



Substance use and subjective health in Chinese Left-behind adolescents in rural areas: The moderating role of cognitive reappraisal

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ABSTRACT

Background/Objective: This study investigated the relationship between substance use (i.e., smoking, drinking, and using illicit drugs), subjective health, and cognitive reappraisal in Chinese left-behind adolescents in rural areas.

Methods: A total of 1,375 Chinese adolescents aged 15–19 years with left-behind experience in rural areas participated in this study. Substance use, substance use risk profile, subjective health complaints, and cognitive reappraisal were assessed.

Results: Substance use was negatively correlated with subjective health, and cognitive reappraisal was positively correlated with both substance use and subjective health. The regression analysis showed that substance use (negative) and cognitive reappraisal (positive) significantly predicted subjective health. The interaction between drinking frequency and cognitive reappraisal was also a significant predictor of subjective health. Furthermore, the simple slope analysis showed that for the group with low cognitive reappraisal, drinking frequency was negatively associated with subjective health, whereas there was no significant effect of drinking frequency on subjective health in the group with high cognitive reappraisal. These results indicated that cognitive reappraisal was a significant moderator in the relationship between drinking frequency and subjective health.

Conclusions: Our results suggest that while substance use has an adverse effect on subjective health, cognitive reappraisal can reduce this adverse effect.

1. Introduction

The economy of mainland China has developed rapidly in the past 40 years, and, as a result, many parents in rural areas have migrated to urban areas for work. However, due to low family income and poor accommodation, many parents have to leave their children in rural areas; these children are referred to as “left-behind children” (Shi et al., 2016). Studies have revealed more problem behaviors such as substance use in individuals with left-behind experience in rural areas than in individuals without left-behind experience (Graham, Jordan, & Yeoh, 2015; Han, Zhao, Pan, & Liao, 2018).

Left-behind experience can result in an increased risk of substance use, such as smoking and drinking (Fang, Wang, & Lei-Lei, 2013). Indeed, many researchers have found that there is a higher rate of substance use among left-behind children (Donoghue et al., 2017; Moore

et al., 2018; Wang, Lin, Lu, Cai, & Zhou, 2020). According to the ecological systems of Bronfenbrenner (1992), problem behaviors (e.g., substance use) in these individuals may be due to interactions between multiple environmental factors, including left-behind experience and social support. For example, higher rates of cannabis use and poorer mental health have been reported in children with less family support (Moore et al., 2018).

Substance use is likely to be related to subjective health (Moore et al., 2018). Phillips-Howard et al. (2010) examined the relationship between substance use and subjective health among 3,641 school children in UK, and found that alcohol drinking was negatively correlated with subjective health. Other studies have reported that an increased risk of consuming alcohol, substance use, and smoking were associated with poor subjective health (Karatzias, Power, & Swanson, 2001; Miller & Plant, 2002; Morgan & Haglund, 2009). Adolescents with left-behind

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experience are more likely to engage in substance use, such as drinking and smoking (Donoghue et al., 2017; Hindocha et al., 2015; Thatcher & Clark, 2008). However, the relationship between substance use and subjective health for left-behind adolescents remains unclear, and the present study therefore examined this.

How to reduce the adverse effects of substance use on subjective health? Cognitive reappraisal may be an effective strategy. Cognitive reappraisal is a type of emotion regulation strategy proposed by Gross (1998), whereby individuals reframe an event with the aim of changing their emotional response to it. Reappraisal theories of emotion suggest that cognitive reappraisal can help individuals view an event as a positive challenge rather than a negative threat, which allows them to better manage challenging situations (Gross, 2015; Moors, 2017). Many studies have revealed that cognitive reappraisal can reduce substance use (Boden, Gross, Babson, & Bonn-Miller, 2013; Fucito, Juliano, & Toll, 2010; Norberg et al., 2016). For example, Boden et al. (2013) found that higher levels of cognitive reappraisal reduced problematic cannabis use. Previous work has also found that cognitive reappraisal is negatively associated with smoking (Fucito et al., 2010) and alcohol consumption (Norberg et al., 2016). Other than substance use, cognitive reappraisal has been found to be positively correlated with subjective health (Garnefski, Kraaij, & Spinhoven, 2001; Mauss, Cook, Cheng, & Gross, 2007). Cognitive reappraisal has been associated with less severe depression and anxiety, increased optimism (Carver, Scheier, & Weintraub, 1989; Garnefski et al., 2001; Janoff-Bulman, 1992), and less negative emotions when confronted with challenging situations (Gross & John, 2003). Xu, Xu, Xu, Zhang, and Li (2020) investigated the moderating effect of cognitive reappraisal on the relationship between stress and anxiety in isolated people with COVID-19, and found that cognitive reappraisal buffered the negative effect of stress on anxiety, which indicates that cognitive reappraisal may be a protective factor for subjective health. These studies highlight the benefits of cognitive reappraisal and raise the question of whether cognitive reappraisal moderates the effect of substance use on subjective health for left-behind adolescents.

Left-behind adolescents usually lack parental support, which means that they are more vulnerable to substance use (Donoghue et al., 2017; Moore et al., 2018). The present study is the first to explore the relationship between substance use and subjective health in left-behind adolescents; furthermore, we investigated the moderation effect of cognitive reappraisal on this relationship. It is meaningful for help left-behind adolescents to reduce substance use and diminish the negative effects of substance use on subjective health. The following hypotheses were formulated:

Hypothesis 1: Substance use (i.e., frequency of smoking, drinking, and illicit drug use) is the significant predictor of subjective health for left-behind adolescents.

Hypothesis 2: Cognitive reappraisal moderates the relationship between substance use and subjective health.

2. Methods

2.1. Participants and procedure

The survey was conducted between March and June 2017. Participants were 2,151 adolescents enrolled at two secondary vocational schools in Anhui province, China. Anhui is a middle-eastern province of China with an average social and economic level. The participants were selected randomly from each major by class, and 38 classes were included in the present study. Data collection was conducted in a computer room of the collaborative schools via online questionnaires. Written consent was obtained from each participant after a full explanation of the study. Parents/guardians of participants aged less than 18 years were informed, and their consent was obtained. The study was reviewed and approved by the Institutional Review Board of Human Research Ethics Committee for Non-Clinical Faculties at Beijing Normal University, China.

The following eligibility criteria were used to select adolescents with left-behind experience in rural area: their registered household was in a rural area (i.e., agricultural *hukou*), and they had a left-behind experience for more than 6 months (i.e., one or both parents had migrated to urban areas while their children stayed in rural areas). A total of 1,375 Chinese left-behind adolescents in rural areas were selected. Of these, 65.3% were boys ($n = 898$) and 34.7% were girls ($n = 477$), and the mean age of participants was 16.42 ($SD = 0.6$) years. The years of education for fathers ranged from 0 to 18 years ($M = 8.62$, $SD = 3.07$), and the years of education for mothers ranged from 0 to 18 years ($M = 8.51$, $SD = 3.07$). The annual family income ranged from 1 to 9 (see the background questionnaire section for details), and the M and SD were 4.25 and 2.07, respectively.

2.2. Instruments

2.2.1. Background questionnaire

The background questionnaire was a self-reported inventory of gender, date of birth, *hukou* (household registered in an agricultural or non-agricultural area), annual family income (scored on a 9-point scale as follows: 1 = ¥ 3000, 2 = ¥ 3001–6000, 3 = ¥ 6001–10000, 4 = ¥ 10001–30000, 5 = ¥ 30001–50000, 6 = ¥ 50001–100000, 7 = ¥ 100001–150000, 8 = 150001–200000, 9 = more than ¥ 200001), years of education for the father and mother, and whether one or both parents had left their hometowns to work in an urban area.

2.2.2. Adolescents' substance use questionnaire

The Adolescents' Substance Use Questionnaire was developed by Siu (2011). It is a 3-item questionnaire that includes the following questions: how often have you smoked cigarettes/drank alcohol/used illicit drugs such as marijuana and ketamine in the past month? Participants respond to each item using a 5-point Likert-type scale ranging from 0 to 4 (0 = never, 1 = once or twice, 2 = several times a month, 3 = several times a week, and 4 = almost every day). A higher score indicates a higher frequency of substance use (i.e., smoking, drinking, and illicit drug use frequency).

2.2.3. Substance use risk profile scale

The original English version of the Substance Use Risk Profile Scale (SURPS) is a 28-item self-report inventory (Woicik, Stewart, Pihl, & Conrod, 2009). The Chinese version of the SURPS 28-item was developed by Wang, Hu, Zheng, and Liu (2017). The SURPS measures four dimensions of personality, as follows: hopelessness, anxiety sensitivity, sensation seeking, and impulsivity. Participants respond to each item using a 4-point Likert-type scale ranging from 1 (strongly agree) to 4 (strongly disagree). Based on the 28-item SURPS scale, items 1, 5, 9, 13, 17, 21, 25, and 28 were included in the dimension of hopelessness; items 2, 6, 10, 14, 18, 22, and 26 were included in the dimension of anxiety sensitivity; items 3, 7, 11, 15, 19, 23, and 27 were included in the dimension of impulsivity; and items 4, 8, 12, 16, 20, and 24 were included in the dimension of sensation seeking. Inverse scoring was used for items 1, 5, 9, 17, 25, and 28. The internal consistency coefficient of the SURPS was 0.79 for anxiety sensitivity, 0.72 for hopelessness, 0.66 for sensation seeking, and 0.77 for impulsivity (Wang, Hu, Zheng, and Liu, 2017).

2.2.4. Subjective health complaints

The Chinese version of the Subjective Health Complaints checklist (Wang, Hu, Zheng, and Liu, 2017) was adapted from the Health Behavior in School-aged Children Symptom Checklist (Haugland & Wold, 2001), and assessed the following 7 symptoms: headaches, abdominal pain, backache, feeling down, irritability, nervousness, and dizziness. Participants were asked to report how often they experienced each symptom using a 5-point Likert-type scale ranging from 0 to 4 (0 = most days, 1 = more than once per week, 2 = once per week, 3 = once per month, and 4 = seldom or never). A higher score indicates fewer

subjective health complaints. In the present study, the internal consistency coefficient of the Subjective Health Complaints checklist was 0.86.

2.2.5. Cognitive reappraisal scale

Cognitive reappraisal was measured using the reappraisal subscale of the Emotion Regulation Questionnaire (Gross, 2002), which comprises the following 6 items: “When I feel more positive emotions (such as joy or amusement), I change what I’m thinking about”, “When I feel less negative emotions (such as sadness or anger), I change what I’m thinking about”, “When I’m faced with a stressful situation, I make myself think about it in a way that helps me stay calm”, “When I feel more positive emotions, I change the way I’m thinking about the situation”, “I control my emotions by changing the way I think about the situation”, and “When I feel less negative emotions, I change the way I’m thinking about the situation”. Participants scored each item using a 7-point Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree), whereby a higher score indicates more cognitive reappraisal. The internal consistency coefficient of the Chinese version of the Cognitive Reappraisal Scale was 0.82 (Wang, Li, Hu, Dong, and Tao, 2017). In the present study, the internal consistency coefficient of the Cognitive Reappraisal Scale was 0.86.

2.3. Validation of the reliability of self-reported substance use in adolescents

The Adolescents’ Substance Use Questionnaire is a self-report questionnaire, which may result in under-reported or unreported substance use. To avoid this, all participants also completed the SURPS. Malmberg et al. (2010) found that the SURPS predicted 11.4% ($R^2 = 0.114$) of single substance use (such as smoking or drinking only), and 31.8% ($R^2 = 0.318$) of comprehensive or overall substance use. In the current study, the SURPS predicted 27.9% ($R^2 = 0.279$), 32.0% ($R^2 = 0.320$), and 35.3% ($R^2 = 0.353$) of smoking, drinking, and illicit drug use reported using the Adolescents’ Substance Use Questionnaire, respectively. Therefore, the results of Adolescents’ Substance Use Questionnaire were considered reliable in the current study.

2.4. Statistical analyses

Statistical analyses were conducted using SPSS 22.0 (SPSS, Chicago, IL). First, the relationships between substance use (smoking, drinking, and illicit drug use), subjective health, cognitive reappraisal, and background variables (gender, age, annual family income, years of education for the father and mother, and whether one or both parents had left home) were tested using Pearson’s correlation coefficient. Subsequently, a regression analysis was performed to test whether cognitive reappraisal moderated the relationship between substance use and subjective health. Background variables were used as the control variables, cognitive reappraisal (± 1 SD), substance use, and the interaction between cognitive reappraisal and substance use (cognitive reappraisal \times smoking frequency, cognitive reappraisal \times drinking frequency, cognitive reappraisal \times illicit drug use frequency) were used as the independent variables, and the subjective health was used as dependent variable. Furthermore, simple slope analyses were used to explore the specific interaction effects (e.g., cognitive reappraisal \times smoking frequency, cognitive reappraisal \times drinking frequency, or cognitive reappraisal \times illicit drug use frequency).

3. Results

3.1. Descriptive statistics

The descriptive statistics for background variables (gender, age, annual family income, years of education of the father and mother, and whether one or both parents had left home) are shown in Table 1. The correlations between background variables, substance use (frequency of

Table 1
Descriptive statistics of background variables for left-behind adolescents.

Participants	Total (N = 1375)	Gender	
		Girl (n = 477, 34.7%)	Boy (n = 898, 65.3%)
Age			
<i>M</i> \pm <i>SD</i>	16.42 \pm 0.60	16.40 \pm 0.62	16.42 \pm 0.59
Range	(15–19)	(15–19)	(15–19)
Annual family income			
<i>M</i> \pm <i>SD</i>	4.25 \pm 2.07	3.83 \pm 1.93	4.48 \pm 2.11
Range	(1–9)	(1–9)	(1–9)
Years of education for father			
<i>M</i> \pm <i>SD</i>	8.62 \pm 3.07	8.38 \pm 3.04	8.74 \pm 3.09
Range	(0–18)	(0–18)	(0–18)
Years of education for mother			
<i>M</i> \pm <i>SD</i>	8.51 \pm 3.07	8.47 \pm 2.96	8.53 \pm 3.12
Range	(0–18)	(0–18)	(0–18)
One or both parents have left home			
Father or mother has left home	n = 229, 16.7%	n = 95, 19.9%	n = 134, 14.9%
Father and mother have left home	n = 1146, 83.3%	n = 382, 80.1%	n = 764, 85.1%

smoking, drinking, and illicit drug use), subjective health, and cognitive reappraisal are shown in Table 2. The frequencies of smoking, drinking, and illicit drug use were negatively correlated with subjective health ($r = -0.10 - -0.16$, $p < 0.01$), and the correlations remained significant when controlling for background variables ($r = -0.11 - -0.17$, $p < 0.01$). Cognitive reappraisal was also significantly positively correlated with subjective health ($r = 0.23$, $p < 0.01$), and this correlation remained significant when controlling for background variables ($r = 0.21$, $p < 0.01$). The frequencies of smoking, drinking, and illicit drug use were positively correlated with cognitive reappraisal ($r = 0.15 - 0.18$, $p < 0.01$), and this correlation remained significant when controlling for background variables ($r = 0.13 - 0.17$, $p < 0.01$). Background variables had either weak or non-significant correlations with substance use, cognitive reappraisal, and subjective health.

3.2. Moderator analyses

Regression analyses were performed to test the moderating effect of cognitive reappraisal on the relationship between substance use and subjective health. In the first step, substance use (frequency of smoking, drinking, and illicit drug use), cognitive reappraisal, and the control variables were added into the model as independent variables. In the second step, the interaction between centralized cognitive reappraisal and substance use was included. The results of the regression analyses are shown in Table 3.

In Model 1, drinking frequency ($\beta = -0.18$, $t = -3.61$, $p < 0.001$) and cognitive reappraisal ($\beta = 0.24$, $t = 8.9$, $p < 0.001$) were significant predictors of subjective health. Smoking frequency and frequency of illicit drug use did not significant predict subjective health (smoking frequency: $\beta = 0.03$, $t = 0.59$, $p = 0.56$; illicit drug use frequency: $\beta = -0.06$, $t = -1.39$, $p = 0.17$). For control variables, only gender significantly predicted subjective health ($\beta = -0.13$, $t = -4.83$, $p < 0.001$).

In Model 2, the interaction between drinking frequency and cognitive reappraisal ($\beta = 0.26$, $t = 3.67$, $p < 0.001$) was a significant predictor of subjective health. In addition, the R^2 -change (ΔR^2) between Model 1 and Model 2 was significant ($\Delta R^2 = 0.03$, $F_{(3,1337)} = 16.52$, $p < 0.001$), which indicates that cognitive reappraisal was a significant moderator in the relationship between drinking frequency and subjective health.

To further investigate the nature of the moderation effect of cognitive reappraisal between cognitive reappraisal and drinking frequency, a simple slope analysis was performed (± 1 SD from the mean; Fig. 1). In

Table 2
The results of Pearson’s correlation among background variables, substance use, subjective health, and cognitive reappraisal.

	M	SD	1.Gender	2	3	4	5	6	7	8	9	10
2. Age	16.42	0.60	-0.02	—								
3. Annual family income	4.25	2.07	-0.15**	-0.03	—							
4. Years of education for father	8.62	3.07	-0.06*	-0.01	0.235**	—						
5. Years of education for mother	8.51	3.07	-0.01	0.01	0.20**	0.56**	—					
6. One or both parents have left home	0.83	0.37	-0.06*	0.01	0.04	-0.01	0.03	—				
7. Smoking frequency	0.64	1.09	-0.13**	0.15**	0.09**	0.09**	0.10**	0.03	—			
8. Drinking frequency	0.66	0.99	-0.11**	0.16**	0.09**	0.12**	0.11**	0.02	0.79**	—		
9. Frequency of illicit drugs use	0.43	0.94	-0.09**	0.20**	0.07**	0.14**	0.15**	0.01	0.69**	0.78**	—	
10. Subjective health	29.69	6.59	-0.14**	-0.07**	0.03	0.04	0.01	0.02	-0.10**	-0.16**	-0.13**	—
11. Cognitive reappraisal	27.27	7.36	-0.11**	0.01	0.07**	0.07*	0.05	0.07*	0.17**	0.15**	0.18**	0.23**

Note: Gender, boy = 0, girl = 1; One or both parents have left home, one = 0, both = 1.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 3
Regression analysis for variables predicting subjective health without the interaction term (Model 1) and with the interaction term (Model 2).

Variable	Model 1			Model 2		
	B	SE	β	B	SE	β
Gender	-0.77	0.37	-0.13***	-0.93	0.36	-0.14***
Age	-0.38	0.29	-0.04	-0.35	0.28	-0.03
Annual family income	0.01	0.09	0.01	0.01	0.09	0.01
Years of education for father	0.08	0.07	0.04	0.07	0.07	0.03
Years of education for mother	0.02	0.07	0.01	0.03	0.07	0.02
One or both parents have left home	0.04	0.46	0.01	0.02	0.45	0.01
Smoking frequency	0.15	0.26	0.03	-0.01	0.26	-0.01
Drinking frequency	-0.20	0.33	-0.18***	-0.13	0.33	-0.17**
Frequency of illicit drugs use	-0.42	0.30	-0.06	-0.81	0.30	-0.11**
Cognitive reappraisal	0.21	0.02	0.24***	0.18	0.02	0.20***
Cognitive Reappraisal \times Smoking frequency				-0.05	0.04	-0.07
Cognitive Reappraisal \times Drinking frequency				0.18	0.05	0.26***
Cognitive Reappraisal \times Frequency of illicit drugs use				0.01	0.04	0.01
R ²	0.11			0.14		
F	15.99***			16.54***		

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

those with a cognitive reappraisal score that was 1 SD below the mean, there was a significant relationship between drinking frequency and subjective health (simple slope = -0.26, $t = -9.81$, $p < 0.001$), which indicated that a higher drinking frequency was associated with worse subjective health. However, in those with a cognitive reappraisal score that was 1 SD above the mean, the effect of drinking frequency on subjective health was not significant (simple slope = -0.07, $t = -0.28$, $p = 0.77$).

4. Discussion

The present study examined the relationship between substance use, subjective health, and cognitive reappraisal in left-behind adolescents, and investigated the moderating effect of cognitive reappraisal in the relationship between substance use and subjective health. We found that substance use (smoking, drinking, and illicit drug use) was negatively correlated with subjective health, which indicates that substance use has

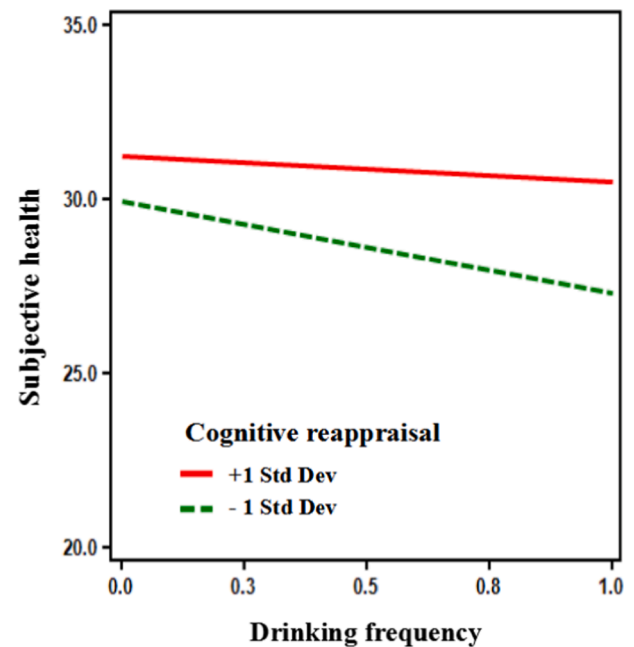


Fig. 1. The interaction between drinking frequency and cognitive reappraisal. The green line represents the relationship between drinking frequency and subjective health when cognitive reappraisal was below average. The red line represents the relationship between drinking frequency and subjective health when cognitive reappraisal was above average. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

an adverse effect on subjective health for Chinese left-behind adolescents in rural areas. Cognitive reappraisal moderated the relationship between substance use and subjective health, which indicates that cognitive reappraisal could be used to reduce the adverse effect of substance use on subjective health.

Left-behind adolescents are more likely to be exposed to substance use (Long et al., 2017). Adolescents are vulnerable to the temptation to use substances and to the effects of these substances (Squeglia & Gray, 2016); furthermore, left-behind adolescents have an easier access to illicit substances given the lack of parental guidance (Catalano et al., 2005). Previous studies have found that adolescents who often communicate with their parents are less likely to use substances (Morgan & Haglund, 2009; Sutherland & Shepherd, 2015). Left-behind adolescents usually have low sense of family belonging and little opportunity to communicate with their parents (Zhao, Sun, Wang, & Zhang, 2018), which may explain their higher substance use.

The present study revealed that substance use (smoking, drinking, and illicit drug use) is negatively correlated with substance use in left-

behind adolescents, which is consistent with previous findings (Moore et al., 2018; Morgan & Haglund, 2009; Phillips-Howard et al., 2010). For example, Moore et al. (2018) revealed that substance use among young adults is associated with poor subjective health. Moreover, epidemiological surveys have consistently revealed there to be a close relationship between substance use and subjective health (Lai, Cleary, Sitharthan, & Hunt, 2015), and substance use decreases subjective mental health and well-being (Schafer & Koyiet, 2018). Left-behind adolescents are more likely to be exposed to substances, and an estimated 1 in 5 adolescents have a diagnosable subjective health problem (Green, McGinnity, Meltzer, Ford, & Goodman, 2005). Having a closer relationship with their parents may help to protect left-behind adolescents against substance use, and thus improve their subjective health.

The present study found that cognitive reappraisal moderated the relationship between drinking and subjective health. In participants with a cognitive reappraisal score that was 1 SD below the mean, a higher drinking frequency was associated with worse subjective health. However, in participants with a cognitive reappraisal score that was 1 SD above the mean, the frequency of drinking was not significantly correlated with subjective health. These results indicate that a higher cognitive reappraisal can reduce the adverse effects of drinking on subjective health in adolescents with left-behind experience. Similarly, previous work has revealed that cognitive reappraisal can help left-behind adolescents regulate their emotions in response to negative life events (Garnefski & Kraaij, 2018); this could explain the moderating effect of cognitive reappraisal on the adverse effect of substance use on subjective health in Chinese adolescents with left-behind experience in the present study. Thus, cognitive reappraisal may protect against the negative effect of substance use on subjective health.

We found that cognitive reappraisal moderated the relationship between drinking and subjective health, but did not moderate the relationship between smoking, illicit drug use, and subjective health. On one hand, while the proportion of drinking was relatively high (36.9%), the proportion of smoking and illicit drug use was relatively low (29.9% and 19.5%), which may have lessened the impact of smoking and illicit drug use on subjective health. On the other hand, in traditional Chinese culture, drinking is usually regarded as a way to temporarily forget one's troubles, and individuals are more likely to drink when they are faced with negative life events. Using cognitive reappraisal to change one's emotional outlook on negative life events and taking a more positive view of life may help to reduce drinking frequency and thus the effect of drinking on subjective health.

Some limitations of the current study should be noted. First, the participants were selected from secondary vocational schools, and the proportion of substance use is reportedly higher for vocational school students than academic school students (Ping et al., 2012). Future studies should expand the types of schools and further investigate whether the present results apply to the larger community (Li et al., 2013). Second, we did not explore the effect of substance use on subjective health over time for left-behind adolescents, and future longitudinal studies could further investigate this. Third, a gender bias may exist given that there were more boys ($n = 898$) than girls ($n = 477$) in the present study. There may have been more boys for two reasons, as follows: (1) left-behind adolescents are those who live in rural areas, and more boys than girls live in rural areas in China (Lund University, 2011); (2) the left-behind adolescents in the present study came from secondary vocational schools, and most of them will become blue-collar workers; traditionally, Chinese parents do not want their daughters to become blue-collar workers, which means the proportion of boys in secondary vocational schools is higher than girls. Future studies should further balance the gender ratio. Finally, we did not include some characteristics of left-behind adolescents, such as the separation length from and contact frequency with their parents. Considering that these characteristics may be important confounders in the association between substance use and subjective health, future studies should include these characteristics in their analyses.

In summary, the present study found that substance use had an adverse effect on subjective health in Chinese left-behind adolescents in rural areas, and cognitive reappraisal reduced this adverse effect. The present results have important implications for reducing substance use and improving subjective health in left-behind adolescents. Families, schools, and governments should pay more attention to left-behind adolescents and help them to reduce substance use. Furthermore, schools could provide cognitive reappraisal training to help left-behind adolescents reduce the adverse effects of substance use on subjective health.

5. Compliance with Ethical Standards**a

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

6. Informed consent**a

Written consent was obtained from each participant after a full explanation of the study procedure. Parents/guardians of participants aged below 18 years old were informed, and their consents were obtained.

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Declaration of Competing of Interest

Daoyang Wang, Haibin Wang, and Cuicui Wang declare that they have no conflict of interest.

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