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## Correlations of impulsivity and aggressive behaviors under the general aggression model among adolescent students in Shanghai, China

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-043785
Article Type:	Original research
Date Submitted by the Author:	17-Aug-2020
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Keywords:	Child & adolescent psychiatry < PSYCHIATRY, PUBLIC HEALTH, Impulse control disorders < PSYCHIATRY

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7 **Correlations of impulsivity and aggressive behaviors under the general aggression model**  
8 **among adolescent students in Shanghai, China**  
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35 Key words: Adolescent; Impulsivity; Aggressive behavior; neighborhood support  
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37 Word counts: 3520 words  
38

39 Total Pages: 20  
40

41 Tables: 4  
42

43 Figures:1  
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45 Supplementary files: 1  
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## ABSTRACT

**Objective:** To describe the aggressive behavior, impulsive level of young adolescents in a sample of Chinese middle school students, as well as to explore the relationship between aggressive behavior and impulsivity.

**Design:** A Computer-Assisted Self-Interview was used to access the correlation of aggressive behavior and impulsivity among young adolescent students. The Barratt Impulsivity Scale was used to measure impulsivity. Aggressive behaviors were determined by self-reports. Chi-square test and binary logistic regression were applied to examine the effect of impulsivity on aggressive behavior.

**Setting:** Three middle schools located in relatively poor communities of Shanghai.

**Participants:** Adolescent students from middle schools in grades 7-9.

**Results:** Totally 1451 students aged 11 to 15 were included in this study (52.01% of boys), and 7.79% of participants reported aggressive behaviors toward others during the past 6 months. Results of logistic regression suggested that high impulsivity is associated with a higher risk of aggressive behavior after adjusting for potential confounders (OR=2.412, 95%CI: 1.427-4.074). Besides, male adolescents with poor family care and poor neighborhood support, being bullied in the past six months, living with brothers or sisters were more likely to behave in aggressive ways.

**Conclusions:** The present study indicates a positive association between impulsivity and aggressive behavior in Chinese adolescent students. Furthermore, adolescent aggressive behavior was affected by multifaceted factors from individual, family, school, and community. Comprehensive intervention strategies such as controlling the aggressor's impulsivity, helping them better channel their anger, creating a better family, school and neighborhood environment and providing support and services for violence victims are needed.

**Keywords:** Adolescent students; Impulsivity; Aggressive behavior

### Strengths and limitations of this study :

1. The study used a reliable and validated scale to access impulsivity among the participants.
2. The findings warrant further exploration of the factors critical to the understanding of aggressive behaviors.
3. The study may be underpowered to test for specific hypotheses such as the relationship between migrant status and aggressive behavior.
4. The possibility of under-reporting on aggressive behavior and the exclusion of participants because of the absence of key variables may introduce selection bias.

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## 1. Introduction

Aggression is a complex concept and it has traditionally been classified into two distinct subtypes, impulsive or premeditated. The former is characterized by uncontrolled and exaggerated responses to the stimuli which provoke them, while the latter is defined as a planned or conscious aggressive act, not spontaneous or related to an agitated state<sup>[1]</sup>. Though aggression is one of the basic human traits aiding in the mechanism of survival, there are culturally bounded limits on acceptable levels of aggression or violent behaviors. Those over the limits of acceptable levels are considered harmful<sup>[2]</sup>.

Adolescence is a critical period for curtailing aggressive behaviors, as this developmental window is often accompanied by changes, stresses, and disparities which could arouse the anger<sup>[3]</sup>. Previous studies have indicated that aggressive behavior was associated with a range of negative outcomes in adolescence, such as the increased risk of depressive symptoms, delinquency, internet addiction, and suicide attempts<sup>[4-7]</sup>. In the school setting, aggressive behavior was related to low scores in academic performance and higher peer rejection<sup>[4, 8]</sup>. At the family level, significant relationships were observed between aggressive behavior on the one hand, and family conflict and low family cohesion on the other<sup>[4]</sup>. More importantly, if aggressive behaviors become prevalent during this stage of development, they can be escalated and persist<sup>[3]</sup>. Evidence from longitudinal research has demonstrated that adolescents with higher levels of aggression are at greater risk of criminal activity and violence, peer victimization, rule-breaking behaviors, internalizing symptoms, and narcissistic and borderline personality features in the future<sup>[9,10]</sup>. Furthermore, adolescents with higher aggressiveness tend to have difficulties in controlling waves of anger in adulthood and to have consistently poorer outcomes across domains of life success<sup>[11,12]</sup>. Also, research has shown that high levels of aggression may result in high social costs because a range of services and resources are needed for the delinquency, incarceration, and unemployment<sup>[5,10]</sup>.

Aggressive behavior in adolescence is a complex phenomenon that cannot be explained by a single factor. The general aggression model (GAM) provides an integrative explanation of aggressive behavior based on three stages<sup>[13]</sup>: 1) inputs: personal and situational factors; 2) routes or individual internal states: affect, cognition, and arousal; 3) outcomes: decision processes with a (non) aggressive result. In this model, the aggressive acts are influenced by genetic, neuropsychiatric, hormonal, cultural, familial, socioeconomic, and environmental factors. Elements involved in each of the three stages may increase or decrease the probability of behaving aggressively. Thus, identification of these risk factors is critical to the understanding of the aggressive behaviors among adolescents.

In recent years, the role of impulsivity on aggressive behavior has been attracted more and more attention<sup>[14]</sup>. Aggression among adolescents takes the form of both impulsive and premeditated

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3 behavior<sup>[15]</sup>. As a personality trait with a strong biological foundation, impulsivity was described as a  
4 quick and unplanned response for internal or external stimuli regardless of the negative consequences  
5 for an individual or others<sup>[16]</sup>. Thus, the definition of impulsivity could easily lead us to the intuitive  
6 relationship between impulsivity and impulsive aggression. However, researches have shown that  
7 impulsivity is present in any type of aggressive act and does not make a distinction between acts of  
8 premeditated or impulsive aggression<sup>[15,17]</sup>. A great number of studies in western countries have  
9 demonstrated a positive association between impulsivity and aggression<sup>[18-20]</sup>.

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15 In China, although adolescent impulsivity or aggression has been reported in many studies,  
16 researches related to adolescent impulsivity was mainly focused on its relationship with internet  
17 addiction and self-injury or suicidal behavior<sup>[21-23]</sup>. The association between impulsivity and  
18 aggressive behavior has been rarely reported. We carried out a school-based cross-sectional study  
19 based on the first follow-up of The Global Early Adolescent Study (GEAS) in Shanghai, which is part  
20 of a multinational longitudinal cohort study that focused on early adolescents in disadvantaged urban  
21 environments. This paper was to examine the relationship between impulsivity and aggressive  
22 behaviors under the GAM model among Chinese students aged 11 to 15.  
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## 30 31 **2. Methods**

### 32 33 **2.1. Study design and participants**

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35 Three public primary middle schools in two sub-districts of the Jingan district were selected for  
36 the present study. The sites were selected because of ongoing research partnerships and also because  
37 they are located in the relatively underdeveloped areas in Shanghai. The criteria for participant  
38 selection include: currently studying in grades 7 to 9 (the initial GEAS conducted in grades 6 to 8),  
39 aged 11 to 15, living in the geographic division of the study areas, and their parents or guardians  
40 consented their participation.  
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45 A total of 1578 adolescents were enrolled in the investigation. Among them, 127 (8.05%) were  
46 excluded because they were aged over 15 years old or lack of key information. And finally, 1451  
47 eligible students were included in the present study (**Figure 1**).  
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### 50 51 **2.2. Procedure**

52 The data collection was carried out by Computer-Assisted Self-Interview (CASI) using tablets  
53 from November to December in 2018. Parental informed consent was collected by head-teachers  
54 during parent-teacher meetings. Students who assented to take part in the survey were asked to fill in  
55 the electronic questionnaires independently during lunch breaks or psychology courses. If they had  
56 any questions, as they did so, they could raise their hands to ask the available investigators. Tablets  
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3 were returned after the process and checked by the investigators to ensure that all necessary questions  
4 were answered before submission.  
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6 It took approximately 30-60 minutes to finish the electronic questionnaire and each student was  
7 compensated for their participation with a small gift valuing about 20 CNY.  
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## 10 **2.3. Measures**

### 11 **2.3.1. Aggressive behavior**

12 Aggressive behavior in the present study was assessed by two items: 1): During the past 6 months,  
13 have you bullied or threatened another boy or girl for any reason? 2): During the past 6 months, have  
14 you slapped, hit or otherwise physically hurt another boy or girl in any way that they did not want?  
15 Each item comprises six answer options: 1) no; 2) yes, both for girls and boys; 3) yes, for boys; 4) yes,  
16 for girls; 5) don't know; 6) refuse to answer. The options 5 to 6 are treated as missing values in data  
17 analysis. The participant was considered to be an aggressor if both or one of the two behaviors listed  
18 above exists.  
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### 25 **2.3.2. Impulsivity and other factors**

26 The impulsivity in the present study was measured by the Barratt Impulsivity Scale (BIS-11), a  
27 valid and reliable instrument developed by Barratt in 1959 and was revised by Patton in 1995 [24]. The  
28 BIS-11 is one of the most often used tools to assess impulsivity. It is composed of 30 items and the  
29 items are grouped into three sub-scales: Attentional impulsivity (AI, 8 items) describes the tendency  
30 to inattention or to make a quick decision; Motor impulsivity (MI, 11 items) is about the propensity to  
31 act solely on the spur of the moment despite the consequences; Nonplanning impulsivity (NPI, 11  
32 items) indicates the lack of a plan for daily or long-term actions [24]. Items are rated on a 4-point Likert-  
33 type scale ranging from 1 "rarely/ never" to 4 "almost always/ always". Among 30 items, eleven of  
34 them are inverted because they relate to lower impulsivity. The re-coded responses of items were  
35 summed into total scores of the full scale and sub-scales with higher scores signaling greater  
36 impulsiveness. Previous studies have demonstrated the high reliability and validity of BIS-11 when  
37 used in Chinese children and adolescents [25]. In the present study, we assessed the internal consistency  
38 of the three subscales and the total scale. The Cronbach's alpha value was 0.50 for AI, 0.78 for NPI,  
39 0.65 for MI, and 0.81 for the total BIS, respectively. Later, the mean score of impulsivity (MSI) was  
40 calculated, which is obtained by dividing the total score of BIS-11 or sub-scales by the number of  
41 relevant valid items. Scores were further dichotomized ( $\leq$ median,  $>$ median) using median thresholds  
42 of all participants when doing multivariate data analysis.  
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56 Demographic and environmental factors considered in the present study include participants' age,  
57 gender, ethnicity, religion, family structure, family cares, and neighborhood support, etc.  
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## 2.4. Data analysis

The primary target of data analysis was to detect the association between impulsivity and aggressive behaviors (as dependent variables). The analysis began with the comparison of the score of BIS-11 and its sub-scales between aggressors and non-aggressors by the independent sample *t*-test. After that, the Chi-square ( $\chi^2$ ) test was applied to assess the differences in aggressive behavior between two groups with high and low impulsivity. Thirdly, multivariate logistic regression was conducted to assess the associations between impulsivity and aggressive behavior. For the dependent variable, four models were explored: 1) model using MSI in BIS-11 (30 items); 2) model using MSI in Attentional sub-scale (8 items); 3) model using MSI in Motor sub-scale (11 items); 4) model using MSI in Nonplanning sub-scale (11 items). In each model, socio-demographic characteristics (age, gender), as well as related social and environmental factors (such as family cares, neighborhood support, et al), were controlled. The statistical analyses were conducted by Stata SE version 15, the level of significance was set at 0.05 (two-tailed).

## 2.5. Ethical considerations

The present study was approved by the ethical committee of the Shanghai Institute of Planned Parenthood Research (Approved No. PJ2017-27).

## 2.6. Patient and public involvement

Young adolescents were invited to test the face validity of the questionnaire in the designing stage. During the survey, all participants were provided with an information sheet about psychosocial resources available to them, as well an option within the survey to indicate interest in supported referrals to services. Adolescents are going to be invited to join the interpretations of the findings and dissemination stages of the study as well.

## 3. Results

### 3.1 Background characteristics of participants

A total of 1451 students (51.21% of boys) aged 11 to 15 with a mean age of  $13.47 \pm 0.96$  were included in this study, the proportion of students in grades 7, 8, 9 is 33.29%, 37.08%, and 29.50%, respectively. The background characteristics of eligible participants are described in **Table 1**. More than four-fifths (83.46%) of participants had Hukou of Shanghai, and almost all (92.49%) of them were taken care of primarily by their parents. More than 70% of participants reported that they had no religion, while nearly 20% of them are Buddhist, and the proportion of Christians or Catholics is 5.44%.

**Table 1** Basic characteristics of eligible participants

Variables	Frequency (n)	Percent (%)
Age (years)		
11~13	720	49.62
14~15	731	50.38
Gender		
Male	743	51.21
Female	708	48.79
Ethnic group*		
Ethnic Han	1425	98.21
Others	25	1.72
Shanghai Hukou*		
Yes	1211	83.46
No	136	9.37
Primary caregiver*		
Self-care	3	0.19
Parents	1342	92.49
Others	94	6.48
Religion*		
No	1040	71.67
Buddhism	278	19.16
Christianity or catholicism	79	5.44
Islam	9	0.62
Others	19	1.31

\*: percentages may not add to 100% due to missing data.

### 3.2 Score of impulsivities between aggressors and non-aggressors

113 (7.79%) of participants reported that they had ever conducted aggressive behavior in the present study. **Table 2** shows the comparison of the scores of impulsivities between aggressors and non-aggressors. The mean score of BIS-11 in aggressors was 68.47, significantly higher than non-aggressors (60.55,  $P < 0.001$ ). Moreover, the mean score of three sub-scales of BIS-11 in aggressors was also higher than their counterparts (17.98 vs 15.82, 25.23 vs 21.84, 25.38 vs 22.99, respectively), the results of  $t$ -test indicated that the differences are statistically significant ( $P < 0.001$ ).

**Table 2** Score of impulsivities, grouping by aggressive behavior

Style of impulsivity	Aggressive behavior			No aggressive behavior			$P$ -value
	n	Mean	S.D	n	Mean	S.D	
Total score of impulsivity	96	68.47	11.41	1220	60.55	9.67	$< 0.001$
Score of attentional impulsivity	105	17.98	3.55	1290	15.82	3.01	$< 0.001$

Score of motor impulsivity	105	25.23	5.60	1291	21.84	4.44	< 0.001
Score of nonplanning impulsivity	102	25.38	5.22	1281	22.99	5.08	< 0.001

Note: The analysis excluded those participants if any items in BIS-11 or sub-scales were missing; the differences between the two groups were compared by a two-independent t-test.

### 3.3 Influence factors of aggressive behavior

In the present study, the Chi-square test and multivariable binary logistic regression model were applied to evaluate the effect of impulsivity on aggressive behavior (**Table 3** and **Table 4**). The results indicate that aggressive behavior was present in 11.61% of students with high impulsivity, which is significantly higher than their counterparts with low impulsivity (3.87%; OR=2.412, 95%CI: 1.427-4.074). Furthermore, all of three sub-types of impulsivity were positively associated with the dependent variable; the results of the multivariate analysis suggested that all components of impulsivity (attentional, motor, non-planning) could significantly increase the risk of aggressive behavior (OR<sub>1</sub>=2.270, 95%CI: 1.388-3.711; OR<sub>2</sub>=2.454, 95%CI: 1.505-4.002; OR<sub>3</sub>=1.830, 95%CI: 1.113-3.007, respectively) (**Table 4**).

The results of the multivariable analysis also suggested that female adolescents may be less likely to be aggressors compared with their male counterparts (OR: 0.459–0.495). Those who perceived very much care from caregivers were less likely to be aggressors (OR: 0.558–0.580). Having brothers or sisters live together (OR: 1.782–1.907), being bullied within the last six months (OR: 9.062–9.358) may greatly increase the risk of conducting aggressive behaviors. However, adolescents' age, number of close friends showed no significant impact on the dependent variable in this study (**Table 4**).

**Table 3** Percentages of aggressive behavior, grouping by personal variables

Variables	No. of participants (n)	Percent (%)	$\chi^2$	P-value
Age (years)				
11~13	720	7.64	0.044	0.834
14~15	731	7.93		
Gender				
Male	743	10.90	20.562	<0.001
Female	708	4.52		
Number of close friends				
0~3	528	7.01	0.704	0.703
4~6	449	8.24		
7~	474	8.23		
Primary caregiver care about you				
Not very	706	10.76	21.156	<0.001
Very	716	4.33		
Have brothers or sisters live together				

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3	Nobody	1143	7.00		
4	At least one	299	10.37	3.786	0.052
5					
6	Neighbors will help each other				
7	Never or seldom	294	12.93		
8	Sometimes	509	7.66	19.391	<0.001
9	Always	567	4.59		
10					
11	Bullied within 6 months				
12	No	872	1.95		
13	Yes	507	18.15	115.53	<0.001
14					
15	Score of impulsivity				
16	Low	749	3.87		
17	High	689	11.61	30.683	<0.001
18					
19	Score of attentional impulsivity				
20	Low	837	4.18		
21	High	601	12.31	33.016	<0.001
22					
23	Score of motor impulsivity				
24	Low	840	4.40		
25	High	598	12.04	29.07	<0.001
26					
27	Score of non-planned impulsivity				
28	Low	741	5.26		
29	High	697	10.04	11.714	<0.001
30					

NOTE: The percentages between groups are compared by the Chi-square test.

**Table 4** Factors associated with aggressive behavior: results of a multivariable binary logistic regression model

Variables	Model 1		Model 2		Model 3		Model 4	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Age (years)								
11~13	ref		ref		ref		ref	
14~15	0.861	(0.539-1.376)	0.839	(0.524-1.341)	0.878	(0.548-1.405)	0.862	(0.541-1.376)
Gender								
Male	ref		ref		ref		ref	
Female	0.467	(0.285-0.765)	0.495	(0.302-0.812)	0.487	(0.298-0.798)	0.459	(0.280-0.752)
Number of close friends								
0~3	ref		ref		ref		ref	
4~6	1.097	(0.616-1.951)	1.113	(0.625-1.984)	1.118	(0.628-1.991)	1.083	(0.610-1.924)
≥7	1.392	(0.792-2.447)	1.326	(0.757-2.324)	1.307	(0.743-2.299)	1.406	(0.801-2.469)
Primary caregiver cares about you								
Not very	ref		ref		ref		ref	
Very	0.576	(0.346-0.956)	0.58	(0.347-0.965)	0.558	(0.336-0.927)	0.569	(0.343-0.943)
Brothers or sisters living together								
Nobody	ref		ref		ref		ref	
At least one	1.782	(1.067-2.977)	1.907	(1.141-3.188)	1.854	(1.106-3.107)	1.845	(1.106-3.078)
Neighbors will help each other								
Never or seldom	ref		ref		ref		ref	
Sometimes	0.665	(0.385-1.147)	0.69	(0.400-1.191)	0.7	(0.404-1.211)	0.695	(0.404-1.197)
Always	0.448	(0.242-0.828)	0.454	(0.246-0.840)	0.465	(0.251-0.863)	0.451	(0.244-0.834)
Bullied within 6 months								
No	ref		ref		ref		ref	
Yes	9.07	(4.921-16.715)	9.206	(5.00-16.963)	9.062	(4.914-16.710)	9.358	(5.079-17.240)

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Score of impulsivity

Low	ref		ref		ref		ref	
High	2.412	(1.427-4.074)	2.27	(1.388-3.711)	2.454	(1.505-4.002)	1.83	(1.113-3.007)

Note: the impulsivity in models 1, 2, 3, and 4 refers to the total impulsivity, attentional impulsivity, motor impulsivity, non-planning impulsivity, respectively.

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#### 4. Discussion

The present study sought to add to our knowledge of the relationship between impulsivity and aggression in Chinese adolescents by exploring this relationship using the GAM model in a sample of primary/middle school students. Consistent with similar research in other populations<sup>[3,18,20]</sup>, adolescents with higher impulsivity were significantly more likely to perform aggressive behaviors. Furthermore, positive associations were found between all subtypes of impulsivity and aggressive behaviors, demonstrating not only motor impulsivity (acting without thinking) but also attentional (unable to be concentrate) and non-planning (lack of forethought) is highly related to adolescents' aggression.

In neuroimaging studies, personality traits such as impulsivity and aggressiveness have been associated with variations in the structure and function of brain networks that regulate mood, impulse, and behavior<sup>[26]</sup>. The physiological mechanism of impulsivity was generally considered as an excitatory response produced by the nervous system; when stimulated by internal or external factors, it may give rise to an intense emotional state within a short period and this emotion constitutes the basis for impulsive behavior<sup>[16]</sup>. On the one hand, an individual can be more decisive and courageous on the spur of impulses in the face of unexpected opportunities or challenges and difficulties. On the other hand, if an individual lacks the cognitive resources necessary to manage impulses, he or she can be driven by desire or anger, which may result in a range of negative outcomes<sup>[27]</sup>. According to the GAM model, when an adolescent appraises a certain situation as a possible source of menace and pain, he or she can become negatively aroused<sup>[13]</sup>. In such a situation, adolescents with higher impulsivity often show a deficiency in social adaptation and emotional self-control and empathy; therefore, they may face more difficulties to deal with social situations, and their incapacity to adequately managing their emotions may lead them to behave in aggressive ways <sup>[28]</sup>.

Comparing our prevalence of aggressive behavior with previous studies implemented in Chinese settings, given the range of reported published estimates from 3.27 % among middle-school students in Hubei Province to 19.80% of middle school students in Henan Province<sup>[29,30]</sup>, our results suggested a moderate prevalence estimate of aggressive behavior (7.79%). This variation may partially be explained by various social conditions (e.g. economic status, cultural environment, social security) and sample ascertainment methods in different studies. The lack of standardized definition and



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4 measurement methods for adolescent aggression may also contribute to the variation.

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6 The result of the present study indicated that female adolescents were less likely to involved in  
7 aggressive behavior toward others than their male counterparts (OR=0.459–0.495), a similar finding  
8 was reported elsewhere<sup>[31]</sup>. Female students tend to have less physical strength than their male peers  
9 and they are always required to be quiet, gentle, and polite under Chinese culture; therefore, these  
10 students may less likely to behave in aggressive ways. A previous study has demonstrated that girls  
11 were prone to social aggression<sup>[32]</sup>, while this study mainly focuses on physical aggression, and thus  
12 the female aggressive behaviors may be under-estimated.

13  
14 The finding that better family care is negatively related to adolescent aggression (OR: 0.558–  
15 0.580) is in line with the family coercion theory, which assumes that positive family interactions  
16 contribute to decreasing youth problem behaviors<sup>[33]</sup>. Poor family care might contribute to adolescent's  
17 aggressive behaviors in many ways: such as less monitoring and lack of adults to confide in when  
18 anger is triggered because of events and processes in the environment. Further, those adolescents who  
19 have grown up with poor family care are more likely to elicit negative responses from their parents as  
20 they begin to assert their autonomy and independence. These negative interactions are likely to result  
21 in increasingly aversive and coercive processes which could put adolescents at a higher risk of  
22 aggression and other behavioral problems<sup>[34]</sup>.

23  
24 The finding of the present study also indicated that adolescents living with their brothers or sisters  
25 were more likely to be aggressors (OR: 1.782–1.907). Generally, because the One-Child Policy of  
26 China officially ended until only in late 2015, adolescents in our sample were assumed to be only one  
27 child if they were from ordinary families. One possible explanation of our result is that students living  
28 with siblings might come from immigrant families as the study sites located in the traditional habitat  
29 for migrant populations in Shanghai (to confirm our hypothesis we further compared the proportion of  
30 “one-child” among migrants and non-migrants, and found that migrants were 6.4 times more likely to  
31 have siblings, see appendix 1). Migrant families tend to have more children, lower incomes and worse  
32 household conditions, and they were expected to have more difficulties to obtain relevant resources,  
33 supports, and treatments, which were historically identified as risk factors for aggression<sup>[35]</sup>. Because  
34 of the ill-equipped emotional regulation skills in adolescents, those students from immigrant families  
35 are more likely to develop a sense of inferiority<sup>[36]</sup>, and thus they might behave in aggressive ways in  
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4 certain conditions to win the so-called identity and dignity.

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6 A previous study has demonstrated that social and environmental factors were the principal  
7 influences of aggression and that neighborhood support was a significant protective factor against  
8 aggression<sup>[37]</sup>. Our study also indicated that the neighborhood support of the adolescents may  
9 significantly decrease their likelihood of aggressive behaviors (OR<sub>1</sub>: 0.665-0.700; OR<sub>2</sub>: 0.448-0.465).  
10  
11 Poor neighborhood environment - characterized by high levels of violence, anger, and disapproval and  
12 low warmth and support - has been reported to be associated with an increased risk of behavior  
13 problems and delinquency and aggression in adolescents<sup>[38]</sup>. In contrast, students were likely to feel  
14 more supported – and less aggressive - in a neighborhood that provides adequate resources and  
15 assistance for youth healthy growth and development, such as after-school programming and  
16 recreational spaces<sup>[39]</sup>. These resources may lead to less aggressive behavior by encouraging social  
17 networks and bonding within the neighborhood<sup>[37]</sup>.

18  
19 Adolescent aggressors tend to have higher levels of life stress than their counterparts without such  
20 behaviors<sup>[40]</sup>. Since the school has become the primary arena for an adolescent, stressors caused by  
21 discordant school relationships were common such as peer conflicts or bullying<sup>[40]</sup>. Consistent with  
22 previous research that showed that school-related tensions were significant predictors of aggression<sup>[33]</sup>,  
23 our study also suggested that peer's bullying was associated with a higher risk of aggressive behavior  
24 (OR: 9.062–9.358). Adolescents with bullying experience are likely to breed a negative intention of  
25 hostility and revenge. If the resulting negative emotions are not handled properly, it would cause  
26 aggressive behavior once the victim has an opportunity to retaliate. Further, adolescents tend to have  
27 a stronger ability to imitate. The bullying or aggression of their schoolmates may set a bad example,  
28 and thus they might behave similarly in certain conditions. This finding implies the efforts to reduce  
29 youth aggression by providing appropriate supports and services to those students who have already  
30 been bullied by his schoolmates or peers.

31  
32 Naturally, there are limitations to this study. Firstly, because of the cross-sectional design, the  
33 results cannot provide firm conclusions regarding the causal effects proposed. Secondly, the aggressive  
34 behavior in this study is based on self-reports, which may result in the underestimation of aggression  
35 (particularly with social aggression). Besides, we did not distinguish the impulsive aggressive  
36 behaviors from premeditated aggressive behaviors. Further studies are needed to explore how  
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4 impulsivity plays differently in these two forms, given their different biological, psychological, and  
5 social etiologic factors as well as management strategies. Finally, more than 8% of enrolled students  
6 were excluded because of the absence of dependent variable, although the distribution of basic  
7 characteristics between enrolled and excluded subjects was not statistically significant, selection bias  
8 may be introduced due to this limitation.  
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14 None the less, aggression is part of our makeup. It is human nature to occasionally be aggressive  
15 towards someone. Teachers, researchers and health promoters need to tell students that there are times  
16 and places where aggression is acceptable. They could also teach adolescents to learn how to channel  
17 aggression to the places where it is appropriate and useful. The result of our study does not imply that  
18 any single individual trait or factor is to be blamed for being the cause of aggressive and violent  
19 behaviors. Instead, we believe that learning what combination of factors contributes to it could point  
20 to leads for designing the intervention strategies to help young adolescents. That said, it is important  
21 to understand that aggressive and violent behaviors continue to be as much a reality in schools as well  
22 as in society at large. Helping young adolescents' learn to control their impulsiveness, channeling the  
23 anger, and helping those who are at higher risks of being aggressive could be other approaches to  
24 improve all adolescents' physical and psychological well-being rather than only taking disciplinary  
25 action against aggressors.  
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### 39 **Conclusions**

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41 Despite these limitations, the current study provides clear evidence of the role of impulsivity and  
42 other factors in aggression in Chinese adolescent students. Consistent with research in other  
43 populations, a positive association between impulsivity and aggressive behavior was found.  
44  
45 Furthermore, results also indicated that aggressive behavior may be affected by multifaceted factors  
46 from individual, family, school and community, suggesting a need for comprehensive intervention  
47 strategies such as controlling the aggressor's impulsivity, teaching them to channel their anger,  
48 creating a supportive and nurturing school and neighborhood environment as well as providing  
49 psychological support and services for violence victims.  
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### 57 **Abbreviations**

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4 BIS-11: Barratt Impulsivity Scale; CASI: Computer Assisted Self-Interview; GAM: General  
5 Aggression Model; GEAS: The Global Early Adolescent Study; MSI: Mean Score of Impulsivity.  
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### 9 **Acknowledgments**

10  
11 The Global Early Adolescent Study is a multinational study that aims to understand the development  
12 of gender norms in early adolescence, and its impacts on adolescent health across time and geographies.  
13 The study operates in conjunction with the World Health Organization (WHO) and the Johns Hopkins  
14 Bloomberg School of Public Health (JHBSPH).  
15

16 We thank all researchers and students who participate in the present study, as well as administrators  
17 and teachers in target schools. We thank the technical support from JHBSPH. We thank Dr.  
18 Venkatraman Chandra-Mouli from the Department of Reproductive Health Research, WHO for  
19 helping review the manuscript.  
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### 29 **Source of funding**

30  
31 The present study was funded by the Innovation-oriented Science and Technology Grant from NHC  
32 Key Laboratory of Reproduction Regulation [CX2017-05] and the Innovation-oriented Youth Science  
33 and Technology Grant [Q2018-1] from Shanghai Institute of Planned Parenthood Research.  
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### 39 **Authors' contributions**

40  
41 Chaohua Lou initiated the GEAS in Shanghai as a coordinator and project leader, all authors are  
42 contributed to the study design and data collection. Chunyan Yu and Jiashuai Zhang conducted the  
43 data analysis and drafted the paper, all authors are involved in the writing of the manuscript and read  
44 and approved the final manuscript.  
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### 50 **Declaration of interest**

51  
52 The authors report no conflicts of interest.  
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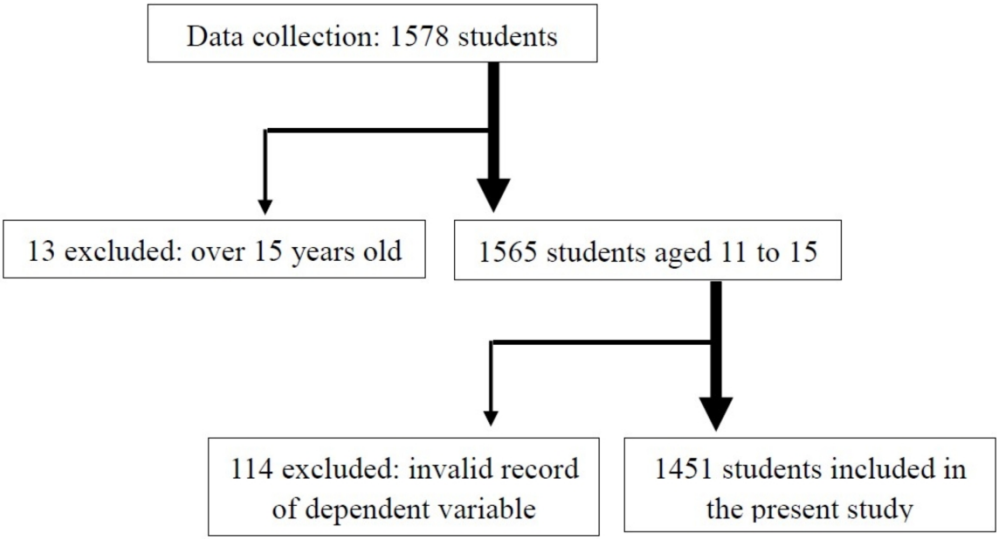


Figure 1: Flow diagram of exclusion and inclusion criteria of participants in data analysis

270x146mm (300 x 300 DPI)

Supplementary file 1:

Table: Differences on distribution of being the only-child between migrant (don't have shanghai Hukou) and non-migrant(have Shanghai Hukou) adolescents

		Only child		$\chi^2$	<i>P</i>	<i>OR</i>	<i>95%CI</i>
		Yes (Exposed)	No (Unexposed)				
Have Shanghai Hukou	Yes (Case)	1028	179	113.2	<0.001	6.38	4.30-9.45
	No (Control)	63	70				

# Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

## Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectional reporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gotsche PC, Vandembroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

		Page
	Reporting Item	Number
<b>Title and abstract</b>		
Title	<a href="#">#1a</a> Indicate the study's design with a commonly used term in the title or the abstract	1

1	Abstract	<a href="#">#1b</a>	Provide in the abstract an informative and balanced summary	2
2			of what was done and what was found	
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6	<b>Introduction</b>			
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10	Background /	<a href="#">#2</a>	Explain the scientific background and rationale for the	3-4
11	rationale		investigation being reported	
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15	Objectives	<a href="#">#3</a>	State specific objectives, including any prespecified	4
16			hypotheses	
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20	<b>Methods</b>			
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23	Study design	<a href="#">#4</a>	Present key elements of study design early in the paper	4
24				
25				
26	Setting	<a href="#">#5</a>	Describe the setting, locations, and relevant dates, including	4-5
27			periods of recruitment, exposure, follow-up, and data	
28			collection	
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34	Eligibility criteria	<a href="#">#6a</a>	Give the eligibility criteria, and the sources and methods of	4
35			selection of participants.	
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40		<a href="#">#7</a>	Clearly define all outcomes, exposures, predictors, potential	5-6
41			confounders, and effect modifiers. Give diagnostic criteria, if	
42			applicable	
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47	Data sources /	<a href="#">#8</a>	For each variable of interest give sources of data and details	5
48	measurement		of methods of assessment (measurement). Describe	
49			comparability of assessment methods if there is more than	
50			one group. Give information separately for for exposed and	
51			unexposed groups if applicable.	
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1	Bias	<a href="#">#9</a>	Describe any efforts to address potential sources of bias	5-6
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4	Study size	<a href="#">#10</a>	Explain how the study size was arrived at	5
5				
6				
7	Quantitative	<a href="#">#11</a>	Explain how quantitative variables were handled in the	6
8	variables		analyses. If applicable, describe which groupings were	
9			chosen, and why	
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15	Statistical	<a href="#">#12a</a>	Describe all statistical methods, including those used to	6
16	methods		control for confounding	
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20	Statistical	<a href="#">#12b</a>	Describe any methods used to examine subgroups and	6
21	methods		interactions	
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26	Statistical	<a href="#">#12c</a>	Explain how missing data were addressed	5-6
27	methods			
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31	Statistical	<a href="#">#12d</a>	If applicable, describe analytical methods taking account of	N/A
32	methods		sampling strategy	
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36	Statistical	<a href="#">#12e</a>	Describe any sensitivity analyses	N/A
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42	<b>Results</b>			
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45	Participants	<a href="#">#13a</a>	Report numbers of individuals at each stage of study—eg	4,7
46			numbers potentially eligible, examined for eligibility,	
47			confirmed eligible, included in the study, completing follow-	
48			up, and analysed. Give information separately for for	
49			exposed and unexposed groups if applicable.	
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57	Participants	<a href="#">#13b</a>	Give reasons for non-participation at each stage	4
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1	Participants	<a href="#">#13c</a>	Consider use of a flow diagram	5
2				
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4	Descriptive data	<a href="#">#14a</a>	Give characteristics of study participants (eg demographic,	7
5			clinical, social) and information on exposures and potential	
6			confounders. Give information separately for exposed and	
7			unexposed groups if applicable.	
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14	Descriptive data	<a href="#">#14b</a>	Indicate number of participants with missing data for each	7
15			variable of interest	
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19	Outcome data	<a href="#">#15</a>	Report numbers of outcome events or summary measures.	7
20			Give information separately for exposed and unexposed	
21			groups if applicable.	
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27	Main results	<a href="#">#16a</a>	Give unadjusted estimates and, if applicable, confounder-	8-11
28			adjusted estimates and their precision (eg, 95% confidence	
29			interval). Make clear which confounders were adjusted for	
30			and why they were included	
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37	Main results	<a href="#">#16b</a>	Report category boundaries when continuous variables were	8-11
38			categorized	
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42	Main results	<a href="#">#16c</a>	If relevant, consider translating estimates of relative risk into	N/A
43			absolute risk for a meaningful time period	
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48	Other analyses	<a href="#">#17</a>	Report other analyses done—e.g., analyses of subgroups	21
49			and interactions, and sensitivity analyses	
50				
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53	<b>Discussion</b>			
54				
55				
56	Key results	<a href="#">#18</a>	Summarise key results with reference to study objectives	12-15
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1	Limitations	<a href="#">#19</a>	Discuss limitations of the study, taking into account sources	14-15
2			of potential bias or imprecision. Discuss both direction and	
3			magnitude of any potential bias.	
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9	Interpretation	<a href="#">#20</a>	Give a cautious overall interpretation considering objectives,	12-15
10			limitations, multiplicity of analyses, results from similar	
11			studies, and other relevant evidence.	
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16	Generalisability	<a href="#">#21</a>	Discuss the generalisability (external validity) of the study	14
17			results.	
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22	<b>Other Information</b>			
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25	Funding	<a href="#">#22</a>	Give the source of funding and the role of the funders for the	16-17
26			present study and, if applicable, for the original study on	
27			which the present article is based	
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# BMJ Open

## Correlations of impulsivity and aggressive behaviors among adolescents in Shanghai, China: cross-sectional data from Global Early Adolescent Study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-043785.R1
Article Type:	Original research
Date Submitted by the Author:	13-Feb-2021
Complete List of Authors:	Yu, Chunyan; Shanghai Institute of Planned Parenthood Research, Department of Epidemiology & Social Science Zhang, Jiashuai; Shanghai Institute of Planned Parenthood Research, Department of Epidemiology & Social Science; Fudan University School of Public Health Zuo, Xiayun; Shanghai Institute of Planned Parenthood Research Lian, Qiguo; Shanghai Institute of Planned Parenthood Research Tu, Xiaowen; Shanghai Institute of Planned Parenthood Research, Dep. of epidemiology & social science Lou, Chaohua; Shanghai Institute of Planned Parenthood Research, Department of Epidemiology & Social Science
<b>Primary Subject Heading</b>:	Mental health
Secondary Subject Heading:	Public health
Keywords:	Child & adolescent psychiatry < PSYCHIATRY, PUBLIC HEALTH, Impulse control disorders < PSYCHIATRY

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3 1 **Correlations of impulsivity and aggressive behaviors among adolescents in Shanghai, China:**  
4  
5 2 **cross-sectional data from Global Early Adolescent Study**

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7 3 Chunyan Yu <sup>1†</sup>, Jiashuai Zhang <sup>2†</sup>, Xiayun Zuo<sup>1</sup>, Qiguo Lian<sup>1</sup>, Xiaowen Tu<sup>1</sup>, Chaohua Lou<sup>1\*</sup>  
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28 14 **Keywords:** Adolescent; Impulsivity; Aggressive behaviors; Neighborhood supports.

29  
30 15 **Word counts:** 4019 words

31  
32 16 **Total Pages:** 22

33  
34 17 **Tables:** 5

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36 18 **Supplementary files:** 2 tables  
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## 1 ABSTRACT

2 **Objective:** To examine the correlations between impulsivity and aggressive behaviors among  
3 Chinese adolescents.

4 **Design:** A school-based cross-sectional study.

5 **Setting:** Three primary middle schools located in less-developed communities of Shanghai.

6 **Participants:** 1524 adolescents aged 11 to 16 years.

7 **Measures:** The impulsivity was measured by Barratt Impulsivity Scale (BIS-11), and the aggressive  
8 behaviors were determined by self-reports. Data were collected through Computer-Assisted Self-  
9 Interview using tablets. Multivariate Firth logistic regression model was conducted to examine  
10 correlations between total, attentional, motor, and non-planning impulsivity and aggressive  
11 behaviors, respectively

12 **Results:** Totally 7.48% of participants reported aggressive behaviors toward others during the past 6  
13 months. The proportion of aggressors among boys and girls was 10.60% and 4.18%, respectively.  
14 Results of the multivariate regression suggested the risk of aggressive behaviors was significantly  
15 increased among those with the highest tertile of total impulsivity (aOR<sub>boys</sub>=3.14, 95%CI: 1.48-6.65;  
16 aOR<sub>girls</sub>=3.74, 95%CI: 1.10-12.76) and motor impulsivity (aOR<sub>boys</sub>=2.91, 95%CI: 1.46-5.82;  
17 aOR<sub>girls</sub>=3.57, 95%CI: 1.25-10.20.), comparing with those with the lowest tertile, for boys and girls,  
18 respectively. Besides, younger age, lower social cohesion, and being bullied within 6 months were  
19 associated with a higher risk of aggressive behaviors among girls. Less family caring and being  
20 bullied within 6 months were associated with the risk among boys.

21 **Conclusions:** The present study indicates a positive association between impulsivity and aggressive  
22 behaviors, with a more salient correlation between motor impulsivity sub-trait and aggressive  
23 behavior among both boys and girls. Furthermore, adolescents' aggressive behaviors were affected  
24 by multiple factors from individual, family, peers, and community. Comprehensive intervention  
25 strategies such as controlling the aggressor's impulsivity, helping them better channel their anger,  
26 creating a better family, school, and neighborhood environment, and providing support and services  
27 for violence victims are needed.

28 **Keywords:** Adolescent; Impulsivity; Aggressive behaviors; Neighborhood supports.

### 29 **Strengths and limitations of this study :**

- 30 1. The study used a reliable and validated scale to access impulsivity among the participants.
- 31 2. The findings warrant further exploration of the impulsiveness subscales to the understanding of  
32 aggressive behaviors critically.

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3 1 3. The simplified measurement of aggressive behavior prevents the further distinction of the  
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5 2 impulsive aggressive behavior from premeditated aggressive behavior. Further studies are needed  
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7 3 to explore how different facets of impulsivity plays differently in these two forms.  
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For peer review only

## 1. Introduction

Aggression is a complex concept. It has traditionally been classified into two distinct subtypes, impulsive (also known as reactive or hostile) or premeditated (also known as proactive or instrumental). The former is characterized by uncontrolled and exaggerated responses to the stimuli, while the latter is defined as planned or conscious aggressive acts, not spontaneous or related to an agitated state<sup>[1]</sup>. Though the division is not without meaningfulness to guide the prevention and intervention due to the potential harm it could cause, there were some criticism of the dichotomous method of characterizing aggressive behavior as the distinction of the two is not that clear and it is the harm that should be concerned regardless the typology of the actions <sup>[2]</sup>.

Previous studies have indicated that aggressive behavior was associated with a range of adverse outcomes in adolescence, such as the increased risk of depressive symptoms, delinquency, internet addiction, and suicide attempts<sup>[3-6]</sup>. In the school setting, aggressive behavior was related to low academic performance scores and higher peer rejection<sup>[3, 7]</sup>. At the family level, significant relationships were observed between aggressive behavior on the one hand and family conflict and low family cohesion on the other<sup>[3]</sup>. More importantly, if aggressive behaviors become prevalent during this developmental stage, they can be escalated and persist<sup>[8]</sup>. Evidence from longitudinal research has demonstrated that adolescents with higher aggression levels are at greater risk of criminal activity and violence, peer victimization, rule-breaking behaviors, internalizing symptoms, and narcissistic and borderline personality features in the future<sup>[9, 10]</sup>. Furthermore, adolescents with higher aggressiveness tend to have difficulties in controlling waves of anger in adulthood and have consistently poorer outcomes across life success domains <sup>[11, 12]</sup>. Also, research has shown that high levels of aggression may result in high social costs because a range of services and resources are needed for the delinquency, incarceration, and unemployment<sup>[5, 9]</sup>.

As a personality trait with a strong biological foundation, impulsivity was defined as a quick and unplanned response for internal or external stimuli regardless of the negative consequences for an individual or others<sup>[13]</sup>. The definition of impulsivity does have overlaps with aggressiveness. It is also one of the main precursors of a set of antisocial behaviors and the basis for several pathological disorders such as attention-deficit/hyperactive disorder, borderline personality disorder and antisocial personality disorder<sup>[14-16]</sup>. A great number of studies in western countries have demonstrated a positive association between impulsivity and aggression<sup>[7, 17-19]</sup>, both concurrently and longitudinally. However, such correlations were majorly explored among the forensic population or clinical sample, or taking the impulsivity as a whole (using the total impulsive score in the analysis) instead of considering it as a multi-facet construct.

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3 1 Among adolescents, studies showed that impulsivity might not be a direct risk for aggression.  
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5 2 Youth often cannot adequately manage their emotions when facing difficulties, leading them to behave  
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7 3 in aggressive ways [20]. Existing research also argues that behaviors resulting from motor impulsiveness  
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9 4 are by nature unplanned or reactive[21]. In contrast, behaviors resulting from attentional (cognitive)  
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11 5 impulsiveness are more likely to be planned or proactive. The latter should be taken more attention  
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13 6 and in consideration of targeted intervention or treatment[14]. Other researches showed that impulsivity  
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15 7 was present in any type of aggressive act and did not distinguish between acts of premeditated or  
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17 8 impulsive aggression[16, 22, 23]. Given the mixed results and their relevance to both healthy and harmful  
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19 9 facets of the behaviors, the role of impulsivity still attracts numerous attentions. The question of  
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21 10 whether a person is capable of modulating their cognition and behavior to fit the demands of a given  
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23 11 environment is imperative[14], which makes understanding the role of impulsiveness in the forming of  
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25 12 aggression among healthy/ordinary population, especially among young adolescents who are at the  
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27 13 critical developing stage urgent.

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29 14 The present study is guided by Bronfenbrenner's ecological model and Blum's conceptual  
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31 15 framework for research targeting early adolescence[24], including family-, school- and neighborhood-  
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33 16 factors in the process of shaping youth's aggressive behavior despite individual biological  
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35 17 characteristics and personal traits[25]. At the family level, family structure and parental connectedness  
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37 18 would help buffer the anger, while school and peer interactions exert significant influences on the  
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39 19 conducting of aggressive havior[25, 26]. Neighborhood environment is another important but always  
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41 20 neglected factor for shaping aggressive behavior as it provides the scenario for multiple health risk  
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43 21 behaviors[27]. For adolescence, specifically, it is a critical period for curtailing aggressive behaviors as  
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45 22 both impulsivity and sensation seeking (both relate to risk-taking behaviors)are at their peak during  
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47 23 this developmental window according to the Dual System Model[21]. The changes, stresses, and  
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49 24 disparities could arouse anger easily[8]. According to Blum's framework[24], adolescence is also a  
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51 25 dynamic developmental period of learning and adaptation, which creates both vulnerabilities and  
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53 26 unique opportunities for early intervention and prevention. Thus, the identification of risk factors is  
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55 27 critical to the understanding of aggressive behaviors among adolescents.

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57 28 There are also culturally bounded limits on acceptable levels of aggression or violent behaviors.  
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59 29 Aggressive behaviors over the boundaries of acceptable levels are often considered harmful[28]. Such  
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30 cultural differences were noted by researchers both in the level of aggression and their correlations,  
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32 31 reflected through the social environment and individual differences, including personality and  
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34 32 cognition [23]. In China, researches on adolescents' impulsiveness were mainly focused on its impacts  
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36 33 on internet addiction[29-31], while researches on the association

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3 1 between impulsivity and aggressive behaviors were scant. We used the wave 2 cross-sectional data  
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5 2 from the Global Early Adolescent Study (GEAS) in Shanghai to examine the correlations of  
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7 3 impulsivity and aggressive behaviors with the consideration of covariates in the individual, family,  
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9 4 school and neighborhood level according to the ecological model. GEAS a multinational longitudinal  
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11 5 study that focused on early adolescents in disadvantaged urban environments with a gender lens. For  
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13 6 the present study, we hypothesized that (1) impulsivity would be positively correlated with young  
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15 7 adolescents' aggressive behavior while the correlation would be strong among motor or non-planning  
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17 8 impulsiveness and aggression; (2) Ecological factors like family interactions, peer interactions and  
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19 9 community environment would be influential to the forming of adolescents' aggressive behaviors.

## 20 11 **2. Methods**

### 23 12 **2.1. Study design and participants**

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25 13 Data for this study were drawn from wave 2 of the GEAS investigation. A stratified cluster  
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27 14 sampling procedure was adopted for the selection of participants in GEAS Shanghai site. Three  
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29 15 primary public middle schools in two less-developed sub-districts of the Jing'an district in Shanghai  
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31 16 were selected, and the fieldwork was implemented with the coordination of key informants from the  
32  
33 17 local teacher's organization. All eligible students in grades 7<sup>th</sup> to 9<sup>th</sup> (the baseline investigation of  
34  
35 18 GEAS was conducted in grades 6<sup>th</sup> to 8<sup>th</sup>) were invited to participate in the study after obtaining their  
36  
37 19 assent and the consent of their parents or guardians.

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39 20 A total of 1611 adolescents participated in the wave 2 investigation. Of them, 87 (5.40%) were  
40  
41 21 excluded because of missing information on impulsivity (16) or aggressive behaviors (71), respectively.  
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43 22 Finally, 1524 eligible students were included in the data analysis.

### 44 23 **2.2. Procedure**

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46 24 Data were collected through tablets using the Computer-Assisted Self-Interview (CASI) method  
47  
48 25 during November and December in 2018. The students were organized by their teachers in the class  
49  
50 26 units to fill in the electronic questionnaire independently during the lunch break or psychological class.  
51  
52 27 In each class, 1-2 trained investigators were present in case the participants need assistance with the  
53  
54 28 tablet using. Communication or discussion among participants during the process was dissuaded, while  
55  
56 29 questions regarding the survey could be raised to the available investigators. The questionnaire took  
57  
58 30 approximately 25 to 40 minutes to finish. The tablets were returned after the process and checked by  
59  
60 31 the investigators to ensure that all necessary questions were answered before submission. Each student  
32  
33 was compensated for their participation with a small gift valued at 20-30 CNY after the process.

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35 The GEAS in Shanghai was approved by the Medical Ethical Committee of the Shanghai Institute



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3 1 of Planned Parenthood Research (No. PJ2017-27); a deemed exempt for secondary data analysis was  
4 2 approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

### 6 3 **2.3. Measures**

#### 8 4 **2.3.1. Aggressive behavior**

10 5 Aggressive behavior was assessed by two items: 1): During the past 6 months, have you bullied  
11 6 or threatened another boy or girl for any reason? 2): During the past 6 months, have you slapped, hit,  
12 7 or otherwise physically hurt another boy or girl in any way that they did not want? Each item comprised  
13 8 six options: 1) no; 2) yes, both for girls and boys; 3) yes, for boys; 4) yes, for girls; 5) don't know; 6)  
14 9 refuse to answer. Options 5 and 6 were treated as missing values in data analysis. A student was  
15 10 classified into an aggressor if both or one of the two behaviors listed above exists.

#### 20 11 **2.3.2. Impulsivity**

22 12 The impulsivity was measured by BIS-11, a valid and reliable instrument developed by Barratt in  
23 13 1959 and revised by Patton in 1995<sup>[32]</sup>. The scale composed of 30 items and grouped into three  
24 14 subscales: attentional impulsivity (AI, 8 items) describes the tendency to inattention or to make a quick  
25 15 decision; motor impulsivity (MI, 11 items) is about the propensity to act solely on the spur of the  
26 16 moment despite the consequences; non-planning impulsivity (NPI, 11 items) indicates the lack of a  
27 17 plan for daily or long-term actions<sup>[32]</sup>. The items were rated by a 4-point Likert-type option from 1  
28 18 (rarely/ never) to 4 (almost always/ always), and mean scores ranged from 1 to 4 of the scales were  
29 19 calculated after partly items were scored transpose, with a higher score indicating greater  
30 20 impulsiveness. We split the continuous mean scores into tertiles in the multivariate regression model  
31 21 due to skewed distributions of mean scores and the absence of generalized cut-off values across  
32 22 researches. The model compared the highest and middle to the lowest tertiles. Previous studies  
33 23 demonstrated the reliability and validity of BIS-11 when used in Chinese children and adolescents,  
34 24 and the polychoric ordinal alpha value in the present study was 0.62 for AI, 0.81 for NPI, and 0.74 for  
35 25 MI, and 0.89 for the total BIS.

#### 46 26 **2.3.3 Covariates**

48 27 Covariates include adolescents' age, binary indicators of gender at the individual level, binary  
49 28 indicators of family structure (only child vs. other), perceived care from the primary caregiver that  
50 29 reflecting family caring at the family level, number of close friends, experiences of being bullied within  
51 30 6 months at the school level, as well as perceived supports from the neighborhood.

### 55 31 **2.4. Data analysis**

56 32 The data analysis began with describing and comparing aggressive behavior, impulsivity, and  
57 33 covariates between boys and girls. Secondly, the differences of the mean scores of BIS-11 and its  
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1 subscales between aggressors and non-aggressors were compared using either *t*-test or *Wilcoxon* test.  
 2 Thirdly, due to the lower prevalence of aggressors in the present study, the multivariate firth logistic  
 3 regression model<sup>[33]</sup> was conducted to assess the association between impulsivity and aggressive  
 4 behavior among the total sample, as well as boys' and girls', respectively. Four models were explored  
 5 for each group using total BIS-11 mean core and the mean score of each subscale (AI, MI, and NPI,  
 6 respectively. In each model, the demographic characteristics, as well as personal and ecological factors  
 7 listed above were controlled. Before modeling, we first examined the cluster effects on the level of  
 8 school (level-3) and class (level-2) through multilevel zero-models to determine if the hierarchical  
 9 structure statistically exists in our data given the cluster obtained by cluster sampling. We found,  
 10 however, the effects were statistically insignificant both for boys or girls, and thus the general logistic  
 11 regression model was chosen for data analysis. The statistical analyses were conducted by Stata SE  
 12 version 15. The level of significance was set  $\alpha=0.05$  at two-tailed.

### 23 24 13 **2.5. Patient and public involvement**

25 Young adolescents were invited to test the face validity of the questionnaire in the designing  
 26 stage. During the survey, all participants were provided with an information sheet about psychosocial  
 27 resources available to them and an option within the study to indicate interest in supported referrals to  
 28 services. Adolescents will be invited to join the interpretations of the findings and dissemination stages  
 29 of the research as well.

## 36 20 **3. Results**

### 37 38 21 **3.1 Sample characteristics**

39 The eligible participants in this study were aged 11 to 16 years old, with a mean age of  $13.32 \pm$   
 40  $0.96$ . Boys included in the analysis were slightly more than girls (51.38% vs. 48.62%). Table 1 exhibits  
 41 the variables used in this study by gender. Compared to boys, girls reported fewer experiences of being  
 42 bullied within 6 months and fewer close friends. Boys scored higher on attentional impulsivity, and  
 43 lower on non-planning impulsivity. Additionally, gender differences in the proportion of only child,  
 44 family caring, social cohesion, total impulsivity, and motor impulsivity are statistically insignificant  
 45 ( $P > 0.05$ ), while the prevalence of aggressive behaviors is higher among boys than among girls ( $P$   
 46  $< 0.05$ ).

53 30 **Table 1** Description of demographic variables, aggressive behaviors, impulsivity, and covariates

55 Variables	56 Total (N=1524)	57 Boys (n=783)	58 Girls (n=741)
59 Aggressors (%)	7.48	10.60	4.18 *
60 Only child (%)	78.74	80.20	77.19

Bulled within 6 month (%)	35.24	39.59	30.23 *
No. of close friends (%)			
0-3	36.35	31.03	41.97 *
4-6	30.71	31.16	20.23
7-	32.94	37.08	27.80
Neighbors caring for each other (%)			
Never or seldom	19.95	20.82	19.03
Sometimes	34.58	33.46	35.76
Always	39.57	39.46	39.68
Perceived care from the primary caregiver (%)			
Lower	48.56	49.04	48.04
Higher	49.51	48.28	50.20
Age (Mean ± SD)	13.32 (0.96)	13.35 (0.98)	13.28 (0.94)
Total impulsivity (Mean ± SD)	2.04 (0.34)	2.05 (0.34)	2.04 (0.33)
Attentional impulsivity (Mean ± SD)	2.00 (0.39)	2.04 (0.41)	1.96 (0.37) &
Motor impulsivity (Mean ± SD)	2.01 (0.42)	2.01 (0.43)	2.00 (0.42)
Non-planning impulsivity (Mean ± SD)	2.11 (0.47)	2.08 (0.47)	2.15 (0.46) <sup>s</sup>

Note: percentages may not add to 100% due to missing data

\*:  $p < 0.05$ , chi-square test; &:  $p < 0.05$ , Wilcoxon test; <sup>s</sup>:  $p < 0.05$ , two-independent t-test.

### 3.2 Score of impulsivity between aggressors and non-aggressors

Table 2 shows the comparison of impulsivity between aggressors and non-aggressors by gender. The mean score of BIS-11 in aggressors was 2.27 and 2.32 among boys and girls, respectively, which were significantly higher than their counterparts ( $P < 0.001$ ). Moreover, the scores of AI, MI, and NPI in aggressors were significantly higher than those of non-aggressors for both boys and girls ( $P < 0.001$ ).

**Table 2** The score (mean ± SD) of impulsivity, grouping by gender and aggressive behavior

	Boys			Girls		
	Aggressors	Non-aggressors	<i>P</i>	Aggressors	Non-aggressors	<i>P</i>
Total impulsivity	2.27 (0.36)	2.02 (0.33)	<0.001*	2.32 (0.40)	2.03 (0.33)	<0.001&
AI	2.27 (0.45)	2.02 (0.39)	<0.001*	2.20 (0.46)	1.95(0.36)	0.002&
MI	2.28 (0.51)	1.98 (0.41)	<0.001&	2.33 (0.52)	1.99 (0.40)	<0.001&
NPI	2.26 (0.44)	2.06 (0.46)	<0.001*	2.41 (0.52)	2.14 (0.46)	0.001*

\*: two-independent t-test; &: Wilcoxon test

### 3.3 Factors associated with aggressive behavior

For the total sample, the multivariate logistic regression model results indicated the risk of aggressive behaviors was significantly increased among those with the highest tertile of total impulsivity, AI, MI, and NPI when compared with those among the lowest tertile (Table 3, OR:

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2  
3 1 1.99~3.23). However, a statistically significant difference was not found among the middle tertile  
4 2 group and the lowest tertile group. Table 4 and Table 5 exhibits the results of gender-stratified data  
5 3 analysis for boys and girls, respectively. Similarly, for total impulsivity and MI(model 1 and model 3),  
6 4 the risk of conducting aggressive behaviors significantly increased in the highest tertile group  
7 5 compared to those in the lowest tertile group. However, for AI and NPI (model 2 and model 4), the  
8 6 risk of conducting aggressive behaviors in the highest or middle tertile group was not statistically  
9 7 increased versus the lowest tertile group.

10 8 The results suggested that female adolescents were less likely to be an aggressor (Table 3, OR:  
11 9 0.43~0.48). For boys, those who reported a higher level of family caring were less likely to be an  
12 10 aggressor (Table 4), whereas such an effect was not significant among girls. On the contrary, older age  
13 11 and higher social cohesion were associated with a lower risk of aggressive behaviors among girls  
14 12 (Table 5), while these effects were not significant among boys. Being bullied within 6 months may  
15 13 significantly increase the risk of aggressive behaviors for both boys and girls. However, the number  
16 14 of close friends, family structure (only child) showed no significant associations with aggressive  
17 15 behaviors in this study (Table 4 and 5).

**Table 3** Factors associated with aggressive behaviors among all samples: results of a multivariable binary Firth logistic regression model

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Age (years)				
11~13	ref	ref	ref	ref
14~16	0.54 (0.34-0.88)	0.54 (0.33-0.87)	0.51 (0.31-0.83)	0.54 (0.34-0.88)
Gender				
Boys	ref	ref	ref	ref
Girls	0.43 (0.27-0.70)	0.48 (0.29-0.77)	0.45 (0.28-0.73)	0.43 (0.27-0.70)
No. of close friends				
0~3	ref	ref	ref	ref
4~6	1.09 (0.62-1.90)	1.08 (0.62-1.90)	1.10 (0.63-1.94)	1.12 (0.64-1.95)
≥7	1.56 (0.90-2.68)	1.42 (0.83-2.44)	1.46 (0.85-2.52)	1.57 (0.91-2.71)
Perceived care from the primary caregiver				
Lower	ref	ref	ref	ref
Higher	0.58 (0.35-0.94)	0.57 (0.35-0.93)	0.58 (0.35-0.95)	0.56 (0.35-0.92)
Only child				
Yes	ref	ref	ref	ref
No	1.62 (0.99-2.68)	1.62 (0.98-2.65)	1.66 (1.01-2.75)	1.56 (0.95-2.57)
Neighbors caring for each other				
Never or seldom	ref	ref	ref	ref
Sometimes	0.65 (0.38-1.11)	0.69 (0.41-1.18)	0.66 (0.39-1.12)	0.66 (0.39-1.12)
Always	0.46 (0.25-0.83)	0.45 (0.25-0.82)	0.43 (0.23-0.78)	0.45 (0.25-0.82)
Being bullied within 6 months				
No	ref	ref	ref	ref
Yes	7.83 (4.44-13.80)	8.23 (4.67-14.50)	8.15 (4.62-14.39)	8.46 (4.81-14.88)

Impulsivity				
Lowest tertile	ref	ref	ref	ref
Middle tertile	2.02 (0.99-4.11)	1.04 (0.55-1.99)	1.26 (0.67-2.37)	1.29 (0.68-2.45)
Highest tertile	3.23 (1.70-6.16)	1.99 (1.12-3.54)	3.07 (1.72-5.50)	2.04 (1.11-3.72)

Note: the impulsivity in the model 1, 2, 3, and 4 refers to the total, attentional, motor, and non-planning impulsivity, respectively.

**Table 4** Factors associated with aggressive behaviors among boys: results of a multivariate binary Firth logistic regression model

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Age (years)				
11~13	ref	ref	ref	ref
14~16	0.69 (0.39-1.20)	0.67 (0.38-1.16)	0.65 (0.37-1.13)	0.70 (0.40-1.21)
No. of close friends				
0~3	ref	ref	ref	ref
4~6	1.25 (0.64-2.46)	1.19 (0.60-2.33)	1.25 (0.63-2.46)	1.26 (0.64-2.46)
≥7	1.68 (0.86-3.27)	1.48 (0.77-2.87)	1.54 (0.79-3.01)	1.65 (0.84-3.21)
Perceived care from the primary caregiver				
Lower	ref	ref	ref	ref
Higher	0.49 (0.27-0.88)	0.47 (0.26-0.84)	0.49 (0.27-0.89)	0.48 (0.27-0.87)
Only child				
Yes	ref	ref	ref	ref
No	1.35 (0.72-2.53)	1.40 (0.75-2.62)	1.35 (0.72-2.54)	1.30 (0.69-2.43)
Neighbors caring for each other				
Never or seldom	ref	ref	ref	ref

Sometimes	0.81 (0.42-1.55)	0.87 (0.46-1.67)	0.85 (0.44-1.64)	0.82 (0.43-1.56)
Always	0.59 (0.28-1.21)	0.58 (0.28-1.20)	0.55 (0.27-1.13)	0.55 (0.27-1.13)
Being bullied within 6 months				
No	ref	ref	ref	ref
Yes	6.93 (3.56-13.50)	7.20 (3.70-13.99)	7.17 (3.67-14.01)	7.49 (3.86-14.53)
Impulsivity				
Lowest tertile	ref	ref	ref	ref
Middle tertile	1.86 (0.82-4.22)	0.84 (0.38-1.88)	1.20 (0.57-2.54)	1.41 (0.68-2.91)
Highest tertile	3.14 (1.48-6.65)	1.96 (0.99-3.89)	2.91 (1.46-5.82)	1.82 (0.89-3.72)

Note: the impulsivity in models 1, 2, 3, and 4 refers to the total, attentional, motor, and non-planning impulsivity, respectively.

**Table 5** Factors associated with aggressive behavior among girls: results of a multivariate binary Firth logistic regression model

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Age (years)				
11~13	ref	ref	Ref	ref
14~16	0.33 (0.12-0.89)	0.34 (0.13-0.89)	0.32 (0.12-0.86)	0.34 (0.13-0.90)
No. of close friends				
0~3	ref	ref	Ref	ref
4~6	0.80 (0.29-2.18)	0.87 (0.32-2.34)	0.92 (0.34-2.50)	0.91 (0.33-2.48)
≥7	1.27 (0.50-3.23)	1.26 (0.50-3.17)	1.26 (0.49-3.24)	1.33 (0.52-3.40)
Perceived care from the primary caregiver				
Lower	ref	ref	Ref	ref
Higher	0.93 (0.39-2.21)	0.93 (0.38-2.26)	0.90 (0.38-2.13)	0.86 (0.37-2.03)
Only child				

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2					
3	Yes	ref	ref	Ref	ref
4	No	2.15 (0.94-4.92)	2.08 (0.91-4.77)	2.20 (0.94-5.15)	2.00 (0.87-4.58)
5					
6	Neighbors caring for each other				
7	Never or seldom	ref	ref	Ref	ref
8	Sometimes	0.47 (0.19-1.17)	0.47 (0.19-1.16)	0.43 (0.17-1.09)	0.46 (0.19-1.16)
9	Always	0.30 (0.10-0.86)	0.31 (0.11-0.88)	0.28 (0.10-0.81)	0.32 (0.11-0.92)
10					
11	Being bullied within 6 months				
12	No	ref	ref	Ref	ref
13	Yes	9.65 (3.38-27.55)	10.24 (3.61-29.06)	10.08 (3.53-28.76)	10.09 (3.55-28.65)
14					
15	Impulsivity				
16	Lowest tertile	ref	ref	Ref	ref
17	Middle tertile	2.67 (0.69-10.37)	1.64 (0.56-4.83)	1.38 (0.44-4.32)	1.15 (0.31-4.34)
18	Highest tertile	3.74 (1.10-12.76)	2.13 (0.73-6.19)	3.57 (1.25-10.20)	2.75 (0.91-8.36)
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Note: the impulsivity in the model 1, 2, 3, and 4 refers to the total, attentional, motor, and non-planning impulsivity, respectively.

#### 4. Discussion

The present study sought to add to our knowledge about the relationship between impulsivity and aggression among adolescents by exploring this relationship in a sample of Chinese primary/middle school students. Positive associations were found between the higher levels of total impulsivity and aggressive behaviors, demonstrating the consistent relationship of impulsivity and aggression [7, 8, 34, 35]. The physiological mechanism of impulsivity was generally considered as an excitatory response produced by the nervous system; when stimulated by internal or external factors, it may give rise to an intense emotional state within a short period. This emotion constitutes the basis for aggressive behavior<sup>[13]</sup>. On the one hand, an individual with high motor impulsivity can be more decisive and courageous on the spur of impulses in the face of unexpected opportunities or challenges and difficulties. On the other hand, if an individual lacks the cognitive resources necessary to manage impulses (of high attentional impulsivity), they can be driven by desire or anger to conduct aggressive behaviors, resulting in a range of adverse outcomes<sup>[36]</sup>.

Studies among forensic and clinical samples found high impulsiveness in both types of aggression, with no significant difference in total scores measured by BIS<sup>[1 22]</sup>. Studies in ordinary western people indicated that the non-planning sub-trait of impulsivity was related to impulsive aggression<sup>[37]</sup>. In our sample, however, the correlation of non-planning impulsivity and aggression is not clearly supported. In the multivariate model of our study, a higher level of motor impulsivity was the only sub-trait that significantly contributed to aggressive behaviors among both boys and girls, suggesting that the aggressive behaviors among Chinese youth are conducted in adolescence majorly because of the act without thinking. Though the effects of attentional and non-planning impulsiveness were not statistically significant, there was a consistent trend in the multivariate model that the risk of conducting aggressive behaviors rose when the impulsive level increased. Our result indicated that it might be the critical window for early intervention during the adolescence period before the sub-trait and related cognitive deficit triggered the harmful behavior.

The finding that better family care is negatively related to adolescent boys' aggression (OR: 0.47~0.49) is in line with the family coercion theory, which assumes that positive family interactions decrease boys' problem behaviors<sup>[33]</sup>. Insufficient family care might contribute to adolescents' aggressive behaviors in many ways: less monitoring and lack of adults to confide in when anger is



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4 1 triggered because of events and processes in the environment. Further, those adolescents who have  
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6 2 grown up with less family care are more likely to elicit negative responses from their parents as they  
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8 3 begin to assert their autonomy and independence. These negative interactions are likely to result in  
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10 4 increasingly aversive and coercive processes, putting adolescents at a higher risk of aggression and  
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12 5 other behavioral problems<sup>[34]</sup>. Interestingly, such a finding was only positive among boys. It might be  
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14 6 because female students are less likely to behave in aggressive ways physically and are always required  
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16 7 to be quiet, gentle, and polite under Chinese culture, which does not distinguish between aggressors  
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18 8 and non-aggressors.

19 9 A previous study has demonstrated that social and environmental factors were the principal  
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21 10 influences of aggression and that neighborhood support was a significant protective factor against  
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23 11 attack <sup>[37]</sup>. Our study also indicated that adolescent girls' neighborhood support may significantly  
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25 12 decrease their likelihood of aggressive behaviors (OR:0.28~0.32). Poor neighborhood environment -  
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27 13 characterized by high levels of violence, anger, and disapproval and low warmth and support - has  
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29 14 been reported to be associated with an increased risk of behavior problems and delinquency and  
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31 15 aggression in adolescents<sup>[38]</sup>. In contrast, students were likely to feel more supported – and less  
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33 16 aggressive - in a neighborhood that provides adequate resources and assistance for youth healthy  
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35 17 growth and development, such as after-school programming and recreational spaces<sup>[39]</sup>. These  
36  
37 18 resources may lead to less aggressive behavior by encouraging social networks and bonding within the  
38  
39 19 neighborhood<sup>[37]</sup>.

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41 20 Adolescent aggressors tend to have higher levels of life stress than their counterparts without such  
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43 21 behaviors<sup>[40]</sup>. Since the school has become the primary arena for an adolescent, stressors caused by  
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45 22 discordant school relationships were expected, such as peer conflicts or bullying<sup>[40]</sup>. Consistent with  
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47 23 previous research that school-related tensions were significant predictors of aggression<sup>[33]</sup>, our study  
48  
49 24 also suggested that peer bullying was associated with a higher risk of aggressive behavior (OR:  
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51 25 7.83~8.46). Adolescents with bullying experience are likely to breed a negative intention of hostility  
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53 26 and revenge. If the resulting negative emotions are not handled properly, it will cause aggressive  
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55 27 behavior once the victim has an opportunity to retaliate. Furthermore, adolescents tend to have a strong  
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57 28 ability to imitate. The bullying or aggression of their schoolmates may set a bad example, and thus  
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59 29 they might behave similarly in certain conditions. This finding implies the efforts to reduce youth  
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4 1 aggression by providing appropriate support and services to those students who have already been  
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6 2 bullied by their schoolmates or peers.

7  
8 3 The result of the present study indicated that female adolescents were less likely to be involved  
9  
10 4 in aggressive behavior toward others than their male counterparts (OR: 0.45–0.48). Females tend to  
11  
12 5 have less physical strength than males, thus, they are less likely to resort to violence to solve problems.  
13  
14 6 Previous studies has demonstrated that girls were prone to social aggression<sup>[38]</sup>. Though this study  
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16 7 included verbal and social aggression in the outcome related to bully (see supplement table S1 and S2  
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18 8 for multivariate analysis using bully, and physical attack as outcomes separately), the main focus was  
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20 9 still on physical aggression. Thus, the girls' aggressive behaviors may be under-estimated.

21  
22 10 We compared the prevalence of aggressive behavior in our study with previous studies  
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24 11 implemented in Chinese settings. Given the range of reported published estimates from 3.27 % among  
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26 12 middle-school students in Hubei Province to 19.80% of middle school students in Henan Province<sup>[39</sup>  
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28 13 <sup>40]</sup>, our results suggested a moderate prevalence estimate of aggressive behavior (7.48%). This  
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30 14 variation may partially be explained by various social conditions (e.g. economic status, cultural  
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32 15 environment, social security) and sample ascertainment methods in different studies. The lack of  
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34 16 standardized definition and measurement methods for adolescent aggression may also contribute to  
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36 17 the variation. The prevalence of aggressive behavior in our sample is significantly lower than that  
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38 18 among either Asian Americans or any other racial/ethnic group (White, Black, Hispanic) in the U.S.,  
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40 19 according to the result from the Youth Risk Behavior Surveillance System. Suggesting that cultural  
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42 20 factors might work as the modifiers between impulsivity and aggression<sup>[41]</sup>. A study among Chinese  
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44 21 and Canadian adolescents suggested that in Eastern cultures, individuals tend to define themselves in  
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46 22 the context of social relationships and group membership. Thus the expression of self-focused  
47  
48 23 emotions is discouraged, and peacefulness is highly valued<sup>[42]</sup>. However, such a trend might decrease  
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50 24 as the age increases or the living environment changes, indicating the necessity to employ a  
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52 25 developmental view of behavioral changes when considering the cultural influences.

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54 26 Naturally, there are limitations to this study. Firstly, the results cannot provide firm conclusions  
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56 27 regarding the causal effects proposed because of the cross-sectional design. Secondly, this study's  
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58 28 aggressive behaviors were assessed by two self-reported items, which may result in the  
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60 29 underestimation of aggression. Besides, we did not distinguish the impulsive aggressive behaviors

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4 1 from premediated aggressive behaviors. Further studies are needed to explore how each facet of  
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6 2 impulsivity plays the role differently in these two forms, given their different biological, psychological,  
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8 3 social etiologic factors and management strategies. Lastly, our findings may be affected by selection  
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10 4 bias due to missing data. However, given the proportion of the enrolled students excluded in the present  
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12 5 study was less than 6%, and we use more robust analytical strategies, the bias was adequately  
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14 6 controlled.

15 7 Aggression is one of the basic human traits aiding in the mechanism of survival. As part of our  
16  
17 8 makeup, it is human nature to be aggressive towards someone occasionally. Teachers, researchers and  
18  
19 9 health promoters need to tell students that there are times and places where aggression is acceptable.  
20  
21 10 They could also teach adolescents to learn how to channel aggression to the areas where it is  
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23 11 appropriate and useful. Our study's result does not imply that any individual trait or factor is to be  
24  
25 12 blamed for being the cause of aggressive and violent behaviors. It is always debatable whether  
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27 13 impulsivity signal healthy or unhealthy trends in the evolutionarily adaptive. Instead, we believe that  
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29 14 learning what combination of factors contributes to it could point to leads for designing the intervention  
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31 15 strategies to help young adolescents. That said, it is essential to understand that aggressive and violent  
32  
33 16 behaviors continue to be as much a reality in schools and society at large. Helping young adolescents  
34  
35 17 learn to control their impulsiveness, channeling the anger, and helping those at higher risks of being  
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37 18 aggressive could be approached to improving all adolescents' physical and psychological well-being  
38  
39 19 rather than only taking disciplinary action against aggressors.

## 40 41 20 42 43 21 **Conclusions**

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45 22 Despite the limitations, this study contributes to the growing body of research that tries to delve  
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47 23 into the relation between three sub-traits of impulsivity and aggressive behaviors through a sample of  
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49 24 Chinese middle school adolescent students. Consistent with research in other populations, a positive  
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51 25 association between impulsivity and aggressive behaviors were found. Specifically, such correlation  
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53 26 was more salient between motor impulsiveness sub-trait and aggressive behavior among boys and  
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55 27 girls. Furthermore, results also indicated that aggressive behaviors were affected by several factors  
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57 28 within the ecological model. Comprehensive intervention strategies such as controlling the  
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59 29 aggressor's impulsivity, teaching them to channel their anger, creating a supportive and nurturing  
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4 1 school and neighborhood environment as well as providing psychological support and services for  
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6 2 violence victims are needed.  
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#### 9 4 **Abbreviations**

10 5 BIS-11: Barratt Impulsivity Scale; CASI: Computer Assisted Self-Interview; AI: attentional  
11 6 impulsivity; MI: motor impulsivity; NPI: non-planning impulsivity; GEAS: The Global Early  
12  
13 7 Adolescent Study.  
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#### 18 9 **Acknowledgments**

20 10 The GEAS is a multinational study that aims to understand the development of gender norms in early  
21 11 adolescence and its impacts on adolescent health across time and geographies. The study operates in  
22 12 conjunction with the World Health Organization and the Johns Hopkins Bloomberg School of Public  
23 13 Health. Support for the study is made possible in part by the United States Agency for International  
24 14 Development (USAID), the World Health Organization, the David and Lucile Packard Foundation,  
25 15 the Bill and Melinda Gates Foundation, the Oak Foundation, and the United Nations Children's Fund.  
26 16 We wish to acknowledge all partners and funders for their supports. We would also thank all  
27 17 researchers and students who participate in the study, as well as administrators and teachers in target  
28 18 schools.  
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#### 40 20 **Source of funding**

41 21 The present study was funded by the Innovation-oriented Science and Technology Grant from NHC  
42 22 Key Laboratory of Reproduction Regulation (CX2017-05), and the Innovation-oriented Youth Science  
43 23 and Technology Grant (Q2018-1) from Shanghai Institute of Planned Parenthood Research.  
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#### 50 25 **Authors' contributions**

51 26 Chaohua Lou initiated the GEAS in Shanghai as a coordinator and project leader. All authors  
52 27 contributed to the study design and data collection. Chunyan Yu and Jiashuai Zhang conducted the  
53 28 data analysis and drafted the paper. All authors are involved in the writing of the manuscript and read  
54 29 and approved the final manuscript.  
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## 2 Declaration of interest

3 The authors report no conflicts of interest.

## 5 Data sharing statement

6 Data are available upon reasonable request but the approval of institutional review board will be  
7 necessary. Please contact the corresponding author for detail.

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## Supplements:

**Table S1** Factors associated with bullying among all samples: results of a multivariable binary logistic regression model

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age (years)				
11~13	ref	ref	ref	ref
14~16	0.58 (0.33-1.02)	0.59 (0.34-1.02)	0.52 (0.29-0.92)	0.59 (0.34-1.02)
Gender				
Boys	ref	ref	ref	ref
Girls	0.42 (0.23-0.74)	0.46 (0.26-0.82)	0.43 (0.24-0.77)	0.42 (0.23-0.74)
No. of close friends				
0~3	ref	ref	ref	ref
4~6	0.90 (0.47-1.74)	0.90 (0.47-1.74)	0.92 (0.47-1.78)	0.94 (0.49-1.81)
≥7	1.39 (0.74-2.59)	1.26 (0.68-2.33)	1.31 (0.70-2.46)	1.39 (0.75-2.61)
Perceived care from the primary caregiver				
Lower	ref	ref	ref	ref
Higher	0.56 (0.31-1.00)	0.55 (0.31-0.98)	0.57 (0.31-1.03)	0.55 (0.31-0.97)
Only child				
Yes	ref	ref	ref	ref
No	1.59 (0.89-2.84)	1.58 (0.89-2.82)	1.64 (0.91-2.95)	1.52 (0.85-2.71)
Neighbors caring for each other				
Never or seldom	ref	ref	ref	ref
Sometimes	0.53 (0.28-0.99)	0.57 (0.30-1.06)	0.54 (0.28-1.02)	0.54 (0.29-1.02)
Always	0.55 (0.28-1.07)	0.54 (0.28-1.05)	0.51 (0.26-1.00)	0.54 (0.28-1.07)

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
<b>Being bullied within 6 months</b>				
No	ref	ref	ref	ref
Yes	7.25 (3.67-14.31)	7.73 (3.91-15.26)	7.58 (3.83-15.01)	7.97 (4.04-15.71)
<b>Impulsivity</b>				
Lowest tertile	ref	ref	ref	ref
Middle tertile	2.30 (0.97-5.44)	1.00 (0.47-2.16)	0.98 (0.44-2.16)	1.06 (0.49-2.27)
Highest tertile	3.62 (1.65-7.94)	1.94 (0.99-3.79)	3.51 (1.78-6.92)	2.04 (1.02-4.08)

Note: the impulsivity in the model 1, 2, 3, and 4 refers to the total, attentional, motor, and non-planning impulsivity, respectively.

**Table S2** Factors associated with physical violence among all samples: results of a multivariable binary logistic regression model

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Age (years)				
11~13	ref	ref	ref	ref
14~16	0.72 (0.41-1.24)	0.71 (0.41-1.23)	0.69 (0.39-1.20)	0.72 (0.42-1.24)
Gender				
Boys	ref	ref	ref	ref
Girls	0.40 (0.22-0.71)	0.45 (0.25-0.80)	0.42 (0.23-0.75)	0.40 (0.23-0.72)
No. of close friends				
0~3	ref	ref	ref	ref
4~6	1.26 (0.65-2.45)	1.25 (0.65-2.44)	1.26 (0.65-2.46)	1.28 (0.66-2.47)
≥7	1.60 (0.84-3.05)	1.46 (0.77-2.78)	1.48 (0.78-2.83)	1.58 (0.83-3.01)
Perceived care from the primary caregiver				
Lower	ref	ref	ref	ref
Higher	0.68 (0.38-1.19)	0.68 (0.38-1.20)	0.67 (0.38-1.19)	0.66 (0.37-1.15)
Only child				
Yes	ref	ref	ref	ref
No	1.33 (0.72-2.44)	1.32 (0.72-2.42)	1.34 (0.73-2.47)	1.29 (0.71-2.37)
Neighbors caring for each other				
Never or seldom	ref	ref	ref	ref
Sometimes	0.64 (0.34-1.21)	0.68 (0.36-1.28)	0.66 (0.35-1.24)	0.66 (0.35-1.23)
Always	0.57 (0.28-1.13)	0.57 (0.29-1.13)	0.53 (0.27-1.05)	0.54 (0.27-1.08)
Being bullied within 6 months				

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
No	ref	ref	ref	ref
Yes	7.40 (3.74-14.64)	7.77 (3.92-15.36)	7.65 (3.87-15.15)	8.18 (4.15-16.16)
Impulsivity				
Lowest tertile	ref	ref	ref	ref
Middle tertile	2.28 (0.97-5.37)	1.20 (0.54-2.65)	1.51 (0.70-3.24)	1.31 (0.63-2.73)
Highest tertile	3.57 (1.62-7.83)	2.41 (1.19-4.88)	3.13 (1.54-6.34)	1.84 (0.91-3.70)

Note: the impulsivity in the model 1, 2, 3, and 4 refers to the total, attentional, motor, and non-planning impulsivity, respectively.

# Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

## Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

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In your methods section, say that you used the STROBE cross sectional reporting guidelines, and cite them as:

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		Page
	Reporting Item	Number
<b>Title and abstract</b>		
Title	<a href="#">#1a</a> Indicate the study's design with a commonly used term in the title or the abstract	1

1	Abstract	<a href="#">#1b</a>	Provide in the abstract an informative and balanced summary	2
2				
3			of what was done and what was found	
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5				
6	<b>Introduction</b>			
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10	Background /	<a href="#">#2</a>	Explain the scientific background and rationale for the	3-4
11	rationale		investigation being reported	
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15	Objectives	<a href="#">#3</a>	State specific objectives, including any prespecified	4
16			hypotheses	
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20	<b>Methods</b>			
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23	Study design	<a href="#">#4</a>	Present key elements of study design early in the paper	4
24				
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26	Setting	<a href="#">#5</a>	Describe the setting, locations, and relevant dates, including	4-5
27			periods of recruitment, exposure, follow-up, and data	
28			collection	
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34	Eligibility criteria	<a href="#">#6a</a>	Give the eligibility criteria, and the sources and methods of	4
35			selection of participants.	
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40		<a href="#">#7</a>	Clearly define all outcomes, exposures, predictors, potential	5-6
41			confounders, and effect modifiers. Give diagnostic criteria, if	
42			applicable	
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47	Data sources /	<a href="#">#8</a>	For each variable of interest give sources of data and details	5
48	measurement		of methods of assessment (measurement). Describe	
49			comparability of assessment methods if there is more than	
50			one group. Give information separately for for exposed and	
51			unexposed groups if applicable.	
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1	Bias	<a href="#">#9</a>	Describe any efforts to address potential sources of bias	5-6
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4	Study size	<a href="#">#10</a>	Explain how the study size was arrived at	5
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7	Quantitative	<a href="#">#11</a>	Explain how quantitative variables were handled in the	6
8	variables		analyses. If applicable, describe which groupings were	
9			chosen, and why	
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15	Statistical	<a href="#">#12a</a>	Describe all statistical methods, including those used to	6
16	methods		control for confounding	
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20	Statistical	<a href="#">#12b</a>	Describe any methods used to examine subgroups and	6
21	methods		interactions	
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26	Statistical	<a href="#">#12c</a>	Explain how missing data were addressed	5-6
27	methods			
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31	Statistical	<a href="#">#12d</a>	If applicable, describe analytical methods taking account of	N/A
32	methods		sampling strategy	
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36	Statistical	<a href="#">#12e</a>	Describe any sensitivity analyses	N/A
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42	<b>Results</b>			
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45	Participants	<a href="#">#13a</a>	Report numbers of individuals at each stage of study—eg	4,7
46			numbers potentially eligible, examined for eligibility,	
47			confirmed eligible, included in the study, completing follow-	
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49			exposed and unexposed groups if applicable.	
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57	Participants	<a href="#">#13b</a>	Give reasons for non-participation at each stage	4
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1	Participants	<a href="#">#13c</a>	Consider use of a flow diagram	5
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4	Descriptive data	<a href="#">#14a</a>	Give characteristics of study participants (eg demographic,	7
5			clinical, social) and information on exposures and potential	
6			confounders. Give information separately for exposed and	
7			unexposed groups if applicable.	
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14	Descriptive data	<a href="#">#14b</a>	Indicate number of participants with missing data for each	7
15			variable of interest	
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19	Outcome data	<a href="#">#15</a>	Report numbers of outcome events or summary measures.	7
20			Give information separately for exposed and unexposed	
21			groups if applicable.	
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27	Main results	<a href="#">#16a</a>	Give unadjusted estimates and, if applicable, confounder-	8-11
28			adjusted estimates and their precision (eg, 95% confidence	
29			interval). Make clear which confounders were adjusted for	
30			and why they were included	
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37	Main results	<a href="#">#16b</a>	Report category boundaries when continuous variables were	8-11
38			categorized	
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42	Main results	<a href="#">#16c</a>	If relevant, consider translating estimates of relative risk into	N/A
43			absolute risk for a meaningful time period	
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48	Other analyses	<a href="#">#17</a>	Report other analyses done—e.g., analyses of subgroups	21
49			and interactions, and sensitivity analyses	
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53	<b>Discussion</b>			
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56	Key results	<a href="#">#18</a>	Summarise key results with reference to study objectives	12-15
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1	Limitations	<a href="#">#19</a>	Discuss limitations of the study, taking into account sources	14-15
2			of potential bias or imprecision. Discuss both direction and	
3			magnitude of any potential bias.	
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9	Interpretation	<a href="#">#20</a>	Give a cautious overall interpretation considering objectives,	12-15
10			limitations, multiplicity of analyses, results from similar	
11			studies, and other relevant evidence.	
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16	Generalisability	<a href="#">#21</a>	Discuss the generalisability (external validity) of the study	14
17			results.	
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22	<b>Other Information</b>			
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25	Funding	<a href="#">#22</a>	Give the source of funding and the role of the funders for the	16-17
26			present study and, if applicable, for the original study on	
27			which the present article is based	
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# BMJ Open

## Correlations of impulsivity and aggressive behaviors among adolescents in Shanghai, China using bioecological model: cross-sectional data from Global Early Adolescent Study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-043785.R2
Article Type:	Original research
Date Submitted by the Author:	26-May-2021
Complete List of Authors:	Yu, Chunyan; Shanghai Institute of Planned Parenthood Research, Department of Epidemiology & Social Science Zhang, Jiashuai; Fudan University School of Public Health Zuo, Xiayun; Shanghai Institute of Planned Parenthood Research, Dep. of epidemiology & social science Lian, Qiguo; Shanghai Institute of Planned Parenthood Research, Dep. of epidemiology & social science Tu, Xiaowen; Shanghai Institute of Planned Parenthood Research, Dep. of epidemiology & social science Lou, Chaohua; Shanghai Institute of Planned Parenthood Research, Department of Epidemiology & Social Science
<b>Primary Subject Heading</b>:	Mental health
Secondary Subject Heading:	Public health
Keywords:	Child & adolescent psychiatry < PSYCHIATRY, PUBLIC HEALTH, Impulse control disorders < PSYCHIATRY

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3 1 **Correlations of impulsivity and aggressive behaviors among adolescents in Shanghai, China**  
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5 2 **using bioecological model: cross-sectional data from Global Early Adolescent Study**

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30 15 Keywords: Adolescent; Impulsivity; Aggressive behaviors; Neighborhood supports.  
31 15  
32 16

33 16 Word counts: 4143 words  
34 16

35 17 Total Pages: 23  
36 17

37 18 Tables: 5  
38 18  
39 19

40 19 Supplementary files: 4 tables  
41 20  
42 20  
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## 1 ABSTRACT

2 **Objective:** To examine the correlations between impulsivity and aggressive behaviors among  
3 Chinese adolescents.

4 **Design:** A school-based cross-sectional study.

5 **Setting:** Three primary middle schools located in less-developed communities of Shanghai.

6 **Participants:** 1524 adolescents aged 11 to 16 years.

7 **Measures:** The impulsivity was measured by Barratt Impulsivity Scale (BIS-11), and the aggressive  
8 behaviors were determined by self-reports. Data were collected through Computer-Assisted Self-  
9 Interview using tablets. Multivariate Firth logistic regression model was conducted to examine  
10 correlations between total, attentional, motor, and non-planning impulsivity and aggressive  
11 behaviors, respectively

12 **Results:** Totally 7.48% of participants reported aggressive behaviors toward others during the past 6  
13 months. The proportion of aggressors among boys and girls was 10.60% and 4.18%, respectively.  
14 Results of the multivariate regression suggested the risk of aggressive behaviors was significantly  
15 increased among those with the highest tertile of total impulsivity (aOR<sub>boys</sub>=3.14, 95%CI: 1.48-6.65;  
16 aOR<sub>girls</sub>=3.74, 95%CI: 1.10-12.76) and motor impulsivity (aOR<sub>boys</sub>=2.91, 95%CI: 1.46-5.82;  
17 aOR<sub>girls</sub>=3.57, 95%CI: 1.25-10.20.), comparing with those with the lowest tertile, for boys and girls,  
18 respectively. Besides, younger age, lower social cohesion, and being bullied within 6 months were  
19 associated with a higher risk of aggressive behaviors among girls. Less family caring and being  
20 bullied within 6 months were associated with the risk among boys.

21 **Conclusions:** The present study indicates a positive association between impulsivity and aggressive  
22 behaviors, with a more salient correlation between motor impulsivity sub-trait and aggressive  
23 behavior among both boys and girls. Furthermore, adolescents' aggressive behaviors were affected  
24 by multiple factors from individuals, family, peers, and community. Comprehensive intervention  
25 strategies such as controlling the aggressor's impulsivity, helping them better channel their anger,  
26 creating a better family, school, and neighborhood environment, and providing support and services  
27 for violence victims are needed.

28 **Keywords:** Adolescent; Impulsivity; Aggressive behaviors; Neighborhood supports.

### 29 **Strengths and limitations of this study :**

- 30 1. The study used a reliable and validated scale to access impulsivity among the participants.
- 31 2. The findings warrant further exploration of the impulsiveness subscales to the understanding of  
32 aggressive behaviors critically.

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3 1 3. The simplified measurement of aggressive behavior prevents the further distinction of impulsive  
4 2 aggressive behavior from premediated aggressive behavior. Further studies are needed to explore  
5 3 how different facets of impulsivity play the role differently in these two forms.  
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For peer review only



## 1. Introduction

Aggression is a complex concept. It has traditionally been classified into two distinct subtypes, impulsive (also known as reactive or hostile) or premeditated (also known as proactive or instrumental). The former is characterized by uncontrolled and exaggerated responses to the stimuli, while the latter is defined as planned or conscious aggressive acts, not spontaneous or related to an agitated state<sup>[1]</sup>. Though the division is not without meaningfulness to guide the prevention and intervention due to the potential harm it could cause, there were some criticism of the dichotomous method of characterizing aggressive behavior as the distinction of the two is not that clear and it is the harm that should be concerned regardless the typology of the actions <sup>[2]</sup>.

Previous studies have indicated that aggressive behavior was associated with a range of adverse outcomes in adolescence, such as the increased risk of depressive symptoms, delinquency, internet addiction, and suicide attempts<sup>[3-6]</sup>. In the school setting, aggressive behavior was related to low academic performance scores and higher peer rejection<sup>[3, 7]</sup>. At the family level, significant relationships were observed between aggressive behavior on the one hand and family conflict and low family cohesion on the other<sup>[3]</sup>. More importantly, if aggressive behaviors become prevalent during this developmental stage, they can be escalated and persist<sup>[8]</sup>. Evidence from longitudinal research has demonstrated that adolescents with higher aggression levels are at greater risk of criminal activity and violence, peer victimization, rule-breaking behaviors, internalizing symptoms, and narcissistic and borderline personality features in the future<sup>[9, 10]</sup>. Furthermore, adolescents with higher aggressiveness tend to have difficulties in controlling waves of anger in adulthood and have consistently poorer outcomes across life success domains <sup>[11, 12]</sup>. Also, research has shown that high levels of aggression may result in high social costs because a range of services and resources are needed for the delinquency, incarceration, and unemployment<sup>[5, 9]</sup>.

As a personality trait with a strong biological foundation, impulsivity was defined as a quick and unplanned response for internal or external stimuli regardless of the negative consequences for an individual or others<sup>[13]</sup>. The definition of impulsivity does have overlaps with aggressiveness. It is also one of the main precursors of a set of antisocial behaviors and the basis for several pathological disorders such as attention-deficit/hyperactive disorder, borderline personality disorder and antisocial personality disorder<sup>[14-16]</sup>. A great number of studies in western countries have demonstrated a positive association between impulsivity and aggression<sup>[7, 17-19]</sup>, both concurrently and longitudinally. However, such correlations were majorly explored among the forensic population or clinical sample, or taking the impulsivity as a whole (using the total impulsive score in the analysis)) instead of considering it as a multi-facet construct.

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3 1 Among adolescents, studies showed that impulsivity might not be a direct risk for aggression.  
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5 2 Youth often cannot adequately manage their emotions when facing difficulties, leading them to behave  
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7 3 in aggressive ways [20]. Existing research also argues that behaviors resulting from motor impulsiveness  
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9 4 are by nature unplanned or reactive[21]. In contrast, behaviors resulting from attentional (cognitive)  
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11 5 impulsiveness are more likely to be planned or proactive. The latter should be taken more attention  
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13 6 and in consideration of targeted intervention or treatment[14]. Other research showed that impulsivity  
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15 7 was present in any type of aggressive act and did not distinguish between acts of premeditated or  
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17 8 impulsive aggression[16, 22, 23]. Given the mixed results and their relevance to both healthy and harmful  
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19 9 facets of the behaviors, the role of impulsivity still attracts numerous attentions. The question of  
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21 10 whether a person is capable of modulating their cognition and behavior to fit the demands of a given  
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23 11 environment is imperative[14], which makes understanding the role of impulsiveness in the forming of  
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25 12 aggression among healthy/ordinary population, especially among young adolescents who are at the  
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27 13 critical developing stage urgent.

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29 14 The present study is guided by Bronfenbrenner's bioecological model and Blum's conceptual  
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31 15 framework for research targeting early adolescence[24], including family-, school- and neighborhood-  
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33 16 factors in the process of shaping youth's aggressive behavior despite individual biological  
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35 17 characteristics and personal traits[25]. At the family level, family structure and parental connectedness  
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37 18 would help buffer the anger. While in school, peer interactions exert significant influences on the  
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39 19 conducting of aggressive behavior[25, 26]. Neighborhood environment is another important but always  
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41 20 neglected factor for shaping aggressive behavior as it provides the scenario for multiple health risk  
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43 21 behaviors[27]. For adolescence, specifically, it is a critical period for curtailing aggressive behaviors as  
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45 22 both impulsivity and sensation seeking (both relate to risk-taking behaviors)are at their peak during  
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47 23 this developmental window according to the Dual System Model[21]. The changes, stresses, and  
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49 24 disparities could arouse anger easily[8]. According to Blum's framework[24], adolescence is also a  
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51 25 dynamic developmental period of learning and adaptation, which creates both vulnerabilities and  
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53 26 unique opportunities for early intervention and prevention. Thus, the identification of risk factors is  
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55 27 critical to the understanding of aggressive behaviors among adolescents.

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57 28 There are also culturally bounded limits on acceptable levels of aggression or violent behaviors.  
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59 29 Aggressive behaviors over the boundaries of acceptable levels are often considered harmful[28]. Such  
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30 cultural differences were noted by researchers both in the level of aggression and their correlations,  
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32 31 reflected through the social environment and individual differences, including personality and  
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34 32 cognition [23]. In China, research on adolescents' impulsiveness were mainly focused on its impacts on  
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36 33 internet addiction and self-injury or suicidal behavior[29-31], while research on the association between  
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38 34 impulsivity and aggressive behaviors were scant. We used the wave 2 cross-sectional data from the

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3 1 Global Early Adolescent Study (GEAS) in Shanghai to examine the correlations of impulsivity and  
4 2 aggressive behaviors with the consideration of covariates in the individual, family, school and  
5 3 neighborhood level according to the bioecological model. GEAS is a multinational longitudinal study  
6 4 that focused on early adolescents in disadvantaged urban environments with a gender lens. For the  
7 5 present study, we hypothesized that (1) impulsivity would be positively correlated with young  
8 6 adolescents' aggressive behavior while the correlation would be strong among motor or non-planning  
9 7 impulsiveness and aggression; (2) ecological factors like family interactions, peer interactions and  
10 8 community environment would be influential to the forming of adolescents' aggressive behaviors.  
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## 13 11 **2. Methods**

### 14 12 **2.1. Study design and participants**

15 13 Data for this study were drawn from wave 2 of the GEAS investigation. A stratified cluster  
16 14 sampling procedure was adopted for the selection of participants in GEAS Shanghai site. Three  
17 15 primary public middle schools in two less-developed sub-districts of the Jing'an district in Shanghai  
18 16 were selected, and the fieldwork was implemented with the coordination of key informants from the  
19 17 local teacher's organization. All eligible students in grades 7<sup>th</sup> to 9<sup>th</sup> (the baseline investigation of  
20 18 GEAS was conducted in grades 6<sup>th</sup> to 8<sup>th</sup>) were invited to participate in the study after obtaining their  
21 19 assent and the consent of their parents or guardians.  
22 20

23 21 A total of 1611 adolescents participated in the wave 2 investigation. Of them, 87 (5.40%) were  
24 22 excluded because of missing information on impulsivity (16) or aggressive behaviors (71), respectively.  
25 23 Finally, 1524 eligible students were included in the data analysis.  
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### 27 25 **2.2. Procedure**

28 26 Data were collected through tablets using the Computer-Assisted Self-Interview (CASI) method  
29 27 during November and December in 2018. The students were organized by their teachers in the class  
30 28 units to fill in the electronic questionnaire independently during the lunch break or psychological class.  
31 29 In each class, 1-2 trained investigators were present in case the participants need assistance with the  
32 30 tablet using. Communication or discussion among participants during the process was dissuaded, while  
33 31 questions regarding the survey could be raised to the available investigators. The questionnaire took  
34 32 approximately 25 to 40 minutes to finish. The tablets were returned after the process and checked by  
35 33 the investigators to ensure that all necessary questions were answered before submission. Each student  
36 34 was compensated for their participation with a small gift valued at 20-30 CNY after the process.  
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38 36 The GEAS in Shanghai was approved by the Medical Ethical Committee of the Shanghai Institute  
39 37 for Biomedical and Pharmaceutical Technologies (Formerly named Shanghai Institute of Planned  
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3 1 Parenthood Research, No. PJ2017-27); a deemed exempt for secondary data analysis was approved by  
4 2 the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

### 6 3 **2.3. Measures**

#### 8 4 **2.3.1. Aggressive behavior**

10 5 Aggressive behavior was assessed by two items: 1): During the past 6 months, have you bullied  
11 6 or threatened another boy or girl for any reason? 2): During the past 6 months, have you slapped, hit,  
12 7 or otherwise physically hurt another boy or girl in any way that they did not want? Each item comprised  
13 8 six options: 1) no; 2) yes, both for girls and boys; 3) yes, for boys; 4) yes, for girls; 5) don't know; 6)  
14 9 refuse to answer. Options 5 and 6 were treated as missing values in data analysis. A student was  
15 10 classified into an aggressor if both or one of the two behaviors listed above exists.

#### 20 11 **2.3.2. Impulsivity**

22 12 Impulsivity was measured by BIS-11, a valid and reliable instrument developed by Barratt in  
23 13 1959 and revised by Patton in 1995<sup>[32]</sup>. The scale composed of 30 items and grouped into three  
24 14 subscales: attentional impulsivity (AI, 8 items) describes the tendency to inattention or to make a quick  
25 15 decision; motor impulsivity (MI, 11 items) is about the propensity to act solely on the spur of the  
26 16 moment despite the consequences; non-planning impulsivity (NPI, 11 items) indicates the lack of a  
27 17 plan for daily or long-term actions<sup>[32]</sup>. The items were rated by a 4-point Likert-type option from 1  
28 18 (rarely/ never) to 4 (almost always/ always). After reversely coded the negatively worded items, we  
29 19 calculated the mean scores of the scales. Higher scores indicated greater impulsiveness. Because of  
30 20 the absence of generalized cut-off values among youth across research, and the interest of us to see the  
31 21 changes of aggressive behaviors with increased levels of impulsivity, we split the continuous mean  
32 22 scores into tertiles in the multivariate regression model (The mean BIS cores of total- and sub- scale  
33 23 for each tertile among boys and girls were exhibited in the supplementary table S1) . The model  
34 24 compared the highest and middle to the lowest tertiles. Previous studies demonstrated the reliability  
35 25 and validity of BIS-11 when used in Chinese children and adolescents, and the polychoric ordinal  
36 26 alpha value in the present study was 0.62 for AI, 0.81 for NPI, and 0.74 for MI, and 0.89 for the total  
37 27 BIS.

#### 50 28 **2.3.3 Covariates**

51 29 Covariates include adolescents' age, binary indicators of gender at the individual level, binary  
52 30 indicators of family structure (only child vs. other), perceived care from the primary caregiver that  
53 31 reflecting family caring at the family level, number of close friends, experiences of being bullied within  
54 32 6 months at the school level, as well as perceived supports from the neighborhood.

### 58 33 **2.4. Data analysis**

60 34 The data analysis began with describing and comparing aggressive behavior, impulsivity, and

1 covariates between boys and girls. Secondly, the differences of the mean scores of BIS-11 and its  
 2 subscales between aggressors and non-aggressors were compared using either *t*-test or *Wilcoxon* test.  
 3 Thirdly, due to the lower prevalence of aggressors in the present study, the multivariate firth logistic  
 4 regression model<sup>[33]</sup> was conducted to assess the association between impulsivity and aggressive  
 5 behavior among the total sample, as well as boys' and girls', respectively. Four models were explored  
 6 for each group using total BIS-11 mean core and the mean score of each subscale (AI, MI, and NPI,  
 7 respectively). In each model, the demographic characteristics, as well as personal and bioecological  
 8 factors listed above were controlled. Before modeling, we first examined the cluster effects on the  
 9 level of school (level-3) and class (level-2) through multilevel zero-models to determine if the  
 10 hierarchical structure statistically exists in our data given the cluster obtained by cluster sampling. We  
 11 found, however, the effects were statistically insignificant both for boys or girls, and thus the general  
 12 logistic regression model was chosen for data analysis. The statistical analyses were conducted by  
 13 Stata SE version 15. The level of significance was set  $\alpha=0.05$  at two-tailed.

## 2.5. Patient and public involvement

15 Young adolescents were invited to test the face validity of the questionnaire in the designing  
 16 stage. During the survey, all participants were provided with an information sheet about psychosocial  
 17 resources available to them and an option within the study to indicate interest in supported referrals to  
 18 services. Adolescents will be invited to join the interpretations of the findings and dissemination stages  
 19 of the research as well.

## 3. Results

### 3.1 Sample characteristics

23 The eligible participants in this study were aged 11 to 16 years old, with a mean age of  $13.32 \pm$   
 24  $0.96$ . Boys included in the analysis were slightly more than girls (51.38% vs. 48.62%). Table 1 exhibits  
 25 the variables used in this study by gender. Compared to boys, girls reported fewer experiences of being  
 26 bullied within 6 months and fewer close friends. Boys scored higher on attentional impulsivity and  
 27 lower on non-planning impulsivity. Additionally, gender differences in the proportion of only child,  
 28 family caring, social cohesion, total impulsivity, and motor impulsivity are statistically insignificant  
 29 ( $P > 0.05$ ), while the prevalence of aggressive behaviors is higher among boys than among girls ( $P$   
 30  $< 0.05$ ).

**Table 1.** Description of demographic variables, aggressive behaviors, impulsivity, and covariates

Variables	Total (N=1524)	Boys (n=783)	Girls (n=741)
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Aggressors (%)	7.48	10.60	4.18 *
Only child (%)	78.74	80.20	77.19
Bullied within 6 month (%)	35.24	39.59	30.23 *
No. of close friends (%)			
0-3	36.35	31.03	41.97 *
4-6	30.71	31.16	20.23
7-	32.94	37.08	27.80
Neighbors caring for each other (%)			
Never or seldom	19.95	20.82	19.03
Sometimes	34.58	33.46	35.76
Always	39.57	39.46	39.68
Perceived care from the primary caregiver (%)			
Lower	48.56	49.04	48.04
Higher	49.51	48.28	50.20
Age (Mean ± SD)	13.32 (0.96)	13.35 (0.98)	13.28 (0.94)
Total impulsivity (Mean ± SD)	2.04 (0.34)	2.05 (0.34)	2.04 (0.33)
Attentional impulsivity (Mean ± SD)	2.00 (0.39)	2.04 (0.41)	1.96 (0.37) &
Motor impulsivity (Mean ± SD)	2.01 (0.42)	2.01 (0.43)	2.00 (0.42)
Non-planning impulsivity (Mean ± SD)	2.11 (0.47)	2.08 (0.47)	2.15 (0.46) <sup>s</sup>

Note: percentages may not add to 100% due to missing data

\*:  $p < 0.05$ , chi-square test; &:  $p < 0.05$ , Wilcoxon test; <sup>s</sup>:  $p < 0.05$ , two-independent t-test.

### 3.2 Score of impulsivity between aggressors and non-aggressors

Table 2 shows the comparison of impulsivity between aggressors and non-aggressors by gender. The mean score of BIS-11 in aggressors was 2.27 and 2.32 among boys and girls, respectively, significantly higher than their counterparts ( $P < 0.001$ ). Moreover, the scores of AI, MI, and NPI in aggressors were significantly higher than non-aggressors for both boys and girls ( $P < 0.001$ ).

**Table 2.** The score (mean ± SD) of impulsivity, grouping by gender and aggressive behavior

	Boys			Girls		
	Aggressors	Non-aggressors	<i>P</i>	Aggressors	Non-aggressors	<i>P</i>
Total impulsivity	2.27 (0.36)	2.02 (0.33)	<0.001*	2.32 (0.40)	2.03 (0.33)	<0.001&
AI	2.27 (0.45)	2.02 (0.39)	<0.001*	2.20 (0.46)	1.95(0.36)	0.002&
MI	2.28 (0.51)	1.98 (0.41)	<0.001&	2.33 (0.52)	1.99 (0.40)	<0.001&
NPI	2.26 (0.44)	2.06 (0.46)	<0.001*	2.41 (0.52)	2.14 (0.46)	0.001*

\*: two-independent t-test; &: Wilcoxon test

### 3.3 Factors associated with aggressive behavior

For the total sample, the multivariate logistic regression model results indicated the risk of aggressive behaviors was significantly increased among those with the highest tertile of total impulsivity, AI, MI, and NPI compared with those among the lowest tertile (Table 3). However, a



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3 1 statistically significant difference was not found among the middle tertile group and the lowest tertile  
4 2 group. Table 4 and Table 5 exhibits the results of gender-stratified data analysis for boys and girls,  
5 3 respectively. Similarly, for total impulsivity and MI(model 1 and model 3), the risk of conducting  
6 4 aggressive behaviors significantly increased in the highest tertile group compared to those in the lowest  
7 5 tertile group. However, for AI and NPI (model 2 and model 4), the risk of conducting aggressive  
8 6 behaviors in the highest or middle tertile group was not statistically increased versus the lowest tertile  
9 7 group.

10 8 The results suggested that female adolescents were less likely to be an aggressor (Table 3). For  
11 9 boys, those who reported a higher level of family caring were less likely to be an aggressor (Table 4),  
12 10 whereas such an effect was not significant among girls. On the contrary, older age and higher social  
13 11 cohesion were associated with a lower risk of aggressive behaviors among girls (Table 5), while these  
14 12 effects were not significant among boys. Being bullied within 6 months may significantly increase the  
15 13 risk of aggressive behaviors for both boys and girls. However, the number of close friends, family  
16 14 structure (only child) showed no significant associations with aggressive behaviors in this study (Table  
17 15 4 and 5).

**Table 3.** Factors associated with aggressive behaviors among all samples: results of a multivariable binary Firth logistic regression model

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Age (years)				
11-13	ref	ref	ref	ref
14-16	0.54 (0.34-0.88)	0.54 (0.33-0.87)	0.51 (0.31-0.83)	0.54 (0.34-0.88)
Gender				
Boys	ref	ref	ref	ref
Girls	0.43 (0.27-0.70)	0.48 (0.29-0.77)	0.45 (0.28-0.73)	0.43 (0.27-0.70)
No. of close friends				
0-3	ref	ref	ref	ref
4-6	1.09 (0.62-1.90)	1.08 (0.62-1.90)	1.10 (0.63-1.94)	1.12 (0.64-1.95)
≥7	1.56 (0.90-2.68)	1.42 (0.83-2.44)	1.46 (0.85-2.52)	1.57 (0.91-2.71)
Perceived care from the primary caregiver				
Lower	ref	ref	ref	ref
Higher	0.58 (0.35-0.94)	0.57 (0.35-0.93)	0.58 (0.35-0.95)	0.56 (0.35-0.92)
Only child				
Yes	ref	ref	ref	ref
No	1.62 (0.99-2.68)	1.62 (0.98-2.65)	1.66 (1.01-2.75)	1.56 (0.95-2.57)
Neighbors caring for each other				
Never or seldom	ref	ref	ref	ref
Sometimes	0.65 (0.38-1.11)	0.69 (0.41-1.18)	0.66 (0.39-1.12)	0.66 (0.39-1.12)
Always	0.46 (0.25-0.83)	0.45 (0.25-0.82)	0.43 (0.23-0.78)	0.45 (0.25-0.82)
Being bullied within 6 months				
No	ref	ref	ref	ref
Yes	7.83 (4.44-13.80)	8.23 (4.67-14.50)	8.15 (4.62-14.39)	8.46 (4.81-14.88)
Impulsivity				
Lowest tertile	ref	ref	ref	ref



Middle tertile	2.02 (0.99-4.11)	1.04 (0.55-1.99)	1.26 (0.67-2.37)	1.29 (0.68-2.45)
Highest tertile	3.23 (1.70-6.16)	1.99 (1.12-3.54)	3.07 (1.72-5.50)	2.04 (1.11-3.72)

Note: the impulsivity in the model 1, 2, 3, and 4 refers to the total, attentional, motor, and non-planning impulsivity, respectively.

**Table 4** Factors associated with aggressive behaviors among boys: results of a multivariate binary Firth logistic regression model

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Age (years)				
11-13	ref	ref	ref	ref
14-16	0.69 (0.39-1.20)	0.67 (0.38-1.16)	0.65 (0.37-1.13)	0.70 (0.40-1.21)
No. of close friends				
0-3	ref	ref	ref	ref
4-6	1.25 (0.64-2.46)	1.19 (0.60-2.33)	1.25 (0.63-2.46)	1.26 (0.64-2.46)
≥7	1.68 (0.86-3.27)	1.48 (0.77-2.87)	1.54 (0.79-3.01)	1.65 (0.84-3.21)
Perceived care from the primary caregiver				
Lower	ref	ref	ref	ref
Higher	0.49 (0.27-0.88)	0.47 (0.26-0.84)	0.49 (0.27-0.89)	0.48 (0.27-0.87)
Only child				
Yes	ref	ref	ref	ref
No	1.35 (0.72-2.53)	1.40 (0.75-2.62)	1.35 (0.72-2.54)	1.30 (0.69-2.43)
Neighbors caring for each other				
Never or seldom	ref	ref	ref	ref
Sometimes	0.81 (0.42-1.55)	0.87 (0.46-1.67)	0.85 (0.44-1.64)	0.82 (0.43-1.56)
Always	0.59 (0.28-1.21)	0.58 (0.28-1.20)	0.55 (0.27-1.13)	0.55 (0.27-1.13)
Being bullied within 6 months				
No	ref	ref	ref	ref
Yes	6.93 (3.56-13.50)	7.20 (3.70-13.99)	7.17 (3.67-14.01)	7.49 (3.86-14.53)

Impulsivity				
Lowest tertile	ref	ref	ref	ref
Middle tertile	1.86 (0.82-4.22)	0.84 (0.38-1.88)	1.20 (0.57-2.54)	1.41 (0.68-2.91)
Highest tertile	3.14 (1.48-6.65)	1.96 (0.99-3.89)	2.91 (1.46-5.82)	1.82 (0.89-3.72)

Note: the impulsivity in models 1, 2, 3, and 4 refers to the total, attentional, motor, and non-planning impulsivity, respectively.

**Table 5.** Factors associated with aggressive behavior among girls: results of a multivariate binary Firth logistic regression model

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Age (years)				
11-13	ref	ref	Ref	ref
14-16	0.33 (0.12-0.89)	0.34 (0.13-0.89)	0.32 (0.12-0.86)	0.34 (0.13-0.90)
No. of close friends				
0-3	ref	ref	Ref	ref
4-6	0.80 (0.29-2.18)	0.87 (0.32-2.34)	0.92 (0.34-2.50)	0.91 (0.33-2.48)
≥7	1.27 (0.50-3.23)	1.26 (0.50-3.17)	1.26 (0.49-3.24)	1.33 (0.52-3.40)
Perceived care from the primary caregiver				
Lower	ref	ref	Ref	ref
Higher	0.93 (0.39-2.21)	0.93 (0.38-2.26)	0.90 (0.38-2.13)	0.86 (0.37-2.03)
Only child				
Yes	ref	ref	Ref	ref
No	2.15 (0.94-4.92)	2.08 (0.91-4.77)	2.20 (0.94-5.15)	2.00 (0.87-4.58)
Neighbors caring for each other				
Never or seldom	ref	ref	Ref	ref
Sometimes	0.47 (0.19-1.17)	0.47 (0.19-1.16)	0.43 (0.17-1.09)	0.46 (0.19-1.16)
Always	0.30 (0.10-0.86)	0.31 (0.11-0.88)	0.28 (0.10-0.81)	0.32 (0.11-0.92)
Being bullied within 6 months				

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No	ref	ref	Ref	ref
Yes	9.65 (3.38-27.55)	10.24 (3.61-29.06)	10.08 (3.53-28.76)	10.09 (3.55-28.65)
Impulsivity				
Lowest tertile	ref	ref	Ref	ref
Middle tertile	2.67 (0.69-10.37)	1.64 (0.56-4.83)	1.38 (0.44-4.32)	1.15 (0.31-4.34)
Highest tertile	3.74 (1.10-12.76)	2.13 (0.73-6.19)	3.57 (1.25-10.20)	2.75 (0.91-8.36)

Note: the impulsivity in the model 1, 2, 3, and 4 refers to the total, attentional, motor, and non-planning impulsivity, respectively.

For peer review only

#### 4. Discussion

The present study sought to add to our knowledge about the relationship between impulsivity and aggression among adolescents by exploring this relationship in a sample of Chinese primary/middle school students. Positive associations were found between the higher levels of total impulsivity and aggressive behaviors, demonstrating the consistent relationship between impulsivity and aggression [7, 8, 34, 35]. The physiological mechanism of impulsivity was generally considered as an excitatory response produced by the nervous system; when stimulated by internal or external factors, it may give rise to an intense emotional state within a short period. This emotion constitutes the basis for aggressive behavior<sup>[13]</sup>. On the one hand, an individual with high motor impulsivity can be more decisive and courageous on the spur of impulses in the face of unexpected opportunities or challenges and difficulties. On the other hand, if an individual lacks the cognitive resources necessary to manage impulses (of high attentional impulsivity), they can be driven by desire or anger to conduct aggressive behaviors, resulting in a range of adverse outcomes<sup>[36]</sup>.

Studies among forensic and clinical samples found high impulsiveness in both types of aggression, with no significant difference in total scores measured by BIS<sup>[1 22]</sup>. Studies in ordinary western people indicated that the non-planning sub-trait of impulsivity was related to impulsive aggression<sup>[37]</sup>. In our sample, however, the correlation of non-planning impulsivity and aggression is not clearly supported. In the multivariate model of our study, a higher level of motor impulsivity was the only sub-trait that significantly contributed to aggressive behaviors among both boys and girls, suggesting that the aggressive behaviors among Chinese youth are conducted in adolescence majorly because of the act without thinking. Though the effects of attentional and non-planning impulsiveness were not statistically significant, there was a consistent trend in the multivariate model that the risk of conducting aggressive behaviors rose when the impulsive level increased. Our result indicated that it might be the critical window for early intervention during the adolescence period before the sub-trait and related cognitive deficit triggered the harmful behavior.

Bronfenbrenner's bioecological model supports the finding in our study that better family care was negatively related to adolescent boys' aggression. The result is also in line with the family coercion theory, which assumes that positive family interactions decrease boys' problem behaviors<sup>[33]</sup>. Insufficient family care might contribute to adolescents' aggressive behaviors in many ways: less

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4 1 monitoring and lack of adults to confide in when anger is triggered because of events and processes in  
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6 2 the environment. Further, those adolescents who have grown up with less family care are more likely  
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8 3 to elicit negative responses from their parents as they begin to assert their autonomy and independence.  
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10 4 These negative interactions are likely to result in increasingly aversive and coercive processes, putting  
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12 5 adolescents at a higher risk of aggression and other behavioral problems<sup>[34]</sup>. Interestingly, such a  
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14 6 finding was only positive among boys. It might be because female students are less likely to behave in  
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16 7 aggressive ways physically and are always required to be quiet, gentle, and polite under Chinese culture,  
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18 8 which does not distinguish between aggressors and non-aggressors.

19 9 A previous study has demonstrated that social and environmental factors were the principal  
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21 10 influences of aggression and that neighborhood support was a significant protective factor against  
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23 11 attack <sup>[37]</sup>. Our study also indicated that adolescent girls' neighborhood support might significantly  
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25 12 decrease their likelihood of aggressive behaviors. Poor neighborhood environment - characterized by  
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27 13 high levels of violence, anger, and disapproval and low warmth and support - has been reported to be  
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29 14 associated with an increased risk of behavior problems and delinquency and aggression in  
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31 15 adolescents<sup>[38]</sup>. In contrast, students were likely to feel more supported – and less aggressive - in a  
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33 16 neighborhood that provides adequate resources and assistance for youth healthy growth and  
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35 17 development, such as after-school programming and recreational spaces<sup>[39]</sup>. These resources may lead  
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37 18 to less aggressive behavior by encouraging social networks and bonding within the neighborhood<sup>[37]</sup>.

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39 19 Adolescent aggressors tend to have higher levels of life stress than their counterparts without such  
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41 20 behaviors<sup>[40]</sup>. Since the school has become the primary arena for an adolescent, stressors caused by  
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43 21 discordant school relationships were expected, such as peer conflicts or bullying<sup>[40]</sup>. Consistent with  
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45 22 the bioecological model as well as the previous research that school-related tensions were significant  
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47 23 predictors of aggression<sup>[33]</sup>, our study also suggested that peer bullying was associated with a higher  
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49 24 risk of aggressive behavior. Adolescents with bullying experience are likely to breed a negative  
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51 25 intention of hostility and revenge. If the resulting negative emotions are not handled properly, it will  
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53 26 cause aggressive behavior once the victim has an opportunity to retaliate. Furthermore, adolescents  
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55 27 tend to have a strong ability to imitate. The bullying or aggression of their schoolmates may set a bad  
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57 28 example, and thus they might behave similarly in certain conditions. This finding implies the efforts  
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59 29 to reduce youth aggression by providing appropriate support and services to those students who have  
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30 already been bullied by their schoolmates or peers.

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4 1 The result of the present study indicated that female adolescents were less likely to be involved  
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6 2 in aggressive behavior toward others than their male counterparts. Females tend to have less physical  
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8 3 strength than males; thus, they are less likely to resort to violence to solve problems. Previous studies  
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10 4 have demonstrated that girls were prone to social aggression<sup>[38]</sup>. Though this study included verbal and  
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12 5 social aggression in the outcome related to bully (see supplement table S2 and S3 for multivariate  
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14 6 analysis using bully and physical attack as outcomes separately), the main focus was still on physical  
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16 7 aggression. Thus, the girls' aggressive behaviors may be under-estimated.

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18 8 We compared the prevalence of aggressive behavior in our study with previous studies  
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20 9 implemented in Chinese settings. Given the range of reported published estimates from 3.27 % among  
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22 10 middle-school students in Hubei Province to 19.80% of middle school students in Henan Province<sup>[39]</sup>  
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24 11 <sup>40]</sup>, our results suggested a moderate prevalence estimate of aggressive behavior. This variation may  
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26 12 partially be explained by various social conditions (e.g., economic status, cultural environment, social  
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28 13 security) and sample ascertainment methods in different studies. The lack of standardized definition  
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30 14 and measurement methods for adolescent aggression may also contribute to the variation. The  
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32 15 prevalence of aggressive behavior in our sample is significantly lower than that among either Asian  
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34 16 Americans or any other racial/ethnic group (White, Black, Hispanic) in the U.S., according to the result  
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36 17 from the Youth Risk Behavior Surveillance System, suggesting that cultural factors might work as the  
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38 18 modifiers between impulsivity and aggression<sup>[41]</sup>. A study among Chinese and Canadian adolescents  
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40 19 suggested that in Eastern cultures, individuals tend to define themselves in the context of social  
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42 20 relationships and group membership. Thus the expression of self-focused emotions is discouraged, and  
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44 21 peacefulness is highly valued<sup>[42]</sup>. However, such a trend might decrease as the age increases or the  
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46 22 living environment changes, indicating the necessity to employ a developmental view of behavioral  
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48 23 changes when considering the cultural influences.

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50 24 Naturally, there are limitations to this study. Firstly, the results cannot provide firm conclusions  
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52 25 regarding the causal effects proposed because of the cross-sectional design. Secondly, this study's  
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54 26 aggressive behaviors were assessed by two self-reported items, which may result in the  
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56 27 underestimation of aggression. Third, instead of using sum-up scores, we used the tertile to categorize  
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58 28 the BIS score in the interest of making better use of existing data. Statistically, it would assume an  
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60 29 underlying qualitative difference between the groups, although such assumption may not exist or be  
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60 30 replicated by other studies. However, we did calculate the summary score of impulsivities, grouping

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4 1 by gender and aggressive behavior (supplementary table S4); the result is consistent with what we  
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6 2 presented using tertile splits. Besides, we did not distinguish impulsive aggressive behaviors from  
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8 3 premediated aggressive behaviors. Further studies are needed to explore how each facet of impulsivity  
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10 4 plays the role in these two forms of aggressive behaviors. To better understand their different biological,  
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12 5 psychological, social etiologic factors would help with making management strategies. Lastly, our  
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14 6 findings may be affected by selection bias due to missing data. However, given the proportion of the  
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16 7 enrolled students excluded in the present study was less than 6%, and we use more robust analytical  
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18 8 strategies, the bias was adequately controlled.

19 9 Aggression is one of the basic human traits aiding in the mechanism of survival. As part of our  
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21 10 makeup, it is human nature to be aggressive towards someone occasionally. Teachers, researchers and  
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23 11 health promoters need to tell students that there are times and places where aggression is acceptable.  
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25 12 They could also teach adolescents to learn how to channel aggression to the areas where it is  
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27 13 appropriate and useful. Our study's result does not imply that any individual trait or factor is to be  
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29 14 blamed for being the cause of aggressive and violent behaviors. It is always debatable whether  
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31 15 impulsivity signal healthy or unhealthy trends in the evolutionarily adaptive. Instead, we believe that  
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33 16 learning what combination of factors contributes to it could point to leads for designing the intervention  
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35 17 strategies to help young adolescents. That said, it is essential to understand that aggressive and violent  
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37 18 behaviors continue to be as much a reality in schools and society at large. Helping young adolescents  
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39 19 learn to control their impulsiveness, channeling the anger, and helping those at higher risks of being  
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41 20 aggressive could be approached to improving all adolescents' physical and psychological well-being  
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43 21 rather than only taking disciplinary action against aggressors.

## 44 45 22 46 23 **Conclusions**

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48 24 Despite the limitations, this study contributes to the growing body of research that tries to delve  
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50 25 into the relation between three sub-traits of impulsivity and aggressive behaviors through a sample of  
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52 26 Chinese middle school adolescent students. Consistent with research in other populations, a positive  
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54 27 association between impulsivity and aggressive behaviors were found. Specifically, such correlation  
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56 28 was more salient between motor impulsiveness sub-trait and aggressive behavior among boys and  
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58 29 girls. Furthermore, results also indicated that aggressive behaviors were affected by several factors  
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60 30 within the bioecological model. Comprehensive intervention strategies such as controlling the

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4 1 aggressor's impulsivity, teaching them to channel their anger, creating a supportive and nurturing  
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6 2 school and neighborhood environment as well as providing psychological support and services for  
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8 3 violence victims are needed.  
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## 11 5 **Abbreviations**

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13 6 BIS-11: Barratt Impulsivity Scale; CASI: Computer Assisted Self-Interview; AI: attentional  
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15 7 impulsivity; MI: motor impulsivity; NPI: non-planning impulsivity; GEAS: The Global Early  
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17 8 Adolescent Study.  
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## 20 10 **Acknowledgments**

21  
22 11 The GEAS is a multinational study that aims to understand the development of gender norms in early  
23  
24 12 adolescence and its impacts on adolescent health across time and geographies. The study operates in  
25  
26 13 conjunction with the World Health Organization and the Johns Hopkins Bloomberg School of Public  
27  
28 14 Health. Support for the study is made possible in part by the United States Agency for International  
29  
30 15 Development (USAID), the World Health Organization, the David and Lucile Packard Foundation,  
31  
32 16 the Bill and Melinda Gates Foundation, the Oak Foundation, and the United Nations Children's Fund.  
33  
34 17 We wish to acknowledge all partners and funders for their supports. We would also thank all  
35  
36 18 researchers and students who participate in the study, as well as administrators and teachers in target  
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38 19 schools.  
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## 42 21 **Source of funding**

43  
44 22 The present study was funded by the Innovation-oriented Science and Technology Grant from NHC  
45  
46 23 Key Laboratory of Reproduction Regulation (CX2017-05), and the Innovation-oriented Youth Science  
47  
48 24 and Technology Grant (Q2018-1) from Shanghai Institute for Biomedical and Pharmaceutical  
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50 25 Technologies.  
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52 26

## 53 27 **Authors' contributions**

54  
55 28 Chaohua Lou initiated the GEAS in Shanghai as a coordinator and project leader. Chaohua Lou and  
56  
57 29 Xiayun Zuo contributed to the study design. Chunyan Yu, Xiayun Zuo, Qiguo Lian, Xiaowen Tu and  
58  
59 30 Chaohua Lou contributed to data collection. Chunyan Yu and Jiashuai Zhang conducted the data



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4 1 analysis and drafted the paper. All authors are involved in the revising of the manuscript and read and  
5  
6 2 approved the final manuscript.

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9 4 **Declaration of interest**

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11 5 The authors report no conflicts of interest.  
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15 7 **Data sharing statement**

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17 8 Data are available upon reasonable request but the approval of institutional review board will be  
18  
19 9 necessary. Please contact the corresponding author for detail.  
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23 11 **Reference**  
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**Supplementary Tables:****Table S1.** Mean scores of impulsivity for each tertile, grouping by gender

	Total impulsivity		AI		MI		NPI	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Lowest tertile	1.71 (0.16)	1.70 (0.17)	1.61 (0.16)	1.60 (0.16)	1.63 (0.17)	1.63 (0.17)	1.61 (0.25)	1.61 (0.25)
Middle tertile	2.05 (0.08)	2.05 (0.08)	2.00 (0.10)	2.01 (0.10)	2.03 (0.10)	2.05 (0.10)	2.14 (0.10)	2.14 (0.10)
Highest tertile	2.43 (0.19)	2.40 (0.20)	2.49 (0.26)	2.44 (0.24)	2.58 (0.30)	2.54 (0.27)	2.61 (0.25)	2.62 (0.24)
Skewness	0.24	0.24	0.45	0.48	0.76	0.64	0.05	-0.05

**Table S2.** Factors associated with bullying among all samples: results of a multivariable binary logistic regression model

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age (years)				
11~13	ref	ref	ref	ref
14~16	0.58 (0.33-1.02)	0.59 (0.34-1.02)	0.52 (0.29-0.92)	0.59 (0.34-1.02)
Gender				
Boys	ref	ref	ref	ref
Girls	0.42 (0.23-0.74)	0.46 (0.26-0.82)	0.43 (0.24-0.77)	0.42 (0.23-0.74)
No. of close friends				
0~3	ref	ref	ref	ref
4~6	0.90 (0.47-1.74)	0.90 (0.47-1.74)	0.92 (0.47-1.78)	0.94 (0.49-1.81)
≥7	1.39 (0.74-2.59)	1.26 (0.68-2.33)	1.31 (0.70-2.46)	1.39 (0.75-2.61)
Perceived care from the primary caregiver				
Lower	ref	ref	ref	ref
Higher	0.56 (0.31-1.00)	0.55 (0.31-0.98)	0.57 (0.31-1.03)	0.55 (0.31-0.97)

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Only child				
Yes	ref	ref	ref	ref
No	1.59 (0.89-2.84)	1.58 (0.89-2.82)	1.64 (0.91-2.95)	1.52 (0.85-2.71)
Neighbors caring for each other				
Never or seldom	ref	ref	ref	ref
Sometimes	0.53 (0.28-0.99)	0.57 (0.30-1.06)	0.54 (0.28-1.02)	0.54 (0.29-1.02)
Always	0.55 (0.28-1.07)	0.54 (0.28-1.05)	0.51 (0.26-1.00)	0.54 (0.28-1.07)
Being bullied within 6 months				
No	ref	ref	ref	ref
Yes	7.25 (3.67-14.31)	7.73 (3.91-15.26)	7.58 (3.83-15.01)	7.97 (4.04-15.71)
Impulsivity				
Lowest tertile	ref	ref	ref	ref
Middle tertile	2.30 (0.97-5.44)	1.00 (0.47-2.16)	0.98 (0.44-2.16)	1.06 (0.49-2.27)
Highest tertile	3.62 (1.65-7.94)	1.94 (0.99-3.79)	3.51 (1.78-6.92)	2.04 (1.02-4.08)

Note: the impulsivity in the model 1, 2, 3, and 4 refers to the total, attentional, motor, and non-planning impulsivity, respectively.

**Table S3.** Factors associated with physical violence among all samples: results of a multivariable binary logistic regression model

Variables	Model 1	Model 2	Model 3	Model 4
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Age (years)				
11~13	ref	ref	ref	ref
14~16	0.72 (0.41-1.24)	0.71 (0.41-1.23)	0.69 (0.39-1.20)	0.72 (0.42-1.24)
Gender				



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Variables	Model 1	Model 2	Model 3	Model 4
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Boys	ref	ref	ref	ref
Girls	0.40 (0.22-0.71)	0.45 (0.25-0.80)	0.42 (0.23-0.75)	0.40 (0.23-0.72)
No. of close friends				
0~3	ref	ref	ref	ref
4~6	1.26 (0.65-2.45)	1.25 (0.65-2.44)	1.26 (0.65-2.46)	1.28 (0.66-2.47)
≥7	1.60 (0.84-3.05)	1.46 (0.77-2.78)	1.48 (0.78-2.83)	1.58 (0.83-3.01)
Perceived care from the primary caregiver				
Lower	ref	ref	ref	ref
Higher	0.68 (0.38-1.19)	0.68 (0.38-1.20)	0.67 (0.38-1.19)	0.66 (0.37-1.15)
Only child				
Yes	ref	ref	ref	ref
No	1.33 (0.72-2.44)	1.32 (0.72-2.42)	1.34 (0.73-2.47)	1.29 (0.71-2.37)
Neighbors caring for each other				
Never or seldom	ref	ref	ref	ref
Sometimes	0.64 (0.34-1.21)	0.68 (0.36-1.28)	0.66 (0.35-1.24)	0.66 (0.35-1.23)
Always	0.57 (0.28-1.13)	0.57 (0.29-1.13)	0.53 (0.27-1.05)	0.54 (0.27-1.08)
Being bullied within 6 months				
No	ref	ref	ref	ref
Yes	7.40 (3.74-14.64)	7.77 (3.92-15.36)	7.65 (3.87-15.15)	8.18 (4.15-16.16)
Impulsivity				
Lowest tertile	ref	ref	ref	ref
Middle tertile	2.28 (0.97-5.37)	1.20 (0.54-2.65)	1.51 (0.70-3.24)	1.31 (0.63-2.73)
Highest tertile	3.57 (1.62-7.83)	2.41 (1.19-4.88)	3.13 (1.54-6.34)	1.84 (0.91-3.70)

Note: the impulsivity in the model 1, 2, 3, and 4 refers to the total, attentional, motor, and non-planning impulsivity, respectively.

**Table S4.** Summary score (mean  $\pm$  SD) of impulsivity, grouping by gender and aggressive behavior

	Boys			Girls		
	Aggressors	Non-aggressors	<i>P</i>	Aggressors	Non-aggressors	<i>P</i>
Total impulsivity	68.07 (11.12)	60.46 (9.77)	<0.001*	69.79 (12.34)	60.84 (9.70)	<0.001 <sup>&amp;</sup>
AI	18.14 (3.65)	16.12 (3.12)	<0.001 <sup>&amp;</sup>	17.76 (3.70)	15.56 (2.88)	0.001 <sup>&amp;</sup>
MI	25.04 (5.46)	21.81 (4.44)	<0.001 <sup>&amp;</sup>	25.70 (5.78)	21.86 (4.45)	<0.001 <sup>&amp;</sup>
NPI	24.99 (4.90)	22.63 (5.14)	<0.001*	26.48 (5.77)	23.49 (5.03)	0.001*

\*: two-independent t-test; &: Wilcoxon test

# Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

## Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectional reporting guidelines, and cite them as:

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		Page
	Reporting Item	Number
<b>Title and abstract</b>		
Title	<a href="#">#1a</a> Indicate the study's design with a commonly used term in the title or the abstract	1

1	Abstract	<a href="#">#1b</a>	Provide in the abstract an informative and balanced summary	2
2				
3			of what was done and what was found	
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6	<b>Introduction</b>			
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10	Background /	<a href="#">#2</a>	Explain the scientific background and rationale for the	3-4
11	rationale		investigation being reported	
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15	Objectives	<a href="#">#3</a>	State specific objectives, including any prespecified	4
16			hypotheses	
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20	<b>Methods</b>			
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23	Study design	<a href="#">#4</a>	Present key elements of study design early in the paper	4
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26	Setting	<a href="#">#5</a>	Describe the setting, locations, and relevant dates, including	4-5
27			periods of recruitment, exposure, follow-up, and data	
28			collection	
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34	Eligibility criteria	<a href="#">#6a</a>	Give the eligibility criteria, and the sources and methods of	4
35			selection of participants.	
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40		<a href="#">#7</a>	Clearly define all outcomes, exposures, predictors, potential	5-6
41			confounders, and effect modifiers. Give diagnostic criteria, if	
42			applicable	
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47	Data sources /	<a href="#">#8</a>	For each variable of interest give sources of data and details	5
48	measurement		of methods of assessment (measurement). Describe	
49			comparability of assessment methods if there is more than	
50			one group. Give information separately for for exposed and	
51			unexposed groups if applicable.	
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1	Bias	<a href="#">#9</a>	Describe any efforts to address potential sources of bias	5-6
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4	Study size	<a href="#">#10</a>	Explain how the study size was arrived at	5
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7	Quantitative	<a href="#">#11</a>	Explain how quantitative variables were handled in the	6
8	variables		analyses. If applicable, describe which groupings were	
9			chosen, and why	
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15	Statistical	<a href="#">#12a</a>	Describe all statistical methods, including those used to	6
16	methods		control for confounding	
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20	Statistical	<a href="#">#12b</a>	Describe any methods used to examine subgroups and	6
21	methods		interactions	
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26	Statistical	<a href="#">#12c</a>	Explain how missing data were addressed	5-6
27	methods			
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31	Statistical	<a href="#">#12d</a>	If applicable, describe analytical methods taking account of	N/A
32	methods		sampling strategy	
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36	Statistical	<a href="#">#12e</a>	Describe any sensitivity analyses	N/A
37	methods			
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42	<b>Results</b>			
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45	Participants	<a href="#">#13a</a>	Report numbers of individuals at each stage of study—eg	4,7
46			numbers potentially eligible, examined for eligibility,	
47			confirmed eligible, included in the study, completing follow-	
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49			exposed and unexposed groups if applicable.	
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57	Participants	<a href="#">#13b</a>	Give reasons for non-participation at each stage	4
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1	Participants	<a href="#">#13c</a>	Consider use of a flow diagram	5
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4	Descriptive data	<a href="#">#14a</a>	Give characteristics of study participants (eg demographic,	7
5			clinical, social) and information on exposures and potential	
6			confounders. Give information separately for exposed and	
7			unexposed groups if applicable.	
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14	Descriptive data	<a href="#">#14b</a>	Indicate number of participants with missing data for each	7
15			variable of interest	
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19	Outcome data	<a href="#">#15</a>	Report numbers of outcome events or summary measures.	7
20			Give information separately for exposed and unexposed	
21			groups if applicable.	
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27	Main results	<a href="#">#16a</a>	Give unadjusted estimates and, if applicable, confounder-	8-11
28			adjusted estimates and their precision (eg, 95% confidence	
29			interval). Make clear which confounders were adjusted for	
30			and why they were included	
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37	Main results	<a href="#">#16b</a>	Report category boundaries when continuous variables were	8-11
38			categorized	
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42	Main results	<a href="#">#16c</a>	If relevant, consider translating estimates of relative risk into	N/A
43			absolute risk for a meaningful time period	
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48	Other analyses	<a href="#">#17</a>	Report other analyses done—e.g., analyses of subgroups	21
49			and interactions, and sensitivity analyses	
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53	<b>Discussion</b>			
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56	Key results	<a href="#">#18</a>	Summarise key results with reference to study objectives	12-15
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1	Limitations	<a href="#">#19</a>	Discuss limitations of the study, taking into account sources	14-15
2			of potential bias or imprecision. Discuss both direction and	
3			magnitude of any potential bias.	
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9	Interpretation	<a href="#">#20</a>	Give a cautious overall interpretation considering objectives,	12-15
10			limitations, multiplicity of analyses, results from similar	
11			studies, and other relevant evidence.	
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16	Generalisability	<a href="#">#21</a>	Discuss the generalisability (external validity) of the study	14
17			results.	
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22	<b>Other Information</b>			
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25	Funding	<a href="#">#22</a>	Give the source of funding and the role of the funders for the	16-17
26			present study and, if applicable, for the original study on	
27			which the present article is based	
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