3.21	–
Self-rated Physical Health	423	1.00	5.00	1.98	.77	–
Self-rated Mental Health	423	1.00	5.00	1.84	.75	–
Delinquency	451	.00	1.10	.08	.12	.63 – .80
Substance Use	451	.00	1.62	.14	.18	.67 – .84
Sexual Partners	434	.00	5.67	.16	.48	–
Frequency of Sex	434	.00	36.00	1.17	4.34	–
Grade Point Average	451	2.75	11.00	7.99	2.00	–
Adulthood Measures						
Psychological Distress	409	1.00	3.09	1.32	.31	.95
Depression	409	1.00	3.69	1.41	.44	.91 – .92
Anxiety	409	1.00	3.90	1.17	.30	.89 – .90
Hostility	409	1.00	3.17	1.30	.32	.73 – .82
Additional Symptoms	409	1.00	3.21	1.40	.41	.76
Body Mass Index	409	17.33	56.49	28.24	6.27	–
Self-rated Physical Health	409	1.50	5.00	3.66	.69	–
Self-rated Mental Health	409	1.00	5.00	3.93	.72	–
Workplace Deviancy	383	1.00	4.31	1.59	.56	.82 – .83
Substance Use	409	1.00	5.09	1.93	.67	.73 – .77

Variables	N	Minimum	Maximum	M	SD	α range
Sexual Partners	408	.00	7.00	1.14	.75	–
Frequency of Sex	408	.00	5.00	1.60	.79	–
Sexual Satisfaction	377	1.67	5.00	3.44	.64	.82 – .83
Relationship Quality	377	−3.26	.88	−.01	.82	.95
Education Attainment	421	1.00	6.00	3.44	1.11	–
Covariates						
Mother Age at Menarche	403	102.00	204.00	155.33	15.82	–
Parent Education	451	1.00	5.50	2.74	.78	–
Family Income	451	−10,245.67	51,800.00	7,938.92	5,648.02	–

Notes. M = mean; *SD* = standard deviation; α = alpha reliability.

Table 2

Associations between Early Pubertal Timing and Outcome Variables in Adolescence and Adulthood

Variables	Early Pubertal Timing Correlation	Early Pubertal Timing Correlation	Fisher's z test	Early Pubertal Timing Correlation
Adolescent Measures	Pearson r	Partial	*p* value	Spearman rho
Psychological Distress	.20[*]	.20[*]	.96	.17[*]
Depression	.17[*]	.16[*]	.87	.15[*]
Anxiety	.18[*]	.18[*]	.82	.15[*]
Hostility	.20[*]	.20[*]	.40	.17[*]
Additional Symptoms	.18[*]	.18[*]	.41	.14[*]
Somatization	.16[*]	.16[*]	.98	.17[*]
Body Mass Index	.16[*]	.15[*]	.52	.20[*]
Self-rated Physical Health	−.02	−.02	.17	.00
Self-rated Mental Health	.04	.04	.17	.01
Delinquency	.12[*]	.13[*]	.18	.14[*]
Substance Use	.22[*]	.22[*]	.35	.19[*]
Sexual Partners	.14[*]	.14[*]	.55	.12[*]
Frequency of Sex	.10[*]	.09[*]	.65	.13[*]
Grade Point Average	−.04	−.05	.24	−.04
Adulthood Measures				
Psychological Distress	.03	.04	.71	.04
Depression	.01	.01	.81	.02
Anxiety	.02	.03	.96	.03
Hostility	.03	.03	.76	.04
Additional Symptoms	.06	.05	.44	.04
Body Mass Index	.08	.08	.55	.07
Self-rated Physical Health	−.06	−.06	.45	−.06
Self-rated Mental Health	−.03	−.03	.18	−.04
Workplace Deviancy	.09	.11	.16	.10
Substance Use	.03	.04	.15	.04
Sexual Partners	.03	.04	.32	.00
Frequency of Sex	.06	.05	.33	.05
Sexual Satisfaction	.02	.01	.70	.00
Relationship Quality	−.04	−.04	.57	−.02
Education Attainment	.03	.02	.30	.02
Covariates				
Mother Age at Menarche	−.14[*]		.07	−.10[*]
Parent Education	.01		.74	.00

Variables	Early Pubertal Timing Correlation	Early Pubertal Timing Correlation	Fisher's z test	Early Pubertal Timing Correlation
Family Income	.02		.67	−.01

Notes.

[*] *p*<.05, two-tailed. The column for the Fisher's z-test evaluates gender differences in the correlations. None were statistically significant.

Table 3

Unstandardized Coefficients for Tests of Accentuation Hypothesis

Variables	N	Constant	Early Pubertal Timing Effect	Grade 7 Assessment	Interaction Effect	p value for the Interaction
			B	B	B	
Adolescent Measures						
Psychological Distress	403	–.01	.19*	.47*	.08	.060
Depression	403	–.01	.17*	.47*	.12*	.018
Anxiety	403	–.02	.17*	.34*	.08	.074
Hostility	403	–.02	.18*	.42*	.11*	.010
Additional Symptoms	403	–.01	.18*	.48*	.09*	.041
Somatization	403	–.01	.16*	.43*	.01	.792
Body Mass Index	403	.00	.05	.82*	–.01	.736
Delinquency	403	.01	.10*	.61*	–.06	.218
Substance Use	403	–.02	.20*	.41*	.23*	.000
Grade Point Average	403	.00	–.02	.76*	–.01	.846
Adulthood Measures						
Psychological Distress	369	.00	–.01	.24*	–.02	.694
Depression	369	.01	–.04	.25*	–.03	.604
Anxiety	369	.01	.01	.17*	–.03	.562
Hostility	369	.01	–.03	.23*	–.08	.114
Additional Symptoms	369	–.01	.03	.20*	.07	.159
Body Mass Index	369	.00	–.02	.58*	.03	.484
Workplace Deviancy	345	.00	.06	.15*	–.09	.164
Substance Use	369	.02	–.01	.24*	–.09	.165
Education Attainment	379	–.01	.02	.35*	.00	.939

Notes. B = unstandardized coefficient.

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*
$p<.05$. Interaction Effect column is the regression coefficient for the multiplicative term between Early Pubertal Timing and the Grade 7 assessment. Models also include covariates for maternal age at menarche, parent education, & family income. All predictors were entered simultaneously and the focal test of the accentuation hypothesis is the Interaction effect and the column of *p*-values for that interaction.