

Psychological characteristic subtypes in adolescents with mental disorders and their associations with self-injury behavior and childhood maltreatment

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ABSTRACT

Objective: Self-injury behavior is a prevalent mental health problem among adolescents. Childhood maltreatment is closely associated with the development of alexithymia, impulsivity, and self-injury behavior in adolescents and young adults with mental disorders; however, the underlying mechanisms remain unclear. This study aims to classify psychiatric patients aged 12 to 24 years into psychological subtypes based on alexithymic and impulsive traits, to explore differences in self-injury behavior among these subtypes, and to examine whether different forms of childhood maltreatment are associated with specific psychological subtypes, thereby providing evidence for clinical intervention and prognosis improvement.

Methods: Clinical data of adolescents and young adults with mental disorders treated between 2021 and 2022 were retrospectively collected. Principal component analysis (PCA) was performed using 6 dimensions derived from the Toronto Alexithymia Scale (TAS)-20 and the Barratt Impulsiveness Scale (BIS)-11, including difficulty identifying feelings (DIF), difficulty describing feelings (DDF), externally oriented thinking (EOT), attentional impulsiveness, motor impulsivity, and non-planning impulsivity. Principal components with eigenvalues (λ) ≥ 1 were retained, and their scores were subjected to 2-step cluster analysis for automatic subtype classification. Differences among the subtypes were compared with respect to demographic characteristics, clinical features, and self-injury behavior-related characteristics. Multivariate Logistic regression models were subsequently used to examine associations between the identified psychological subtypes and different forms of childhood maltreatment.

Results: A total of 634 adolescents and young adults with mental disorders were included, among whom 459 (72.4%) had a history of self-injury behavior. The diagnostic distribution comprised depressive disorders ($n=295$, 46.5%), bipolar disorder ($n=136$, 21.5%), anxiety disorders ($n=61$, 9.6%), schizophrenia ($n=14$, 2.2%), and other disorders ($n=128$, 20.2%), including personality disorders, obsessive-compulsive disorder, post-traumatic stress

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disorder, somatoform disorders, and eating disorders. PCA reduced the 6 dimensions related to alexithymia and impulsivity into 2 independent principal components (Z1 and Z2). Based on individual scores on Z1 and Z2, 2-step cluster analysis automatically classified participants into 3 clusters (K1, K2, and K3). The psychological characteristics of the K1 group were characterized by high motor impulsivity accompanied by marked difficulties in identifying and expressing emotions. The K2 group exhibited relatively low levels of impulsivity and alexithymia. The K3 group was characterized by high attentional impulsivity, high non-planning impulsivity, and externally oriented thinking. No significant differences were observed among the 3 groups in the distribution of primary psychiatric diagnoses ($P>0.05$). Comparisons of self-injury behavior-related characteristics showed that the K2 group had significantly lower rates of self-injury, lower self-injury frequency, lower self-injury addiction scores, and lower self-injury motivation scores than the other 2 groups (all $P<0.05$). No significant differences were found between the K1 and K3 groups in self-injury prevalence, self-injury addiction scores, and external emotion regulation motives ($P>0.05$). However, the K1 group scored significantly higher than the K3 group on the motivational dimensions of social influence, internal emotion regulation, and sensation seeking, while exhibiting a lower frequency of self-injury behavior ($P<0.05$) in the last year. Multivariable Logistic regression analysis revealed that childhood emotional abuse may be a risk factor for developing the K1 psychological subtype; childhood physical abuse may be a risk factor for developing both K1 and K3 psychological subtypes; and childhood emotional neglect was associated with the development of K1 and K2 psychological subtypes.

Conclusion: Adolescents and young adults with mental disorders can be classified into 3 distinct psychological subtypes based on alexithymia and impulsive traits. These subtypes differ in the prevalence and motivational characteristics of self-injury behavior, independent of clinical diagnosis. Furthermore, the development of different psychological subtypes may be associated with exposure to different forms of childhood maltreatment. These findings suggest that providing targeted emotional regulation and impulse-control interventions for adolescents exposed to specific childhood adversities may help reduce the occurrence and frequency of self-injury behavior.

KEY WORDS

adolescents and young adults; self-injury behavior; alexithymia; impulsivity; childhood maltreatment

青少年精神障碍患者心理特征亚型及其与自伤行为和童年期虐待之间的关系

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[摘要] 目的: 自伤行为是青少年高发的心理健康问题, 童年期虐待与青少年精神障碍患者的述情障碍、冲动性心理特征及自伤行为的发生和发展密切相关, 但其机制尚不明确。本研究旨在通过依据个体述情障碍和冲动性心理特征对12~24岁青少年精神心理障碍患者进行亚型分类, 探索不同亚型个体间自伤行为特征的差异, 同时分析不

同类型的童年期虐待是否与特定的心理特征亚型相关, 以期为患者的临床治疗和预后改善提供依据。**方法:** 回顾性收集 2021 至 2022 年青少年精神障碍患者的临床资料, 利用多伦多述情障碍量表(Toronto Alexithymia Scale, TAS)-20 及 Barratt 冲动性量表(Barratt Impulsiveness Scale, BIS)-11 的 6 个维度(情感辨别不能、情感描述不能、外向性思维、注意冲动性、运动冲动性和无计划冲动性)特征进行主成分分析, 对 $\lambda \geq 1$ 的主成分使用二阶聚类法进行自动亚型聚类。比较不同类别患者在人口学资料、临床特征及自伤行为相关特征 3 个方面指标上的差异。同时, 利用多元 Logistic 回归模型探索聚类分析得到的心理亚型是否与不同类型的童年期虐待有关。**结果:** 共纳入 634 例青少年精神障碍患者资料, 459 例(72.4%)曾出现过自伤行为。入组患者中, 抑郁障碍 295 例(46.5%)、双相情感障碍 136 例(21.5%)、焦虑障碍 61 例(9.6%)、精神分裂症 14 例(2.2%)、其他障碍 128 例(20.2%; 包括人格障碍、强迫性障碍、创伤后应激障碍、躯体形式障碍、进食障碍等)。主成分分析可将述情障碍与冲动性相关的 6 个维度转化为 2 个互不相关且具有独立意义的主成分(Z1 及 Z2), 依据个案在 Z1 和 Z2 的得分, 利用二阶聚类法将研究对象自动聚为 3 组(K1、K2、K3), K1 组患者的心理特征可归纳为高运动冲动性且存在较明显的情感辨别及情感表达障碍, K2 组患者的心理特征表现为较低程度的冲动性及述情障碍, K3 组患者心理特征为高注意冲动性、无计划冲动性及外向性思维。3 个亚组在主要诊断构成上的差异无统计学意义($P > 0.05$); 3 个心理特征亚组的自伤行为相关特征比较结果显示, K2 组的自伤发生率、自伤行为频率、自伤成瘾性评分、自伤行为动机评分均显著低于其他 2 组(均 $P < 0.05$); K1 组和 K3 组患者在自伤发生率、自伤成瘾性评分、自伤的外部情绪调节等指标上的差异无统计学意义($P > 0.05$), 但 K1 组患者在自伤社会影响、自伤的内部情绪调节、感觉刺激 3 个动机维度上的评分均显著高于 K3 组患者, 而近一年自伤行为频率则低于 K3 组($P < 0.05$)。多元 Logistic 回归分析结果显示, 童年期遭受情感虐待可能是个体形成 K1 组心理特征的危险因素; 童年期遭受躯体虐待可能是个体形成 K1 和 K3 组心理特征的危险因素; 童年期遭受情感忽视与 K1 和 K2 组心理特征的形成有关。**结论:** 依据述情障碍和冲动性心理特征可将青少年精神障碍患者分为 3 种亚型, 各亚型在自伤行为发生率及自伤行为出现的动机等方面存在差异, 且独立于患者的临床诊断。而不同心理特征亚型的形成可能与不同类型的童年期创伤暴露有关, 这提示对遭受不同童年创伤的青少年精神障碍患者提供针对性的情绪调控与冲动控制策略可能有助于降低自伤行为发生率和频率。

[关键词] 青少年; 自伤行为; 述情障碍; 冲动性; 童年期虐待

Self-injury refers to a harmful and dangerous psychopathological behavior in which an individual intentionally and directly injures their own body tissue^[1]. Children and adolescents are high-risk groups for self-injury, which can have long-term negative impacts on their health and daily lives. In particular, it is closely linked to an increased risk of suicide and places a significant burden on families and society. Self-injury has become a major public health challenge, as revealed in a 2019 study^[2] of the global burden of disease published in the journal *Lancet*, which identified self-injury as the third leading cause of disability-adjusted life years (DALYs) among adolescents and young adults aged 10 to 24 years.

Some research^[3-4] classifies self-injury or self-harm into non-suicidal self-injury (NSSI) and deliberate self-injury (DSH) with suicidal intent based on the presence of suicidal intent. However, due to the lack of standardized terminology and clear definitions of self-injury, along with the clinical reality of repeated self-injury episodes where suicidal intent is often ambiguous and individuals are difficult to clearly categorize, using the broadest concept of self-injury may be the most

practical approach for research. Accordingly, researchers^[3] conducted a meta-analysis of relevant incidence reports across different countries and regions and found that the lifetime prevalence of self-injury behavior in the adolescent community group aged 12 to 18 was about 16.7%, also showing an increasing trend year by year. Among patients in adolescent psychiatry clinics, self-injury is the most common behavioral problem, and the detection rate may exceed 60%^[5].

At present, extensive research has been carried out on the etiology of self-injury behavior and the personality factors and psychological characteristics of self-injured individuals^[6]. In addition to mental illness and living environment, childhood abuse is also considered one of the important causes of self-injury^[7-8], and psychological traits like impulsivity and emotional regulation capacity may play important mediating roles between these etiological factors and self-injury behavior^[9-11]. To the best of our knowledge, research is limited on the relationship between the clinical features of self-injury and specific psychological subtypes. Furthermore, limited studies^[12-14] have investigated whether different types of childhood maltreatment exert

distinct influences on self-injury behavior via mediating traits. Therefore, this study aims to identify psychological subtypes based on emotion management ability (represented by alexithymia) and impulsivity within a clinical adolescent sample, explore differences in self-injury clinical features across these subtypes and analyze the relationships between different types of childhood maltreatment, specific psychological subtypes, and self-injury characteristics.

1 Participants and methods

1.1 Ethics statement

This study was approved by the Ethics Committee of Xiangya Hospital, Central South University (Approval No. 202211690). Written informed consent was obtained from all participants. For minors or individuals lacking full decision-making capacity, consent was obtained from their legal guardians, following the participant's expressed assent.

1.2 Participants

Adolescent patients were recruited from the outpatient departments of a hospital, between 2021 and 2022. Inclusion criteria were as follows: 1) Age between 12 and 24 years; 2) meeting at least one diagnostic criterion for a mental disorder based on the 10th Revision of the International Classification of Diseases (ICD)-10; and 3) ability to understand and complete all self-report instruments. Exclusion criteria included: 1) Diagnosis of intellectual disability or severe physical illness; 2) current or past psychoactive substance use disorder; and 3) confirmed or suspected genetic disorders.

1.3 Methods

1.3.1 Participant evaluation and data collection

Each participant was independently evaluated by 2 psychiatrists, each with over 10 years of clinical experience, to determine eligibility according to the inclusion and exclusion criteria. Participants meeting the criteria were informed about the study by a trained research assistant, who also obtained written informed consent. Subsequently, participants and their guardians completed the clinical information scales under the assistant's guidance.

1.3.2 Measures

Information collected in the clinical data questionnaire consisted of general information, including the age and gender of the patients, as well as clinical information such as a history of psychoactive substance use (such as tobacco and alcohol) and a family history of mental illness. After that, participants completed 5 self-report measures. 1) The Ottawa Self-Injury Inventory (OSI) to assess the occurrence, frequency, addiction potential, and motivational dimensions of self-injury, including social influence, internal and external emotion regulation, and sensation seeking. 2) The Symptom Checklist-90 (SCL-90) to evaluate psychological symptom severity across 9 domains (somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoia, and psychoticism). 3) The Childhood Trauma Questionnaire (CTQ) to measure childhood maltreatment across 5 domains: Physical abuse (PA), emotional abuse (EA), sexual abuse (SA), physical neglect (PN), and emotional neglect (EN). Higher scores indicated greater severity. 4) The Toronto Alexithymia Scale (TAS)-20 to assess alexithymia in 3 domains: Difficulty identifying feelings (DIF), difficulty describing feelings (DDF), and externally oriented thinking (EOT). The higher scores indicated greater alexithymia. 5) The Barratt Impulsiveness Scale (BIS)-11 to measure impulsivity across 3 domains: Attentional, motor, and non-planning impulsivity. The higher the scores, the stronger impulsivity traits.

1.4 Statistical analysis

To enhance clinical interpretability, principal component analysis (PCA) was first conducted on 6 dimensions (3 from TAS-20 and 3 from BIS-11). The resulting uncorrelated principal components were used as input for a two-step cluster analysis to identify distinct psychological subtypes. Subsequently, analysis of variance (ANOVA) and chi-square tests were used to compare demographic variables (e.g., age and sex), clinical indicators (e.g., diagnosis and SCL-90 scores), and self-injury behavior (e.g., frequency, addiction, and motivational scores) across clusters. To control potential confounding, age and sex were adjusted for when comparing SCL-90 scores across clusters. Then, in analyses of self-injury-related scores, the SCL-90 total mean score was further included as a covariate. In order

to investigate whether different types of psychological subtypes are caused by different types of childhood abuse, we set grouping category as the dependent variable with the presence of various types of childhood abuse as the independent variables, and analyzed the risk factors using multiple Logistic regression models.

All analyses were conducted using SPSS version 28.0. Normally distributed continuous variables were expressed as mean $\pm$ standard deviation (SD) and analyzed using independent samples *t*-tests. The categorical variables were described as frequencies (percentages), the χ^2 test or the Fisher exact test was used to analyze categorical variables. A two-tailed $P < 0.05$ was considered statistically significant.

2 Results

2.1 Sample characteristics

A total of 634 participants were included in the final analysis, comprising 177 males and 457 females. The age was (16.14 $\pm$ 2.92) years. The distribution of primary psychiatric diagnoses was as follows: 295 (46.5%) cases of depressive disorder, 136 cases (21.5%) of bipolar disorder, 61 (9.6%) cases of anxiety disorder, 14 (2.2%) cases of schizophrenia, and 128 (20.2%) cases of other disorders (including personality disorder, obsessive-compulsive disorder, post-traumatic stress disorder, somatoform disorder, eating disorder). A total of 459 (72.4%) participants reported a history of self-injury. The mean total score on the SCL-90 was 250.84 $\pm$ 78.55, indicating a moderate level of psychological symptom burden.

2.2 PCA and cluster identification

PCA was conducted on 6 variables including 3 alexithymia dimensions (DIF, DDF, EOT from TAS-20) and 3 impulsivity dimensions (attentional, motor, and non-planning from BIS-11). An orthogonal Varimax rotation method was employed and 2 components (Z1 and Z2) with $\lambda \geq 1$ were extracted, accounting for 62.56% of the total variance (Table 1). Component Z1 was heavily loaded on attentional impulsivity, non-planning impulsivity, and externally oriented thinking, while component Z2 was primarily associated with motor impulsivity, difficulty identifying feelings, and difficulty describing feelings (Table 2). These 2 uncorrelated components were used for two-step cluster analysis, and

participants were classified into 3 psychological subtypes (a K1 group, a K2 group, and a K3 group) according to their scores. For the 2-step cluster analysis, log-likelihood was specified as the distance measure, Bayesian Information Criterion (BIC) as the clustering criterion, and the number of clusters was automatically determined. The scores of each principal component were summarized using means with standard deviations. 253 (39.9%) patients in the K1 group had principal component scores of -0.122 ± 0.611 , 0.727 ± 0.699 on Z1 and Z2, respectively; and 196 (30.9%) patients in the K2 group had scores of -0.915 ± 0.662 , -0.674 ± 0.665 on Z1 and Z2, respectively; and that of 185 (29.2%) patients in the K3 group were 1.137 ± 0.499 on Z1, and -0.280 ± 1.004 on Z2.

The results suggested that the psychological characteristics of the patients in the K1 group could be summarized as high motor impulsivity with obvious emotional discrimination and emotional expression disorders. The characteristics in the K2 group were demonstrated with relatively lower degree of impulsivity and alexithymia. And that in the K3 group were high attentional impulsivity, unplanned impulsivity, and extraverted thinking. Group differences in Z1 and Z2 scores were statistically significant ($P < 0.001$), supporting the validity of the clusters.

2.3 Comparison of psychological subtypes

No significant differences were found in the distribution of primary psychiatric diagnoses across subtypes ($P > 0.05$, Table 3). However, there were significant differences between groups in terms of sex ratio, age, SCL-90 total mean scores, and factor scores, incidence of self-injury behavior, frequency of self-injury behavior, self-injury addiction scores, and self-injury behavior motivation scores ($P < 0.05$). Post-hoc analysis of the characteristic indicators of self-injury behavior with differences between groups showed that the incidence of self-injury, the frequency of self-injury, the score of self-injury addiction, and the motivation score of self-injury behavior in the K2 group were significantly lower than those of the other 2 groups ($P < 0.05$). The comparison between the K1 and K3 groups showed that there was no significant difference in the incidence of self-injury, self-injury addiction score, and external emotion regulation of self-injury ($P > 0.05$), and the scores of the K1 group were significantly higher

than those of the K3 group, but the frequency of self-injury behavior in the last year was lower than that of the K3 (both $P < 0.05$, Table 3). After covariate adjustment, the between-group differences in the SCL-90 total mean score and individual item scores remained unchanged. However, after further controlling for the SCL-90 total mean score, the previously significant group differences in addictive features of self-injury ($F = 41.51$, $P < 0.001$), external emotion regulation function ($F = 6.93$, $P = 0.001$), and internal emotion regulation function ($F = 41.94$, $P < 0.001$) became non-significant ($F = 2.63$, $P = 0.073$, partial $\eta^2 = 0.010$; $F = 0.602$, $P = 0.548$, partial $\eta^2 = 0.002$; $F = 1.828$, $P = 0.162$, partial $\eta^2 = 0.007$). In contrast, the previously significant group differences in the social influence and sensation seeking functions of self-injury ($F = 37.74$, $P = 0.001$; $F = 42.48$, $P < 0.001$) remained significant ($F = 6.124$, $P = 0.002$, partial $\eta^2 = 0.022$; $F = 4.894$, $P = 0.008$, partial $\eta^2 = 0.017$) after controlling for sex, age, and the SCL-90 total mean score. However, after covariate adjustment, the

previously significant pairwise difference in the social influence function of self-injury between the K2 and K3 groups was no longer significant, and the previously significant difference in the sensation seeking function of self-injury between the K1 and K3 groups also became non-significant. These findings suggested that the group differences in addictive features of self-injury and emotion-regulation-related self-injury functions may be largely attributable to overall psychiatric symptom severity. In contrast, the social influence and sensation seeking functions of self-injury remained significantly different at the overall group level after adjustment, suggesting that these dimensions may be more closely related to psychological subtype characteristics independent of general symptom severity. Nevertheless, the attenuation of specific pairwise comparisons indicates that some subgroup differences were partly explained by age, sex, or overall psychiatric symptom severity. Therefore, these adjusted results should be interpreted cautiously.

Table 1 Principal component analysis of psychological characteristics of adolescent patients with mental disorders

Components	Initial eigenvalues			Extraction the sum of squares of the loads		
	Total	Percentage of variance	Percentage of cumulative	Total	Percentage of variance	Percentage of cumulative
Z1	2.42	40.25	40.25	2.42	40.25	40.25
Z2	1.34	22.31	62.56	1.34	22.31	62.56
Z3	0.82	13.66	76.21			
Z4	0.67	11.13	87.33			
Z5	0.55	9.12	96.46			
Z6	0.21	3.54	100.00			

Extraction method: Principal component analysis method.

Table 2 Orthogonal rotation matrix for principal component analysis of psychological characteristics of adolescent patients with mental disorders

Psychological characteristics	Components	
	Z1	Z2
BIS-11: Attentional impulsiveness	0.888	-0.005
BIS-11: Motor impulsiveness	0.311	0.696
BIS-11: Non-planning impulsiveness	0.869	0.109
TAS-20: Difficulty identifying feelings	0.248	0.770
TAS-20: Difficulty describing feelings	-0.316	0.637
TAS-20: Externally oriented thinking	0.654	0.166

Rotation method is orthogonal Varimax rotation method.

BIS-11: Barratt Impulsiveness Scale-11; TAS-20: Toronto Alexithymia Scale-20.

2.4 Associations between psychological subtypes and childhood maltreatment

Multivariate Logistic regression analyses (Table 4) examined associations between subtype membership and types of childhood abuse, using each subtype as the reference group in turn.

With the K1 group as the reference category, individuals without physical abuse were more likely to exhibit the K2 group psychological profile rather than the K1 group [odds ratio (OR) = 2.044, 95% confidence interval (CI) 1.237 to 3.377, $P = 0.005$], indicating that exposure to physical abuse was associated with greater

odds of belonging to the K1 group rather than the K2 group. Similarly, individuals without emotional abuse were more likely to belong to the K2 group rather than the K1 group ($OR=3.096$, 95% CI 1.981 to 4.837, $P<0.001$). For the K3 group, individuals without emotional abuse were more likely to belong to the K3 group rather than the K1 group ($OR=2.248$, 95% CI 1.453 to 3.476, $P<0.001$), and those without emotional neglect were also more likely to belong to the K3 group rather than the K1 group ($OR=2.499$, 95% CI 1.616 to 3.866, $P<0.001$). In other words, compared with the K3 group, the K1 group profile was more strongly associated with experiences of emotional abuse and emotional neglect.

With the K2 group as the reference category, individuals without physical abuse had lower odds of belonging to the K3 group rather than the K2 group ($OR=0.559$, 95% CI 0.325 to 0.960, $P=0.035$), suggesting that physical abuse was associated with a greater likelihood of forming psychological profile of the K3 group. In contrast, individuals without emotional neglect were more likely to belong to the K3 group rather than the K2 group ($OR=2.634$, 95% CI 1.668 to 4.158, $P<0.001$), indicating that those with emotional neglect were relatively more likely to show profile of the K2 group.

Table 3 Comparison of general data and clinical characteristics of different psychological characteristics subgroups

Index		Group K1 ($n=253$)	Group K2 ($n=196$)	Group K3 ($n=185$)	$F/\chi^2/t$	P	Post-hoc analysis between groups ^b		
							K1 vs K2	K1 vs K3	K2 vs K3
Age/Years		16.34±2.98	16.82±3.05	15.15±2.53	17.383	<0.001		**	**
Gender/No.	Male	65	76	36	18.682	<0.001	**		**
	Female	188	120	149					
Diagnose/No.	Depressive disorder	123	84	88	11.747	0.163			
	Bipolar disorder	61	35	40					
	Anxiety disorder	19	25	17					
	Schizophrenia	4	7	3					
	Other obstacles ^a	39	45	37					
SCL-90 scores	Total mean score	3.19±0.69	2.19±0.71	2.87±0.89	93.480	<0.001	**	**	**
	Somatization	2.79±0.88	1.79±0.64	2.40±0.95	77.566	<0.001	**	**	**
	Obsessive-compulsive symptoms	3.36±0.75	2.47±0.84	2.96±0.89	63.496	<0.001	**	**	**
	Interpersonal sensitivity	3.32±0.80	2.39±0.89	3.00±1.00	60.253	<0.001	**	**	**
	Depression	3.58±0.79	2.51±0.97	3.36±1.06	74.422	<0.001	**	*	**
	Anxiety	3.31±0.89	2.26±0.87	2.93±1.07	69.826	<0.001	**	**	**
	Hostility	3.45±0.90	2.29±1.10	3.11±1.23	64.334	<0.001	**	**	**
	Phobic anxiety	2.77±0.94	1.86±0.96	2.47±1.11	47.244	<0.001	**		**
	Paranoia	3.01±0.85	2.15±0.99	2.68±1.08	42.689	<0.001	**	**	**
Ever self-injury/%	Psychoticism	2.98±0.77	1.98±0.71	2.65±0.92	84.640	<0.001	**	**	**
	Yes	81.8	52.0	81.1	58.861	<0.001	**		**
	No	18.2	48.0	18.9					

Table 3 (continued)

							Post-hoc analysis between groups ^b		
Index		Group K1 (n=253)	Group K2 (n=196)	Group K3 (n=185)	F/χ^2	P	K1	K1	K2
							vs	vs	vs
							K2	K3	K3
Frequency of self-injury in the last year/%	Never	29.2	55.6	35.7	55.546	<0.001	**	**	**
	At least once	36.0	28.6	20.5					
	Always	28.5	13.3	38.4					
	Every day	6.3	2.5	5.4					
Self-injury addiction score		11.45±7.87	4.95±5.88	11.30±8.50	41.51	<0.001	**		**
Social influence of self-injury score		6.70±4.98	2.75±3.38	5.25±4.56	37.74	<0.001	**	**	**
External emotion regulation of self-injury score		12.13±5.77	8.31±16.50	10.70±6.06	6.93	0.001	**		*
Internal emotion regulation of self-injury score		9.37±5.29	4.75±4.21	7.84±5.11	41.94	<0.001	**	**	**
Sensation seeking of self-injury score		4.89±3.36	2.03±2.37	3.99±3.14	42.48	<0.001	**	**	**

Normally distributed continuous variables are expressed as mean±standard deviation and analyzed using independent samples t -test. The categorical variables are described as frequencies (percentages), and the χ^2 test or the Fisher exact test is used to analyze categorical variables. ^aIncludes personality disorders, obsessive-compulsive disorders, post-traumatic stress disorders, somatoform disorders, eating disorders. ^bStatistical significance for between-group comparisons is indicated as follows. * $P<0.05$ and ** $P<0.01$.

Table 4 Multivariate Logistic regression results on the relationship between different psychological characteristic subtypes and childhood abuse

Childhood maltreatment		B	SE	Wald χ^2	P	OR	95% CI
Reference category: K1							
K2	PA=0 ^a	0.715	0.256	7.789	0.005	2.044	1.237 to 3.377
	EA=0	1.130	0.228	24.631	<0.001	3.096	1.981 to 4.837
K3	EA=0	0.810	0.222	13.261	<0.001	2.248	1.453 to 3.476
	EN=0	0.916	0.223	16.943	<0.001	2.499	1.616 to 3.866
Reference category: K2							
K1	PA=0	-0.715	0.256	7.789	0.005	0.489	0.296 to 0.808
	EA=0	-1.130	0.228	24.631	<0.001	0.323	0.207 to 0.505
K3	PA=0	-0.582	0.276	4.441	0.035	0.559	0.325 to 0.960
	EN=0	0.968	0.233	17.277	<0.001	2.634	1.668 to 4.158
Reference category: K3							
K1	EA=0	-0.810	0.222	13.261	<0.001	0.445	0.288 to 0.688
	EN=0	-0.916	0.223	16.943	<0.001	0.400	0.259 to 0.619
K2	PA=0	0.582	0.276	4.441	0.035	1.789	1.042 to 3.073
	EN=0	-0.968	0.233	17.277	<0.001	0.380	0.240 to 0.599

^aSuffering no abuse. PA: Physical abuse. EA: Emotional abuse. EN: Emotional neglect. B : Regression coefficient. SE : Standard error; OR : Odds ratio; CI : Confidence interval.

With the K3 group as the reference category, individuals without emotional abuse had lower odds of belonging to the K1 group rather than the K3 group ($OR=0.445$, 95% CI 0.288 to 0.688, $P<0.001$), indicating that exposure to emotional abuse was associated with higher odds of belonging to the K1

group rather than the K3 group, with a reciprocal *OR* of approximately 2.25. Similarly, individuals without emotional neglect had lower odds of belonging to the K1 group rather than the K3 group (*OR*=0.400, 95% *CI* 0.259 to 0.619, *P*<0.001), suggesting that emotional neglect was associated with higher odds of profile of the K1 group, with a reciprocal *OR* of approximately 2.50. Compared with the K3 group, individuals without physical abuse were more likely to belong to the K2 group (*OR*=1.789, 95% *CI* 1.042 to 3.073, *P*=0.035), whereas those without emotional neglect had lower odds of belonging to the K2 group rather than the K3 group (*OR*=0.380, 95% *CI* 0.240 to 0.599, *P*<0.001), corresponding to an approximately 62.0% reduction in odds.

Taken together, emotional abuse might be a significant risk factor for membership in the K1 group physical abuse was probably a predictor of membership in both the K1 and K3 groups, and emotional neglect was likely associated with both the K1 and K2 groups. These results suggested that specific subtypes are differentially associated with distinct forms of childhood trauma.

3 Discussion

Self-injury in adolescence is a complex behavior influenced by an interplay of genetic, psychological, psychiatric, and sociocultural factors. Meta-analytic evidence has shown that adolescents with a history of self-injury have a 22.5-fold higher risk of suicide compared to those without such behaviors^[15]. Among youth with psychiatric disorders, self-injury is particularly prevalent and may interact with the primary symptoms of various mental disorders^[16], resulting in poor prognosis and more serious harm^[17]. In this study, PCA was carried out on the variables with high correlation, and 2 uncorrelated components were constructed, and then cluster analysis was performed on this basis, which could effectively solve the problem of inconspicuous feature drive caused by direct cluster locking using the original index, and increased the clinical interpretability of the different subtypes obtained. Consistent with our hypothesis, we found that there are 3 subtypes of psychological characteristics related to self-injury behavior and they are independent

of diagnosis in adolescents with mental disorders, and the characteristics of self-injury behavior are different among different subtypes. On the one hand, this result might support the theory that patients with high alexithymia and impulsivity have a higher incidence of self-injury in previous studies^[18-19]. On the other hand, it suggested that although the incidence of self-injury in patients with different types of alexithymia or impulse control disorder is similar, the frequency and motivation of self-injury may differ.

A large number of studies have shown that childhood abuse may lead to the emergence of self-injury behaviors^[20-21]. It has been found that childhood trauma can cause differences in different functional dimensions of brain regions^[22] or structural dimensions such as cortical thickness, which may lead to different developmental trajectories^[23-24]. However, there is still a lack of sufficient research on the differences in the outcomes of self-injury caused by different types of abuse^[25], and a limited number of previous studies have preliminarily found that emotional childhood abuse is at higher risk of self-injury behavior than other forms of abuse in childhood^[26-27]. So, this study may provide possible clues of above perspective at the cross-sectional level. More specifically, the K1 and K3 groups showed significantly higher self-injury motives and occurrence rates than the K2 group, and childhood physical abuse was a shared risk factor for the psychological profiles of the K1 and K3 groups. According to a four-function model, self-injury may be maintained by automatic and social reinforcement^[28]. Childhood physical abuse may repeatedly associate the body with pain, punishment, loss of control, and threat during development. In adolescence, when effective emotion regulation strategies are lacking, the body may become a medium for expressing, displacing, or regulating internal distress, thereby contributing to the formation of internal and external reinforcement of self-injury behavior. Emotional neglect is mainly characterized by a lack of perceived personal importance and love, distant family relationships, and insufficient family support, and its harmful nature is often more covert. In contrast, emotional abuse typically involves insulting, devaluing, or hostile family interactions, which may represent an extreme and severe psychological blow to children. Compared with physical or sexual abuse, children and

adolescents may be less likely to recognize emotional maltreatment as abuse and may therefore be less likely to seek help or receive external support^[29]. This lack of positive emotional support may impair the development of emotional awareness and emotional processing, leading to greater difficulties in identifying and expressing emotions. When combined with higher motor impulsivity, individuals may be more likely to translate unspoken internal distress into behavioral expression, thereby increasing the likelihood of recent self-injury^[30]. This may partly explain the higher occurrence of self-injury in the K1 group compared with the K2 group. Although both the K1 and K3 groups were associated with physical abuse, their underlying psychological mechanisms may differ. The K1 group was characterized by higher motor impulsivity and marked difficulties in identifying and expressing emotions, suggesting that these individuals may have greater difficulty recognizing and verbalizing negative emotions. Higher motor impulsivity may further increase emotional arousal and the tendency toward bodily or behavioral coping^[31]. Thus, the higher occurrence of self-injury in K1 may primarily reflect the translation of emotional distress into immediate behavioral responses. In contrast, the K3 group was characterized by attentional impulsivity, non-planning impulsivity, and externally oriented thinking. These features may indicate difficulties in sustained monitoring of emotions and behavioral consequences, reduced executive control, and limited ability to develop alternative coping plans under stress, thus leading to recurrent self-injury with higher frequency^[32]. The K2 group showed lower occurrence and frequency of self-injury than both the K1 and K3 groups, as well as lower self-injury function scores. This may suggest that better alexithymia capacities and lower impulsivity serve as protective factors against self-injury.

A previous neuroimaging study^[33] has shown that NSSI is associated with abnormalities in regions such as the insula, the anterior cingulate cortex (ACC), the medial prefrontal cortex (mPFC), the dorsolateral prefrontal cortex (dlPFC), amygdala, the orbitofrontal cortex (OFC), and striatum, which are jointly involved in emotion regulation, self-referential processing, interpersonal processing, reward processing, and behavioral control. A triple-network model suggests that

cognitive and affective dysfunctions in psychiatric disorders can be understood in terms of altered interactions among the default mode network, central executive network, and salience network^[34]. Our study classified psychological subtypes based on impulsivity and alexithymia, which is broadly consistent with this theoretical framework. However, as no neuroimaging data were collected in the present study, these inferences require further validation using resting-state functional connectivity, emotion recognition tasks, social exclusion tasks, and executive control tasks.

Furthermore, this study demonstrated that specific types of childhood trauma may be mediated by different types of psychological characteristic subtypes and have an impact on the characteristics of self-injury behavior, suggesting that clinicians may need to pay more attention to collecting details of childhood trauma exposure when evaluating self-injury behavior. In other words, more precise interventions tailored to different subtypes may be beneficial to teenagers with self-injury behavior. For K1, intervention should primarily target difficulties in identifying and describing emotions, as well as motor impulsivity, to help individuals transform vague internal distress into emotional experiences that can be identified, expressed, and regulated^[35]. For individuals with recent self-injury behaviors, interventions focusing on emotion regulation and distress tolerance may be further incorporated as a systematic review and meta-analysis of DBT-A have suggested^[19]. For the K3 group, interventions should focus more on the risk of recurrent self-injury, attentional control deficits, and non-planning impulsivity. Although not all individuals in this group may show a high incidence of self-injury, those who engage in self-injury may be more prone to recurrent patterns. Clinically, greater attention should therefore be given to self-injury frequency, self-injury functions, stress-related triggers, capacity for evaluating behavioral consequences, and availability of alternative coping strategies. Interventions may emphasize executive function training, problem-solving skills, crisis planning, behavioral chain analysis, and functional alternatives to self-injury. For the K2 group, although the risk of self-injury was relatively low, potential psychological vulnerabilities related to childhood emotional neglect should still be considered.

Interventions may focus on preventive support and the reinforcement of protective factors, including strengthening family support, improving communication, enhancing emotional expression, establishing stable social support, and providing early screening and psychoeducation during stressful events^[36]. For individuals with childhood emotional neglect but low current risk of self-injury, intervention goals should extend beyond self-injury prevention to include helping them recognize emotional needs, increase willingness to seek help, and make better use of available support resources.

Several limitations should be acknowledged. First, the sample was recruited from a single clinical site, potentially limiting generalizability. Second, psychiatric diagnoses were based on clinical judgment rather than structured diagnostic interviews, and comorbidities were not comprehensively assessed. Comorbidity may impose additional symptom burdens on the primary disorder, thereby influencing the association between disorder-specific psychological characteristics and self-injury behaviors. Although this study adopted a transdiagnostic approach, the lack of detailed comorbidity information still limits the refinement of a psychological subtype framework across psychiatric disorders. Third, data on childhood maltreatment were obtained through retrospective self-report, and current psychiatric symptom status may influence participants' recall and appraisal of past adverse experiences. In particular, among individuals with more severe current symptoms or higher levels of emotional distress, subjective perceptions of childhood trauma and evaluations of its harmful impact may deviate from the facts, thereby introducing recall bias. In addition, the lack of detailed control for current medication status, medication type, and dosage is an important limitation of this study, so future research should collect more comprehensive information on pharmacological treatment. Finally, this study adopted a cross-sectional design without longitudinal assessment, which limits the ability to determine the temporal order and potential causal pathways among the variables. Therefore, the present findings should be interpreted as associative rather than causal. Future studies with prospective longitudinal designs and larger samples are needed to validate these findings and clarify the underlying mechanisms.

This study identified three distinct psychological subtypes among adolescents with mental disorders, based on alexithymia and impulsivity traits. These subtypes differed in self-injury behavior patterns and motivations and were possibly associated with different forms of childhood maltreatment. The findings provide new insights into the heterogeneity of self-injury behavior and highlight the need for subtype-specific assessment and intervention strategies. Incorporating psychological profiling and trauma history into clinical evaluations may enhance the effectiveness of early prevention and treatment efforts for adolescent self-injury.

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