

Letter to the Editor

**Gender Differences in the Relationships between Pubertal Stages and the Perpetration of Self-inflicted and Interpersonal Violence among Middle School Students in China***SU Pu Yu^{1,2,3,&#}, WANG Geng Fu^{1,&}, REN Hao Yang^{4,&}, CHEN Li Ru¹, ZHANG Guo Bao¹, and SUN Ying^{1,2,3}

Self-inflicted and interpersonal violence are the two main types of adolescent violence. Individuals involved in self-inflicted violence both cause and receive the harm, while those who engage in interpersonal violence often aim to harm others. Self-harm and suicide are common types of self-inflicted violence. Non-fatal violence, such as aggression, bullying, and physical fighting, are common forms of interpersonal violence between adolescents^[1].

Puberty is a crucial stage of human development in which individuals reach sexual maturity and experience great psychosocial transformations^[2]. The effects of puberty on health are profound and paradoxical. On the one hand, puberty is fundamental to one's future health. On the other hand, health problems can occur that are related to puberty development, such as behavioral and mental health problems, e.g., aggression and depression^[2].

Prevalence rates of suicide, self-harm, and interpersonal violence are at their peak in adolescence^[3]. Previous studies have indicated that self-harm and interpersonal violence in adolescents are a reflection of developmental changes that occur at puberty^[3]. Furthermore, hormonal changes and maturation in the structure and function of brain systems during that time are associated with violent behaviors among adolescents^[4,5]. However, most studies on the topic have only included either self-inflicted or interpersonal violence. Few studies have examined the relationship between the pubertal stage and both self-inflicted and interpersonal

violence. Both self-harm and suicide are sub-types of self-inflicted violence and have many similarities. Similarly, the different sub-types of interpersonal violence have some features in common, such as risk factors^[1]. However, the properties of self-inflicted and interpersonal violence can vary greatly. Self-inflicted violence is often considered a type of internalized violence, whereas interpersonal violence is externalized, which raises the question of whether violence is on a continuum (if you engage in one form of violence you are likely to engage in another) or if some youth fall into different categories (self-inflicted only, other-directed only, or both). Thus, we aimed to classify the different categories based on the target of violence to better understand the problem of adolescent violence. Previous findings have suggested there might be gender differences with regard to violence^[3]. Additionally, hormonal, brain structure, and brain function changes during puberty differ between males and females^[4,5], providing biological clues for gender differences in adolescence violence.

Thus, this study we aim to explore the relationships between puberty and violence in the genders so as to learn whether those gender differences exist.

This study was part of the 'Adolescent Health and Risk Behaviors Survey in Anhui Province' research project. The detailed information has been described in our previous study^[6]. High school students are beyond the age at which puberty is usually complete^[7]. Therefore, only middle school students were invited to participate. The study was

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The self-reported puberty development scale was used to assess pubertal development, which is composed of five elements: onset and age at menarche, breast development in girls, changes to voice and facial hair growth in boys, body hair growth, growth spurt and skin changes^[8]. Each element is measured on a four-point scale as follows: 1) not yet started, 2) barely started, 3) definitely started, 4) seems complete. Menarche was coded as a dichotomous variable, with either No (0 points) or Yes (1 point). According to the criteria of Carskadon and Acebo^[8], a 5-level (I-V) categorical scale comparable to Tanner's sexual maturation scale stages was calculated.

We chose non-suicidal self-harm and suicide attempts to measure adolescent self-inflicted violence. The questions assessing self-inflicted violence were as follows: (a) Have you ever harmed yourself in a way that was deliberate but not intended as a means by which to take your life? These might include hitting, hair-pulling, head-banging, pinching, biting, cutting, overdosing, and ingesting non-ingestible substances^[9]; (b) Have you attempted suicide in the past six months? Attempted suicide is defined as having carried out suicidal behaviors but surviving, either by being saved by others or by having the fatal actions fail. Attempted suicide refers to intentionally self-inflicted poisoning, injury, or self-harm with a fatal intent^[10]. Self-inflicted violence was measured based on a positive response to either question.

Based on previous studies^[1], three items were developed to measure interpersonal violence perpetration (i.e. physical violence, verbal violence, and sexual violence), based on our social context. The three specific items were as follows: 1) Have you harmed someone by hitting, kicking, pushing, or smashing them in the past 6 months? 2) Have you harmed someone by scolding, insulting, cursing, or threatening them in the past 6 months? 3) Have you ever harmed someone in a sexual way, e.g., kissed someone, touched someone sexually, or had intercourse with someone without their consent? For this study, the interpersonal violence measure was dichotomized as one or more items versus none. The participants in this study were then categorized into four groups: 1) engaged in self-inflicted violence only (SV), 2) engaged in interpersonal violence only (IV), 3) engaged in both self-inflicted and interpersonal violence (SV + IV), or 4) not engaged in either form of violence (None).

Depression is correlated with self-inflicted violence and is also known to induce self-injury and suicide^[10]. Thus, we decided to include this variable in our analysis. Zung's Self-rating Depression Scale (SDS) was adopted in this study to evaluate depression. Childhood abuse has been confirmed as a risk factor for adolescent self-inflicted violence and interpersonal violence perpetration. We also investigated childhood maltreatment in this study. The items assessing childhood physical abuse, emotional abuse, sexual abuse, physical neglect, and emotional neglect were based on the Childhood Trauma Questionnaire (CTQ) short form questions. Detailed information about SDS and CTQ-SF was described in our previous study^[6].

Age was calculated from the birth date to the survey date and was used in the bivariate analyses, classified into years (12, 13, 14), and in the logistic analyses as a continuous variable. We also controlled for the potential influence of several sociodemographic variables on violent behaviors: relationships with both parents (good vs. bad), family structure (nuclear family, single-parent family, large family, and others), family economic status (good, medium, or bad), the education of both parents (low, medium, or high), and number of friends (< 3 and ≥ 3).

Before this study, the questionnaire used was retaken at one-week intervals with 156 junior and senior students to test its reliability and validity. The Kappa values ranged from 0.80 to 0.94. The Cronbach's alpha coefficients ranged from 0.72 to 0.88.

Analyses were performed using SPSS version 23.0. Chi-squared tests were conducted comparing pubertal stage and involvement in violence. Effect sizes of chi-square test were assessed by Cramer's ϕ coefficient. Three multivariable logistic regression models were employed to explore the relationship between pubertal stage and violence perpetration in both male and female students. In each of the three models, pubertal stage (early stage was used as the reference) was coded as the predictor, and the violence perpetration (without violence was used as reference) was coded as the outcome variable. After calculating the age-adjusted odds ratio (aOR) in Model 1, we adjusted for age and sociodemographic variables in Model 2. In Model 3, we adjusted for age, sociodemographic variables, depression, and childhood maltreatment. $P < 0.05$ were considered statistically significant.

We excluded 54 students, because they were older than age 15.0, at which stage puberty is usually

complete. In this study, the majority of Grade 7 participants were 12 and 13 years old, the Grade 8 participants were 13 and 14 years old, and the Grade 9 group was 14 and 15 years old. The mean age of the boys and girls was 13.46 ± 0.90 years and 13.43 ± 0.93 years, respectively.

In this sample, most participants were found to be in pubertal stages II, III, and IV. Therefore, the pubertal stages reported in this article were classified into three levels: early (Stages I and II), middle (Stage III), and late (Stages IV and V). As shown in Table 1, the majority of participants reported pubertal stages between III (middle, 31.8%) and IV/V (late, 49.2%). Overall, 43.8% of the total students reported being involved in violence during the past 6 months, with 8.7% of them reporting self-inflicted violence only, 23.8% admitting to interpersonal violence only, and 11.3% admitting to both types of violence (Table 1). In both males and females, puberty stage was associated with the perpetration in self-inflicted and interpersonal violence (Table 2). Relationships with both parents; being an only child; number of friends; physical, emotional, and/or sexual abuse; physical and/or emotional neglect; and depression were associated with the perpetration of self-inflicted and interpersonal violence ($P < 0.05$, Supplementary Table S1 available in www.besjournal.com).

Table 1. Basic sample characteristics

Variables	N (%)	Mean \pm SD
Sex		
Male	1,410 (52.1)	
Female	1,294 (47.9)	
Relationship with mother		
Good	2,036 (75.3)	
Bad	668 (24.7)	
Relationship with father		
Good	1,792 (66.3)	
Bad	912 (33.7)	
Only child		
Yes	1,378 (51.0)	
No	1,326 (49.0)	
Family structure		
Nuclear family	11,780 (65.8)	
Single-parent family	2,245 (9.1)	
Large family	61,613 (22.7)	
Others	6,666 (2.4)	

		Continued
Variables	N (%)	Mean \pm SD
Family economic status		
Good	378,378 (14.0)	
Medium	2,124 (78.5)	
Bad	202 (7.5)	
Mother education		
High	457 (16.9)	
Medium	1,330 (49.2)	
Low	917 (3.9)	
Father education		
High	866 (32.0)	
Medium	1,486 (55.0)	
Low	352 (13.0)	
Number of friends		
< 3	676 (25.0)	
≥ 3	2,028 (75.0)	
Physical abuse		5.63 \pm 1.80
Emotional abuse		6.26 \pm 2.31
Sexual abuse		5.26 \pm 1.31
Physical neglect		5.42 \pm 1.48
Emotional neglect		5.54 \pm 1.84
Total SDS scores		42.11 \pm 7.60
Puberty stage		
I/II (early)	514 (19.0)	
III (middle)	861 (31.8)	
IV/V (late)	1,329 (49.2)	
Violence		
None	1,520 (56.2)	
SV	235 (8.7)	
IV	644 (23.8)	
SV + IV	305 (11.3)	

Note. SV, self-inflicted violence only; IV, interpersonal violence only; SV + IV, both self-inflicted and interpersonal violence; None, not engaged in any violence at all.

Table 3 Displays the aORs for violence when age (Model 1); age and sociodemographic factors (Model 2); and age, the above-described sociodemographic factors, depression and childhood abuse, and neglect (Model 3) are controlled for. In Model 1, a comparison between boys in the initial puberty Stages I/II and the advanced Stages III and IV/V is made. Boys in the advanced stages were more likely

to report being involved in interpersonal violence perpetration ($aOR = 1.53$, 95% CI : 1.10–2.13 and $aOR = 1.79$, 95% CI : 1.23–2.60, respectively), whereas girls in the advanced stages were more often involved in self-inflicted violence ($aOR = 1.81$, 95% CI : 1.01–3.28 and $aOR = 1.84$, 95% CI : 1.03–3.31, respectively). Both boys and girls in the advanced stages were more likely to be involved in self-inflicted and interpersonal violence perpetration compared with those in Stages I/II ($aOR = 1.62$, 95% CI : 1.03–2.68 and $aOR = 3.05$, 95% CI : 1.76–5.28, respectively, in males and $aOR = 3.84$, 95% CI : 1.63–9.04; $aOR = 4.68$, 95% CI : 2.05–10.66, respectively, in females). After controlling for age, sociodemographic factors, depression, and childhood maltreatment in Models 2 and 3, the association between puberty and violence remained significant (Table 3). Our findings are consistent with previous studies, which have supported a link between puberty and violence^[3]. They show that puberty is a special period that correlates with adolescent violence, providing another perspective to better understand both ends of that equation.

In this study, gender differences were observed between boys and girls with regard to their engagement in violence. There are two key reasons for the differences. First, the biological differences between adolescent girls and boys may be the cause for this discrepancy. Males and females show differences in brain structure, organization, and hormonal perfusion during the course of development^[4]. Testosterone has been associated with aggression in men, as it activates the subcortical areas of the brain that generate the trait^[5]. These discrepancies might work synergistically, granting girls higher levels of impulse control than boys.

Hence, we deduced that adolescent males were likely to become involved in interpersonal violence.

Another reason for the discrepancy is cultural and social influences. In China, people share a common confucian culture, which is a type of collectivism that emphasizes social and work group goals above individual needs and desires. More value is placed on males than on females, in that males are asked to assume more social responsibilities, while females are asked to undertake more family tasks. Males are often asked to be more masculine, while females are expected to be more introverted. Family education and childrearing patterns are, to a large extent, influenced by traditional cultures, and parents often impose their own values on their children. Those factors are likely to function through a complex path to make girls susceptible to self-inflicted violence and boys to interpersonal violence perpetration. However, these findings are best regarded as preliminary data that flag issues for future research.

The restrictions and limitations of this study must be noted. First, due to the properties of a cross-sectional study, the ability to establish a causal relationship between pubertal stages and violence is limited. Only three middle schools were included in the study; therefore, the conclusions cannot be generalized to all adolescent students in China. Moreover, we used a crude measure to assess both self-inflicted and interpersonal violence perpetration. In future studies, more detailed measures should be adopted when exploring the association between pubertal stages and violence. Second, the number of participants in the SV- and IV-only groups was small, which limited the generalizability of the results. Future research should

Table 2. Prevalence of violence according to gender and puberty

Variables	N	None [N (%)]	SV [N (%)]	IV [N (%)]	SV + IV [N (%)]	P value	Cramer's ϕ
Male						0.002	0.085
I/II (early)	304	175 (57.6)	11 (3.6)	91 (29.9)	27 (8.9)		
III (middle)	550	267 (48.5)	27 (4.9)	197 (35.8)	59 (10.7)		
IV/V (late)	556	244 (43.9)	28 (5.0)	195 (35.1)	89 (16.0)		
Female						0.001	0.009
I/II (early)	210	161 (76.7)	17 (8.1)	25 (11.9)	7 (3.3)		
III (middle)	311	205 (65.9)	44 (14.1)	29 (9.3)	33 (10.6)		
IV/V (late)	773	468 (60.5)	108 (14.0)	107 (13.8)	90 (11.6)		

Note. SV, self-inflicted violence only; IV, interpersonal violence only; SV + IV, both self-inflicted and interpersonal violence; None, not engaged in any violence at all.

use a larger sample size. Third, more potential risk factors, such as anxiety, should be included when examining the association between puberty and violence.

Puberty stage was associated with adolescent violence, and both were influenced by gender. This study found that puberty is a special period for students who are susceptible to violence perpetration and a key phase for implementing prevention programs to reduce those behaviors. Future studies are warranted to better understand

the relationships between puberty, adolescent violence, and gender.

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Table 3. Multivariable logistic regressions for violence according to puberty among girls and boys

Puberty stage	Model 1 [aOR (95% CI)]	Model 2 [aOR (95% CI)]	Model 3 [aOR (95% CI)]
SV			
Boys			
I/II (early)	1 ref.	1 ref.	1 ref.
III (middle)	1.87 (0.88, 3.99)	1.85 (0.87, 3.94)	2.00 (0.93, 4.33)
IV/V (late)	2.50 (1.09, 5.77)	2.51 (1.07, 5.86)	2.80 (1.19, 6.60)
Girls			
I/II (early)	1 ref.	1 ref.	1 ref.
III (middle)	1.81 (1.01, 3.28)	1.86 (1.01, 3.46)	1.81 (1.01, 3.40)
IV/V (late)	1.84 (1.03, 3.31)	1.85 (1.03, 3.32)	1.88 (1.03, 3.43)
IV			
Boys			
I/II (early)	1 ref.	1 ref.	1 ref.
III (middle)	1.53 (1.10, 2.13)	1.51 (1.09, 2.11)	1.53 (1.09, 2.15)
IV/V (late)	1.79 (1.23, 2.60)	1.70 (1.17, 5.86)	1.68 (1.14, 2.48)
Girls			
I/II (early)	1 ref.	1 ref.	1 ref.
III (middle)	0.94 (0.52, 1.69)	0.96 (0.53, 1.74)	0.95 (0.52, 1.74)
IV/V (late)	1.54 (0.92, 2.58)	1.55 (0.92, 2.61)	1.62 (0.95, 2.76)
SV + IV			
Boys			
I/II (early)	1 ref.	1 ref.	1 ref.
III (middle)	1.62 (1.03, 2.68)	1.64 (1.05, 2.73)	4.00 (2.22, 7.24)
IV/V (late)	3.05 (1.76, 5.28)	3.47 (1.92, 6.27)	1.95 (1.13, 3.36)
Girls			
I/II (early)	1 ref.	1 ref.	1 ref.
III (middle)	3.84 (1.63, 9.04)	3.99 (1.69, 9.43)	3.89 (1.62, 9.38)
IV/V (late)	4.68 (2.05, 10.66)	4.71 (2.06, 10.75)	4.59 (1.97, 10.73)

Note. Significant ($P < 0.05$) factors are in bold. Model 1: Adjusted for age. Model 2: Adjusted for age, relationship with both parents, only child, and number of friends. Model 3 added depression, childhood maltreatment for adjusting based on Model 2. SV, self-inflicted violence only; IV, interpersonal violence only; SV + IV, both self-inflicted and interpersonal violence; aOR, adjusted odds ratio.

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REFERENCES

1. Duke NN, Borowsky IW. Adolescent interpersonal violence: implications for health care professionals. *Prim Care*, 2014; 41, 671–89.
2. Sawyer SM, Afifi RA, Bearinger LH, et al. Adolescence: a foundation for future health. *Lancet*, 2012; 379, 1630–40.
3. Hemphill SA, Kotevski A, Herrenkohl TI, et al. Pubertal stage and the prevalence of violence and social/relational aggression. *Pediatrics*, 2010; 126, e298–305.
4. Kaczkurkin AN, Raznahan A, Satterthwaite TD. Sex differences in the developing brain: insights from multimodal neuroimaging. *Neuropsychopharmacology*, 2019; 44, 71–85.
5. Geniole SN, Bird BM, McVittie JS, et al. Is testosterone linked to human aggression? A meta-analytic examination of the relationship between baseline, dynamic, and manipulated testosterone on human aggression. *Horm Behav*, 2019; 104644.
6. Wang GF, Han AZ, Zhang GB, et al. The association between childhood physical disability or long-term health problems and depression among adolescents in China: mediating effect of childhood maltreatment. *Asian J Psychiatr*, 2019; 46, 105–10.
7. Sun Y, Tao FB, Su PY, et al. National estimates of the pubertal milestones among urban and rural Chinese girls. *J Adolesc Health*, 2012; 51, 279–84.
8. Carskadon MA, Acebo C. A self-administered rating scale for pubertal development. *J Adolesc Health*, 1993; 14, 190–5.
9. Gao Q, Fan H, Di F, et al. Suicide behaviors in adult in patients with mental disorders in Beijing, China. *Int J Environ Res Public Health*, 2017; 14, E259.
10. Wan YH, Chen J, Sun Y, et al. Impact of childhood abuse on the risk of non-suicidal self-injury in mainland Chinese adolescents. *PLoS One*, 2015; 10, e0131239.

Supplementary Table S1. Socio-demographic characteristics, depression, childhood abuse and neglect, and the perpetration of self-inflicted and interpersonal violence

Variables	N/Mean \pm SD	None [N (%)]	SV [N (%)]	IV [N (%)]	SV + IV [N (%)]	P value
Relationship with mother						< 0.001
Good	2,036	1,270 (62.4)	187 (9.2)	409 (20.1)	170 (8.3)	
Bad	668	319 (47.8)	86 (12.9)	166 (24.9)	97 (14.5)	
Relationship with father						< 0.001
Good	1,792	1,130 (63.1)	153 (8.5)	354 (19.8)	155 (8.6)	
Bad	912	459 (50.3)	120 (13.2)	221 (24.2)	112 (12.3)	
Only child						< 0.001
Yes	1,378	805 (58.4)	106 (7.7)	331 (24.0)	136 (9.9)	
No	1,326	784 (59.1)	167 (12.6)	244 (18.4)	131 (9.9)	
Family structure						0.088
Nuclear family	1780	1,055 (59.3)	171 (9.6)	387 (21.7)	167 (9.4)	
Single-parent family	245	135 (55.1)	30 (12.2)	60 (24.5)	20 (8.2)	
Large family	613	367 (59.9)	62 (10.1)	116 (18.9)	68 (11.1)	
Others	66	32 (48.5)	10 (15.2)	12 (18.2)	12 (18.2)	
Family economic status						0.104
Good	378	210 (55.6)	41 (10.8)	93 (24.6)	34 (9.0)	
Medium	2,124	1,260 (59.3)	203 (9.6)	450 (21.2)	211 (9.9)	
Bad	202	119 (58.9)	29 (14.4)	32 (15.8)	22 (10.9)	
Mother education						0.944
High	457	270 (59.1)	43 (9.4)	94 (20.6)	50 (10.9)	
Medium	1,330	778 (58.5)	132 (9.9)	291 (21.9)	129 (9.7)	
Low	917	541 (59.0)	98 (10.7)	190 (20.7)	88 (9.6)	
Father education						0.140
High	866	525 (60.6)	76 (8.8)	179 (20.7)	86 (9.9)	
Medium	1,486	862 (58.0)	152 (10.2)	333 (22.4)	139 (9.4)	
Low	352	202 (57.4)	45 (12.8)	63 (17.9)	42 (11.9)	
Number of friends						0.011
< 3	676	375 (55.5)	83 (12.3)	136 (20.1)	82 (12.1)	
≥ 3	2,028	1,214 (59.9)	190 (9.4)	439 (21.6)	185 (9.1)	
Physical abuse	5.63 \pm 1.80	5.38 \pm 1.21	5.92 \pm 1.99	5.72 \pm 2.15	6.59 \pm 2.98	< 0.001
Emotional abuse	6.26 \pm 2.31	5.94 \pm 1.97	7.16 \pm 2.76	6.13 \pm 2.05	7.54 \pm 3.32	< 0.001
Sexual abuse	5.26 \pm 1.31	5.16 \pm 1.10	5.26 \pm 1.17	5.32 \pm 1.50	5.67 \pm 1.96	< 0.001
Physical neglect	5.42 \pm 1.48	5.26 \pm 1.17	5.57 \pm 1.47	5.51 \pm 1.78	6.02 \pm 2.16	< 0.001
Emotional neglect	5.54 \pm 1.84	5.35 \pm 1.47	5.99 \pm 2.25	5.56 \pm 1.82	6.18 \pm 2.92	< 0.001
Total SDS scores	42.11 \pm 7.60	41.13 \pm 7.48	44.69 \pm 7.61	42.29 \pm 7.24	44.96 \pm 7.70	< 0.001

Note. SV, self-inflicted violence only; IV, interpersonal violence only; SV + IV, both self-inflicted and interpersonal violence; None, not engaged in any violence at all. Chi-square tests were used to test the relationship between relationship with both parents, only child, family structure, family economic status, mother education, father education, number of friends and the perpetration of self-inflicted and interpersonal violence. One-way ANOVA was performed to explore the relationship between physical abuse, emotional abuse, sexual abuse, physical neglect, emotional neglect, total SDS scores and the perpetration of self-inflicted and interpersonal violence.