

The Relationship Between Perceived Stress, Impulsivity, Executive Dysfunction and Non-Suicidal Self-Injury Thoughts Among Chinese College Students: A Gender Difference Study

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Background: The present study aimed to investigate the potential role of perceived stress, impulsivity trait, executive dysfunction in non-suicidal self-injury (NSSI) thoughts among college students, as well as the gender differences.

Methods: A sample of 890 university students completed self-report measures of NSSI thoughts in the past month, the level of perceived stress, impulsivity traits, and executive dysfunction.

Results: Compared to those with low level of perceived stress, participants with high level of perceived stress reported significant higher levels of impulsivity trait and executive dysfunction, and higher frequency of NSSI thoughts, and there were no gender differences. Male participants with NSSI thoughts, compared to males without NSSI thoughts, reported significant higher levels of perceived stress and executive dysfunction. Female participants with NSSI thoughts, compared to females without NSSI thoughts, reported significant higher levels of perceived stress, impulsivity trait, and executive dysfunction. Hierarchical regression analysis revealed only executive dysfunction was associated with NSSI thoughts in males, while only perceived stress was associated with NSSI thoughts in females.

Conclusion: This study revealed different influence factors for NSSI thoughts in male and female college students. NSSI thoughts in males were more likely associated with executive dysfunction while in females were due to recently perceived stress.

Keywords: perceived stress, impulsivity, executive dysfunction, non-suicidal self-injury, gender difference

Introduction

Non-suicidal self-injury (NSSI; eg, direct and deliberate damage or alteration of bodily tissue in the absence of any suicidal intent) is a vital mental health concern among emerging adults, with the lifetime prevalence of NSSI estimated to be 18.5–24.0%.¹ A recent study reported that the prevalence rate of NSSI was as high as nearly 22% in the past year among Chinese college students.² And mounting evidence suggests NSSI is significantly associated with a wide range of psychiatric disorders including depression, bipolar disorder, eating disorder, and substance use disorders^{3,4} and also later suicidal risk.⁵ The risk of suicide in the first year following NSSI was 66 times the annual risk of suicide in the general population.⁶ Engagement in NSSI during the first year in university was at increased risk for both suicidal ideation and

attempts across the university years.⁷ These findings indicate that NSSI poses a significant public health concern on college students worldwide.

So far, there are several theoretical accounts regarding the aetiology and maintenance of NSSI, one of the most important theories concerns stress. Consistent with the stress-sensitivity theory,⁸ exposure to stressful life events (SLEs) and subjective experiences of stress (ie, perceived stress) have been demonstrated to be correlated with increased engagement, frequency, and persistence of NSSI among youth and emerging adults, treating NSSI as a way of alleviating stress.⁹ Kim et al,¹⁰ found that, compared to the suicide attempters and typically developing controls, the NSSI group rated themselves as more interpersonally sensitive and reported a double mean perceived stress score during the Prisoner's Dilemma task assessing interpersonal functioning. After experiencing acute stress, individuals commonly endorse engaging in NSSI to cope with difficult emotion.¹¹ The transition from high school to university life involves acute stressors and challenges for many emerging adults, eg, adjustment to new environment, navigating new social relationship, living away from parents the first time, and higher education program.¹² Previous studies have demonstrated that stress is related to impulsivity,^{13,14} and higher perceived stress, even after controlling for negative affect, was concurrently associated with lower persistence and higher urgency in college students,¹⁵ and impulsivity has emerged as a possible phenotype underlying NSSI.¹⁶ Furthermore, psychosocial stress impairs prefrontal cortex integrity and connectivity,¹⁷ which are integral for a major aspect of executive function that includes inhibition of impulses and self-control. In turn, executive dysfunction exacerbated by stress is related to maladaptive behaviors^{18,19} that includes NSSI. Therefore, a high level of impulsivity and impaired executive function may be mediating factors for stress-induced NSSI. However, to date, little research has tested perceived stress as a predictor of NSSI and how executive function and impulsivity influence the relationship between perceived stress and NSSI among emerging adults.

The Urgency Theory suggests that individuals, under heightened negative affect, are more inclined to engage in rash actions (eg, NSSI).²⁰ NSSI may be impulsive primarily as it can usually be performed quickly and with little preparation or planning.²¹ Consistently, studies have shown that self-reported impulsivity are associated with NSSI, including the behaviour frequency, the condition severity, and the number of methods used, and with the absence of forethought before engaging in NSSI.^{22,23} And a recent longitudinal study identified heightened impulsivity as a potential risk factor for NSSI, independently predicting new onset of NSSI over and above other risk factors (eg, positive parenting and general distress).²⁴ These findings indicate that impulsivity may be a contributing factor in explaining why some individuals engage in NSSI. However, there exist inconsistent results, with some studies reporting a relationship between impulsivity and NSSI,²⁵ whereas others have failed to find a relationship.²³ Thus, the relationship between impulsivity and NSSI should be further explored.

Generally speaking, executive functioning play an important role in shaping individuals' emotional and social competencies and behaviours.²⁶ Thus, executive function deficits can lead to a wide range of difficulties regulating one's emotions, thoughts, and actions, which in turn might lead to suicidal ideation and/or behaviour.²⁷ Neuroimaging studies have reported significant anterior cingulate cortex activation and reduced medial prefrontal cortex connectivity in adolescents with NSSI compared to healthy controls,^{28,29} these brain region changes are crucial for the performance of executive function. However, the results of executive functioning in adolescent with NSSI engagement are inconsistent, some studies indicating little evidence of executive functioning differences between adolescents with NSSI and healthy controls;³⁰ while others demonstrating significant executive function deficits in NSSI groups,^{31,32} and adolescents who currently NSSI exhibiting poor decision-making skills compared to those with a previous history of NSSI.³³

Another important factor involved in NSSI is gender. We noticed that there are gender differences regarding the NSSI characteristics or developmental patterns,^{34,35} and a higher lifetime prevalence of NSSI has been reported by females than males.³⁶ And previous studies have also reported gender difference among young adults in stress levels (ie, higher levels of perceived stress reported in female than male),³⁷ impulsivity (ie, significantly more functional and dysfunctional impulsivity reported in men than women),³⁸ and executive function (ie, men reporting greater difficulty in self-motivation and self-management to time, while women reporting greater difficulty in self-regulation of emotion),³⁹ thus, the gender differences in the relationships between perceived stress, impulsivity, executive function and NSSI among college students need to be considered.

Taken together, theories have highlighted the potential role of stress, impulsivity, and executive function in NSSI engagement, and there exist gender differences in NSSI, perceived stress level, impulsivity, and executive functioning. The present study aimed to investigate how these factors together influence NSSI thoughts among college students, as well as the gender differences.

Methods

Participants

The Ethics Committee of Shanghai Changning Mental Health Center approved the current study, in line with the Declaration of Helsinki. All subjects were informed of potential risks and the complete privacy of their information before completing the questionnaires during class time without time limit. A total of 980 Chinese college students who signed informed consent were recruited by a random cluster sampling method from Hunan University of Chinese Medicine in Changsha (a developing and growing city in central China) in December 2022. After eliminating questionnaires with obvious careless answering patterns or unfinished answers, there were 890 effective participants (including 599 females, 291 males), ranging in age from 18 to 23 years old (total, 18.30 ± 0.56 ; male, 18.35 ± 0.63 ; female, 18.27 ± 0.52). The demographic characteristics of the sample were shown in [Supplement Table 1](#).

Measures

Non-Suicidal Self-Injury (NSSI)

The revised non-suicidal self-injury (NSSI) behaviour scale, adapted from the Ottawa Self-injury Inventory (OSI),⁴⁰ was used to assess the frequency of NSSI thoughts in the past month in the present study and was rated as 0 = never, 1 = at least once, 2 = weekly, 3 = every day. The OSI has been shown excellent internal consistency of 0.67 to 0.87 in a sample of university students,⁴¹ the revised scale used in this study also demonstrates good validity and reliability among Chinese adolescents with mental disorders and college students.^{42,43}

Perceived Stress

The Perceived Stress Scale is a widely used scale for measuring perceived stress and the original 14-item scale was developed in 1983 by Cohen et al.⁴⁴ The Chinese Perceived Stress Scale (CPSS) was revised by TZ Yang and Huang,⁴⁵ which has demonstrated excellent validity and reliability among Chinese populations, comprises 14 self-reported items to analyse the individual perception of stressful events in the past month, including two dimensions: sense of loss of control (7 items) and tension (7 items). Each item is rated on a 5-point Likert scale (0–4). Total score ranges from 0 to 56, with higher score indicating higher level of perceived stress.⁴⁶ 0–28 indicates normal stress, 29–42 indicates high stress, and 43–56 indicates excessive stress. The Cronbach's alpha coefficient of the total scale was 0.835, and the subscales of sense of loss of control and tension were 0.855 and 0.813, respectively, in this study.

Impulsivity

Impulsivity was assessed by the simplified eight-item impulsivity scale (the Brief Barratt Impulsiveness Scale, BBIS), which was translated into Chinese and validated by Leng et al.⁴⁷ The Chinese version of BBIS retained all eight items and set the same dimensions as the original version proposed by Morean et al.⁴⁸ The BBIS was scored on a 4-point scale (from 1 to 4) and consists of two dimensions, namely impulsive behaviour (eg, I act on the spur of the moment) and poor self-regulation (eg, I plan tasks carefully). Items 1, 4, 5, and 6 are reverse scoring questions. Higher scores indicate higher self-reported impulsivity. The Chinese version of BBIS has good validity and reliability among Chinese college students.⁴⁹ We obtained a Cronbach's alpha of 0.783 in our sample.

Executive Function

Dysexecutive function was assessed by the Dysexecutive Questionnaire (DEX),⁵⁰ and the Chinese version of the DEX was validated by Chan.⁵¹ The DEX assesses the five domains of everyday dysexecutive function covering inhibition, in-resistance, social regulation, intentionally, knowing-doing dissociation. It consists of 20 items using a 5-point scale from "Never" to "Very often" (0–4); the total score ranges from 0 to 80, with higher scores reflecting greater severity of

dysexecutive behaviour. The Chinese DEX has been shown to have satisfactory psychometric properties across clinical and non-clinical populations.^{51,52} In the present study, the Cronbach's alpha of the DEX was 0.915.

Data Analysis

Data analysis was performed by SPSS 21 software. Independent-sample *t*-test and chi-square analysis were used to test for differences between continuous and categorical variables, respectively. Harman's single-factor method was used to test the common method bias. Pearson correlation analysis was used to explore the relationships between perceived stress, impulsivity and executive dysfunction among Chinese college students. Hierarchical regression analysis was used to explore influencing factors for NSSI thoughts in the past month. The hierarchical regression consisted of three regression models. In Model 1, the total score or factor scores of perceived stress scale were included, predicting NSSI thoughts in the past month. In Model 2, based on Model 1, poor self-regulation score and impulsive behaviour score were also included, predicting NSSI thoughts in the past month. In Model 3, based on model 2, executive dysfunction score was further included, predicting NSSI thoughts in the past month. The significance criterion was $p < 0.05$ in this study.

Results

Common Method Bias

Harman's single-factor method was used to test the common method bias, which showed that the variance explanation of the largest factor was 27.548 (<40).

Differences in Impulsivity, Executive Dysfunction, and NSSI Thoughts in the Past Month at High and Low Perceived Stress Levels

Compared to those with high level of perceived stress, both male and female college students with low level of perceived stress had lower score of impulsivity (poor self-regulation and impulsive behaviour), lower score of executive dysfunction and lower frequency of NSSI thoughts in the past month, and the differences were statistically significant ($p < 0.05$) (See Table 1).

Correlation Analysis for Perceived Stress, Impulsivity and Executive Dysfunction

Both in male and female college students, correlation analysis shown that the total score of perceived stress and its factors (sense of loss of control and tension) were positively correlated with the scores of impulsivity factors (poor self-regulation and impulsive behaviour) and the total score of executive dysfunction (all p values < 0.05). The scores of

Table 1 Differences in Impulsivity, Executive Dysfunction, and NSSI Thoughts in the Past Month Among Chinese College Students at High and Low Perceived Stress Levels Across Gender (N_{male}=291, N_{female}=599)

Variables			Perceived Stress		t/x^2	p
			High	Low		
Male	Poor self-regulation		9.69±1.99	7.99±2.02	-7.010	<0.001
	Impulsive behaviour		9.92±2.33	8.35±2.17	-5.811	<0.001
	Executive dysfunction		29.80±13.48	19.06±11.11	-7.371	<0.001
	NSSI thoughts in the past month	Yes	12 (10.91%)	8 (4.42%)	4.501	0.034
Female		No	98 (89.09%)	173 (95.58%)		
	Poor self-regulation		9.84±2.09	8.04±2.08	-10.526	<0.001
	Impulsive behaviour		9.88±2.35	8.49±2.04	-7.661	<0.001
	Executive dysfunction		31.23±11.53	18.95±10.02	-13.777	<0.001
	NSSI thoughts in the past month	Yes	61 (22.18%)	15 (4.63%)	41.367	<0.001
		No	214 (77.82%)	309 (95.37%)		

Note: Data analysis: Independent-sample *t*-test or chi-square analysis.

Abbreviation: NSSI, non-suicidal self-injury.

impulsivity factors (poor self-regulation and impulsive behaviour) were positively correlated with the total score of executive dysfunction (all p values < 0.05) (See Table 2).

Differences in Perceived Stress Levels, Impulsivity, and Executive Dysfunction Between the Groups with or Without NSSI Thoughts in the Past Month

Among male college students, compared to the group without NSSI thoughts in the past month, the group with NSSI thoughts in the past month had higher perceived stress level (total perceived stress, sense of loss of control and tension) and executive dysfunction scores, and the differences were statistically significant (all p values < 0.05). There was no significant difference between the scores of impulsivity factors (poor self-regulation and impulsive behaviour) ($p > 0.05$). Among female college students, compared to the group without NSSI thoughts in the past month, the group with NSSI thoughts in the past month had higher perceived stress level (total perceived stress, sense of loss of control and tension), the higher scores of impulsivity factors (poor self-regulation and impulsive behaviour) and executive dysfunction. And the differences were statistically significant (all p values < 0.05) (See Table 3).

Hierarchical Regression Analysis for the Total Score of Perceived Stress, Impulsivity and Executive Dysfunction Predicted NSSI Thoughts in the Past Month and Gender Difference

The hierarchical regression consisted of three regression models. Model 1 included total score of perceived stress as an independent variable. In Model 2, based on Model 1, poor self-regulation and impulsive behaviour of impulsivity factors were added as independent variables. In Model 3, executive dysfunction was added as independent variable based on Model 2.

In the hierarchical regression model, Model 1 included total score of perceived stress as an independent variable, total score of perceived stress positively predicted NSSI thoughts in the past month ($p < 0.05$) among male and female college students (Table 4). Nagelkerke R^2 was 0.085 for male and 0.121 for female in model 1.

In Model 2, based on Model 1, poor self-regulation and impulsive behaviour of impulsivity factors were added as independent variables. The results showed that the total score of perceived stress positively predicted NSSI thoughts in the past month ($p < 0.05$). However, poor self-regulation and impulsive behaviour of impulsivity factors did not predict NSSI thoughts in the past month ($p > 0.05$) among male and female college students (Table 4). Nagelkerke R^2 was 0.085 for male and 0.125 for female in model 2.

Table 2 Correlation Analysis for Perceived Stress, Impulsivity and Executive Dysfunction Among Chinese College Students and Gender Difference ($N_{\text{male}}=291$, $N_{\text{female}}=599$)

Population	Variables	Total Perceived Stress	Sense of Loss of Control	Tension	Poor Self-Regulation	Impulsive Behaviour	Executive Dysfunction
Male	Total perceived stress	I					
	Sense of loss of control	0.789**	I				
	Tension	0.730**	0.157**	I			
	Poor self-regulation	0.476**	0.490**	0.220**	I		
	Impulsive behaviour	0.417**	0.275**	0.364**	0.433**	I	
	Executive dysfunction	0.529**	0.257**	0.565**	0.327**	0.548**	I
Female	Total perceived stress	I					
	Sense of loss of control	0.824**	I				
	Tension	0.793**	0.309**	I			
	Poor self-regulation	0.453**	0.477**	0.248**	I		
	Impulsive behaviour	0.400**	0.278**	0.372**	0.451**	I	
	Executive dysfunction	0.651**	0.439**	0.621**	0.465**	0.556**	I

Notes: ** $p < 0.01$; Data analysis: Pearson correlation analysis.

Table 3 Differences in Perceived Stress Levels, Impulsivity, and Executive Dysfunction Between the Groups with or Without NSSI Thoughts in the Past Month and Gender Difference ($N_{\text{male}}=291$, $N_{\text{female}}=599$)

Gender		NSSI Thoughts in the Past Month	n	Mean \pm SD	t	P
Male	Total perceived stress	No	271	22.88 \pm 7.56	-3.159	0.002
		Yes	20	28.40 \pm 7.32		
	Sense of loss of control	No	271	12.62 \pm 5.32	-1.992	0.047
		Yes	20	15.05 \pm 4.58		
	Tension	No	271	10.26 \pm 4.71	-2.833	0.005
		Yes	20	13.35 \pm 4.57		
	Poor self-regulation	No	271	8.59 \pm 2.18	-1.322	0.187
		Yes	20	9.25 \pm 1.94		
	Impulsive behaviour	No	271	8.89 \pm 2.36	-1.296	0.196
		Yes	20	9.60 \pm 2.30		
Female	Executive dysfunction	No	271	22.34 \pm 12.79	-3.825	<0.001
		Yes	20	33.70 \pm 13.31		
	Total perceived stress	No	523	23.93 \pm 7.79	-6.429	<0.001
		Yes	76	30.05 \pm 7.54		
	Sense of loss of control	No	523	13.12 \pm 5.15	-4.158	<0.001
		Yes	76	15.71 \pm 4.47		
	Tension	No	523	10.81 \pm 4.53	-5.579	<0.001
		Yes	76	14.34 \pm 5.25		
	Poor self-regulation	No	523	8.79 \pm 2.24	-2.081	0.038
		Yes	76	9.37 \pm 2.36		
	Impulsive behaviour	No	523	9.01 \pm 2.26	-3.158	0.002
		Yes	76	9.89 \pm 2.38		
	Executive dysfunction	No	523	23.65 \pm 12.04	-4.979	<0.001
		Yes	76	31.05 \pm 12.65		

Note: Data analysis: Independent-sample t-test.

Abbreviation: NSSI, non-suicidal self-injury.

In Model 3, executive dysfunction was added as independent variable based on Model 2. The results showed that, in male college students, the total score of perceived stress, poor self-regulation and impulsive behaviour of impulsivity factors did not predict NSSI thoughts in the past month ($p > 0.05$), executive dysfunction positively predicted non-suicidal NSSI thoughts in the past month ($p < 0.05$). In female college students, total score of perceived stress positively predicted NSSI thoughts in the past month ($p < 0.05$), poor self-regulation and impulsive behaviour of impulsivity factors and executive dysfunction did not predict NSSI thoughts in the past month ($p > 0.05$) (Table 4). Nagelkerke R^2 was 0.139 for male and 0.128 for female in model 3.

Hierarchical Regression Analysis for the Factors of Perceived Stress, Impulsivity and Executive Dysfunction Predicted NSSI Thoughts in the Past Month and Gender Difference

The hierarchical regression consisted of three regression models. Model 1 included two factors (sense of loss of control and tension) of perceived stress as independent variables. In Model 2, based on Model 1, poor self-regulation and impulsive behaviour of impulsivity factors were added as independent variables. In Model 3, executive dysfunction was added as independent variable based on Model 2.

In the hierarchical regression model, model 1 included two factors (sense of loss of control and tension) of perceived stress as independent variables, sense of loss of control of perceived stress did not predict NSSI thoughts in the past month ($p > 0.05$); however, tension of perceived stress positively predicted NSSI thoughts in the past month ($p < 0.05$) among male college students. Sense of loss of control and tension of perceived stress positively predicted NSSI thoughts in the past month among female college students ($p < 0.05$) (Table 5). Nagelkerke R^2 was 0.087 for male and 0.124 for female in model 1.

Table 4 Hierarchical Regression Analysis for the Total Score of Perceived Stress, Impulsivity and Executive Dysfunction Predicted NSSI Thoughts in the Past Month ($N_{\text{male}}=291$, $N_{\text{female}}=599$)

Gender			B	SE	Wale	df	P	OR 95% CI
Male	Model 1	Total perceived stress	0.098	0.032	9.341	1	0.002	1.103(1.036, 1.175)
	Model 2	Total perceived stress	0.097	0.035	7.499	1	0.006	1.102(1.028, 1.181)
		Poor self-regulation	-0.002	0.128	0	1	0.987	0.998(0.777, 1.282)
		Impulsive behaviour	0.018	0.112	0.026	1	0.873	1.018(0.811, 1.267)
	Model 3	Total perceived stress	0.052	0.04	1.676	1	0.195	1.053(0.974, 1.139)
		Poor self-regulation	0.037	0.136	0.072	1	0.788	1.037(0.795, 1.354)
		Impulsive behaviour	-0.115	0.131	0.764	1	0.382	0.892(0.69, 1.153)
		Executive dysfunction	0.059	0.024	5.805	1	0.016	1.06 (1.011, 1.112)
Female	Model 1	Total perceived stress	0.101	0.017	35.714	1	<0.001	1.106(1.070, 1.144)
	Model 2	Total perceived stress	0.101	0.019	29.063	1	<0.001	1.106(1.066, 1.148)
		Poor self-regulation	-0.061	0.066	0.85	1	0.357	0.941(0.828, 1.071)
		Impulsive behaviour	0.063	0.062	1.029	1	0.31	1.065(0.943, 1.202)
	Model 3	Total perceived stress	0.09	0.022	17.521	1	<0.001	1.094(1.049, 1.142)
		Poor self-regulation	-0.069	0.066	1.087	1	0.297	0.933(0.819, 1.063)
		Impulsive behaviour	0.039	0.066	0.348	1	0.555	1.04(0.913, 1.184)
		Executive dysfunction	0.014	0.015	0.987	1	0.321	1.015(0.986, 1.044)

Note: Data analysis: Hierarchical regression analysis.

Table 5 Hierarchical Regression Analysis for the Factors of Perceived Stress, Impulsivity and Executive Dysfunction Predicted NSSI Thoughts in the Past Month ($N_{\text{male}}=291$, $N_{\text{female}}=599$)

Gender			B	SE	Wale	df	P	OR 95% CI
Male	Model 1	Sense of loss of control	0.082	0.05	2.761	1	0.097	1.086(0.985, 1.197)
		Tension	0.112	0.045	6.202	1	0.013	1.118(1.024, 1.221)
	Model 2	Sense of loss of control	0.079	0.055	2.105	1	0.147	1.082(0.973, 1.205)
		Tension	0.11	0.047	5.537	1	0.019	1.116(1.019, 1.223)
		Poor self-regulation	0.014	0.134	0.011	1	0.918	1.014(0.779, 1.32)
		Impulsive behaviour	0.011	0.113	0.009	1	0.924	1.011(0.81, 1.261)
	Model 3	Sense of loss of control	0.065	0.058	1.246	1	0.264	1.067(0.952, 1.196)
		Tension	0.039	0.057	0.466	1	0.495	1.04(0.93, 1.163)
		Poor self-regulation	0.024	0.141	0.028	1	0.867	1.024(0.776, 1.35)
		Impulsive behaviour	-0.113	0.132	0.73	1	0.393	0.894(0.69, 1.157)
Female	Model 1	Sense of loss of control	0.061	0.025	5.748	1	0.017	1.063(1.011, 1.117)
		Executive dysfunction	0.061	0.025	5.748	1	0.017	1.063(1.011, 1.117)
		Sense of loss of control	0.074	0.029	6.705	1	0.01	1.077(1.018, 1.14)
		Tension	0.123	0.026	22.446	1	<0.001	1.131(1.075, 1.191)
	Model 2	Sense of loss of control	0.079	0.031	6.35	1	0.012	1.082(1.018, 1.151)
		Tension	0.118	0.027	18.733	1	<0.001	1.125(1.067, 1.187)
		Poor self-regulation	-0.045	0.068	0.435	1	0.509	0.956(0.836, 1.093)
		Impulsive behaviour	0.054	0.063	0.728	1	0.394	1.055(0.933, 1.193)
	Model 3	Sense of loss of control	0.076	0.032	5.671	1	0.017	1.078(1.013, 1.148)
		Tension	0.105	0.032	10.815	1	0.001	1.111(1.043, 1.182)
		Poor self-regulation	-0.056	0.07	0.646	1	0.422	0.945(0.825, 1.084)
		Impulsive behaviour	0.036	0.066	0.296	1	0.587	1.037(0.91, 1.181)
		Executive dysfunction	0.012	0.015	0.629	1	0.428	1.012 (0.983, 1.042)

Note: Data analysis: Hierarchical regression analysis.

In model 2, based on model 1, poor self-regulation and impulsive behaviour of impulsivity factors were added as independent variables. The results showed that, among male college students, sense of loss of control of perceived stress and two factors of impulsivity (poor self-regulation and impulsive behaviour) did not predict NSSI thoughts in the past month ($p > 0.05$). But tension of perceived stress positively predicted NSSI thoughts in the past month ($p < 0.05$).

Among female college students, two factors of perceived stress (sense of loss of control and tension) positively predict NSSI thoughts in the past month ($p < 0.05$). However, and two factors of impulsivity (poor self-regulation and impulsive behaviour) did not predict NSSI thoughts in the past month ($p > 0.05$) (Table 5). Nagelkerke R^2 was 0.087 for male and 0.127 for female in model 2.

In Model 3, executive dysfunction was added as independent variable based on Model 2. The results showed that, among male college students, two factors of perceived stress (sense of loss of control and tension) and two factors of impulsivity (poor self-regulation and impulsive behaviour) did not predict NSSI thoughts in the past month ($p > 0.05$), but executive dysfunction positively predicted NSSI thoughts in the past month ($p < 0.05$). Among female college students, two factors of perceived stress (sense of loss of control and tension) positively predicted NSSI thoughts in the past month ($p < 0.05$), but two factors of impulsivity (poor self-regulation and impulsive behaviour) and executive dysfunction did not predict NSSI thoughts in the past month ($p > 0.05$) (Table 5). Nagelkerke R^2 was 0.140 for male and 0.129 for female in model 3.

Discussion

In the present study, we explored the associations between perceived stress, impulsivity and executive dysfunction with NSSI thoughts in the past month among Chinese college students, and found the different roles of perceived stress and executive dysfunction in NSSI thoughts in the past month between females and males.

This study firstly supported the stress-vulnerability theory,⁵³ we found that with high levels of perceived stress, both males and females reported higher levels of impulsivity traits and executive dysfunction, indicating the possibility that stress might augment individual differences such as impulsivity trait and executive function. The positive association between perceived stress and impulsivity is line with the statement that experience of stressful life events and adverse environmental circumstances can lead to the development of impulsivity traits and maladaptive coping styles.^{54,55} Perceived stress were also found to be closely associated with mental symptomatology or behavioral problems with impulsive features, such as Internet gaming disorder,⁵⁶ binge-drinking,⁵⁷ and inattention and hyperactivity/impulsivity symptoms.⁵⁸ In addition, previous studies have reported a longitudinal relationship of perceived stress predicting subsequent decline in executive functioning in older adults,⁵⁹ and higher perceived stress levels were closely associated with decreased hippocampal volume in young people,⁶⁰ which was associated with worse memory.⁶¹ However, our result of no gender difference in the positive association between perceived stress and executive dysfunction is not consistent with the findings of prior studies, for example, the relationship between subjective chronic stress and executive functioning performance were stronger in males compared to females,⁶² and the associations between perceived stress and executive functioning decline were only in males, not in females.⁶³ The inconsistent findings may due to the differences in age of the samples, the above two studies focusing on aged people, while our present study on emerging adults, indicating old men more vulnerable to negative effects of stress on executive function decline.

In the present study, participants with high level of perceived stress, both males and females, reported higher frequency of NSSI thoughts; and participants with NSSI thoughts, both males and females, reported higher level of perceived stress. These results indicated a strong positive association between perceived stress and NSSI thoughts among emerging adults. Previous studies have found that perceived daily stress earlier in the day was associated with greater likelihood of fleeting NSSI thoughts, persistent thoughts, and intense urges later in the day in youth adults,⁶⁴ and NSSI also predicted increased perceived stress over time in emerging adults.⁶⁵ In addition, participants with NSSI thoughts, both males and females, reported high level of executive dysfunction in our presents study. Santamarina-Perez et al,²⁹ reported that adolescents with NSSI, compared to health controls, showed significantly reduced medial prefrontal cortex (mPFC) connectivity, these brain region changes play a key role in the performance of executive functions. And recent studies also provided evidence of a connection between NSSI and executive dysfunction, with depressed adolescents who engaged in NSSI exhibiting poorer cognitive flexibility compared to adolescents without NSSI engagement, and cognitive flexibility may worsen with the increase of NSSI frequency,⁶⁶ and psychiatric patients with deliberate self-harm demonstrating greater deficits in cognitive flexibility as compared to both clinical comparison and healthy groups.⁶⁷ However, contrary to our finding, the study of Mürner-Lavanchy et al,³⁰ showed little evidence that adolescent patients with NSSI exhibited worse neurocognition (including working memory, executive function, etc) and machine learning

was not able to classify control vs NSSI groups based on these neurocognitive features. This inconsistent finding may due to the difference in measures assessing executive function (self-reported scale vs behavioral task), further research is needed to better understand the mechanistic impacts of NSSI on executive function using neuroimaging methods.

Furthermore, we found that female students with NSSI thoughts had higher levels of impulsivity traits, ie, higher scores of poor self-regulation and impulsive behavior, while male students did not. Indeed, previous studies have reported a prospective link between impulsivity trait and NSSI,²⁴ or trait impulsivity, especially in the form of negative urgency, independently predicted new onset of NSSI.⁶⁸ However, after adjusting for perceived stress and executive dysfunction, our study rejected the urgency theory of NSSI²⁰ and found that whether in males or females, impulsivity, or its dimensions poor self-regulation and impulsive behaviors, were not associated with NSSI thoughts. Consistently, other researchers found behavioral impulsivity was not a character of NSSI,⁶⁹ even in the context of negative mood.⁷⁰ And a meta-analysis showed a small association between behavioral impulsivity and NSSI.⁷¹ Given these inconsistencies, a comprehensive enquire into the associations between NSSI and impulsivity phenotypes should include both self-report and behavioral measures of this construct.⁷²

More interestingly, when considering perceived stress, impulsivity trait, and executive dysfunction together, hierarchical regression analysis showed that only executive dysfunction predicted NSSI thoughts in the past month in males; while in female, only perceived stress predicted NSSI thoughts in the past month. These findings demonstrated gender differences in the influence factors for NSSI thoughts among college students, consistent with the Stress-sensitivity Theory, females are prone to NSSI thoughts when they perceive stress. As for males, NSSI thoughts were more likely to coexisting with executive dysfunction, or happened with executive dysfunction settings. This finding highlighted the cognitive processes underlying NSSI and emphasize the importance of assessing and addressing executive function in the treatment of NSSI for males. And our results, to some intent, did not support the Urgency Theory, as impulsivity traits were not associated with NSSI thoughts both in males and females. These findings provide some directions for clinical prevention and intervention targets for NSSI among emerging adults, more attention should focus on executive dysfunction in males and perceived stress level in females.

It is important to note that there were some limitations that should be considered when interpreting the results. First, all information was collected by self-reported scales, despite the perceived validity and reliability of the self-assessment questionnaire, measurement bias should not be ignored. And executive dysfunction should be measured with more objective tools or tests. Second, no causality can be draw with cross-sectional designs, stronger evidences should be identified with cohort or experimental studies. Third, though we considered stress, we did not distinguish chronic and acute stress which may play different role in NSSI thoughts. Fourth, all participants were recruited from one college and sample size was not large enough which restricted our representativeness and extrapolation. Last, our study only included a limited number of influencing factors for NSSI in college students, future studies should include other potential influencing factors (ie, trauma history, family dynamics, peer influence, or access to mental health services), and also consider the complexity and varied motivations behind NSSI, in order to comprehensively understand the mechanism of NSSI behavior.

In conclusion, this study revealed different influence factors for NSSI thoughts in the past month in male and female college students in China. NSSI thoughts in males were more likely associated with executive dysfunction while in females were due to perceived stress. And impulsivity was not important with NSSI thoughts. This study proved valuable evidences with better understanding of NSSI and its sex difference, which may help with prevention and interventions of NSSI.

Data Sharing Statement

The supporting data can be accessed from the corresponding author (Jingbo Gong) on reasonable request.

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Disclosure

The authors report no conflicts of interest in this work.

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