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The effects of pubertal timing on externalizing behaviors in adolescence and early adulthood: A meta-analytic review



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ABSTRACT

Using a meta-analytic approach, this investigation examines the association between early pubertal timing and externalizing behaviors in adolescence and early adulthood. The findings showed that the effect size of early pubertal maturation on externalizing behaviors was $r = 0.180$. This small, yet significant effect size is consistent with the models of early pubertal maturation in that early maturation is associated with higher levels of externalizing behaviors. Using contrast analyses, we examined three potential moderators of this association: sex, the concurrent versus long-term effect of early puberty, and types of puberty assessments. Neither sex nor type of pubertal timing assessment moderated the effect significantly. However, results indicated that the effect was stronger for studies that measured pubertal timing and externalizing behaviors concurrently rather than longitudinally (i.e., examining prospective effect of pubertal timing on later externalizing behaviors). The findings are discussed in terms of implications for future research.

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Early puberty is a risk factor for the development of adolescent psychopathologies, including externalizing behaviors such as classroom disruptions, aggression, delinquency, and social deviancy. Although there have been many literature reviews on this topic (e.g., Ge & Natsuaki, 2009; Graber, 2013; Mendle & Ferrero, 2012; Mendle, Turkheimer, & Emery, 2007; Negri & Susman, 2011; Rudolph, 2014), no meta-analysis has been conducted to date. Meta-analysis on pubertal timing and externalizing behaviors would help further advance the field for the following reasons. First, while there are many studies that do report a positive association between early puberty and externalizing problems, there are also many studies that *do not* find early puberty to predict adolescent externalizing behaviors (e.g., Carter, Caldwell, Matusko, Antonucci, & Jackson, 2011; Obeidallah, Brennan, Brooks-Gunn, & Earls, 2004; Stattin, Kerr, & Skoog, 2011). Therefore, quantification of the pubertal timing effect using a systematic meta-analysis would further the literature by providing a general overview of the statistical associations between early pubertal maturation and externalizing behaviors. Second, quantification of the effect size can inform applied science. It can provide clues to the question of whether targeting early maturing youths is an effective and efficient strategy for interventions and prevention of externalizing behaviors. If the effect of early pubertal maturation is found to be robust in the meta-analysis, it is especially alarming because in the context of secular trend of puberty, the age of pubertal onset has been steadily decreasing in both sexes in the last 25 years (Anderson & Must, 2005; Golub et al., 2008; Sorenson et al., 2012). For these reasons, the overarching aim of this study is to fill this critical gap in the literature by conducting a meta-analytic review to further our understanding of the strength of the associations between timing of

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pubertal maturation and externalizing behavior. We do this by analyzing effect sizes and multiple moderators on more than 36,000 adolescents.

Although previous studies have shown the association between early pubertal maturation and externalizing behaviors, the strength of this link varies greatly among studies (Ge & Natsuaki, 2009; Ge, Natsuaki, Jin, & Biehl, 2011). In this report, we sought to examine whether the following potential moderators contribute to the mixed results in the literature: sex of the adolescent (Graber, Lewinsohn, Seeley, & Brooks-Gunn, 1997; Najman et al., 2009); whether the researchers assessed a concurrent or long-term effect of pubertal timing (Graber et al., 1997); and types of pubertal timing measurement (Brooks-Gunn, Warren, Rosso, & Gargiulo, 1987; Dorn & Biro, 2011; Shirtcliff, Dahl, & Pollak, 2009). Thus, an additional aim of this study is to examine whether these potential moderators alter the effect size of pubertal timing on externalizing behaviors.

Early puberty and externalizing behaviors

It is well documented that adolescents who experience pubertal maturation earlier than their same-age, same-sex peers are more likely to have negative developmental outcomes, including externalizing behaviors and affiliation with deviant peers, especially in adolescence (e.g., Caspi, Lynam, Moffitt, & Silva, 1993; Felson & Haynie, 2002; Ge, Brody, Conger, Simons, & Murry, 2002; Lynne, Graber, Nichols, Brooks-Gunn, & Botvin, 2007; Mensah et al., 2013; Stattin & Magnusson, 1990). For instance, in a longitudinal study with more than 500 young adults, early maturers tended to have significantly higher rates of disruptive behavior disorders (i.e., conduct disorder and oppositional defiant disorder) and antisocial personality traits in early adulthood compared with on-time maturers (Graber, Seeley, Brooks-Gunn, & Lewinsohn, 2004). More recently, Mrug et al. (2014) echo similar results, but add that early pubertal timing, compared to on-time or late pubertal timing, is related to a wide range of externalizing behaviors including delinquency, physical aggression, relational aggression, and nonphysical aggression.

Several hypotheses have been put forth to explain this association between early pubertal maturation and externalizing behaviors (see Ge & Natsuaki, 2009 for a review). One possible explanation is that the hormonal changes associated with puberty increases the risk for developing externalizing problems by heightening an adolescent's novelty-seeking behaviors and other biological systems such as stress reactivity and brain development (Rudolph, 2014). Another hypothesis suggests that the gap between physical and psychological (i.e., cognitive and emotional) maturities places early physical maturers at risk for developing externalizing behaviors. This maturation disparity model asserts that early maturers' externalizing behaviors are reflections of misalignment of their slow-developing neural and cognitive development and their body's fast-paced development, leading to a host of social and emotional demands for which the adolescent is not yet cognitively or emotionally equipped (Ge & Natsuaki, 2009; Moffitt, 1993). Another hypothesis proposes that early puberty places an adolescent into a demanding transition that is novel, uncertain, and ambiguous, which may exacerbate pre-existing vulnerabilities including pre-pubertal behavioral problems (Caspi & Moffitt, 1991; Giletta et al., 2015; Graber, 2013; Hamilton et al., 2014; Rudolph, 2014). Lastly, Ge and Natsuaki (2009) outline the contextual amplification hypothesis, which states that an adverse situation (e.g., family conflict, peer challenges) amplifies the effects of the rapid hormonal and biological changes occurring in an adolescent's body, exacerbating developing psychopathologies.

Despite the theoretical elaboration of the aforementioned mechanisms, the empirical literature has not demonstrated the consistent effects of early pubertal maturation. Some studies report significant effect sizes that are rather small (e.g., $r = 0.09$, Burt, McGue, DeMarte, Krueger, & Iacono, 2006), while other studies have reported larger effects (e.g., $r = 0.55$, Storvoll & Wichstrøm, 2002). Therefore, because of the theoretical implications and the statistical inconsistencies in the literature, it is important to compute the aggregated effect size across studies, and the variation in effect sizes, if any, that needs to be explained.

Moderators of the pubertal timing effect

To explain the potential heterogeneity in effect sizes, we focused on three possible moderators: sex of the adolescent, short- vs. long-term effects of pubertal timing, and assessments of pubertal maturation.

Sex

Sex differences in the effect of pubertal timing is discussed extensively in the domain of internalizing psychopathology; early maturing girls tend to have higher rates of depression, anxiety, and other internalizing symptoms during adolescence and adulthood while the evidence on adolescent boys' internalizing symptoms and pubertal maturation are mixed (Fernandez-Castelao & Kroner-Herwig, 2014; Kaltiala-Heino, Marttunen, Rantanen, & Rimpelä, 2003; Mendle & Ferrero, 2012; Natsuaki, Biehl, & Ge, 2009). Stronger effects of early maturation in female internalizing symptoms are theorized that features of female pubertal development (e.g., curvy body, breast development, menarche) can elicit social and emotional challenges, and the stress associated with these challenges deplete yet-developed early maturing girls' coping and resources to deal with the pressures, which in turn can contribute to depression and anxiety (Natsuaki, Samuels, & Leve, 2014). For males, on the other hand, earlier work suggests that features associated with male puberty such as voice change, facial hair, and growth spurt bring social advantages, such that early maturing boys can enjoy potential dominance, power, and leadership in peer relationships (McCabe & Ricciardelli, 2004; Simmons & Blyth, 1987). However, recent empirical research

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