Parent-adolescent conflict, peer victimization, and Internet gaming disorder among Chinese adolescents: The moderating effect of OXTR gene rs53576 polymorphism

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Research Article

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Abstract

**Background:** Despite growing evidence that parent-adolescent conflict positively correlates with Internet gaming disorder (IGD) among adolescents, its underlying mediating and moderating mechanisms have not been thoroughly examined. Based on the social development model and gene-environment interaction perspective, this study investigates whether the indirect association of parent-adolescent conflict, which impacts adolescent IGD through peer victimization, was moderated by the oxytocin receptor (OXTR) gene rs53576 polymorphism.

**Methods:** Overall, 673 Chinese adolescents (Mean$_{age}$ = 12.81 years; SD = 0.48 years; 54% boys) were included in this study. The participants completed questionnaires concerning parent-adolescent conflict, peer victimization, and IGD, and genomic DNA was extracted from each participant’s saliva and buccal cells.

**Results:** The findings indicated that peer victimization mediated the link between parent-adolescent conflict and IGD among adolescents. The OXTR gene rs53576 polymorphism also moderated this indirect link. Specifically, the indirect effect of parent-adolescent conflict on adolescent IGD through peer victimization was significant for adolescents with AA homozygotes. However, it was non-significant for G-carrier adolescents.

**Conclusion:** This research simultaneously considers the roles of family, peers, and genetics in the occurrence of adolescent IGD. Furthermore, it provides beneficial information to customize interventions for adolescent IGD prevention.

Background

Internet gaming disorder (IGD) is the uncontrollable, excessive, and compulsive playing of Internet games that causes psychological, physical, and social damage [1]. In particular, adolescent IGD is a critical public health issue worldwide [2, 3]. Recent studies report that the prevalence of IGD among Chinese adolescents ranges from 3.1–5.0% [4, 5, 6]. The dangers and high prevalence of IGD prompted us to understand the impact factors and mechanisms influencing IGD risk in adolescents so that targeted intervention programs can be developed.

Many factors affect adolescent IGD, and environmental adversity (i.e., parent-adolescent conflict) has long been considered a significant risk factor for adolescent IGD [7, 8]. Parent-adolescent conflict becomes more common and intense during adolescence. Chinese families have traditionally valued family member harmony and cohesion; thus, parent-adolescent conflict may have more severe repercussions for Chinese adolescents [9]. Adolescents frequently subjected to parent-adolescent conflicts may believe their values are not understood or supported by their parents. Consequently, they are more likely to be overwhelmed by unpleasant emotions and might indulge in gaming to escape from stressful realities or foster other, new social relationships [10, 11]. Sufficient empirical evidence supports the idea that parent-adolescent conflict is instrumental in facilitating adolescent IGD. A systematic review
by Schneider et al. [7] determined that parent-adolescent conflict was strongly and positively related to adolescent IGD. Similarly, Zhou et al. [8] found that higher parent-adolescent conflict is associated with greater Internet gaming addiction. Accordingly, parent-adolescent conflict might be a central risk factor for IGD among Chinese adolescents.

Prior studies have identified the harmful impacts of parent-adolescent conflict on IGD among adolescents; however, a significant shortcoming of these studies is that this relationship’s underlying mediating and moderating mechanism has seldom been explored. Based on the social development model [12], this study intends to gauge whether peer socialization (i.e., peer victimization) mediates the link between parent-adolescent conflict and adolescent IGD. Furthermore, a few studies found that genetic factors could explain the variation in IGD [13, 14], suggesting that genetic factors may influence IGD [15]. Understanding the interaction of genetic and environmental factors in IGD may be the basis for the better development of IGD treatments. To explore the interplay between genetic and environmental factors on IGD, this study, based on a gene-environment interactions perspective [16], aims to estimate whether genetic factors (i.e., oxytocin receptor gene rs53576 polymorphism) can moderate this mediating process.

The Mediating Role of Peer Victimization

The social development model [12] contends that peer socialization is an indispensable process whereby socialization units (e.g., family) influence adolescent behavior. A favorable family environment contributes to positive social bonds and prevents problem behaviors by inhibiting adolescents’ association with risky peers. Conversely, if adolescents establish negative social bonds in an adverse family environment, they are more susceptible to risky peers and, in turn, develop problem behaviors. For this study, parent-adolescent conflict may increase peer victimization, which in turn may impact IGD among adolescents. Thus, peer victimization may mediate the relationship between parent-adolescent conflict and adolescent IGD.

Peer victimization refers to a person experiencing intentional aggression and injury from peers over time, including verbal, physical, and relational victimization [17]. First, peer victimization as a stressor is likely to increase psychological distress [18]. Adolescents may utilize internet games to relieve the stress generated by peer victimization, which makes them more likely to develop IGD [19, 20]. For example, with a sample of 2,116 Chinese adolescents, Li and Zhu [19] observed that peer victimization was a significant risk factor in the emergence of IGD. Similarly, a survey among 3,080 Chinese adolescents also showed that greater peer victimization was associated with increased severity of adolescent IGD [20]. Second, parent-adolescent conflict may also contribute to peer victimization [21, 22]. Conflict with parents can result in low self-esteem and lack of assertiveness among adolescents [23, 24]. Such characteristics can lead to victimization. Moreover, parent-adolescent conflict may contribute to adolescents’ habituation of negative interpersonal interaction patterns [25]. Such adolescents are more likely to distrust, remain hostile toward, and inappropriately react to peers, making them more of a target. One study of Greek
adolescents indicated that parent-child conflict was positively correlated with and a potent predictor of adolescent experience victimization [22].

Furthermore, previous studies have underlined a mediating role of peer victimization between negative family factors and adolescents' problem behaviors [26, 27]. For example, research involving 3,180 Chinese adolescents revealed that peer victimization acted as a mediator of the association between parental corporal punishment and aggressive behavior [26]. Likewise, Xu et al. [27] discovered that parental corporal punishment could promote the internalizing of mental health problems (i.e., anxiety and depression) through increasing peer victimization. These results indicate that peer victimization may be a crucial process by which parent-adolescent conflict influences adolescent IGD. Therefore, based on the literature reviewed above, Hypothesis 1 is as follows:

Peer victimization mediates the link between parent-adolescent conflict and IGD among adolescents.

The Moderating Role of OXTR rs53576

The effects of parent-adolescent conflict and peer victimization are theoretically the most consistent and essential factors explaining adolescent IGD. However, not all adolescents are equally influenced by parent-adolescent conflict and peer victimization. Genetic factors may underlie these inter-individual differences in susceptibility to parents and peers. Furthermore, according to the perspective of gene-environment interactions [16], both genetics and the environment may work together in individual behavior development. Therefore, the impact of parent-adolescent conflict and peer victimization on adolescent IGD may be moderated by genetic factors.

The oxytocin receptor gene rs53576 polymorphism (OXTR rs53576) is critical in regulating social behavior [28]. Since social interaction is a prominent feature of online games [11], the OXTR rs53576 may be essential for understanding the genetic etiology of IGD. A study provides evidence for a genetic association between OXTR gene polymorphism and social media use [29]. Accumulating empirical studies affirm that rs53576 is closely related to parenting [30], peer relationships [31], and other problem behaviors [32, 33]. Furthermore, research shows that rs53576 can moderate the association between environmental factors and problem behaviors among adolescents [31, 32]. A longitudinal study following adolescents between 13 to 18 years of age noted that OXTR gene polymorphisms (including rs53576) interacted with deviant peer affiliation in antisocial behavior [31]. In a survey of Chinese Han adolescents, Shao et al. [32] specified that rs53576 moderated the link between stressful life events and aggression. Hence, rs53576 might also be a critical candidate gene for understanding inter-individual differences in adolescent IGD when parent-adolescent conflict and peer victimization are experienced.

The differential susceptibility model [34] proposed that individuals with “plastic” genotypes are more susceptible to the negative influences of unfavorable environments and thus tend to exhibit problem behaviors. Conversely, they are more sensitive to the positive effects of favorable environments and are more likely to develop positively. Previous studies have found that adolescents with a particular genotype of rs53576 are more likely to be maladjusted when facing negative situations and benefit more from
positive situations. For example, Hygen et al. [30] conveyed that positive parenting predicted high-level student-teacher relationships, and inadequate parenting predicted higher deterioration of student-teacher relationships for children with AA homozygotes of rs53576. Notably, no effects of parenting were reported on student-teacher relationships among G allele children. Similarly, Zheng et al. [35] demonstrated that the negative influence of childhood adversity on general trust is only significant for AA genotype carriers, not G-allele carriers. These studies indicate that the AA genotype might alter adolescents’ vulnerability and resilience by magnifying or buffering sensitivity to stressful environments. Thus, Hypothesis 2 is based on the above empirical evidence and theoretical analyses:

Adolescent rs53576 will moderate the indirect pathway between parent-adolescent conflict and IGD via peer victimization. The indirect path between parent-adolescent conflict and IGD via peer victimization will differ among adolescents with AA and AG/GG genotypes.

Gender Difference

Abundant empirical research validates that male individuals are more vulnerable to IGD than female individuals [36, 37]. The interplay of genes and environment on adolescent development may also have gender-specific effects. For instance, Vaht et al. [33] noted that AA genotypes were significantly associated with alcohol use at the age of 15 for boys, whereas no such associations were found among girls. Accordingly, this study will consider gender as a moderator in the direct or indirect association between parent-adolescent conflict and IGD. These explorations provide more insight into gender differences in our model and contribute to developing more reasonable interventions for adolescent IGD.

The Current Study

This study employs the social development model [12] and the gene-environment interaction model [16] to account for underlying mechanisms whereby parent-adolescent conflict is associated with adolescent IGD. In addition, this study constituted a moderated mediation model to examine the first and second hypotheses. Figure 1 illustrates the research model.

Method

Participants

The participants were 673 students (364 males and 309 females) from two junior secondary schools in Guangdong province, southern China. Ages ranged from 11 to 15 years, and the mean age was 12.81 (SD = 0.48).

Measures

Parent-adolescent Conflict Questionnaire.

Parent-adolescent conflict was measured with the eight-item Chinese version of the Parent-adolescent Conflict Questionnaire [38]. Adolescents reported the frequency of conflict with their parents in the last six months (e.g., “Have you ever had conflicts with your parents about your schoolwork?”). All items were
answered using a 5-point Likert scale, from 1 = *never* to 5 = *several times a day*. Each item’s totals were averaged, with a higher value indicating a more serious conflict between adolescents and parents. The questionnaire showed good reliability in this study (Cronbach’s $\alpha = 0.86$).

*Peer Victimization Questionnaire.*

Peer victimization was gauged by nine items adapted from an earlier published Peer Victimization Questionnaire [39, 40]. This questionnaire measures the frequency of experiencing relational, physical, and verbal victimization from peers during the past half-year (e.g., “Someone is threatening to hit you”). Each item was answered on a 5-point Likert scale (1 = *never*, 5 = *four or more times*). The average value of all items was computed, with a higher value inferring more peer victimization. This questionnaire demonstrated good reliability in this study (Cronbach’s $\alpha = 0.89$).

*Internet Gaming Disorder Scale.*

IGD was assessed with a nine-item IGD scale [41]. Its nine items are adapted from the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) and identify nine core criteria of IGD [42]. The scale aims to measure the frequency of IGD symptoms over six months. Adolescents rated the items on a 3-point Likert scale consisting of 0 (*never*), 0.5 (*sometimes*), and 1 (*yes*). An example is, “Do you experience difficulty reducing or controlling the amount of time spent playing internet games?” The total score of all items is then calculated, with a higher score indicating higher degrees of IGD. The IGD scale demonstrated good reliability in this study (Cronbach’s $\alpha = 0.80$).

*Genotyping.*

Genotyping for rs53576 was performed by Tianyi Huiyuan Biotechnology Co., Ltd. in Wuhan, China, using a saliva DNA extraction kit to collect samples from each adolescent.

**Procedure**

Adolescents, parents, and school administrators gave written informed consent before data collection began. The survey materials, including the questionnaires and the saliva DNA extraction kit, were administered to adolescents by trained research assistants during class time. The research assistants provided verbal and written instructions for all survey material. Adolescents were informed that this investigation was anonymous and confidential to encourage honest responses. Additionally, they were advised that if any question made them feel uncomfortable, they could refrain from replying. They could withdraw at any time. Adolescents completed the self-report questionnaires independently and provided saliva DNA samples within 30 minutes. As a token of appreciation, those who completed the survey received stationery. The Ethics Review Committee of Education School, Guangzhou University approved the study (date of approval: May 27, 2019; protocol number: GZHU 2019012).

**Statistical analyses**
This study employed SPSS Version 20.0 to perform statistical analysis and adopted means imputation to address missing data. First, the Hardy-Weinberg equilibrium was utilized to estimate the distribution of genotypes carried by the participants. Then, descriptive statistics and correlation analysis for each variable were computed. Hayes's [43] PROCESS macro (Model 73) in SPSS was employed to examine the moderated mediation effect. Age was included as the control variable. Moreover, this study utilized a bootstrapping method based on 1,000 samples to test the path coefficients for statistical significance and explained the indirect effects with 95% bias-corrected bootstrapped confidence intervals (CIs). The indirect effect was considered significant when the 95% CI did not contain zero.

**Results**

**Descriptive Statistics of Genetic Data**

The genotyping data of rs53576 revealed that 307 (45.6%) adolescents carried two A alleles (AA), 302 (44.9%) carried one A and one G allele (AG), and 64 (9.5%) carried two G alleles (GG). The genotype frequencies of rs53576 were compatible with the Hardy-Weinberg equilibrium ($\chi^2 = 0.69, p = 0.41$). In line with prior studies [32, 44], adolescents with G allele homozygotes or heterozygotes were grouped for comparison with those having A homozygotes (i.e., AA = 1, GA = GG = 0). This design enhanced statistical power.

**Descriptive Statistics and Correlations**

Table 1 displays the means, standard deviations, and correlations for all study variables. Parent-adolescent conflict ($r = 0.29, p < 0.001$) and peer victimization ($r = 0.36, p < 0.001$) were positively correlated with IGD. Furthermore, significant positive associations between parent-adolescent conflict and peer victimization were found ($r = 0.25, p < 0.001$). However, rs53576 was not correlated with parent-adolescent conflict ($r = 0.02$), peer victimization ($r = -0.03$), or IGD ($r = -0.01$, all $p > 0.05$). Lastly, gender was positively correlated with parent-adolescent conflict ($r = 0.11, p < 0.01$), peer victimization ($r = 0.12, p < 0.01$), and IGD ($r = 0.29, p < 0.001$).
Table 1
Descriptive statistics and correlations among variables

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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<tbody>
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<td>1.Age</td>
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<td>1.000</td>
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<td>2.Gender</td>
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<td>1.000</td>
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<tr>
<td>3.PAC</td>
<td>0.05</td>
<td>0.11**</td>
<td>1.000</td>
<td></td>
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<tr>
<td>4.Peer victimization</td>
<td>-0.03</td>
<td>0.12**</td>
<td>0.25***</td>
<td>1.000</td>
<td></td>
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<tr>
<td>5.IGD</td>
<td>0.13**</td>
<td>0.29***</td>
<td>0.29***</td>
<td>0.36***</td>
<td>1.000</td>
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<tr>
<td>6.rs53576</td>
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<td>-0.07</td>
<td>0.02</td>
<td>-0.03</td>
<td>-0.01</td>
<td>1.000</td>
</tr>
<tr>
<td>Mean</td>
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<td>1.93</td>
<td>1.60</td>
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<tr>
<td>SD</td>
<td>0.48</td>
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<td>0.82</td>
<td>0.65</td>
<td>0.31</td>
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</tbody>
</table>

**Note**

Gender was dummy coded such that 1 = male and 0 = female. rs53576 polymorphism was dummy coded (AA = 1, GA = GG = 0). PAC = parent-adolescent conflict, IGD = Internet gaming disorder. ** p < .01, *** p < .001.

**Testing for Moderated Mediation**

Table 2 presents the testing results for moderated mediation. In Eq. 1, parent-adolescent conflict showed a significant main effect on peer victimization ($\beta = 0.38, p < 0.001$). Still, the main effects of rs53576 and gender on peer victimization were non-significant. Moreover, the effects of all interactions between parent-adolescent conflict, rs53576, and gender on peer victimization were non-significant. In Eq. 2, the interaction between peer victimization and rs53576 showed significant effects on IGD ($\beta = 0.24, p < 0.05$). In addition, the interaction between gender and peer victimization showed significant effect on IGD ($\beta = 0.20, p < 0.05$). Still, the triple interaction effect between peer victimization, gender, and rs53576 on IGD was non-significant.
Table 2
The moderated mediation effect of parent-adolescent conflict on adolescent IGD.

<table>
<thead>
<tr>
<th></th>
<th>Equation 1 (peer victimization)</th>
<th>Equation 2 (IGD)</th>
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<tbody>
<tr>
<td></td>
<td>$\beta$</td>
<td>$SE$</td>
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<tr>
<td>Age</td>
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<td>0.04</td>
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<tr>
<td>Study variables:</td>
<td></td>
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<tr>
<td>PAC</td>
<td>0.38</td>
<td>0.08</td>
</tr>
<tr>
<td>rs53576</td>
<td>-0.13</td>
<td>0.11</td>
</tr>
<tr>
<td>Gender</td>
<td>0.13</td>
<td>0.10</td>
</tr>
<tr>
<td>PAC × rs53576</td>
<td>-0.10</td>
<td>0.12</td>
</tr>
<tr>
<td>PAC × Gender</td>
<td>-0.17</td>
<td>0.11</td>
</tr>
<tr>
<td>rs53576 × Gender</td>
<td>0.14</td>
<td>0.15</td>
</tr>
<tr>
<td>PAC × Gender × rs53576</td>
<td>0.05</td>
<td>0.15</td>
</tr>
<tr>
<td>PV</td>
<td>0.12</td>
<td>0.08</td>
</tr>
<tr>
<td>PV × rs53576</td>
<td>0.24</td>
<td>0.12</td>
</tr>
<tr>
<td>PV × Gender</td>
<td>0.20</td>
<td>0.10</td>
</tr>
<tr>
<td>PV × Gender × rs53576</td>
<td>-0.23</td>
<td>0.15</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>$F$</td>
<td>7.36***</td>
<td></td>
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</tbody>
</table>

Note: Values are standardized coefficients. Gender was dummy coded (1 = male, 0 = female). Rs53576 polymorphism was dummy coded: AA = 1 and GA = GG = 0. PAC = parent-adolescent conflict, PV = peer victimization, IGD = Internet gaming disorder. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Next, a simple slope test was conducted to identify the interaction effect of rs53576 and peer victimization on IGD. As Fig. 2 illustrates, the moderating effect of rs53576 in the link between peer...
victimization and IGD was significant for AA genotype adolescents ($\beta = 0.36$, $SE = 0.09$, $t = 4.10$, $p < 0.001$, 95% CI [0.19, 0.53]). However, it was non-significant for GG and AG genotypes adolescents ($\beta = 0.12$, $SE = 0.08$, $t = 1.40$, $p = 0.163$, 95% CI [-0.05, 0.28]).

A simple slope test was also performed to examine the interaction effect of gender and peer victimization on IGD. Figure 3 shows that higher levels of peer victimization were significantly correlated with greater levels of IGD among male adolescents ($\beta = 0.32$, $SE = 0.06$, $t = 5.46$, $p < 0.001$, 95% CI [0.20, 0.43]). Nevertheless, this association was non-significant for female adolescents ($\beta = 0.12$, $SE = 0.08$, $t = 1.40$, $p = 0.16$, 95% CI [-0.05, 0.28]).

Finally, the bias-corrected percentile bootstrap denoted that the indirect pathway between parent-adolescent conflict and IGD through peer victimization was significant for AA genotype adolescents (indirect effect = 0.10, $SE = 0.04$, 95% CI [0.04, 0.19]). However, this indirect pathway was non-significant among adolescents with AG and GG genotypes (indirect effect = 0.44, $SE = 0.03$, 95% CI [-0.01, 0.12]). Hence, the mediating effect of peer victimization in the relationship between parent-adolescent conflict and adolescent IGD was moderated by rs53576.

Discussion

Based on the social development model [12] and gene-environment interactions perspective [16], this research constructed a moderated mediation model to assess mediation and moderation mechanisms of the association between parent-adolescent conflict and IGD in a sample of Chinese adolescents. Notably, parent-adolescent conflict was indirectly associated with IGD via peer victimization, and rs53576 served as a moderator in this indirect association. These outcomes advance understanding of the combined effects of environmental variables (i.e., parent-adolescent conflict and peer victimization) and genetics (i.e., rs53576) on adolescent IGD.

Consistent with Hypothesis 1, peer victimization significantly mediated the relationship between parent-adolescent conflict and adolescent IGD. This finding is consistent with the social development model [12], confirming that peer victimization is a significant essential mediator that helps explain why an adverse family environment is associated with increased problem behavior among adolescents [26, 27]. Furthermore, according to the ecological systems theory [45], this result supports the opinion that socialization units (i.e., family and peer contexts) are interdependent, and the functioning of one context has critical implications for the operation of other contexts. When adolescents experience intense conflict with their parents, they are more likely to suffer peer victimization, which, in turn, is associated with increased cases of IGD. The negative social interaction patterns formed in parent-adolescent conflict may make it difficult for adolescents to be accepted by peers, leading to peer victimization. Additionally, parent-adolescent conflict always increases adolescents’ negative self-assessment, such as lowering self-esteem [23, 24], another reason for peer victimization. Victimized adolescents can depend on internet games to relieve negative emotions and compensate for basic psychological needs, which increases the
risk of developing IGD \[19, 20\]. The main contribution of this finding is to promote the understanding of the mechanisms associated with parent-adolescent conflict and IGD.

In line with Hypothesis 2, rs53576 significantly moderates the indirect pathway between parent-adolescent conflict and IGD via peer victimization. Specifically, the impact of peer victimization on adolescent IGD was moderated by rs53576. For AA genotype adolescents, higher peer victimization predicted a greater risk of emerging IGD. Conversely, lower peer victimization contributed to diminishing IGD. However, the effect of peer victimization on IGD was non-significant for G allele genotype adolescents. This outcome is consistent with the differential susceptibility model \[34\] and prior studies \[30, 35\], highlighting that AA genotype carriers have “better” outcomes under positive environments and “worse” outcomes under poor environments. We reveal for the first time that rs53576 exhibited susceptibility in the relationship between peer victimization and IGD, bridging the research gap on the lack of genetic and environmental influences on IGD development.

The connection of the \textit{OXTR}-amygdala provides a possible explanation for this result, as \textit{OXTR} rs53576 may influence social behaviors by modulating the activation of the amygdala \[46, 47\], a critical brain structure involved in emotional regulation processes. For instance, Wang et al. \[47\] found that AA homozygous female carriers exhibited smaller amygdala volumes and lower functional coupling of prefrontal-amygdala circuitry than G allele carriers, possibly heightening anxiety symptoms. Therefore, adolescents with AA homozygotes may have more robust amygdala activation in adverse environments, showing a more profound emotional response. Hence, AA genotype adolescents may magnify the negative effect of peer victimization, displaying more negative emotional reactivity and increasing the risk of IGD. Conversely, they may inhibit or diminish the reaction under conditions of low-level peer victimization, thus reducing IGD. Besides, the A allele genotype has been found associated with higher stress reactivity and lower sociality \[28, 48\]. Thus, AA genotype adolescents who suffer peer victimization are more likely to experience stress or emerging social problems and may relieve stress by fostering social relationships through Internet games. AA genotype carriers are also likelier to enjoy better interpersonal relationships in positive environments \[30\] and experience more happiness than G allele carriers \[49\]. Therefore, AA genotype adolescents experiencing less peer victimization may feel satisfied with their emotional needs and interpersonal relationships, minimizing the need to seek alternative sources of satisfaction.

Finally, gender moderated the link between peer victimization and IGD among adolescents. Specifically, the risk impact of peer victimization on IGD was only significant among male adolescents. Like previous studies, boys reported slightly higher overt victimization than girls \[50\] and higher IGD risk \[37\]. In terms of developmental maturation, increasing maturity may decrease the susceptibility to peer influence \[51\]. Girls mature faster than boys during adolescence \[52\]. As a result, they typically exhibit more resistance to peer influence than boys \[51\]. Thus, adolescent girls may be more immune to peer victimization, while boys may be more susceptible. Additionally, male individuals are more sensitive to the rewards of Internet games \[36\]. Therefore, male adolescents who experience peer victimization are more likely to rely on Internet games for emotional release, increasing the risk of emerging IGD.
Still, gender differences were not found for the moderating effect of rs53576 on the indirect pathway of parent-adolescent conflict and adolescent IGD via peer victimization. The interplay of rs53576, parent-adolescent conflict, and peer victimization on adolescent IGD does not report gender-specific effects. Although previous studies outline that male individuals exhibit higher rates of IGD [36, 37], the findings in this study suggested that the moderating effects of rs53576 and gender on the link between parent-adolescent conflict, peer victimization, and adolescent IGD may be independent.

Limitations

This research has three limitations. First, the current study used a cross-sectional methodology, which cannot establish causal inference among variables. Hence, longitudinal approaches are needed to examine this moderated mediation model further. Second, all data collected relied on self-report questionnaires, which may be affected by common method bias. Therefore, future studies need to be conducted with objective informants and multiple methods for data collection, such as interviews, documentary data, parent reports, and peer nominations. Third, only a single nucleotide polymorphism (rs53576) was examined within the OXTR gene. Hence, it is necessary to consider more single nucleotide polymorphisms in the OXTR gene to comprehensively assess the association between the gene and IGD among Chinese adolescents.

Implications For Practice

Despite these limitations, the present study can provide two practical implications. First, developing a peer victimization prevention program might reduce IGD, given that it mediated the association between parent-adolescent conflict and IGD among adolescents. Comprehensive approaches are considered an effective method of minimizing victimization, and the success of these approaches requires cooperation from schools, parents, and adolescents [17]. For example, parents should teach adolescents how to recognize peer victimization. Teachers should educate about coping strategies for victimization, and schools should design curricula that promote social skills [17]. Second, the indirect pathways of parent-adolescent conflict on adolescent IGD via peer victimization may vary by rs53576 genotypes. Adolescents with the rs53576 AA genotype may be more at risk of emerging IGD when experiencing parent-adolescent conflict and peer victimization. The preventive design of reducing parent-adolescent conflict, peer victimization, and Internet games reliance may yield positive intervention effects that can prevent IGD among adolescents with the rs53576 AA genotype.

Conclusion

In summary, this study provides substantial evidence for understanding the environmental influences and genetic etiology of IGD among Chinese adolescents. We found that peer victimization was a mediator in the association between parent-adolescent conflict and IGD. Moreover, the moderating role of both OXTR rs53576 and gender was manifested in the second stage of the mediation model. Adolescents carrying
the AA genotype of rs53576 showed higher sensitivity to the association between peer victimization and IGD.

**Declarations**

**Ethical Approval**

This study was granted approval by the Ethics Review Committee of Education School, Guangzhou University (date of approval: May 27, 2019; protocol number: GZHU 2019012).

**Consent for publication**

Written informed consent for publication was obtained from all participants.

**Availability of data and materials**

The data presented in this study are available on request from the corresponding author (CY).

**Competing interests**

The authors declare no conflict of interest.

**Funding**

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**Authors’ contributions**

QL: conceptualization, methodology, formal analysis, writing-original draft preparation, writing-review and editing; HL: investigation, writing-review and editing; CY: conceptualization, methodology, investigation, data curation, writing-review and editing, project administration; XQ: writing-review and editing, supervision, funding acquisition; PC: methodology, writing-review and editing; SL: methodology, writing-review and editing.

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We would like to thank all the participants in this study.

**References**


Figures
Figure 1

The proposed moderated mediation model.

Note: PAC = parent-adolescent conflict, PV = peer victimization, IGD = Internet gaming disorder.

Figure 2
The interaction effect between peer victimization and rs53576 on adolescent IGD.

Figure 3

The interaction effect between peer victimization and gender on adolescent IGD.