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Pubertal stage and the prevalence of violence and social relational aggression

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Abstract

Objective—Violence and social relational aggression are global problems that become prominent in early adolescence. This study examines associations between pubertal stage and adolescent violent behavior and social relational aggression.

Methods—This paper draws on cross-sectional data from the International Youth Development Study (IYDS), which comprised two state-wide representative samples of students in grades 5, 7 and 9 ($N = 5,769$) in Washington State in the United States and Victoria, Australia, drawn as a 2-stage cluster sample in each state. The study used carefully matched methods to conduct a school-administered, self-report student survey measuring behavioral outcomes including past year violent behavior (measured as attacking or beating up another person) and social relational aggression (excluding peers from the group, threatening to spread lies or rumors), as well as a comprehensive range of risk and protective factors and pubertal development.

Results—Compared with early puberty, the odds of violent behavior were approximately three-fold higher in mid-puberty (odds ratio [OR]: 2.87; 95% confidence interval [CI]: 1.81,4.55) and late puberty (OR: 3.79; 95% CI: 2.25,6.39), after adjustment for age, gender, state, and state by gender interaction. For social relational aggression, there were weaker overall associations after adjustment but these included an interaction between pubertal stage and age, showing stronger associations with pubertal stage at younger age ($p = .003$; mid-puberty OR 1.78; 95% CI 1.20,2.63; late puberty OR 3.00; 95% CI 1.95,4.63. Associations between pubertal stage and violent behavior and social relational aggression remained (although the magnitude of effects was reduced), after the inclusion of social contextual mediators in the analyses.

Conclusions—Pubertal stage was associated with higher rates of violent behavior and social relational aggression, with the latter association seen only at younger ages. Puberty may be an important phase for interventions aimed at preventing the adolescent rise in violent and antisocial behaviors.

Keywords

puberty; adolescent; juvenile delinquency; aggression

Adolescent aggression has high costs for individuals, and their peers, families, schools and communities.^{1–3} Rates of violence and social relational aggression (e.g., excluding peers from one's group activities) range between 10–20%^{4, 5} and peak in adolescence.^{6–8} There is an extensive literature examining the social contextual and biological influences on violence and antisocial behavior in youth. A potentially important but less studied influence is puberty, and its role in triggering both the biological and social contextual changes of adolescence.

Puberty begins in late childhood through endocrine changes that lead to sexual maturation and reproductive capability.⁹ In humans, puberty coincides with physical growth and brain maturational changes and also with emotional, cognitive and behavioral changes.⁹ In the 1960s, Marshall and Tanner developed a system of reliable staging of the external signs of puberty (e.g., pubic hair).^{10, 11} Pubertal timing is defined by whether pubertal development is early, on time or late compared to peers of the same age. The distinction between pubertal stage and pubertal timing is important as both pubertal stage and timing may have independent effects on risks for the development of behavioral problems in early adolescence.⁹

There are particular reasons to consider associations between puberty and violence and social relational aggression. First, for violent behavior, changes in physical size, particularly for boys, provide opportunities to use physical violence to assert oneself and inflict more damage on others and property than at early stages of development.⁷ Second, links between puberty and antisocial behaviors including violence and social relational aggression appear stronger for boys with antisocial friends, suggesting that advancing pubertal stage produces either a change in peer group and/or greater susceptibility to peer influence.⁹ The growing influence of peer behaviors on risks for substance use and abuse with advancing pubertal stage has been demonstrated.¹² Third, puberty may also be associated with increases in other risk factors for violence and antisocial behavior such as conflict with parents and school disengagement, and individual risk factors such as increased substance use.^{13, 14}

In this paper, we examine associations between pubertal stage and violent behavior and social relational aggression in adolescence, after controlling for key demographic characteristics, individual risk factors, and social contextual mediating factors. We draw on data from the International Youth Development Study (IYDS), comprising two state-wide representative samples of students in grades 5, 7 and 9 ($N = 5,769$) in Washington State in the United States (US) and Victoria, Australia, drawn as a 2-stage cluster sample in each state. Our aims were to ascertain whether

1. pubertal stage is associated with violent behavior and social relational aggression independently of age, gender, and state; and
2. any associations found with pubertal stage can be explained by controlling for social contextual factors.

Method

Participants

A two-stage cluster sampling approach was used for school and student recruitment in 2002. Schools were randomly selected in the first stage and a target classroom within each school

was randomly selected in the second stage. Within each state and grade level, public and private schools containing grades 5, 7, or 9 were randomly selected using a probability proportional to grade-level size sampling procedure.¹⁵ More details about recruitment and participation rates are described in McMorris and colleagues.⁴

Procedure

Protocols were approved by the University of Washington Human Subjects Review Committee and the Royal Children's Hospital Ethics in Human Research Committee in Victoria. To control for seasonal effects, surveys in 2002 were administered in February to June in Washington State and in May to November in Victoria by study staff.⁴ Surveys were group-administered in classrooms during a 50–60 minute period. Students absent from school were administered surveys later under the supervision of trained school personnel or in less than 3% of cases, over the telephone by study staff. Upon survey completion, students in Washington State received \$10. Victorian students received a small pocket calculator upon return of their consent forms.

Measures

The self-reported measures of violent behavior and social relational aggression and risk and protective factors were drawn from the *Communities that Care* survey which has acceptable psychometric properties.^{16–18}

Antisocial behavior

Violent behavior was measured by two items asking how often in the past 12 months students had (1) attacked someone with the idea of seriously hurting them, and (2) beaten up someone so badly that s/he required medical treatment. Response options ranged from *Never* to *40 or more times* on an 8-point scale (Cronbach's alpha, $\alpha = 0.60$). A dichotomous measure was created for violent behavior; violent behavior was present (score of 1) if students reported either behavior one or more times and absent (score of 0) if students responded never to both questions.

Social relational aggression was assessed by two items asking how many times in the past 12 months students had (1) gotten back at another student by not letting them be in their group of friends, and (2) told lies or started rumors about other students to make other friends not like them. The items were rated on an 8-point scale ranging from *Never* to *40 or more times* ($\alpha = 0.62$). A dichotomous measure for interpersonal aggression was also formed. Students engaging in social relational aggression 3 or more times were scored as present (score of 1) and students reporting none to two reports of social relational aggression were scored as absent (0).

Pubertal development

Pubertal stage was assessed with Carskadon and Acebo's self-report version of the Pubertal Development Scale (PDS).^{19–20} Adolescents reported their stage of pubertal development on five indices of pubertal growth. All participants were asked about growth, body hair, and skin changes. Adolescent males were asked about changes to voice and growth of facial hair whilst females were asked about breast development. Response options are: (1) *not yet started*, (2) *barely started*, (3) *definitely started*, and (4) *seems complete*. Following the criteria of Carskadon and Acebo (1993), a 5-level (I to V) categorical scale comparable to Tanner's Sexual Maturation Scale stages was calculated. In previous analyses on the IYDS sample, the majority of students reported pubertal stages between stage II and IV.¹² Hence, pubertal stages reported in this paper were categorized in 3 levels; early (stages I and II), middle (stage III) and late (stages IV and V). In a previous paper using IYDS data, Bond and

colleagues found excellent concordance within one stage between self-reports on Tanner's Sexual Maturation Scale and the PDS (males 89%, females 97%).²¹ There was lower but moderate agreement ($\kappa_{\text{males}} 0.42$, $\kappa_{\text{females}} 0.57$) for individual stage agreement.²¹ The PDS demonstrated Cronbach's alphas of 0.81 for both male and female participants in this study.

Social contextual mediating factors

Poor family management was measured with a 9-item scale, giving scores ranging from 1 (*definitely no*) to 4 (*definitely yes*) ($\alpha = .81$). Items included whether parents would know if the student did not come home on time and the family has clear rules about alcohol and drug use.

Antisocial friends was measured with a 3-item scale assessing how many of the participant's best friends (from 0, *none of my friends* to 4, *four of my friends*) in the past 12 months had been suspended from school, stolen something worth more than US\$5/AUS\$10, and attacked someone with the idea of seriously hurting them ($\alpha = .68$).

School connections were assessed by calculating the mean of 3 scales, reflecting commitment to school (e.g., how interesting most of the school subjects were to the student rated on a 5-point scale; $\alpha = .77$), opportunities for prosocial involvement (e.g., students have lots of chances to help decide things like class activities and rules; $\alpha = .54$), and recognition for prosocial involvement (e.g., teachers notice when the student does a good job and lets him/her know about it; $\alpha = .71$). Response options for both opportunities and recognition for prosocial involvement ranged from 1 (*definitely no*) to 4 (*definitely yes*).

Individual risk factors

Depressive symptoms were measured using the Short Mood and Feelings Questionnaire.²² This 13-item scale correlates moderately with the CDI23 ($r = .67$) and the Diagnostic Interview Schedule for Children (DISC; $r = .65$) depression scale.^{24–26}

Lifetime alcohol use and *lifetime tobacco use* were assessed using self-report items derived from the Monitoring the Future surveys.²⁷ Lifetime alcohol use and tobacco use was defined as *any* use of alcohol and tobacco. Response options ranged from *no, never* (scored 0) to *yes, 3 or more in the past year* (scored 1).

Analysis

Logistic regression models were used to estimate associations (as odds ratios, OR) between dichotomous outcomes and pubertal stage, with adjustment for covariates. All analyses controlled for age, gender, and state. Interaction effects involving age, gender, location and pubertal stage were explored. To test mediating factors, analyses first adjusted for individual risk factors (depressive symptoms and lifetime tobacco and alcohol use) and then focused on exemplars of established social contextual factors within the peer group (antisocial friends), family (poor family management), and school (connection) where there is evidence of change with pubertal stage.²⁸ All prevalence estimates and measures of association used robust “information-sandwich” estimates of SEs, with adjustment for clustering within schools. Data analysis was performed with the Stata (Release 10.0) program.²⁹

Results

Study Sample

Each age cohort in the sample comprised the following in each state (Victoria = VIC, Washington State = WA): for Grade 5 $n_{\text{VIC}} = 927$, $n_{\text{WA}} = 943$; for Grade 7 $n_{\text{VIC}} = 984$, n_{WA}

= 961; and for Grade 9 $n_{VIC} = 973$, $n_{WA} = 981$. In each state, the Grade 5 cohort was comprised almost entirely of 10- and 11-year-olds, the Grade 7 cohort of 12- and 13-year-olds, and the Grade 9 cohort of 14- and 15-year-olds, and males and females were equally represented. The mean age of the Washington State males was 12.7 years ($SD = 1.7$) and 12.6 years ($SD = 1.7$) for females. In the Victorian sample, the mean age for males was 12.5 years ($SD = 1.7$) and 12.4 years ($SD = 1.7$) for females.

Table 1 shows the distribution of pubertal stages in the sample. In both Washington State and Victoria, the majority of males reported pubertal stages between I/II and III; 24% and 20% were at stage IV/V in Washington State and Victoria, respectively. Females reported later pubertal stages with the majority in stage IV/V, although females in Washington State reported later pubertal stages than Victorian females.

Violent behavior was more prevalent in Victorian males compared to Victorian females ($p < .001$) but there was a substantially smaller gender difference amongst Washington State students ($p = .033$). In Victoria, more males than females engaged in social relational aggression ($p = .026$), but this gender difference was not seen in the Washington State sample.

Association of Pubertal Stage with Violent Behavior and Social Relational Aggression

Unadjusted logistic regression models showed that the odds of both violent behavior and social relational aggression were elevated in pubertal stages III and IV/V (Table 2). Multivariable logistic regression models were fitted to examine whether these associations remained after adjusting for age, gender, and state. The model for violent behavior included an interaction between gender and state, consistent with the patterns seen in Table 1. For this outcome, there was no evidence for an interaction between pubertal stage and age (Wald chi-square $p = 0.6$, 2df). After adjustment, compared with early puberty, the odds of violent behavior were approximately two-and-a-half-fold higher in mid-puberty and late puberty.

An interaction was found between pubertal stage and age in the model for social relational aggression (Wald chi-square $p = 0.005$, 1df), indicating that the odds of social relational aggression increased with age for students in pubertal stages I/II but not for those in stages IV/V. An alternative interpretation of these results is obtained by deriving estimated ORs comparing pubertal stages at different ages. For example, the model implies that the OR for stage III vs stages I/II at age 10 was 2.5 (95% CI 1.2, 5.2) while by age 13 this reduced to 1.3 (95% CI 0.8, 2.1). Comparison with stages IV/V does not make sense until at least age 12, when some children reach these advanced stages. The estimated OR comparing stage IV/V with stages III at age 12 was 1.4 (95% CI 0.96, 2.0), reducing to 0.77 (95% CI 0.53, 1.1) by age 15.

Testing of Social Mediators

Logistic regression was used to investigate whether social contextual factors mediate the association between pubertal stage and antisocial behavior outcomes (Table 3 and Table 4).

Poor family management, school connection and antisocial friends had robust independent associations with violent behavior. However, only the inclusion of antisocial friends substantially decreased the association of pubertal stage with violent behavior, with poor family management having a smaller effect. After adjustment for all potential mediators, the association with violent aggression was considerably diminished.

The addition of individual risk factors and social mediators had only a small impact on the age-related puberty effects outlined in Table 2.

Discussion

Pubertal stage was associated with both adolescent violence and social relational aggression. After considering possible confounders including gender and state, the odds of violence in mid- and late-puberty were around three times higher than in early puberty. Importantly, the pubertally associated increase in risk of violent behavior occurs independently of increases in age. There was a more complex pattern of association for social relational aggression. Overall, there were weaker associations with pubertal stage after adjustment but these included an interaction between pubertal stage and age, showing stronger associations with pubertal stage at younger ages. This suggests that the adolescent increase in social relational aggression is related to the timing of puberty; differences in pubertal stage are more salient with respect to social relational aggression at younger ages than they are at older ages. Further adjustment for individual risk factors and the inclusion of social mediating factors such as antisocial friends reduced the association between pubertal stage and violent behavior. On the other hand, the association between pubertal stage and social relational aggression generally persisted even after the inclusion of social mediating factors, although antisocial peers reduced the magnitude of the association. The effects appeared to be consistent across the two socially distinct contexts of the north-western US and southeastern Australia.

The findings in this study are consistent with those of previous research showing links between pubertal stage and a range of adolescent risk behaviors including antisocial behavior.⁹ However, existing literature has been limited by small and non-representative sample sizes, not adjusting analyses for individual level risk factors, and the inclusion of a limited range of social contextual factors making comparisons between studies difficult.^{30–32} A unique aspect of this study was the inclusion of a large, state-wide representative sample from two states, adjustment for individual risk factors, and the inclusion of modifiable social contextual factors. Further, compared to other studies that have included general measures of antisocial behavior, this study measured violence and social relational aggression, enabling a better understanding of how puberty affects these specific adolescent antisocial behaviors.

The large sample size and coverage of an age range relevant to puberty allowed the examination of the separate and joint effects of age and pubertal stage, in effect testing for effects related to pubertal timing. Further, this study used rigorous design and standardized procedures for participant recruitment, survey development and administration, and data management to overcome the common methodological limitations of many previous cross-national comparisons.^{4, 33} It is one of only a few quality studies of community samples of adolescents and has rich data on social contextual factors.

Some study limitations should be noted. First, pubertal measures were based on self-report, rather than direct observation, to minimize intrusion. Validation studies of the PDS support the use of this self-report measure in large epidemiological studies where the use of pictorial measures may be considered inappropriate and increase rates of missing data.^{21, 34} A further limitation is given the age range of participants, there were relatively fewer males in pubertal stages IV/V and this may have influenced the results. However, the associations were sufficiently strong to be detected despite this limitation. Third, cross-sectional data have been analyzed in this paper, limiting interpretations about causal processes. Longitudinal analyses of the associations between pubertal stage and violent behavior and social relational aggression are crucial in progressing understanding in this area. In

particular, longitudinal analyses will enable a more direct examination of the possible mediating factors of the association between pubertal stage and violent behavior and social relational aggression. Further, statistical adjustment of the analyses may not remove all of the contributing influence of the confounders. Finally, the measures of violent behavior and social relational aggression are relatively brief, although they include the core components of these constructs.

The patterns of association between pubertal stage and violence differ from those of pubertal stage and social relational aggression. For violence, the association with pubertal stage was reduced after the inclusion of social mediators including antisocial friends and poor family management. In contrast, for social relational aggression, the inclusion of social mediators yielded smaller reductions in associations with pubertal stage. Antisocial friends and poor family management have consistently been associated with adolescent violent behavior, emphasizing the importance of prevention approaches targeting these social contexts. For social relational aggression there may be other social contextual mediators not measured in this study that require further research. Sex hormones may also have an important role in the development of violence during puberty and although it was beyond the scope of this study, further research in this area is warranted.³⁵

Conclusion

Pubertal change brought substantially higher rates of both violence and social relational aggression that were independent of age, substance use and emotional well-being. The association between violence and pubertal stage was to a large extent explained by antisocial friends and poor family management suggesting both these areas as potential targets for preventive intervention at this developmental stage. Although antisocial friends had some effect on the pubertal association between social relational aggression and pubertal stage, this relationship could only in small part be explained by the mediators examined in this study.

ABBREVIATIONS

IYDS	International Youth Development Study
OR	odds ratio
CI	confidence interval
α	Cronbach's alpha
PDS	Pubertal Development Scale
CDI	Children's Depression Inventory
DISC	Diagnostic Interview Schedule for Children
SE	standard error
VIC	Victoria
WA	Washington State
df	degrees of freedom
US	United States
NHMRC	National Health and Medical Research Council

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Table 1

Prevalence of the study outcomes (violent behavior and social relational aggression) and pubertal classification of secondary students in Victoria, Australia and Washington State, United States

	Washington State (%)		Victoria (%)	
	Male	Female	Male	Female
<i>Pubertal stage</i>				
I/II (Early)	35.2	11.3	34.5	13.3
III (Middle)	41.4	26.6	45.3	32.7
IV/V (Late)	23.5	62.1	20.1	54.0
	<i>n</i> = 1138	<i>n</i> = 1160	<i>n</i> = 1132	<i>n</i> = 1180
<i>Violent behavior</i>				
Not in the past year	93.5	95.5	89.2	96.8
≥ 1 time in the past year	6.5	4.5	10.8	3.2
	<i>n</i> = 1138	<i>n</i> = 1160	<i>n</i> = 1132	<i>n</i> = 1180
<i>Social relational aggression</i>				
Not in the past year/1–2 times in year	93.0	92.9	90.0	92.6
≥ 3 times in the past year	7.0	7.1	10.0	7.4
	<i>n</i> = 1138	<i>n</i> = 1160	<i>n</i> = 1132	<i>n</i> = 1180

Table 2

Association between pubertal stage and the antisocial behavior outcomes for students in Victoria, Australia and Washington State, United States, controlling for age, state and gender

<i>Violent behavior (N = 4,610)</i>		
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Pubertal stage		
I/II (Early)	1.00	1.00
III (Middle)	2.98 (1.93,4.62)	2.87 (1.81,4.55)
IV/V (Late)	2.94 (1.89,4.56)	3.79 (2.25,6.39)
Age (per year)		1.10 (0.99,1.21)
Female gender vs male ¹		
Victoria		0.21 (0.14,0.32)
Washington State		0.51 (0.35,0.74)
Washington State vs Victoria (males)		0.56 (0.41,0.77)
Washington State vs Victoria (females)		1.36 (0.85,2.19)
<i>Relational aggression (N = 4,610)</i>		
Pubertal stage		
I/II (Early)	1.00	1.00
III (Middle)	2.56 (1.76,3.73)	1.78 (1.20,2.63) ²
IV/V (Late)	3.65 (2.54,5.24)	3.00 (1.95,4.63) ²
Age (per year)		
Pubertal stage I/II		1.70 (1.30,2.22)
Pubertal stage III		1.38 (1.23,1.55)
Pubertal stage IV/V		1.11 (0.99,1.24)
Female gender vs male		0.73 (0.56,0.94)
Washington State vs Victoria		0.78 (0.62,0.98)

¹ Interaction effect gender by state, $p = .001$

² Odds ratios at age 12 (interaction effect pubertal stage by age, $p = .003$)

Table 3

Association (as odds ratios) between violent behavior and pubertal stage in 4,610 secondary school students Washington State and Victoria, after the inclusion of individual level risk factors and possible mediating variables from the social context.

	Adjusted analysis				
	Multivariable models incorporating social mediators				
	Individual risk factors	Poor family management	School connection	Antisocial friends	Full model
Pubertal stage					
I/II (Early)	1.00	1.00	1.00	1.00	1.00
III (Middle)	2.38 (1.51,3.76)	2.27 (1.43,3.60)	2.39 (1.51,3.80)	2.07 (1.26,3.40)	1.86 (1.13,3.04)
IV/V (Late)	2.56 (1.50,4.37)	2.29 (1.33,3.95)	2.54 (1.49,4.33)	1.95 (1.09,3.49)	1.60 (0.89,2.87)
Individual risk factors					
Depressive symptoms	3.09 (2.40,3.97)	2.68 (2.07,3.49)	2.53 (1.95,3.29)	2.32 (1.75,3.08)	1.88 (1.39,2.53)
Lifetime tobacco use	2.64 (2.00,3.48)	2.26 (1.71,3.00)	1.47 (1.87,3.26)	1.63 (1.19,2.22)	1.35 (0.97,1.89)
Lifetime alcohol use	2.10 (1.48,2.98)	1.88 (1.32,2.68)	1.99 (1.40,2.82)	1.69 (1.18,2.42)	1.33 (0.91,1.95)
Social mediators					
Poor family management		2.32 (1.74,3.10)			1.41 (1.01,1.97)
School connection			0.43 (0.31,0.61)		1.01 (0.69,1.49)
Antisocial friends				2.77 (2.41,3.19)	2.54 (2.19,2.95)

Note.

All analyses in this table control for gender, state and state by gender interaction.

Association (as odds ratios) between social relational aggression and pubertal stage in 4,610 secondary school students Washington State and Victoria, after the inclusion of individual level risk factors and possible mediating variables from the social context.

Table 4

	Adjusted analyses				
	Multivariate models incorporating social mediators				
	Individual risk factors	Poor family management	School connection	Antisocial friends	Full model
Pubertal stage					
I/II (Early)	1.00	1.00	1.00	1.00	1.00
III (Middle)	1.60 (1.08,2.38) [/]	1.58 (1.06,2.35) [/]	1.60 (1.07,2.38) [/]	1.50 (1.00,2.24) [/]	1.49 (1.00,2.23) [/]
IV/V (Late)	2.25 (1.42,3.55) [/]	2.18 (1.38,3.44) [/]	2.24 (1.41,3.54) [/]	1.98 (1.25,3.16) [/]	1.97 (1.24,3.13) [/]
Age (per year)					
Pubertal stage I/II	1.60 (1.21,2.11)	1.57 (1.19,2.07)	1.59 (1.20,2.10)	1.59 (1.20,2.11)	1.60 (1.21,2.11)
Pubertal stage III	1.28 (1.14,1.44)	1.26 (1.12,1.42)	1.27 (1.13,1.44)	1.28 (1.13,1.44)	1.28 (1.13,1.45)
Pubertal stage IV/V	1.05 (0.93,1.19)	1.04 (0.92,1.18)	1.05 (0.92,1.18)	1.05 (0.93,1.19)	1.05 (0.93,1.20)
Individual risk factors					
Depressive symptoms	2.08 (1.63,2.67)	2.00 (1.56,2.56)	2.03 (1.57,2.61)	1.80 (1.39,2.33)	1.84 (1.41,2.40)
Lifetime tobacco use	1.84 (1.42,2.38)	1.76 (1.35,2.29)	1.82 (1.40,2.36)	1.45 (1.11,1.91)	1.45 (1.10,1.91)
Lifetime alcohol use	1.49 (1.10,2.00)	1.43 (1.06,1.94)	1.47 (1.09,2.00)	1.35 (1.00,1.83)	1.35 (0.99,1.84)
Social mediators					
Poor family management		1.27 (1.01,1.60)			1.11 (0.87,1.40)
School connection			0.89 (0.65,1.20)		1.19 (0.86,1.65)
Antisocial friends				1.63 (1.44,1.84)	1.64 (1.44,1.86)
p value for interaction effect pubertal stage by age	.005	.005	.005	.006	.005

Note.

All analyses in this table control gender and state.

[/] Odds ratios at age 12