Suicidality and self-injury behaviours across the lifespan in mental and substance use disorders

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Suicidality and self-injury behaviours across the lifespan in mental and substance use disorders

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Editorial: Suicidality and self-injury behaviours across the lifespan in mental and substance use disorders

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Editorial on the Research Topic
Suicidality and self-injury behaviours across the lifespan in mental and substance use disorders

Suicidality and self-injury continue to represent significant challenges worldwide, particularly among individuals affected by mental health and substance use disorders. These behaviours are complex and multifaceted, influenced by an interplay of biological, psychological, and social factors that evolve across developmental stages and cultural contexts. The collection of articles presented in this *Frontiers in Psychiatry* Research Topic provides timely and valuable insights into these critical phenomena, exploring the underlying mechanisms, risk factors, and potential avenues for intervention.

A prominent theme emerging from this Research Topic is the nuanced relationship between non-suicidal self-injury (NSSI) and suicidal behaviour. While these behaviours are related, they present distinct clinical features and trajectories, requiring careful differentiation and targeted approaches for prevention and treatment.

For example, a population-based study from South Korea by Kim et al. highlighted the association between smoking status and suicidal ideation, planning, and attempts. This research underscores the importance of integrating behavioural health factors into suicide prevention strategies and the need to address modifiable lifestyle risks in public health initiatives.

Adolescence was identified as a particularly vulnerable period in several contributions. Zhu et al. developed a predictive model to identify adolescents at elevated risk for NSSI within six months following psychiatric hospitalisation, emphasising the critical window for early intervention. Complementing this, Xu et al. demonstrated through a longitudinal analysis that NSSI can both precede and result from suicidal ideation among

youths, revealing a reciprocal relationship that challenges traditional linear models of risk. These findings highlight the importance of continuous monitoring and individualised support in clinical practice.

Advances in neuroimaging have enhanced our understanding of the biological underpinnings of suicidality. Tymofiyeva et al. focused on the resting-state functional connectivity of the putamen in depressed adolescents with a history of suicide attempts, identifying potential biomarkers that could inform future personalised treatment approaches. In parallel, Orsolini et al. investigated social cognitive deficits, particularly impairments in Theory of Mind, in youths transitioning from NSSI to suicide attempts. Their study suggests that difficulties in understanding others' mental states may contribute to the progression towards suicidal behaviour.

The role of digital environments in shaping self-injurious behaviour is becoming increasingly recognised. Orsolini et al. explored how online interactions may influence NSSI among young people, highlighting both the risks and opportunities inherent in social media use. Their findings call for the development of innovative prevention strategies that engage youth within digital contexts.

From a diagnostic perspective, two articles critically assessed the DSM-5 criteria for suicidal behaviour and NSSI disorders. Oliogu and Ruocco conducted a comprehensive review of the clinical utility, pathophysiology, and treatment options associated with suicidal behaviour disorder, while Dierickx et al. compared patterns of NSSI engagement and severity among emerging adults. These contributions are vital as the field seeks consensus on diagnostic boundaries and subsequent clinical management.

Cultural and social factors also play a significant role in suicidality and self-injury. Meisler et al. examined NSSI and mental health among female Arab minority students, revealing how identity conflict and acculturation stress shape these behaviours. Their work underscores the need for culturally sensitive interventions that are tailored to diverse populations.

Finally, Pató et al. focused on an often-overlooked group - prisoners, investigating suicidal behaviour through the lens of behavioural addiction. Their study broadens our understanding of the risk factors and mechanisms associated with suicidality in incarcerated populations.

Overall, these studies clearly illustrate the multifaceted nature of suicidality and self-injury, which is shaped by developmental, neurobiological, psychosocial, and cultural influences. All of these studies emphasise the need for an integrated and multidisciplinary

approach from the assessment phase onwards, along with a tailored diagnostic and treatment approach adapted to different age groups and target populations.

This Research Topic not only advances knowledge but also identifies important gaps for future inquiry. Longitudinal studies to clarify causality, the refinement of neurobiological markers, and the development of culturally attuned, evidence-based prevention and treatment programmes should be prioritised.

As the global burden of suicide and self-injury persists, especially among individuals with mental health and substance use disorders, this collection offers a valuable framework for clinicians, researchers, and policymakers seeking to reduce harm and save lives throughout the lifespan.

Author contributions

RK: Writing – original draft, Writing – review & editing. RR: Writing – original draft, Writing – review & editing. LO: Writing – original draft, Writing – review & editing.

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Examining the relationship between non-suicidal self-injury and mental health among female Arab minority students: the role of identity conflict and acculturation stress

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Background and objective: Research suggests that individuals from minority backgrounds, including immigrants and ethnic minorities, may be at a higher risk for non-suicidal self-injury (NSSI). The aim of the present research is to examine the relationship between non-suicidal self-injury (NSSI) and identity conflict and acculturation stress, depression, and risk behaviors among female Arab minority students.

Methods: The sample analyzed consisted of 1,529 female Arab students (85.8% B.A. students, 14% M.A. students) aged 21−54 ($M = 23$, SD = 4.17). The participants completed self-reported questionnaires assessing NSSI engagement, identity conflict and acculturation stress, depression, and risky substance use behavior.

Results: As expected, we found a significant positive association between NSSI and identity crisis. In addition, an identity conflict and acculturation stress impact the effect of depression and risky substance use behaviors in engaging in self-injury. Namely, participants were more likely to engage in NSSI when they also experienced identity conflict and acculturation stress and exhibited depressive symptoms and tended to display risky substance use behavior.

Conclusion: These findings provide evidence that the relationship between depression, risky substance use behavior, and NSSI may be stronger among individuals who experience higher levels of identity conflict and acculturation stress. Implications for intervention and future research are briefly presented.

KEYWORDS

non-suicidal self-injury, identity conflict, depression, risky substance use behaviors, acculturation stress

1. Introduction

Non-suicidal self-injury (NSSI) behavior is a growing worldwide clinical and public health concern. NSSI is defined as the direct and deliberate destruction of one's own bodily tissue (for example, by cutting, burning, or scratching oneself badly) in the absence of the intent to die and for reasons not socially sanctioned [1, 2]. NSSI is affected by cultural and economic conditions

and life experiences that may lead to such behavior. The literature has consistently demonstrated that the young adult population is at increased risk for self-injury compared to the general population (3, 4). Researchers and clinicians emphasize the increased magnitude of NSSI as a psychological and physiological health risk for young adults, thus increasingly devoting research attention to this phenomenon (5). For instance, a meta-analysis estimated that 13% of young adults (aged 18–24) have engaged in self-injury at some point in their lives (6).

Self-injury may be linked to numerous psychiatric disorders (5, 7) including major depressive disorder (MDD), which is a significant predictor of future NSSI (8, 9). For example, in Australia, among 12–17-year-olds with depression, 47% reported non-suicidal self-harm over the course of 1 year. In contrast, among 12–17 years nonclinical adolescents, only 4.2% report engaging in non-suicidal self-harm behavior (10). Some studies suggest that people may choose to engage in NSSI to reduce feelings of numbness or emptiness (11, 12), which are emotions that also characterize a depressive phase (13). In other words, the action of self-harm is expected to lead to relief from the negative emotions that accompany depression.

NSSI has also been associated with risky substance use behavior, such as alcohol and cannabis use, especially among young adults (14). Like NSSI, which is used to reduce aversive stress (15), alcohol has been found to reduce various negative emotions (16). Additionally, cannabis use was associated with an increased prevalence of self-injury (17). Mechanisms underlying this relationship suggest the role of shared genes and a family environment (18).

People who identify as members of a minority group are typically more likely to engage in NSSI (19). Minority stress, as defined by minority stress theory (20), has been directly associated with increased NSSI risk in ethnic minorities due to an identity conflict (21). Identity conflict is perceived as an incompatibility between two or more of an individual's identity domains (22). Even though holding multiple identities could increase well-being and predict successful adjustment following life changes (23), there may be a dissonance between the meanings of one's different identities that may be threatening and challenging to deal with (24). Accordingly, heightened levels of anxiety and depression were found among bicultural people who experienced conflict between their distinct cultural identities (25).

Social structure inequities can lead to increased stress caused by acts of discrimination and social exclusion, which are added burdens that socially advantaged groups are not equally exposed to (26). The assumption is that the decreased social standing of stigmatized minority groups could lead to individuals' increased exposure to stressful life situations and social inequality. In addition, such groups have fewer resources to cope with such events. The cognitive-emotional model of NSSI (27) suggests that emotional reactivity affects how individuals interact with the world. In ethnic minorities, such emotional reactivity may result from earlier life experiences, such as stressful social environments. These experiences may be avoided or modulated through the use of NSSI.

In the current study, the population being studied is the Female Arab minority student's population in Israel. As a result of the process of westernization within Israel, the Arab minority in Israel is often referred to as a society in transition, caught between Eastern and Western cultures. They speak a different language (Arabic) compared to the majority group's language (Hebrew), have other religions (rather than Judaism)—most Arabs in Israel are Muslims—and preserve an autonomous cultural existence (28). Moreover, as minorities in the context of the Israeli-Palestinian conflict, Palestinian citizens of Israel have not been treated as equal citizens in many respects, such as accessing medical services and workforce participation (29). This reality has significant implications for the mental health of this population. For example, Arab citizens of every demographic, socioeconomic status, and state of health are more likely to report a lower level of life satisfaction along with a higher level of feelings of loneliness than Jews (30).

The results of NSSI by gender are mixed. Yet, evidence has been found attesting to a higher prevalence of NSSI among females compared to males (31–33). Some hypotheses for why women are at greater risk of self-harm than men are, for example, due to their greater propensity for depression (34). Another possibility is gender socialization of emotions that may impact the type of emotions men and women experience in a way that leads women to be more likely to engage in NSSI [e.g., shame vs. anger; (35)]. Thus, because women are at higher risk of engaging in NSSI than men, we chose to focus on young women in this study.

To date, several studies have examined the association between identity conflict, acculturation stress and NSSI among ethnic minorities (36–38). However, these studies did not examine these associations in the presence of depressive symptoms and risky substance use behaviors. In the context of our study, it was vital to focus on a population that presents a unique intersection of gender and ethnic identity—the female Arab minority students in Israel. Several factors informed this choice: (1) There is a noticeable gap in studies that explore NSSI in this population. (2) as discussed, the Arab minority in Israel undergoes distinctive cultural changes, often referred to as a society in transition, toggling between Eastern and Western influences. (3) For Arab women, attending university in Israel signifies an educational journey and a cultural shift laden with potential identity conflicts and stressors. Considering these considerations, our study was designed to provide an essential understanding of NSSI among female Arab minority students in Israel.

Additionally, the research on identity conflict, acculturation stress, and NSSI has mainly been investigated among gender and ethnic minorities in the United States. Therefore, this study aims to examine the association between NSSI, identity conflict and, acculturation stress, depression, and risky substance use behavior as presented by alcohol misuse and cannabis use. We hypothesized that (1) there would be a significant association between identity conflict and acculturation stress and engaging in NSSI, depression, and risky substance use behaviors; (2) a significant positive association would be observed between depression and NSSI; (3) a significant positive association would be found between risky substance use behavior and NSSI; and (4) Identity conflict and acculturation stress would impact the effect of depression and risky substance use behavior on NSSI.

2. Method

2.1. Participants

The study included 1,529 female Arab students (85.8% B.A. students, 14% M.A. students) aged 21–54 ($M = 23$, SD = 4.17). Participants defined themselves as either religious (12.5%), traditional

(69%), or secular (17.4%), and they studied in several academic institutions in Israel.

2.2. Procedure

The participants were recruited by (1) advertising on social media, (2) face-to-face recruitment in colleges and universities, and (3) using the snowball method. All participants were informed about the aim of the study and were directed to an online webpage and were asked to complete the questionnaires anonymously. They were also provided with links to local mental health resources. The inclusion criteria for our study were: (A) Self-identified female Arab students (B) Currently enrolled in academic institutions in Israel and (C) Aged between 21 and 54 years. Exclusion criteria included: (A) Individuals not currently enrolled in an academic institution and (B) Those outside the age bracket we specified. Participation was voluntary and were not monetarily compensated for participating in this study. The study was approved by the Institutional Review Board (IRB) at the Academic College of Tel-Aviv-Jaffa.

2.3. Measures

2.3.1. Patient health questionnaire-9

A nine-item self-report questionnaire aimed to assess the severity of depression (39). The questionnaire assesses how often the subjects had been disturbed by any of the nine items during the immediately preceding 2 weeks (e.g., "Little interest or pleasure in doing things"). Each item is rated on a 4-point Likert scale (*0 = not at all; 1 = several days; 2 = more than half the days; and 3 = nearly every day*). The total score ranges from 0 to 27, with higher scores indicating greater severity of depression. In our study, we used a cut-off point of 10. Thus, those who received a score of 10 or higher were considered to be suffering from depression. We used the Arabic version of PHQ-9, and the internal consistency in this study was $\alpha = 0.90$.

2.3.2. The deliberate self-harm inventory

The DSHI is a self-report measure that assesses the lifetime history of various aspects of DSH [DSHI-Y; (40)]. The DSHI assesses participants' intentionality (i.e., whether the self-harm was inflicted on purposes) and specifies the damage affected to tissue (e.g., "Have you ever intentionally severely scratched yourself, to the extent that scarring or bleeding occurred? If yes, how many times have you done this?"). Each item on the measure is rated on a 5-point Likert-type scale (*1 = No; 2 = Yes; 3 = Yes, 2–5 times; 4 = Yes, 6–10 times; 5 = Yes, more than 10 times*). This scale is used as a dichotomous variable to distinguish self-harming participants who frequently engaged in DSH from self-harming participants who engaged in DSH infrequently. Participants who reported engaging in NSSI at least one time were assigned a score of "1," whereas those who did not report engaging in NSSI were assigned a score of "0". The internal consistency in this study was $\alpha = 0.73$.

2.3.3. The CRAFFT (car, relax, alone, forget, friends, trouble) questionnaire − 2.0 version

This 4-item clinical assessment tool is designed to screen for substance-related risks (alcohol or cannabis use) and subsequent problems (e.g., "*During the past 12 Months, on how many days did you drink more than a few sips of beer, wine, or any drink containing alcohol?*") (41). The answer options are dichotomous (Yes/No); Each "*Yes*" answer is scored as "1" and a total score of two or higher identifies "high risk" for substance use disorder. The internal consistency in this study was $\alpha = 0.74$.

2.3.4. Acculturation stress scale − revised

The Social, Attitudinal, Familial and Environmental Acculturation Stress Scale [SAFE-R; (42)] is a self-report questionnaire aimed to assess negative stressors experienced by both immigrant and later-generation individuals as they acculturate to the host culture (e.g., "I do not feel at home"). Participants are asked to rate the extent to which they perceive 24 items to be stressful in their lives on a 5-point Likert-type scale ranging from 0 ("Have not experienced stress") to 5 ("Extremely stressful"), with higher scores indicating higher levels of acculturative stress. In our study, we used a cut-off point of 53 and the internal consistency in this study was $\alpha = 0.89$.

2.3.5. Demographics variables

Demographic information about age, marital status, parents' residence, religiosity, and psychological treatment history were also obtained.

2.4. Data analysis

Statistical analyses were conducted with IBM SPSS Statistics version 27.0. Participants with and without NSSI were compared regarding demographic and clinical characteristics using *t*-tests or chi-square as appropriate. Logistic regression was used to analyze variables that differed significantly between those with and without NSSI. The selection of these variables was based on their consistent associations with NSSI in the existing literature and their statistical significance. Specifically, *depression*, *identity conflict*, *acculturative stress, risky substance use behavior* and *religiosity* were chosen based on their consistent associations with NSSI in the existing literature and their statistical significance in the analyses. In order to maintain coherence and avoid multicollinearity, additional demographic variables that showed statistical associations with NSSI were omitted (including the variables "*psychotherapy*" and "*medication*"). Finally, confirmatory path analysis models were conducted to identify and describe pathways to NSSI. Models were compared, and the parsimony model was chosen based on goodness of fit statistics, which includes comparison fit index (CFI), incremental fit index (IFI), and root mean square error of approximation (RMSEA). The alpha value was set to 0.05.

3. Results

Table 1 represents the characteristics of the study population, which included 1,529 participants aged 22–54 years. The sample included participants from three religions and of different levels of religiosity: Muslim (*N* = 1,230, 80%), Christian (*N* = 187, 12.3%) and Druse (*N* = 90, 5.9%), 85.8% are B.A. students (*N* = 1,313) and 14% M.A. students (*N* = 215). Clinically, 33.6% of the sample reported NSSI

TABLE 1 Demographic and clinical characteristics of the sample
(*N* = 1,529).

Age (*M*; SD)	23	4.17
	N	%
Gender (female)	1,529	100
Ethnicity		
Muslim	1,230	80
Christian	187	12.3
Druse	90	5.9
Religiosity		
Religious	192	12.5
Traditional	1,070	69
Secular	267	17.4
Marital status		
Married	209	13.6
Single	1,306	85
Divorced	13	0.08
Parents' settlement pattern		
Arab village	830	50.4
Arab city	121	8
Mixed city	587	38.3
Residence		
Dorms	347	22.6
Rented apartment	364	23.8
Parents' house	818	53.4
Education		
Bachelor's degree	1,313	85.8
Master's degree	215	14
Year of study		
First-year	567	37
Second year	419	27.4
Third year	306	20
Fourth year	237	15.5
Psychotherapy		
Yes	215	14.1
Medication		
Yes	72	4.7
Clinical characteristics		
NSSI	513	33.6
Depression	668	43.7
Identity conflict and acculturation stress	793	52
Risky substance use behavior	168	11.2

The term mixed city refers to cities in which the population includes both a significant
number of Jewish and Arab residents (43).

(*N* = 513). Additionally, about half of the sample (*N* = 668, 43.7%)
reported depression, and 11.2% reported risky substance use behavior
(*N* = 168).

TABLE 2 Severity of NSSI engagement by type of injury among
participants engaging NSSI (*N* = 513).

	1 time	2–5 times	6–10 times	<10 times	*N* (%)
Cutting	132 (52.8%)	87 (34.8%)	13 (5.2%)	18 (7.2%)	250 (43.8)
Burning	33 (86.8%)	5 (13.2%)	0	0	38 (19)
Scratching	81 (47.4%)	59 (34.5%)	18 (10.5%)	13 (7.6%)	171 (33)
Self-biting	0	0	4 (40%)	6 (60%)	10 (0.19)
Banging head/body	127 (54.3%)	78 (33.3%)	12 (5.1%)	17 (7.3%)	234 (45)
Self-punching	123 (57.5%)	72 (33.6%)	9 (4.2%)	10 (4.7%)	214 (41.4)

There are participants who engaged in various types.

Table 2 displays the extent of engagement in Non-Suicidal Self-
Injury (NSSI) by injury type among participants who have partaken
in NSSI (*N* = 513). The most frequently observed type of injury is
cutting (*N* = 250, 43.8%), whereas self-biting is the least prevalent
(*N* = 10, 0.19%). Notably, for the majority of injury types, the
predominant frequency of engagement is one time; however, in the
case of self-biting, the most common frequency is more than 10 times
(*N* = 6, 60%).

Table 3 presents a comparison between the two study groups:
those with NSSI and those with no engagement with NSSI. Participants
who engaged in NSSI reported significantly higher depression
(*t* = 11.473, *p* < 0.001), and identity conflict and acculturative stress
(*t* = 8.496, *p* < 0.001) compared to those who did not report. Regarding
risky substance use behavior, those with no NSSI behavior reported
more risky substance use behaviors compared to those with no NSSI
(χ^2 = 33.451, *p* < 0.001). There were no differences in terms of marital
status, parents' settlement pattern, residence, and degree.

As presented in Table 4, there was a significant correlation
between NSSI and identity conflict and acculturative stress (*r* = 0.144,
p < 0.01) as well as risky substance use behavior (*r* = 0.119, *p* < 0.01) and
depression (*r* = 0.228, *p* < 0.1). Identity conflict and acculturative stress
were significantly correlated to risky substance use behavior (*r* = 0.083,
p < 0.01) and depression (*r* = −0.360, *p* < 0.01), and risky substance use
behaviors were also correlated with depression (*r* = 0.052, *p* < 0.05).

Table 5 presented the results of the logistic regression analysis
showing that participants are more likely to engage in NSSI when they
also experience depression (*B* = 0.088, *p* < 0.001), identity conflict and
acculturative stress (*B* = 0.012, *p* = 0.016) and tend to display risky
substance use behavior (*B* = 0.171, *p* = 0.005).

Finally, A confirmatory path analysis model to identify pathways
to NSSI was conducted. The model has indicated a good fit
(CFI = 0.974, TLI = 0.921, NFI = 0.967, RMSEA = 0.05). As
hypothesized, there was a significant direct effect of identity conflict
and acculturative stress on NSSI (*β* = 0.59, *p* = 0.37, SE = 0.005, 95%
[0.010, 0.108]) as well as an indirect effect through its impact on
depression (*β* = 0.155, *p* < 0.001, SE = 0.002, 95% [0.011, 0.016]) and
risky substance use behavior (*β* = 0.012, *p* < 0.001, SE = 0.001, 95%
[0.001, 0.002]) (Figure 1).

TABLE 3 Demographic and clinical characteristics by NSSI.

	Without NSSI history (N = 1,016)	NSSI history (N = 513)	Test	df	p
Age (M ± SD)	22.62 ± 3.87	23.14 ± 4.30	$t = -2.318$	1,523	0.021
Ethnicity; % (N)					
Muslim	79% (801)[a]	84% (429)[b]	$\chi^2 = 15.264$	3	0.002
Christian	14% (140)[a]	10% (47)[b]			
Druse	7% (66)[a]	4.6% (24)[a]			
Religiosity; % (N)					
Religious	14% (141)[a]	10% (51)[b]	$\chi^2 = 12.989$	2	0.002
Traditional	70% (720)[a]	68.2% (350)[a]			
Secular	15.2% (155)[a]	22% (112)[a]			
Marital status; % (N)					
Married	13.7% (139)	13.6% (70)	$\chi^2 = 0.44$	2	0.978
Single	85.4% (868)	85% (438)			
Divorced	0.9% (9)	0.7% (4)			
Residence					
Dorms	22% (225)	23.7% (122)	$\chi^2 = 2.517$	2	0.284
Rented apartment	23% (233)	25.5% (131)			
Parents' house	55% (558)	50% (260)			
Degree; % (N)					
Bachelor's degree	84.4% (858)	88.6% (455)	$\chi^2 = 5.497$	1	0.19
Master's degree	15.5% (158)	11% (57)			
Year of study; % (N)					
First year	33.2% (338)[a]	44.6% (229)[b]	$\chi^2 = 19.147$	3	<0.001
Second year	30% (298)[a]	23.5% (121)[b]			
Third year	21.2% (216)[a]	17.5% (90)[a]			
Fourth year	16% (164)[a]	14% (73)[a]			
Psychotherapy; % (N)	11.4% (116)	19.2% (99)	$\chi^2 = 17.520$	1	<0.001
Medication; % (N)	3.5% (36)	7% (36)	$\chi^2 = 9.169$	1	0.002
Clinical characteristics					
Depression (M ± SD)	0.337 ± 0.47	0.633 ± 0.48	$t = 11.473$	1,527	<0.001
Risky substance use behavior % (N)	31.3% (326)	68.6% (793)	$\chi^2 = 33.451$	6	<0.001
Identity conflict and acculturation stress (M ± SD)	52.366 ± 13.17	58.567 ± 14.049	$t = 8.496$	1,527	<0.001

Items with different superscripts are significantly different at α = 0.017.

4. Discussion

The objective of the current study was to estimate the frequency of NSSI and to examine the association of this behavior with identity conflict and acculturative stress, depression, and risky substance use behavior among female Arab students. The results showed high frequencies of engaging in NSSI in this sample compared to other studies (32, 44, 45). In fact, we found that identity conflict and acculturative stress impact the effect of depression and risky substance use behaviors on NSSI.

This finding is consistent with previous findings (46, 47) and may be explained by the association between minority stress and dysregulation,

which increases the risk of self-harm. While people engage in NSSI for various reasons, they often use it to regulate intense or unwanted emotions (48). This is supported, for example, by empirical evidence that difficulties in emotion regulation—that is, the processes by which people regulate the characteristics of their emotions—characterize NSSI (49). While the current study did not directly examine emotional dysregulation, previous research has highlighted the association between minority stress, dysregulation, and the risk of self-harm. Additionally, marked differences were found in the emotion regulation of self-injurers compared to non-injurers (50). Moreover, ethnic discrimination events (such as those characterized by minority stress) and fear of stereotyping were found to often cause expressive suppression as an emotionally focused strategy (51,

TABLE 4 Pearson correlation matrix of NSSI, demographic and clinical variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. I.C & Acculturation stress	–	0.083**	0.360**	0.144**	−0.047	−0.013	0.036	−0.002	−0.075**	0.020	−0.057*	−0.005	−0.085**	−0.066**
2. Risky substance use behavior		–	0.052*	0.119**	−0.012	−0.027	0.046	−0.113**	−0.071**	0.008	0.259**	−0.381**	−0.112**	−0.100
3. Depression			–	0.282**	−0.056*	−0.053*	−0.050	0.01	−0.064*	−0.033	−0.019	−0.068**	−0.137**	−0.140**
4. NSSI				–	−0.059*	−0.060*	−0.082**	−0.034	−0.003	0.037	−0.024	−0.091**	−0.107**	−0.077**
5. Age					–	0.451**	0.338**	0.264**	0.604**	−0.035	−0.012	0.053*	−0.130**	−0.061
6. Degree						–	−0.064**	0.164*	0.266**	0.019	−0.041	0.026	−0.156**	−0.034
7. Year							–	0.045	0.159**	−0.019	0.056*	0.044	−0.056*	−0.02
8. Residence								–	0.244**	0.004	−0.032	0.160**	0.014	−0.014
9. Marital status									–	−0.003	−0.79**	0.142**	−0.039	0.009
10. Parents settlement pattern										–	−0.149**	0.058**	−0.011	−0.009
11. Ethnicity											–	−0.332**	−0.074**	−0.061**
12. Religion												–	0.091**	0.059*
13. Psychotherapy													–	0.328**
14. Medication														–

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

TABLE 5 Logistic regression of correlates of religiosity, age, degree, depression, risky substance use behaviors and identity conflict and acculturation stress.

	B	SEB	Wald	p	OR (95%CI)
Religiosity	−0.170	0.117	2.084	0.149	0.844 [0.671, 1.063]
Age	−0.016	0.017	0.961	0.327	0.984 [0.953, 1.016]
Degree	−0.186	0.195	0.906	0.341	0.831 [0.567, 1.217]
Depression	0.088	0.011	67.748	>001	1.092 [1.070, 1.115]
Risky substance use behavior	0.171	0.060	8.005	0.005	1.187 [1.054, 1.336]
Identity conflict and acculturation stress	0.012	0.005	5.836	0.016	1.012 [1.002, 1.021]
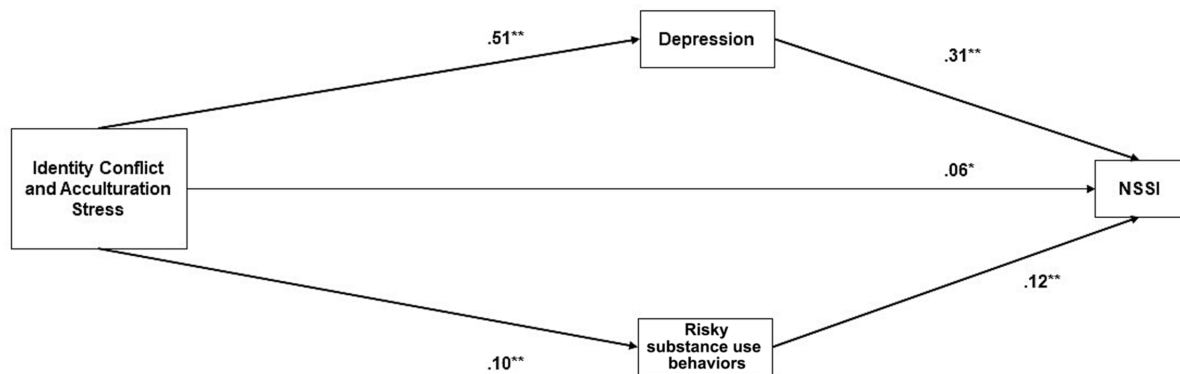
FIGURE 1
Path model for clinical indicators: NSSI, depression, identity conflict and acculturation stress, and risky substance use behavior. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

52). These strategies contribute to problems in self-regulation that could lead to maladaptive coping (53).

Indirectly, minority stress could lead to NSSI due to symptoms of depression, mainly due to racism and discrimination (54, 55). In our study, this is reflected by the fact that most participants with identity conflict and acculturative stress also reported high levels of depression. Our results indicate a relationship between identity conflict, acculturative stress, and depressive symptoms. However, the severity or prevalence of high levels of depression among these participants was not explicitly quantified in our results. The severity of depression may worsen due to the failure to receive professional help (56). In fact, Participants of this study who experience high levels of identity conflict and acculturation stress may exhibit feelings of confusion and uncertainty about their identity, particularly if there is a conflict between one's original cultural identity and the identity required to navigate the new cultural environment. This can lead to a sense of disconnection from oneself and a lack of belonging, which can contribute to the risk of NSSI as a way of coping with emotional pain.

Acculturation stress may increase the risk of NSSI through its impact on social support. Immigrants and individuals from minority backgrounds may have limited access to social support networks, particularly if they experience discrimination or face language barriers (15, 57). This lack of social support can increase feelings of loneliness and emotional distress, which can contribute to the risk of NSSI.

A study that compared the Arab and Jewish populations in Israel found that of those who reported mental distress, among Arabs, only 14% sought psychotherapy, compared to 36% among Jews (58). The inaccessibility to psychotherapy in Arab society is due to economic, geographic, linguistic, and cultural factors (59). Lack of access to mental health services, rather than cultural barriers such as stigma, was considered to be the main obstacle to help-seeking in this Arab minority population (60). Moreover, Data from the Information Department of the Ministry of Health shows that only 7% of the mental health clinics in Israel operated among the Arab population (61). Specifically, given that previous literature has reported that depression is a valid predictor of NSSI (62, 63) and in view of the findings of the present study, in which the participants were all university students, the current set of services available to meet the needs of Arab citizens students should be reviewed, and academic institutions should consider ways to provide these services.

In times of mental distress and the absence of sources of support, internet use increases (64). While the current study did not directly examine Internet use, it's worth noting the broader

context in which NSSI exists. Previous research indicates that Internet use is increasing remarkably among certain populations suffering from psychosocial problems (65), low self-esteem (66), and difficulties in emotion regulation (67), which, as noted, characterize ethnic minorities. In addition, disadvantaged groups use the Internet to diversify their information sources and social networks (68). Indeed, it was found that the Arab citizens of Israel are more likely than Israeli Jews to search for health information and to communicate online about health-related issues (69). For this particular population (who may be in a state of mental distress and do not receive proper professional help), extensive use of the Internet may expose them to websites that encourage self-harm, as well as to websites that contain technical information on self-harm methods (70). Participants with a history of NSSI were also more likely to engage in risky substance use behavior. Alongside the findings that NSSI and alcohol consumption serve similar emotion regulation functions, alcohol use also increases at the ages when NSSI decreases [e.g., the transition from high school to college; (71)], which suggests that alcohol use could eventually replace NSSI as a means of emotion regulation. As for cannabis use, high THC/CBD levels have been found to cause depression (72), impulsive behaviors (73), and difficulty regulating adverse effects (74). In turn, these conditions are associated with self-injurious behaviors. As noted earlier, these behaviors among ethnic minorities may reflect a stress response to racial/or ethnic stressors (75, 76). Early adulthood is often marked by a greater exploration of one's social and community identity. Therefore, a minority population may often be subjected to more open manifestations of discrimination and may, in turn, develop a sense of internalized negativity that often leads to coping based on drugs and alcohol (77).

Moreover, although other minorities in Israel were beyond the scope of this study, it is noteworthy that Israel is a unique place to study the mental difficulty of minorities. Due to mass immigration, religious diversity, and a dynamic political, social, and economic environment, the Israeli population is comprised of a growing number of ethnic groups in Israel (78). Although the Arab population constitutes the largest ethnic minority, there are many additional ethnic minority populations, such as Armenians, Cirassians, Assyrians, and some Jewish minority groups. Future work should consider investigating the relationship between identity conflict and NSSI among other ethnic minorities in Israel.

One of the salient aspects of our findings is the data on help-seeking behaviors. Understanding the nuances of how the studied population approaches assistance, especially in mental health, provides a critical perspective into their unique challenges and potential avenues for intervention.

From our results, it is evident that multiple factors influenced the propensity for help-seeking among our participants. Cultural and societal norms, language barriers, perceived stigma, and availability of accessible resources are some potential barriers that might deter individuals from actively seeking help. Understanding these barriers is essential given the high reported levels of identity conflict, acculturative stress, and NSSI. The disparity in the number of participants experiencing distress and those actually seeking help emphasizes the urgent need for more adapted and accessible mental health services for this population. Addressing these barriers could not only enhance the mental well-being of the individuals but also

reduce the occurrences of NSSI, which our study highlighted as prevalent in this community.

Furthermore, the focus on help-seeking behaviors may offer knowledge that promotes future interventions that are both culturally sensitive and effective in addressing the unique challenges faced by this population.

4.1. Limitations

Several limitations of this study should be noted. Firstly, the measures we used to measure all variables were limited to self-reporting, creating the possibility for a recall and social desirability bias. Secondly, the current study's generalizability is limited since we did not investigate the differences between the subgroups within the sample. Therefore, further research is needed to investigate differences between the subgroups and perhaps to compare the Arab population in Israel to Arab populations in the MENA countries. Thirdly, this study referred to risky behavior such as alcohol consumption and substance use. Future research should address different types of risky substance use behavior, such as unprotected sexual activity, risky uses of social media, and dangerous driving. Fourthly, our study employed a cross-sectional design, which limits the ability to establish causality. While the associations we observed provide valuable insights, they do not indicate direct causal relationships. A longitudinal study design would be more appropriate to elucidate the temporal dynamics and causality between the variables of interest.

Fifthly, the omission of attention checks in our survey instruments emerges as a notable limitation, compromising our ability to validate the authenticity and attentiveness of participant responses. Although this decision was made to preserve the original structure of established questionnaires, it introduces the potential for inaccurate responses. Future research could explore strategies to maintain instrument validity while also ensuring respondent attentiveness to enhance the robustness of data. Finally, Arab society is a traditional and conservative society characterized by high levels of patriarchal, authoritarian, and religious norms (79). Therefore, certain risky substance use behaviors, such as those we examined in our study, are considered indecent behavior, and constitute social taboos (80, 81). For example, regarding alcohol, the Quran prohibits the consumption of alcohol (82). Therefore, in view of the cultural characteristics of the current study population, there may be a differential bias regarding measures of risky substance use behavior. Presumably, the results would be more accurate and comprehensive if the cultural barriers were controlled.

4.2. Implications

Despite these limitations, the strengths of this study—such as the large sample size and that, to the best of our knowledge, it was the first study to examine a relationship between identity conflict and acculturation stress, depression and risky substance use behavior— suggest topics for future research and the development of positive intervention programs focusing on the well-being of the Arab population. Various intervention programs could prevent or reduce the occurrence of depression and NSSI behavior. Such intervention

programs include regular monitoring of the students' mood through daily self-examination in the form of a "mood thermometer" and referral to psychotherapy, if necessary (25), cognitive-behavioral group therapy (83), along with psychoeducation for students and mental health professionals, which includes information about NSSI and how to respond compassionately and effectively to peer disclosures of NSSI (84). In and of itself, awareness might increase sharing and help-seeking, especially given that one of NSSI's primary functions is the communication of distress.

In light of our findings, several avenues for future research are recommended, including (1) Expanding the population sample: While our investigation is focused on female Arab students, it is essential to consider the experiences of male Arab students. Comprehensive picture of the phenomenon within the broader Arab student population in Israel. (2) As mentioned earlier, Given the cross-sectional nature of our research, a longitudinal approach in subsequent studies could better clarify cause-and-effect relationships, tracking the evolution of identity conflict, acculturation stress, and NSSI over time. (3) Our study established correlations between identity conflict, acculturation stress, depression, risky substance use behavior, and NSSI. A logical next step would be to explore the deeper mechanisms propelling individuals from experiencing these stressors to engaging in NSSI.

5. Conclusion

The present study contributes to a growing body of evidence suggesting that ethnic minorities are at increased risk for NSSI. The results of this study highlight the importance of addressing both acculturation stress and depression in order to prevent and treat NSSI, especially among vulnerable populations. Interventions should be culturally appropriate and tailored to the specific needs of individuals from different cultural backgrounds. Early detection and treatment of depression and acculturation stress can help reduce the risk of NSSI and promote positive mental health outcomes.

More specifically, this research may contribute to a broader understanding of the mental distress experienced by the Arab population in Israel, especially among Arab women, since NSSI and depression are still taboo in this population, along with low societal awareness of the phenomenon.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Author contributions

SM and SH conceived and designed the analysis. SS collected data. SM performed the analysis and original draft preparation. SM, SS, MO, IT, and SH: conceptualization, supervision, and editing. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

1. Nock MK. Self-injury. *Annu Rev Clin Psychol.* (2010) 6:339–63. doi: 10.1146/annurev.clinpsy.121208.131258

2. Lengel GJ, Ammerman BA, Washburn JJ. Clarifying the definition of non-suicidal self-injury. *Crisis.* (2022) 43:119–26. doi: 10.1027/0227-5910/a000764

3. Armiento JS, Hamza CA, Willoughby T. An examination of disclosure of non-suicidal self-injury among university students. *J Community Appl Soc Psychol.* (2014) 24:518–33. doi: 10.1002/casp.2190

4. Voss C, Hoyer J, Venz J, Pieper L, Beesdo-Baum K. Non-suicidal self-injury and its co-occurrence with suicidal behavior: an epidemiological-study among adolescents and young adults. *Acta Psychiatr Scand.* (2020) 142:496–508. doi: 10.1111/acps.13237

5. Cipriano A, Cella S, Cotrufo P. Non-suicidal self-injury: a systematic review. *Front Psychol.* (2017):8. doi: 10.3389/fpsyg.2017.01946

6. Swannell SV, Martin GE, Page A, Hasking P, St John NJ. Prevalence of non-suicidal self-injury in nonclinical samples: systematic review, meta-analysis and meta-regression. *Suicide Life Threat Behav.* (2014) 44:273–303. doi: 10.1111/sltb.12070

7. Bentley KH, Cassiello-Robbins CF, Vittorio L, Sauer-Zavala S, Barlow DH. The association between non-suicidal self-injury and the emotional disorders: a meta-analytic review. *Clin Psychol Rev.* (2015) 37:72–88. doi: 10.1016/j.cpr.2015.02.006

8. Claes L, Luyckx K, Bijttebier P. Non-suicidal self-injury in adolescents: prevalence and associations with identity formation above and beyond depression. *Personal Individ Differ.* (2014) 61-62:101–4. doi: 10.1016/j.paid.2013.12.019

9. Fox KR, Franklin JC, Ribeiro JD, Kleiman EM, Bentley KH, Nock MK. Meta-analysis of risk factors for non-suicidal self-injury. *Clin Psychol Rev.* (2015) 42:156–67. doi: 10.1016/j.cpr.2015.09.002

10. Zubrick SR, Hafekost J, Johnson SE, Sawyer MG, Patton G, Lawrence D. The continuity and duration of depression and its relationship to non-suicidal self-harm and suicidal ideation and behavior in adolescents 12–17. *J Affect Disord.* (2017) 220:49–56. doi: 10.1016/j.jad.2017.05.050

11. D'Agostino A, Pepi R, Rossi Monti M, Starcevic V. The feeling of emptiness: a review of a complex subjective experience. *Harv Rev Psychiatry.* (2020) 28:287–95. doi: 10.1097/hrp.0000000000000269

12. Hornor G. Non-suicidal self-injury. *J Pediatr Health Care.* (2016) 30:261–7. doi: 10.1016/j.pedhc.2015.06.012

13. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders: DSM-5* 5th edn. Arlington, VA: American Psychiatric Publishing. (2013).

14. Bresin K, Mekawi Y. Different ways to drown out the pain: a meta-analysis of the association between non-suicidal self-injury and alcohol use. *Arch Suicide Res*. (2020) 26:348–69. doi: 10.1080/13811118.2020.1802378

15. Taylor PJ, Jomar K, Dhingra K, Forrester R, Shahmalak U, Dickson JM. A meta-analysis of the prevalence of different functions of non-suicidal self-injury. *J Affect Disord*. (2018) 227:759–69. doi: 10.1016/j.jad.2017.11.073

16. Bresin K. A meta-analytic review of laboratory studies testing the alcohol stress response dampening hypothesis. *Psychol Addict Behav*. (2019) 33:581–94. doi: 10.1037/adb0000516

17. Escelsior A, Belvederi Murri M, Corsini GP, Serafini G, Aguglia A, Zampogna D, et al. Cannabinoid use and self-injurious behaviours: a systematic review and meta-analysis. *J Affect Disord*. (2021) 278:85–98. doi: 10.1016/j.jad.2020.09.020

18. Few LR, Grant JD, Nelson EC, Trull TJ, Grucza RA, Bucholz KK, et al. Cannabis involvement and non-suicidal self-injury: a discordant twin approach. *J Stud Alcohol Drugs*. (2016) 77:873–80. doi: 10.15288/jsad.2016.77.873

19. Young R, Sproeber N, Groschwitz RC, Preiss M, Plener PL. Why alternative teenager's self-harm: exploring the link between non-suicidal self-injury, attempted suicide and adolescent identity. *BMC Psychiatry*. (2014) 14:137. doi: 10.1186/1471-244x-14-137

20. Meyer IH. Prejudice, social stress, and mental health in lesbian, gay, and bisexual populations: conceptual issues and research evidence. *Psychol Bull*. (2003) 129:674–97. doi: 10.1037/0033-2909.129.5.674

21. Wester KL, Trepal HC. Non-suicidal self-injury: exploring the connection among race, ethnic identity, and ethnic belonging. *J Coll Stud Dev*. (2015) 56:127–39. doi: 10.1353/csd.2015.0013

22. Hirsh JB, Kang SK. Mechanisms of identity conflict. *Personal Soc Psychol Rev*. (2015) 20:223–44. doi: 10.1177/1088868315589475

23. Iyer A, Jetten J, Tsivrikos D, Postmes T, Haslam SA. The more (and the more compatible) the merrier: multiple group memberships and identity compatibility as predictors of adjustment after life transitions. *Br J Soc Psychol*. (2009) 48:707–33. doi: 10.1348/014466608x397628

24. Brook AT, Garcia J, Fleming MA. The effects of multiple identities on psychological well-being. *Personal Soc Psychol Bull*. (2008) 34:1588–600. doi: 10.1177/0146167208324629

25. Chen C, Li X, Deng Y. Effect of emotional distress monitoring and intervention in preventing non-suicidal self-injury (NSSI) of college students. *Health Behav Policy Rev*. (2022) 9:846–52. doi: 10.1111/j.1467-6494.2008.00505.x

26. Botha M, Frost DM. Extending the minority stress model to understand mental health problems experienced by the autistic population. *Soc Ment Health*. (2018) 10:20–34. doi: 10.1177/2156869318804297

27. Hasking P, Whitlock J, Voon D, Rose A. A cognitive-emotional model of NSSI: using emotion regulation and cognitive processes to explain why people self-injure. *Cognit Emot*. (2016) 31:1543–56. doi: 10.1080/02699931.2016.1241219

28. Al-Haj, M. *Education, empowerment, and control: The case of the Arabs in Israel*. Albany, New York: State University of New York Press (2012).

29. Hazan RY, Dowty A, Hofnung M, Rahat G. Introduction to Israeli politics and society In: *The Oxford Handbook of Israeli Politics and Society* (2020). 1–15.

30. localities CBoSI. (2020). Available at: https://www.cbs.gov.il/he/publications/Pages/2019/.aspx.

31. Bresin K, Schoenleber M. Gender differences in the prevalence of non-suicidal self-injury: a meta-analysis. *Clin Psychol Rev*. (2015) 38:55–64. doi: 10.1016/j.cpr.2015.02.009

32. Kiekens G, Hasking P, Bruffaerts R, Alonso J, Auerbach RP, Bantjes J, et al. Non-suicidal self-injury among first-year college students and its association with mental disorders: results from the world mental health international college student (WMH-ICS) initiative. *Psychol Med*. (2021) 53:875–86. doi: 10.1017/s0033291721002245

33. Muehlenkamp JJ, Brausch AM. Body image as a mediator of non-suicidal self-injury in adolescents. *J Adolesc*. (2012) 35:1–9. doi: 10.1016/j.adolescence.2011.06.010

34. Rai D, Zitko P, Jones K, Lynch J, Araya R. Country- and individual-level socioeconomic determinants of depression: multilevel cross-national comparison. *Br J Psychiatry*. (2013) 202:195–203. doi: 10.1192/bjp.bp.112.112482

35. Schoenleber M, Berenbaum H, Motl R. Shame-related functions of and motivations for self-injurious behavior. *Personal Disord Theory Res Treat*. (2014) 5:204–11. doi: 10.1037/per0000035

36. Angoff HD, McGraw JS, Docherty M. Intersecting identities and non-suicidal self-injury among youth. *Identity*. (2020) 21:98–114. doi: 10.1080/15283488.2020.1863216

37. Gholamrezaei M, De Stefano J, Heath NL. Non-suicidal self-injury across cultures and ethnic and racial minorities: a review. *Int J Psychol*. (2015) 52:316–26. doi: 10.1002/ijop.12230

38. Rojas-Velasquez DA, Pluhar EI, Burns PA, Burton ET. Non-suicidal self-injury among African American and Hispanic adolescents and young adults: a systematic review. *Prev Sci*. (2020) 22:367–77. doi: 10.1007/s11121-020-01147-x

39. Kroenke K, Spitzer RL, Williams JB. The PHQ-9. *J Gen Intern Med*. (2001) 16:606–13. doi: 10.1046/j.1525-1497.2001.016009606.x

40. Gratz KL. *Deliberate self-harm inventory – Youth version*. Jackson, MS: Unpublished measure. University of Mississippi Medical Center (2009).

41. Knight JR, Sherritt L, Shrier LA, Harris SK, Chang G. Validity of the CRAFFT substance abuse screening test among adolescent clinic patients. *Arch Pediatr Adolesc Med*. (2002) 156:607. doi: 10.1001/archpedi.156.6.607

42. Mena FJ, Padilla AM, Maldonado M. Acculturative stress and specific coping strategies among immigrant and later generation college students. *Hisp J Behav Sci*. (1987) 9:207–25. doi: 10.1177/07399863870092006

43. Falah G. Living together apart: Residential segregation in mixed Arab-Jewish cities in Israel. *Urban Studies*. (1996) 33:823–57.

44. Davis LT, Weiss NH, Tull MT, Gratz KL. The relation of protective factors to deliberate self-harm among African American adults: moderating roles of gender and sexual orientation identity. *J Ment Health*. (2017) 26:351–8. doi: 10.1080/09638237.2017.1340610

45. Polanco-Roman L, Tsypes A, Soffer A, Miranda R. Ethnic differences in prevalence and correlates of self-harm behaviors in a treatment-seeking sample of emerging adults. *Psychiatry Res*. (2014) 220:927–34. doi: 10.1016/j.psychres.2014.09.017

46. Gandhi A, Luyckx K, Maitra S, Kiekens G, Verschueren M, Claes L. Directionality of effects between non-suicidal self-injury and identity formation: a prospective study in adolescents. *Personal Individ Differ*. (2017) 109:124–9. doi: 10.1016/j.paid.2017.01.003

47. Hamza CA, Willoughby T. Non-suicidal self-injury and suicidal risk among emerging adults. *J Adolesc Health*. (2016) 59:411–5. doi: 10.1016/j.jadohealth.2016.05.019

48. Brausch AM, Clapham RB, Littlefield AK. Identifying specific emotion regulation deficits that associate with non-suicidal self-injury and suicide ideation in adolescents. *J Youth Adolesc*. (2021) 51:556–69. doi: 10.1007/s10964-021-01525-w

49. Gratz KL, Roemer L. The relationship between emotion dysregulation and deliberate self-harm among female undergraduate students at an urban commuter university. *Cogn Behav Ther*. (2008) 37:14–25. doi: 10.1080/16506070701819524

50. Davis TS, Mauss IB, Lumian D, Troy AS, Shallcross AJ, Zarolia P, et al. Emotional reactivity and emotion regulation among adults with a history of self-harm: laboratory self-report and functional MRI evidence. *J Abnorm Psychol*. (2014) 123:499–509. doi: 10.1037/a0036962

51. Johns M, Inzlicht M, Schmader T. Stereotype threat and executive resource depletion: examining the influence of emotion regulation. *J Exp Psychol Gen*. (2008) 137:691–705. doi: 10.1037/a0013834

52. Mata-Greve F, Torres L. Ethnic discrimination, sexism, and depression among Latinx women: the roles of anxiety sensitivity and expressive suppression. *J Latinx Psychol*. (2020) 8:317–31. doi: 10.1037/lat0000154

53. Ong E, Thompson C. The importance of coping and emotion regulation in the occurrence of suicidal behavior. *Psychol Rep*. (2018) 122:1192–210. doi: 10.1177/0033294118781855

54. Lee DL, Ahn S. Discrimination against Latina/os. *Couns Psychol*. (2011) 40:28–65. doi: 10.1177/0011000011403326

55. Talavera DC, Odafe M, Cheref S, Hong JH, Leslie R, Walker RL. Stress in relation to anxiety and depression among racial/ethnic minority women: the differential impact of cultural mismatch on somatic and cognitive symptoms. *J Multicult Couns Dev*. (2019) 47:131–40. doi: 10.1002/jmcd.12127

56. Vigo D, Haro JM, Hwang I, Aguilar-Gaxiola S, Alonso J, Borges G, et al. Toward measuring effective treatment coverage: critical bottlenecks in quality- and user-adjusted coverage for major depressive disorder. *Psychol Med*. (2020) 52:1948–58. doi: 10.1017/s0033291720003797

57. Colucci E, Minas H, Szwarc J, Guerra C, Paxton G. In or out? Barriers and facilitators to refugee-background young people accessing mental health services. *Transcult Psychiatry*. (2015) 52:766–90. doi: 10.1177/1363461515571624

58. Elroy I, Rosen B, Samuel H, Elmakias I. Mental health services in Israel: needs, patterns of utilization and barriers – survey of the general adult population. *Myers-JDC-Brookdale and the ministry of Health*. (2017) Available at: https://brookdale.jdc.org.il/wp-content/uploads/2017/09/English_summary_749-17.pdf

59. Mansbach-Kleinfeld I, Farbstein I, Levinson D, Apter A, Erhard R, Palti H, et al. Service use for mental disorders and unmet need: results from the Israel survey on mental health among adolescents. *Psychiatr Serv*. (2010) 61:241–9. doi: 10.1176/ps.2010.61.3.241

60. Daeem R, Mansbach-Kleinfeld I, Farbstein I, Apter A, Elias R, Ifrah A, et al. Barriers to help-seeking in Israeli Arab minority adolescents with mental health problems: results from the Galilee study. *Israel J Health Policy Res*. (2019) 8:45. doi: 10.1186/s13584-019-0315-7

61. National Councils for Health, Ministry of health. *Summary report: the gaps in public services in the mental health reform*. (2016). Available at: https://www.health.gov.il/Services/Committee/NationalCouncils/mental/Documents/22072019.pdf

62. Knorr AC, Tull MT, Anestis MD, Dixon-Gordon KL, Bennett MF, Gratz KL. The interactive effect of major depression and non-suicidal self-injury on current suicide risk and lifetime suicide attempts. *Arch Suicide Res*. (2016) 20:539–52. doi: 10.1080/13811118.2016.1158679

63. Valencia-Agudo F, Burcher GC, Ezpeleta L, Kramer T. Non-suicidal self-injury in community adolescents: a systematic review of prospective predictors, mediators and moderators. *J Adolesc*. (2018) 65:25–38. doi: 10.1016/j.adolescence.2018.02.012

64. Hawi NS. Internet addiction among adolescents in Lebanon. *Comput Hum Behav.* (2012) 28:1044–53. doi: 10.1016/j.chb.2012.01.007

65. Kuss D, Griffiths M, Karila L, Billieux J. Internet addiction: a systematic review of epidemiological research for the last decade. *Curr Pharm Des.* (2014) 20:4026–52. doi: 10.2174/13816128113199990617

66. Pantic I. Online social networking and mental health. *Cyberpsychol Behav Soc Netw.* (2014) 17:652–7. doi: 10.1089/cyber.2014.0070

67. Estévez A, Jáuregui P, Sánchez-Marcos I, López-González H, Griffiths MD. Attachment and emotion regulation in substance addictions and behavioral addictions. *J Behav Addict.* (2017) 6:534–44. doi: 10.1556/2006.6.2017.086

68. Mesch GS. Minority status and the use of computer mediated communication: a test of the social diversification hypothesis. *Cahiers de la Méditerranée.* (2012) 85:71–82. doi: 10.4000/cdlm.6670

69. Mesch GS. Ethnic origin and access to electronic health services. *Health Informatics J.* (2016) 22:791–803. doi: 10.1177/1460458215590863

70. Sakarya D, Güneş C, Sakarya A. Googling suicide: evaluation of websites according to the content associated with suicide. *Turk J Psychiatry.* (2012) 24:44–8. doi: 10.5080/u6870

71. Plener PL, Allroggen M, Kapusta ND, Brähler E, Fegert JM, Groschwitz RC. The prevalence of non-suicidal self-injury (NSSI) in a representative sample of the German population. *BMC Psychiatry.* (2016) 16:353. doi: 10.1186/s12888-016-1060-x

72. Gobbi G, Atkin T, Zytynski T, Wang S, Askari S, Boruff J, et al. Association of cannabis use in adolescence and risk of depression, anxiety, and suicidality in young adulthood. *JAMA Psychiatry.* (2019) 76:426. doi: 10.1001/jamapsychiatry.2018.4500

73. Cosker E, Schwitzer T, Ramoz N, Ligier F, Lalanne L, Gorwood P, et al. The effect of interactions between genetics and cannabis use on neurocognition. A review. *Prog Neuro-Psychopharmacol Biol Psychiatry.* (2018) 82:95–106. doi: 10.1016/j.pnpbp.2017.11.024

74. Zimmermann K, Walz C, Derckx RT, Kendrick KM, Weber B, Dore B, et al. Emotion regulation deficits in regular marijuana users. *Hum Brain Mapp.* (2017) 38:4270–9. doi: 10.1002/hbm.23671

75. Clark R, Anderson NB, Clark VR, Williams DR. Racism as a stressor for African Americans: a biopsychosocial model. *Am Psychol.* (1999) 54:805–16. doi: 10.1037/0003-066x.54.10.805

76. Harrell SP. A multidimensional conceptualization of racism-related stress: implications for the well-being of people of color. *Am J Orthopsychiatry.* (2000) 70:42–57. doi: 10.1037/h0087722

77. Weber G. Using to numb the pain: substance use and abuse among lesbian, gay, and bisexual individuals. *J Ment Health Couns.* (2008) 30:31–48. doi: 10.17744/mehc.30.1.2585916185422570

78. Goldscheider C. *Israel's changing society: Population, ethnicity, and development.* New York: Routledge. (2019).

79. Abu-Asbah K, Raian-Garaa N, Nasra M. Psychological treatment in Arab society in Israel: between tradition and modernity. *Hevra v'Revaha (Society and Welfare) - Social Work Quarterly* (2014) 34:101–121 (in Hebrew).

80. AlMarri TSK, Oei TPS. Alcohol and substance use in the Arabian gulf region: a review. *Int J Psychol.* (2009) 44:222–33. doi: 10.1080/00207590801888752

81. Morad M, Merrick E, Schwarz A, Merrick J. A review of suicide behavior among Arab adolescents. *Sci World J.* (2005) 5:674–9. doi: 10.1100/tsw.2005.84

82. Michalak L, Trocki K. Alcohol and Islam: an overview. *Contemp Drug Probl.* (2006) 33:523–62. doi: 10.1177/009145090603300401

83. Araki H, Oshima Y, Iida D, Tanaka K. Effects of brief depression prevention program based on cognitive behavior therapy among college students: a randomized controlled trial. *Kitasato Med J.* (2019) 49:26–34.

84. Gayfer B. Addressing knowledge, attitudes, and self-efficacy within disclosures of NSSI in a university campus peer-support setting: a pilot intervention. *Doctoral.* Ontario, Canada: The University of Guelph. (2020).

DSM-5 non-suicidal self-injury disorder in a community sample: comparing NSSI engagement, recency and severity among emerging adults

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Up to one in five emerging adults engage in non-suicidal self-injury (NSSI). Providing a better understanding of factors that differentiate between who engages in lifetime NSSI and who is more likely to engage in recent and clinically severe NSSI can provide meaningful information for prevention and intervention of NSSI. The present study ($n = 669$) considered NSSI lifetime engagement (no prior history of NSSI vs. lifetime NSSI), recency [past NSSI (>12 months ago) vs. recent (≤12-month) NSSI], and clinical severity among those with recent NSSI (subthreshold vs. DSM-5 NSSI disorder). The prevalence of NSSI disorder was 8.4% in emerging adults aged 18 to 26 years old. Higher anxiety levels were related to NSSI engagement, but only depressive symptoms and NSSI versatility were consistently associated with more recent NSSI and NSSI disorder. A stepped-care approach may be required in addressing NSSI among emerging adults.

KEYWORDS

non-suicidal self-injury, recency, severity, non-suicidal self-injury disorder, emerging adults

1 Introduction

Non-Suicidal Self-Injury (NSSI), which refers to direct and deliberate damage to an individual's own bodily tissue without suicidal intent (1), is a major mental health challenge among emerging adults (2, 3). In accordance with the Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR) (4), we use the term NSSI, which excludes self-injury with suicidal intent. If there is some intent to die present, it is classified as a suicide attempt. In contrast, the term 'self-harm,' still often used in British literature (5), encompasses both non-suicidal and suicidal self-injurious behaviors. Emerging adulthood (i.e., 18–25 years old) is typically described as the developmental period between adolescence and young adulthood which is marked by increased exploration and psychosocial risk-taking, but also vulnerability towards NSSI (6, 7). Among first-year college students (age 18–20; $n = 20,842$), the lifetime and 12-month prevalence of NSSI is estimated at one in five and one in 10, respectively (2). Age of NSSI onset is most often situated in mid-adolescence (age 14 to 16), with a second peak during emerging adulthood (8). More than half of the adolescents with a history of NSSI persist to self-injure during emerging adulthood (8, 9), but the probability of desisting NSSI is also highest at ages 18 to 21 (10). Emerging adults reporting recent and clinically considered severe NSSI are

at higher risk for adverse outcomes such as mental disorders, suicidal thoughts and behaviors, and suicide attempts than peers who engaged in NSSI in the past (9, 11), which underscores the importance of effective differentiation among those with a lifetime history of NSSI. Considering severity, the NSSI Disorder (NSSI-D) was added to the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (12). To meet a diagnosis for NSSI-D, individuals need to report NSSI engagement at least 5 days during the past year, with NSSI causing significant distress or severe impairment across life domains (12). Other diagnostic criteria include affective or social precipitants, NSSI urges, and the expectation that NSSI will result in relief, resolve interpersonal difficulties, or increase positive feelings. Prevalence of NSSI-D is estimated at 0.2–0.8% among emerging adults, with higher rates in women than men (13, 14). In line with prior studies (2, 9), providing a better insight into factors that differentiate individuals who engage in lifetime NSSI (vs. no NSSI) and who are more likely to engage in recent (≤ 12 months vs. > 12 months ago) and clinically severe NSSI among those with recent NSSI (subthreshold vs. NSSI-D) can provide meaningful information for prevention and intervention strategies that target NSSI. Namely, (a) differentiation in the presence/absence of lifetime NSSI engagement can tell us more about risk factors for the onset of NSSI, which can feed general primary care and preventative initiatives; (b) differentiation between recency of NSSI (≤ 12 months vs. > 12 months ago) is important for secondary care and therapeutic interventions; and (c) differentiation between severity (subthreshold NSSI vs. NSSI-D) can improve insights of tertiary or specialized care.

Overall, studies have shown higher levels of depression, anxiety, disruptive behaviors, personality dysfunctioning and anger, and lower levels of self-esteem (13, 15) in individuals who engage in NSSI compared to those who do not (i.e., lifetime NSSI engagement vs. no NSSI). Prior work also suggests that higher internalized anger expression (compared to externalized anger expression) is associated with an increased risk of NSSI (16). However, few studies have examined whether these clinical constructs might also help to differentiate between those who are more likely to engage in recent (≤ 12 months vs. > 12 months ago) and clinically severe NSSI among those with recent NSSI (subthreshold vs. NSSI-D) (2, 15). There is some evidence that individuals who engage in 12-month NSSI report higher levels of negative affect, rumination, self-criticism, personality dysfunctioning, severe life stress and impairment, and mood disorders compared to those with past NSSI or compared to those who never engaged in NSSI (9, 13, 17–19). NSSI recency has also been positively associated with an earlier onset (11 years or younger, compared to 14–17 years old) and with onset in the year before college (2). Finally, a handful of studies investigated DSM-5 NSSI-D and observed that individuals meeting NSSI-D criteria reported increased NSSI versatility (i.e., the number of different NSSI methods), higher levels of psychopathology and significantly more impaired functioning than individuals who self-injured in the past year but do not meet the NSSI-D criteria (i.e., subthreshold NSSI) (20). Yet, given that up to one in five emerging adults engage in NSSI, more work is required considering meaningful differences among those with a lifetime history of NSSI (2, 5, 21). Obtaining a clearer picture regarding the unique clinical correlates and potential risk factors of NSSI engagement, recency, and severity would provide valuable information for prevention efforts and clinical assessment.

To help address this gap in the literature, the present study compares emerging adults with and without a lifetime NSSI history (i.e., engagement), recent vs. past NSSI (recency: ≤ 12 months vs. > 12

months ago), and subthreshold NSSI vs. NSSI-D with respect to gender, age of NSSI onset, NSSI versatility, anxiety, depression, personality dysfunctioning, self-esteem, anger-in and anger-out (i.e., internalized and externalized anger expression, respectively). We expect individuals with recent NSSI and NSSI-D to report more NSSI versatility, either early or pre-college onset (i.e., 13 years or younger; or 17 years or older), more anxious and depressive symptoms, more personality dysfunctioning, more internalized (i.e., self-critical) anger expression, and less self-esteem than individuals with past NSSI and subthreshold NSSI, respectively. Given that theory (e.g., the Benefits and Barriers model (21) suggests that negative mood is an "affective engine" that drives repeated NSSI) and empirical literature suggests that negative mood uniquely increases risk for persistent NSSI (9, 13, 14, 17, 18), we expect that individuals with more severe depressive symptomatology will be more likely to report NSSI engagement, recent NSSI, and NSSI-D. In addition, we anticipate meaningful differences between individuals with past and subthreshold NSSI and those with NSSI-D.

2 Methods

Data were collected through an anonymous web-based survey using convenience sampling. The sample comprised 669 emerging adults (M_{age} = 21.48; SD = 2.20; range 18 to 26 years), of whom 205 participants (30.64%) identified as men and 454 (69.36%) as women. The study was approved by SMEC KU Leuven. Invitations to participate in an anonymous web-based survey were sent to socio-cultural organizations (e.g., sports clubs and music societies) to distribute among their Dutch-speaking emerging adult members. There was no reimbursement for participation in the study. The study took about 20 min.

The data collection comprised socio-demographic variables (i.e., age and gender) and self-report questionnaires. Participants who reported lifetime NSSI (dichotomous item) completed a follow-up questionnaire (22) evaluating NSSI methods, age of onset, and NSSI-D criteria (KR-20 = 0.73). Consistent with prior work that considered heterogeneity in engagement, recency and severity of NSSI (14, 22), we differentiated between emerging adults with no history of NSSI vs. lifetime NSSI (engagement); recent vs. past NSSI (recency: ≤ 12 months vs. > 12 months ago) and severity of NSSI among those with recent NSSI (subthreshold NSSI vs. NSSI-D).

Anxiety and depression were evaluated using the Anxiety (10 items; α = 0.91) and Depression (16 items; α = 0.94) subscales of the Symptom Checklist-Revised (SCL-90-R) (23). The items were scored on a 5-point Likert scale ranging from 1 (Not at all) to 5 (Extremely). Higher anxiety or depression scores reflected more severe anxiety and depressive symptoms, respectively. Personality dysfunctioning was assessed using the Dutch Five-Item Screening Scale for Personality Disorders (FISSPD; α = 0.83) (24). Participants were asked to report to what extent they agree with five items on a 5-point Likert scale ranging from 0 (Completely disagree) to 4 (Completely agree). The mean score of the five items resulted in a single severity score with a higher score indicating increasing severity of personality dysfunctioning. Self-esteem (10 items; α = 0.89) was measured using the Rosenberg Self-Esteem Scale (25). Participants were asked to rate their agreement with 10 items on a 4-point Likert scale ranging from 0 (Strongly agree) to 3 (Strongly disagree). Higher scores on the total

scale indicated more self-esteem. Lastly, internalized and externalized anger expression were assessed using the anger-in (8 items; $\alpha = 0.71$) and anger-out (8 items; $\alpha = 0.78$) subscales of the State Trait Anger Expression Inventory 2 (STAXI-2) [26]. Participants self-reported the frequency with which anger is expressed on a 4-point Likert scale ranging from 1 (Almost never) to 4 (Almost always). Higher scores on anger-in or anger-out reflect more internalized or externalized anger expression, respectively.

A series of binary logistic regression models was estimated to understand the association between the clinical constructs and NSSI engagement (no NSSI vs. lifetime NSSI), NSSI recency (recency: ≤ 12 months vs. > 12 months ago), and NSSI severity (subthreshold vs. NSSI-D). For each comparison, we conducted bivariate (controlling for gender) and multivariate models (including all covariates simultaneously) with two-sided significance tests. Correlates that remain significant throughout the multivariate analyses will be compared using norm scores, if available.

3 Results

Lifetime and 12-month prevalence of NSSI was 32.9 and 16.0%, respectively. Prevalence of DSM-5 NSSI-D was 8.4%. There were 449 emerging adults with no prior history of NSSI and 220 individuals with a lifetime history of NSSI. Of these, 108 reported past NSSI (>12 months) and 107 recent NSSI (≤ 12 months). Of those with recent NSSI, 50 individuals reported subthreshold NSSI and 56 met criteria for NSSI-D. Five participants (0.75%) could not be classified due to missing data. The groups are visualized in Figure 1.

When controlling for gender, higher anxiety and depression, increased personality dysfunctioning and anger-in, and decreased levels of self-esteem increased odds for lifetime NSSI engagement (compared to no NSSI). As can be seen in Table 1, higher anxiety and depression remained independently associated with NSSI engagement in a multivariate model controlling for all clinical correlates. Similarly, higher anxiety and depression, personality dysfunctioning and anger-in, and decreased self-esteem were significantly associated with increased odds of recent NSSI (≤ 12 months) compared to those with past NSSI. Individuals with recent NSSI also reported greater NSSI versatility than those who self-injured more than 12 months ago. Multivariate models showed that NSSI versatility and higher depression levels were independently associated with NSSI recency when controlling for all clinical correlates. In addition, reporting an

age of onset of NSSI after 17 years of age became a significant correlate of recent NSSI in this multivariate model. Finally, we evaluated associations among those with NSSI-D (compared to subthreshold NSSI), and found that greater NSSI versatility and higher anxiety and depression, personality dysfunctioning, and anger-in were associated with increased odds of NSSI-D; whereas self-esteem was associated with decreased odds of NSSI-D. However, only NSSI versatility and depressive symptoms remained independently associated with NSSI-D in the multivariate model.

To evaluate meaningful differences in depression scores between groups, we used the norm scores of the Dutch community population. This revealed that individuals without NSSI engagement (17.23; SD = 13.60) scored low-to-below-average for depression (SCL-90-R), those that reported past NSSI scored average-to-above-average (22.07; SD = 14.01), whereas individuals with subthreshold (29.92; SD = 14.09), and NSSI-D (40.25; SD = 11.74) scored high and very high, respectively. A one-way post-hoc ANOVA confirmed that the differences for depression between these groups were significant [$F(3, 659) = 56.58$, $p < 0.001$], with significant incremental increases across all groups (Tukey post-hoc). Considering NSSI versatility, there were no norm scores available. Mean number of different NSSI methods for the past NSSI, subthreshold NSSI, and NSSI-D groups were 2.1 (SD = 1.3), 3.0 (SD = 1.6), and 4.3 (SD = 1.9), respectively. The differences in average NSSI versatility between groups were again significant [$F(2, 211) = 36.82$, $p < 0.001$] with significant incremental increases for the past NSSI, the subthreshold NSSI and the NSSI-D group (Tukey post-hoc).

4 Discussion

The present study examined differentiated meaningful epidemiological NSSI outcomes (i.e., engagement, recency, and severity) and investigated associations with respect to clinical symptomatology: being (a) no NSSI vs. lifetime NSSI (engagement), (b) past vs. 12-month NSSI (recency) among those with lifetime NSSI, and (c) subthreshold NSSI vs. NSSI-D among those with recent NSSI (severity). Findings suggest that both anxiety and depression are associated with NSSI engagement, but only depression was consistently associated with more recent and clinically severe NSSI. Personality dysfunctioning, self-esteem and anger-in also showed associations across the comparison groups but became nonsignificant when depression was taken into account. This pattern of findings aligns with Hooley and Franklin [21] Benefits and Barriers
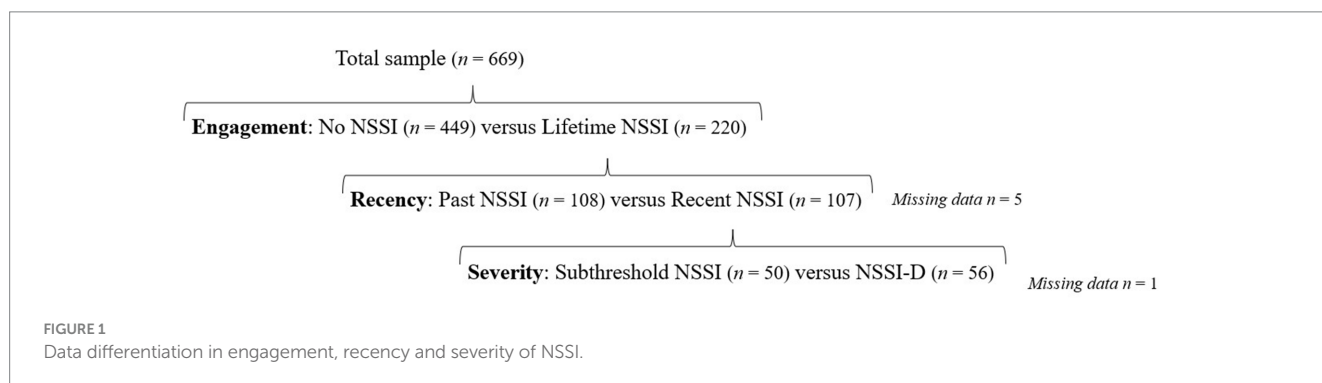

FIGURE 1
Data differentiation in engagement, recency and severity of NSSI.

TABLE 1 Bivariate and multivariate logistic regression analyses examining NSSI behavior.

		Engagement: No NSSI versus lifetime NSSI history across the sample (n = 669)[a]		Recency: Past (i.e., > 12-months) versus recent (≤ 12-months) NSSI among those with lifetime NSSI history (n = 215)		Severity: Subthreshold (i.e., 12-month NSSI without disorder) versus DSM-5 NSSI disorder among those with recent NSSI (n = 106)	
		Bivariate analyses	Multivariate analyses	Bivariate analyses	Multivariate analyses	Bivariate analyses	Multivariate analyses
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Being woman		**1.61 (1.12–2.32)***	1.28 (0.85–1.92)	1.21 (0.65–2.26)	0.72 (0.31–1.68)	1.16 (0.47–2.88)	0.75 (0.21–2.69)
Age of NSSI onset[b]							
	13 or younger			*(ref)*	*(ref)*	*(ref)*	*(ref)*
	13 to 17			1.05 (0.51–2.16)	1.39 (0.54–3.57)	1.38 (0.47–4.08)	1.86 (0.49–7.03)
	17 or older			1.76 (0.66–4.70)	**4.05 (1.15–14.28)***	0.91 (0.23–3.67)	5.05 (0.78–32.79)
NSSI versatility				**1.84 (1.50–2.26)***	**1.92 (1.49–2.46)***	**1.50 (1.18–1.91)***	**1.77 (1.26–2.49)***
SCL-90-R							
	Anxiety	**1.08 (1.06–1.11)***	**1.03 (1.00–1.07)***	**1.07 (1.03–1.10)***	0.97 (0.92–1.03)	**1.07 (1.02–1.12)***	1.01 (0.94–1.10)
	Depression	**1.05 (1.04–1.06)***	**1.02 (1.00–1.05)***	**1.07 (1.04–1.09)***	**1.06 (1.02–1.11)***	**1.07 (1.03–1.10)***	**1.08 (1.01–1.15)***
FISSPD							
	Personality dysfunctioning	**1.92 (1.59–2.30)***	1.13 (0.85–1.48)	**2.04 (1.48–2.81)***	0.98 (0.59–1.65)	**1.75 (1.12–2.72)***	0.76 (0.36–1.61)
RSE							
	Self-esteem	**0.31 (0.22–0.43)***	0.66 (0.42–1.02)	**0.27 (0.15–0.49)***	0.73 (0.32–1.69)	**0.35 (0.15–0.78)***	1.14 (0.34–3.85)
STAXI-2							
	Anger-in	**1.06 (1.02–1.10)***	0.98 (0.93–1.02)	**1.07 (1.00–1.14)***	1.00 (0.91–1.10)	**1.14 (1.04–1.25)***	1.11 (0.97–1.27)
	Anger-out	1.04 (1.00–1.08)	1.01 (0.97–1.06)	1.06 (0.99–1.13)	1.04 (0.96–1.14)	1.03 (0.95–1.12)	1.01 (0.90–0.14)
Nagelkerke R²			0.19		0.45		0.41

*p < 0.05, **p < 0.01, ***p < 0.001. Significant odds ratios are made boldface.

[a]For No NSSI versus lifetime NSSI, Age of NSSI onset and NSSI versatility were excluded.

[b]To avoid overlap with recent NSSI, individuals who reported age of onset ≤ 12 months ago were excluded from the bivariate model involving Age of NSSI onset.OR, Odds Ratio; NSSI, Non-Suicidal Self-Injury; SCL-90-R, Revised Symptom Checklist; FISSPD, Five-Item Screening Scale for Personality Disorders; RSE, Rosenberg Self-Esteem; STAXI-2, State–Trait Anger Expression Inventory 2.

Model, which defines emotional distress as the maintaining factor for NSSI after its onset.

We found a rate of 8.4% for NSSI-D in the present sample, which is considerably higher than in prior work (i.e., 0.2–0.8%; 12,26). One potential reason for this might be because the study was conducted during the COVID-19 pandemic (27). In line with Ammerman et al. (28), higher NSSI versatility was associated with NSSI recency and severity. Due to habituation, individuals may need to engage in different methods of NSSI (i.e., increased NSSI versatility) to experience the same emotion-regulatory effect (29). Importantly, individuals using different methods of NSSI are also more likely to report suicidal thoughts and behaviors (30).

Notably, we identified depression as a consistent, non-specific correlate of recent and severe NSSI among emerging adults, with the highest symptoms found among individuals meeting the criteria for NSSI-D. The present study cannot indicate the direction of this relationship, with prior work indicating that this relationship might be bi-directional (2). In addition, NSSI and depression may also have shared risk factors (e.g., trauma, emotion regulation difficulties) (31), suggesting that a unified approach for general primary care and preventative initiatives (32), in which interventions aiming at shared risk factors, may be useful to prevent both the onset of NSSI and depression.

Our findings support a stepped-care approach in which NSSI is addressed both dimensionally and categorically across different levels of care (33). The dimensional level comprises treating NSSI as a behavior that occurs on a continuum that considers engagement, recency, and severity when matching interventions to individuals' needs. Considering engagement, it seems important for prevention and general care to target general risk factors such as anxiety and depression. For individuals who have engaged in past NSSI and those engaging in recent NSSI, it could be advised to discuss NSSI in therapy and explore the factors that facilitate desistance of the behavior. Emerging adults who have engaged in NSSI in the past should thus not be left without support, as the study results also point out that these individuals report significantly more anxious and depressive symptoms compared to individuals who have never engaged in NSSI. This is in line with recent work that NSSI recovery constitutes more than just behavioral cessation and involves also discussion around ongoing thoughts and ambivalence about stopping NSSI (34–36). Finally, the categorical approach includes identifying individuals who meet the NSSI-D criteria and might require specialized treatment that involve a targeted focus on NSSI (e.g.,

dialectical behavior therapy). The merits of a stepped-care approach were recently also acknowledged by DSM-5's recent text revision (4) which mentions NSSI as a behavior that may warrant ongoing clinical attention in its own right.

The current study's results should be interpreted considering the following limitations. The study design was cross-sectional in nature. This implies that the findings should be replicated in future prospective research to consider the directionality between constructs. Additionally, the data collection was based on convenience sampling, which may lead to sampling bias and implies that prevalence rates should be interpreted with caution. Further, the study consisted of only self-report questionnaires, which can result in reporting bias and shared method variance. Even though the NSSI-D criteria (4) and other clinical constructs that were included were assessed using well-validated instruments, future work should consider assessing NSSI disorder criteria using a golden standard diagnostic interview (3, 20). These limitations notwithstanding, this study shows that depressive symptoms and NSSI versatility are consistently associated with more recent and more severe NSSI among emerging adults who self-injure. These findings highlight the need to capture meaningful differences among emerging adults reporting engagement in self-injury by considering the recency and severity of NSSI routinely in future research studies.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Social and Societal Ethics Committee (Katholieke Universiteit Leuven, Belgium) under file number G-2021-3870-R2 (MAR). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

SD, LC, TB, DS, and GK contributed to conceptualization and design of the study. SD organized the database and wrote the original draft of the manuscript. SD and GK performed the statistical analysis. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

1. International Society for the Study of self-injury. *What is self-injury?* (2018). Available at: https://itriples.org/about-self-injury/what-is-self-injury/.

2. Kiekens G, Hasking P, Bruffaerts R, Alonso J, Auerbach RP, Bantjes J, et al. Non-suicidal self-injury among first-year college students and its association with mental disorders: results from the world mental health international college student (WMH-ICS) initiative. *Psychol Med*. (2021) 53:875–86. doi: 10.1017/s0033291721002245

3. Swannell SV, Martin GE, Page A, Hasking P, St John NJ. Prevalence of nonsuicidal self-injury in nonclinical samples: systematic review, meta-analysis and meta-regression. *Suicide Life Threat Behav*. (2014) 44:273–303. doi: 10.1111/sltb.12070

4. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders, text revision (DSM-5-TR)*. 5th ed (2022) text revision.

5. Hooley JM, Fox KR, Boccagno C. Nonsuicidal self-injury: diagnostic challenges and current perspectives. *Neuropsychiatr Dis Treat*. (2020) 16:101–12. doi: 10.2147/ndt.s198806

6. Nelson LJ. The theory of emerging adulthood 20 years later: a look at where it has taken us, what we know now, and where we need to go. *Emerg Adulthood*. (2021) 9:179–88. doi: 10.1177/2167696820950884

7. Kiekens G, Hasking P, Claes L, Boyes M, Mortier P, Auerbach RP, et al. Predicting the incidence of non-suicidal self-injury in college students. *Eur Psychiatry*. (2019) 59:44–51. doi: 10.1016/ j.eurpsy.2019.04.002

8. Gandhi A, Luyckx K, Baetens I, Kiekens G, Sleuwaegen E, Berens A, et al. Age of onset of non-suicidal self-injury in Dutch-speaking adolescents and emerging adults: an event history analysis of pooled data. *Compr Psychiatry*. (2018) 80:170–8. doi: 10.1016/j.comppsych.2017.10.007

9. Kiekens G, Claes L, Hasking P, Mortier P, Bootsma E, Boyes M, et al. A longitudinal investigation of non-suicidal self-injury persistence patterns, risk factors, and clinical outcomes during the college period. *Psychol Med*. (2022) 53:6011–26. doi: 10.1017/s0033291722003178

10. Turner BJ, Helps CE, Ames ME. Stop self-injuring, then what? Psychosocial risk associated with initiation and cessation of nonsuicidal selfinjury from adolescence to early adulthood. *J Psychopathol Clin Sci*. (2022) 131:45–57. doi: 10.1037/abn0000718

11. Hamza CA, Willoughby T. Nonsuicidal self-injury and suicidal risk among emerging adults. *J Adolesc Health*. (2016) 59:411–5. doi: 10.1016/j.jadohealth.2016.05.019

12. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. 5th ed (2013).

13. Benjet C, González-Herrera I, Castro-Silva E, Méndez E, Borges G, Casanova L, et al. Non-suicidal self-injury in Mexican young adults: prevalence, associations with suicidal behavior and psychiatric disorders, and DSM-5 proposed diagnostic criteria. *J Affect Disord*. (2017) 215:1–8. doi: 10.1016/j.jad.2017.03.025

14. Kiekens G, Hasking P, Claes L, Mortier P, Auerbach RP, Boyes M, et al. The DSM-5 nonsuicidal self-injury disorder among incoming college students: prevalence and associations with 12-month mental disorders and suicidal thoughts and behaviors. *Depress Anxiety*. (2018) 35:629–37. doi: 10.1002/da.22754

15. Cipriano A, Cella S, Cotrufo P. Nonsuicidal self-injury: a systematic review. *Front Psychol*. (2017) 8:8. doi: 10.3389/fpsyg.2017.01946

16. Cipriano A, Cella S, Cotrufo P. Non-suicidal self-injury among Italian adolescents: the role of parental rejection, self-concept, anger expression, and body investment. *Clin Neuropsychiatry*. (2020) 17:330. doi: 10.36131/cnfioritieditore20200602

17. Kiekens G, Hasking P, Nock M, Kleiman E, Kirtley OJ, Houben M, et al. A comparison of affective-cognitive dynamics in daily life between emerging adults with and without past-year non-suicidal self-injury. *Behav Ther*. (2022). doi: 10.31234/osf.io/a2nh3

18. Burke TA, McArthur BA, Daryanani I, Abramson LY, Alloy LB. Latent classes of trait affect and cognitive affective regulation strategies are associated with depression, non-suicidal self-injury, and well-being. *J Affect Disord*. (2018) 225:180–7. doi: 10.1016/j.jad.2017.08.015

19. Eggermont K, Raymaekers K, Claes L, Buelens T, Bogaerts A, Luyckx K. Impairment in personality functioning throughout adolescence and co-development with personality traits, emotion regulation strategies, and psychopathology. *J Res Pers*. (2023) 104:104380. doi: 10.1016/j.jrp.2023.104380

20. Zetterqvist M. The DSM-5 diagnosis of nonsuicidal self-injury disorder: a review of the empirical literature. *Child Adolesc Psychiatry Ment Health*. (2015) 9:31. doi: 10.1186/s13034-015-0062-7

21. Hooley JM, Franklin JC. Why do people hurt themselves? A new conceptual model of nonsuicidal self-injury. *Clin Psychol Sci*. (2017) 6:428–51. doi: 10.1177/2167702617745641

22. Buelens T, Luyckx K, Kiekens G, Gandhi A, Muehlenkamp JJ, Claes L. Investigating the DSM-5 criteria for non-suicidal self-injury disorder in a community sample of adolescents. *J Affect Disord*. (2020) 260:314–22. doi: 10.1016/j.jad.2019.09.009

23. Arrindell WA, Ettema JHM. *SCL-90: Handleiding bij een multidimensionele psychopathologie-indicator [SCL-90: Manual to a multidimensional psychopathology indicator]*. 2nd ed. Amsterdam: Pearson (2003).

24. Eggermont K, Luyckx K, Smits D, Bogaerts A, Buelens T, Bastiaens T, et al. The validation of a five-item screening scale for personality disorders in Dutch-speaking community adolescents and adults. *J Psychopathol Behav Assess*. (2022) 44:418–31. doi: 10.1007/s10862-022-09951-1

25. Franck E, De Raedt R, Barbez C, Rosseel Y. Psychometric properties of the Dutch Rosenberg self-esteem scale. *Psychol Belg*. (2008) 48:25–31. doi: 10.5334/pb-48-1-25

26. Lievaart M, Franken IHA, Hovens JE. Anger assessment in clinical and nonclinical populations: further validation of the state-trait anger expression inventory-2. *J Clin Psychol*. (2016) 72:263–78. doi: 10.1002/jclp.22253

27. Zetterqvist M, Landberg JLS, Svedin CG. The psychosocial consequences of covid-19 in adolescents with nonsuicidal self-injury. *Child Adolesc Psychiatry Ment Health*. (2023) 17:33. doi: 10.1186/s13034-023-00566-2

28. Ammerman BA, Jacobucci R, Turner BJ, Dixon-Gordon KL, McCloskey MS. Quantifying the importance of lifetime frequency versus number of methods in conceptualizing nonsuicidal self-injury severity. *Psychol Violence*. (2020) 10:442–51. doi: 10.1037/vio0000263

29. Tanner AK, Hasking P, Martin G. Suicidality among adolescents engaging in nonsuicidal self-injury (NSSI) and firesetting: the role of psychosocial characteristics and reasons for living. *Child Adolesc Psychiatry Ment Health*. (2015) 9:33. doi: 10.1186/s13034-015-0068-1

30. Turner BJ, Layden BK, Butler SM, Chapman AL. How often, or how many ways: clarifying the relationship between non-suicidal self-injury and suicidality. *Arch Suicide Res*. (2013) 17:397–415. doi: 10.1080/13811118.2013.802660

31. Fox KR, Franklin JC, Ribeiro JD, Kleiman EM, Bentley KH, Nock MK. Meta-analysis of risk factors for nonsuicidal self-injury. *Clin Psychol Rev*. (2015) 42:156–67. doi: 10.1016/j.cpr.2015.09.002

32. Bentley KH. Applying the unified protocol transdiagnostic treatment to nonsuicidal self-injury and co-occurring emotional disorders: a case illustration. *J Clin Psychol*. (2017) 73:547–58. doi: 10.1002/jclp.22452

33. Plener PL. Tailoring treatments for adolescents with nonsuicidal self-injury. *Eur Child Adolesc Psychiatry*. (2020) 29:893–5. doi: 10.1007/s00787-020-01523-6

34. Gray N, Hasking P, Boyes ME. The impact of ambivalence on recovery from non-suicidal self-injury: considerations for health professionals. *J Public Ment Health*. (2021) 20:251–8. doi: 10.1108/ JPMH-07-2020-0093

35. Kelada L, Hasking P, Melvin G, Whitlock J, Baetens I. "I do want to stop, at least I think I do": an international comparison of recovery from nonsuicidal self-injury among young people. *J Adolesc Res*. (2016) 33:416–41. doi: 10.1177/0743558416684954

36. Lewis SP, Hasking PA. Self-injury recovery: a person-centered framework. *J Clin Psychol*. (2020) 77:884–95. doi: 10.1002/ jclp.23094

DSM-5 suicidal behavior disorder: a systematic review of research on clinical utility, diagnostic boundaries, measures, pathophysiology and interventions

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Background: It has been a decade since Suicidal Behavior Disorder (SBD) was introduced in Section III of the DSM-5 under "Conditions for Further Study". SBD is chiefly characterized by a self-initiated sequence of behaviors believed at the time of initiation to cause one's own death and occurring in the last 24 months.

Aims: To systematically review empirical studies on SBD to identify primary research themes and promising future research directions.

Method: A search of empirical articles on SBD published between May 2013 and March 2023 was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Results: Screening of 73 records by two independent raters yielded 14 eligible articles. The primary research themes identified from these articles included clinical utility of SBD to predict future suicide risk, association of SBD with closely related disorders, psychometric properties of SBD measures, pathophysiology of SBD, and the effectiveness of interventions for people with SBD.

Conclusion: Understanding of SBD has slowly progressed since its introduction a decade ago and has mainly been applied in research to define study groups displaying suicidal behavior. The clinical utility of SBD for predicting future suicide risk is low and more research is needed to understand measurement of the diagnosis and its distinctiveness from related disorders and other self-harming behaviors.

Introduction

Suicide is a major public health concern (1). Over 700,000 people die due to suicide each year, not accounting for the number of suicide attempts that likely occur but go unreported (2). Over the years, research in the field of suicidology has identified several risk factors for suicidal behavior, including previous suicide attempts, psychiatric disorders, hopelessness, impulsivity, aggression, and childhood trauma (3). Despite this, predicting future suicidal behavior and treatment following a suicide attempt continues to be a significant challenge for individuals, families, mental health professionals, and researchers (3) due to the complex and ever-changing mechanisms of underlying suicidal behavior.

An ongoing conversation among researchers and mental health practitioners is whether suicidal behavior should be formulated as a distinct diagnosis in official psychiatric diagnostic nosologies. It is often discussed as a symptom in the context of another psychiatric disorder, such as major depressive disorder (MDD) or borderline personality disorder (BPD; 4). However, growing evidence highlights the potential for the introduction of a specific disorder of suicidal behavior because of the unique pathophysiology associated with suicide attempt and the clinical utility of such a diagnosis for predicting future suicide attempt (1, 4, 5). The American Psychiatric Association (6) proposed Suicidal Behavior Disorder (SBD), an attempt in the Diagnostic and Statistical Manual of Mental Disorders (DSM) to capture suicidality as a diagnosis rather than a clinical feature requiring attention.

The proposed criteria were put forth in Section III of the Fifth Edition of the DSM (DSM-5), under "Conditions for Further Study" (6, p.783). Diagnoses in this section are not yet intended for clinical use but instead are presented to encourage future research with common language and parameters (6). The hope is that following the accumulation of research supporting the incremental validity and clinical utility of these proposed conditions, they can be placed with the other official and clinically recognized mental disorders in Section II of the DSM in future editions.

According to the APA (6), SBD is characterized by a suicide attempt within the last 24 months (Criterion A). A suicide attempt is defined as "a self-initiated sequence of behaviors by an individual who, at the time of initiation, expected that the set of actions would lead to his or her own death" (6, p. 801). The act cannot meet the criteria for non-suicidal self-injury, that is, self-injury with the intention to relieve negative feelings or cognitive state in order to achieve a positive mood state (Criterion B) and cannot be applied to suicidal ideation or preparatory acts (Criterion C). If the attempt occurred during a state of delirium or confusion or solely for political or religious objectives, then SBD is ruled out (Criteria D & E). SBD, current, is given when the suicide attempt occurred within the last 12 months, and SBD, in early remission, when it has been 12-24 months since the last attempt.

March 2022 marked the APA's latest release, the DSM-5-Text Revision (DSM-5-TR), wherein SBD did not develop as expected or hoped for (nor any separate diagnosis for suicidal behavior) by some researchers and practitioners (1, 7). Indeed, arguments to include SBD in the DSM-5 centered on evidence to support its reliability and validity, and the potential to improve approaches to identification of suicidal behavior through greater integration with

clinical practice (4, 8). The identification of suicidal behavior in mental health care service settings is not without its potential drawbacks, however, especially given the stigma attached to the behavior (9, 10). Furthermore, criticisms of the SBD diagnosis, specifically, include the clinical utility and specificity of the 24-month timeframe during which a suicide attempt has occurred (Criterion A), and the boundary between non-suicidal self-injury and suicide attempt (Criterion B; 11).

Ultimately, SBD was removed as a condition for further study in Section III and instead placed under "Other Conditions That May Be a Focus of Clinical Attention" in Section II. The conditions in this section are meant to draw clinician attention to the presence and breadth of additional issues routinely encountered in clinical practice and provide a procedure for their systematic documentation (12). Diagnostic codes are provided for current suicidal behavior, initial and subsequent encounters, and lifetime history. Specifiers for non-suicidal self-injury, current or history, are also provided. These changes appear to be in line with the International Classification of Diseases—11th Revision, which includes "Aspects of intentional self-harm events", for example, under so-called "Extension Codes" and within the "Dimensions of External Cause" classification scheme.

According to the APA (13), the rationale for the exclusion of SBD from the DSM-5-TR was based on concerns that the proposed disorder did not meet the criteria for a mental disorder but instead constituted a behavior with diverse causes. The proposed diagnosis was also criticized for having limited clinical utility because it did not provide information on the current risk for suicide; it only described recent suicide history. Another influence on the exclusion of SBD was the view that a diagnostic label based on a single past event could lead to increased stigma and discrimination towards people with a history of suicidal behavior (13). The DSM steering committee also believed that the deletion of SBD would not hinder further research activity related to suicidality. The APA (12) suggested that a diagnostic code for the presence of suicidal behavior would help improve documentation of these behaviors when occurring with other disorders and mitigate the risk of future suicide attempts or death. This is in addition to encouraging research targeting the treatment of suicidal behavior specifically rather than as a symptom of an associated condition. Whereas questions about the validity and clinical utility of the diagnosis primarily concerned future suicide risk and the potential for stigma and discrimination, a comprehensive review of empirical studies addressing these and other characteristics of SBD is not yet available.

This systematic review aims to summarize the research on SBD conducted over the last decade, since the publication of the DSM-5 in 2013. It could be argued that many studies of recent suicidal behavior might qualify for such a review; however, the intention of the present systematic review is to draw specific attention to SBD as conceptualized in the DSM-5, in part to develop an understanding of the extent to which the introduction of the diagnosis has stimulated research in the last 10 years. Furthermore, as the diagnosis was removed from the DSM-5-TR, a contemporary synthesis of empirical studies that identifies primary research themes and outlines the scope of such work may be informative and highlight potential research areas warranting possible further scrutiny (e.g., to modify or refine the diagnosis to improve its clinical utility and validity).

Method

Inclusion and exclusion criteria

Studies were eligible for inclusion in the narrative review if they were original empirical reports and reported on the SBD diagnosis as a major focus of the study. To capture as many relevant studies as possible, the range of eligible topics and outcomes was intentionally broad. Given the APA's description of the rationale for excluding SBD from DSM-5-TR, research was nevertheless expected to be identified in the areas of clinical utility (e.g., predicting future suicidal behavior), stigma and discrimination, pathophysiology, and psychometric properties of SBD measures.

Search strategy

A literature search for empirical articles was conducted on March 13, 2023, through PubMed and PsycINFO. A combination of the following key terms was used: "Suicidal behavior disorder", "suicidal behavior disorder", and "DSM." The search included studies published between May 2013 and March 2023.

Study selection

Two authors (EO, AR) independently screened selected materials using the Covidence systematic review management software. Articles were screened and reported according to the methods outlined by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Articles were first assessed by title and abstract according to the eligibility criteria, and promising articles then underwent full-text review. Screening results discrepancies between authors were discussed until a consensus was reached (Figure 1).

Data collection and analysis

The study aim, population characteristics, and key findings were recorded for each article and grouped by primary theme. As anticipated, given the diversity of the aims and methods of the studies identified, they were not suitable for a quantitative synthesis (e.g., meta-analysis). Accordingly, a qualitative review of the findings was carried out and organized according to the common themes that emerged from the studies.

Results

The search returned 73 records (13 duplicates were subsequently removed), of which 14 were deemed eligible for inclusion in the systematic review, including one article that was discussed further due to a discrepancy between the rating authors and was excluded. Articles judged to be irrelevant for the systematic review through the screening and rating process included review articles/commentaries and empirical reports for which SBD was not stated as the primary focus of the study. Scrutiny of the topics of the articles suggested that they fell within five general areas: (a) clinical utility; (b) validity based on boundaries with related conditions; (c) psychometric properties of SBD measures; (d) pathophysiology of SBD; and (e) interventions for people with SBD. Accordingly, the reporting of the results of these studies is organized around these topics.

Clinical utility

Clinical utility is defined as the extent to which a diagnosis assists clinical decision-making by fulfilling the various clinical functions of a psychiatric classification system (14). Two studies investigated SBD as a predictor of future suicide risk, addressing one aspect of clinical utility, communicating clinical information to practitioners (14). Lasisi and colleagues (15), in their study on the prevalence and correlates of suicide risk in incarcerated youth, found that of 262 incarcerated youth in northern Nigeria, SBD had a prevalence rate of 7.6% and was not significantly associated with suicide risk. The absence of current depression, previous incarceration, increasing age, and family circumstances were more predictive of suicide risk.

In an earlier study, Lübbert and colleagues (3) found that their sample of 212 people with current SBD represented a very heterogeneous group, with those at risk of future suicidal behavior demonstrating severity on key clinical features not captured by the SBD diagnosis (i.e., psychopathology, suicidal ideation, hopelessness, genetic and environmental risk factors, and specific personality trait). These studies, in addition to relatively few studies investigating the clinical utility of SBD, raise the question of what, if any, additional information is provided to practitioners by an SBD diagnosis. The authors of both articles named the cross-sectional design as a limitation of their studies, limiting the temporal conclusions that can be drawn.

Diagnostic boundaries

NSSID is another proposed diagnosis under "Conditions for Further Study" in DSM-5 and, unlike SBD, was retained in the DSM-5-TR. NSSID is characterized by intentional self-inflicted damage to the body's surface that is likely to induce bleeding, bruising or pain occurring on five or more days over the last year. The intention of these behaviors is not to die but to induce relief, achieve a positive state, resolve interpersonal difficulty, or a combination of these (7).

SBD has been studied in relation to NSSID and BPD because of the prevalence of suicidal behavior in both disorders. Groschwitz and colleagues (16) investigated the association between NSSID and SBD in 111 adolescent psychiatric inpatients and found that the two tend to co-occur, with NSSID acting as a strong risk factor for the occurrence of SBD. Similar results were found by Szewczuk-Bogusławska and colleagues (17). There was high co-occurrence of SBD and NSSID in their sample of 196 adolescent girls with conduct disorder, and a diagnosis of NSSID, with a minimum of
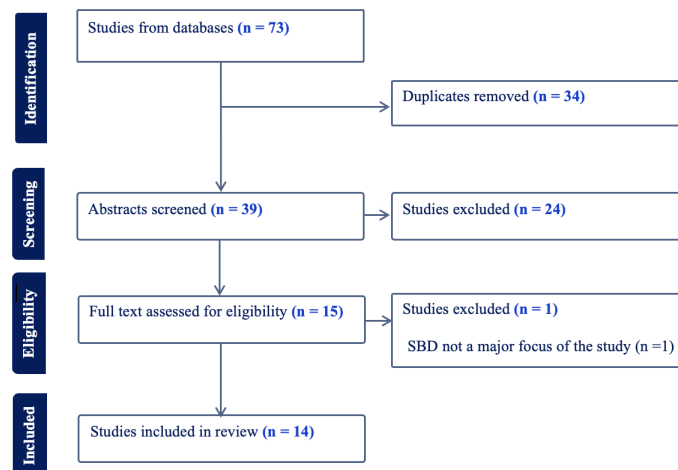
FIGURE 1
Screening of articles according to PRISMA guidelines.

eight days of self-injury engagement within the last 12 months, significantly predicted the risk of SBD.

SBD has also been studied with BPD. Ducasse and colleagues (5) compared the psychological and clinical traits of suicidal vulnerability in 92 SBD patients, both with and without BPD. They found that scores in clinical and psychological traits of suicidal vulnerability increased along a dimension from healthy controls to SBD patients occupying the intermediate position, and comorbid SBD and BPD were associated with particularly high scores of suicidal vulnerabilities. The authors suggest that BPD could act as a specifier for SBD diagnoses.

Consistent with this, Levine et al. (18), in a similar investigation on BPD and NSSID, also found that although the number of serious suicide attempts was primarily associated with BPD, there were some incidents of suicide attempts reported by individuals who met no diagnostic criteria for BPD. This again suggests the presence of an intermediate group with clinically relevant suicidal attempts, as described by SBD, but who do not otherwise meet the criteria for BPD. SBD captures this group that may be missed or may warrant targeted treatment.

Psychometric properties of SBD measures

The Self-Injurious Thoughts and Behaviors Interview (SITBI) is a structured clinical interview that assesses the presence, frequency, and characteristics of a wide range of self-injurious thoughts and behaviors (19). Fischer and colleagues (20) assessed the psychometric quality and properties of the German translation of the SITBI (SITBI-G) in 111 adolescent inpatients. They employed Cohens Kappa to evaluate test-retest and interrater reliability of the SITBI-G for assessing SBD. They found that the SITBI-G showed moderate to good test-retest reliability when assessing for SBD (k =.64) and current SBD (k =.52). Additionally, it exhibited excellent interrater reliability for SBD (k=1.00) and current SBD (k=1.00).

Lee et al. (21) found similar results when developing and providing initial psychometric validation for the Korean version

(SITBI-K) to assess SBD in 108 undergraduate subclinical research participants. Both author groups concluded that a diagnosis of SBD can be established using their language version of the SITBI. The limitation of both studies is the lack of information on the translation procedures utilized to ensure comparability to the English version. Additionally, the long-form version of the SITBI does not directly assess for functional impairment, a criterion for an SBD diagnosis. This was pointed out by Fischer et al. (20) but not Lee et al., which would limit both studies' results and interpretation.

Pathophysiology

The pathophysiology of suicidal behavior is complex and involves interactions among multiple biological systems (for a review, see 22). Research on the pathophysiology of SBD, more specifically, has until now exclusively centered on endocrinological markers, and these findings appear to be reported by the same or overlapping research groups. In the first of three articles on related topics, Duval et al. (23) investigated thyrotropin (thyroid-stimulating hormone; TSH) and prolactin (PRL) responses to protirelin (thyrotropin-releasing hormone; TRH) stimulation tests in depressed inpatients with either current SBD (last suicide attempt within the last one year) or SBD in early remission (last suicide attempt in the last 1-2 years), as well as non-psychiatric controls. Participants with SBD in early remission did not differ from controls across TSH and PRL measurements. However, compared to controls and SBD participants in early remission, the current SBD group showed lower changes (following TRH injection) in TSH at the first measurement time (2300 h) and lower differences in changes in TSH response between the two measurement times (2300 h and 0800 h). Among participants with current SBD, the latter values were also significantly negatively correlated with lethality ratings of the most recent suicide attempt. Additionally, free thyroxine levels were lower in current SBD compared to controls. Some of the findings were accentuated in a subgroup of participants with current SBD who

were classified as violent suicide attempters. The findings were interpreted to support the theory that individuals with current SBD show an inadequate homeostatic mechanism implicating the TRH response to lowered serotonin activity.

In a separate report, Duval et al. (24) investigated multiple hormonal responses to apomorphine (APO), which is a dopamine receptor agonist, and protirelin (TRH), in depressed inpatients with current or in early remission SBD, and non-psychiatric controls. Similar to the pattern of findings in Duval et al. (23), participants with SBD in early remission did not differ from controls in their responses to APO and TRH tests, although there were various indicators of adrenocorticotropic hormone and APO-induced growth hormone dysregulation. Duval et al. (25) grouped participants in the same manner and studied their prolactin responses to APO and protirelin at different time points. Baseline prolactin measurements did not differ across the three groups, and comparable to the results of prior studies, SBD participants in early remission showed no differences from controls across the various measurements. However, participants with current SBD displayed lower prolactin suppression values than controls, and smaller differences in prolactin change values between the two testing times (2300 h and 0800 h); the co-occurrence of these observations was higher in patients whose most recent suicide attempt was violent and highly lethal. Taken together, the results suggest a dysregulation of the hypothalamic-prolactin axis in depressed patients with current SBD.

Interventions

The efficacy of established interventions to treat SBD specifically has been investigated and seen promising results. Ducasse and colleagues (26) conducted a pilot study investigating the usefulness of an add-on Acceptance and Commitment Therapy (ACT) group program to decrease suicidal ideation in 35 patients with current SBD. They found that an adjunctive ACT group program decreased suicidal ideation through increasing acceptance skills and meaning of existence and reducing the impact of modifiable suicidal risk factors (i.e., hopelessness, psychological pain, quality of life) in patients with current SBD. In a randomized controlled trial (RCT) conducted a few years later in 40 adults with current SBD, the authors found that the rate of change in ACT for suicidal ideation was higher than in the relaxation group (27). Both author groups concluded that ACT might be an effective intervention for patients with SBD. Another aspect of clinical utility discussed by First and colleagues (14) is improving clinical outcomes; a diagnosis should assist in choosing effective interventions that achieve this. The focus on suicidal ideation in these studies limits its interpretation and effectiveness for people with SBD because suicidal ideation is not a defining feature in the diagnosis and represents somewhat of an exclusion criterion.

Henrion and colleagues (28) took a different approach by investigating the effectiveness of a psychoeducational program for managing patients with current SBD. They found that when compared to a relaxation group, although both groups benefited from their respective groups, the psychoeducation program had more profound implications for daily functioning through specific processes of targeting suicidal risk (e.g., developing an internal locus of control and acquiring scientific knowledge on suicidal behavior) and reducing stigma, the psychoeducation program may represent a promising intervention for suicide prevention. The generalizability of these results is limited due to a small sample size (n = 18).

Discussion

The present systematic review comprehensively summarized original empirical studies of SBD as defined in the DSM-5, Section III. While the number of studies identified in the review was relatively low, the scope of the work represented a range of primary themes, including clinical utility (e.g., suicide risk), diagnostic validity compared to related diagnoses, psychometric characteristics of SBD measures, pathophysiology, and psychological interventions. The majority of research on SBD located by the search was conducted outside of North America. Only one study (18) was conducted in the United States. The remaining studies on SBD were conducted in several countries, including Nigeria, Germany, Switzerland, Poland, Korea, and France. The research was conducted with similar frequency in adolescents and adults. All but two studies were conducted with inpatients, presumably representing more extreme cases of SBD requiring hospitalization.

Consistent with the rationale for change provided by the DSM-5-TR steering committee, the clinical utility of SBD may be judged as low, as the features most predictive of suicide risk, such as cognition and psychopathology (29, 30), are not fully captured in SBD. Additionally, many studies used the diagnosis to demarcate a timeframe (i.e., less than one year since the last suicide attempt) rather than clinical characteristics related to the suicide attempt that may be informative for intervention and possibly safety planning (e.g., medical lethality of the last suicide attempt). Relatedly, emerging research indicates that current (past year) SBD among depressed inpatients (especially those with a recent violent and high-lethality attempt) may be linked to a specific profile of endocrinological markers compared to those with SBD in early remission. These findings suggest that the timing of the most recent suicide attempt and associated clinical characteristics may differentiate subtypes of SBD, at least at a pathophysiological level. Second, NSSID was found to be a strong predictor of SBD and will likely continue to be studied in relation to suicidal behavior in the absence of SBD. Although SBD is suggested to provide a diagnosis for subthreshold clinically significant presentation, as seen in work related to BPD, more research is needed to support this and a potential reformulation of the diagnosis to suit this specific function. It is also possible that the new diagnostic codes for suicidal behavior and non-suicidal self-injury may capture this intermediate group.

At first glance, the psychometric properties of the translated versions of the SITBI for assessing SBD seem promising, but when considering that full SBD criteria are not covered in the measure, their results should be cautiously interpreted and generalized. Finally, ACT and a psychoeducational program were administered in a group of individuals with SBD in RCTs, and both were shown to be more effective than relaxation controls. Conclusions that can be drawn from the existing literature on SBD in several respects are limited and likely contributed to its removal from the DSM-5-TR.

Future directions

While there is no clear future direction for SBD as a diagnosis, many researchers in the field argue for the adoption of a diagnostic entity for suicidal behavior for reasons related to clinical utility and the implications of conceptualizing suicidality as a symptom rather than a disorder (1, 4). The present review identified a relatively small number of studies on SBD, possibly because the diagnostic formulation of SBD in the DSM-5 did not stimulate sufficient interest in studying the disorder (11, 31). Nevertheless, the emerging research on SBD highlights topics that may be worthy of future study. For example, SBD could serve as an anchoring diagnosis for studies aimed at reducing suicide risk and related symptoms and functional impairment.

Author contributions

EO: Conceptualization, Investigation, Methodology, Project administration, Visualization, Writing – original draft. AR: Methodology, Supervision, Validation, Writing – review & editing.

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References

1. Fehling KB, Selby EA. Suicide in DSM-5: Current evidence for the proposed suicide behavior disorder and other possible improvements. *Front Psychiatry* (2020) 11:499980. doi: 10.3389/fpsyt.2020.499980

2. World Health Organization. *Suicide* (2021). Available at: https://www.who.int/news-room/fact-sheets/detail/suicide.

3. Lübbert M, Bahlmann L, Josfeld S, Bürger J, Schulz A, Bär K-J, et al. Identifying distinguishable clinical profiles between single suicide attempters and re-attempters. *Front Psychiatry* (2021) 12:754402. doi: 10.3389/fpsyt.2021.754402

4. Oquendo MA, Baca-Garcia E. Suicidal behavior disorder as a diagnostic entity in the DSM-5 classification system: Advantages outweigh limitations. *World Psychiatry* (2014) 13(2):128–30. doi: 10.1002/wps.20116

5. Ducasse D, Lopez-Castroman J, Dassa D, Brand-Arpon V, Dupuy-Maurin K, Lacourt L, et al. Exploring the boundaries between borderline personality disorder and suicidal behavior disorder. *Eur Arch Psychiatry Clin Neurosci* (2020) 270(8):959–67. doi: 10.1007/s00406-019-00980-8

6. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders, 5th ed.* Arlington, VA: American Psychiatric Association (2013). doi: 10.1176/appi.books.9780890425596.

7. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders* (2022). doi: 10.1176/appi.books.9780890425787.

8. Posner K, Brodsky B, Yershova K, Buchanan J, Mann J. The classification of suicidal behavior. In: Nock M, editor. *The oxford handbook of suicide and self-injury.* New York, NY: Oxford University Press (2014). p. 7–22. doi: 10.1093/oxfordhb/9780195388565.001.0001

9. Hom MA, Albury EA, Gomez MM, Christensen K, Stanley IH, Stage DL, et al. Suicide attempt survivors' experiences with mental health care services: A mixed methods study. *Prof Psychology: Res Pract* (2020) 51(2):172–83. doi: 10.1037/pro0000265

10. Oquendo MA, Porras-Segovia A. Barriers for the research, prevention, and treatment of suicidal behavior. In: Baca-Garcia E, editor. *Behavioral neurobiology of suicide and self harm.* Cham: Springer (2020). doi: 10.1007/7854_2020_159

11. Malhi GS, Bell E. Make news: Suicidal behaviour disorder – A "diagnosis" with good intentions? *Aust New Z J Psychiatry* (2019) 53(9):927–31. doi: 10.1177/0004867419872533

12. American Psychiatric Association. *Addition of diagnostic codes for Suicidal behavior and nonsuicidal self-injury [Fact Sheet]* (2022). Available at: https://www.psychiatry.org/File%20Library/Psychiatrists/Practice/DSM/DSM-5-TR/apa-dsm5tr-suicidalbehaviorandnonsuicidalselfinjury.pdf.

13. American Psychiatric Association. *DSM-5-TR update: Supplement to Diagnostic and Statistical Manual of Mental Disorders* (2022). Available at: https://www.psychiatry.org/getmedia/34c43e15-2618-4d2b-9f67-6bef5c40f75a/APA-DSM5TR-Update-September-2022.pdf.

14. First MB, Pincus HA, Levine JB, Williams JB, Ustun B, Peele R. Clinical utility as a criterion for revising psychiatric diagnoses. *Am J Psychiatry* (2004) 161(6):946–54. doi: 10.1176/appi.ajp.161.6.946

15. Lasisi MD, Nuhu FT, Adebayo F, Eseigbe EE, Sheikh TL. Spectrum and predictors of suicidal risk among incarcerated youth in a correctional facility in Kaduna, northern Nigeria. *Vulnerable Children Youth Stud* (2022) 17(2):147–58. doi: 10.1080/17450128.2021.1990456

16. Groschwitz RC, Kaess M, Fischer G, Ameis N, Schulze UM, Brunner R, et al. The association of non-suicidal self-injury and suicidal behavior according to DSM-5 in adolescent psychiatric inpatients. *Psychiatry Res* (2015) 228(3):454–61. doi: 10.1016/j.psychres.2015.06.019

17. Szewczuk-Bogusławska M, Kaczmarek-Fojtar M, Adamska A, Frydecka D, Misiak B. Assessment of the association between non-suicidal self-injury disorder and suicidal behaviour disorder in females with conduct disorder. *BMC Psychiatry* (2021) 21(1):172–2. doi: 10.1186/s12888-021-03168-4

18. Levine AZ, Aljabari R, Dalrymple K, Zimmerman M. Nonsuicidal self-injury and suicide: Differences between those with and without borderline bersonality disorder. *J Pers Disord* (2020) 34(1):131–44. doi: 10.1521/pedi_2018_32_385

19. Nock MK, Holmberg EB, Photos VI, Michel BD. Self-injurious thoughts and behaviors interview: Development, reliability, and validity in an adolescent Sample. *psychol Assess* (2007) 19(3):309–17. doi: 10.1037/1040-3590.19.3.309

20. Fischer G, Ameis N, Parzer P, Plener PL, Groschwitz R, Vonderlin E, et al. The German version of the self-injurious thoughts and behaviors interview (SITBI-G): A tool to assess non-suicidal self-injury and suicidal behavior disorder. *BMC Psychiatry* (2014) 14(1):265–5. doi: 10.1186/s12888-014-0265-0

21. Lee SJ, Cho YJ, Hyun MH. Self-injurious thoughts and behaviors interview-korean version: psychometric properties. *Psychiatry Invest* (2021) 18(2):157–65. doi: 10.30773/pi.2020.0302

22. Abou Chahla MN, Khalil MI, Comai S, Brundin L, Erhardt S, Guillemin GJ. Biological factors underpinning suicidal behaviour: an update. *Brain Sci* (2023) 13(3):505. doi: 10.3390/brainsci13030505

23. Duval F, Mokrani M-C, Erb A, Gonzalez opera F, Calleja C, Paris V. Relationship between chronobiological thyrotropin and prolactin responses to protirelin (TRH) and suicidal behavior in depressed patients. *Psychoneuroendocrinology* (2017) 85:100–9. doi: 10.1016/j.psyneuen.2017.07.488

24. Duval F, Mokrani M-C, Danila V, Erb A, Gonzalez Lopera F, Tomsa M. Dopamine function and hypothalamic-pituitary-thyroid axis activity in major depressed patients with suicidal behavior. *Brain Sci* (2022) 12(5):621. doi: 10.3390/brainsci12050621

25. Duval F, Mokrani MC, Danila V, Lopera FG, Erb A, Tomsa M. Hypothalamic-prolactin axis regulation in major depressed patients with suicidal behavior. *Psychoneuroendocrinology* (2023) 151:106050. doi: 10.1016/j.psyneuen.2023.106050

26. Ducasse D, René E, Béziat S, Guillaume S, Courtet P, Olié E. Acceptance and commitment therapy for management of suicidal patients: A pilot study. *Psychother Psychosomatics* (2014) 83(6):374–6. doi: 10.1159/000365974

27. Ducasse D, Jaussent I, Arpon-Brand V, Vienot M, Laglaoui C, Béziat S, et al. Acceptance and commitment therapy for the tanagement of suicidal patients: A randomized controlled trial. *Psychother Psychosomatics* (2018) 87(4):211–22. doi: 10.1159/000488715

28. Henrion A, Courtet P, Arpon-Brand V, LaFrancesca A, Lacourt L, Jaussent I, et al. PEPSUI, A psychoeducational program for the management of suicidal patients: A qualitative study from a randomized controlled trial. *Front Psychiatry* (2020) 11:500447. doi: 10.3389/fpsyt.2020.500447

29. Fernández-Sevillano, González-Pinto A, Rodríguez-Revuelta J, Alberich S, Gónzalez-Blanco L, Zorrilla I, et al. Suicidal behaviour and cognition: A systematic review with special focus on prefrontal deficits. *J Affect Disord* (2021) 278:488–96. doi: 10.1016/j.jad.2020.09.044

30. Favril L, Yu R, Uyar A, Sharpe M, Fazel S. Risk factors for suicide in adults: systematic review and meta-analysis of psychological autopsy studies. *Evidence-Based Ment Health* (2022) 25(4):148–55. doi: 10.1136/ebmental-2022-300549

31. Obegi JH. Rethinking suicidal behavior disorder. *Crisis: J Crisis Intervention Suicide Prev* (2019) 40(3):209–19. doi: 10.1027/0227-5910/a000543

Check for updates

"Swipe & slice": decoding digital struggles with non-suicidal self-injuries among youngsters

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Introduction: Nonsuicidal-self-injury (NSSI)-related content recently emerged on social networking sites (SNS), despite its relationship with NSSI conducts is still unclear.

Methods: Hence, the current population-based cross-sectional study investigated the interplay between SNS use, NSSI content engagement, risky social media challenges (RSMCs), in a sample of 404 young adults (aged 18−24), focusing on the influence of problematic social media use (PSMU) and fear of missing out (FoMO).

Results: Around 51.5% of the samplewas engaged inNSSI-related contents on SNS, being mostly females (p<0.001), younger (p=0.005), transgender people and nonbinary people (p=0.030) and those who displayed higher PSMU (p<0.001) or FoMO (p=0.031). Around 66.2% of the sample currently practice NSSIs, predominantly among females (p<0.001), those using BeReal (p=0.012), actively looking for NSSIrelated contents on SNS (p<0.001) to be part of a group (p=0.0025) or learn how to practice NSSI (p=0.025). PSMU (p<0.001) and FoMO (p<0.001) emerged as significant predictors of NSSI content engagement, particularly among active seekers. NSSI conducts were significantly predicted by FoMO (p<0.001) and Snapchat (p=0.044), while negatively predicted by male sex (p<0.001), higher educational level (p=0.019) and age at which NSSI-related contents were firstly looked for (p=0.028).

Discussion: These findings underline the need to implement preventivepolicies and targeted interventions to monitor NSSI-related contents on SNS, the impact of PSMU and FoMO on NSSI, particularly among youngsters.

KEYWORDS

fear of missing out, non-suicidal self-injury, social network site, problematic social media use, risky Social Media Challenges

1 Introduction

Non-suicidal self-injury (NSSI) is defined as any deliberate destruction of one's own bodily tissues, enacted for non-suicidal reasons that are not sanctioned by social and/or cultural norms (1). In recent years, there has been a significant surge in NSSI-related content on the Internet (2, 3). Various forms of NSSI-based web content, including material on message boards, blogs, video-sharing websites, and especially on social networks, have been empirically examined (2). The COVID-19 pandemic has undoubtedly led to an increase in online activity, with youths uploading videos and posts on various social networks (4, 5). Recent research has delved into how this content is portrayed and speculated on its potential impact on at-risk populations, particularly youths who engage in self-harm and more likely may have direct access to such material (6–9).

Indeed, previous studies suggested that the engagement of young adults in health-risk behaviors is influenced by social motivations, such as the need to "belong to", the desire for popularity, and the fear of missing out (FoMO), i.e. the feeling of apprehension that one is either not in the known or missing out on information, social events, life experiences and so forth (1, 8). Perceived social standing in the peer network, including popularity and a sense of belonging, also plays a significant role (10). Young adults with a weaker sense of peer belonging, a stronger need to belong to socially notorious groups, and/or a greater sense of FoMO may be at higher risk of being engaging in Risky Social Media Challenges (RSMCs), more likely due to the need to conform to peer group norms or avoid exclusion (6). Moreover, self-reported popularity and the need for notoriety and SNS-based approval are consistently linked to risky behaviors, often used to convey one's "coolness" to peers. The primary reason for uploading content to social networking sites (SNS) seemed to be the need to 'attract' views and likes, serving as a measure of online popularity (1, 8). However, these motivators towards SNS usage and these gained SNS-mediated 'social positions and roles' should be considered in association to predict youth risk behavior on SNS and, consequently, their influence in being engaged in RSMCs (6, 11). Coherently, a previous study demonstrated that peer influence on substance use was stronger among emerging adults with high perceived popularity and a strong sense of belonging to peers (6, 11). Another study found that higher perceived popularity predicted increased substance use, but only when the need for popularity was also high (6, 11). Additionally, evidence suggests that the need for popularity, the need for belonging, and FoMO combined are able to predict social media use behaviors (6, 11). Therefore, identifying young adults at a higher risk of participating in RSMCs requires examining classes of individuals who share common social motivations and positions in the peer context (6, 11, 12).

Considering NSSI as a highly stigmatized and often misunderstood behavior, communication on the topic is more likely to occur in a virtual environment, where the Internet facilitates personal connections and anonymous disclosure of topics that would otherwise be difficult to discuss with peers but also family members. While online communication of NSSI may have some benefits on preventing these behaviors, on the other hand, certain contents and forms of communication on the Internet, such as NSSI/suicidality-based challenges on SNS (e.g., the Blue Whale Challenge, and others), may indeed contribute to the reinforcement of NSSI (2, 6) and determine serious consequences (13, 14).

Basic social media challenges involve recording and uploading videos of oneself performing specific behaviors and then nominating others to do the same. While some challenges have positive intentions and are relatively safe, such as the ALS ice bucket challenge, many others involve serious (and potentially fatal) risky health behaviors, such as the Cinnamon Challenge (ingesting a spoonful of cinnamon without liquid), the Tide Pod Challenge (ingesting a Tide Pod containing chemicals), and the Kiki Challenge (dancing next to a moving vehicle). Videos of youths engaging in risky social media challenges (RSMCs) have garnered millions of views on social networking sites (SNSs) like YouTube and have resulted in serious health consequences, including aspiration, poisoning, car accidents, and even death (6).

Therefore, our study aims at investigating the NSSI phenomenon mediated by SNSs by exploring the impact of a PSMU and FoMO on NSSI-related contents on SNS and/or the occurrence of NSSI behaviors, within a sample of young adults (aged 18–24) from the general population, within the SWATCH (Social Withdrawal And TeCno-mediated mental Health issues) study, aiming at assessing all web-based psychopathological mental health issues. The NSSI phenomenon was explored specifically collecting information on motivators, NSSI functions, NSSI frequency, and SNS-related NSSI contents.

2 Materials and methods

2.1 Study design and recruitment strategies

This Italian population-based observational cross-sectional study was conducted from July 2023 to October 2023. The population sample consisted of young adults (aged 18–24), according to the World Health Organization (WHO)'s definition (15). recruited from the general population by using a snowball sampling recruitment strategy. No exclusion criteria have been identified for this study, despite we originally included a question by asking all participants if they had previous contacts with mental health professionals for any reason. However, being this variable not mandatory to be filled out, we did not receive a significant number of replies by participants. Participation was anonymous and voluntary without monetary or other incentives. All participants gave informed consent to take part in the study. Sample size was calculated using the Statistical Software G*Power version 3.1. (Franz, Universitat Kiel, Germany), by keeping the values of confidence level as 99%, anticipated population proportion 0.5, an α error of 0.05, a power of 80%, and taking into consideration all variables to be entered in the multivariable analysis, in order to obtain at least an effect size of >0.6. A total sample size of 369 was established to be reached for the present study. Participants were requested to fill out a set of self-report questionnaires administered through the EUSurvey platform

(https://ec.europa.eu/eusurvey/home/welcome). The total sample included 404 participants, 31 of them were excluded due to denial of informed consent and/or refusal to participate in the study. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and according to the guidelines for Good Clinical Practice (GCP) (16), following the approval by the local Institutional Review Board. All participants gave informed consent to take part in the study.

2.2 Measurements

We collected a set of socio-demographic and clinical variables, including participants' age, sex, gender identity and level of education (in years), use of social networks (specifically), use of SNSs and which one specifically. We also asked participants if they ever searched for Risky Social Media Challenges (RSMCs) on social networks and the main reason/motivation for looking for them. Moreover, a set of self-rated questionnaires were requested to be filled out (as described below).

The Italian Version of Bergen Social Media Addiction Scale (BSMAS) (17) is a 6-items scale used to assess problematic social media use, based on the core components of addiction (i.e., salience, mood modification, tolerance, withdrawal, conflict, and relapse) (18). The scale is rated on a 5-point Likert scale ranging from 1 "very rarely" to 5 "very often". The scale is referred to experiences related to social media use within a time frame of 12 months. The highest is the BSMAS total score, the highest is the propensity to develop problematic social media use. We adopted a cutoff of 19 to discriminate between problematic versus non problematic use of social media (PSMU versus notPSMU), according to the study by 19. In our study, BSMAS displays a good internal reliability (Cronbach's α= 0.761).

The Italian Version of the Fear of Missing Out Scale (FoMOs) (20) is a 10-items questionnaire on a 5-point Likert-type scale (from 1 = "not at all true of me" to 5 = "extremely true of me"), assessing individuals' levels of FoMO on the developments they perceive on social media. The total score ranges from 10 to 50, with higher scores indicating a greater fear of missing out. A good Cronbach's α internal consistency was described (21). In our study, FoMOs displayed a good internal reliability (Cronbach's α = 0.794).

The Italian translation of the Inventory of Statements About Self-Injury (ISAS) (22) was used to assess the relationship between NSSI, social media use and frequency. The scale was designed to assess each NSSI function documented in the research literature comprehensively. The ISAS comprises an initial section assessing lifetime frequency of 12 NSSI behaviors performed "intentionally (i.e., on purpose) and without suicidal intent". The behaviors assessed are banging/hitting self, biting, burning, carving, cutting, wound picking, needle-sticking, pinching, hair pulling, rubbing skin against rough surfaces, severe scratching, and swallowing chemicals (22). Participants were asked to estimate the number of times they have performed each behavior (from "never in life" to "everyday"). Those endorsing one or more NSSI behaviors were asked to assess 13 potential functions of NSSI according to the ISAS section of the questionnaire: a) affect-regulation; b) anti-dissociation; c) anti-

suicide; d) autonomy; e) interpersonal boundaries; f) interpersonal influence; g) marking distress; h) peer bonding; i) revenge; l) self-care; m) self-punishment; n) sensation seeking; and, o) toughness. Each function is assessed by 3 items (from "0 = not relevant", "1 = somewhat relevant", and "2 = very relevant") depending on the individual's "experience of (non-suicidal) self-harm behavior". The score for each of the 13 ISAS functions can range from 0 to 6. In our study, ISAS displays a good internal reliability (Cronbach's α = 0.854).

2.3 Statistical analysis

Data analysis was performed using the Statistical Package for Social Science for MacOS (SPSS) Software, version 27.0 (IBM Corp., Armonk NY). All the analyses were two-sided with α of 0.05. Descriptive statistics were performed in order to describe the socio-demographic and clinical characteristics of the sample, by summarizing categorical variables as frequency (N) and percentage (%). After analyzing the continuous variables for skewness, kurtosis, normality distribution through the Shapiro-Wilk test, and the equality of variances by Levene test, parametric or non-parametric statistical tests were used, when appropriate. Normally distributed continuous variables were represented using the average mean and standard deviation (SD), whether normally distributed, or the median and 95% Confidence Interval (95% CI) when not normally distributed. To compare all socio-demographic and categorical variables in each group, the χ^2 Test was used. The Analysis of Variance (ANOVA) was performed to compare both BSMAS and FoMOs total scores across all socio-demographic and categorical variables (including those derived by the ISAS questionnaire). Before specifically assessing the predictors of NSSI behavior related to SNS, two preliminary multivariate linear regression analyses were run to investigate whether socio-demographic and other SNS- and/or NSSI-related predictors are potentially associated with the probability to develop a PSMU (as assessed by using the BSMAS total score as dependent variable) and FoMO (as assessed by using the FoMOs total score as dependent variable) within our sample of young adults. Then, in order to identify potential risky and protective socio-demographic and SNS-and/or NSSI related to SNS-related factors associated with the probability to develop NSSI conducts, a stepwise binary logistic regression analysis was run within all our sample. The odds ratios (OR), corresponding to 95% of confidence intervals (CI), standardized coefficient β values were generated for each variable.

3 Results

3.1 Socio-demographic and clinical characteristics of the sample

The majority of the sample (84.7%; n = 316) were women, with around 70% (n = 261) of them who declared to be cisgender. 78.8% (n=294) reported being students. The mean age of the sample is 21.1 (SD = 2.7) and the average educational level was 13.3 (SD = 2.5).

Overall, 99.7% (n = 372) of participants declared to have used at least one social network in their daily life. Snapchat (96.8%; n = 361) and Instagram (92.5%; n = 345) seemed to be the most used social media as declared by participants. The mean age of subjects who use TikTok (p < 0.001) and Snapchat (p = 0.028) is significantly lower than those who do not use them. The mean age of subjects who use Facebook (p < 0.001) and Instagram (p = 0.005) is significantly higher than those who do not use them. There is no difference in the age of participants who use Twitter (p = 0.739) or BeReal (p = 0.136) and those who do not use them. Around 92.5% (n = 345) of participants declared to know about the Blue Whale Challenge and more than half of the sample (51.5%; n = 192) referred to have looked for NSSI contents on SNS. Women more frequently reported having searched NSSI contents on SNS (p < 0.001), compared to the male counterpart. It was also observed that those searching for NSSI content less significantly use Facebook (p = 0.002), while they much more declared to use TikTok (p = 0.009) or other SNS among those not listed in the questionnaire (p = 0.01). Subjects who reported to have looked for NSSI contents on SNS are significantly younger than those who do not have searched for such contents (p = 0.005). Most of the subjects who have seen NSSI contents on SNS have sought such contents for curiosity (50.5%; n = 107) or for help/support (30.1%; n = 66). The average educational level of subjects who have seen NSSI contents on SNS for seeking help is significantly higher than those who do it for other reasons (p = 0.02). Only 4.8% (n = 18) of participants reported to actively follow accounts and/or online pages/groups posting NSSI-related contents. The average age at which participants declared they first searched for or watched NSSI-related content is 14.0 (SD = 2.0). The mean age of transgender people and non-binary subjects (p = 0.030) and females (p < 0.001) who first searched for or watched NSSI-related contents was significantly lower than cisgender subjects and males. At the same time, the average age of subjects who first searched for or watched NSSI-related contents with the purpose of being part of a group (p = 0.045) or the purpose to learn how to do NSSI (p = 0.001) is significantly lower than those who do it for other reasons. Table 1 summarizes all the socio-demographic and clinical characteristics of the sample.

3.2 Psychopathological characteristics of the sample

The mean score at BSMAS is 15.8 (SD = 2.7), being males who scored significantly lower at BSMAS total score (p = 0.021) compared to females. After stratifying the sample in two groups (PSMU versus notPSMU), according to the BSMAS cut-off, around 53.4% (N = 199) of participants displayed significant PSMU, being mainly females (p = 0.033). Subjects who have watched NSSI-related content on SNS scored significantly higher at the BSMAS total score than subjects who did not (p = 0.007). Participants who searched NSSI-related contents to learn how to do NSSI scored significantly higher at the BSMAS total score than subjects who did it for other reasons (p < 0.001) (Table 2).

The mean score at FoMOs is 28.8 (SD = 2.7), without any sex-based differences (p = 0.380). Subjects who use TikTok (p = 0.002) or BeReal (p = 0.002) scored significantly higher scores at the

TABLE 1 Socio-demographic and clinical characteristics of the sample.

		Count	%
Sex	males	57	15.3%
	females	316	84.7%
Gender	cisgender people	261	70%
	transgender people	10	2.7%
	non binary people	102	27.3%
Student	no	79	21.2%
	yes	294	78.8%
Using Social Networks	no	1	0.3%
	yes	372	99.7%
Use Facebook	no	299	80.2%
	yes	74	19.8%
Use Instagram	no	28	7.5%
	yes	345	92.5%
Use TikTok	no	180	48.3%
	yes	193	51.7%
Use Twitter	no	344	92.2%
	yes	29	7.8%
Use BeReal	no	309	82.8%
	yes	64	17.2%
Use Snapchat	no	361	96.8%
	yes	12	3.2%
Use Other Social Media	no	325	87.1%
	yes	12	3.2%
Search NSSI content	no	181	48.5%
	yes	192	51.5%
Search NSSI content for Curiosity	no	95	49.7%
	yes	96	50.3%
Search NSSI content for Seeking Help	no	133	69.6%
	yes	58	30.4%
Search NSSI content for Pleasure	no	175	91.6%
	yes	16	8.4%
Search NSSI content for Need to belong to a group	no	162	84.8%
	yes	29	15.2%
Search NSSI content to Learn how to do it	no	162	84.8%
	yes	29	15.2%
Search NSSI content for popularity	no	184	96.3%

(Continued)

TABLE 1 Continued

		Count	%
	yes	7	3.7%
Search NSSI content for Other reasons	no	167	87.4%
	yes	24	12.6%
Follow NSSI inherent pages	no	355	95.2%
	yes	18	4.8%
Know Blue Whale challenge	no	28	7.5%
	yes	345	92.5%

NSSI: Non-Suicidal Self-Injury.

FoMOs than subjects who declared to not use them. Subjects who have watched NSSI-related content on SNS scored significantly higher at the FoMOs total score than subjects who did not (p = 0.031) (Table 3).

According to the ISAS, 85% (n = 317) of the sample reported a history of self-injurious gestures, while 66.2% (n = 247) currently practice NSSIs. Most of the sample who currently practice NSSI declared to do it to vent (64.8%; n = 160) or to self-punishment (42.5%; n = 105). The most frequently reported methods to act NSSI were (in order of frequency): hindering wound healing (64.4%; n = 159), biting themselves (42.1%; n = 104), pinching themselves (40.1%; n = 99), scratching themselves (34.4%; n = 85) and getting cuts (31.6%; n = 78). Subjects who declared to not practice NSSIs were significantly

TABLE 2 Socio-demographic and clinical characteristics of the sample stratified according to the BSMAS.

		M	SD	p-value
Sex	males	14.6	4.2	**0.021**
	females	16.0	4.3	
Gender	cisgender people	15.8	4.2	0.935
	transgender people	15.4	4.1	
	non binary people	15.7	4.4	
Student	no	15.5	3.9	0.582
	yes	15.8	4.4	
Use Facebook	no	15.7	4.1	0.858
	yes	15.9	4.8	
Use Instagram	no	14.6	4.3	0.136
	yes	15.9	4.3	
Use TikTok	no	15.3	4.5	0.063
	yes	16.2	4.0	
Use Twitter	no	15.7	4.3	0.689
	yes	16.1	4.0	
Use BeReal	no	15.7	4.3	0.674
	yes	16.0	4.3	
Use Snapchat	no	15.8	4.2	0.443
	yes	14.8	5.3	
Use of Other Social Media	no	15.8	4.3	0.781
	yes	15.6	4.4	
Search NSSI content	no	15.2	4.2	**0.007**
	yes	16.3	4.2	
Search NSSI content for curiosity	no	16.1	4.3	0.520
	yes	16.5	4.2	
Search NSSI content for seeking help	no	16.0	4.2	0.149

(Continued)

TABLE 2 Continued

		M	SD	p-value
	yes	17.0	4.3	
Search NSSI content for pleasure	no	16.2	4.2	0.195
	yes	17.6	4.0	
Search NSSI content for need to belong to a group	no	16.1	4.3	0.063
	yes	17.7	3.6	
Search NSSI content to learn how to do it	no	15.9	4.2	**<0.001**
	yes	18.7	3.4	
Search NSSI content for popularity	no	16.3	4.2	0.842
	yes	16.0	4.0	
Search NSSI content for Other reasons	no	16.4	4.2	0.518
	yes	15.8	4.3	
Follow NSSI inherent pages	no	15.7	4.2	0.189
	yes	17.1	5.1	
Knowledge about Blue Whale challenge	no	16.0	4.8	0.762
	yes	15.7	4.2	

In bold significant p-values. NSSI, Non-Suicidal Self-Injury; BMAS, Bergen Social Media Addiction Scale.
M, mean; SD, Standard deviation.

older ($p = 0.002$), with higher educational level ($p = 0.005$) and they were older when they first searched NSSI-related contents on SNS ($p < 0.001$). Participants who manifested NSSI conduct scored significantly higher at the BMAS ($p < 0.001$) and FoMOs ($p < 0.001$) total scores. At the same time, subjects who currently practice NSSI declared to use much more likely BeReal ($p = 0.012$) and less frequently Facebook ($p = 0.055$), they were mostly females ($p < 0.001$), search more for NSSI-related contents on SNS ($p < 0.001$), and declared to look for NSSI-related contents on SNS more likely to be part of a group ($p = 0.0025$) and to learn how to practice NSSI ($p = 0.025$) and are mostly constituted by subjects with a PSMU ($p < 0.001$). Participants who currently practice NSSI to punish themselves ($p = 0.011$) or subjects who bite themselves ($p = 0.022$) or tear their hair out ($p = 0.025$) scored significantly higher at the BMAS total score, compared to their counterparts. Only subjects who perform NSSI by hitting themselves displayed a significantly lower educational level ($p < 0.001$) (Table 4).

According to the multivariate linear regression model, PSMU (as assessed by using BSMAS total score) was positively predicted by total score of the FoMOs ($B = 0.204$, $p < 0.001$) and from researching NSSI contents with the purpose of learning how to practice NSSI ($B = 2.225$, $p = 0.005$) ($R = 0.441$, $R2 = 0.195$, $F(2,185) = 22.359$, $p < 0.001$) (Table 5). According to another multivariate linear regression model, we found that FoMO (as assessed by using the FoMOs total score) was positively predicted by BMAS total score ($B=0.695$, $p<0.001$) and from using BeReal as predominant preferred SNS ($B = 2.657$, $p = 0.037$) ($R = 0.423$, $R2 = 0.179$, $F(2,185) = 20.101$, $p < 0.001$) (Table 6).

A logistic regression analysis was performed to ascertain the effects of FoMO, PSMU and socio-demographic and clinical characteristics on the likelihood of developing NSSI conducts. The logistic regression model was statistically significant, $\chi2(2) =$

54.503, $p < 0.001$. The model explained 40.8% (Nagelkerke R2) of the variance in subjects who commit NSSI and correctly classified 86.2% of cases. According to the logistic regression model, NSSI conducts were significantly predicted by using Snapchat (Exp(B) = 7.783; 95%IC = 1.061 - 57.09; $p = 0.044$) and by higher FoMO levels (Exp(B) = 1.162; 95%IC = 1.088 - 1.240; $p < 0.001$) and negatively predicted by male sex (Exp(B) = 0.065; 95%IC = 0.016 - 0.261; $p < 0.001$), higher educational level (Exp(B) = 0.778; 95%IC = 0.631 - 0.959; $p = 0.019$) and age at which NSSI-related contents were researched/looked for (Exp(B) = 0.770; 95%IC = 0.610 - 0.971; $p = 0.028$) (Table 7).

4 Discussion

To the best of our knowledge, our study provides significant insights into the relationship between social media use, engagement with NSSI-related content, and the prevalence of RSMCs among young adults. In particular, our findings clearly supported our research hypothesis about a potential role of a PSMU and/or FoMO as potential risk factors in increasing the chance to be engaged with NSSI-related contents and behaviors due to SNS use, particularly in those more vulnerable people. In fact, according to our findings, it seems that being attracted by looking for NSSI-related contents on SNS also increases the likelihood to develop a PSMU due to the need to have access to this type of information. Moreover, BeReal appeared to be the most predominant SNS platform able to elicit RSMCs, at least in our study.

One key-point observation from the study is the high prevalence of NSSI-related behaviors among the surveyed sample

TABLE 3 Socio-demographic and clinical characteristics of the sample stratified according to the FoMO.

		M	SD	p-value
Sex	males	29.5	7.4	0.380
	females	28.6	7.3	
Gender	cisgender people	29.1	7.0	0.378
	transgender people	28.7	10.0	
	non binary people	27.9	7.8	
Student	no	28.3	7.2	0.501
	yes	28.9	7.4	
Use Facebook	no	28.8	7.1	0.857
	yes	28.6	8.2	
Use Instagram	no	26.9	7.3	0.161
	yes	28.9	7.3	
Use TikTok	no	27.6	7.1	**0.002**
	yes	29.9	7.4	
Use Twitter	no	28.7	7.3	0.329
	yes	30.0	7.8	
Use BeReal	no	28.2	7.3	**0.002**
	yes	31.4	7.0	
Use Snapchat	no	28.7	7.3	0.426
	yes	30.4	6.9	
Use Other Social Media	no	28.7	7.3	0.873
	yes	28.9	7.5	
Search NSSI content	no	27.9	6.8	**0.031**
	yes	29.6	7.7	
Search NSSI content for Curiosity	no	30.1	8.1	0.313
	yes	29.0	7.3	
Search NSSI content for Seeking Help	no	29.1	7.8	0.200
	yes	30.6	7.4	
Search NSSI content for Pleasure	no	29.7	7.8	0.424
	yes	28.1	6.3	
Search NSSI content for Need to belong to a group	no	29.2	7.7	0.162
	yes	31.4	7.3	
Search NSSI content to Learn how to do it	no	29.1	7.7	0.054
	yes	32.1	7.1	
Search NSSI content for popularity	no	29.6	7.7	0.557
	yes	27.9	7.5	
Search NSSI content for Other reasons	no	29.8	7.8	0.246
	yes	27.8	6.9	
Follow NSSI inherent pages	no	28.6	7.3	0.078
	yes	31.7	7.4	

(Continued)

TABLE 3 Continued

		M	SD	p-value
Know Blue Whale challenge	no	30.5	8.8	0.289
	yes	28.6	7.2	

In bold significant p-values. NSSI, Non-Suicidal Self-Injury; FoMOs, Fear Of Missing Out - Scale.
M, mean; SD, Standard deviation.

(which indeed comes from the general population and not a clinical sample), with a substantial percentage of participants who declared a current regular engagement in NSSIs (around two third of the sample) or a previous history of NSSIs (around 85% of the sample). These results highlight the urgent need for targeted interventions and support mechanisms to address the underlying psychological distress and maladaptive coping strategies prevalent among our current youth generation (4). These findings are indeed consistent with previous research carried out during the post-COVID-19 era which demonstrated a 2-/3-fold increase in NSSI, particularly among youngsters (23–25). Among the main motivations to practice NSSIs declared by our sample, are listed the need 'to vent' or the 'self-punishment'. While as the most frequently reported NSSI means were reported (in order of frequency): 'hindering wound healing', biting, pinching, scratching themselves or getting cuts. Our findings reported that the female sex and having a lower education level seemed to represent the main socio-demographic risk factors for manifesting NSSIs in our sample of Italian young adults (8, 19).

Furthermore, in our study, almost all participants declared to fully know and to be aware about the 'Blue Whale Challenge' and other RSMCs, while more than half of the sample (mainly females, younger and with a higher educational level) declared to have looked for NSSI-related contents on SNS (particularly on TikTok), mostly for curiosity or for seek help/support (7, 8). Dramatically, the mean age declared by participants on their first use of SNS to look for NSSI-related content ranges from 12 to 16-years-old, being the lower age mainly represented by trans-gender and non-binary subjects and females, in line with previous published literature (24, 26–28). The main motivations for looking for NSSI-related contents appeared to be, according to our findings, mostly age-related, i.e. the lowest is the age of participant, the highest is the probability that the participant's declared motivation for looking for NSSI-related on SNS content is represented by the need to belong to a SNS-based peer group or the need to access to information on how to perform NSSIs (29, 30). However, only a minority of the sample (around 5%) declared to actively and regularly follow accounts posting NSSI-related contents on SNS.

Furthermore, the study found that both problematic social media use (PSMU) and fear of missing out (FoMO) seemed to act as significant predictors of youths' engagement on NSSI-related content on SNS and behaviors. Regarding the relationship between SNS and NSSI, in our study, we found that participants who declared a current NSSI conduct significantly displayed higher risk for the development of PSMU and FoMO. These findings appeared to be in line with previous published studies (31–33).

TABLE 4 Clinical characteristics of the sample regarding self-harm conducts.

		Count	%
Committed Self-injurious gestures in life	no	56	15.0%
	yes	317	85.0%
Practice actual self-injurious gestures	no	126	33.8%
	yes	247	66.2%
Self-harm to calm down	no	218	58.4%
	yes	155	41.6%
Self-harm to punish myself	no	261	70.0%
	yes	112	30.0%
Self-harm to ask for help	no	314	84.2%
	yes	59	15.8%
Self-harm to feel like I'm a part of a group	no	367	98.4%
	yes	6	1.6%
Self-harm to be popular	no	372	99.7%
	yes	1	0.3%
Self-harm to vent	no	180	48.3%
	yes	193	51.7%
Cutting	no	295	79.1%
	yes	78	20.9%
Scratching	no	288	77.2%
	yes	85	22.8%
Burn yourself	no	347	93.0%
	yes	26	7.0%
Bite yourself	no	269	72.1%
	yes	104	27.9%
Hit yourself	no	308	82.6%
	yes	65	17.4%
Hinder the healing of a wound	no	214	57.4%
	yes	159	42.6%
rubbing on the rough	no	326	87.4%
	yes	47	12.6%
Pinches	no	274	73.5%
	yes	99	26.5%

(Continued)

TABLE 4 Continued

		Count	%
Tear your hair	no	327	87.7%
	yes	46	12.3%
Needles	no	336	90.1%
	yes	37	9.9%
Ingest harmful substances	no	345	92.5%
	yes	28	7.5%
Other ways	no	318	85.3%
	yes	55	14.7%

Participants who declared to have looked for and/or who currently regularly look for NSSI-related contents on SNS are those subjects who displayed significantly higher BSMAS total scores and FoMOs total scores. The highest BSMAS total scores in this sub-sample are displayed by females and among those participants who declared to actively look for NSSI-related contents on SNS with the intention to access more information on NSSI and to learn means and methods to practice NSSI in real life. These findings potentially support the research hypothesis that PSMU and/or FoMO could exacerbate individuals' vulnerability to manifest NSSI conducts, among those who actively seek out NSSI-related contents on social media platforms (34, 35). These findings emphasize the role of social media in facilitating access to harmful content and shaping individuals' perceptions and behaviors, as previously already documented in more vulnerable people (36).

The association between specific social media platforms and engagement with NSSI content is also noteworthy. In fact, the logistic regression model clearly evidenced that NSSI conducts are significantly predicted by using SnapChat (OR=7.8) and having a FoMO (OR=1.2). Snapchat emerges as a significant predictor of NSSI behaviors, highlighting the need for targeted interventions on platforms popular among young adults. One could argue that Snapchat could probably emerge as a possible predictor for NSSIs because those subjects who use it are those who enjoy it for achieving more privacy that is not always guaranteed by other SNS. However, further studies should confirm our hypothesis and our findings in order to build targeted preventive interventions to specifically address SnapChat users at-risk for NSSI conducts. Conversely, according to our findings, being a male, having a higher educational level and an older age at the first time looking for NSSI-related contents on SNS seemed to act as possible protective factors for the development of NSSIs, as already documented in previous literature (28, 33).

Despite the abovementioned promising findings and the valuable insights provided into the association between social media use and engagement with NSSI content on SNS among young adults, it is necessary to be prudent before considering these findings generalizable to the clinical and other nonclinical samples, by carefully addressing and discussing all potential limitations. Firstly, while PSMU and FoMO appeared to be potentially associated with a higher risk to develop NSSI conducts, the cross-sectional design of the study did not allow to draw definitive conclusions regarding their causal relationship. Hence, further studies should carefully evaluate whether PSMU and/or FoMO are consequent or risky causal factors for the development of NSSI-related content behaviors and/or NSSI conducts. In fact, while individuals with higher levels of PSMU and FoMO could be more likely prone to seek out NSSI-related contents on SNS, it is equally plausible that those already predisposed to NSSI behaviors are drawn to such content regardless of their social media habits. Therefore, the directionality of the relationship between social media use and NSSI engagement remains a topic for further investigation, by implementing longitudinal studies. Secondly, the use of self-report assessment tools could potentially determine a response bias and inaccuracies in data collection, despite the anonymous data collection on the web could in turns predispose a higher participants' openness in providing relevant information on a particularly sensible topic such as NSSI. On the other hand, participants could have underreported or overreported their social media use and engagement with NSSI content due to social desirability bias or memory recall errors. Therefore, our findings should be adequately replicated also in clinical samples and by an in-person recruitment strategy, by also integrating the assessment tools with clinician-guided semi-structured interviews. Thirdly, our sample is represented by young adults (aged 18–24) coming from a representative sample of Italian young adults, mainly represented by females. Therefore, one could argue that our findings should be properly replicated by comparing all age groups with each other and by including a sex-balanced sample, in order to explore whether these findings are only age and/or sex-specific within the Italian general population. Fourthly, other variables have not been investigated, such as the age of the first use of smartphone, Internet, the family context and the use of these tools within the family members, the attachment style and other personality features of participants, cultural differences in social media use, attitudes towards mental health and the norms surrounding NSSI behaviors, as well as to screen the sample according to a previous and/or current history for a personal and/or family psychiatric disorder. Furthermore, our study lacks to fully investigate the role of potential 'protective factors', such as a concomitant psychotherapy and/or psychological support, the family context, other personality

TABLE 5 Multivariate Linear Regression with BSMAS total score (as dependent variable).

	B	SE	Beta	t	p-value
FoMOs total score	0.204	0.036	0.373	5.596	**<0.001**
Search NSSI contents on SNS to learn how to practice NSSI	2.225	0.776	0.191	2.866	**0.005**

SE, Standard Error; FoMOs, Fear of Missing Out - Scale; NSSI, Non-Suicidal Self-Injury; SNS, Social Networking Site.
In bold significant p-values.

TABLE 6 Multivariate Linear Regression with FoMOs total score (as dependent variable).

	B	SE	Beta	t	p-value
BMAS total score	0.695	0.123	0.380	5.653	**<0.001**
Using BeReal	2.657	1.265	0.141	2.101	**0.037**

SE, Standard Error; BMAS, Bergen Social Media Addiction Scale.
In bold significant p-values.

variables such as the level of interpersonal sensitivity, resilience, and so forth. Further studies should also assess and consider not only risky but also potential protective factors in the onset and maintenance of SNS-driven NSSI conducts. Lastly, while the study identifies certain social media platforms, such as Snapchat, as significant predictors of NSSI behaviors, it should be considered that social media platforms are extremely dynamic and constantly evolving, hence, these findings should be furtherly implemented and replicated over the time based on the emergence of new SNS and functionalities. Finally, another potential bias could be represented by the lack of replies to the questionnaire item assessing previous contacts with a mental health professional, which was a not mandatory item to be filled out, which did not receive a sufficient number of replies to be considered in our analysis. Therefore, a further study should also consider this variable in order to stratify the sample accordingly.

Overall, our study confirmed the complex interplay between social media use, NSSI-related content search on SNS, and engagement with NSSI conduct among youngsters. These findings could help in addressing focused preventive and treatment strategies that necessarily require a multifaceted age-tailored and sex-based approach that encompasses both individual-level interventions and structural changes to mitigate the harmful effects of social media on more vulnerable people (particularly, transgenders people, non-binary subjects, females and pre-adolescents). Further research is needed to explore the longitudinal effects of social media use, PSMU and FoMO on NSSI-related mental health outcomes and inform evidence-based interventions aimed at promoting positive online behaviors and reducing the occurrence of NSSI-related contents on SNS as well as the propensity to actively look for NSSI-related con rTMS on SNS and subsequently to increase the likelihood to drive more vulnerable youngsters towards the development of NSSI behaviors.

Future research should be implemented in order to better explore all various avenues (risky and protective factors) derived by our findings as discussed above. These include also investigating cultural influences on the use of SNS platforms both for looking for NSSI-related contents for curiosity and for learning how to practice them in real life. In this regard, another research direction should clearly provide a multicentric and multi-ethnic/cultural stratification sample able to stratify the risk in being engaged in NSSI-related contents and the consequent risk to determine NSSI conducts, considering also the country-based differences. Particularly, it would be interesting also to evaluate the 'migration effect' as well as the variable to belong to the next generation following a migratory flux in mediating the relationship between the quest for NSSI-related contents and the consequent risk to use these contents to incentivize NSSI conducts and/or suicidality. Moreover, another research direction should also include to clearly examine whether PSMU could act as predictor or rather a consequence of the behavior to actively look for NSSI-related contents in SNS, in order to better understand how to properly address preventive measures. Another research direction should clearly investigate the role of concomitant psychological and/or psychopathological conditions in predisposing youngsters towards the propensity to use SNS as a mean to cope with these states and consequently use SNS to look for NSSI-related contents with the aim to find a mean to manage distress and/or alleviate an anxiety and/or depressive condition. Furthermore, another research direction should carefully consider the role of sex orientation in depending and investigating the role of SNS in privately managing concomitant stigma-related psychological conditions in this vulnerable population, in order to develop specific preventive and supporting interventions and policies to prevent suicide and self-injury among youngest but also considering the LGBTQI+ population.

Overall, our findings confirmed the importance and the urgent need to fully understand the complex interplay between social motivations, psychological factors, and online behavior in predicting engagement of youngsters with NSSI-related contents and RSMCs. While this study sheds light on the intricate

TABLE 7 Binary logistic regression analysis predicting NSSI conducts.

	B	SE	Wald	df	p-value	Exp (B)	95% C.I. Exp (B)	
FoMOs total score	0.150	0.033	20.158	1	**<0.001**	1.162	1.088	1.240
Sex (Male)	-2.739	0.712	14.784	1	**<0.001**	0.065	0.016	0.261
Educational level	-0.252	0.107	5.525	1	**0.019**	0.778	0.631	0.959
Using Snapchat	2.052	1.017	4.074	1	**0.044**	7.783	1.061	57.090
Age at which NSSI content was first researched/watched on SNS	-0.261	0.119	4.859	1	**0.028**	0.770	0.610	0.971

SE, Standard Error; df, degree of freedom; C.I., Confidence Interval; FoMOs, Fear of Missing Out - Scale; NSSI, Non-Suicidal Self-Injury; SNS, Social Networking Site.
In bold values means significant p-values.

relationship between social media use and engagement with NSSI-related contents on SNS among youngsters, it also underscores the need for ongoing exploration and collaborative efforts to address the unpredictable challenges posed by digital platforms. By fostering digital literacy, implementing robust SNS content moderation, and providing accessible psychological and psychiatric SNS-driven supporting services, institutions and clinicians could potentially strive towards creating safer online environments promoting mental well-being. However, as all currently are invested and shaped by the ever-evolving, fluid and dynamic virtual landscape and dynamics between social media and mental health, one could argue that there is always an urgent need to investigate the techno-bio-psychosocial model of mental health considering not only the detrimental effect of technology and SNS but also its potentiality in shaping the future of mental health, posing innovation and a digital collective action as means to shape a more compassionate digital future for all.

Data availability statement

The datasets presented in this article are not readily available due to identification of sensible data. Requests to access the datasets should be directed to LO, l.orsolini@staff.univpm.it.

Ethics statement

The studies involving humans were approved by Local Institutional Review Board of the Department of Experimental and Clinical Medicine/DIMSC, Polytechnic University of Marche, Ancona, Italy (protocol code ACPS-D-21-00347, 28th September, 2021). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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References

1. Cipriano A, Cella S, Cotrufo P. Nonsuicidal self-injury: A systematic review. *Front Psychol.* (2017) 8:282818. doi: 10.3389/fpsyg.2017.01946

2. Lewis SP, Mahdy JC, Michal NJ, Arbuthnott AE. Googling self-injury: the state of health information obtained through online searches for self-injury. *JAMA Pediatr.* (2014) 168:443–9. doi: 10.1001/jamapediatrics.2014.187

3. Seko Y, Kidd SA, Wiljer D, McKenzie KJ. On the creative edge. *Qualitative Health Res.* (2015) 25(10):1334–46. doi: 10.1177/1049732315570134

4. Orsolini L, Volpe U, Albert U, Carmassi C, Carrà G, Cirulli F, et al. Use of social network as a coping strategy for depression among young people during the COVID-19 lockdown: findings from the COMET collaborative study. *Ann Gen Psychiatry.* (2022) 21:44. doi: 10.1186/s12991-022-00419-w

5. Sampogna G, Di Vincenzo M, Luciano M, Della Rocca B, Albert U, Carmassi C, et al. The effect of social media and infodemic on mental health during the COVID-19 pandemic: results from the COMET multicentric trial. *Front Psychiatry.* (2023) 14:1226414. doi: 10.3389/fpsyt.2023.1226414

6. Ward S, Dumas TM, Srivastava A, Davis JP, Ellis W. Uploading risk: examining the social profile of young adults most susceptible to engagement in risky social media challenges. *Cyberpsychol Behav Soc Netw.* (2021) 24:846–50. doi: 10.1089/cyber.2020.0846

7. De Luca L, Giletta M, Nocentini A, Menesini E. Non-suicidal self-injury in adolescence: the role of pre-existing vulnerabilities and COVID-19-related stress. *J Youth Adolesc.* (2022) 51:2383–95. doi: 10.1007/s10964-022-01669-3

8. Wang YJ, Li X, Ng CH, Xu DW, Hu S, Yuan TF. Risk factors for non-suicidal self-injury (NSSI) in adolescents: A meta-analysis. *eClinicalMedicine.* (2022) 46:101350. doi: 10.1016/j.eclinm.2022.101350

9. Serra G, Apicella M, Iannoni ME, Trasolini M, Andracchio E, Chieppa F, et al. Urgent psychiatric consultations for suicidal ideation and behaviors in Italian adolescents during different COVID-19 pandemic phases. *J Pers Med.* (2023) 13 (7):1112. doi: 10.3390/jpm13071112

10. Dong Y, Chen M, Wu Z, Zhang Z. Covid-19 psychological pressures, depression and FOMO: the mediating role of online social support and emotional regulation. *BMC Psychol.* (2024) 12:116. doi: 10.1186/s40359–024-01610–2

11. Dumas TM, Davis JP, Ellis WE. Is it good to be bad? A longitudinal analysis of adolescent popularity motivations as a predictor of engagement in relational aggression and risk behaviors. *Youth Soc.* (2019) 51:659–79. doi: 10.1177/0044118X17700319

12. Dumas TM, Davis JP, Maxwell-Smith MA, Bell A. From drinking group norms to individual drinking consequences: A moderated mediation model examining the role of members' Status, identification with the group and with emerging adulthood. *Subst Use Misuse.* (2018) 53:1311–23. doi: 10.1080/10826084.2017.1408651

13. Khasawneh A, Chalil Madathil K, Dixon E, Wiśniewski P, Zinzow H, Roth R. Examining the self-harm and suicide contagion effects of the blue whale challenge on youTube and twitter: qualitative study. *JMIR Ment Heal.* (2020) 7:e15973. doi: 10.2196/15973

14. Khasawneh A, Madathil KC, Zinzow H, Wisniewski P, Ponathil A, Rogers H, et al. An investigation of the portrayal of social media challenges on YouTube and Twitter. *Trans. Soc. Comput*. (2021) 4(1). doi: 10.1145/3444961.

15. World Health Organization (WHO). *Adolescence: A period needing special attention. Health for the World's adolescents report*. Geneva: World Health Organization (2014).

16. World Health Organization. WHO handbook for guideline development. World Health Organization (2014).

17. Monacis L, De Palo V, Griffiths MD, Sinatra M. Social networking addiction, attachment style, and validation of the Italian version of the Bergen Social Media Addiction Scale. *J Behav Addict*. (2017) 6:178–86. doi: 10.1556/2006.6.2017.023

18. Griffiths M. A 'components' model of addiction within a biopsychosocial framework. *J Subst Use*. (2005) 10:191–7. doi: 10.1080/14659890500114359

19. Bányai F, Zsila Á, Király O, Maraz A, Elekes Z, Griffiths MD, et al. Problematic social media use: results from a large-scale nationally representative adolescent sample. *PLoS One*. (2017) 12:e0169839. doi: 10.1371/journal.pone.0169839

20. Casale S, Fioravanti G. Factor structure and psychometric properties of the Italian version of the fear of missing out scale in emerging adults and adolescents. *Addict Behav*. (2020) 102:106179. doi: 10.1016/j.addbeh.2019.106179

21. Can G, Satici SA. Adaptation of fear of missing out scale (FoMOs): Turkish version validity and reliability study. *Psicol Reflexão e Crítica Rev Semest do Dep Psicol da UFRGS*. (2019) 32(1):3. /pmc/articles/PMC6967379/. doi: 10.1186/s41155-019-0117-4

22. Klonsky ED, Glenn CR. Assessing the functions of non-suicidal self-injury: psychometric properties of the inventory of statements about self-injury (ISAS). *J Psychopathol Behav Assess*. (2009) 31:215–9. doi: 10.1007/s10862-008-9107-z

23. Turner BJ, Robillard CL, Ames ME, Craig SG. Prevalence and correlates of suicidal ideation and deliberate self-harm in Canadian adolescents during the coronavirus disease 2019 pandemic. *Can J Psychiatry*. (2022) 67:403–6. doi: 10.1177/07067437211036612

24. De Luca L, Pastore M, Palladino BE, Reime B, Warth P, Menesini E. The development of Non-Suicidal Self-Injury (NSSI) during adolescence: A systematic review and Bayesian meta-analysis. *J Affect Disord*. (2023) 339:648–59. doi: 10.1016/j.jad.2023.07.091

25. Deng H, Zhang X, Zhang Y, Yan J, Zhuang Y, Liu H, et al. The pooled prevalence and influential factors of non-suicidal self-injury in non-clinical samples during the COVID-19 outbreak: A meta-analysis. *J Affect Disord*. (2023) 343:109–18. doi: 10.1016/j.jad.2023.09.036

26. Liu RT, Sheehan AE, Walsh RFL, Sanzari CM, Cheek SM, Hernandez EM. Prevalence and correlates of non-suicidal self-injury among lesbian, gay, bisexual, and transgender individuals: A systematic review and meta-analysis. *Clin Psychol Rev*. (2019) 74:101783. doi: 10.1016/j.cpr.2019.101783

27. Surace T, Fusar-Poli L, Vozza L, Cavone V, Arcidiacono C, Mammano R, et al. Lifetime prevalence of suicidal ideation and suicidal behaviors in gender non-conforming youths: a meta-analysis. *Eur Child Adolesc Psychiatry*. (2021) 30:1147–61. doi: 10.1007/s00787–020-01508–5

28. Kim H, Jhon M, Kim JW, Kang HJ, Ryu S, Kim SY, et al. Suicide and non-suicidal self-injury from internet addiction among Korean adolescents. *Soa Chongsonyon Chongsin Uihak*. (2023) 34:152–8. doi: 10.5765/jkacap.230015

29. Bello I, Rodríguez-Quiroga A, Quintero J. Suicidal and self-harm behavior in adolescents, an unsolved problem. A comprehensive review. *Actas Esp Psiquiatr*. (2023) 51:10–20.

30. Zubair UM, Khan MKM, Albashari MM. Link between excessive social media use and psychiatric disorders. *Ann Med Surg*. (2023) 85:875–8. doi: 10.1097/MS9.0000000000000112

31. Cheek SM, Reiter-Laver T, Goldston DB. Social rejection, popularity, peer victimization, and self-injurious thoughts and behaviors among adolescents: A systematic review and meta-analysis. *Clin. Psychol Rev*. (2020) 82:101936. doi: 10.1016/j.cpr.2020.101936

32. Dam VAT, Dao NG, Nguyen DC, Vu TMT, Boyer L, Auquier P, et al. Quality of life and mental health of adolescents: Relationships with social media addiction, Fear of Missing out, and stress associated with neglect and negative reactions by online peers. *PloS One*. (2023) 18:e0286766. doi: 10.1371/journal.pone.0286766

33. McEvoy D, Brannigan R, Cooke L, Butler E, Walsh C, Arensman E, et al. Risk and protective factors for self-harm in adolescents and young adults: An umbrella review of systematic reviews. *J Psychiatr Res*. (2023) 168:353–80. doi: 10.1016/j.jpsychires.2023.10.017

34. da Silva Bandeira BE, Dos Santos Júnior A, Dalgalarrondo P, de Azevedo RCS, Celeri EHVR. Nonsuicidal self-injury in undergraduate students: a cross-sectional study and association with suicidal behavior. *Psychiatry Res*. (2022) 318:114917. doi: 10.1016/j.psychres.2022.114917

35. McEvoy D, Brannigan R, Walsh C, Arensman E, Clarke M. Identifying high-risk subgroups for self-harm in adolescents and young adults: A longitudinal latent class analysis of risk factors. *J Affect Disord*. (2024) 351:40–8. doi: 10.1016/j.jad.2024.01.230

36. Jarvi SM, Swenson LP, Batejan KL. Motivation for and use of social networking sites: Comparisons among college students with and without histories of non-suicidal self-injury. *J Am Coll Health*. (2017) 65:306–12. doi: 10.1080/07448481.2017.1312410

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The role of Theory of Mind in the transition towards suicidal attempts in youth NSSI: an exploratory pilot study

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Non-suicidal self-injury (NSSI) can both precede and co-occur with suicidal attempts (SA). Underlying mechanisms/factors leading to the transition to SA in NSSI youths have been proposed (including the role of social cognition), despite they should be yet confirmed. Therefore, the study aims at exploring the role of the Theory of Mind in the differentiation of a sample of NSSI youngsters (aged 15-24) according to the presence of SA. We divided the sample into 4 groups using the Deliberate Self Harm Inventory (DSHI) and Columbia Suicide Severity Rating Scale (C-SSRS): control group (notNSSInotSA), NSSI without SA (NSSInotSA), NSSI with SA (NSSIplusSA), and SA without NSSI (SAonly). NSSIplusSA patients displayed higher Reading the Mind in the Eyes Test (RMET) scores (indicative of ToM abilities) than both the NSSInotSA (p=0.0016) and SAonly groups (p=0.0198), while SAonly patients showed lower RMET scores compared to the control group (p=0.0214). Multiple regression models used to differentiate NSSInotSA and NSSIplusSA found a significant association between RMET and LOSCS-CSC (Level Of Self-Criticism Scale-Comparative Self-Criticism) (pC=0.0802, pD=0.0016, pG=0.0053). Our findings supported the hypothesis that a hypertrophic affective ToM may possibly be associated with the occurrence of SA in youth NSSI. Further larger and longitudinal studies should confirm these preliminary findings, by exploring all social cognition dimensions.

1 Introduction

Non-suicidal self-injury (NSSI) consists in the use of non-lethal, self-aimed, deliberate behaviours leading to the destruction of one's own body tissue, in the absence of the aim to end one's life (1). It commonly manifests during early adolescence, with an average age of onset between 13 and 16-years-old (2), an age characterised by drastic changes and stressors that can notably facilitate the emergence of personal vulnerabilities and maladaptive strategies. Recent meta-analytic work stated how the occurrence of NSSI behaviour during development shows an initial increase in correspondence of early adolescence, followed by a peak and a subsequent decline (3). Reported data sums up to a relatively high prevalence in this population, estimated to be 16% (4), and, as such, NSSI is identified as a major public health concern (5, 6), even more so as it associates with different negative outcomes, including suicidal behaviours (7). Suicidal behaviours are defined as nonfatal suicidal thoughts and behaviours and classified as a) suicide ideation, the presence of thoughts of ending one's life; b) suicide plans, the formulation of a specific method to do so; c) suicide attempts (SA), which refer to potentially self-injurious behaviours in which there is at least some intent, overt or inferred, to die (8). These behaviours are well-known harbingers of suicide death in youths, that represent the fourth leading cause of death among 15-19 year olds worldwide (9, 10), with reported global suicide rate amounting to 3.8 per 100,000 people among adolescents (11).

Overall, NSSI can co-occur and precede SA. In fact, 70% of youths with NSSI reported a positive history of at least one SA and a SA risk 3-fold higher than youths without NSSI (12). Therefore, NSSI has been identified as one of the strongest predictors of SA by both cross-sectional and longitudinal studies (13, 14). Despite vast literature on the matter, the etiopathogenesis underpinning this association has yet to be clarified (15, 16). Some neurobiological studies highlighted the role of emotional intelligence and emotional dysregulation (17). Other works have theorised possible facilitating mechanisms underlying both phenomena. Since NSSI was associated with higher lethality of suicide attempts (18), it was theorised that pain desensitisation induced by NSSI could facilitate the enactment of suicidal thoughts (19, 20), leading to an acquired capability to commit SA (21, 22). Other studies hypothesised a psychopathological continuum of self-injurious behaviours with NSSI escalating in SA, particularly when associated with high psychological distress (23, 24). Finally, other authors proposed the role of shared risk factors and, particularly, the identification of specific psycho-social vulnerability domains shared by NSSI and SA (25–27).

In fact, literature seems to point out several areas that could underlie both phenomena, including depressive symptomatology (28–30), dissociative symptoms (31), impulsiveness (31–34), emotion identification (35, 36), expression (37, 38) and dysregulation (39–41), aggressivity and anger pervasiveness (42), feelings of worthlessness (43), and social reactivity (e.g., sensitivity to interpersonal rejection) (44, 45). Despite that, data on possible differences between NSSI and SA relative to these factors is relatively scarce, particularly in youths.

Therefore, our study aimed to investigate the role of a set of psychopathological dimensions in distinguishing between NSSI youths with or without a lifetime history of SA. In particular, our primary aim was to investigate whether current social cognition could discriminate NSSI youths with or without SA, as previous studies suggested its impairment in suicidal attempters (46). Social cognition includes empathy (e.g., the ability to understand the mental states of others and responding to them with affective mobilisation) and the theory of the Mind (ToM), i.e. the ability to infer the emotional states of others based on social cues (47, 48). We specifically explored the affective component of ToM, referring to the understanding of feelings and emotions of others (46). We presume it has a role in suicidality shift in NSSI youths, as it can influence youth engagement in prosocial behaviour, and the development of effective interpersonal communication and interpersonal reactivity/vulnerability. Secondary outcomes investigated whether specific dysfunctional coping patterns, such as emotional dysregulation, anger rumination and self-criticism, could contribute to the development of SA in youth NSSI. Exploratory outcomes included the role of dissociation and alexithymia as precipitating and/or mediating agents for SA among at-risk NSSI youths. The final goal was to preliminarily explore in a sample of youths which variables could help to clinically stratify NSSI youths at-risk for SA, through a pilot study carried out in a real-world setting, ultimately leading to target-specific preventive and treatment programs.

2 Method

2.1 Study design and selection of participants

A retrospective chart-review study was carried out by recruiting all adolescent and young inpatients hospitalised at our Transition Psychiatry Inpatient Service, and outpatients afferent to our Transition Psychiatry Outpatient Service at the Unit of Clinical Psychiatry, University Hospital of Marche, Polytechnic University of Marche, Ancona (Italy), during the timeframe September 2020 to December 2023. A total of 72 patients were involved in this study. Written informed consent was obtained from the patients or their parents (when aged less than 18-year-old) after they were informed about the purpose of the study. Patients were retrospectively included in the study if they met the following inclusion criteria: a) aged 15-24; b) education level not lower than elementary school, to ensure ability to read and correctly interpret the proposed scales; c) absence of active psychotic symptomatology at the evaluation; d) signed informed consent for collecting and analysing clinical data for research purpose, collected during baseline assessment. Participants were excluded if they met one or more of the following: a) intellectual disability or cognitive impairment; b) diagnosis of organic mental disorder according to the DSM-5

criteria (49); c) being either under the influence of substances and/or alcohol at the moment of the evaluation; d) incomplete filled out questionnaires; e) linguistic difficulties (i.e., not Italian speaker or foreign without a sufficient ability to understand Italian language). Recruited patients had also the possibility to withdraw their participation without any clinical or therapeutic consequence. 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. The Institutional Review Board approved our study (Prot 32/2024). This research study was conducted retrospectively from data obtained for clinical purposes.

2.2 Measures

An *ad hoc* case report form was specifically designed and hetero-administered by the researchers to collect sociodemographic (e.g., age, ethnicity, marital status, living status, parental marital status, employment status, education level) and clinical data (e.g., personal and family psychiatric history). History of NSSI and SA was assessed through the administration by a trained clinician of the Italian version of the Deliberate Self-Harm Inventory (50, 51) and the Columbia–Suicide Severity Rating Scale (C-SSRS) (52). The DSHI is a 17-item behaviourally based questionnaire that identifies the manifestation of self-harm without conscious suicidal intent. Respondents answer whether or not they engaged in specific acts (dichotomous answer), by providing also frequency and time of onset. DSHI displays a Cronbach's alpha of 0.82, indicating high internal consistency. The DSHI showed adequate test-retest reliability over a period ranging from 2 to 4 weeks (50, 51). The C-SSRS is a clinician-administered questionnaire assessing suicidal risk, by evaluating both suicidal ideation and behaviour. The SA subscale is rated on a nominal scale that includes actual, aborted, and interrupted attempts, preparatory behaviours, nonsuicidal self-injurious behaviour (52).

Moreover, a set of assessment tools to investigate clinical and psychological dimensions were administered to all participants (listed below). All scales and questionnaires, even if self-administered, were compiled in the presence of healthcare personnel, in order to favour full engagement of the patients in the task.

Reading the Mind in the Eyes Test (RMET), used to assess affective ToM, is a 36- item that presents participants with photographs of a set of eyes and asks them to identify the emotion displayed from 4 choices. Total score ranges from 0 to 36, where a typical score is in the range 22-30 and < 22 indicates difficulties in emotion recognition. The validation study on the Italian version herein adopted confirmed internal consistency with a Cronbach's α of 0.605 (53, 54).

Difficulties in Emotion Regulation Strategies (DERS) is a widely-used measure to assess difficulties in emotion regulation. It consists of 36 self-report items on a 5-point Likert scale, with responses from 1 to 5, ranging from "almost never" to "almost always". Total scores range from 36 to 180, with higher scores suggesting greater problems with emotion regulation. The Italian version adopted in this study identifies the following subscales: Non-acceptance of emotional responses (Non-Acceptance), Difficulty engaging in distracting behaviours (Distracting), Impulse control difficulties (Impulse), Lack of emotional awareness (Awareness), Limited access to emotion regulation strategies (Strategies), Lack of emotional clarity (Clarity). The total score displays a high internal consistency (α = 0.90), as well each subscale presenting a Cronbach's α ranging from 0.74 to 0.88 (55, 56).

Anger Rumination Scale (ARS) assesses the tendency to focus attention on angry moods, on current anger-provoking situations and recall past anger episodes. The Italian version we adopted consists of a 13-item self-report tool rated on a 4-point Likert scale ranging from 1 to 4 ("almost never" to "almost always"). Total scores range from 13 to 52, with higher scores indicating higher tendency to dwell in anger rumination. An excellent internal consistency (α = 0.93) and a 1-month test-retest reliability of 0.77 was reported (57, 58).

Level Of Self-Criticism Scale (LOSCS) measures two dimensions of self-criticism: Comparative Self-Criticism (CSC) and Internalised Self-Criticism (ISC). The Italian version used in our study consists of a 22-item self-report questionnaire scored over a Likert scale from 1 ("not at all") to 7 ("very well"). Total scores range from 22 to 154, with higher scores linked to higher self-criticism. A good internal consistency was reported for both CSC (α = 0.81) and ISC (α = 0.87) (59, 60).

Dissociative Experiences Scale (DES-II) is a 28-item, self-report measure of the frequency of dissociative experiences such as derealisation, depersonalisation, absorption and amnesia. Total scores range from 0 to 100, where high levels of dissociation are indicated by scores of 30 or more. A high internal consistency (α = 0.94) was reported for the Italian version (61).

Toronto Alexithymia Scale (TAS-20) measures difficulty in identifying and describing emotions. It is a 20-item, self-administered questionnaire, scored 1 to 5, that comprises three scales: Difficulty Identifying Feelings (DIF), Difficulty Describing Feelings (DDF), and Externally Oriented Thinking (EOT). Total score ≤ 49 is negative for alexithymia, 50-60 equals to undetermined results whereas ≥ 61 indicates the presence of alexithymia. The Italian version reported a satisfactory Cronbach's α in community (0.75) and clinical population (0.82) (62, 63).

2.3 Statistical analysis

Participants were divided in four groups, according to DSHI and C-SSRS: a) subjects manifesting NSSI without previous history of SA (NSSInotSA); b) subjects manifesting both phenomena (NSSIplusSA); c) subjects manifesting SA without history of NSSI (SAonly); d) subjects without a history of NSSI nor SA (notNSSInorSA, acting as clinical control group). Subjects with NSSI were identified when a yearly frequency of NSSI > 5 events/year was reported at the DSHI. Subjects with SA were identified as those whose total sum of the C-SSRS Suicidal behaviours subscale

items "Total # of Attempts" and "Total # of interrupted" amounted at more than 1 attempt (Total# ≥ 1). Descriptive statistics were expressed as mean and standard deviation (SD) for the quantitative variables, after confirming normality of their distribution through Shapiro-Wilk test. Qualitative variables were presented in absolute frequency (n) and percentage (%). Association between qualitative variables and the distribution of the four groups under study were tested through χ2-tests. One-way analysis of variance (ANOVA) was performed to compare all continuous variables across the four groups and, whenever a statistically significant group effect was observed, differences between groups were further investigated through pairwise t-tests with pooled SD. P-values for pairwise t-tests were adjusted through the Benjamini & Hochberg method for p-value correction (64). Finally, quantitative variables showing group effect were tested for possible association with all others in respect to NSSI group differentiation through multiple linear regression models with two predictor variables, one of which was always the factor defining the belonging to either NSSInotSA or NSSIplusSA. All statistical analyses were performed using R Statistical Software (Version 4.3.3, R Core Team 2024).

3 Results

3.1 Socio-demographic and clinical features of the sample

All socio-demographic characteristics are summarised in Table 1. A total of 72 adolescents and young adults were consecutively assessed during the timeframe September 2020-December 2023. Most of the sample consisted of females (81.9%), without any significant difference across four groups (p=0.2587). The mean age was 17.7 years (SD=2.4), without significant differences across four groups (p=0.3971). χ2-test for the

inpatient/outpatient categories confirmed that patients with SA were more likely to have accessed our clinic through hospitalisation rather than outpatient treatment (p=0.0019). Among the studied sample, the most represented primary diagnosis was Bipolar Disorder (26.4%), followed by Personality Disorder (22.2%) and Depressive Disorder (19,4%), with Mood Disorders comprehensively amounting to more than 45% of the entire sample.

The χ2-test test revealed significant differences among the 4 groups regarding frequencies of primary diagnosis (p=0.0043). In particular, NSSInotSA patients showed a higher-than-expected frequency of Eating Disorder diagnosis than all other groups, whereas Depressive Disorder was underrepresented for this group of patients. Moreover, the notNSSInorSA subjects were more likely to be diagnosed with OCD, and less likely to present Bipolar Disorder than all others. According to DSHI, the NSSInotSA group significantly showed an earlier age of appearance of self-harming behaviours compared to NSSIplusSA (p=0.0275).

3.2 Psychopathological features of participants

ANOVA revealed a group effect for multiple of the analysed scales and subscales, as reported in Table 2. Pairwise t-tests were thus performed to verify statistical differences among pairs of the groups under study (Table 3).

Interestingly, NSSIplusSA patients displayed higher RMET scores than both the NSSInotSA and SAonly groups (respectively, p=0.0016 and p=0.0198), while SAonly patients showed lower RMET scores compared to the control group (p=0.0214).

DERS total scores were significantly higher in both NSSInotSA (p=0.0190) and NSSIplusSA (p=0.0250) compared to the control group, with a similar trend for the DERS Impulse subscale

TABLE 1 Socio-demographic features of the sample.

		nonNSSInorSA	NSSInotSA	NSSIplusSA	SAonly	TOTAL	TEST p-value
TOTAL Number (%)		21 (29.2%)	21 (29.2%)	20 (27.8%)	10 (13.9%)	72	
AGE Mean (SD)		18.29 (2.72)	17.33 (2.46)	17.25 (1.68)	18.30 (2.91)	17.72 (2.42)	0.3971
YEARS OF EDUCATION Mean (SD)		11.71 (2.28)	10.90 (1.55)	11.25 (2.36)	12.20 (2.10)	11.42 (2.09)	0.3673
ETHNICITY	**CAUCASIAN** Frequency (%)	20 (95.2%)	20 (95.2%)	17 (85.0%)	8 (80.0%)	65 (90.3%)	0.3545
	AFRICAN Frequency (%)	0 (0%)	1 (4.8%)	2 (10.0%)	0 (0%)	3 (4.2%)	
	SOUTH-AMERICAN Frequency (%)	0 (0%)	0 (0%)	1 (5.0%)	1 (10.0%)	2 (2.8%)	
	ASIAN Frequency (%)	1 (4.8%)	0 (0%)	0 (0%)	1 (10.0%)	2 (2.8%)	

(Continued)

TABLE 1 Continued

		nonNSSInorSA	NSSInotSA	NSSIplusSA	SAonly	TOTAL	TEST p-value
GENDER	**FEMALE** Frequency (%)	15 (71.4%)	18 (85.7%)	16 (80.0%)	10 (100.0%)	59 (81.9%)	0.2587
	MALE Frequency (%)	6 (28.6%)	3 (14.3%)	4 (20.0%)	0 (0%)	13 (18.1%)	
OCCUPATION	**STUDENT** Frequency (%)	17 (81.0%)	19 (90.5%)	17 (85.0%)	9 (90.0%)	62 (86.1%)	0.6787
	WORKER Frequency (%)	1 (4.8%)	0 (0%)	2 (10.0%)	0 (0%)	3 (4.2%)	
	UNEMPLOYED Frequency (%)	3 (14.3%)	2 (9.5%)	1 (5.0%)	1 (10.0%)	7 (9.7%)	
LIVINGSTATUS	**WITH FAMILY OF ORIGIN** Frequency (%)	19 (90.5%)	18 (85.7%)	19 (95.0%)	10 (100.0%)	66 (91.7%)	0.6536
	ALONE Frequency (%)	2 (9.5%)	1 (4.8%)	0 (0%)	0 (0%)	3 (4.2%)	
	WITH A PARTNER Frequency (%)	0 (0%)	1 (4.8%)	0 (0%)	0 (0%)	1 (1.4%)	
	FOSTER CARE Frequency (%)	0 (0%)	1 (4.8%)	1 (5.0%)	0 (0%)	2 (2.8%)	
PARENTALMARITALSTATUS	**LIVING TOGETHER** Frequency (%)	17 (81.0%)	14 (66.7%)	13 (65.0%)	6 (60.0%)	50 (69.4%)	0.3312
	SEPARATED/ DIVORCED Frequency (%)	2 (9.5%)	6 (28.6%)	7 (35.0%)	4 (40.0%)	19 (26.4%)	
	WIDOWED Number (%)	2 (9.5%)	1 (4.8%)	0 (0%)	0 (0%)	3 (4.2%)	
TYPE	**INPATIENT** Number (%)	7 (33.3%)	12 (57.1%)	15 (75.0%)	10 (100.0%)	44 (61.1%)	**0.0019**
	OUTPATIENT Number (%)	14 (66.7%)	9 (42.9%)	5 (25.0%)	0 (0%)	28 (38.9%)	
DIAGNOSIS	**NONE** Number (%)	1 (4.8%)	0 (0%)	1 (5.0%)	0 (0%)	2 (2.8%)	**0.0043**
	PSYCHOTIC Number (%)	0 (0%)	0 (0%)	1 (5.0%)	0 (0%)	1 (1.4%)	
	BIPOLAR Number (%)	2 (9.5%)	6 (28.6%)	8 (40.0%)	3 (30.0%)	19 (26.4%)	
	DEPRESSIVE Number (%)	6 (28.6%)	1 (4.8%)	5 (25.0%)	2 (20.0%)	14 (19.4%)	
	ANXIETY Number (%)	2 (9.5%)	1 (4.8%)	0 (0%)	0 (0%)	3 (4.2%)	
	OCD Number (%)	6 (28.6%)	0 (0%)	0 (0%)	0 (0%)	6 (8.3%)	
	PTSD Number (%)	2 (9.5%)	1 (4.8%)	1 (5.0%)	2 (20.0%)	6 (8.3%)	
	EATING DISORDER Number (%)	0 (0%)	5 (23.8%)	0 (0%)	0 (0%)	5 (6.9%)	

(Continued)

TABLE 1 Continued

		nonNSSInorSA	NSSInotSA	NSSIplusSA	SAonly	TOTAL	TEST p-value
	PERSONALITY DISORDER Number (%)	2 (9.5%)	7 (33.3%)	4 (20.0%)	3 (30.0%)	16 (22.2%)	
FAMILYHISTORYOFPSYCHIATRICDISORDER	**NONE** Number (%)	9 (42.9%)	10 (47.6%)	11 (55.5%)	5 (50.0%)	35 (48.6%)	0.5788
	PSYCHOTIC Number (%)	0 (0%)	0 (0%)	2 (10.0%)	0 (0%)	2 (2.8%)	
	BIPOLAR Number (%)	2 (9.5%)	0 (0%)	1 (5.0%)	0 (0%)	3 (4.2%)	
	DEPRESSIVE Number (%)	1 (4.8%)	5 (23.8%)	2 (10.0%)	2 (20.0%)	10 (13.9%)	
	ANXIETY Number (%)	3 (14.3%)	1 (4.8%)	0 (0%)	1 (10.0%)	5 (6.9%)	
	OCD Number (%)	1 (4.8%)	0 (0%)	0 (0%)	0 (0%)	1 (1.4%)	
	PTSD Number (%)	0 (0%)	1 (4.8%)	0 (0%)	0 (0%)	1 (1.4%)	
	EATING DISORDER Number (%)	2 (9.5%)	1 (4.8%)	0 (0%)	0 (0%)	3 (4.2%)	
	SUBSTANCE USE DISORDER Number (%)	0 (0%)	1 (4.8%)	2 (10.0%)	1 (10.0%)	4 (5.6%)	
	PERSONALITY DISORDER Number (%)	3 (14.3%)	2 (9.5%)	2 (10.0%)	1 (10.0%)	8 (11.1%)	

In bold significant p-values.

TABLE 2 Psychometric features of the sample and across all four groups.

VARIABLE		nonNSSInorSA	NSSInotSA	NSSIplusSA	SAonly	Total	ANOVA p-value
RMET	Mean	23.62	22.43	25.05	20.60	23.25	**0.0016**
	SD	3.37	2.66	3.14	2.46	3.27	
LOSCS-ISC	Mean	39.67	56.76	49.00	52.70	49.06	**0.0008**
	SD	14.03	10.47	14.35	13.22	14.46	
LOSCS-CSC	Mean	44.48	62.52	53.70	50.10	53.08	**0.0005**
	SD	14.53	8.32	15.53	13.30	14.68	
LOSCS	Mean	84.14	117.86	104.05	102.80	102.10	**0.0004**
	SD	27.40	17.34	26.77	24.06	27.04	
ARS	Mean	27.67	38.86	34.40	34.80	33.79	**0.0018**
	SD	8.81	7.30	9.41	11.39	9.79	
DES-II	Mean	23.57	43.76	36.30	47.70	36.35	**0.0053**
	SD	17.62	16.97	21.50	29.81	22.08	
TAS-20 - DIF	Mean	21.76	23.33	25.60	21.40	23.24	0.1670
	SD	6.61	6.51	4.32	6.79	6.15	

(Continued)

TABLE 2 Continued

VARIABLE		nonNSSInorSA	NSSInotSA	NSSIplusSA	SAonly	Total	ANOVA p-value
TAS-20 - DDF	Mean	16.48	17.48	18.20	18.80	17.57	0.3035
	SD	3.91	3.47	3.85	2.57	3.63	
TAS-20 - EOT	Mean	20.43	21.67	23.05	21.70	21.69	0.3193
	SD	4.06	4.40	5.13	3.68	4.46	
TAS-20 Total	Mean	58.05	62.19	67.80	62.80	62.63	**0.0191**
	SD	9.37	9.76	9.60	9.80	10.11	
DERS - Non-Acceptance	Mean	15.86	21.33	20.60	16.60	18.88	**0.0423**
	SD	6.21	7.09	7.21	8.28	7.33	
DERS - Distracting	Mean	16.52	21.81	19.90	16.40	18.99	**0.0027**
	SD	5.57	4.06	4.29	6.24	5.35	
DERS - Impulse	Mean	15.95	22.90	22.00	17.90	19.93	**0.0075**
	SD	7.42	6.56	6.42	8.39	7.53	
DERS - Awareness	Mean	17.24	18.95	18.35	16.70	17.97	0.5733
	SD	4.94	5.07	4.85	5.38	4.98	
DERS - Strategies	Mean	25.29	29.90	30.80	26.00	28.26	0.0671
	SD	6.65	7.00	7.06	10.68	7.75	
DERS - Clarity	Mean	7.57	9.90	9.60	8.90	9.00	0.0784
	SD	2.91	2.95	3.25	3.35	3.17	
DERS Total	Mean	107.52	134.10	131.35	111.30	122.42	**0.0070**
	SD	25.08	26.59	24.85	40.97	30.00	

NSSI, non-suicidal self-injury; SA, suicidal attempts; RMET, Reading the Mind in the Eyes Test; LOSCS, Level Of Self-Criticism Scale; ISC, Internalised Self-Criticism; CSC, Comparative Self-Criticism; ARS, Anger Rumination Scale; DES-II, Dissociative Experiences Scale-II; TAS-20, Toronto Alexithymia Scale-20 items; DERS, Difficulties in Emotion Regulation Strategies. In bold significant p-values.

(p=0.0130 and p=0.0230 respectively). The DERS Distracting subscale showed significantly higher scores only in the NSSInonSA group compared to the control group (p=0.0053) and SAonly (p=0.0170).

ARS scores reported a significant difference between NSSInotSA and nonNSSInorSA (p=0.0008), with the former showing higher scores.

A similar trend emerged regarding the CSC subscale of LOSCS, with the NSSInotSA group presenting higher scores compared to notNSSInorSA (p=0.0002) and SAonly (p=0.0498). Interestingly,

the p-value between the two NSSI groups for this subscale is barely above statistical significance (p=0.0532). The LOSCS scale itself evidenced higher values for both NSSI groups in respect to the control one (p=0.0002 and p=0.0315), whereas the ISC subscale reported all clinical groups with higher scores than the controls (p=0.0004 for NSSInonSA, p=0.0508 for NSSIplusSA, p=0.0347 for SAonly).

Regarding exploratory variables, significantly higher DES-II scores were found in both NSSInotSA (p=0.0097) and SAonly groups (p=0.0097), compared to the control group. Higher TAS-

TABLE 3 Pairwise t-tests results showing significant differences of test results among the four groups.

	NSSIplusSA	NSSIplusSA	NSSIplusSA	NSSInotSA	NSSInotSA	SAonly
	notNSSInorSA	NSSInotSA	SAonly	notNSSInorSA	SAonly	notNSSInorSA
RMET	0.1568	**0.0198**	**0.0016**	0.2019	0.1568	**0.0214**
DERS	**0.0250**	0.7550	0.1040	**0.0190**	0.7600	0.7550
DERS - Non-Acceptance	0.1050	0.7850	0.2220	0.0850	0.1700	0.7850
DERS - Distracting	0.0634	0.2629	0.1065	**0.0053**	**0.0170**	0.9480

(Continued)

TABLE 3 Continued

	NSSIplusSA	NSSIplusSA	NSSIplusSA	NSSInotSA	NSSInotSA	SAonly
	notNSSInorSA	NSSInotSA	SAonly	notNSSInorSA	SAonly	notNSSInorSA
DERS - Strategies	0.1300	0.8100	0.2100	0.1500	0.8100	0.2700
DERS - Impulse	**0.0230**	0.6820	0.2070	**0.0130**	0.1380	0.5690
DERS - Clarity	0.1200	0.7500	0.6700	0.1000	0.6000	0.5300
ARS	0.0569	0.1744	0.9086	**0.0008**	0.1744	0.0844
LOSCS	**0.0315**	0.1085	0.8943	**0.0002**	0.1322	0.0977
LOSCS-ISC	0.0508	0.0924	0.4673	**0.0004**	0.4673	**0.0347**
LOSCS-CSC	**0.0532.**	**0.0532.**	0.4825	**0.0002**	**0.04980**	0.3241
DES-II	0.1032	0.2994	0.2352	**0.0097**	0.6197	**0.0097**
TAS-20	**0.0110**	0.1980	0.2430	0.2430	0.2430	0.2430

NSSI, non-suicidal self-injury; SA, suicidal attempts; RMET, Reading the Mind in the Eyes Test; DERS, Difficulties in Emotion Regulation Strategies; ARS, Anger Rumination Scale; LOSCS, Level Of Self-Criticism Scale; ISC, Internalised Self-Criticism; CSC, Comparative Self-Criticism; DES-II, Dissociative Experiences Scale-II; TAS-20, Toronto Alexithymia Scale-20 items. In bold significant p-values.

20 total scores were observed in NSSIplusSA compared to the control group (p=0.0110).

Multiple regression models were run to differentiate NSSInotSA and NSSIplusSA considering multiple variables (Table 4). Those that had a significant general p-value (pG, thus being good representation of the data), as well as statistically significant p-values for association between the two variables taken into account (pA) and for the differentiation between the NSSInonSA and NSSIplusSA groups (pD) are the following: a) LOSCS - CSC associated with TAS-20//DDF (pC=0.0138, pD=0.0105, pG=0.0043); b) LOSCS - CSC associated with DERS (pC=0.0004, pD=0.0188, pG=0.0002); c) TAS-20 associated with DERS (pC=2^{-5}, pD=0.0137, pG=2^{-5}); d) RMET associated with LOSCS - CSC (pC=0.0802, pD=0.0016, pG=0.0053).

TABLE 4 Multivariate Regression models statistically significative for differentiation between NSSInonSA and NSSIplusSA.

	Variables	Estimate	SE	t	F	p
LOSCS-CSC	Intercept	39.7114	9.1890	4.3220		**0.0001**
	TAS-20-DDF	1.3053	0.5056	2.5820		**0.0138**
	Groups	-9.7686	3.6293	-2.6920		**0.0105**
	Model				6.318	**0.0043**
LOSCS-CSC	intercept	28.0051	9.1147	3.0730		**0.0039**
	DERS	0.25742	0.0658	3.9150		**0.0004**
	Groups	-8.1171	3.3096	- 2.4530		**0.0189**
	Model				11.2300	**0.0002**
TAS-20	intercept	31.1238	6.6572	4.6750		**3.64^{-5}**
	DERS	0.2317	0.0480	4.8240		**2.3^{-5}**
	Groups	6.24553	2.4173	2.5840		**0.0137**
	Model				14.3400	**2.23^{-5}**
RMET	intercept	18.3244	2.3651	7.748		**2.45^{-9}**
	LOSCS-CSC	0.0656	0.0365	1.7970		0.0802
	Groups	3.200	0.9384	3.411		**0.0016**
	Model				6.0380	**0.0053**

NSSI, non-suicidal self-injury; SA, suicidal attempts; RMET, Reading the Mind in the Eyes Test; DERS, Difficulties in Emotion Regulation Strategies; LOSCS, Level Of Self-Criticism Scale; CSC, Comparative Self-Criticism; DES-II, Dissociative Experiences Scale-II; TAS-20, Toronto Alexithymia Scale-20 items. In bold significant p-values.

4 Discussion

The current study aims to identify a set of psychopathological dimensions between young subjects who manifest only NSSI versus those who display both NSSI and SA, to investigate which vulnerability factors could help stratifying the population of NSSI youths with respect to the risk of presentation of suicidal acts. Our primary objective was to investigate the association between the affective component of ToM and suicidality in a sample presenting NSSI or not. Our findings revealed that NSSIplusSA patients displayed statistically significant higher RMET scores compared to both the NSSInotSA and SAonly groups, while the SAonly group displayed lower scores when compared to the control group. These preliminary findings could potentially suggest that a higher affective ToM may share a distinct, significant relation with suicidality within youth NSSI. Indeed, one could argue that ToM could display different patterns across the lifespan (65) and even more so during adolescence: core features of ToM continue to develop as youngsters are faced with increasingly complex social situations amidst their brain development. Thus, in this paper we hypothesise that a hypertrophic ToM should be further explored as an age-specific marker of suicidality shift within NSSI youths: those with an hypermentalising asset tend to over-interpret information from their social environment about others' mental states (66, 67). A higher ToM could be maladaptive for interpersonal functioning as it may lead NSSI youths to potentially mistakenly interpret rejection, abandonment or criticism, exacerbating beliefs of burdensomeness and/or lack of connectedness. This could contribute to excessive interpersonal reactivity and social distress, which in turn could determine the transition to suicidal acts. Our findings were also supported by a previous study (68). Interestingly, lower scores at RMET seem to characterise the SAonly group in our sample. This data is coherent with previous literature (36) that suggested how inaccurate mentalising patterns such as lack in others' emotion recognition seems to be associated with suicidal behaviours. This possibly suggests the presence of different triggering mechanisms and/or underpinned afflictions determining SA in youths with or without NSSI.

A recent meta-analytic work comparing subjects with eating disorders (ED) and NSSI with both a clinical and a healthy control group, found a higher NSSI prevalence in ED subjects, without identifying any significant group-differences on SA (69). Despite our small sample, our findings also partially confirmed this meta-analysis, even though we found a higher comorbid ED diagnosis only in NSSInotSA but not in the NSSIplusSA group. Our results could suggest the possible presence of different subtypes of NSSInjurers, where self-harm as whole could hold a separate meaning and as such it could imply a different likelihood of SA co-occurrence or development. Indeed, these findings should need further replication studies.

Regarding the potential discrimination through dysfunctional coping patterns between the two NSSI groups, our findings did not find any relevant differences in emotional dysregulation dimension. Both NSSInotSA and NSSIplusSA showed significantly higher DERS scores compared to the control group, which is consistent with previous published literature. An association between NSSI and emotion regulation difficulties has been clearly confirmed (40), with NSSI being historically identified as a possible maladaptive strategy to modulate intense emotional reactions (70). Studies on SA and emotion dysregulation, instead, showed contrasting findings (41, 71, 72). Similarly, significant differences regarding the anger-type rumination dimension were not observed, as it resulted significantly higher in all three clinical groups. These findings are consistent with previous literature which supported the presence of a predominant ruminative thought pattern within both NSSI and SA, with self-injury acting as a maladaptive strategy to discontinue highly intensive ruminative cycles (73, 74), particularly in more potentially harmful or dreadful SA (42, 75, 76). Furthermore, interesting findings were observed in the self-criticism dimension, which could partially be associated with those derived by our primary outcome. Although our results observed significantly higher LOSCS scores for both NSSI groups compared to the control group, when we investigated the CSC subscale we found significantly higher scores within NSSInotSA and a subthreshold trend discriminating between two NSSI groups is observed. Indeed, aberrant self-criticism has been described as a facilitator for the development of NSSI and SA (15, 43) as NSSI may represent a sort of self-punishment in response to worthlessness ideation (77, 78), whereas specific types of self-criticism, such as the feeling of an inadequate self with tendency to perfectionism, have been found to increase likelihood of suicidality, both in adult and adolescent samples.

Furthermore, findings relative to exploratory variables warrant for further investigation of dissociative symptomatology. Previous literature already documented the role of dissociative symptomatology in youths with history of NSSI and SA (31, 79), but no discrimination between the NSSI groups (NSSInotSA and NSSIplusSA) was ever suggested. It was proposed that NSSI could act as an "anti-dissociative" (80), while other researchers suggested the presence of a dissociative subtype of NSSI in which self-harm could have a "pro-dissociative function", as physical pain could facilitate emotional and mental distress anaesthesia (81). Interestingly, the latter has been associated with a shorter shift towards SA (82) and dissociation was suggested as SA facilitator, as it could favour numbness to physical pain and disconnection from one's body (83), a theory that has been also explored by a study using virtual reality (84). Our findings described significant higher DES-II scores in NSSInotSA and SAonly groups compared to the control group, whereas the NSSIplusSA group showed lower scores, hence suggesting a potential 'protective' role of dissociation regarding the presentation of SA among NSSI individuals exclusively. Thus, we suggest that a subtype of NSSI youths at higher risk of suicidality could be identified depending on dissociative dimension.

Overall, despite our exploratory pilot study shedding light on interesting findings, several limitations to the current work should be properly addressed. Firstly, the cross-sectional design precludes causal inferences between ToM and suicidality risk in youth NSSI. Secondly, the relatively small sample prevented us from comparing subgroups and may have invalidated statistical significance where

we clearly found a subthreshold trend discriminating between two NSSI groups. Numerosity is particularly relevant in this study as the sample has been divided in 4 groups, thus increasing it could help clarify some borderline situations and reduce statistical error. Moreover, our study did not investigate possible ToM variations determined by age, symptomatology, nor severity of illness. Ultimately, we relied on RMET to preliminarily explore potential variations of ToM: psychometric properties of the test have been recently debated (85), despite the Italian validation study confirming its validity (54). Hence, these limitations contribute to the aforementioned preliminary and pilot nature of the current study, which should be further strengthened by recruiting a larger sample size, including adult subjects, with longitudinal design and a full set of rigorous social cognition assessment tools.

Overall, current findings provide significant implications for future research directions, as well as for timely and target-specific clinical intervention for suicidality risk in youth NSSI. Our primary outcome suggested a role of affective component of ToM in suicidality enactment among NSSI youths. This should be extensively investigated in both clinical and neuroimaging studies, in addition to emotional intelligence, empathy and cognitive components of ToM, to define their role in interpersonal hyper-reactivity which could underpin higher risk to act suicide. Finally, interventional studies should also evaluate which social-cognitive interventions (such as mentalisation-based therapies, cognitive behavioural therapy, etc.) (86, 87) could effectively address this hypermentalising dimension in at-risk youths, possibly aiming at the reduction of social sensitivity-induced distress and implementation of more functional interpersonal strategies.

Data availability statement

The datasets presented in this article are not readily available because of identifiable participants' data. Requests to access the datasets should be directed to l.orsolini@staff.univpm.it.

Ethics statement

The studies involving humans were approved by Local Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

LO: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Methodology, Conceptualization. DC: Writing – original draft, Investigation, Formal analysis, Data curation. AC: Writing – review & editing, Investigation, Data curation. ER: Writing – review & editing, Supervision, Investigation, Data curation. GL: Resources, Writing – review & editing, Visualization. UV: Writing – review & editing, Visualization, Validation, Supervision.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. Cha CB, Nock MK. "Suicidal and nonsuicidal self-injurious thoughts and behaviors." In: Mash EJ, Barkley RA, editors. *Child psychopathology (3rd ed.)*. The Guilford Press (2014). pp. 317–42.

2. Muehlenkamp JJ, Xhunga N, Brausch AM. Self-injury age of onset: A risk factor for NSSI severity and suicidal behavior. *Arch Suicide Res*. (2018) 23:551–63. doi: 10.1080/13811118.2018.1486252

3. De Luca L, Pastore M, Palladino BE, Reime B, Warth P, Menesini E. The development of Non-Suicidal Self-Injury (NSSI) during adolescence: A systematic review and Bayesian meta-analysis. *J Affect Disord*. (2023) 339:648–59. doi: 10.1016/j.jad.2023.07.091

4. Farkas BF, Takacs ZK, Kollárovics N, Balázs J. The prevalence of self-injury in adolescence: a systematic review and meta-analysis. *Eur Child Adolesc Psychiatry*. (2023). doi: 10.1007/s00787-023-02264-y

5. Vega D, Sintes A, Fernández M, Puntí J, Soler J, Santamarina P, et al. Review and update on non-suicidal self-injury: who, how and why? *Actas espanolas psiquiatria*. (2018) 46:146–55.

6. Auerbach RP, Pagliaccio D, Allison GO, Alqueza KL, Alonso MF. Neural correlates associated with suicide and nonsuicidal self-injury in youth. *Biol Psychiatry*. (2021) 89:119–33. doi: 10.1016/j.biopsych.2020.06.002

7. Turner BJ, Austin SB, Chapman AL. Treating nonsuicidal self-injury: a systematic review of psychological and pharmacological interventions. *Can J Psychiatry Rev Can psychiatrie*. (2014) 59:576–85. doi: 10.1177/070674371405901103

8. Nock MK, Borges G, Bromet EJ, Cha CB, Kessler RC, Lee S. Suicide and suicidal behavior. *Epidemiol Rev*. (2008) 30:133–54. doi: 10.1093/epirev/mxn002

9. Hughes JL, Horowitz LM, Ackerman JP, Adrian MC, Campo JV, Bridge JA. Suicide in young people: screening, risk assessment, and intervention. *BMJ*. (2023) 381: e070630. doi: 10.1136/bmj-2022-070630

10. Chen PJ, Mackes N, Sacchi C, Lawrence AJ, Ma X, Pollard R, et al. Parental education and youth suicidal behaviours: a systematic review and meta-analysis. *Epidemiol Psychiatr Sci*. (2022) 31:e19. doi: 10.1017/S204579602200004X

11. Lovero KL, Dos Santos PF, Come AX, Wainberg ML, Oquendo MA. Suicide in global mental health. *Curr Psychiatry Rep*. (2023) 25:255–62. doi: 10.1007/s11920-023-01423-x

12. Nock MK, Joiner TE Jr, Gordon KH, Lloyd-Richardson E, Prinstein MJ. Non-suicidal self-injury among adolescents: diagnostic correlates and relation to suicide attempts. *Psychiatry Res*. (2006) 144:65–72. doi: 10.1016/j.psychres.2006.05.010

13. Asarnow JR, Porta G, Spirito A, Emslie G, Clarke G, Wagner KD, et al. Suicide attempts and nonsuicidal self-injury in the treatment of resistant depression in adolescents: findings from the TORDIA study. *J Am Acad Child Adolesc Psychiatry*. (2011) 50:772–81. doi: 10.1016/j.jaac.2011.04.003

14. Chesin MS, Galfavy H, Sonmez CC, Wong A, Oquendo MA, Mann JJ, et al. Nonsuicidal self-injury is predictive of suicide attempts among individuals with mood disorders. *Suicide life-threatening behavior*. (2017) 47:567–79. doi: 10.1111/sltb.12331

15. Poudel A, Lamichhane A, Magar KR, Khanal GP. Non suicidal self injury and suicidal behavior among adolescents: co-occurrence and associated risk factors. *BMC Psychiatry*. (2022) 22:96. doi: 10.1186/s12888-022-03763-z

16. Hamza CA, Stewart SL, Willoughby T. Examining the link between nonsuicidal self-injury and suicidal behavior: a review of the literature and an integrated model. *Clin Psychol review*. (2012) 32:482–95. doi: 10.1016/j.cpr.2012.05.003

17. Halicka J, Szewczuk-Bogusławska M, Adamska A, Misiak B. Neurobiology of the association between non-suicidal self-injury, suicidal behavior and emotional intelligence: A review. *Arch Psychiatry Psychother*. (2020) 22:25–35. doi: 10.12740/APP/117705

18. Andover MS, Gibb BE. Non-suicidal self-injury, attempted suicide, and suicidal intent among psychiatric inpatients. *Psychiatry Res*. (2010) 178:101–5. doi: 10.1016/j.psychres.2010.03.019

19. Anestis MD, Knorr AC, Tull MT, Lavender JM, Gratz KL. The importance of high distress tolerance in the relationship between nonsuicidal self-injury and suicide potential. *Suicide life-threatening behavior*. (2013) 43:663–75. doi: 10.1111/sltb.12048

20. Klonsky ED, Victor SE, Saffer BY. Nonsuicidal self-injury: what we know, and what we need to know. *Can J Psychiatry Rev Can psychiatrie*. (2014) 59:565–8. doi: 10.1177/070674371405901101

21. Joiner T. *Why people die by suicide*. New York: Harvard University Press (2005).

22. Stanley B, Gameroff MJ, Michalsen V, Mann JJ. Are suicide attempters who self-mutilate a unique population? *Am J Psychiatry*. (2001) 158:427–32. doi: 10.1176/appi.ajp.158.3.427

23. Cammisa L, Pacifici S, Fegatelli DA, Calderoni D, Fantini F, Ferrara M, et al. Non-suicidal self-injury and suicide attempt: A continuum or separated identities? *Eur Psychiatry*. (2021) 64:S174. doi: 10.1192/j.eurpsy.2021.463

24. Knorr AC, Ammerman BA, Hamilton AJ, McCloskey MS. Predicting status along the continuum of suicidal thoughts and behavior among those with a history of nonsuicidal self-injury. *Psychiatry Res*. (2019) 273:514–22. doi: 10.1016/j.psychres.2019.01.067

25. Prinstein MJ. Introduction to the special section on suicide and nonsuicidal self-injury: a review of unique challenges and important directions for self-injury science. *J consulting Clin Psychol*. (2008) 76:1–8. doi: 10.1037/0022-006X.76.1.1

26. Guan K, Fox KR, Prinstein MJ. Nonsuicidal self-injury as a time-invariant predictor of adolescent suicide ideation and attempts in a diverse community sample. *J consulting Clin Psychol*. (2012) 80:842–9. doi: 10.1037/a0029429

27. Pompili M, Goracci A, Giordano G, Erbuto D, Girardi P, Klonsky ED, et al. Relationship of non-suicidal self-injury and suicide attempt: a psychopathological perspective. *Psychopathology*. (2915) 21:348–53.

28. Wolfe KL, Nakonezny PA, Owen VJ, Rial KV, Moorehead AP, Kennard BD, et al. Hopelessness as a predictor of suicide ideation in depressed male and female adolescent youth. *Suicide life-threatening behavior*. (2019) 49:253–63. doi: 10.1111/sltb.12428

29. Orsolini L, Latini R, Pompili M, Serafini G, Volpe U, Vellante F, et al. Understanding the complex of suicide in depression: from research to clinics. *Psychiatry Invest*. (2020) 17:207–21. doi: 10.30773/pi.2019.0171

30. Faura-Garcia J, Calvete E, Orue I. Longitudinal associations between nonsuicidal self-injury, depressive symptoms, hopelessness, and emotional dysregulation in adolescents. *Arch suicide research: Off J Int Acad Suicide Res*. (2023), 1–15. doi: 10.1080/13811118.2023.2237075

31. Calati R, Bensassi I, Courtet P. The link between dissociation and both suicide attempts and non-suicidal self-injury: Meta-analyses. *Psychiatry Res*. (2017) 251:103–14. doi: 10.1016/j.psychres.2017.01.035

32. Brokke SS, Landrø NI, Haaland VØ. Impulsivity and aggression in suicide ideators and suicide attempters of high and low lethality. *BMC Psychiatry*. (2022) 22:753. doi: 10.1186/s12888-022-04398-w

33. Cassels M, Neufeld S, van Harmelen AL, Goodyer I, Wilkinson P. Prospective pathways from impulsivity to non-suicidal self-injury among youth. *Arch suicide research: Off J Int Acad Suicide Res*. (2022) 26:534–47. doi: 10.1080/13811118.2020.1811180

34. Bruno S, Anconetani G, Rogier G, Del Casale A, Pompili M, Velotti P. Impulsivity traits and suicide related outcomes: A systematic review and meta-analysis using the UPPS model. *J Affect Disord*. (2023) 339:571–83. doi: 10.1016/j.jad.2023.07.086

35. In-Albon T, Bürli M, Ruf C, Schmid M. Non-suicidal self-injury and emotion regulation: a review on facial emotion recognition and facial mimicry. *Child Adolesc Psychiatry Ment Health*. (2013) 7:5. doi: 10.1186/1753-2000-7-5

36. Ferrer I, Alacreu-Crespo A, Salvador A, Genty C, Dubois J, Sénèque M, et al. I cannot read your eye expression: suicide attempters have difficulties in interpreting complex social emotions. *Front Psychiatry*. (2020) 11:543889. doi: 10.3389/fpsyt.2020.543889

37. De Berardis D, Fornaro M, Orsolini L, Valchera A, Carano A, Vellante F, et al. Alexithymia and suicide risk in psychiatric disorders: A mini-review. *Front Psychiatry*. (2017) 8:148. doi: 10.3389/fpsyt.2017.00148

38. Dong Z, Zhou J, Conti A, Westwood SJ, Fu X, Liu Q, et al. Association between alexithymia and non-suicidal self-injury in psychiatric patients: the mediating role of self-esteem and the moderating role of emotional intelligence. *J Psychiatr Res*. (2023) 162:57–64. doi: 10.1016/j.jpsychires.2023.04.006

39. Halicka J, Kiejna A. Non-suicidal self-injury (NSSI) and suicidal: Criteria differentiation. *Adv Clin Exp medicine: Off Organ Wroclaw Med University*. (2018) 27:257–61. doi: 10.17219/acem/66353

40. Wolff JC, Thompson E, Thomas SA, Nesi J, Bettis AH, Ransford B, et al. Emotion dysregulation and non-suicidal self-injury: A systematic review and meta-analysis. *Eur psychiatry: J Assoc Eur Psychiatrists*. (2019) 59:25–36. doi: 10.1016/j.eurpsy.2019.03.004

41. de la Torre-Luque A, Essau CA, Lara E, Leal-Leturia I, Borges G. Childhood emotional dysregulation paths for suicide-related behaviour engagement in adolescence. *Eur Child Adolesc Psychiatry*. (2023) 32:2581–92. doi: 10.1007/s00787-022-02111-6

42. Kazgan Kılıçaslan A, Yıldız S, Kurt O, Atmaca M. Comparison of non-suicidal self-injury and suicide attempts in relation to anger rumination. *Alpha Psychiatry*. (2022) 23:82–8. doi: 10.5152/alphapsychiatry.2022.21620

43. Young HA, Davies J, Freegard G, Benton D. Nonsuicidal self-injury is associated with attenuated interoceptive responses to self-critical rumination. *Behav Ther*. (2021) 52:1123–36. doi: 10.1016/j.beth.2021.02.010

44. Szanto K, Dombrovski AY, Sahakian BJ, Mulsant BH, Houck PR, Reynolds CF 3rd, et al. Social emotion recognition, social functioning, and attempted suicide in late-life depression. *Am J geriatric psychiatry: Off J Am Assoc Geriatric Psychiatry*. (2012) 20:257–65. doi: 10.1097/JGP.0b013e31820eea0c

45. Tatnell R, Kelada L, Hasking P, Martin G. Longitudinal analysis of adolescent NSSI: the role of intrapersonal and interpersonal factors. *J Abnormal Child Psychol*. (2014) 42:885–96. doi: 10.1007/s10802-013-9837-6

46. Nestor BA, Sutherland S. Theory of mind and suicidality: a meta-analysis. *Arch Suicide Res*. (2021) 22:1–22. doi: 10.1080/13811118.2021.1939209

47. Ferguson FJ, Austin EJ. Associations of trait and ability emotional intelligence with performance on Theory of Mind tasks in an adult sample. *Pers Individ Differences*. (2010) 49:414–8. doi: 10.1016/j.paid.2010.04.009

48. Megías-Robles A, Gutiérrez-Cobo MJ, Cabello R, Gómez-Leal R, Baron-Cohen S, Fernández-Berrocal P. The 'Reading the mind in the Eyes' test and emotional intelligence. *R Soc Open science*. (2020) 7:201305. doi: 10.1098/rsos.201305

49. WHO. *DSM-V: american psychiatric association. Diagnostic and statistical manual of. Mental disorders. 5th edn*. APA (2013).

50. Gratz KL. Measurement of deliberate self-harm: Preliminary data on the Deliberate Self-Harm Inventory. *J Psychopathol Behav Assessment*. (2001) 23:253–63. doi: 10.1023/A:1012779403943

51. Rossi Monti M, D'Agostino A. Il Deliberate Self-Harm Inventory (DSHI): validazione linguistico-culturale della versione italiana. *Psichiatria e Psicoterapia*. (2010) 29:47–53.

52. Posner K, Brown GK, Stanley B, Brent DA, Yershova KV, Oquendo MA, et al. The Columbia-Suicide Severity Rating Scale: initial validity and internal consistency findings from three multisite studies with adolescents and adults. *Am J Psychiatry*. (2011) 168:1266–77. doi: 10.1176/appi.ajp.2011.10111704

53. Baron-Cohen S, Wheelwright S, Hill J, Raste Y, Plumb I. The "Reading the Mind in the Eyes" Test revised version: a study with normal adults, and adults with Asperger syndrome or high-functioning autism. *J Child Psychol psychiatry Allied disciplines*. (2001) 42:241–51. doi: 10.1017/S0021963001006643

54. Vellante M, Baron-Cohen S, Melis M, Marrone M, Petretto DR, Masala C, et al. The "Reading the Mind in the Eyes" test: systematic review of psychometric properties

and a validation study in Italy. *Cogn neuropsychiatry*. (2013) 18:326–54. doi: 10.1080/13546805.2012.721728

55. Sighinolfi C, Norcini Pala A, Chiri LR, Marchetti I, Sica C. Difficulties in Emotion Regulation (DERS): traduzione e adattamento italiano. *Psicoterapia Cognitiva Comportamentale*. (2010) 16:141–70.

56. Gratz KL, Roemer L. Multidimensional assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the difficulties in emotion regulation scale. *J Psychopathol Behav Assessment*. (2004) 26:41–54. doi: 10.1023/B:JOBA.0000007455.08539.94

57. Sukhodolsky DG, Golub A, Cromwell EN. Development and validation of the anger rumination scale. *Pers Individ Differences*. (2001) 31:689–700. doi: 10.1016/S0191-8869(00)00171-9

58. Baldetti M, Bartolozzi C, Fiore F. La validazione italiana dell'Anger Rumination Scale. Lavoro presentato al IV Forum sulla formazione in psicoterapia. *Ottobre*. (2001), 14–6.

59. Thompson R, Zuroff DC. The Levels of Self-Criticism Scale: comparative self-criticism and internalized self-criticism. *Pers Individ Differences*. (2004) 36:419–30. doi: 10.1016/S0191-8869(03)00106-5

60. Manfredi C, Caselli G, Pescini F, Rossi M, Rebecchi D, Ruggiero GM, et al. Parental criticism, self-criticism and their relation to depressive mood: an exploratory study among a non-clinical population. *Res Psychother-Psych*. (2016) 19. doi: 10.4081/ripppo.2016.178

61. Schimmenti A. Dissociative experiences and dissociative minds: Exploring a nomological network of dissociative functioning. *J Trauma dissociation: Off J Int Soc Study Dissociation (ISSD)*. (2016) 17:338–61. doi: 10.1080/15299732.2015.1108948

62. Bagby RM, Parker JD, Taylor GJ. The twenty-item Toronto Alexithymia Scale–I. Item selection and cross-validation of the factor structure. *J psychosomatic Res*. (1994) 38:23–32. doi: 10.1016/0022-3999(94)90005-1

63. Bressi C, Taylor G, Parker J, Bressi S, Brambilla V, Aguglia E, et al. Cross validation of the factor structure of the 20-item Toronto Alexithymia Scale: an Italian multicenter study. *J psychosomatic Res*. (1996) 41:551–9. doi: 10.1016/s0022-3999(96)00228-0

64. Benjamini Y, Hochberg Y. Controlling the false discovery rate: A practical and powerful approach to multiple testing. *J R Stat Society*. (1995) 57:289–300. doi: 10.1111/j.2517-6161.1995.tb02031.x

65. Serafin M, Surian L. Il Test degli Occhi: uno strumento per valutare la "teoria della mente". *Giornale italiano di psicologia Rivista trimestrale*. (2004) 4:839–62. doi: 10.1421/18849

66. Sharp C, Pane H, Ha C, Venta A, Patel AB, Sturek J, et al. Theory of mind and emotion regulation difficulties in adolescents with borderline traits. *J Am Acad Child Adolesc Psychiatry*. (2011) 50:563–573.e1. doi: 10.1016/j.jaac.2011.01.017

67. Sharp C, Ha C, Carbone C, Kim S, Perry K, Williams L, et al. Hypermentalizing in adolescent inpatients: treatment effects and association with borderline traits. *J Pers Disord*. (2013) 27:3–18. doi: 10.1521/pedi.2013.27.1.3

68. Hatkevich C, Venta A, Sharp C. Theory of mind and suicide ideation and attempt in adolescent inpatients. *J Affect Disord*. (2019) 256:17–25. doi: 10.1016/j.jad.2019.05.051

69. Sohn MN, Dimitropoulos G, Ramirez A, McPherson C, Anderson A, Munir A, et al. Non-suicidal self-injury, suicidal thoughts and behaviors in individuals with an eating disorder relative to healthy and psychiatric controls: A systematic review and meta-analysis. *Int J Eat Disord*. (2023) 56:501–15. doi: 10.1002/eat.23880

70. Linehan MM. *Cognitive-behavioral treatment of borderline personality disorder*. New York: Guilford Press (1993).

71. Pan LA, Hassel S, Segreti AM, Nau SA, Brent DA, Phillips ML. Differential patterns of activity and functional connectivity in emotion processing neural circuitry to angry and happy faces in adolescents with and without suicide attempt. *psychol Med*. (2013) 43:2129–42. doi: 10.1017/S0033291712002966

72. Turton H, Berry K, Danquah A, Pratt D. The relationship between emotion dysregulation and suicide ideation and behaviour: A systematic review. *J Affect Disord Rep*. (2021). doi: 10.1016/j.jadr.2021.100136.char

73. Selby EA, Joiner TE Jr. Emotional cascades as prospective predictors of dysregulated behaviors in borderline personality disorder. *Pers Disord*. (2013) 4:168–74. doi: 10.1037/a0029933

74. Aadahl V, Wells A, Hallard R, Pratt D. Metacognitive beliefs and suicidal ideation: an experience sampling study. *Int J Environ Res Public Health*. (2021) 18:12336. doi: 10.3390/ijerph182312336

75. Morrison R, O'Connor RC. A systematic review of the relationship between rumination and suicidality. *Suicide life-threatening behavior*. (2008) 38:523–38. doi: 10.1521/suli.2008.38.5.523

76. Tang H, Xiong T, Shi J, Chen Y, Liu X, Zhang S, et al. Global and reflective rumination are related to suicide attempts among patients experiencing major depressive episodes. *BMC Psychiatry*. (2021) 21:117. doi: 10.1186/s12888-021-03119-z

77. Fox KR, Ribeiro JD, Kleiman EM, Hooley JM, Nock MK, Franklin JC. Affect toward the self and self-injury stimuli as potential risk factors for nonsuicidal self-injury. *Psychiatry Res*. (2018) 260:279–85. doi: 10.1016/j.psychres.2017.11.083

78. Zelkowitz RL, Cole DA. Self-criticism as a transdiagnostic process in nonsuicidal self-injury and disordered eating: systematic review and meta-analysis. *Suicide life-threatening behavior*. (2019) 49:310–27. doi: 10.1111/sltb.12436

79. Swenson LP, Spirito A, Dyl J, Kittler J, Hunt JI. Psychiatric correlates of nonsuicidal cutting behaviors in an adolescent inpatient sample. *Child Psychiatry Hum Dev*. (2008) 39:427–38. doi: 10.1007/s10578-008-0100-2

80. Nester MS, Pierorazio NA, Shandler G, Brand BL. Characteristics, methods, and functions of non-suicidal self-injury among highly dissociative individuals. *J Trauma dissociation: Off J Int Soc Study Dissociation (ISSD)*. (2023) 24:333–47. doi: 10.1080/15299732.2023.2181475

81. Ford JD, Gómez JM. The relationship of psychological trauma and dissociative and posttraumatic stress disorders to nonsuicidal self-injury and suicidality: a review. *J Trauma dissociation: Off J Int Soc Study Dissociation (ISSD)*. (2021) 16:232–71. doi: 10.1080/15299732.2015.989563

82. O'Loughlin C, Burke TA, Ammerman BA. Examining the time to transition from nonsuicidal self-injury to suicide attempt. *Crisis*. (2021) 42:157–61. doi: 10.1027/0227-5910/a000715

83. Orbach I. Dissociation, physical pain, and suicide: a hypothesis. *Suicide life-threatening behavior*. (1994) 24:68–79. doi: 10.1111/j.1943-278X.1994.tb00664.x

84. Caulfield NM, Karnick AT, Capron DW. Exploring dissociation as a facilitator of suicide risk: A translational investigation using virtual reality. *J Affect Disord*. (2022) 297:517–24. doi: 10.1016/j.jad.2021.10.097

85. Higgins WC, Kaplan DM, Deschrijver E, Ross RM. Construct validity evidence reporting practices for the Reading the Mind in the Eyes Test: A systematic scoping review. *Clin Psychol Rev*. (2024) 108:102378. doi: 10.1016/j.cpr.2023.102378

86. Bateman A, Fonagy P. 8-year follow-up of patients treated for borderline personality disorder: mentalization-based treatment versus treatment as usual. *Am J Psychiatry*. (2008) 165:631–8. doi: 10.1176/appi.ajp.2007.07040636

87. Rossouw TI, Fonagy P. Mentalization-based treatment for self-harm in adolescents: a randomized controlled trial. *J Am Acad Child Adolesc Psychiatry*. (2012) 51:1304–1313.e3. doi: 10.1016/j.jaac.2012.09.018

Frontiers in Psychiatry

Examining putamen resting-state connectivity markers of suicide attempt history in depressed adolescents

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Introduction: Suicide is a current leading cause of death in adolescents and young adults. The neurobiological underpinnings of suicide risk in youth, however, remain unclear and a brain-based model is lacking. In adult samples, current models highlight deficient serotonin release as a potential suicide biomarker, and in particular, involvement of serotonergic dysfunction in relation to the putamen and suicidal behavior. Less is known about associations among striatal regions and relative suicidal risk across development. The current study examined putamen connectivity in depressed adolescents with (AT) and without history of a suicide attempt (NAT), specifically using resting-state functional magnetic resonance imaging (fMRI) to evaluate patterns in resting-state functional connectivity (RSFC). We hypothesized the AT group would exhibit lower striatal RSFC compared to the NAT group, and lower striatal RSFC would associate with greater suicidal ideation severity and/or lethality of attempt.

Methods: We examined whole-brain RSFC of six putamen regions in 17 adolescents with depression and NAT (M_{Age} [SD] = 16.4[0.3], 41% male) and 13 with AT (M_{Age} [SD] = 16.2[0.3], 31% male).

Results: Only the dorsal rostral striatum showed a statistically significant bilateral between-group difference in RSFC with the superior frontal gyrus and supplementary motor area, with higher RSFC in the group without a suicide attempt compared to those with attempt history (voxel-wise $p<.001$, cluster-wise $p<.01$). No significant associations were found between any putamen RSFC patterns and suicidal ideation severity or lethality of attempts among those who had attempted.

Discussion: The results align with recent adult literature and have interesting theoretical and clinical implications. A possible interpretation of the results is a mismatch of the serotonin transport to putamen and to the supplementary motor area and the resulting reduced functional connectivity between the two

areas in adolescents with attempt history. The obtained results can be used to enhance the diathesis-stress model and the Emotional paiN and social Disconnect (END) model of adolescent suicidality by adding the putamen. We also speculate that connectivity between putamen and the supplementary motor area may in the future be used as a valuable biomarker of treatment efficacy and possibly prediction of treatment outcome.

Introduction

Suicide is currently a leading cause of death in adolescents and young adults (1). The neurobiological correlates of suicide risk in youth, however, remain unclear (see (2) for a review). Given that adolescence represents a time of significant brain plasticity governing the growth of cognitive and social competencies (3) as well as puberty-related changes (4), clarifying the neural correlates of suicide risk in this vulnerable population will have important implications for developing adolescent-specific interventions to reduce suicidality during this high-risk period.

To prevent adolescent suicide and employ our current assessment methods more effectively, there is an urgent need to know *who* is at risk for attempting suicide and *when* that risk is greatest. However, to date, consensus is lacking for a brain-based model of adolescent suicidal behavior. One of the most recent models has been proposed by Mann and Risk, highlighting neurotransmitter dysregulation, and in particular, consistent evidence established over several decades that deficient serotonin release is a biomarker of suicidal behavior (5–7). With this foundation, there has been increasing interest in forming distinct associations of serotonergic markers with depression versus suicide (8, 9), and with violent versus nonviolent suicide (10, 11). Evidence from positron-emission topography (PET) neuroimaging studies suggests that serotonin dysregulation—and specifically up-regulated serotonin 1A autoreceptor binding in brainstem raphe nucleus neurons—is predictive of higher-lethality suicidal behavior (12, 13).

Notably, this work collectively suggests that although the role of serotonergic dysfunction in mood disorders and suicidality is complex, clarifying specific neural correlates with suicidality can be informed by examination of the putamen. Specifically, serotonin is released by brainstem raphe nuclei into the dorsal striatum which comprises the caudate and putamen (14); here, putamen serotonin levels supersede that of the caudate (15). In one PET study of adults with depression and at least one prior suicide attempt, serotonin binding potential measured via serotonin transporter (SERT) activity was significantly decreased in the midbrain/pons and putamen of patients relative to healthy controls (16). In another

PET study of adolescents that probed a peer interaction task, higher suicidal ideation was associated with reduced putamen activity (17). Taken together, this work suggests that it is likely that the putamen plays an important role related to risk of suicide attempts in adolescents, a hypothesis that remains untested. In a study of adult subjects that seeded the putamen during a motor-task paradigm, striatal motor/sensory network connections were associated with almost exclusively suicidal behaviors (with one subject in the study displaying non-suicidal self-harm behavior) (18). Although increasing interest has been devoted to task-based functional magnetic resonance imaging (fMRI) in the study of suicidal behavior in adolescents – both as a safer alternative to PET, and a determinant of functional connectivity associated with suicide risk, it is difficult to pinpoint the precise functional network patterns that are associated with suicidal behavior given the diverse tasks that have been used across investigations. Thus, it is imperative that we investigate patterns of intrinsic (i.e., task-independent) functional connectivity if we are to facilitate comparisons across samples and studies, and to identify specific neurobiological targets with relevance in clinical research studies.

No studies to date have specifically examined resting-state fMRI patterns of the putamen in adolescents with and without a history of a suicide attempt. In the current study, we sought to address this important knowledge gap by comparing whether striatal resting-state functional connectivity (RSFC) differentiated depressed adolescents with a history of a suicide attempt (AT) versus those without (NAT). While not all suicidal adolescents are depressed, we chose to examine a depressed population because of the high risk for suicidal behavior in depressed adolescents. We conducted a comprehensive assessment of history of depression and suicidal thoughts and behaviors using well-validated, interview-based instruments. Critically, our study directly compared depressed adolescents with a history of AT with a well-matched group that was also depressed but with no history of AT; comparisons with a psychiatrically healthy control group would not be sufficient for determining whether the suicide attempt-related RSFC patterns we observe are in fact due to a history of AT or simply the presence of a psychiatric disorder. In addition, we explored whether striatal RSFC patterns were associated with severity of suicidal ideation or

lethality of attempt. Based on the studies reviewed above, we hypothesized that: 1) the AT group would exhibit lower striatal RSFC compared to the NAT group, and 2) lower striatal RSFC would be associated with greater suicidal ideation severity and/or lethality of attempt.

Methods and materials

Participants

Thirty adolescents (aged 13-17 years; 11 male/19 female) with Major Depressive Disorder (MDD) were recruited from 35 adolescent psychiatric and primary care clinics throughout the San Diego county area (United States). Although multiple clinics referred potentially depressed adolescents to the study, all diagnoses of MDD were made independently of the source clinic and all scanning took place at only one site. Gathering of all self-report measures was conducted at the same site or was self-paced at the participant's home. All participants were medically healthy and were not taking any antidepressant medications or supplements at the time of scan.

Participants gave written informed assent and their parent/legal guardian provided written informed consent. Participants were financially compensated for their time. The institutional review boards of University of California San Diego, University of California San Francisco, Rady Children's Hospital, and the county of San Diego approved this study.

Demographic and clinical assessments

In this paper we define suicidality as suicidal ideation or behavior, and we define suicidal behavior as a completed or uncompleted suicide attempt. To determine diagnostic status, the Schedule for Affective Disorders and Schizophrenia or School-Age Children-Present and Lifetime Version (19) was administered to all adolescents. Depressive symptom severity was assessed using the clinician-administered Children's Depression Rating Scale-Revised (CDRS-R) (20), the self-reported Beck Depression Inventory-2 (BDI-II) (21, 22) and Reynolds Adolescent Depression Scale-2 (RADS-2) (23). Anxiety was measured using the Multidimensional Anxiety Scale for Children (MASC) (24). Trauma was measured with the Childhood Trauma Questionnaire (CTQ) (25); this measure was added to the assessment battery at a later timepoint, which contributed to expected missing data (reported in Table 1). The Stressful Life Events Schedule (SLES) was used to assess stressors in children and adolescents (26). Psychosocial functioning was assessed with the Children's Global Assessment Scale (CGAS) (27). All participants were also administered the Wechsler Abbreviated Scale of Intelligence (WASI) (28); Standard Snellen Eye Chart (29); Ishihara Color Plates test (8 plate, 2005 ed.) (30); Customary Drinking and Drug Use Record (CDDR) (31); and the Family Interview for Genetics Studies (FIGS) (32). Participants also reported demographics, Tanner Stage, and medical and developmental history.

Exclusion criteria were as follows:

1. IQ score < 80, as determined by the WASI.
2. Color blindness or having less than 20/40 correctible vision as established by the Ishihara Color Plates test and Standard Snellen Eye Chart, respectively.
3. Contraindications for MRI (e.g., ferrometallic implants, braces, claustrophobia).
4. Pregnancy or the possibility thereof.
5. Evidence of drug misuse (illicit or prescription) within the previous month or two or more alcoholic drinks per week currently or within the previous month as determined by the CDDR.
6. Left-handedness.
7. Prepubertal status (< Tanner stage 3).
8. Inability to comprehend and comply with study procedures.
9. Use of medications with a central nervous system effect in the two weeks prior to scanning.
10. Any history of neurologic disorder (e.g., meningitis, migraine, HIV), head trauma, a learning disability, serious medical health problems, or a complicated or premature birth before 33 weeks gestation (due to the possibility of abnormal neurodevelopment).
11. CDRS-R T-score < 55.
12. A primary psychiatric diagnosis other than MDD.

Assessment of history of suicide attempt and ideation

History of suicide attempt was assessed by administering the pediatric version of the Columbia Suicide Severity Rating Scale (C-SSRS) (33), a semi-structured interview that probes lifetime history of suicidal thoughts (including nature and severity of ideation) and behaviors (including preparatory acts, and actual, interrupted, or aborted attempts). For our analyses, any actual, interrupted, or aborted attempt was classified as an AT. We used a 0-5 coding for lethality as a continuous measure of lethality severity. We also summed the five suicidal ideation severity items (lifetime) to compute a continuous measure of suicidal ideation severity. These measures of lethality and suicidal ideation severity were used in subsequent analyses assessing brain-behavior associations within the AT group only.

MR data acquisition

MR images were acquired on a 3T GE MR750 MRI system (Milwaukee, WI) at the Center for Functional MRI at the University of California, San Diego. One 8 min 32 sec T2*-weighted echo planar image (EPI) scan (256 volumes TR/TE=2s/30ms, flip angle=90°, 64×64 matrix, 3×3×3mm voxels, 40 axial slices, parallel imaging method: ASSET, acceleration factor: 2) was acquired. A T1-weighted (T1w) scan (TR/TE=8.1ms/3.17ms, flip angle=12°, 256×256 matrix, 1×1×1mm voxels, 168 sagittal slices)

TABLE 1 Summary of demographic and clinical differences between depressed adolescents with and without a history of attempt.

Characteristic	AT	NAT	Statistic	p-value
Number of participants (n)	13	17		
Gender (M/F)	4/9	7/10	$X^2(1.00) = 0.04$	0.84
Age at time of scan (years)	16.2 ± 0.3 (14.4-17.8)	16.4 ± 0.3 (14.2-17.9)	$t(27.46) = -0.59$	0.56
Hollingshead Socioeconomic Score	33 ± 15 (11-59)†	26 ± 36 (11-70)†	W = 120	0.71
Tanner Score	4.5 ± 0.5 (3-5)†	4 ± 1 (3-5)†	W = 108	0.95
Wechsler Abbreviated Scale of Intelligence (Verbal)	111.7 ± 3.5 (89-132)	99.8 ± 2.8 (87-131)	$t(24.73) = 2.64$	**0.01**
Wechsler Abbreviated Scale of Intelligence (Performance)	103.5 ± 3 (86-120)	98.5 ± 2.2 (80-110)	$t(23.38) = 1.35$	0.19
Wechsler Abbreviated Scale of Intelligence (Full)	108.2 ± 3.2 (89-129)	99.4 ± 2 (84-119)	$t(20.81) = 2.37$	**0.03**
Children's Global Assessment Scale	65 ± 19 (47-85)†	70 ± 25 (48-90)†	W = 112	0.95
Children's Depression Rating Scale (Standardized)	69.3 ± 4 (33-85)	66.7 ± 2.6 (44-82)	$t(21.31) = 0.55$	0.59
Reynolds Adolescent Depression Scale Dysphoric Mood (Standardized)	65 ± 2.3 (47-76)	60.2 ± 3.2 (35-78)	$t(26.90) = 1.23$	0.23
Reynolds Adolescent Depression Scale Anhedonia/Negative Affect (Standardized)	55.3 ± 1.8 (40-65)	53.3 ± 3.5 (15-73)	$t(23.56) = 0.51$	0.62
Reynolds Adolescent Depression Scale Negative Self-evaluation (Standardized)	64.5 ± 3.2 (40-81)	59.3 ± 3.1 (39-85)	$t(27.27) = 1.18$	0.25
Reynolds Adolescent Depression Scale Somatic Complaints (Standardized)	58.7 ± 1.8 (44-67)	57.9 ± 2.8 (31-74)	$t(25.95) = 0.23$	0.82
Reynolds Adolescent Depression Scale Total (Standardized)	64.3 ± 2.6 (42-80)	61.1 ± 3.5 (35-87)	$t(27.58) = 0.75$	0.46
Beck Depression Inventory II	23.2 ± 3.1 (4-45)	22.3 ± 3.5 (0-47)	$t(27.99) = 0.20$	0.84
Multidimensional Anxiety Scale for Children (Standardized)	55.4 ± 2.1 (41-68)	57.2 ± 2.9 (32-76) [1]	$t(25.99) = -0.49$	0.63
Childhood Trauma Questionnaire (Total)	56.4 ± 2.9 (43-70) [4]	51.6 ± 5.2 (40-67) [12]	$t(6.58) = 0.81$	0.44
CTQ: Emotional Abuse	14.4 ± 1.3 (9-19) [4]	11.4 ± 2.7 (5-17) [12]	$t(5.95) = 1.03$	0.34
CTQ: Physical Abuse	8 ± 0.6 (6-12) [4]	6.8 ± 1.1 (5-10) [12]	$t(6.40) = 0.95$	0.38
CTQ: Sexual Abuse	5.3 ± 0.3 (5-8) [4]	5 ± 0 (5-5) [12]	$t(8.00) = 1.00$	0.35
CTQ: Emotional Neglect	13.8 ± 1.5 (7-20) [4]	11.2 ± 3 (5-21) [12]	$t(5.94) = 0.77$	0.47
CTQ: Physical Neglect	8.8 ± 1 (5-12) [4]	8.4 ± 1 (5-11) [12]	$t(10.69) = 0.27$	0.79
CTQ: Minimization/Denial	5.1 ± 0.7 (3-8) [4]	6.8 ± 1.6 (3-11) [12]	$t(5.39) = -0.98$	0.37
SLES: Number of stressful events	10 ± 11 (2-20)†	9 ± 7.5 (1-30) [2]†	W = 114	0.45
SLES: Number of severe events	5 ± 8 (1-14)†	3 ± 4.5 (0-27) [2]†	W = 117	0.38
SLES: Total Sum Stress	29 ± 37 (4-60)†	19 ± 18 (3-100) [2]†	W = 120	0.31
C-SSRS: Lethality (median, range)	1 (0-3)			
C-SSRS: NSSI (%)	15.38%	5.88%		
C-SSRS: SI (median, range)	5 (1-5)	1 (1-3)		

SD, standard deviation; IQR, interquartile range; M, male; F, female; C-SSRS, Columbia Suicide Rating Scale; NSSI, non-suicidal self-injurious behaviors; SI, suicidal ideation.
Mean ± SD or median ± IQR if indicated by †. [] indicated the number of missing data points.
Statistic: W, Wilcox rank sum test; χ^2, χ^2 test for equality of proportions; t, Student's t-test.
Bold means p < .05.

was acquired for spatial normalization and functional localization. Participants were instructed to lay as still as possible without falling asleep and were presented with a fixation cross that was placed centrally on a screen at the foot of the scanner and viewed via a head coil-mounted mirror. All participants were asked whether they had fallen asleep during the scan, and all adolescents reported that they had not.

Functional MRI preprocessing

In-house scripts using AFNI (34) and FSL (35) were used for analysis. T1w images were skull-stripped and transformed to MNI152 space using linear (36, 37) and nonlinear (38) alignment. Cerebrospinal fluid (CSF), grey matter (GM), and white matter (WM) were then segmented (39). EPI time-series were slice-time

and motion corrected, aligned to the T1w images (40) and smoothed with a 4.2mm full-width at half-maximum isotropic Gaussian kernel within a GM mask.

To control for the effects of physiological processes (cardiac and respiratory cycles) (41) we removed signal associated with several nuisance covariates. Specifically, we regressed from each volume of the EPI time-series signal associated with the six motion parameters, mean signal from the ventricles, a local estimate of the signal from white matter, and their de-trended derivatives (i.e., 16 regressors of non-interest). Local white matter regressors were created for each voxel within the eroded white matter mask by averaging the signal within a local spherical mask (5mm radius) around each voxel. This method permits the estimation of the nuisance parameters while simultaneously avoiding the grey matter. Additionally, it has been shown to be robust to distance-dependent motion artifacts in resting state analysis (42). We opted not to include a global signal regressor due to the controversy surrounding its use for connectivity-based analyses (43–47). Band-pass filtering (0.009 – 0.08 Hz) was conducted simultaneously on the EPI data and nuisance regressors to avoid the reintroduction of signal outside the range of the band-pass filter during the subsequent multiple linear regression process (48).

Finally, since motion can produce spurious correlations in resting-state data, we adopted the volume scrubbing technique advocated by Power et al. (49). The scrubbing procedure identifies and censors volumes that exhibit abnormal values in movement-related emetrics. This technique relies on two movement-related metrics: frame-wise displacement (FD) and the temporal derivative of the root mean square (RMS) variance over voxels (DVARS). Here, volumes were excluded if FD exceeded 0.5 or the DVARS exceeded 5. Additionally, the volume immediately preceding, and 2 volumes immediately after each censored volume were also excluded. This was combined with the removal of outlier volumes where more than 10% of voxels were greater than the median absolute deviation of the detrended time-series. Participants who had more than 20% (50 volumes) of their volumes censored were excluded from further analysis.

The cleaned time-series were transformed to MNI152 standard space at 3×3×3mm resolution for subsequent analyses.

Seed creation and RSFC analysis

Putamen seed centers of mass were chosen based on a prior report (50). Six seeds of radius 4mm were created in MNI152 space at 1×1×1mm resolution: Dorsal Rostral Putamen (DRP; ±25, 8, 6), Dorsal Caudal Putamen (DCP; ±28, 1, 3), and Ventral Rostral Putamen (VRP; ±20, 12, -3). Seeds were subsequently transformed to 3×3×3mm using nearest-neighbor resampling. The Pearson's correlation of the average seed time-series and cleaned whole-brain EPI time-series was computed and subjected to Fisher's r-to-z transform.

Functional MRI analysis

To test the hypothesis that the RSFC pattern of the putamen differs between depressed adolescents with a history of suicide

attempt and those with no such history, we performed two levels of analysis as described below.

First-level analysis

Putamen seed centers of mass were chosen based on a prior report (50). Six seeds of radius 4mm were created in MNI152 space at 1×1×1mm resolution: dorsal rostral putamen (DRP; ±25, 8, 6), dorsal caudal putamen (DCP; ±28, 1, 3), and ventral rostral putamen (VRP; ±20, 12, -3). Seeds were subsequently transformed to 3×3×3mm using nearest-neighbor resampling. The Pearson correlation of the average seed time-series and cleaned whole-brain EPI time-series was computed and subjected to Fisher's r-to-z transform.

Group-level analysis

Whole-brain voxel-wise t-tests (one-sample) were conducted to identify regions where RSFC was significantly different from 0. These were thresholded at voxel-wise p=.001.

Minimum cluster sizes were determined by a Monte-Carlo method that accounts for the estimated smoothing by using permutation testing. This method has been shown to accurately control the false positive rate (51). The cluster-wise p value was set at.01 and the associated minimum cluster size was 2,754 µL (102 voxels).

Between-group (AT versus NAT) differences in each seed's RSFC were assessed using whole-brain t-tests. These differences were constrained to lie within the mask showing significantly non-zero RSFC identified using the one-sample t-tests described above (voxel-wise threshold: p = 0.01). Correction for multiple comparisons was accomplished identically to the one-sample tests. The cluster-wise p-value was set at 0.05 yielding a minimum cluster size of 4,590 µL.

Demographic and clinical measures analysis

Analyses were conducted using R (52) to assess between group differences and to determine how well matched the groups were. Welch t-tests or Wilcoxon tests were used to assess group differences in continuous variables and χ^2 tests were used to assess group differences in categorical variables.

The Spearman's correlation analysis was performed to assess brain-behavior correlations. Specifically, we analyzed associations between any putamen RSFC patterns and suicidal ideation severity as well as lethality of AT as measured by the C-SSRS within the AT group.

Results

Demographic and clinical measures

All participants were right-handed, and the groups were well-matched for IQ, socioeconomic status, age, gender, ethnicity, and

pubertal stage, as well as clinical measurements, with significant differences reported only for Weschler Abbreviated Scale of Intelligence (Verbal and Full scales) (Table 1).

Group differences in putamen resting-state functional connectivity

Of the six putamen seeds, only the dorsal rostral putamen showed a statistically significant between-group difference in RSFC, with higher RSFC in the NAT (z=0.31) compared to the AT (z=0.1) group. The region identified occupied 9,477 µL with a peak voxel at (x=-2, y=-24, z=54) and extended bilaterally into the superior frontal gyrus and supplementary motor area (z=-2.94, $p < 0.05$; Figure 1).

Brain-behavior correlations

The relationship between brain connectivity and features of suicidality was assessed by using Spearman's correlations. No significant correlations were identified between any putamen RSFC patterns and suicidal ideation severity or lethality of AT as measured by the C-SSRS within the AT group (all $ps > 0.1$).

Discussion

To our knowledge, the current study is the first to examine potential group differences of putamen RSFC in depressed adolescents with a history of suicide attempt relative to those with no such history. Our results suggest that putamen circuitry may play an important role in adolescent suicidality. Specifically, we found that the dorsal rostral region of the putamen had a statistically significant between-group difference in RSFC, with higher RSFC in the NAT compared to the AT group. The region extended bilaterally into the superior frontal gyrus and

supplementary motor area. These findings are important to help advance the field of adolescent suicidality research as they improve our understanding of the brain circuitry associated with history of suicide attempt and may help guide therapies as discussed in more detail below.

The current study findings have a striking similarity with those from a recent study conducted by Wagner and colleagues (53) which suggests the existence of a heritable association with suicidal vulnerability. In that study, relatives of suicide victims exhibited two sub-networks of decreased RSFC compared with healthy subjects, one of which ($p = .02$) was composed of 21 nodes connected by 26 edges mainly located in the fronto-cingulo-striatal network, i.e., the bilateral putamen, bilateral anterior cingulate cortex, dorsomedial prefrontal cortex, bilateral supplementary motor area, right premotor cortex, bilateral thalamus, right superior temporal gyrus, and right hippocampus.

Notably, the regions obtained in our study – largely located in the supplementary motor area – as well as the seeded putamen, are all located within the central serotonergic pathway in the brain (54) (Figure 2). Serotonin is produced in the raphe nuclei in the brainstem, from which serotonergic projections project to the striatum [including the putamen, to a larger degree than the caudate (15)] and neocortex (including the supplementary motor area) (54) (Figure 2). Collectively, these serotonergic systems play a critical role in mood, avoidance behavior, fear, and anxiety (54). The results of our study suggest that there may be a mismatch of the serotonin transport to putamen and to the supplementary motor area and the resulting reduced functional connectivity between the two areas in adolescents with a history of a suicide attempt.

There are several psychological constructs that are potentially linked to the aberrations found in this study, such as impulsivity and delay discounting. Whereas the sensory motor area (as an inhibitory structure) plays a critical role in exerting control over voluntary actions in situations of response conflict (55), impulsivity may relate to striatal gray matter volumes (56). In regard to adolescent suicide, Spirito and colleagues (57) concluded that impulsive aggression may be the mechanism through which
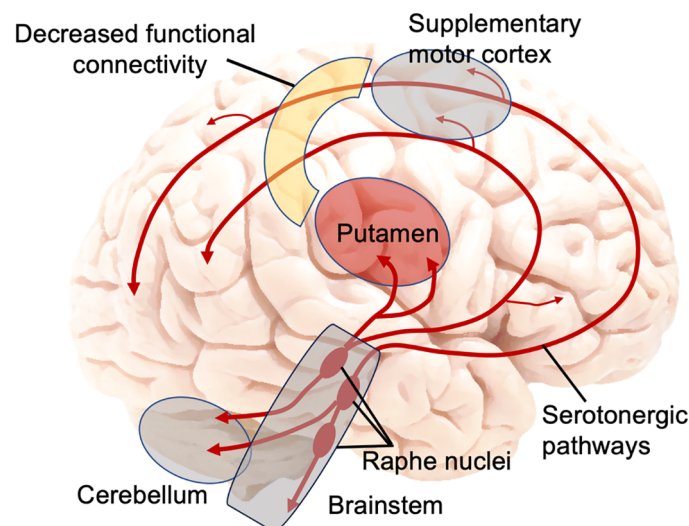

FIGURE 1
Region showing between-group difference of RSFC of the right dorsal rostral putamen.
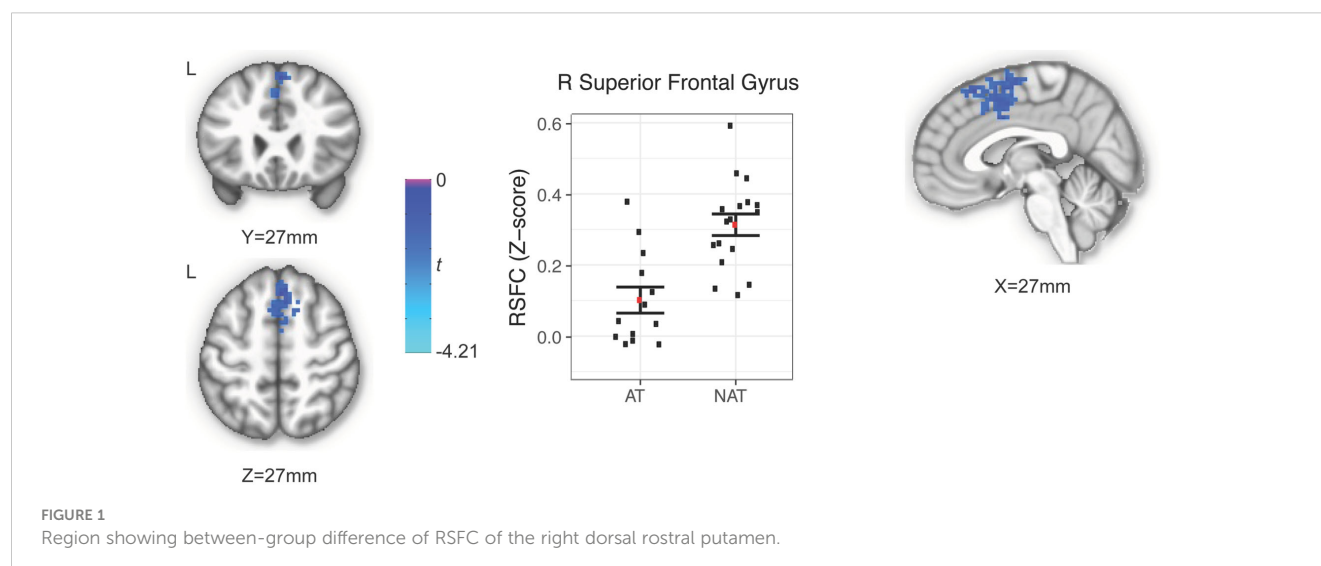
FIGURE 2
Main serotonin pathways in the brain and decreased functional connectivity between putamen and supplementary motor cortex in adolescent suicide attempters. Figure was constructed by the authors, adapted from (54).

decreased serotonergic activity is related to suicidal behavior (57). However, the link between impulsivity and suicidality has been questioned (58, 59). Unfortunately, we did not assess aggression or impulsivity in the current study and, thus, cannot contribute to this issue experimentally. It is also possible that a more sophisticated mechanism involving a social component is at play. For example, one recent study demonstrated that during peer exclusion and inclusion, youth with high suicidal ideation, including AT, showed significantly lower activity in precentral and postcentral gyrus, superior temporal gyrus, medial frontal gyrus, insula, and putamen compared to youth with lower suicidality (17). Finally, the well-documented fundamental involvement of the putamen in psychological pain and sadness (60) may represent the brain – behavior link of this dysregulation observed in those with AT.

Theoretical and clinical implications

We would like to describe two examples of theoretical implications of our results. The obtained results suggest that the diathesis-stress model recently proposed by Mann and Rizk (7) (7) may be enhanced by adding putamen explicitly to their model, where serotonin dysfunction is implicated. The aforementioned study by Wagner and colleagues (53) further suggests that it is the diathesis—rather than the stress—part of the model that is linked to the fronto-cingulo-striatal network, given that relatives without mental illness showed this aberration. At the same time, reductions—and not increases of putamen volume—were observed in subjects with a family history of suicide compared with subjects who used a violent suicidal means, which suggests that some morphological variations in this structure may represent endophenotypes of suicidal vulnerability, while others may modulate action selection (61).

Our results can also help refine another model, specifically the Emotional paiN and social Disconnect (END) model of adolescent

suicidality recently proposed by our group (62). This model is centered on two key neural circuits: (1) the emotional/mental pain circuit, and (2) the social disconnect/distortion circuit. In the original END model, the emotional pain circuit, consisting of the cerebellum, amygdala, and hippocampus, shows similar aberrations in adolescents with suicidal ideation as in AT (but to a smaller degree). The social disconnect circuit is unique to adolescent AT and includes the lateral orbitofrontal cortex, the temporal gyri, and the connections between them. As mentioned above, involvement of putamen in psychological pain and sadness has been well-documented (60). The current study results, in conjunction with prior literature, may warrant adding the putamen to the psychological pain circuit of the conceptual END model, along with the cerebellum – another important structure on the serotonergic pathway robustly linked to psychological pain (54, 60, 62) (Figure 2).

This study may have potential wider future clinical implications, provided routine application of MRI becomes widespread in adolescent psychiatric practice (63). For example, based on our results and the discussed models, it is possible that connectivity between putamen and the supplementary motor area will increase with treatment, and we suggest that, if confirmed, this connectivity may be used as a valuable biomarker of treatment efficacy and possibly prediction of treatment outcome. We note the lack of experimental evidence to date regarding the impact of treatment on increasing connectivity between these regions, and further research is needed to validate this possibility.

Results of this study should be interpreted in the light of limitations, including its retrospective nature and the modest sample size secondary to the difficulty of recruiting this particular population. Although the homogeneity of our sample is a study strength and depression is one of the strongest psychiatric risk factors for suicide, suicidal behaviors are nonetheless a transdiagnostic phenomenon; focusing solely on depressed adolescents precludes us from examining whether or not putamen-based RSFC patterns are present in adolescents with other psychiatric disorders who have a history of suicide attempt. Another important limitation is that we are not

measuring serotonin directly. Positron emission tomography that is commonly used for such measurements is not typically performed in adolescents due to concerns of using radioisotopes in teens. Neurotransmitters other than serotonin (in particular, dopamine) as well as hormones may play a role in putamen activity and structure. Given evidence of serotonergic regulation of dopamine transmission, and the complex interactions that occur between these two neurotransmitter systems (64, 65), it may be the case that dopamine and/or serotonin dysregulation will prove to mechanistically explain potential links between striatal volume – specifically putamen volume - and suicidal vulnerability (66). For instance, work in an independent sample of adolescents has demonstrated that behavior on an implicit suicidal cognition task is related to volumes of the putamen and caudate in depressed adolescents (66) and typically developing youth (67). Both the putamen and caudate are rich in dopaminergic receptors and are involved in processes related to stimulus–action mappings (e.g., prepotent inhibition, motivational behaviors, etc.). The putamen and sensory motor area play a crucial role in the dopamine pathway in other diseases where behavior and movement execution are dysregulated (e.g., Parkinson's disease, 68), suggesting that future study of suicidal vulnerability among adolescents should consider the role of both serotonin and dopamine. As mentioned earlier, in our study we did not assess impulsivity, psychological pain, or some other constructs that could have improved our understanding of suicidal behaviors in youth. Future directions would include measuring such constructs and testing refined theoretical models of suicide risk (such as our END conceptual model of adolescent suicide or those developed by Mann and Rizk).

In summary, the current study found compelling evidence of a relation between dorsal rostral striatum and bilateral between-group differences in connectivity with the superior frontal gyrus and supplementary motor area. Our findings of increased connectivity in the group without a suicide attempt compared to those with attempt history suggest that putamen circuitry may serve as an important biomarker associated with adolescent suicidality. Findings also suggest pathways of further inquiry related to testing conceptual models that incorporate dopamine and serotonin transmission.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the institutional review boards of University of California San Diego, University of California San Francisco, Rady Children's Hospital, and the county of San Diego. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

OT: Writing – original draft, Writing – review & editing, Conceptualization, Methodology. TH: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing, Funding acquisition. CC: Conceptualization, Data curation, Formal analysis, Methodology, Software, Visualization, Writing – original draft, Writing – review & editing. SG: Methodology, Writing – original draft, Writing – review & editing, Conceptualization. RR: Writing – original draft, Writing – review & editing. SD: Writing – original draft, Writing – review & editing. JM: Writing – original draft, Writing – review & editing. TTY: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing.

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References

1. Goldstick JE, Cunningham RM, Carter PM. Current causes of death in children and adolescents in the United States. *New Engl J Med*. (2022) 386:1955–6. doi: 10.1056/NEJMc2201761

2. Auerbach RP, Pagliaccio D, Allison GO, Alqueza KL, Alonso MF. Neural correlates associated with suicide and nonsuicidal self-injury in youth. *Biol Psychiatry*. (2021) 89:119–33. doi: 10.1016/j.biopsych.2020.06.002

3. Blakemore S-J. The social brain in adolescence. *Nat Rev Neurosci*. (2008) 9:267–77. doi: 10.1038/nrn2353

4. Ho TC, Gifuni AJ, Gotlib IH. Psychobiological risk factors for suicidal thoughts and behaviors in adolescence: A consideration of the role of puberty. *Mol Psychiatry*. (2022) 27:Article 1. doi: 10.1038/s41380-021-01171-5

5. Mann J. The neurobiology of suicide. *Nat Med*. (1998) 4:25–30. doi: 10.1038/nm0198-025

6. Mann JJ. The serotonergic system in mood disorders and suicidal behaviour. *Philos Trans R Soc London Ser B Biol Sci*. (2013) 368:20120537. doi: 10.1098/rstb.2012.0537

7. Mann JJ, Rizk MM. A brain-centric model of suicidal behavior. *Am J Psychiatry*. (2020) 177:902–16. doi: 10.1176/appi.ajp.2020.20081224

8. Bielau H, Mawrin C, Krell D, Agelink MW, Trübner K, Davis R, et al. Differences in activation of the dorsal raphe nucleus depending on performance of suicide. *Brain Res*. (2005) 1039:43–52. doi: 10.1016/j.brainres.2005.01.055

9. Parsey RV, Hastings RS, Oquendo MA, Huang Y, Simpson N, Arcement J, et al. Lower serotonin transporter binding potential in the human brain during major depressive episodes. *Am J Psychiatry*. (2006) 163:52–8. doi: 10.1176/appi.ajp.163.1.52

10. Lin P-Y, Tsai G. Association between serotonin transporter gene promoter polymorphism and suicide: Results of a meta-analysis. *Biol Psychiatry*. (2004) 55:1023–30. doi: 10.1016/j.biopsych.2004.02.006

11. Gos T, Günther K, Bielau H, Dobrowolny H, Mawrin C, Trübner K, et al. Suicide and depression in the quantitative analysis of glutamic acid decarboxylase-Immunoreactive neuropil. *J Affect Disord*. (2009) 113:45–55. doi: 10.1016/j.jad.2008.04.021

12. Sullivan GM, Oquendo MA, Milak M, Miller JM, Burke A, Ogden RT, et al. Positron emission tomography quantification of serotonin(1A) receptor binding in suicide attempters with major depressive disorder. *JAMA Psychiatry*. (2015) 72:169–78. doi: 10.1001/jamapsychiatry.2014.2406

13. Oquendo MA, Galfalvy H, Sullivan GM, Miller JM, Milak MM, Sublette ME, et al. Positron emission tomographic imaging of the serotonergic system and prediction of risk and lethality of future suicidal behavior. *JAMA Psychiatry*. (2016) 73:1048–55. doi: 10.1001/jamapsychiatry.2016.1478

14. Mathur BN, Lovinger DM. Serotonergic action on dorsal striatal function. *Parkinsonism Rel Disord*. (2012) 18:S129–31. doi: 10.1016/S1353-8020(11)70040-2

15. Hörtnagl H, Pifl C, Hörtnagl E, Reiner A, Sperk G. Distinct gradients of various neurotransmitter markers in caudate nucleus and putamen of the human brain. *J Neurochem*. (2020) 152:650–62. doi: 10.1111/jnc.14897

16. Nye JA, Purselle D, Plisson C, Voll RJ, Stehouwer JS, Votaw JR, et al. DECREASED BRAINSTEM AND PUTAMEN SERT BINDING POTENTIAL IN DEPRESSED SUICIDE ATTEMPTERS USING [^{11}C]-ZIENT PET IMAGING: research article: [C-11] ZIENT PET. *Depression Anxiety*. (2013) doi: 10.1002/da.22049. n/a-n/a.

17. Harms MB, Casement MD, Teoh JY, Ruiz S, Scott H, Wedan R, et al. Adolescent suicide attempts and ideation are linked to brain function during peer interactions. *Psychiatry Res: Neuroimaging*. (2019) 289:1–9. doi: 10.1016/j.pscychresns.2019.05.001

18. Marchand WR, Lee JN, Johnson S, Thatcher J, Gale P, Wood N, et al. Striatal and cortical midline circuits in major depression: Implications for suicide and symptom expression. *Prog Neuropsychopharmacol Biol Psychiatry*. (2012) 36:290–9. doi: 10.1016/j.pnpbp.2011.10.016

19. Kaufman J, Birmaher B, Brent D, Rao U, Flynn C, Moreci P, et al. Schedule for affective disorders and schizophrenia for school-age children-present and lifetime version (K-SADS-PL): initial reliability and validity data. *J Am Acad Child Adolesc Psychiatry*. (1997) 36:980–8. doi: 10.1097/00004583-199707000-00021

20. Mayes TL, Bernstein IH, Haley CL, Kennard BD, Emslie GJ. Psychometric properties of the children's depression rating scale–revised in adolescents. *J Child Adolesc Psychopharmacol*. (2010) 20:513–6. doi: 10.1089/cap.2010.0063

21. Beck AT, Steer RA, Carbin MG. Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. *Clin Psychol Rev*. (1988) 8:77–100. doi: 10.1016/0272-7358(88)90050-5

22. Beck AT, Steer RA, Brown G. Beck Depression Inventory–II [dataset]. American Psychological Association (2011). doi: 10.1037/t00742-000

23. Reynolds WM. *RADS-2, Reynolds Adolescent Depression Scale: Professional Manual*. Lutz, FL: Psychological Assessment Resources (2002).

24. March JS, Parker JDA, Sullivan K, Stallings P, Conners CK. The multidimensional anxiety scale for children (MASC): factor structure, reliability, and validity. *J Am Acad Child Adolesc Psychiatry*. (1997) 36:554–65. doi: 10.1097/00004583-199704000-00019

25. Bernstein DP, Ahluvalia T, Pogge D, Handelsman L. Validity of the Childhood trauma questionnaire in an adolescent psychiatric population. *J Am Acad Child Adolesc Psychiatry*. (1997) 36:340–8. doi: 10.1097/00004583-199703000-00012

26. Williamson DE, Birmaher B, Ryan ND, Shiffrin TP, Lusky JA, Protopapa J, et al. The stressful life events schedule for children and adolescents: Development and validation. *Psychiatry Res*. (2003) 119:225–41. doi: 10.1016/s0165-1781(03)00134-3

27. Shaffer D. A children's global assessment scale (CGAS). *Arch Gen Psychiatry*. (1983) 40:1228. doi: 10.1001/archpsyc.1983.01790100074010

28. Wechsler D. Wechsler abbreviated scale of intelligence. (2012). doi: 10.1037/t15170-000

29. Johnson AT, Dooly CR, Simpson CR. Generating the Snellen chart by computer. *Comput Methods Programs Biomed*. (1998) 57:161–6. doi: 10.1016/S0169-2607(98)00036-4

30. Hardy LH, Rand G, Rittler MC. Tests for the detection and analysis of color-blindness I the Ishihara test: an evaluation. *J Optical Soc America*. (1945) 35:268. doi: 10.1364/JOSA.35.000268

31. Brown SA, Myers MG, Lippke L, Tapert SF, Stewart DG, Vik PW. Psychometric evaluation of the Customary Drinking and Drug Use Record (CDDR): A measure of adolescent alcohol and drug involvement. *J Stud Alcohol*. (1998) 59:427–38. doi: 10.15288/jsa.1998.59.427

32. Brent DA, Mann JJ. Family genetic studies, suicide, and suicidal behavior. *Am J Med Genet Part C: Semin Med Genet*. (2005) 133C:13–24. doi: 10.1002/ajmg.c.30042

33. Posner K, Brown GK, Stanley B, Brent DA, Yershova KV, Oquendo MA, et al. The columbia–suicide severity rating scale: initial validity and internal consistency findings from three multisite studies with adolescents and adults. *Am J Psychiatry*. (2011) 168:1266–77. doi: 10.1176/appi.ajp.2011.10111704

34. Cox RW. AFNI: software for analysis and visualization of functional magnetic resonance neuroimages. *Comput Biomed Res an Int J*. (1996) 29:162–73. doi: 10.1006/cbmr.1996.0014

35. Smith SM, Jenkinson M, Woolrich MW, Beckmann CF, Behrens TEJ, Johansen-Berg H, et al. Advances in functional and structural MR image analysis and implementation as FSL. *NeuroImage*. (2004) 23 Suppl 1:S208–19. doi: 10.1016/j.neuroimage.2004.07.051

36. Jenkinson M, Smith SM. A global optimisation method for robust affine registration of brain images. *Med Image Anal*. (2001) 5:143–56. doi: 10.1016/S1361-8415(01)00036-6

37. Smith SM, Zhang Y, Jenkinson M, Chen J, Matthews PM, Federico A, et al. Accurate, robust, and automated longitudinal and cross-sectional brain change analysis. *NeuroImage*. (2002) 17:479–89. doi: 10.1006/nimg.2002.1040

38. Andersson JLR, Jenkinson M, Smith SM. *Non-linear registration, aka Spatial normalisation*. University of Oxford: FMRIB (2007).

39. Zhang Y, Brady M, Smith SM. Segmentation of brain MR images through a hidden Markov random field model and the expectation-maximization algorithm. *IEEE Trans Med Imaging*. (2001) 20:45–57. doi: 10.1109/42.906424

40. Saad ZS, Glen DR, Chen G, Beauchamp MS, Desai R, Cox RW. A new method for improving functional-to-structural MRI alignment using local Pearson correlation. *NeuroImage*. (2009) 44:839–48. doi: 10.1016/j.neuroimage.2008.09.037

41. Fox MD, Snyder AZ, Vincent JL, Corbetta M, Van Essen DC, Raichle ME. The human brain is intrinsically organized into dynamic, anticorrelated functional networks. *Proc Natl Acad Sci*. (2005) 102:9673–8. doi: 10.1073/pnas.0504136102

42. Jo HJ, Gotts SJ, Reynolds RC, Bandettini PA, Martin A, Cox RW, et al. Effective preprocessing procedures virtually eliminate distance- dependent motion artifacts in resting state FMRI. *J Appl Math*. (2013) 2013:1-9. doi: 10.1155/2013/935154

43. Fox MD, Zhang D, Snyder AZ, Raichle ME. The global signal and observed anticorrelated resting state brain networks. *J Neurophysiol*. (2009) 101:3270–83. doi: 10.1152/jn.90777.2008

44. Murphy K, Birn RM, Handwerker DA, Jones TB, Bandettini PA. The impact of global signal regression on resting state correlations: are anti- correlated networks introduced? *NeuroImage*. (2009) 44:893–905. doi: 10.1016/j.neuroimage.2008.09.036

45. Weissenbacher A, Kasess C, Gerstl F, Lanzenberger R, Moser E, Windischberger C. Correlations and anticorrelations in resting-state functional connectivity MRI: a quantitative comparison of preprocessing strategies. *NeuroImage*. (2009) 47:1408–16. doi: 10.1016/j.neuroimage.2009.05.005

46. Anderson JS, Druzgal TJ, Lopez-Larson M, Jeong E-K, Desai K, Yurgelun-Todd D. Network anticorrelations, global regression, and phase-shifted soft tissue correction. *Hum Brain Mapp*. (2010) 32:919–34. doi: 10.1002/hbm.21079

47. Saad ZS, Gotts SJ, Murphy K, Chen G, Jo HJ, Martin A, et al. Trouble at rest: how correlation patterns and group differences become distorted after global signal regression. *Brain Connect*. (2012) 2:25–32. doi: 10.1089/brain.2012.0080

48. Hallquist MN, Hwang K, Luna B. The nuisance of nuisance regression: Spectral misspecification in a common approach to resting-state fMRI preprocessing reintroduces noise and obscures functional connectivity. *NeuroImage*. (2013) 82:208–25. doi: 10.1016/j.neuroimage.2013.05.116

49. Power JD, Barnes KA, Snyder AZ, Schlaggar BL, Petersen SE. Spurious but systematic correlations in functional connectivity MRI networks arise from subject motion. *NeuroImage*. (2012) 59:2142–54. doi: 10.1016/j.neuroimage.2011.10.018

50. Gabbay V, Ely BA, Li Q, Bangaru SD, Panzer AM, Alonso CM, et al. Striatum-based circuitry of adolescent depression and anhedonia. *J Am Acad Child Adolesc Psychiatry*. (2013) 52:628–41.e13. doi: 10.1016/j.jaac.2013.04.003

51. Cox RW, Chen G, Glen DR, Reynolds RC, Taylor PA. FMRI clustering in AFNI: false-positive rates redux. *Brain Connectivity*. (2017) 7:152–71. doi: 10.1089/brain.2016.0475

52. R Core Team. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing (2019).

53. Wagner G, de la Cruz F, Köhler S, Pereira F, Richard-Devantoy S, Turecki G, et al. Connectomics-based functional network alterations in both depressed patients with suicidal behavior and healthy relatives of suicide victims. *Sci Rep*. (2019) 9:14330. doi: 10.1038/s41598-019-50881-y

54. Nummenmaa L, Seppälä K, Vesa P. Molecular imaging of the human emotion circuit. In: Boggio P, Wingenbach TS, Comfort W, Lira. M, Marrins L, editors. *How can social and affective neuroscience explain various aspects of human everyday interaction? – From theory to methodology*. Sao Paulo, Hogrefe (2020).

55. Obeso I, Robles N, Marrón EM, Redolar-Ripoll D. Dissociating the role of the pre-SMA in response inhibition and switching: A combined online and offline TMS approach. *Front Hum Neurosci*. (2013) 7:150. doi: 10.3389/fnhum.2013.00150

56. Caravaggio F, Plitman E, Chung JK, Gerretsen P, Kim J, Iwata Y, et al. Trait impulsiveness is related to smaller post-commissural putamen volumes in males but not females. *Eur J Neurosci*. (2017) 46:2253–64. doi: 10.1111/ejn.13661

57. Spirito A, Esposito-Smythers C. Attempted and completed suicide in adolescence. *Annu Rev Clin Psychol*. (2006) 2:237–66. doi: 10.1146/annurev.clinpsy.2.022305.095323

58. Witte TK, Merrill KA, Stellrecht NE, Bernert RA, Hollar DL, Schatschneider C, et al. "Impulsive" youth suicide attempters are not necessarily all that impulsive. *J Affect Disord*. (2008) 107:107–16. doi: 10.1016/j.jad.2007.08.010

59. Watkins HB, Meyer TD. Is there an empirical link between impulsivity and suicidality in bipolar disorders? A review of the current literature and the potential psychological implications of the relationship. *Bipolar Disord*. (2013) 15:542–58. doi: 10.1111/bdi.12090

60. Meerwijk EL, Ford JM, Weiss SJ. Brain regions associated with psychological pain: Implications for a neural network and its relationship to physical pain. *Brain Imaging Behav*. (2013) 7:1–14. doi: 10.1007/s11682-012-9179-y

61. Jollant F, Wagner G, Richard-Devantoy S, Köhler S, Bär K-J, Turecki G, et al. Neuroimaging-informed phenotypes of suicidal behavior: A family history of suicide and the use of a violent suicidal means. *Trans Psychiatry*. (2018) 8:120. doi: 10.1038/s41398-018-0170-2

62. Tymofiyeva O, Reeves KW, Shaw C, Lopez E, Aziz S, Max JE, et al. A Systematic Review of MRI Studies and the "Emotional paiN and social Disconnect (END)" Brain model of suicidal behavior in youth. *Behav Neurol*. (2023) 2023:7254574. doi: 10.1155/2023/7254574

63. Tymofiyeva O, Zhou VX, Lee C-M, Xu D, Hess CP, Yang TT. MRI insights into adolescent neurocircuitry-A vision for the future. *Front Hum Neurosci*. (2020) 14:237. doi: 10.3389/fnhum.2020.00237

64. Alex KD, Pehek E. Pharmacologic mechanisms of serotonergic regulation of dopamine neurotransmission. *Pharmacol Ther*. (2007) 113:296–320. doi: 10.1016/j.pharmthera.2006.08.004

65. Hashemi P, Dankoski EC, Lama R, Wood KM, Takmakov P, Wightman RM. Brain dopamine and serotonin differ in regulation and its consequences. *Proc Natl Acad Sci*. (2012) 109:11510–5. doi: 10.1073/pnas.1201547109

66. Ho TC, Cichocki AC, Gifuni AJ, Catalina Camacho M, Ordaz SJ, Singh MK, et al. Reduced dorsal striatal gray matter volume predicts implicit suicidal ideation in adolescents. *Soc Cogn Affect Neurosci*. (2018) 13:1215–24. doi: 10.1093/scan/nsy089

67. Ho TC, Teresi GI, Ojha A, Walker JC, Kirshenbaum JS, Singh MK, et al. Smaller caudate gray matter volume is associated with greater implicit suicidal ideation in depressed adolescents. *J Affect Disord*. (2021) 278:650–7. doi: 10.1016/j.jad.2020.09.046

68. Yu R, Liu B, Wang L, Chen J, Liu X. Enhanced functional connectivity between putamen and supplementary motor area in Parkinson's disease patients. *PloS One*. (2013) 8(3):e59717.

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Investigating suicidal behavior among prisoners in the light of the behavioral addiction approach: results of a multicenter cross-sectional study

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Introduction: The behavioral addiction model posits that repetitive suicidal behaviors can serve as maladaptive strategies for managing stress and negative emotional states, akin to substance addiction. Both behaviors involve negative emotions, offer temporary psychological relief, and persist, indicating shared neurobiological mechanisms. This study explored psychometric differences among major repeaters, occasional attempters, and non-suicidal prisoners.

Methods: A multi-centre cross-sectional survey of 363 inmates across four prisons assessed depression, cognitive-emotional regulation, impulsivity, perceived stress, lifetime non-suicidal self-injury and suicide attempts.

Results: Mild depression, moderate suicidal ideation, and moderate impulsivity were common, with nearly half of the participants having attempted suicide at least once. Hierarchical multiple regression analyses revealed that repeated suicidal behavior in the past increases susceptibility to future suicidal thoughts, with suicide attempts serving as a maladaptive emotion regulation strategy among repeated attempters.

Discussion: The results reveal differences in emotional dysregulation, impulsivity, and stress coping strategies among the studied groups, reinforcing the idea of suicidality as a form of behavioral addiction. The addiction approach helps explain the sensitivity to later suicidal thoughts in former attempters and self-harmers, offering valuable insights for tailored interventions within correctional settings.

KEYWORDS

inmates, suicide, self-harm, addictive behavior, depression, impulsivity, emotion regulation, mindfulness

1 Introduction

In several countries suicidality in prison is the leading cause of death (1–5). This phenomenon is not necessarily linked to incarceration. In many countries, including Hungary, the number of completed suicides and attempted suicides during incarceration is extremely low (6–8). However, the incarcerated population is significantly more at risk of suicide during their entire life history: among prisoners 8.6% of men (95% CI 6.1-11.2) and 12.2% of women (95% CI 7.1-17.3) attempt suicide over the course of a lifetime, compared with 2.7% in general population (9). It could mean that prisoners belonged to a risk group even before incarceration, and that the risk of suicide attempts also can be increased even after release. This disparity highlights the crucial need to understand the factors contributing to the high rates of suicide attempts, thereby facilitating the establishment of appropriate screening procedures and interventions.

Meta-analyses (2, 4) have identified key risk factors associated with suicide attempts and self-harm among incarcerated individuals, including factors preceding suicide, comorbid mental disorders, single-person cell placement, lack of visits, abuse during incarceration, violent offenses, life sentences, and remand. The strongest clinical factors associated with an increased risk of suicide include current or recent suicidal ideation, which raises the likelihood of suicide by over ten times. Additionally, a history of previous non-suicidal self-injury (NSSI) or suicide attempts (SA) represents an eight-fold risk (2, 4).

Prisoners are exposed to heightened levels of chronic stress, stemming from interpersonal, financial, and legal factors. The emotionally taxing nature of prison life necessitates effective coping mechanisms, often leading to the development of adjustment and mental disorders (10, 11). The chronic stress factors affecting prisoners often precede the time of imprisonment, they are often exposed to childhood and adult traumas (abandonment, emotional, physical or sexual traumas as well) (12). During incarceration, prisoners face stressors such as the possible disruption of partner and family relationships, lack of social support, being assaulted; having major financial difficulties or institutional conflicts with other inmates or staff (10). The primary concerns can manifest as substance-related and addictive disorders, impulsivity-related conditions such as personality disorders, impulse control disorders, and major depression (13–18). Despite the elevated incidence of mental disorders among incarcerated individuals, coupled with their heightened vulnerability, healthcare resources in this context remain limited (13).

Several theories and research have investigated the risk factors of suicide in the general population. One of the most comprehensive models for suicide attempts is the integrated motivational-volitional (IMV) model of suicidal behavior by O'Connor and Kirtley (19). The model underscores vulnerability to suicide across three phases: pre-motivation, motivation, and action. The pre-motivation phase considers diathesis, environmental factors, and early life events that underlie suicidal ideation. The motivation phase centers on entrapment due to failure and humiliation, influenced by variables affecting self-regulation. The action phase involves transitioning from thought to suicide attempt, influenced by access to means, pain sensitivity, and impulsivity (19).

Additionally, various models delve into the complexities of NSSI. The cognitive-emotional model (20) posits that emotional reactivity, mental representation of self-harm, negative self-representations, and thoughts related to NSSI contribute to it as a maladaptive coping strategy. Similarly, the four-function model (21) describes processes maintaining NSSI through automatic/social and negative/positive reinforcement, primarily serving intrapersonal functions, such as emotion regulation and reducing negative emotional states. Furthermore, the cognitive-emotional reactivity model (22) integrates insights from recurrent depression, applying them to borderline personality disorder, where maladaptive coping strategies like self-harm reinforce connections between negative thoughts, emotions, and bodily sensations. Therefore, NSSI becomes more and more automatic because of the repetitions.

Research has investigated the potential similarities between SA, NSSI, and behavioral addictions (23–28). This concept challenges traditional views and suggests that considering recurrent suicidal behavior as an addiction could transform treatment approaches, perhaps comparing them with approaches typically used for substance addiction.

Behavioral addictions are triggered by specific patterns and involve compulsive engagement in a particular activity, despite negative consequences. It should be mentioned that these addictions are not officially recognized in the DSM-5. Unlike substance addictions, behavioral addictions are defined by behaviors that become overwhelmingly dominant in an individual's life, profoundly impacting their daily functioning, physical and mental health, and the surrounding environment (29). While this classification remains a subject of ongoing debate among experts, numerous studies have unearthed intriguing connections that warrant exploration.

The addictive model of self-harming behavior by Blasco-Fontecilla, Fernández-Fernández (25) emphasizes that individuals with frequent SA or NSSI (≥5 attempts in a lifetime) may be considered behavioral addicts. The recurrence of self-harm and SA is primarily linked to negative emotions, such as relieving emptiness or helplessness seeking attention. This model suggests common neurobiological mechanisms, including the involvement of the mesocorticolimbic reward system and the release of endogenous opioids, shared between self-harm and addiction. Both self-harm and addiction provide relief from psychological pain and activate the stress and opioid systems. Similarly to addiction, self-harming behaviors may become more persistent and severe over time. Self-harm can sensitize individuals to suicidal thoughts and behaviors, making them more susceptible to triggering by stressful life events. There is also a risk of relapse in both self-harm and addiction, often precipitated by similar life events (25).

The urge to self-harm in individuals with NSSI parallels addictive features (30), including increased repetition, impulsivity, rumination, and withdrawal symptoms (24, 25, 31). Higher scores at the addictive features subscale of the Ottawa Self-Injury Inventory are associated with greater distress over urges to self-

injure, and also with more frequent and severe NSSI (28). Analyzing the language used in forum posts related to NSSI, Himelein-Wachowiak, Giorgi (27) found that over 75% of the users in their sample fulfilled a minimum of two NSSI-adapted diagnostic criteria of substance use disorders in their posts.

Adolescent studies on NSSI also found addictive features, displaying an underlying urge, increasing severity and frequency, difficulty in stopping self-harming behavior, and relief after self-harm (26). High impulsivity and emotional dysregulation were identified as major risk factors for self-harm, leading to the characterization of certain elements of self-harm as behavioral addiction (32). Childhood abuses and traumas were frequently observed among adolescents with NSSI, and three out of five psychiatric outpatients exhibited addictive features in their self-harming behavior, often co-occurring with other substance or behavioral addictions (33).

Our study examines the connection between traditional addiction concepts and the understanding of suicidal behavior as an addiction. It explores the implications of this connection specifically within the incarcerated population.

2 Measures and methods

2.1 Procedures and sample

Our cross-sectional multi-center survey was conducted between June-August of 2021, included prisoners (N=363) from 4 prisons on a voluntary basis. Based on sample size calculation (34) a total of 232 participants were required, considering a 95% confidence interval with a 5% margin of error. The study was carried out persons convicted by final judgement. Exclusion criteria were psychological condition preventing the completion of the test, such as acute psychosis, severe intellectual disability, and psychoactive substance abuse, based on previous medical records or on the advices of the institutional psychologist or psychiatrist.

A psychologist remained present throughout the test session to offer assistance with question interpretation.

2.2 Measures

Participants completed questionnaires below in the following order:

Individual data sheet: Following the informed information and consent section, participants provided demographic information. This included gender, age, education, employment, marital status, and, for incarcerated individuals, the reason for and duration of detention.

NSSI occurrence questions: "Have you ever intentionally harmed yourself with suicide intention?" [yes/no]. If the respondent answers "Yes", further questions were asked about the frequency ("If yes, how many times?" [1/2/…/6/more than 6]) and the way ("How did you do it?") of self-harm.

Cognitive emotion regulation questionnaire (CERQ): a 36-item self-report questionnaire in which the respondent determines how he or she reacts to negative, unpleasant events on a five-point scale (1-5 points) (35). The nine subscales (36, 37), each with four

items, examine five adaptive (acceptance, positive focus, planning, positive reappraisal, perspective taking) and four non-adaptive (self-blame, rumination, catastrophizing, blaming others) cognitive emotion regulation mechanisms.

Five facet mindfulness questionnaire (FFMQ): 39-item self-report questionnaire designed to measure mindfulness as a personality trait, the five subscales are observation, description, act with awareness, non-judgment, and non-reactivity (38). We used the scale as one-dimensional.

Beck depression inventory (BDI-S): a 9-item self-report scale measuring the severity of depression on a 4-point Likert scale (0-3 point) from 'not at all' to 'completely agree'. The most reliable cut-off point was found to be 10 points; however, in the case of depression independent of anxiety, the questionnaire already indicates a clinical level from 6 points (39, 40).

Perceived stress scale (PSS4): a 4-question, 5-point Likert scale (0-4 point) asking about thoughts and feelings that characterize a person's perception of stress (41, 42).

Short version of the Barratt Impulsivity Scale (BIS-S-8): an 8-item self-report questionnaire in which the respondent indicates on a four-point Likert scale (1-4 point) how often he or she is likely to make the statement (43, 44).

Paykel suicide scale (PAYKEL): a 5-item self-report questionnaire designed to explore the respondent's suicidal thoughts, ideation and attempts in the past two weeks on a 4-point Likert scale (0-4 point) (45). *Questions on SA*: In addition, separate questions assess whether the respondent has had a suicide attempt in the past, with a yes/no responses. If the respondent answered "Yes" to the last question of the Paykel Suicide Scale, two additional questions were added to the questionnaire: on the frequency of suicide attempts ("If yes, how many times?" [1/2/…/6/more than 6]) and on the method ("How did you make the attempt?").

2.3 Ethics

All subjects were informed about the study, and all provided informed consent. All data were anonymized before processing, and participants had the right to withdraw their data from the research at any time without providing a reason in accordance with the Ethical Code for Psychologists adopted by the Hungarian Psychological Association and the Hungarian Psychological Society. The research was approved by regional and institutional ethical committees.

2.4 Data analysis

Data analysis was conducted with IBM SPSS Statistics 28$^{©}$ and JASP for hierarchical multiple regression analysis. Missing values were excluded from the analysis. A significance level (α) of.05 or less was considered significant. Cronbach's alpha analysis was conducted for reliability assessment of the measurement tools used in the study (Table 1).

As the hypothesis of a normal distribution was rejected (Shapiro-Wilk test), the frequencies of SA and NSSI were categorized as follows. Inmates were classified into four

Variables	Mean (SD)	Cronbach's α
BDI-S	6.011 (5.458)	.842
PAYKEL	2.154 (4.087)	.916
FFMQ	127.265 (17.698)	.858
BIS-S-8	16.398 (4.609)	.746
CERQ adaptive	64.052 (15.706)	.896
CERQ non-adaptive	44.154 (12.516)	.856
PSS4	6.647 (3.243)	.702

BDI-S, Beck Depression Inventory Shortened; PAYKEL, Paykel Suicide Scale; FFMQ, Five Facet Mindfulness Questionnaire; BIS-S-8, Barratt Impulsivity Scale Shortened; CERQ, Cognitive Emotion Regulation Questionnaire; PSS4, Perceived Stress Questionnaire Shortened.

subgroups based on SA and NSSI: 1) major repeater (MR) - total lifetime SA or NSSI ≥ 5, 2) repeated attempter (RA) - total SA or NSSI between 2-4 times, 3) one-time attempter (OA), and 4) non-attempter (NA). Binary logistic regression models with Wald forward method were employed to examine potential differences in psychological characteristics (level of depression, cognitive-emotional strategies, impulsivity, mindfulness skills and perceived stress) among these groups concerning suicidal behavior (MR, RA, OA, or NA in the case of NSSI and SA). There is no collinearity or multi-collinearity between the variables, and we have checked for collinearity prior to the analysis of the binary logistic regression (r<0.62 and VIF=1.068-1.929 in all cases).

Hierarchical multiple regression analyses were conducted to examine four models: the moderating effects of previous NSSI and SA on the relationship between perceived stress and suicide thoughts, and between depression level and suicide thoughts.

3 Results

3.1 Reliability indexes and mean scores

The baseline characteristics of the sample are shown in Table 2. Table 1 shows the reliability indexes and mean scores of scales. All of the baseline Cronbach's alpha scores were appropriate for early stage studies (α>.70) based on recommendation (46). Prisoners have on average mild level of depression, moderate level of suicide thoughts, moderate impulsivity and perceived stress level, with normal adaptive and maladaptive cognitive emotional strategies.

3.2 Characteristics of suicidal behavior

In terms of suicidal behavior, the sample distribution was as follows: 38.4% (N=101) of prisoners had a history of lifetime NSSI. Among them, 38.4% engaged in NSSI once, 35.6% were repeated attempters (RA) with 2-4 attempts, and 31.7% were major repeaters (MR) with at least 5 NSSI incidents during their lifetime. The most

common method of NSSI was cutting (77.2%), followed by hitting themselves till tissue harm (6.9%) and burning themselves (5.9%).

Additionally, 43.3% (N=114) of inmates had attempted suicide previously, with 41.3% being once attempters (OA), 33.3% RA, and 25.4% MR. The most frequent suicide methods were via drugs or self-poisoning (42.1%), cutting (39.5%), and self-hanging (20.2%).

We conducted exploratory binary logistic regression models including all significant psychometric variables such as level of depression, suicide thoughts, mindfulness, emotion regulation skills, impulsivity and perceived stress in relation to the frequency of SA or NSSI (Tables 3, 4). Out of the six models, two were found to be significant with acceptable explanatory power (Nagelkerke R^2 > 0.2). These models examined the characteristics associated with SA (Model 2 and 3).

Individuals who engaged in repeated SA repeatedly during lifetime, exhibited lower level of non-adaptive emotional regulation strategies and elevated level of suicidal ideation compared to NA or OA individuals (Table 4). A similar, yet more pronounced, pattern was observed in the model exploring the characteristics of those with a history of SA. Those who attempted suicide during their life history can be characterized by more intense suicidal thoughts even in the present, and their non-adaptive strategies were lower. Notably, the effect of adaptive strategies was not found to be significant in the model (Table 4).

None of the models explaining previous NSSI demonstrated adequate explanatory power (Nagelkerke R^2 <0.2) (Table 3). Therefore, the observed effects can be considered as potential tendencies that require further investigation. The presence of a higher level of suicidal thoughts, elevated perceived stress, and surprisingly, a higher level of mindfulness skills, appeared to be outlined as tendencies among those who had previously self-injured compared to those who never committed NSSI (Table 4).

3.3 Hierarchical regression analysis: the moderator role of previous suicide behavior to the relationship of depression and suicide ideation

Using hierarchical regression (HR), we analyzed the extent to which the number of suicidal ideations (PAYKEL) is predicted by the level of depression (BDI-S) or perceived stress (PSS4), and how previous NSSI or SA moderates this relationship. No one-dimensional outlier excluding the trial was found in the data based on the outlier labelling rule (Tukey, 1977).

HR model 1 (Figure 1): In the first model we examined the relationship between depression and suicide thoughts (BDI-S ➜ PAYKEL). The initial model was significant (F(2.360) = 82.207 p<.001). Depression explained 31% of the variance in suicidal ideation (R^2Adj = .314). At second level we entered NSSI as a moderator into the model (HR model 1a), which had a significant moderator effect (p<.001). Including the interaction in the model the explained variance increased significantly by 1.2% (F(1.359) = 6.581, p<.05). When examining the interaction of depression on suicidal ideation (BDI-S ➜ PAYKEL) with SA (HR model 1b), the

TABLE 2 Baseline characteristics of the inmate sample (N = 363).

Variable	Frequency / Mean (SD)
Age	39.54 years (range 21-75 ys, SD = 10.07)
Sex (female : male)	48.2% (N= 175) : 51.8% (N = 188)
Education	11.3% lower than basic education 40.5% primary education 43.3% secondary education 5.0% higher education
Marital status	33.1% single 30.0% stable relationship 17.9% married 14.9% divorced 4.1% widowed
Reason of incarceration	46.7% non-violent 53.2% violent
Average time spent in prison during lifetime	84.46 months (SD = 60.66 months)
Time spent in prison during lifetime	9.5% less than a year 12.1% 1-2 years 31.2% 2-5 years 29.0% 5-10 years 18.2% more than 10 years

4 Discussion

Suicidality in prison is a major issue, with incarcerated individuals showing higher lifetime suicide attempt rates compared to the general population [9]. This study explores the connection between suicidality and behavioral addictions, highlighting that recurrent suicidal behavior may function similarly to addiction. Both behaviors involve negative emotions, provide psychological relief, and can become more persistent over time [23–28]. This addiction-like nature of suicidality indicates shared neurobiological mechanisms [25] and highlights the need for targeted interventions within the incarcerated population.

Our multicentre cross-sectional study involved 363 incarcerated individuals. At the study's outset, a standardized Hungarian questionnaire for assessing suicide or NSSI as behavioral addictions was unavailable, and questions regarding addiction posed challenges during the correctional institutions' approval process. Therefore, we assessed the behavioral addiction approach indirectly. We deliberately chose measurement tools—assessing depression, cognitive-emotional regulation, impulsivity, mindfulness skills, perceived stress, and lifetime incidents of self-harm and suicide attempts—to capture multifaceted aspects of suicidal behavior among inmates. These instruments are suitable for assessing both suicidal behavior and the underlying psychological mechanisms of behavioral addiction. The datasheet on SA and NSSI helped assess the frequency and severity of suicidal behaviors. Although inmates could provide open-ended responses for triggers, this method proved unreliable, and the data were not analyzed. A semi-structured interview would likely be more effective. Negative emotions such as emptiness or helplessness and elevated stress levels are primary triggers for both self-harm and addiction [19, 22, 25]. To assess these, we administered the BDI-S and PSS4. The PAYKEL scale provides information on suicidal thoughts, plans, and intentions, central to the second phase of the IMV model [19] in understanding suicidal behavior. From the perspective of behavioral addictions, it offers insights into craving. High impulsivity and emotional dysregulation increase the risk of self-harm, sharing addictive features such as repetition,

moderating effect of previous attempts of suicide was also significant (p<.001) and obtained results were consistent with the previous moderation: including SA in the model increased the explained variance significantly ($F_{(1.359)} = 8.627$, p<.05) by 1.6%.

HR model 2 (Figure 2): In the second model, we examined the relationship between perceived stress and suicide thoughs (PSS4 ➔ PAYKEL), the model was significant ($F_{(2.360)} = 76.326$ p<.001). Perceived stress explained 31% of the variance in suicide (R^2Adj = .317. The effects of the interactions (HR model 2a: NSSI x PSS4 ➔ PAYKEL and HR model 2b: NSSI x PSS4 ➔ PAYKEL) were also significant (p<.001). Including the moderating variables in the model increased the explained variance for both previous SA and NSSI by 2.4%, the increases were significant in both cases [$F_{(1.359)} = 12.83$, p<.001].

TABLE 3 Model coefficients and summary indicators of binary logistic regression models.

	χ^2	df	p	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
Model 1: SA_MR	16.996	2	<.001	158.759	.056	.125
Model 2: SA_RA	46.130	2	<.001	248.660	.145	.229
Model 3: SA_A	74.500	3	<.001	296.936	.224	.312
Model 4: NSSI_MR	9.378	2	.009	175.543	.031	.067
Model 5: NSSI_RA	20.768	3	<.001	276.765	.068	.107
Model 6: NSSI_A	14.097	3	.003	341.284	.047	.067

SA, suicide attempts; NSSI, non-suicidal self-injury; MR, multirepeater attempt as reference category; RA, repeated attempt as reference category; A, attempt of suicide or NSSI in lifehistory as reference category. Method, Wald backward.
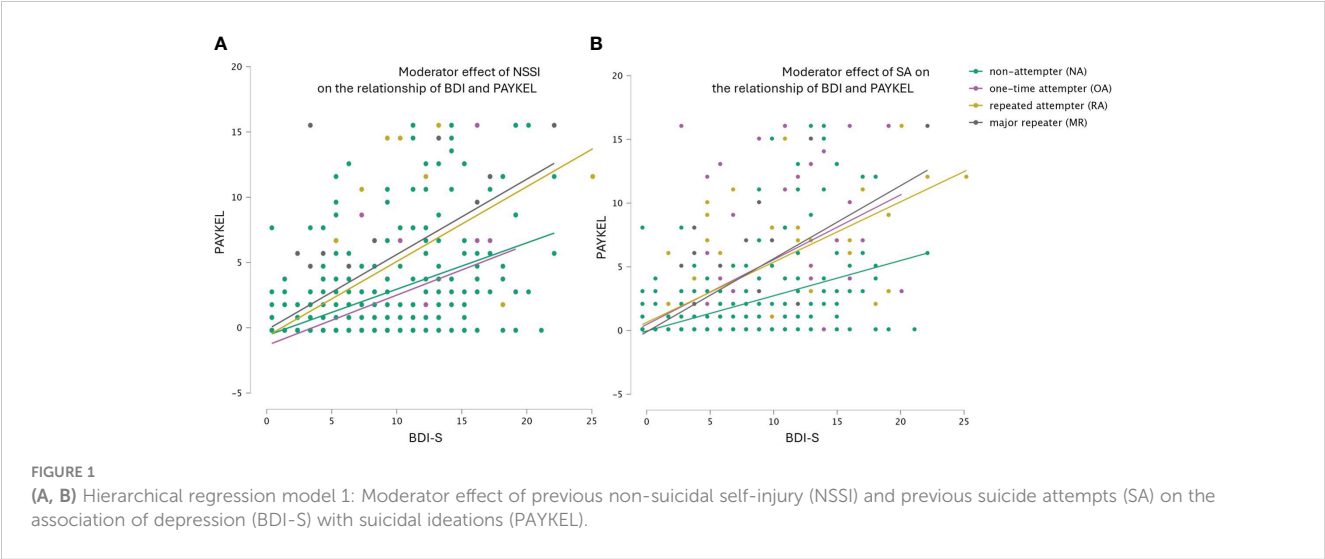
TABLE 4 Statistical indicators of variables in the equation of binary logistic regression models.

	Wald χ^2	p	OR	95% CI
Model 1: SA_MR				
CERQ non-adaptive	9.789	.002	.940	.905-.977
BIS-S-8	4.896	.027	1.106	1.012-1.210
Model 2: SA_RA				
CERQ_non-adaptive	21.608	<.001	.933	.905-.960
PAYKEL	18.122	<.001	1.141	1.074-1.213
Model 3: SA_A				
CERQ adaptive	3.426	.064	1.017	.999-1.035
CERQ non-adaptive	20.388	<.001	.944	.921-.968
PAYKEL	34.679	<.001	1.243	1.156-1.337
Model 4: NSSI_MR				
PAYKEL	9.509	.002	1.137	1.048-1.233
FFMQ	3.796	.051	1.025	1.000-1.050
Model 5: NSSI_RA				
PSS4	3.093	.079	1.105	.989-1.234
PAYKEL	9.134	.003	1.121	1.041-1.208
FFMQ	7.750	.005	1.029	1.008-1.049
Model 6: NSSI_A				
PSS4	5.412	.020	1.124	1.019-1.241
PAYKEL	2.913	.088	1.061	.991-1.135
FFMQ	3.119	.077	1.016	.998-1.033

SA, suicide attempts; NSSI, non-suicidal self-injury; MR, multirepeater attempt as reference category; RA, repeated attempt as reference category; A, attempt of suicide or NSSI in lifehistory as reference category; CERQ, Cognitive Emotional Regulation Questionnaire; BIS-S-8, Barratt Impulsivity Scale Shortened; PAYKEL, Paykel Suicide Scale; FFMQ, Five Facet Mindfulness Questionnaire; PSS4, Perceived Stress Scale; Method: Wald backward.

difficulty stopping, and relief after self-harm. These factors contribute to the persistence and severity of suicidal behaviors, like substance addiction, especially in individuals with a history of trauma or abuse (30–33). These factors relate to the third phase of the IMV model, turning ideas into action (19). To assess these factors, we used the BIS-S-8, CERQ, and FFMQ.

The analysis revealed the prevalence of mild depression, moderate suicidal ideation, and impulsivity, coupled with a notable history of suicide attempts and self-harm among our sample, underscores the urgent need for tailored interventions. Our findings align with the addiction model, which posits that frequent engagement in suicidal behaviors sensitizes individuals to heightened suicidal ideation during stressful periods. This sensitization mirrors the craving concept in substance addictions, highlighting a potential neurobiological basis shared between behavioral and substance dependencies. We observed a prevalence of mild depression, moderate suicide thoughts, moderate impulsivity, and slightly increased perceived stress in the sample. Furthermore, particularly high percentage of the inmates in our sample attempted suicide or committed non-suicidal self-harm during their life history. Nearly half (43.3%) of the participants attempted suicide at least once. This rate is significantly higher than the approximately 10% reported in large sample studies (9), and also it represents an increased risk for suicidal behavior based on the motivation phase of the IMV model of suicidal behavior (19). According to Hungarian data, this phase usually does not turn into the action phase during detention. Based on 2020 data, the completed suicide rate is 0.36 per 100.000 inmates in Hungarian prisons (8), which is among the lowest rates globally (47). Based on the IMV model, this indicates that the system sets a suitable limit for access to the means and that suicide attempts cannot take place under controlled conditions. However, after release, the possibility of access to means increases, as well as impulsive behavior would be controlled less, so the likelihood of suicidal behavior may increase also. The Hungarian example confirms that restrictive actions and control are extremely important in reducing suicidal behavior during detention,
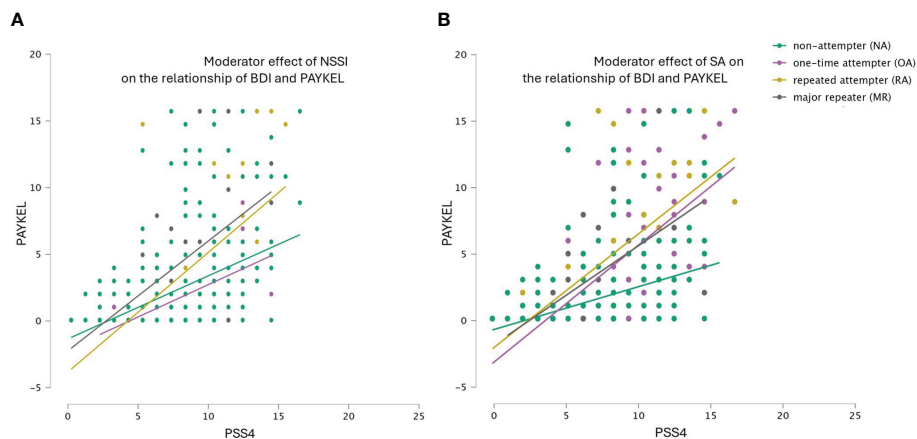

FIGURE 1
(A, B) Hierarchical regression model 1: Moderator effect of previous non-suicidal self-injury (NSSI) and previous suicide attempts (SA) on the association of depression (BDI–S) with suicidal ideations (PAYKEL).

FIGURE 2
(A, B) Hierarchical regression model 2: Moderator effect of previous non-suicidal self-injury (NSSI) and previous suicide attempts (SA) on the association of perceived stress (PSS4) with suicidal ideations (PAYKEL).

however the deeper understanding of motivational factors can also help to reduce the occurrence of later suicidal behavior.

We hypothesized that major repetition (at least 5 times during life history) of suicide attempts (SA) or non-suicidal self-injury (NSSI) would represent a distinct suicidal among repeaters. Our binary logistic analysis did not confirm this hypothesis, but certain trends were identified (Tables 3, 4). A more frequent history of SA in the past (Model 1-3) correlated with a heightened manifestation of suicidal ideation in the present. This result is consistent with the addiction approach, which suggests that more frequent suicidal behavior sensitizes individuals to later suicidal thoughts in stressful life events (25). The elevated level of suicidal ideation involved not only a cognitive aspect but also an urge and planning, as defined by the Paykel Suicidal Thoughts Scale. This characteristic is comparable to cravings in addictions (24–26, 28, 31). Additionally, individuals engaging in repeated SA exhibited lower levels of non-adaptive emotion regulation strategies (Model 2). Suggesting that suicidal behavior may serve an emotion regulation function, particularly accentuated in those with more frequent attempts. Suicide behavior, in this context, may be distinguished from cognitive emotion regulation strategies, potentially taking precedence as a maladaptive coping mechanism.

Regarding NSSI (Model 4-6), similar tendencies in suicidal thinking were observed, but without noticeable differences in emotion regulation strategies. Conversely, perceived stress levels increased, both in the relationship between self-injurious and non-self-injurious individuals and with an escalation in the number of self-injuries in their life history. This could suggest a diminished level of frustration tolerance in those reporting more frequent self-harm. It is crucial to emphasize that these differences are subtle and indicative of trends, warranting further investigation.

Hierarchical regression models (Figures 1, 2) supported the additive model of suicidal behavior. At comparable levels of perceived stress or depression, inmates with a history of more frequent NSSI or SA reported a higher frequency of suicidal thoughts than those with less frequent suicidal behavior throughout their life history. Low distress tolerance or frustration

tolerance are also key factors of substance or behavioral addiction. The difficulty in sustaining negative emotions plays an important role not only in the development of addictive disorders but also in their maintenance and relapses (48, 49). This finding aligns also with the sensitization theory of the addiction approach, suggesting that repeated suicidal behavior may affect neurobiological mechanisms related to stress and relief systems (25).

After release the risk of suicide among former inmates can be seven times higher than in general population (50), that is why it is very important to identify the factors that may be risk factors for later suicide, even during detention. Understanding this aspect is particularly crucial for prisoners, as incarceration often limits access to means and opportunities for suicide, despite the elevated stress levels they may experience (10), inmates are under controlled conditions. However, upon release, this controlled environment dissolves, significantly amplifying the risk of suicide, especially for those who previously relied on this kind of maladaptive emotion regulation patterns. Based on our results, severe repeater inmates are at a higher risk of future suicide attempts. They exhibit a behavioral pattern that resembles addiction, suggesting that their suicidal behavior could be interpreted as a form of dependence. In their cases even minor stressors or depressive episodes can substantially escalate suicidal ideation during the post-release period. The addiction perspective can assist in their treatment, with a focus on addressing specific behavioral and cognitive patterns.

4.1 Limitations

An inherent limitation of our study lies in its cross-sectional design and reliance on retrospective data regarding past instances of self-harm and suicide attempts, which may introduce biases and distortions. Unfortunately, in this study, we were unable to distinguish between the frequency and methods of suicidal behavior occurring before incarceration and those developing since the start of incarceration. However, if future approval processes allow for this distinction, it would be an important

aspect in understanding the background of suicidal behavior in this population.

Another limitation is that a questionnaire directly measuring behavioral addiction was not administered. However, based on the open-ended responses on the datasheet, the quantitative methodology also presents limitations in understanding certain relationships within the prison environment. Given the sensitivity of the subject matter, employing qualitative methods could offer deeper insights into suicidal behavior among prisoners. Nonetheless, the study's multicentric nature and its focus on understanding the suicidal tendencies of a hard-to-reach population contribute to its strength, alongside its relatively large sample size.

4.2 Conclusion

In conclusion, our research examines the factors of the motivational phase of suicidal behavior from the perspective of behavioral addictions. Based on the Hungarian data, it can be seen that institutional-level procedures contribute to keeping suicidal behavior at a low-level during detention. However, the high level of suicidal thoughts, moderate impulsivity and frequency of suicide attempts occurring in the life history in the study sample indicate that it would be advisable to pay attention to the risk factors of the motivational phase during detention to prevent suicide after release. This kind of factors could be improving emotion and impulse regulation or increasing frustration tolerance to decrease the urge to suicidal behaviors in negative emotional states. These findings underscore the necessity of continued research to better comprehend and address the unique challenges faced by incarcerated individuals.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Research Ethics Committee of Semmelweis University (TUKEB number: 92/2015) Directorate of the Hungarian Prison Service Headquarters. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. Favril L, Indig D, Gear C, Wilhelm K. Mental disorders and risk of suicide attempt in prisoners. *Soc Psychiatry Psychiatr Epidemiol*. (2020) 55:1145–55. doi: 10.1007/s00127-020-01851-7

2. Favril L, Yu R, Hawton K, Fazel S. Risk factors for self-harm in prison: A systematic review and meta-analysis. *Lancet Psychiatry*. (2020) 7:682–91. doi: 10.1016/S2215-0366(20)30190-5

3. Habtamu E, Desalegn D. Suicidal behavior and associated factors among prisoners in dilla town, dilla, Ethiopia 2020: an institutional based cross-sectional study. *PloS One*. (2022) 17:15. doi: 10.1371/journal.pone.0267721

4. Zhong S, Senior M, Yu R, Perry A, Hawton K, Shaw J, et al. Risk factors for suicide in prisons: A systematic review and meta-analysis. *Lancet Public Health*. (2021) 6:e164–e74. doi: 10.1016/S2468-2667(20)30233-4

5. Khezri M, Sharifi H, Mirzazadeh A, Mehmandoost S, Hosseini-Hooshyar S, Ghalekhani N, et al. A national study of suicidal ideation and suicide attempt among incarcerated people in Iran. *Int J Ment Health Addict*. (2023) 21:3043–60. doi: 10.1007/s11469-022-00773-6

6. Lehoczki Á. Suicide and self-harm in prison [Öngyilkosság és önkárosítás a börtönvilágban]. *Börtönügyi Szemle*. (2012) 2012:33–40.

7. Lehoczki Á. Analysis of completed suicides in the hungarian correctional system [a magyar büntetés-végrehajtásban történt befejezett szuicidumok elemzése]. *Börtönügyi Szemle*. (2015) 2015:64–75.

8. Rutkai K, Sánta L. Prisoners statistics: data related to incarceration [Fogvatartotti statisztikák: fogvatartással összefüggő Adatok]. *Börtönstatisztikai Szemle*. (2020) 2020:6–10.

9. Castillejos MC, Huertas P, Martín P, Moreno Küstner B. Prevalence of suicidality in the european general population: A systematic review and meta-analysis. *Arch Suicide Res*. (2021) 25:810–28. doi: 10.1080/13811118.2020.1765928

10. Moore KE, Siebert S, Brown G, Felton J, Johnson JE. Stressful life events among incarcerated women and men: association with depression, loneliness, hopelessness, and suicidality. *Health Justice*. (2021) 9:22–. doi: 10.1186/s40352-021-00140-y

11. Marzano L, Hawton K, Rivlin A, Smith EN, Piper M, Fazel S. Prevention of suicidal behavior in prisons: an overview of initiatives based on a systematic review of research on near-lethal suicide attempts. *Crisis*. (2016) 37:323–34. doi: 10.1027/0227-5910/a000394

12. Wolff N, Shi J. Childhood and adult trauma experiences of incarcerated persons and their relationship to adult behavioral health problems and treatment. *Int J Environ Res Public Health*. (2012) 9:1908–26. doi: 10.3390/ijerph9051908

13. Franke I, Vogel T, Eher R, Dudeck M. Prison mental healthcare: recent developments and future challenges. *Curr Opin Psychiatry*. (2019) 32:342–7. doi: 10.1097/yco.0000000000000504

14. Baranyi G, Fazel S, Langerfeldt SD, Mundt AP. The prevalence of comorbid serious mental illnesses and substance use disorders in prison populations: A systematic review and meta-analysis. *Lancet Public Health*. (2022) 7:E557–E68. doi: 10.1016/S2468-2667(22)00093-7

15. Bedaso A, Ayalew M, Mekonnen N, Duko B. Global estimates of the prevalence of depression among prisoners: A systematic review and meta-analysis. *Depress Res Treat*. (2020) 2020:3695209. doi: 10.1155/2020/3695209

16. Fazel S, Seewald K. Severe mental illness in 33,588 prisoners worldwide: systematic review and meta-regression analysis. *Br J Psychiatry*. (2012) 200:364–73. doi: 10.1192/bjp.bp.111.096370

17. van Buitenen N, van den Berg CJW, Meijers J, Harte JM. The prevalence of mental disorders and patterns of comorbidity within a large sample of mentally ill prisoners: A network analysis. *Eur Psychiatry*. (2020) 63:e63–e. doi: 10.1192/j.eurpsy.2020.63

18. Fazel S, Hayes AJ, Bartellas K, Clerici M, Trestman R. Mental health of prisoners: prevalence, adverse outcomes, and interventions. *Lancet Psychiatry*. (2016) 3:871–81. doi: 10.1016/S2215-0366(16)30142-0

19. O'Connor RC, Kirtley OJ. The integrated motivational-volitional model of suicidal behaviour. *Philos Trans R Soc London Ser B Biol Sci*. (2018) 373:1–10. doi: 10.1098/rstb.2017.0268

20. Hasking P, Whitlock J, Voon D, Rose A. A cognitive-emotional model of nssi: using emotion regulation and cognitive processes to explain why people self-injure. *Cogn Emotion*. (2017) 31:1543–56. doi: 10.1080/02699931.2016.1241219

21. Nock MK, Prinstein MJ. A functional approach to the assessment of self-mutilative behavior. *J consulting Clin Psychol*. (2004) 72:885–90. doi: 10.1037/0022-006X.72.5.885

22. Kresznerits S, Zinner-Gérecz Á, Perczel-Forintos D. [Borderline personality disorder and non-suicidal self-injury: the role of mindfulness training in risk reduction]. *Psychiatr Hung*. (2023) 38:142–52.

23. Delgado-Gornez D, Blasco-Fontecilla H, Alegria AA, Legido-Gil T, Artes-Rodriguez A, Baca-Garcia E. Improving the accuracy of suicide attempter classification. *Artif Intell Med*. (2011) 52:165–8. doi: 10.1016/j.artmed.2011.05.004

24. Blasco-Fontecilla H, Artieda-Urrutia P, Berenguer-Elias N, Garcia-Vega JM, Fernandez-Rodriguez M, Rodriguez-Lomas C, et al. Are major repeater patients addicted to suicidal behavior? *Adicciones*. (2014) 26:321–33. doi: 10.20882/adicciones.26.4

25. Blasco-Fontecilla H, Fernández-Fernández R, Colino L, Fajardo L, Perteguer-Barrio R, de Leon J. The addictive model of self-harming (Non-suicidal and suicidal) behavior. *Front Psychiatry*. (2016) 7:8. doi: 10.3389/fpsyt.2016.00008

26. Nixon MK, Cloutier PF, Aggarwal S. Affect regulation and addictive aspects of repetitive self-injury in hospitalized adolescents. *J Am Acad Child Adolesc Psychiatry*. (2002) 41:1333–41. doi: 10.1097/00004583-200211000-00015

27. Himelein-Wachowiak M, Giorgi S, Kwarteng A, Schriefer D, Smitterberg C, Yadeta K, et al. Getting "Clean" from nonsuicidal self-injury: experiences of addiction on the subreddit R/selfharm. *J Behav Addict*. (2022) 11:128–39. doi: 10.1556/2006.2022.00005

28. Guérin-Marion C, Martin J, Deneault A-A, Lafontaine M-F, Bureau J-F. The functions and addictive features of non-suicidal self-injury: A confirmatory factor analysis of the ottawa self-injury inventory in a university sample. *Psychiatry Res*. (2018) 264:316–21. doi: 10.1016/j.psychres.2018.04.019

29. Goodman A. Addiction: definition and implications. *Br J Addict*. (1990) 85:1403–8. doi: 10.1111/j.1360-0443.1990.tb01620.x

30. Washburn JJ, Juzwin KR, Styer DM, Aldridge D. Measuring the urge to self-injure: preliminary data from a clinical sample. *Psychiatry Res*. (2010) 178:540–4. doi: 10.1016/j.psychres.2010.05.018

31. Faye P. Addictive characteristics of the behavior of self-mutilation. *J psychosocial Nurs Ment Health Serv*. (1995) 33:36–9. doi: 10.3928/0279-3695-19950601-08

32. Liu J, Gao Y, Liang C, Liu X. The potential addictive mechanism involved in repetitive nonsuicidal self-injury: the roles of emotion dysregulation and impulsivity in adolescents. *J Behav Addict*. (2022) 11:953–62. doi: 10.1556/2006.2022.00077

33. Ying W, Shen Y, Ou J, Chen H, Jiang F, Yang F, et al. Identifying clinical risk factors correlated with addictive features of non-suicidal self-injury among a consecutive psychiatric outpatient sample of adolescents and young adults. *Eur Arch Psychiatry Clin Neurosci*. (2024) 274:291–300. doi: 10.1007/s00406-023-01636-4

34. Viechtbauer W, Smits L, Kotz D, Budé L, Spigt M, Serroyen J, et al. A simple formula for the calculation of sample size in pilot studies. *J Clin Epidemiol*. (2015) 68:1375–9. doi: 10.1016/j.jclinepi.2015.04.014

35. Garnefski N, Kraaij V. The cognitive emotion regulation questionnaire: psychometric features and prospective relationships with depression and anxiety in adults. *Eur J psychol Assess*. (2007) 23:141–9. doi: 10.1027/1015-5759.23.3.141

36. Geisler FCM, Vennewald N, Kubiak T, Weber H. The impact of heart rate variability on subjective well-being is mediated by emotion regulation. *Pers Individ Dif*. (2010) 49:723–8. doi: 10.1016/j.paid.2010.06.015

37. Miklósi M, Martos T, Kocsis-Bogár K, Perczel Forintos D. A kognitív érzelem-reguláció Kérdőív magyar változatának pszichometriai jellemzői. *Psychiatria Hungarica*. (2011) 26:102–11.

38. Baer RA, Smith GT, Hopkins J, Krietemeyer J, Toney L. Using self-report assessment methods to explore facets of mindfulness. *Assessment*. (2006) 13:27–45. doi: 10.1177/1073191105283504

39. Rózsa S, Szádóczky E, Füredi J. Psychometric properties of the hungarian version of the shortened beck depression inventory. *Psychiatria Hungarica*. (2001) 16:384–402.

40. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. *Arch Gen Psychiatry*. (1961) 4:561–71. doi: 10.1001/archpsyc.1961.01710120031004

41. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav*. (1983) 24:385–96. doi: 10.2307/2136404

42. Stauder A, Konkoly Thege B. Az észlelt stressz kérdőíve (Pss) magyar verziójának jellemzői. *Mentálhigiéné és Pszichoszomatika*. (2006) 7:203–16. doi: 10.1556/Mental.7.2006.3.4

43. Steinberg L, Sharp C, Stanford MS, Tharp AT. New tricks for an old measure: the development of the barratt impulsiveness scale-brief (Bis-brief). *psychol Assess*. (2013) 25:216–26. doi: 10.1037/a0030550

44. Horváthné Pató I, Szekeres T, Kresznerits S, Perczel-Forintos D. [the barratt impulsiveness scale-brief-8 in an incarcerated sample: suicide risk, impulsivity and mindfulness]. *Psychiatr Hung*. (2023) 38:203–17.

45. Paykel ES, Myers JK, Lindenthal JJ, Tanner J. Suicidal feelings in the general population: A prevalence study. *United Kingdom: R Coll Psychiatrists*. (1974) 124:460–9. doi: 10.1192/bjp.124.5.460

46. Nunnally JC, Bernstein IH. *Psychometric theory. 3rd Edition*. New York: McGraw-Hill (1994).

47. Fazel S, Ramesh T, Hawton K. Suicide in prisons: an international study of prevalence and contributory factors. *Lancet Psychiatry*. (2017) 4:946–52. doi: 10.1016/s2215-0366(17)30430-3

48. Kim HS, Hodgins DC. Component model of addiction treatment: A pragmatic transdiagnostic treatment model of behavioral and substance addictions. *Front Psychiatry*. (2018) 9:406. doi: 10.3389/fpsyt.2018.00406

49. Ramirez-Castillo D, Garcia-Roda C, Guell F, Fernandez-Montalvo J, Bernacer J, Morón I. Frustration tolerance and personality traits in patients with substance use disorders. *Front Psychiatry*. (2019) 10:421. doi: 10.3389/fpsyt.2019.00421

50. Janca E, Keen C, Willoughby M, Borschmann R, Sutherland G, Kwon S, et al. Sex differences in suicide, suicidal ideation, and self-harm after release from incarceration: A systematic review and meta-analysis. *Soc Psychiatry Psychiatr Epidemiol*. (2023) 58:355–71. doi: 10.1007/s00127-022-02390-z

Nonsuicidal self-injury as the gateway and consequence of suicidal ideation among adolescents: a cross-lagged regression analysis

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Background: There is a consensus that both nonsuicidal self-injury (NSSI) and suicidal ideation as risk factors for suicidal behavior have a strong connection. However, a lack of longitudinal information has limited the clarification of the concrete relationship between them.

Aims: This study aimed to examine the specific mechanism between NSSI and suicidal ideation over time, during adolescence.

Method: A longitudinal study was conducted with 193 Chinese adolescents. NSSI and suicidal ideations were examined over the course of a 1year followed-up, and three waves of data were collected.

Results: The NSSI at time T1 significantly positively predicted suicidal ideation at time T2; Suicidal ideation at time T2 also significantly positively predicted NSSI at time T3.

Limitations: Given that the small number of participants with suicidal ideation and NSSI, the findings of the study should be interpreted with caution and a lager sample is needed in the future.

Conclusion: It was suggested that NSSI may occur before suicidal ideation, which in turn would strengthen NSSI, so interventions should be carried out from two aspects (behaviors and thoughts) to improve adolescents' mental health.

Introduction

NonSuicidal Self-Injury (NSSI) refers to a series of behaviors that directly, intentionally, and repeatedly harm one's own body without suicidal intention, including cutting, scratching, burning, and other intentional destruction of body tissues, which is not socially acceptable (1, 2). The destructive consequences of NSSI make it extremely dangerous (3). For instance, NSSI is one of the most important risk factors for suicide (4–6). Although the purpose of self-injury is not suicide, individuals who engage in NSSI are much more likely to commit suicide or suicide attempts than others (7–10). A longitudinal study found that the risk of suicide in the first year was 0.7% in NSSI, which is 66 times higher than in the general population and the risk of suicide increased to 3% fifteen years later (11). Previous research also finds that NSSI and suicide are closely linked since 10% to 37% of NSSI patients attempt suicide at some point in their lives (12, 13). As a key stage of individual development, it is very important to pay attention to the issue of adolescents' NSSI.

A large amount of evidence has confirmed that adolescents are at high risk of NSSI (4, 14, 15). Adolescents may have more vulnerability to be impulsive and with less mental resilience in the state of psychological and physiological immaturity (16). They cannot properly manage their negative emotions and some of them are prone to performing some extreme NSSI behaviors (17, 18). The incidence of NSSI was approximately 4% in the general population (19) and was much more common (13.9% ~ 40.2%) in adolescents (20, 21). As a major public health concern, the rate of NSSI in adolescents is on the rise in both China and Western countries (22, 23). Meanwhile, the occurrence of NSSI varies by region. The prevalence of NSSI among Chinese adolescents (31.4%~57.4%) is higher than that in Western countries (2, 14). NSSI is a repetitive behavior, as 55.1% of the group who engaged in the behavior at baseline continued to partake in NSSI in the following 6 months, while the proportion of adolescents seeking assistance in preventing was very small (24).

There was no doubt that NSSI and suicidal ideation are closely related. Studies have shown that the presence and frequency of NSSI can predict suicidal ideation (25, 26). Regarding NSSI itself, studies have shown that individuals who engaged in self-injury are more likely to report simultaneous suicidal ideation with an odds ratio of 8.39 (27). Research in a sample of 1,561 adolescents aged 14–24 years also suggested who engaging in NSSI had a high risk for suicidal ideation and some of its affecting factors, such as depression (28). To date, most studies focused on suicidal ideation and NSSI as co-occurrence variables (29), but there was little research on the time dimension mechanism between them. NSSI was seen in some studies as one of the most robust predictors of both suicidal thoughts and behaviors (30, 31); however, it seems less solid as a predictor in other studies (32, 33). A recent study using the ecological momentary assessment (EMA) to monitor a sample of borderline personality disorder patients for 7 days found that NSSI reduced suicidal ideation within the next few hours (34). Thus, the confusion lies not only in whether NSSI increases or decreases suicidal ideation, but also the near absence of longitudinal research

considering the role of suicidal ideation in NSSI. It is also unclear to consider only the relationship between the two, because previous studies have confused suicidal ideation and behavior, as well as other mental disorders.

Given that there is currently no agreed-upon theory to explain the relationship between adolescents' NSSI and suicidal ideation, we can only hypothesize the link between them with some existing theories. The interpersonal psychological theory of suicide (IPTS) emphasized NSSI can be considered as an indispensable "gateway or tool" for individuals to improve their acquired ability for engaging suicide (35, 36). An integrated model, consistent with IPTS, is used to understand acquired capability for suicide will at least partially mediate the link between NSSI and suicidal behavior (30). Neuroimaging evidence showed that the pain processing of self-injured individuals was abnormal, and pain could be seen as a reward to explain their repeated addictive NSSI (37). Several studies have demonstrated that individuals with a repeated history of NSSI exhibit greater pain tolerance and pain thresholds (i.e., less fear of pain) (38–40). A questionnaire survey of inpatient psychiatric sample proved that NSSI can predict suicide readiness by increasing individual pain tolerance and fearless of death (41). The above evidence showed that if NSSI and suicidal behavior exist as a continuous process, then NSSI should be considered as the development before suicidal behavior (10, 12). Based on the IPTS, the present study hypothesized that NSSI would predict suicidal ideation later.

How the NSSI develops when individuals arise suicidal ideation is also a concern. According to the experiential avoidance model (EAM) of NSSI, in order to escape from unpleasant emotional experiences, individuals engage in NSSI and strengthen this behavior (42, 43). Specifically, when individuals faced with a similar situation again, NSSI would be an automatic escape reaction (44). Adolescents with NSSI have undeniable defects in emotional regulation, and they may experience more negative emotions (45). Suicidal ideation is often inseparable from certain negative emotions (depression, hopelessness, anxiety, etc.) (46–48). When strong suicidal ideation cannot be dispelled, NSSI may be consequence for adolescents to reduce negative effects. Thus, this study hypothesized that current suicidal ideation would predict subsequent NSSI.

In summary, the purposes of this study are to answer three questions: (1) whether there is a relationship between suicidal ideation and NSSI at any point in time; (2) whether NSSI would predicts later suicidal ideation; and (3) whether current suicidal ideation predicted subsequent NSSI.

Materials and methods

Participants and procedure

For the current study, we conducted a prospective longitudinal study of adolescents from a middle school in Tianjin, China through three measurements. The first measurement was conducted in the fourth week of the second semester from 2016 to 2017 academic year.

Data were collected as part of a school-wide psychological assessment of a middle school. All procedures and ethical aspects of this study were approved by ethics committee of the Academy of Psychology and Behavior of Tianjin Normal University (XI2020–03) and the middle school. To avoid discomfort of participants, all questions about suicidal ideation and NSSI behaviors were intermixed with other items. The on-site hosts and supervisors were some postgraduate psychology students who had received specific training in advance. Before filling in the questionnaires, participants were given a brief description of the study and told that the answers would be confidential. In principle of voluntary participation, all participants also filled out informed consent forms for their participation. And they were given a small gift in return for completing the questionnaire.

Measures

Demographics

Participants completed a demographic questionnaire that assessed age, sex, family economic status (compared to the local average level), one-child in family, household type, national, regions.

Suicide ideation

One item of the Suicide ideation/suicide attempt questionnaire were drawn for measuring how often adolescents thought about suicide in the past week. This item used a four-point scale (1 = occasionally or none; 2 = sometimes; 3 = often; 4 = duration), the higher the score, the stronger the suicidal ideation. Although the scale has only one item for measuring suicidal ideation, it is widely used in suicide research (49, 50). In this study, all items were in Chinese.

NSSI

NSSI was measured by the Adolescents Self-Harm Scale (ASHS), which was well used in Chinese research (51). We chose 3 items to assess adolescents' self-injury from the scale, such as " Have you ever intentionally cut, burned, slashed yourself, or hurt yourself in any other way?", "Have you ever intentionally poked open a wound to stop it from healing?" and "Have you ever hurt yourself physically by intentionally letting someone else hit or bite you?" Participants needed to response every item in " Yes " or "No". In this study, all items were in Chinese.

Data analytic strategy

Firstly, descriptive analyses were examined including bivariate correlations between suicidal ideation and NSSI behaviors and demographic characteristics of participants in SPSS24.0. In addition, we use kurtosis and skewness to test if the data are normally distributed. It can be considered as a normal distribution when the two metrics are closer to zero.

Although suicide ideation has been associated with NSSI behaviors in previous studies, these studies have not established a causal relationship (i.e., whether NSSI behaviors is affected by suicide ideation, or whether suicide ideation is affected by NSSI behaviors). The relationship between two or more observational variables over time can be analyzed using an autoregressive cross-lag model. Therefore, this study constructed a three-wave cross-lagged model to clarify the issue with M-plus7.0.

According to the analysis procedure of van Lier et al. (52), we constructed four models. And we analyzed differences in global model fit between them to examine contributions longitudinally of each predictive path. The first model (M1) is a autoregressive model (baseline model) specifying no cross-lagged longitudinal effects. The second model (M2) only contains the cross-lagged regression path from X (suicidal ideation) to Y (NSSI) in one direction, and the others are the same as M1. The third model (M3) only contains the cross-lagged regression path from Y (NSSI) to X (suicidal ideation) in one direction, and the others are the same as M1. The fourth model (M4) is the full model, which both includes the cross-lagged regression path from X to Y and from Y to X.

The model analysis adopted the maximum likelihood estimator with robust standard errors (MLR), which is suitable for non-normal distribution and non-independent data and can provide statistical indicators such as standard error and chi-square value for the non-normal data and process the missing data at the same time (53). Four criteria were used to evaluate the fit of the model (54, 55): the chi-square (χ^2; less degrees of freedom suggests a good fit), the comparative fit index (CFI ≥ 0.95 suggests a good fit), the root-mean-square error of approximation (RMSEA < 0.08 suggests a good fit), and the standardized root-mean-square residual (SRMR ≤ 0.08 suggests a good fit).

Results

Descriptive statistics

A total of 293 paper-and-pencil version questionnaires were issued and 271 were effectively collected (valid response rate: 92.49%), including 140 boys and 131 girls. The second measurement was conducted in the fourth week of the first semester of the 2017–2018 academic year, and 231 people were tracked, with a tracking rate of 85.24%. Participants include 113 boys and 118 girls, 40 of whom were lost. The third measurement was conducted in the fourth week of the second semester of the 2017–2018 academic year, and 193 people were tracked, with a tracking rate of 83.55%. It includes 95 boys and 98 girls, 38 of whom were lost. The average age in this final sample was 14.45 years (SD = 0.61). Other demographic characteristics were outlined in Table 1.

The results of an independent sample t-test showed no significant difference in suicidal ideation and NSSI behaviors ($p > 0.05$) between subjects for whom data were excluded and retained, indicating that was random.

In addition, the results of skewness and kurtosis showed that not all variables at all-time points conform to normal distribution. Other descriptive characteristics were outlined in Table 2.

TABLE 1 Demographic characteristics of sample.

	N	Percentage
Gender		
Male	*98*	*49.20%*
Female	*98*	*50.80%*
Family economic status (Compared to the local average level)		
Far above	1	0.50%
Slightly above	40	20.70%
Average level	130	67.40%
Slightly below	20	10.40%
Far below	2	1.00%
Household type		
The nuclear family	141	73.10%
Single parent families	8	4.10%
Others	44	22.80%
One-child in family		
Yes	62	32.10%
No	131	67.90%
National		
Han	188	97.40%
Manchu	2	1.00%
Others	3	1.60%
Regions		
urban	73	37.80%
rural	120	62.20%

Correlation analysis of variables

Bivariate correlations between suicidal ideation and NSSI behaviors were presented in Table 3. The correlation of suicidal ideation between time points T1, T2 and T3 was significant, which the correlation coefficient was 0.30 ~ 0.50; There was also a significant correlation between NSSI behaviors at time points T1,

T2 and T3, with the correlation coefficient of 0.53 ~ 0.66. The above data show a certain stability of suicidal ideation and NSSI levels of adolescents. Table 3 also showed a significant contemporaneity correlation between suicidal ideation and NSSI at time points T1, T2, and T3. At the same time, the stepwise correlation between them at T1, T2 and T3 was also significant.

Cross-lagged model analysis of variables

In the environment of M-plus7.0, Cross-lagged analysis was used to explore the relationship between suicidal ideation and NSSI of adolescents. The model fitting information of each competition model (M1-M4) was shown in Table 4.

First, a baseline model (M1) was tested to estimate the stability coefficient of the relationship between suicidal ideation and NSSI in adolescents. The Cross-lagged paths of two variables at three time points were not examined. Baseline model (M1) fit indices was: χ^2 (9) = 22.021, p = 0.009, CFI = 0.925, RMSEA = 0.087, SRMR = 0.095. The model fit indices was not good and was not easy to be accepted.

Next, based on the baseline model, model 2 (M2: the cross-lagged regression path from suicidal ideation to NSSI in one direction) and model 3 (M3: the cross-lagged regression path from NSSI to suicidal ideation in one direction) are investigated respectively. Compared with M1, the results of these two models have improved but still indicated a lack of perfect fit: $\Delta\chi^2_{(M2-M1)}$ = 6.22, $\Delta df_{(M2-M1)}$ = 2, p = 0.045; $\Delta\chi^2_{(M3-M1)}$ = 5.81, $\Delta df_{(M3-M1)}$ = 2, p = 0.055.

Finally, stability and all cross-lagged path (M4) of that relationship between suicidal ideation and NSSI of adolescents were simultaneously detect. The results of M4 showed that the model fit was good: χ^2(5) = 10.029, p = 0.074, CFI = 0.971, RMSEA = 0.072, SRMR = 0.037. Again, compared with M1,the results were $\Delta\chi^2_{(M4-M1)}$ = 12.01, $\Delta df_{(M4-M1)}$ = 4, p = 0.017.This indicated that there are significant differences between two models, and M4 were the best one to reflect the relationship between variables among all the models. Therefore, model 4 served as the final model we use for analysis.

Figure 1 presented the results of the cross-lagged analysis of the model 4. NSSI (0.59 ~ 0.63) was more stable than suicidal ideation (0.22 ~ 0.49). The NSSI at time T1 significantly positively predicted suicidal ideation at time T2. Suicidal ideation at time T2 also significantly positively predicted NSSI at T3.

TABLE 2 Means, standard deviations, ranges, skewness, kurtosis.

	T1 SI	T2 SI	T3 SI	T1 NSSI	T2 NSSI	T3 NSSI
Percentage	25.90%	21.20%	28.00%	20.20%	16.10%	20.20%
M ± SD	1.45 ± 0.88	1.32 ± 0.70	1.46 ± 0.83	0.29 ± 0.65	0.23 ± 0.61	0.33 ± 0.72
Range	1–4	1–4	1–4	0–3	0–3	0–3
Kurtosis	1.99	2.44	1.68	2.5	2.96	2.25
Skewness	2.87	5.59	1.7	6.01	8.93	4.24

T1 SI, Time 1 Suicidal Ideation; T2 SI, Time 2 Suicidal Ideation; T3 SI, Time 3 Suicidal Ideation; T1 NSSI, Time 1 NonSuicidal Self-Injury Behaviors; T2 NSSI, Time 2 NonSuicidal Self-Injury Behaviors; T3 NSSI, Time 3 NonSuicidal Self-Injury Behavior.

TABLE 3 Correlations of study variables.

	T1 SI	T2 SI	T3 SI	T1 NSSI	T2 NSSI	T3 NSSI
T1 SI	–					
T2 SI	0.30***	–				
T3 SI	0.28***	0.50***	–			
T1 NSSI	0.39***	0.29***	0.24***	–		
T2 NSSI	0.33***	0.27***	0.17***	0.63***	–	
T3 NSSI	0.23***	0.30***	0.26***	0.53***	0.66***	–

T1 SI, Time 1 Suicidal Ideation; T2 SI, Time 2 Suicidal Ideation; T3 SI, Time 3 Suicidal Ideation; T1 NSSI, Time 1 NonSuicidal Self-Injury Behaviors; T2 NSSI, Time 2 NonSuicidal Self-Injury Behaviors; T3 NSSI, Time 3 NonSuicidal Self-Injury Behaviors.
***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, same as below.

Discussion

The stability of suicidal ideation and NSSI among adolescents

The bivariate correlation analysis showed that the correlation between suicidal ideation and NSSI was higher and higher at the three time points. This suggested that the levels of suicidal ideation and NSSI among adolescents are somewhat stable across time, in line with the differential activation theory of suicidality (DAT), which believed that suicidal ideation occurs repeatedly (56). In particular, the study found that individuals with depression also have an extremely high recurrence rate of suicidal ideation (57–59). In a longitudinal study of the epidemiology of suicidal ideation among urban and rural Chinese adolescents, age and suicidal ideation history were the only predictors of future suicidal ideation (60). According to the EAM of NSSI, it has the function of emotion management (42, 44). This meant that before NSSI, adolescents usually had strong negative experiences such as frustration, depression, helplessness and stress, while after NSSI, negative experiences are alleviated or eliminated, and the adolescents felt relieved and relaxed (45, 61). This process was seen as a reinforcing effect, meaning that the same behavior will happen again in a similar situation (42, 62).

Therefore, it was not difficult to understand that the suicidal ideation and NSSI of adolescents will occur repeatedly when adolescents continuously face situations, such as academic pressure and unhealthy interpersonal relationships, that evoke negative emotions over a long period.

NSSI as a gateway of suicidal ideation among adolescents

The results of the cross-lagged model analysis showed that NSSI at time T1 significantly positively predicted suicidal ideation at time T2. This indicated that the more NSSI adolescents experienced, the higher the possibility of suicidal ideation. Since adolescents are not mature, physically and mentally, they are more likely to be affected by a sense of perceived burdensomeness and thwarted belongingness (63, 64). However, these two feelings alone were not enough to make adolescents develop thoughts about suicide (35). Adolescents who engaged in NSSI were more likely to have suicidal thoughts than those who did not (23). In line with the opinion of IPTS, NSSI was a gateway to suicidal ideation in adolescents (31, 35). NSSI is caused not only by negative events, but also by adolescents' curious and rebellious nature. Furthermore, repeated NSSI gave adolescents a higher pain tolerance and an acquired capability for suicide (by

FIGURE 1
Graph of cross-lagged model of suicidal ideation and nonsuicidal self-injury. All coefficients are standardized regression coefficients (β); Behind the coefficient is standard error (*SE*); One-way arrow solid line indicates the effect is significant, dotted line indicates the effect is not significant.
***p < 0.001, **p < 0.01, *p < 0.05.
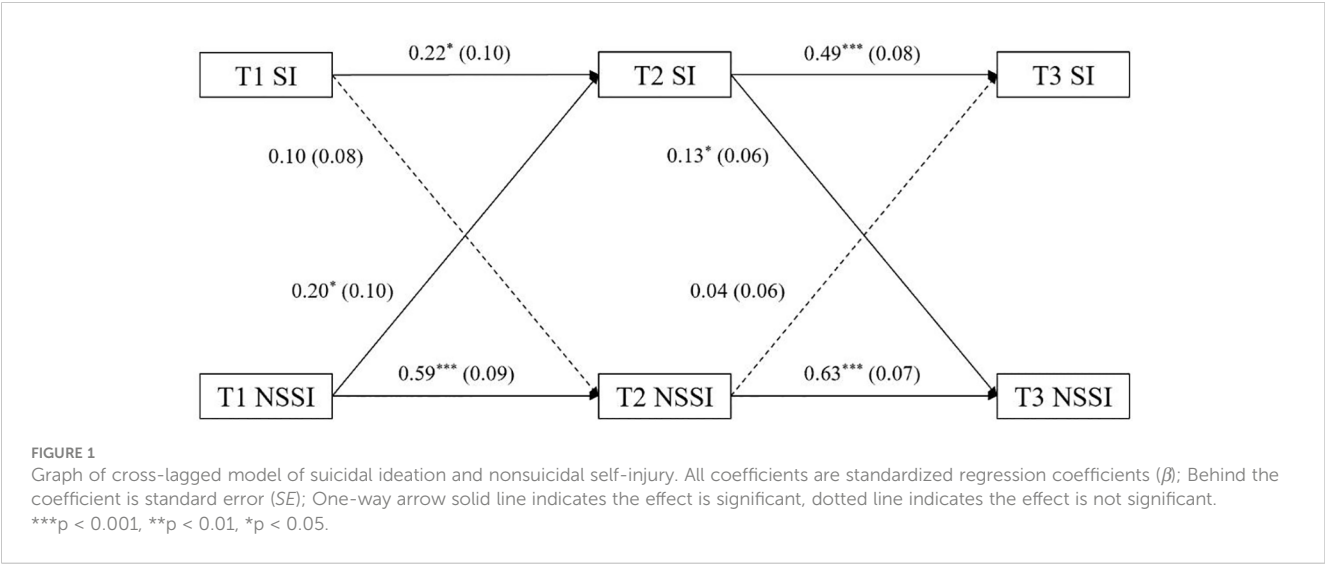
TABLE 4 Model fit indices of the three-wave panel model.

Model	χ^2	p	df	CFI	TLI	RMSEA	SRMR	$\Delta\chi^2$	p	Δdf	Scaling Correction Factor
M1	22.021**	0.009	9	0.925	0.884	0.087	0.095	–	–	–	1.37
M2	15.751*	0.028	7	0.950	0.900	0.080	0.075	6.22*	0.045	2	1.36
M3	16.238*	0.023	7	0.947	0.894	0.083	0.060	5.81	0.055	2	1.38
M4	10.029	0.074	5	0.971	0.919	0.072	0.037	12.01*	0.017	4	1.37

χ^2, Scaled Chi-Square; df, Degrees of Freedom; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; RMSEA, Root Mean Square Error of Approximation; SRMR, Standardized Root Mean Square Residual; $\Delta\chi^2$, Satorra-Bentler Chi-Square Difference Test.
***p < 0.001, **p < 0.01, *p < 0.05.

overcoming the internal fear) (65). As a result, NSSI is transformed into suicidal ideation.

NSSI as a consequence of suicidal ideation among adolescents

Another result of the cross-lagged model analysis showed that suicidal ideation at time T2 also significantly positively predicted NSSI at timeT3. This suggested that NSSI was not only the cause of suicidal ideation, but also the result of suicidal ideation. It was unclear the effect of suicidal ideation on NSSI. In order to avoid the influence of negative emotions in suicidal ideation, adolescents adopt the way of NSSI to alleviate negative feelings according the EAM of NSSI (42, 45). However, the NSSI at this time has an inherent essential difference from the first one, and it is riskier. That's another question. Why the NSSI at time T1 and suicidal ideation at time T2 significantly and positively predicted suicidal ideation at time T2 and NSSI at time T3 separately, but neither suicidal ideation at time T1and the NSSI at time T2 significantly and positively predicted NSSI and suicidal ideation at time T3 separately. Our study suggested that suicidal ideation and NSSI can predict each other in the longitudinal, but this relationship is a chronological. Briefly, a series of effects after this all depend on the first cause of NSSI. Therefore, strengthening the prevention and intervention of Chinese adolescents' NSSI plays an extremely important role in the occurrence of suicidal ideation and behaviors (2, 23).

Limitations

There are still several limitations should also be mentioned, though this study has some merit. First, the measurement tools we used are all simple questionnaires, which needs to be validated in future studies, and more complete measurement tools can be adopted in the future research. For example, we can consider the relationship between the frequency and pattern of NSSI and suicidal ideation. Second, our sample was one of convenience with Chinese adolescents, and it is not clear to what extent the results of our research are applicable to other Chinese people. In addition, given that the small number of participants with suicidal ideation and NSSI, the findings of the study should be interpreted with caution

and a lager sample is needed to be collected and analyzed in the future. Thirdly, due to the inherently dynamic nature of suicide ideation (66, 67), although cross-lagged model can help us observe changes in suicidal ideation and self-injury, shorter observation times could be adopted in the future.

Conclusions

In this study, NSSI and suicidal ideation over a long period of time among adolescents were analyzed together. Our study suggested that, if the occurrence and development of NSSI and suicidal ideation were regarded as a linear process, there was a reciprocally predictive relationship between them. NSSI may occur before suicidal ideation, which in turn would strengthen NSSI. This also prompted that interventions should be carried out from two aspects (behaviors and thoughts) to improve adolescents' mental health.

Data availability statement

The datasets presented in this article are not readily available because of participant confidentiality and privacy. Requests to access the datasets should be directed to linlin@tjnu.edu.cn.

Ethics statement

The studies involving humans were approved by the ethics committee of the Academy of Psychology and Behavior of Tianjin Normal University. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

ZX: Writing – original draft, Writing – review & editing, Methodology, Conceptualization, Formal analysis. NL: Formal analysis, Methodology, Software, Visualization, Writing – original draft, Writing – review & editing. YK: Formal analysis, Methodology,

Visualization, Writing – review & editing. LL: Investigation, Methodology, Writing – review & editing, Software. YL: Writing – review & editing, Data curation, Software. HZ: Writing – review & editing, Data curation, Software. YH: Writing – review & editing, Data curation. SZ: Writing – review & editing, Conceptualization, Funding acquisition, Project administration, Supervision.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. Nock MK. Self-injury. *Annu Rev Clin Psychol*. (2010) 6:339–63. doi: 10.1146/annurev.clinpsy.121208.131258

2. Jiang GR, Yu LX, Zheng Y, Feng Y, Ling X. The current status, problems and recommendations on non-suicidal self-injury in China. *Adv psychol Sci*. (2011) 19:861–73. doi: 10.3724/SP.J.1042.2011.00861

3. Cipriano A, Cella S, Cotrufo P. Nonsuicidal self-injury: A systematic review. *Front Psychol*. (2017) 8:1946. doi: 10.3389/fpsyg.2017.01946

4. Hawton K, Saunders KEA, O'Connor RC. Self-harm and suicide in adolescents. *Lancet*. (2012) 379:2373–82. doi: 10.1016/S0140-6736(12)60322-5

5. Ribeiro JD, Franklin JC, Fox KR, Bentley KH, Kleiman EM, Chang BP, et al. Self-injurious thoughts and behaviors as risk factors for future suicide ideation, attempts and death: A meta-analysis of longitudinal studies. *Psychological Medicine*. (2016) 46:225–36. doi: 10.1017/S0033291715001804

6. Baer MM, Lacroix JM, Browne JC, Hassen HO, Perera KU, Weaver J, et al. Non-suicidal self-injury elevates suicide risk among United States military personnel with lifetime attempted suicide. *Arch Suicide Res*. (2017) 22:453–64. doi: 10.1080/13811118.2017.1358225

7. Sinclair JMA, Hawton K, Gray A. Six year follow-up of a clinical sample of self-harm patients. *J Affect Disord*. (2010) 121:247–52. doi: 10.1016/j.jad.2009.05.027

8. Stewart JG, Esposito EC, Glenn CR, Gilman SE, Pridgen B, Gold J, et al. Adolescent self-injurers: Comparing non-ideators, suicide ideators, and suicide attempters. *J Psychiatr Res*. (2017) 84:105–12. doi: 10.1016/j.jpsychires.2016.09.031

9. Halicka J, Kiejna A. Non-suicidal self-injury (NSSI) and suicidal: Criteria differentiation. *Adv Clin Exp Med*. (2018) 27:257–61. doi: 10.17219/acem/66533

10. Bahamdan A, Aldhawyan A. Non-suicidal self-injurious behavior among the Saudi population: A systematic review. *F1000Research*. (2022) 11:1–9. doi: 10.12688/f1000research.106946.1

11. Hawton K, Zahl D, Weatherall R. Suicide following deliberate self-harm: Long-term follow-up of patients who presented to a general hospital. *Br J Psychiatry*. (2003) 182:537–42. doi: 10.1192/bjp.182.6.537

12. Asarnow JR, Porta G, Spirito A, Emslie G, Clarke G, Wagner KD, et al. Suicide attempts and nonsuicidal self-injury in the treatment of resistant depression in adolescents: Findings from the TORDIA study. *J Am Acad Child Adolesc Psychiatry*. (2011) 50:772–81. doi: 10.1016/j.jaac.2011.04.003

13. Wilcox HC, Arria AM, Caldeira KM, Vincent KB, Pinchevsky GM, O'Grady KE. Longitudinal predictors of past-year non-suicidal self-injury and motives among college students. *psychol Med*. (2011) 42:717–26. doi: 10.1017/S0033291711001814

14. Han AZ, Xu G, Su PY. A Meta-analysis of characteristics of nonsuicidal selfinjury among middle school students in mainland China. *Chin J School Health*. (2017) 38:1665–70. doi: 10.16835/j.cnki.1000-9817.2017.11.019

15. Muehlenkamp JJ, Xhunga N, Brausch AM. Self-injury age of onset: A risk factor for NSSI severity and suicidal behavior. *Arch Suicide Res*. (2019) 23:551–63. doi: 10.1080/13811118.2018.1486252

16. Royuela-Colomer E, Fernández-González L, Orue I. Longitudinal associations between internalizing symptoms, dispositional mindfulness, rumination and impulsivity in adolescents. *J Youth Adolescence*. (2021) 50:2067–78. doi: 10.1007/s10964-021-01476-2

17. Tatnell R, Hasking P, Newman L, Taffe J, Martin G. Attachment, emotion regulation, childhood abuse and assault: examining predictors of NSSI among adolescents. *Arch Suicide Res*. (2017) 21:610–20. doi: 10.1080/13811118.2016.1246267

18. Kelada L, Hasking P, Melvin G. Adolescent NSSI and recovery: the role of family functioning and emotion regulation. *Youth Soc*. (2018) 50:1056–77. doi: 10.1177/0044118X16653153

19. Briere JN, Gil E. Self-mutilation in clinical and general population samples: prevalence, correlates and functions. *Am J Orthopsychiatry*. (1998) 68:609–20. doi: 10.1037/h0080369

20. Ross S, Heath N. A study of the frequency of selfmutilation in a community sample of adolescents. *J Youth Adolescence*. (2002) 31:67–77. doi: 10.1023/A:1014089117419

21. Bjarehed J, Lundh L. Deliberate self-harm in 14-year-old adolescents: How frequent is it, and how is it associated with psychopathology, relationship variables, and styles of emotional regulation. *Cogn Behav Ther*. (2008) 37:26–37. doi: 10.1080/16506070701778951

22. Rodham K, Hawton K. Epidemiology and phenomenology of nonsuicidal self-injury. In: Nock MK, editor. *Understanding nonsuicidal self-injury: Origins, assessment, and treatment*. American Psychological Association, Washington, DC (2009). p. 37–62. doi: 10.1037/11875-003

23. Yang DM, Han WM, Shao CX, Su XX. Surveillance for selfinjury and suicide among middle school students in Beijing Tongzhou District during 2008–2012. *Chin J School Health*. (2013) 34:1351–3. doi: 10.16835/j.cnki.1000-9817.2013.11.026

24. Stallard P, Spears M, Montgomery AA, Phillips R, Sayal K. Self-harm in young adolescents (12-16 years): Onset and short-term continuation in a community sample. *BMC Psychiatry*. (2013) 13:328–31. doi: 10.1186/1471-244X-13-328

25. Burke TA, Hamilton JL, Cohen JN, Stange JP, Alloy LB. Identifying a physical indicator of suicide risk: non-suicidal self-injury scars predict suicidal ideation and suicide attempts. *Compr Psychiatry*. (2016) 65:79–87. doi: 10.1016/j.comppsych.2015.10.008

26. Brausch AM, Woods SE. Emotion regulation deficits and nonsuicidal selfuicidal prospectively predict suicide ideation in adolescents. *Suicide Lifeideents.yrg/ Behav*. (2019) 49:868–80. doi: 10.1111/sltb.12478

27. Maciejewski DF, Creemers HE, Lynskey MT, Madden PAF, Heath AC, Statham DJ, et al. Overlapping genetic and environmental influences on nonsuicidal self-injury and suicidal ideation: different outcomes, same etiology? *JAMA Psychiatry*. (2014) 71:699–705. doi: 10.1001/jamapsychiatry.2014.89

28. Jenkins AL, Singer J, Conner BT, Calhoun S, Diamond G. Risk for suicidal ideation and attempt among a primary care sample of adolescents engaging in nonsuicidal self-injury. *Suicide Life-Threatening Behav*. (2014) 44:616–28. doi: 10.1111/sltb.12094

29. Poudel A, Lamichhane A, Magar KR, Khanal GP. Non suicidal self injury and suicidal behavior among adolescents: Co-occurrence and associated risk factors. *BMC Psychiatry*. (2022) 22:1–12. doi: 10.1186/s12888-022-03763-z

30. Hamza CA, Stewart SL, Willoughby T. Examining the link between nonsuicidal self-injury and suicidal behavior: A review of the literature and an integrated model. *Clin Psychol Rev*. (2012) 32:482–95. doi: 10.1016/j.cpr.2012.05.003

31. Whitlock J, Muehlenkamp J, Eckenrode J, Purington A, Baral Abrams G, Barreira P, et al. Nonsuicidal self-injury as a gateway to suicide in young adults. *J Adolesc Health*. (2013) 52:486–92. doi: 10.1016/j.jadohealth.2012.09.010

32. Nock MK, Kessler RC. Prevalence of and risk factors for suicide attempts versus suicide gestures: Analysis of the national comorbidity survey. *J Abnormal Psychol*. (2006) 115:616–23. doi: 10.1037/0021-843X.115.3.616

33. Wilkinson P, Kelvin R, Roberts C, Dubicka B, Goodyer I. Clinical and psychosocial predictors of suicide attempts and nonsuicidal self-injury in the adolescent depression antidepressants and psychotherapy trial (adapt). *Am J Psychiatry*. (2011) 168:495–501. doi: 10.1176/appi.ajp.2010.10050718

34. Herzog S, Choo TH, Galfalvy H, Mann JJ, Stanley BH. Effect of non-suicidal self-injury on suicidal ideation: Real-time monitoring study. *Br J Psychiatry*. (2022) 221:1–3. doi: 10.1192/bjp.2021.225

35. Joiner TE. *Why people die by suicide*. Cambridge, MA: Harvard University Press (2005). doi: 10.1001/jama.295.17.2082

36. Van Orden KA, Witte TK, Cukrowicz KC, Braithwaite SR, Selby EA, Joiner TE. The interpersonal theory of suicide. *psychol Rev*. (2010) 117:575–600. doi: 10.1037/a0018697

37. Osuch E, Ford K, Wrath A, Bartha R, Neufeld R. Functional MRI of pain application in youth who engaged in repetitive non-suicidal self-injury vs. psychiatric controls. *Psychiatry Research: Neuroimaging*. (2014) 223:104–12. doi: 10.1016/j.pscychresns.2014.05.003

38. Franklin JC, Hessel ET, Prinstein MJ. Clarifying the role of pain tolerance in suicidal capability. *Psychiatry Res*. (2011) 189:362–7. doi: 10.1016/j.psychres.2011.08.001

39. Kirtley OJ, O'Carroll RE, O'Connor RC. Pain and self-harm: A systematic review. *J Affect Disord*. (2016) 203:347–63. doi: 10.1016/j.jad.2016.05.068

40. Koenig J, Rinnewitz L, Warth M, Hillecke TK, Brunner R, Resch F, et al. Psychobiological response to pain in female adolescents with nonsuicidal self-injury. *J Psychiatry Neurosci*. (2017) 42:189–99. doi: 10.1503/jpn.160074

41. George SE, Page AC, Hooke GR, Stritzke WG. Multifacet assessment of capability for suicide: Development and prospective validation of the acquired capability with rehearsal for suicide scale. *psychol Assess*. (2016) 28:1452–64. doi: 10.1037/pas0000276

42. Chapman AL, Gratz KL, Brown MZ. Solving the puzzle of deliberate self-harm: The experiential avoidance mode. *Behav Res Ther*. (2006) 44:371–94. doi: 10.1016/j.brat.2005.03.005

43. Anderson NL, Crowther JH. Using the experiential avoidance model of non-suicidal self-injury: Understanding who stops and who continues. *Arch Suicide Res*. (2012) 16:124–34. doi: 10.1080/13811118.2012.667329

44. Brereton A, McGlinchey E. Self-harm, emotion regulation, and experiential avoidance: A systematic review. *Arch Suicide Res*. (2020) 24:1–24. doi: 10.1080/13811118.2018.1563570

45. Wolff JC, Thompson E, Thomas SA, Nesi J, Bettis AH, Ransford B, et al. Emotion dysregulation and non-suicidal self-injury: A systematic review and meta-analysis. *Eur Psychiatry*. (2019) 59:25–36. doi: 10.1016/j.eurpsy.2019.03.004

46. Sarchiapone M, Mandelli L, Carli V, Iosue M, Wasserman C, Hadlaczky G, et al. Hours of sleep in adolescents and its association with anxiety, emotional concerns, and suicidal ideation. *Sleep Med*. (2014) 15:248–54. doi: 10.1016/j.sleep.2013.11.780

47. Horwitz AG, Berona J, Czyz EK, Yeguez CE, King C. Positive and negative expectations of hopelessness as longitudinal predictors of depression, suicidal ideation, and suicidal behavior in highvior, adolescents. *Suicide Life-Threatening Behav*. (2017) 47:168–76. doi: 10.1111/sltb.12273

48. Qiu T, Klonsky ED, Klein DN. Hopelessness predicts suicide ideation but not attempts: A 10-year longitudinal study. *Suicide Life-Threatening Behav*. (2017) 47:718–22. doi: 10.1111/sltb.12328

49. Kim YS, Koh YJ, Leventhal B. School bullying and suicidal risk in Korean middle school students. *Pediatrics*. (2005) 115:357–63. doi: 10.1542/peds.2004-0902

50. Herba CM, Ferdinand RF, Stijnen T, Veenstra R, Oldehinkel AJ, Ormel J, et al. Victimization and suicide ideation in the TRAILS study: Specific vulnerabilities of victims. *J Child Psychol Psychiatry*. (2008) 49:867–76. doi: 10.1111/j.1469-7610.2008.01900.x

51. Ying MT, Jiang GR, Yu LX, Lu T. Patterns of reinforcement sensitivity for non-suicidal self-injury in college students. *Acta Psychologica Sin*. (2016) 48:258–70. doi: 10.3724/SP.J.1041.2016.00258

52. van Lier PA, Vitaro F, Barker ED, Brendgen M, Tremblay RE, Boivin M. Peer victimization, poor academic achievement, and the link between childhood externalizing and internalizing problems. *Child Dev*. (2012) 83:1775–88. doi: 10.1111/j.1467-8624.2012.01802.x

53. Chen N, Liu HY. Comparison of methods addressing MNAR missing data when fitting a latent growth model: selection model and ML. *J psychol Sci*. (2015) 38:446–51. doi: 10.16719/j.cnki.1671-6981.2015.02.016

54. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct Equation Modeling*. (1999) 6:1–55. doi: 10.1080/10705519909540118

55. Kline RB. Principles and practice of structural equation modeling, *fourth ed*. New York NY: Guilford (2016).

56. Lau MA, Segal ZV, Williams JMG. Teasdale's differential activation hypothesis: Implications for mechanisms of depressive relapse and suicidal behaviour. *Behav Res Ther*. (2004) 42:1001–17. doi: 10.1016/j.brat.2004.03.003

57. Williams JMG, Crane C, Barnhofer T, van der Does AJ, Segal ZV. Recurrence of suicidal ideation across depressive episodes. *J Affect Disord*. (2006) 91:189–94. doi: 10.1016/j.jad.2006.01.002

58. Patel KR, Immaneni S, Singam V, Rastogi S, Silverberg JI. Association between atopic dermatitis, depression, and suicidal ideation: A systematic review and meta-analysis. *J Am Acad Dermatol*. (2019) 80:402–10. doi: 10.1016/j.jaad.2018.08.063

59. Kang C, Zheng Y, Yang L, Wang X, Zhao NA, Guan TF, et al. Prevalence, risk factors and clinical correlates of suicidal ideation in adolescent patients with depression in a large sample of Chinese. *J Affect Disord*. (2021) 290:272–8. doi: 10.1016/j.jad.2021.04.073

60. Zhou T. Epidemiological survey on depressive symptoms and suicide ideation among urban and rual adolescents—taking changsha city and yueyang county in hunan province for example, M.A. Hunan Normal University, Hunan (2014).

61. Klonsky ED. The functions of self-injury in young adults who cut themselves: Clarifying the evidence for affect-regulation. *Psychiatry Res*. (2009) 166:260–8. doi: 10.1016/j.psychres.2008.02.008

62. Brown RC, Plener PL. Non-suicidal self-injury in adolescence. *Curr Psychiatry Rep*. (2017) 19:1–8. doi: 10.1007/s11920-017-0767-9

63. Horton SE, Hughes JL, King JD, Kennard BD, Westers NJ, Mayes TL, et al. Preliminary examination of the interpersonal psychological theory of suicide in an adolescent clinical sample. *J Abnormal Child Psychol*. (2016) 44:1133–44. doi: 10.1007/s10802-015-0109-5

64. Miller AB, Esposito-Smythers C, Leichtweis RN. A short-term, prospective test of the interpersonal-psychological theory of suicidal ideation in an adolescent clinical sample. *Suicide Life-Threatening Behav*. (2016) 46:337–51. doi: 10.1111/sltb.12196

65. Chu C, Buchman-Schmitt JM, Stanley IH, Hom MA, Tucker RP, Hagan CR, et al. The interpersonal theory of suicide: A systematic review and meta-analysis of a decade of cross-national research. *psychol Bull*. (2017) 143:1313–45. doi: 10.1037/bul0000123

66. Kleiman EM, Coppersmith DDL, Millner AJ, Franz PJ, Fox KR, Nock MK. Are suicidal thoughts reinforcing? A preliminary real-time monitoring study on the potential affect regulation function of suicidal thinking. *J Affect Disord*. (2018) 232:122–6. doi: 10.1016/j.jad.2018.02.033

67. Bryan CJ, Rozek DC, Butner J, Rudd MD. Patterns of change in suicide ideation signal the recurrence of suicide attempts among high-risk psychiatric outpatients. *Behav Res Ther*. (2019) 120:103392. doi: 10.1016/j.brat.2019.04.001

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Prospectively predicting 6-month risk for non-suicidal self-injury among adolescents after psychiatric hospitalization based on a predictive model

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Background: It is challenging to predict the occurrence of non-suicidal self-injury (NSSI) among adolescents over short periods. Moreover, the predictive value of indices for NSSI remains elusive. Thus, this study aimed to identify predictors of NSSI within 6 months among adolescents after psychiatric hospitalization by establishing a risk assessment model.

Methods: A total of 632 high-risk participants were included in this study. The distribution characteristics of adolescent NSSI were initially assessed through a cross-sectional survey, following which risk factors were identified using logistic regression analysis. The risk score method was then used to construct a 6-month risk assessment model for NSSI. Lastly, the predictive effect of the model was evaluated by indicators such as the area under the receiver operating characteristic (ROC) curve and the positive predictive value.

Results: After 6 months, 412 cases of NSSI were identified. According to the logistic regression model, the frequency of relapses, medication status, and NSSI history were identified as influencing factors. Higher scores on the Impulsive Behavior Scale and Pittsburgh Sleep Quality Index were associated with a higher risk of NSSI. Conversely, higher scores on the Pain and Belief Perception Scale were correlated with a lower risk of NSSI. Moreover, the area under the ROC curve for the predictive model was 0.9989, with a 95% confidence interval of (0.9979, 0.9999), highlighting its high predictive ability and accuracy. The predictive model was validated using 78 patients, yielding an area under the ROC curve of 0.9703 and a 95% confidence interval of (0.9167, 0.9999), demonstrating outstanding predictability.

Conclusion: These results collectively showed that the predictive model could accurately predict adolescent NSSI. Thus, the model's primary variables may be applied to predict the risk of NSSI in the clinical setting.

1 Background

Non-suicidal self-injury (NSSI) is defined as deliberate and intentional harm to one's body without suicidal intent (1, 2) by cutting, hitting, scratching, and burning oneself (3). Mounting evidence indicates that the physiological growth of middle school students is accelerating during this developmental stage (4). Nevertheless, their psychological development frequently lags behind. During this period, adolescents have low psychological resilience, are susceptible to impulsive behaviors and excessive NSSI behaviors, and are unable to properly manage their negative emotions (5). Notably, NSSI not only causes severe physical and psychological injury to middle school students but also raises the risk of suicide among self-injurers, thereby imposing an additional burden on society and families. In 2018, 48,344 suicides were reported in the United States alone (6), with a key cause being the increase in NSSI behaviors (6, 7). Indeed, NSSI has become a substantial worldwide public health issue, especially among teenagers (8–10).

To date, numerous studies have examined the important components or predictors of NSSI. For instance, Gandhi et al. (11) described that the incidence of NSSI is the highest in 14–15-year-old individuals and progressively declines over time. Meanwhile, younger adolescents are at a higher risk of developing NSSI. Additionally, earlier studies (12) identified depression and a history of previous NSSI as risk factors for NSSI behavior in teenagers. NSSI may also be a result of familial or environmental dysfunction. Divorce or widowhood signifies a breakdown in family relationships, which exerts a significant negative influence on adolescents. Parental harsh punishment, low parental monitoring, and poor quality of attachment to parent predicted are associated with an increased risk of subsequent NSSI onset in adolescents, whereas positive parenting behaviors are associated with lower odds of NSSI onset during the following year (13). Therefore, the lack of functional family dynamics is a significant external contributor to NSSI behaviors in teenagers.

According to a previous study, NSSI is associated with impulsive tendencies and neurocognitive impulsivity (14). Notably, difficulties with impulse control (feeling out of control while distressed) were positively associated with NSSI history. These difficulties can differentiate between individuals with and without a history of NSSI (15). Patients with NSSI behaviors have impaired inhibitory control, behavioral disinhibition, and increased motor impulsivity. Based on previous studies, we speculate that impulsive behavior may be a predictor of NSSI behavior.

The non-linear association between sleep duration and NSSI in teenagers suggests that sleep patterns are linked to the patient's NSSI status over the previous year (16). Poor sleep is associated with a higher risk of NSSI as a proxy for unfavorable emotion regulation. A study also found that current sleep patterns had a modest impact on the association between past and current NSSI behaviors. At the same time, a history of past NSSI could predict the occurrence of nightmares and suicide attempts. The strongest predictor of current NSSI was the recollection of past NSSI incidents, while current poor sleep was merely modestly associated with current NSSI behaviors. An additional indicator of current NSSI behaviors was experiencing nightmares within the last 6 months (17). Therefore, the predictive value of sleep for NSSI warrants further investigation.

Pain processing has emerged as a critical biological factor affecting the occurrence of NSSI. Indeed, diminished pain sensitivity and baseline opioid deficit were identified as possible risk factors for NSSI (18). However, clinical evidence for the association between pain sensitivity and NSSI is lacking, necessitating further exploration (18). Parallel mediation analyses have demonstrated that psychache independently mediated significant links between any type of teenage trauma and NSSI (19). Mental pain, a generally unbearable pain, modulates the occurrence of trauma and NSSI behavior in adolescents. Nevertheless, the correlation between pain processing and NSSI requires further investigation.

Despite extensive research conducted on NSSI, significant gaps remain. The majority of previous studies investigating NSSI examined the overall frequency of NSSI behaviors without considering the type of behavior or frequency of specific behaviors performed (20–22), oversights that may have potentially led to missing crucial information that could contribute to risk assessment. Consequently, only a few variables with satisfactory predictive power have been identified (23), most likely due to the limited variance in NSSI occurrence that can be explained by individual predictors. Variables that have been identified as predictive of NSSI behavior in young adults include depressive symptoms, anxiety symptoms, female gender, affective dysregulation, and ruminative cognitive styles (24–28).

In addition to examining predictors of NSSI, it is essential to identify potential processes or major risk factors that can assist doctors, parents, and community workers in making decisions on the prevention and management of NSSI. Based on these predictors, tailored psychological intervention measures or psychological care programs can be implemented. There is a pressing need to precisely identify those at high risk for future suicidal behavior. Therefore, new predictive methods or models are required to identify adolescents at high risk.

This study aimed to examine the 6-month risk for non-suicidal self-injury among adolescents after psychiatric hospitalization. Specifically, it sought to investigate the direct predictive effect on NSSI based on a predictive model. Given that NSSI may be impacted by general demographics, medication adherence, sleep quality, pain perception, impulsive behavior, etc., it is necessary to examine these variables. Moreover, these variables are readily accessible to medical personnel and easier to acquire than hematological indicators. The 6-month period following hospitalization is a crucial time point for patients. Consequently, the predictive model was based on the obtained data, and a confirmatory study was performed to validate its accuracy and predictive ability.

2 Methods

2.1 Participants

From January 2019 to July 2023, data on adolescents with NSSI hospitalized in the psychiatry department of a tertiary general hospital were collected. The inclusion criteria for participants were as follows: a) met the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria NSSI, b) aged 13–23 years, c) no gender restriction, d) hospitalized patients who could be followed up, and e) informed consent was obtained, with voluntary participation. This research adhered to the principle of voluntariness, respecting and safeguarding the privacy of research participants. Exclusion criteria for patients were as follows: a) strong suicidal ideation; b) present or prior history of schizophrenia, delusional illness, anxiety disorder, intellectual disability, and autism; c) history of psychoactive substance; and d) severe physical diseases. In this investigation, purposeful sampling was employed. A total of 632 patients met the inclusion criteria.

2.2 Measures

2.2.1 Clinical observation index collection questionnaire

The questionnaire was derived from a review of relevant research, consultations with psychiatric professionals, and consideration of the hospital's conditions, which included the following information: a) gender, b) age, c) educational attainment degree, d) marital status, e) whether the participant was an only child, f) family relationship status, g) medication adherence, h) NSSI history, and i) NSSI recurrence.

2.2.2 Beck Scale for Suicide Ideation

The Beck Scale for Suicide Ideation [Beck Scale for Suicide Ideation-Chinese Version (BSI-CV)] compiled by Beck (29) was translated and reviewed by Li Xianyun et al. (30) and covered 19 items, with each item scored on a 3-point scale (0–2 points), yielding a total score ranging between 0 and 38 points. Greater scores reflect stronger suicidal ideation and suicide risk. Cronbach's α coefficients for suicidal ideation in the last week and at its most severe point were 0.68 and 0.87, respectively, while the test–retest reliability coefficients were 0.64 and 0.76, respectively.

2.2.3 Impulsive Behavior Scale BIS-11

The Barratt Impulsiveness Scale (BIS-11) was originally developed by Barratt in 1959 (31), and Zhou Liang adapted the Chinese version based on the revised 2006 Barratt Impulsiveness Scale (32). The scale consists of 26 items, with 11 items reverse-scored. It includes three subscales: attentional impulsivity, motor impulsivity, and non-planning impulsivity. Responses were rated on a 4-point Likert scale (1 to 4), with higher scores indicating greater levels of impulsivity. In this study, Cronbach's α coefficient for the scale was 0.75.

2.2.4 Pain Beliefs and Perceptions Inventory

The Pain Beliefs and Perceptions Inventory (PBPI) was designed by the American psychologist Williams et al. (33) to examine the impact of temporal changes on patients' pain beliefs. The scale covers four dimensions: the perception that pain is inexplicable, the belief that it will persist, the conviction that the agony cannot be cured, and the sense of self-blame. Higher scores indicate stronger negative beliefs. Chinese scholars translated this scale in 2008. Cronbach's α coefficient for the measured scale was 0.731 (34).

2.2.5 Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index (PSQI) was compiled in 1989 by Dr. Buysse, a psychiatrist at the University of Pittsburgh, USA (35). It consists of 19 self-evaluated items and five items rated by others. Each item is scored on a scale of 0 to 3, with a total score of 0 to 21. It consists of seven components, including subjective sleep quality, time taken to fall asleep, sleep duration, sleep efficiency, sleep disorders, use of sleep medications, and daytime functions, divided into the sum of 7-factor points. A total PSQI score of ≤7 indicates normal sleep, whereas a total score of >7 suggests sleep disorders. In terms of reliability, Cronbach's α coefficient of the PSQI was 0.7962. In terms of validity, the correlation coefficient between the total scores from repeated tests was 0.8126.

2.3 Data collection

Prior to data collection, patients and their primary caregivers were informed of the study's objective and relevance and willingly provided informed consent. Upon discharge from the psychiatry ward, all scales were assessed according to the physician's order. Four registered nurses in the psychiatry unit, as well as two graduate students and two certified head nurses, performed the data collection. The objective and

methodology of the study, data collection protocols, and quality control measures were covered during investigator training. Data were collected from the hospital's medical record information system in strict accordance with operational criteria. Staff members engaged in mutual supervision to ensure that data collection was completed within the allotted time and in accordance with ethical standards and quality control requirements. The instructor conducted the final quality assurance. Every Friday afternoon, research team members actively raised issues encountered during data collection and addressed recurring issues. Patients in the psychiatry unit completed the surveys in accordance with a unified set of instructions. Those unfamiliar with the surveys or who experienced difficulty in writing were provided with detailed explanations. The questionnaires were promptly collected after completion, and the acquired data were stored by the project manager to prevent modifications. After discharge, patients were predominantly followed up via telephone. Following the completion of data collection, two data entry operators inputted and verified the data.

2.4 Statistical analysis

All statistical analyses were performed using SAS 9.4. Continuous variables conforming to a normal distribution were expressed as means and standard deviations and compared using independent-samples t-tests. Variables with a skewed distribution were presented as the median and interquartile ranges and compared using the Wilcoxon rank-sum test. Quantitative data were compared using either ANOVA or the Wilcoxon rank-sum test. Categorical data were described as frequencies and compared using the χ^2 test or Fisher's exact test. In this study, logistic regression analysis was performed to analyze count variables and construct the predictive model. The model was validated using the Hosmer–Lemeshow goodness-of-fit test, and receiver operating characteristic (ROC) curve analysis was performed to assess the predictive capacity of the model.

3 Results

3.1 Patient characteristics

A total of 632 cases, aged between 13 and 23 years with an average age of 17.26 ± 2.31, were included in this study. Among them, 204 patients presented with first-time NSSI, representing 32.28% of all cases. The remaining 428 patients experienced recurrent NSSI, accounting for 67.72% of the cohort. Within 6 months after hospitalization, 412 cases developed NSSI, accounting for 65.19% of the cohort.

3.2 Single-factor analysis of NSSI risk within 6 months after hospitalization

Single-factor analysis was carried out on demographic characteristics, family relationships, medication adherence, self-injury history, hospitalization, Beck suicide ideation scores, BIS-

11 scores, Pain Beliefs and Perceptions Inventory scores, and Pittsburgh Sleep Quality Index. Group comparison for categorical data was carried out using the χ^2 test, and the results revealed four statistically significant variables, namely, gender, medication adherence, and NSSI history and recurrence ($p < 0.05$). See Table 1.

The t-test was used to compare quantitative data and identified five statistically significant variables associated with NSSI risk, namely, the number of relapses, the Beck suicidal ideation scale scores, the Impulsive Behavior Scale BIS-11 scores, Pain and Belief Perception Scale scores, and the Pittsburgh Sleep Quality Index ($p < 0.05$). See Table 2.

3.3 Multivariate analysis of NSSI risk within 6 months after hospitalization

Furthermore, nine variables with statistical significance in the univariate analysis were incorporated in the binary logistic regression for stepwise regression analysis to account for confounding factors and further explore influencing factors. As summarized in Table 3, the number of relapses, medication adherence, NSSI history, impulsive behavior, pain, and belief perception scale scores, and the Pittsburgh Sleep Quality Index were included in the regression equation. Importantly, the logistic model identified the frequency of relapses, medication adherence, and NSSI history as factors influencing the outcomes. Among them, the risk of NSSI in patients with poor medication compliance was 4.00 times higher than that of patients with good medication compliance after 6 months. Similarly, the risk of NSSI in patients with a history of NSSI was 5.807 times that of patients without a history of NSSI after 6 months. Notably, for each additional recurrence, the risk of NSSI increased by 2.150 times. In addition, impulsive behavior, Pain and Belief Perception Scale scores, and sleep quality index were correlated with the predicted risk of NSSI. Specifically, the Impulsive Behavior Scale scores were positively correlated with NSSI risk after 6 months. Conversely, the Pain and Belief Perception Scale score was negatively correlated with NSSI risk after 6 months. Finally, the Pittsburgh Sleep Quality Index was positively correlated with NSSI risk after 6 months. See Table 3.

3.4 Nomogram construction for NSSI risk among adolescents within 6 months after hospitalization

The developed nomogram is illustrated in Figure 1, with each variable corresponding to a specific score. The overall score was determined by summing the individual scores. The projected likelihood of the total score reflects the risk of NSSI within 6 months after hospitalization among adolescents.

3.5 Validation of predictive models

This study employed the logistic regression model to construct an NSSI risk prediction model within 6 months after

TABLE 1 χ^2 test results of NSSI risk within 6 months after hospitalization.

Participant variables	Without NSSI n (%)	With NSSI n (%)	Statistical testing	p
Gender			18.658*	<0.001
Male = 1	32 (14.6)	124 (30.1)		
Female = 0	188 (85.5)	288 (69.9)		
Education degree			3.779*	0.286
Junior high school = 0	44 (20.0)	88 (21.4)		
High school = 1	96 (43.6)	196 (47.6)		
Junior college = 2	31 (14.1)	62 (15.0)		
Undergraduate and above = 3	49 (22.3)	66 (16.0)		
Marriage status			△	0.873
Unmarried = 0	217 (98.6)	407 (98.8)		
Married = 1	3 (1.4)	5 (1.2)		
The only child			0.668*	0.414
No = 0	135 (61.4)	239 (58.0)		
Yes = 1	85 (38.6)	173 (42.0)		
Family relationship			△	0.435
Discord = 0	3 (1.4)	8 (2.0)		
General = 1	91 (41.4)	149 (36.3)		
Harmony = 2	126 (57.3)	254 (61.7)		
Regular medication			16.577*	<0.001
No = 0	105 (47.7)	129 (31.3)		
Yes = 1	115 (52.3)	283 (68.7)		
NSSI history			55.429*	<0.001
No = 0	131 (59.5)	120 (29.1)		
Yes = 1	89 (40.5)	292 (70.9)		
Recurrence			76.547*	<0.001
No = 0	120 (54.6)	84 (20.4)		
Yes = 1	100 (45.5)	328 (79.6)		

NSSI, non-suicidal self-injury.

*: χ^2 test; △: Fisher exact probability method.

hospitalization. The result showed that the area under the ROC curve of the predictive model was 0.9989, with a 95% confidence interval of (0.9979, 0.9999) based on the original data. At a critical value of 0.597, the sensitivity, specificity, and Youden's index were 0.981, 0.982, and 0.963, respectively. See Figure 2.

To evaluate the predictive ability of the model, 78 newly studied cases were included. Among them, 30 were male (38.46%) and 48 were female (61.54%). Their average age ranged from 13 to 22 years, with a mean of 17.51 ± 2.295 years. The area under the ROC curve was 0.9703 for these cases, with a 95% confidence interval of (0.9167, 0.9999). See Figure 3.

4 Discussion

This prospective study aimed to assess the 6-month risk for NSSI among adolescents hospitalized for psychiatric reasons. Specifically, the direct predictive effect on NSSI was explored using a predictive model. Moreover, baseline predictors of NSSI over a 6-month follow-up period were identified using multivariable models. Our findings conjointly revealed that adolescent NSSI is impacted not only by demographic variables such as gender and age but also by medication adherence, sleep index, pain perception, impulsive behavior, and other variables.

TABLE 2   *t*-Test results of NSSI within 6 months after hospitalization.

Variable	Whether NSSI occurred within 6 months	N	Mean	Standard deviation	Statistical testing	*p*
Age	No	220	17.19	2.249	0.57	0.570
	Yes	412	17.30	2.345		
The number of relapses	No	220	0.800	0.925	8.89	<0.001
	Yes	412	1.476	0.903		
Beck suicidal ideation scale	No	220	13.855	5.637	7.82	<0.001
	Yes	412	18.087	6.891		
Impulsive Behavior Scale BIS-11	No	220	83.27	5.2903	11.48	<0.001
	Yes	412	87.45	3.7721		
Pain and Belief Perception Scale	No	220	1.07	0.7022	46.57	<0.001
	Yes	412	-1.21	0.5127		
Pittsburgh Sleep Quality Index	No	219	5.25	0.9217	25.29	<0.001
	Yes	411	7.55	1.1682		

NSSI, non-suicidal self-injury.

While considering pain perception, medication compliance, and sleep quality pose challenges in risk recognition, a predictive model of NSSI was constructed and validated, highlighting its high predictive and testing abilities. This model can be promoted and implemented in clinical settings.

4.1 The prevalence of NSSI among adolescents is relatively high

The prevalence of NSSI in this study was 32.28%. Another study reported a self-injury detection rate of 33.7% among 3,600 middle school children (36). A research team previously conducted a meta-analysis on the prevalence of NSSI in teenagers and reported a global prevalence of 21% [Effect Size (ES) = 0.21, 95% CI (0.18, 0.25)] among teenagers.

However, as demonstrated in this study, the prevalence of NSSI is very high. This finding may be ascribed to the timing and location of the survey or the age range of participants. The mental health education system in China requires further improvement and development. The rehabilitation model should evolve from hospitalization to early prevention. In addition, the mental health service system in Europe, North America, and Oceania is relatively well-established, with adolescents accessing professional mental health education earlier (37, 38). Variations in the timing of investigation may also lead to differences in the incidence of NSSI. With socioeconomic development and increased academic pressure, adolescent mental health issues may become more prominent, leading teenagers to resort to extreme measures to cope with negative emotions. Consequently, NSSI has emerged as a global mental health issue that should be prioritized by researchers and clinical experts. On the one hand, it is essential to foster an atmosphere favorable to the healthy

TABLE 3   Logistic stepwise regression analysis of NSSI risk within 6 months after hospitalization.

Variable	Estimated value	Standard deviation	Wald χ^2	*p*	RR	95% confidence interval	
Constant	−105.9	22.834	21.528	<0.0001			
Medication	1.386	0.697	3.957	0.047	4.000	1.021	15.676
Number of relapses	0.765	0.347	4.879	0.027	2.150	1.090	4.240
NSSI history	1.759	0.728	5.835	0.016	5.807	1.393	24.196
Impulsive Behavior Inventory BIS-11	1.043	0.247	17.792	<0.0001	2.837	1.748	4.607
Pain and Belief Perception Scale	−3.502	0.549	40.737	<0.0001	0.030	0.010	0.088
Pittsburgh Sleep Quality Index	1.574	0.376	17.525	<0.0001	4.826	2.310	10.084

The result of the Hosmer–Lemeshow test yielded a chi-square value of 0.5018 (*p* > 0.05), indicating that the model fits well.
NSSI, non-suicidal self-injury.

FIGURE 1
Nomogram.
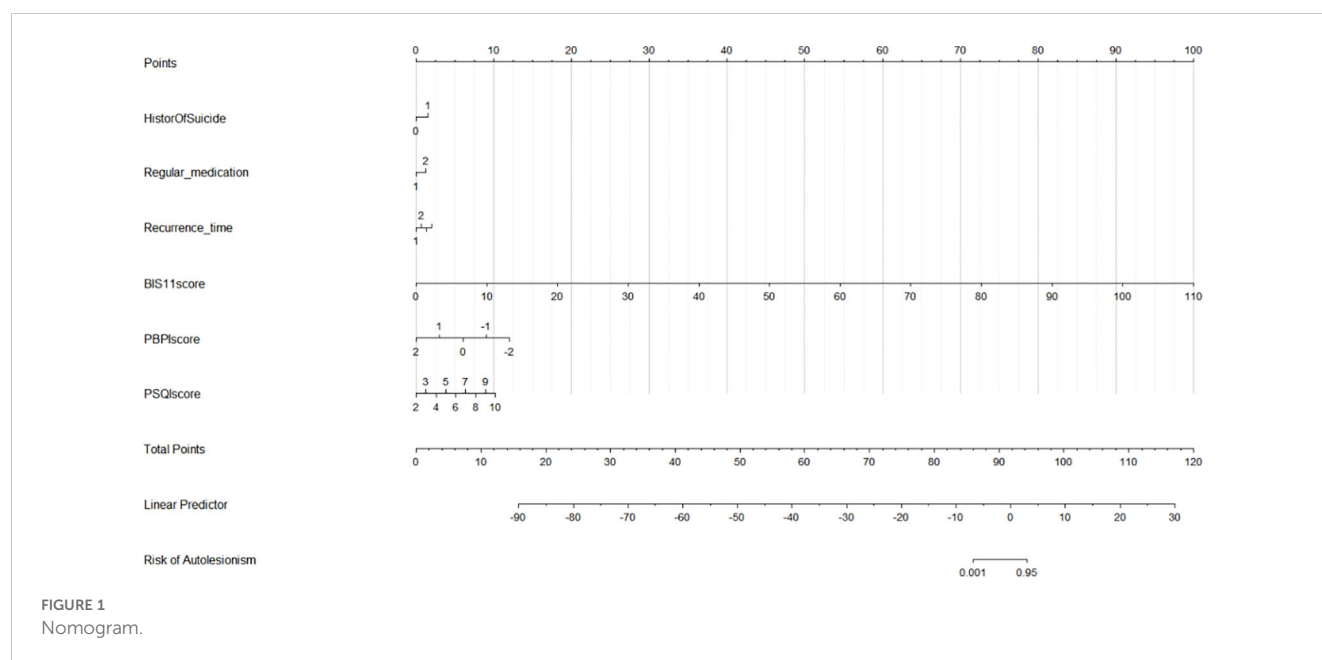
development of youth. On the other hand, it is vital to promote early screening for NSSI and implement prompt intervention methods in order to assist adolescents in developing effective coping strategies and avoiding NSSI.

4.2 Analysis of risk factors in the NSSI risk prediction model

4.2.1 Increased recurrences increase the risk of NSSI post-hospitalization

Notably, recurrent NSSI has become one of the most prevalent characteristics associated with this behavior (39). According to longitudinal research on NSSI undertaken by Plener et al. (40), NSSI typically initiates during early to middle adolescence and recurs throughout the lifespan of individuals. A questionnaire survey at a university unveiled that the detection rate of two or more self-harming behaviors was 67.3% (41), with 8.8% of male participants employing over five methods for NSSI (41). According to the experience avoidance paradigm, the purpose of NSSI is to evade or escape undesirable experiences or behaviors. Chapman's experience avoidance model posits that individuals with emotional management disorders may respond to triggering external events by resorting to self-injury as a coping strategy to escape painful emotional experiences (42).

NSSI has significant characteristics of behavioral addiction and is a mechanism for emotional venting. If individuals experience a reduction in negative emotions immediately after NSSI, the tendency to implement this behavior becomes stronger when the negative emotions occur in the future. At the same time, as a repetitive behavior, the self-reinforcing nature of NSSI leads individuals to adopt it as an avoidance strategy over time, thus possessing the characteristics of addiction, which poses challenges to terminating such behaviors. Therefore, when adolescents derive a sense of pleasure, transient psychological stimulation, or relief from

unpleasant emotions through NSSI, they are likely to routinely use it. In clinical treatment, it is crucial that adolescents are provided with outlets or other methods for expressing their feelings. Elucidating the motivations, psychological challenges, and nursing needs of adolescents with NSSI is paramount to assisting adolescents in reducing and ceasing NSSI behaviors.

4.2.2 Medication compliance affects NSSI risk

From a pharmacological standpoint, drug compliance refers to the degree to which a patient implements the drug treatment plan. Deviations from the medication requirements of the treatment plan

FIGURE 2
Results of the predictive model validating the original data.

FIGURE 3
Validation of the predictive model for 78 cases within 6 months after hospitalization.
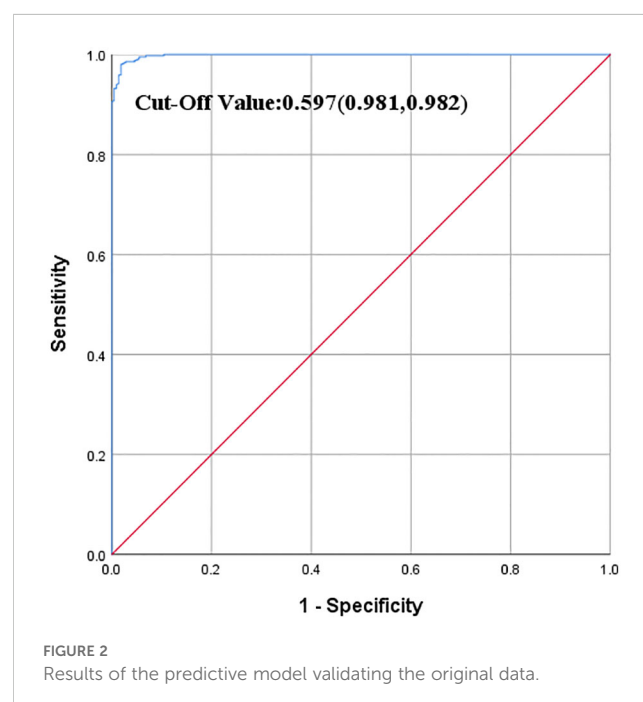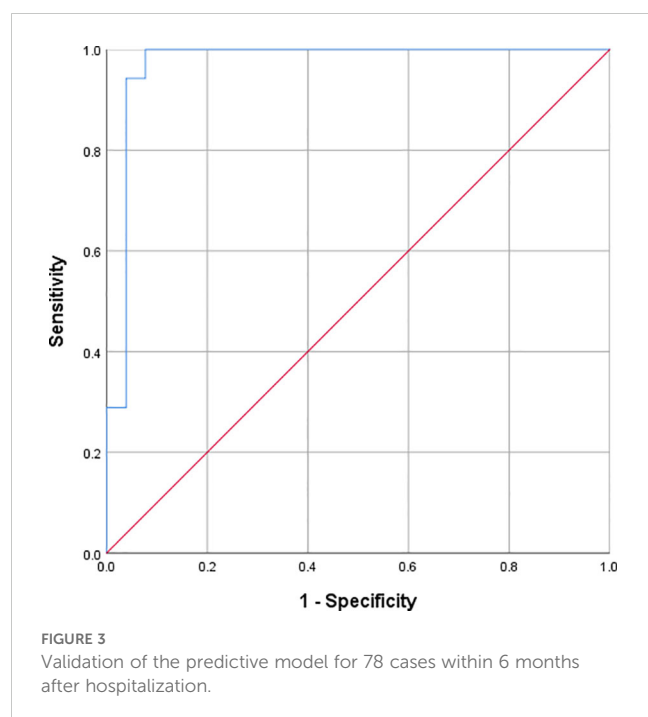
in any aspect of this process due to patient-related factors lead to varying degrees of non-compliance, which eventually affects therapeutic outcomes. Data on 2,013 adolescents were obtained from the Canada Mental Health Reporting System using the Resident Assessment Instrument-Mental Health (RAI-MH) and analyzed using logistic regression. According to the results, intentional abuse of prescription drugs was identified as the most significant factor related to NSSI (43). Following hospital discharge and during the out-of-hospital follow-up period, healthcare professionals should focus on providing important compliance guidance and intervention, emphasizing the safety of medications and the ability of regular medication adherence to facilitate recovery and prevent recurrence.

4.2.3 NSSI history is a key factor in predicting NSSI

A history of NSSI may result in increased pain tolerance and decreased fear of death, culminating in recurrent self-harming behaviors (44, 45). In addition, a huge body of evidence indicates that patients with a history of NSSI are more likely to struggle with emotional management and self-efficacy resistance. Difficulties in emotion management and resistance to self-efficacy influence the associations between outcome expectations and previous NSSI history (46). Furthermore, an adolescent's previous suicide attempt can easily escalate into additional self-harm attempts. However, when adolescents engage in self-harming behavior, they frequently refrain from additional harm out of the associated fear and pain (47). This inherent urge for self-resistance and self-injury mostly results in NSSI. Taken together, challenges linked to emotional regulation and low self-efficacy in resisting self-harm are indicative of a history of NSSI. Addressing the patient's emotional control, self-efficacy, and underlying causes of NSSI can successfully prevent recurrences.

4.2.4 Impulsive adolescents are more likely to develop NSSI

According to recent research, NSSI is associated with impulsive tendencies but not with impulsive actions noted in laboratory tasks, even in situations involving negative moods (14). Neurocognitive impulsivity is connected with more frequent and recent NSSI episodes, particularly in negative emotional circumstances, including actual or perceived criticism in close relationships. NSSI is a method for promptly releasing negative emotions and anger. However, an earlier study identified an association between recurrent NSSI and greater behavioral compulsivity and poor decision-making, but not with behavioral impulsivity (48), inconsistent with the findings of this research.

The use of impulsive qualities as predictors of NSSI requires the incorporation of other laboratory markers. To determine the association between impulsive behavior and NSSI, longer follow-up periods or larger sample sizes are required. As key contributors to the emotional support network of hospitalized adolescents with NSSI, healthcare professionals can aid adolescents in identifying and articulating specific emotions and feelings about NSSI and engaging in self-awareness and cognitive reconstruction. They can also guide adolescents to accept their negative emotions in a healthy manner and focus on the present, thereby effectively reducing the risk of impulsive events.

4.2.5 Lower pain and belief perception beliefs scores were associated with a higher risk of NSSI

In recent years, an increasing number of studies have examined alterations in the pain perception of patients with NSSI. Adolescents with impaired pain perception may adopt negative coping mechanisms in response to pain, leading to a reduction in pain levels during NSSI episodes and an increase in the frequency and severity of NSSI. More importantly, individuals with NSSI may perceive pain differently from non-NSSI patients. Kirtley et al. (49) demonstrated that patients with NSSI experience altered pain perception. While studies exploring the relationship between NSSI and pain perception are scarce, several studies have concluded that the pain threshold and pain tolerance of patients with NSSI are higher (50, 51). For example, Schmahl et al. (52) determined that painful stimulation promoted the activation of the dorsal prefrontal cortex in patients with NSSI and concomitantly inhibited the activation of the posterior parietal cortex compared to the healthy control group. Changes in pain perception in response to this unpleasant stimulation may represent a resistance mechanism in NSSI patients (53). Furthermore, post-hospital education on pain perception and coping style is critical. Adolescents lack positive coping methods for psychological pain and physical pain. Their negative coping style leads to a cycle of self-denial and self-harm, which drives NSSI behaviors. Understanding and enhancing their pain coping mechanisms can assist in mitigating NSSI behaviors.

4.2.6 Worse sleep quality was positively correlated with the risk of NSSI

Insomnia increases anxiety levels, which in turn exacerbates NSSI behavior. Poor sleep duration and insomnia symptoms have been established to enhance an individual's impulsivity, which is a

significant risk factor for NSSI (54). Specifically, sleep disorders and poor sleep quality decrease the ability to regulate emotions, thereby increasing the risk of NSSI behavior (55, 56). Herein, 81.2% of participants scored in the clinical range for poor sleep on the PSQI. Likewise, 81.2% reported a circadian preference for evening (night owl) patterns. PSQI scores were positively associated with the levels of self-harm (suicide attempts and NSSI) and were identified as a predictor for self-harm within 30 days. Of note, the rates of self-harm were high during the follow-up period, with 45.0% and 33.7% at 6 and 12 months, respectively (54). The current study uncovered that sleep quality was strongly correlated with NSSI, in agreement with the findings of previous studies. In order to reduce the risk of NSSI, healthcare practitioners or parents address sleep disorders in adolescents, encourage regular sleep schedules, and ensure appropriate sleep on weekends. In addition, psychological interventions for college students with NSSI could incorporate psychological counseling or treatment methods (such as cognitive behavioral therapy for insomnia and stimulation control therapy) to alleviate sleep disorders, thereby indirectly mitigating NSSI behaviors.

4.3 The NSSI risk prediction model displayed high predictive performance

Based on multivariate regression analysis, a nomogram integrating multiple predictors was developed and validated (57). The area under the ROC curve of the original model was 0.9989, with a 95% confidence interval of (0.9979, 0.9999). Following this, the clinical information of new patients was introduced into the model for risk prediction, yielding an area under the ROC curve of 0.9703, with a 95% confidence interval of (0.9167, 0.9999), signifying that the NSSI risk prediction model could accurately predict the risk of NSSI within 6 months after discharge. Moreover, despite participants in the modeling group and the validation group being from different hospitals, the area under the ROC curve was comparable, highlighting the generalizability of the model. Therefore, this model can be used to predict NSSI behaviors within 6 months following hospitalization.

4.4 Practical implications and research on the NSSI risk prediction model

The developed models may enhance the decision-making process of physicians regarding patient adherence to the identified risk factors. The risk score model generated herein, based on the identified major risk factors, allows for the collection of information using fewer variables, positioning it as a simple and effective approach. When applying this model to screen high-risk groups, healthcare professionals can select appropriate cut-off points tailored to their clinical needs. Providing real-time predictions of NSSI risk factors during patient enrollment may enable healthcare professionals to proactively implement intervention strategies and prioritize high-risk patients. For adolescents identified as high-risk during follow-up, urgent psychological assistance should be

administered. Furthermore, the medical staff should contact the parents and instruct them to monitor their child's sleep, ensure medication adherence, and assist them in overcoming negative feelings. Overall, this study laid a theoretical and methodological groundwork for future longitudinal cohort studies focusing on teenagers. Nevertheless, it is worth acknowledging that the NSSI prediction model remains in the early stages of development. While this study primarily focused on identifying key risk factors, future reports will describe how we also used study data to develop and validate an adaptive screening model. Theoretically, this research has established the groundwork for a more robust, comprehensive, and scientific model.

5 Limitations

Nonetheless, this study has some limitations that cannot be overlooked. To begin, short and customized measures were employed to evaluate the majority of NSSI components in order to minimize respondent burden. Despite the assessed variables being identified as significant univariable predictors of NSSI, the use of brief scales may have compromised the reliability of the measurements and our ability to properly capture each construct. To identify future predictors while limiting patient impact and the workload on the medical personnel, additional objective indicators should be included. In addition, given the cross-sectional nature of this study, the acquired data may be biased, posing challenges in inferring causality. The area under the ROC curve, sensitivity, and specificity of the risk assessment model are not optimal, indicating the need for future studies to identify more significant explanatory factors. Expanding model generalizability necessitates the incorporation of new data sources, especially from recurrent patients. Third, we did not adjust for non-response by weighting the sample. Further analysis of indicator weights may be more conducive to improving the predictability of the model. Therefore, ongoing investigation into risk variables is vital for further development of this model.

6 Conclusion

In this study, the number of relapses, medication adherence, and NSSI history were identified as the most significant predictors of patient outcomes. Despite the limitations posed by the variability of risk variables for risk stratification, the results conjointly indicate that a multivariable prediction model can be beneficial for the short-term prediction of NSSI in adolescents (58). Additionally, the predictive model constructed herein exhibited favorably discriminatory power and accuracy and could effectively predict the risk of NSSI in adolescents. More importantly, these models may assist in identifying potentially key targets for clinical risk evaluation and prevention. Using prediction algorithms derived from large-scale data sources, screening systems for risk recognition may be pioneered (58). To enhance the validation of clinical samples, modern tools or machine learning techniques based on AI can be used.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Ethics statement

The Shanxi Baiqiuen Hospital Ethics Committee approved the study(Approved No.YXLL-2022–013). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/ next of kin in accordance with the national legislation and institutional requirements.

Author contributions

WZ: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. LC: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. HZ: Conceptualization, Funding acquisition, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing. FH: Investigation, Writing – original draft. ML: Data curation, Investigation, Writing – review & editing. XD: Formal analysis, Validation, Writing – review & editing. XF: Data curation, Investigation, Writing – review & editing. WL: Conceptualization,

Funding acquisition, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. Klonsky ED. Non-suicidal self-injury: an introduction. *J Clinical Psychol*. (2007) 63:1039–43. doi: 10.1002/jclp.20411

2. International society for the study of self-injury (2020). Available online at: https://itriples.org/category/about-self-injury/ (Accessed August 21, 2022).

3. Muehlenkamp JJ, Gutierrez PM. An investigation of differences between self-injurious behavior and suicide attempts in a sample of adolescents. *Suicide life-threatening behavior*. (2004) 34:12–23. doi: 10.1521/suli.34.1.12.27769

4. Shorey S, Ng ED, Wong C. Global prevalence of depression and elevated depressive symptoms among adolescents: A systematic review and meta-analysis. *Br J Clin Psychol*. (2021) 61(2):287–305. doi: 10.1111/bjc.12333

5. Lockwood J, Townsend E, Daley D, Sayal K. Impulsivity as a predictor of self-harm onset and maintenance in young adolescents: a longitudinal prospective study. *J Affective Disord*. (2020) 274:583–92. doi: 10.1016/j.jad.2020.05.021

6. Centers for Disease Control and Prevention [CDC]. WISQARS: Web-based inquiry statistics query and reporting system (2019). Available online at: http://www.cdc.gov/ncipc/wisqars/default.htm (Accessed August 21, 2022).

7. Hedegaard H, Curtin SC, Warner M. *Increase in suicide mortality in the United States, 1999-2018*. Atlanta, USA: Centers for Disease Control and Prevention (2020). Available online at: https://www.cdc.gov/nchs/products/databriefs/db362.htm. NCHS Data Brief No. 362.

8. Kiekens G, Hasking P, Bruffaerts R, Alonso J, Auerbach RP, Bantjes J, et al. Non-suicidal self-injury among first-year college students and its association with mental disorders: results from the World Mental Health International College Student (WMH-ICS) initiative. *psychol Med*. (2021) 53(3):1–12. doi: 10.1017/S0033291721002245

9. Muehlenkamp JJ. Distinguishing between suicidal and nonsuicidal self-injury. In: Nock MK, editor. *The oxford handbook of suicide and self-injury*. Oxford University Press, New York (2014). p. 23–46.

10. Nock MK. Self-injury. *Annual Rev Clin Psychol*. (2010) 6:339–63. doi: 10.1146/annurev.clinpsy.121208.131258

11. Gandhi A, Luyckx K, Molenberghs G, Baetens I, Goossens L, Maitra S, et al. Maternal and peer attachment, identity formation, and non-suicidal self-injury: a longitudinal mediation study. *Child Adolescent Psychiatry Mental Health*. (2019) 13:7. doi: 10.1186/s13034-019-0267-2

12. Cunningham KC, Aunon FM, Patel TA, Mann AJ, DeBeer BB, Meyer EC, et al. Nonsuicidal self-injury disorder, borderline personality disorder, and lifetime history of suicide attempts among male and female veterans with mental health disorders. *J Affect Disord*. (2021) 287:276–81. doi: 10.1016/j.jad.2021.03.033

13. Victor Sarah E, Hipwell Alison E, Stepp Stephanie D, Scott Lori N. Parent and peer relationships as longitudinal predictors of adolescent non-suicidal self-injury onset. *Child Adolesc Psychiatry Ment Health*. (2019) 13:1. doi: 10.1186/s13034-018-0261-0

14. Allen K, Fox KR, Schatten HT, Hooley JM. Frequency of nonsuicidal self-injury is associated with impulsive decision-making during criticism. *Psychiatry Res*. (2019) 271:68–75. doi: 10.1016/j.psychres.2018.11.022

15. Baer MM, LaCroix JM, Browne JC, Hassena HO, Perera KU, Soumoff A, et al. Impulse control difficulties while distressed: A facet of emotion dysregulation links to Non-Suicidal Self-Injury among psychiatric inpatients at military treatment facilities. *Psychiatry Res*. (2018) 269:419–24. doi: 10.1016/j.psychres.2018.08.082

16. Tang Y, Wan Y, Xu S, Zhang S, Hao J, Tao F. Nonlinear relationship between sleep duration and non-suicidal self-injurious behaviour among Chinese adolescents. *BMC Psychiatry*. (2021) 21:521. doi: 10.1186/s12888-021-03539-x

17. Khazaie H, Khazaie S, Zakiei A, Dürsteler KM, Brühl AB, Brand S, et al. When non-suicidal self-injury predicts non-suicidal self-injury and poor sleep-results from a larger cross-sectional and quasi-longitudinal study. *Int J Environ Res Public Health*. (2021) 18:13011. doi: 10.3390/ijerph182413011

18. Van der venne P, Balint A, Drews E, Parzer P, Resch F, Koenig J, et al. Pain sensitivity and plasma beta-endorphin in adolescent non-suicidal self-injury. *J Affective Disord.* (2021) 278:199–208. doi: 10.1016/j.jad.2020.09.036

19. Holden RR, Patterson AA, Fekken GC. Childhood trauma and non-suicidal self-injury: Mental pain and depression as mediators in university and community samples? *Pers Individ Dif.* (2022) 187:111414. doi: 10.1016/j.paid.2021.111414

20. Burke TA, Stange JP, Hamilton JL, Cohen JN, O'Garro-Moore J, Daryanani I, et al. Cognitive and emotion-regulatory mediators of the relationship between behavioral approach system sensitivity and nonsuicidal self-injury frequency. *Suicide life-threatening Behav.* (2015) 45:495–504. doi: 10.1111/sltb.12145

21. Guan K, Fox KR, Prinstein MJ. Nonsuicidal self-injury as a time-invariant predictor of adolescent suicide ideation and attempts in a diverse community sample. *J Consulting Clinical Psychol.* (2012) 80:842–9. doi: 10.1037/a0029429

22. Whitlock J, Muehlenkamp J, Eckenrode J, Purington A, Baral Abrams G, Barreira P, et al. Nonsuicidal self-injury as a gateway to suicide in young adults. *J Adolesc health: Off Publ Soc Adolesc Med.* (2013) 52:486–92. doi: 10.1016/j.jadohealth.2012.09.010

23. Fox KR, Franklin JC, Ribeiro JD, Kleiman EM, Bentley KH, Nock MK. Meta-analysis of risk factors for nonsuicidal self-injury. *Clinical Psychol Review.* (2015) 42:156–67. doi: 10.1016/j.cpr.2015.09.002

24. Hankin BL, Abela JR. Nonsuicidal self-injury in adolescence: prospective rates and risk factors in a 2½ year longitudinal study. *Psychiatry Res.* (2011) 186:65–70. doi: 10.1016/j.psychres.2010.07.056

25. Hankin BL. Cognitive vulnerability-stress model of depression during adolescence: investigating depressive symptom specificity in a multi-wave prospective study. *J Abnormal Child Psychol.* (2008) 36:999–1014. doi: 10.1007/s10802-008-9228-6

26. Hoff ER, Muehlenkamp JJ. Nonsuicidal self-injury in college students: the role of perfectionism and rumination. *Suicide life-threatening Behavior.* (2009) 39:576–87. doi: 10.1521/suli.2009.39.6.576

27. Jacobson CM, Gould M. The epidemiology and phenomenology of non-suicidal self-injurious behavior among adolescents: a critical review of the literature. *Arch suicide research: Off J Int Acad Suicide Res.* (2007) 11:129–47. doi: 10.1080/13811110701247602

28. Wilcox HC, Arria AM, Caldeira KM, Vincent KB, Pinchevsky GM, O'Grady KE. Longitudinal predictors of past-year non-suicidal self-injury and motives among college students. *Psychological Med.* (2012) 42:717–26. doi: 10.1017/S0033291711001814

29. De Beurs DP, Fokkema M, De Groot MH, De Keijser J, Kerkhof AJ. Longitudinal measurement invariance of the Beck Scale for Suicide Ideation. *Psychiatry Res.* (2015) 225:368–73. doi: 10.1016/j.psychres.2014.11.075

30. Li XY, Fei LP, Zhang YL, Xu D, Tong YS, Yang FD, et al. Reliability and validity of the Chinese version of Beck Suicide Ideation Scale(BSI-CV)in adult community resident. *Chin Med Health J.* (2011) 25:862–6. doi: 10.3969/j.issn.1000-6729.2011.11.013

31. Barratt ES. Anxiety and impulsiveness related to psychomotor efficiency. *Perceptual Motor Skills.* (1959) 9:191–8. doi: 10.2466/pms.1959.9.3.191

32. Zhou L, Xiao SY, He XY, Li J, Liu HM. Reliability and validity of chinese version of barratt impulsiveness scale- 11. *Chin J Clin Psychol.* (2006) 14:343–344 + 342. doi: 10.3969/j.issn.1005-3611.2006.04.005

33. Williams DA, Thorn BE. An empirical assessment of pain beliefs. *Pain.* (1989) 36:351–8. doi: 10.1016/0304-3959(89)90095-X

34. He T, Zhang MF. The relationship between degree of pain and pain beliefs. *Chin J Nurs.* (2011) 46:909–11. doi: 10.3761/j.issn.0254-1769.2011.09.026

35. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res.* (1989) 28(2):193–213. doi: 10.1016/0165-1781(89)90047-4

36. Chen XL, Tang HM, Zhou YX, Yang LX, Fu SJ, Zhang LM, et al. The relationship between bullying behavior, emotional behavior and non-suicidal self-harm of middle school students. *J Nanchang Univ (Medical Science).* (2019) 59:71–5. doi: 10.13764/j.cnki.ncdm.2019.01.017

37. Happell B, Warner T, Waks S, O'Donovan A, Manning F, Doody R, et al. Something special, something unique: Perspectives of experts by experience in mental health nursing education on their contribution. *J Psychiatr Ment Health Nurs.* (2021) 29 (2):346–58. doi: 10.1111/jpm.12773

38. Auerbach RP, Mortier P, Bruffaerts R, Alonso J, Benjet C, Cuijpers P, et al. WHO World Mental Health Surveys International College Student Project: Prevalence and distribution of mental disorders. *J Of Abnormal Psychol.* (2018) 127:623–38. doi: 10.1037/abn0000362

39. Blasco-Fontecilla H, Fernández-Fernández R, Colino L, Fajardo L, Perteguer-Barrio R, De Leon J. The addictive model of self-harming (Non-suicidal and suicidal) behavior. *Frontiers Psychiatry.* (2016) 7:8. doi: 10.3389/fpsyt.2016.00008

40. Plener PL, Schumacher TS, Munz LM, Groschwitz RC. The longitudinal course of non-suicidal self-injury and deliberate self-harm: a systematic review of the literature. *Borderline Pers Disord And Emotion Dysregulation.* (2015) 2:2. doi: 10.1186/s40479-014-0024-3

41. Xu HF, Wang CZ, Hou SB, Hu MM, Li YW, Wang KY. Status quo and analysis of the research on non-suicidal self-injury behaviors of college students. *psychol Monthly.* (2021) 14:221–3. doi: 10.19738/j.cnki.psy.2021.14.105

42. Chapman AL, Gratz KL, Brown MZ. Solving the puzzle of deliberate self-harm: the experiential avoidance model. *Behav Res Ther.* (2006) 44:371–94. doi: 10.1016/j.brat.2005.03.005

43. Stewart SL, Baiden P, Theall-Honey L. Examining non-suicidal self-injury among adolescents with mental health needs, in Ontario, Canada. *Arch suicide research: Off J Int Acad Suicide Res.* (2014) 18:392–409. doi: 10.1080/13811118.2013.824838

44. Hird K, Hasking P, Boyes M. Relationships between outcome expectancies and non-suicidal self-injury: moderating roles of emotion regulation difficulties and self-efficacy to resist self-injury. *Arch suicide research: Off J Int Acad Suicide Res Advance Online.* (2021) 26(4):1688–701. doi: 10.1080/13811118.2021.1983492

45. Carpenter RW, Trull TJ. The pain paradox: borderline personality disorder features, self-harm history, and the experience of pain. *Pers Disord.* (2015) 6:141–51. doi: 10.1037/per0000112

46. Jiang Y, Ren Y, Liu T, You J. Rejection sensitivity and adolescent non-suicidal self-injury: Mediation through depressive symptoms and moderation by fear of self-compassion. *Psychol Psychotherapy.* (2021) 94(Suppl 2):481–96. doi: 10.1111/papt.12293

47. Peckham AD, Jordan H, Silverman A, Jarvi Steele S, Björgvinsson T, Beard C. From urges to action: negative urgency and nonsuicidal self-injury in an acute transdiagnostic sample. *Arch suicide research: Off J Int Acad Suicide Res.* (2020) 24:367–83. doi: 10.1080/13811118.2019.1625831

48. Lutz NM, Chamberlain SR, Goodyer IM, Bhardwaj A, Sahakian BJ, Jones PB, et al. Behavioral measures of impulsivity and compulsivity in adolescents with nonsuicidal self-injury. *CNS spectrums.* (2021) 27(5):1–9. doi: 10.1017/S1092852921000274

49. Kirtley OJ, O'Carroll RE, O'Connor RC. The role of endogenous opioids in non-suicidal self-injurious behavior: methodological challenges. *Neurosci Biobehav Rev.* (2015) 48:186–9. doi: 10.1016/j.neubiorev.2014.11.007

50. Ludäscher P, von Kalckreuth C, Parzer P, Kaess M, Resch F, Bohus M, et al. Pain perception in female adolescents with borderline personality disorder. *European Child Adolescent Psychiatry.* (2015) 24:351–7. doi: 10.1007/s00787-014-0585-0

51. Pavony MT, Lenzenweger MF. Somatosensory processing and borderline personality disorder: pain perception and a signal detection analysis of proprioception and exteroceptive sensitivity. *Pers Disord.* (2014) 5:164–71. doi: 10.1037/per0000017

52. Schmahl C, Baumgärtner U. Pain in borderline personality disorder. *Modern Trends Pharmacopsychiatry.* (2015) 30:166–75. doi: 10.1159/000435940

53. Zinchuk MS, Avedisova AS, Voinova NI, Kustov GV, Pashnin EV, Gulyaeva NV, et al. Vospriyatie boli pri nesuitsidal'nom samopovrezhdayushchem povedenii [Pain perception and nonsuicidal self-injurious behavior. *Zhurnal nevrologii i psikhiatrii imeni S.S. Korsakova.* (2020) 120:144–52. doi: 10.17116/jnevro2020120121144

54. Asarnow JR, Bai S, Babeva KN, Adrian M, Berk MS, Asarnow LD, et al. Sleep in youth with repeated self-harm and high suicidality: Does sleep predict self-harm risk? *Suicide life-threatening Behavior.* (2020) 50:1189–97. doi: 10.1111/sltb.12658

55. Fitzpatrick S, Varma S, Ip J. The impact of homeostatic and circadian sleep processes on non-suicidal self-injury and suicide urges in borderline personality disorder. *Arch suicide research: Off J Int Acad Suicide Res.* (2021) 26(3):1–16. doi: 10.1080/13811118.2021.1932647

56. Scamaldo KM, Tull MT, Gratz KL. The role of sleep disturbance in the associations of borderline personality disorder symptom severity to nonsuicidal self-injury and suicide risk among patients with substance use disorders. *Pers Ment Health.* (2021) 16(1):59–69. doi: 10.1002/pmh.1526

57. Park SY. Nomogram: An analogue tool to deliver digital knowledge. *J Thorac Cardiovasc Surg.* (2018) 155:1793. doi: 10.1016/j.jtcvs.2017.12.107

58. Belsher BE, Smolenski DJ, Pruitt LD, Bush NE, Beech EH, Workman DE, et al. Prediction models for suicide attempts and deaths: A systematic review and simulation. *JAMA Psychiatry.* (2019) 76:642–51. doi: 10.1001/jamapsychiatry.2019.0174

Association between smoking status and suicidal ideation, planning, and attempts among adults in South Korea: a population-based cross-sectional survey

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Introduction: Suicide is a significant global public health concern influenced by diverse factors. Smoking is associated with an increased risk of suicide-related behaviors, yet age- and sex-specific risks remain unclear. This study examined the association between smoking status and suicide-related behaviors, with specific estimates for different age and sex groups.

Methods: This study investigated the association between smoking status (never-smoker, ex-smoker, and current smoker) and suicide-related behaviors (suicidal ideation, planning, and attempts). We extracted the data from the Korea National Health and Nutrition Examination Survey database between January 1st, 2015, and December 31st, 2021. A total of 32,837 participants were included in this study, with a mean (SD) age of 52.3 (0.09) years. Multivariable logistic regression was adjusted for age, sex, BMI, income level, education level, active physical activity, alcohol consumption, and comorbid conditions (perceived stress, perceived symptoms of depression, hypertension, diabetes mellitus, and dyslipidemia). We explored the potential dose-response relationship by stratifying the analysis based on participants' smoking intensity, as measured by pack-years. We also performed the subgroup analysis for the following variables: age groups, sex, income level, alcohol consumption, active physical activity, perceived stress, and perceived symptoms of depression. Statistical significance was set at $P < 0.05$. Statistical analyses were done using R software, version 4.2.3.

Results: Current smokers demonstrated significantly elevated risks for suicidal ideation (OR 2.022, 95% CI 1.913–2.137), planning (OR 2.138, 95% CI 1.930–2.368), and attempts (OR 2.082, 95% CI 1.942–2.232). Ex-smokers also exhibited increased risks for suicidal ideation (OR 1.553, 95% CI 1.467–1.644) and attempts (OR 1.567, 95% CI 1.458–1.684), though not for planning (OR 1.087, 95% CI 0.963–1.228). Our findings suggested the potential dose-dependent

relationship. Notably, males aged 40−59 were found to be the most vulnerable group for suicide-related behaviors.

Conclusion: This study underscores the significant association of smoking with increased risks of suicidal behaviors, particularly among current smokers. Males aged 40 to 59 emerged as a high-risk group. Findings emphasize the critical role of smoking cessation in suicide prevention, necessitating targeted interventions. Prospective studies should delve into causal pathways to inform effective prevention strategies.

1 Introduction

Suicide remains a major concern of global public health. Suicidal behaviors are influenced by the interplay between clinical, biological, psychological, and environmental factors (1). According to the 2021 Global Burden of Disease study, the global burden of suicide was revealed to be significant. In 2021, the age-standardized mortality rate from suicide was estimated to be 8.99 per 100,000 individuals (95% uncertainty interval [UI] 8.34 to 9.64) (2). Within Asia, the rates varied across regions, with Central Asia at 9.73 (95% UI 8.78 to 10.70), South Asia at 11.6 (95% UI 9.77 to 12.6), East Asia at 7.28 (95% UI 6.25 to 8.83), and Southeast Asia at 4.80 (95% UI 4.20 to 5.39) (2). Notably, South Korea showed a notable age-standardized mortality rate of 18.1 per 100,000 individuals, 95% UI 11.1 to 19.7 (2). The mortality rate from suicide varied among different regions, genders, and age groups, which suggests that targeted strategies for suicide prevention are required for vulnerable populations.

While diverse preventative strategies are available for suicide, such as universal, selective, indicated, and multicomponent interventions (1), identifying modifiable risk factors is crucial for more targeted intervention and efficient use of limited resources. Herein, an umbrella review summarized the individual-level risk factors for suicide mortality. Among them, smoking was found to be associated with a two-fold increase in risk for suicide mortality (relative risk 2.4, 95% confidence interval [CI] 2.1 to 2.8) (3). Several studies have provided reliable evidence that smoking affects serotonin function, which can affect depression, major psychiatric disorders, and suicidal behavior (4, 5). Previous studies have firmly established observational associations between smoking and suicide-related behaviors, including suicidal ideation, planning, attempts, and completed suicides (6, 7). A systematic review with meta-analyses that encompassed 63 studies reported that current smokers were associated with an elevated risk of suicidal ideation (odds ratio [OR] 2.05, 95% CI 1.53 to 2.58), suicide planning (OR 2.36, 95% CI 1.69 to 3.02), and suicide attempts (OR 2.84, 95% CI 1.49 to 4.19) (7). Nonetheless, to the best of our knowledge, the

stratified associations across age and sex groups have not yet been elucidated using a large number of participants. Previous meta-analytic studies did not conduct subgroup analyses for these moderators, while the burden of suicide varied among different age and sex groups.

Herein, this study aimed to investigate the association between smoking status and suicide-related behaviors (ideation, planning, and attempts). We conducted an additional analysis to explore the possible dose-responsive relationship by examining the associations according to smoking intensity, as measured by pack-years. Findings from this study could provide valuable insights for healthcare professionals and policymakers regarding the comparative risk of suicide-related behaviors in relation to smoking across different sex and age groups. This could highlight vulnerable populations and facilitate more targeted strategies for suicide prevention.

2 Methods

The study was conducted according to the guidelines of the Declaration of Helsinki and was approved by the Institutional Review Board of Wonju Severance Christian Hospital, Wonju, Republic of Korea (CR324321). The participant consent was waived since we used deidentified and retrospective data.

2.1 Participants recruitment

The current study utilized the Korea National Health and Nutrition Examination Survey (KNHANES) data. The KNHANES is a population-based survey with a cross-sectional design that is stratified, multistage, and clustered based on age, sex, and geographic area of participants. The KNHANES contains participants' health status, including physical and laboratory examinations and nutritional assessments. Using the KNHANES data, we enrolled participant candidates from January 1st, 2015, to

December 31st, 2021. Among them, we specifically included those aged 20 and above to ensure that only the adult population was enrolled. Then, we excluded individuals from the dataset whose data could not be used in the analyses due to missing information.

2.2 Study design and variables

This study aimed to explore the association between smoking status and suicidal ideation, planning, and attempts. We also investigated each of these associations by considering participants' smoking intensity, as measured by pack-years. Moreover, we provided age-stratified estimates for each investigated association.

The participants' smoking status was categorized as follows: 'never-smokers', 'ex-smokers', and 'current smokers.' We also evaluated the smoking intensity by examining the total number of cigarette packs they smoked over their lifetime, which was categorized into three groups: less than 10 pack-years, 10 to 15 pack-years, and 15 or more pack-years.

The outcomes of interest were participants' suicidal ideation, planning, and attempts during the investigated periods. Suicidal ideation was evaluated with the query, "Have you seriously considered suicide in the past year?" Suicidal planning was gauged with the inquiry, "Have you made detailed plans to commit suicide in the past year?" Suicide attempts were examined with the question, "Have you actually tried to commit suicide in the past year?"

As covariates, we included the following variables in this study: age, sex, body mass index (BMI), income level, education level, active physical activity, alcohol consumption status, and participant's comorbid conditions (perceived stress, perceived symptoms of depression, hypertension, dyslipidemia, and type 2 diabetes mellitus). Age groups were categorized into seven brackets: 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, and 80 and over. Income levels were divided into four groups based on quartile ratios, ranging from Q1 (lowest) to Q4 (highest). Education levels were classified into four groups: elementary school or below, middle school graduate, high school graduate, and college graduate or above. Active physical activity was split into two categories—yes or no—depending on whether individuals engaged in moderate-intensity physical activity for 150 minutes or more per week, or high-intensity physical activity for 75 minutes or more per week, or a combination of moderate and high-intensity activities (where 1 minute of high-intensity equals 2 minutes of moderate-intensity), totaling the equivalent time for each activity. Alcohol consumption status was delineated into two groups: heavy consumption (≥ 140g/week for males or ≥ 70g/week for females) and non-heavy consumption (< 140g/week for males and < 70g/week for females). Perceived stress was evaluated with the query, "How much stress do you usually experience in your daily life?" categorized as severe, moderate, mild, and none. Perceived symptoms of depression were assessed with the inquiry, "Have you experienced feeling consistently sad or hopeless for two weeks or more to the extent that it significantly affected your daily life in the past year?", with responses recorded as either yes or no. Hypertension was identified through a blood pressure reading of

≥140/90 mmHg or by the query "Are you currently taking medication to control your blood pressure?" Dyslipidemia was defined by a total cholesterol level of 240 mg/dL or higher. Type-2 diabetes mellitus was determined by a fasting blood glucose level of ≥126 mg/dL.

2.3 Statistical analysis

To evaluate the differences in study variables among the three groups (never-smokers, ex-smokers, and current smokers), we conducted the analysis of variance (ANOVA) followed by posthoc analysis for continuous variables and χ^2 test for categorical variables. The Kolmogorov-Smirnov normality analysis was implemented for continuous variables. If the result indicated normality, it was conveyed as mean and standard error. As a main analysis, we examined the association between smoking status and the risk of suicidal ideation, planning, and attempts. We employed multivariable logistic regression analysis, using never-smokers as the reference group, to estimate the OR and corresponding 95% CI for both ex-smokers and current smokers. To adjust for potential confounders, we tested four models: Model 1 (crude analysis), Model 2 (adjusted for age and sex), Model 3 (adjusted for age, sex, BMI, income level, education level, active physical activity, and alcohol consumption), and Model 4 (adjusted for age, sex, BMI, income level, education level, active physical activity, alcohol consumption, and comorbid conditions [perceived stress, perceived symptoms of depression, hypertension, diabetes mellitus, and dyslipidemia]). We assessed the goodness of fit for each main model using the Nagelkerke R-squared value, an adjusted version of the Cox & Snell R-square [8]. Nagelkerke R-squared value ranges from 0 to 1, and a higher value signifies a better model fit, which indicates that the included covariates better explain the variability in the risk of suicidal ideation, planning, and attempts.

We explored the potential dose-response relationship by stratifying the analysis based on participants' smoking intensity (less than 10 pack-years, 10 to 15 pack-years, and 15 or more pack-years). We also performed the subgroup analysis for the following variables: age groups (20-29, 30-39, 40-49, 50-59, 60-69, 70-79, and 80 and over), sex (male vs. female), income level (Q1, Q2, Q3, and Q4), alcohol consumption (heavy consumption vs. non-heavy consumption), active physical activity (yes vs. no), perceived stress (severe, moderate, mild, and none), and perceived symptoms of depression (yes vs. no).

The threshold for statistical significance was set at $P < 0.05$, and all statistical analyses were two-sided. Statistical analyses were performed using R software, version 4.2.3.

3 Results

3.1 Participants characteristics

Among the identified participant candidates between January 1st, 2015, and December 31st, 2021, a total of 32,837 participants

were included in this study. Participants had a mean (SD) age of 52.3 (0.09) years and comprised more females (18,968 [57.8%]) than males (13,869 [42.2%]). Out of the 32,837 participants, 20,225 (61.6%) were classified as never-smokers, 7,313 (22.3%) as ex-smokers, and 5299 (16.1%) as current smokers. Regarding suicide-related behaviors, 924 (2.8%) individuals displayed suicidal ideation, 499 (1.5%) demonstrated suicidal planning, and 183 (0.6%) attempted suicide. The detailed characteristics of this study participants are presented in Table 1.

3.2 Main analysis: association between smoking status and suicidal ideation, planning, and attempts

Among the models, the fully adjusted model (Model 4) demonstrated the highest Nagelkerke R-squared values for all outcomes of interest: 0.365 for suicidal ideation, 0.179 for suicidal planning, and 0.195 for suicidal attempts (Table 2). After fully adjusting for potential confounders, ex-smokers were found to be associated with a statistically significant higher risk of suicidal ideation (OR 1.553, 95% CI 1.467 to 1.644) and suicide attempts (OR 1.567, 95% CI 1.458 to 1.684) compared to never-smokers, while the association with suicidal planning was not significant (OR 1.087, 95% CI 0.963 to 1.228). For current smokers, associations with suicidal ideation (OR 2.022, 95% CI 1.913 to 2.137), suicidal planning (OR 2.138, 95% CI 1.930 to 2.368), and suicide attempts (OR 2.082, 95% CI 1.942 to 2.232) retained statistical significance even after adjustment for potential confounders (Table 2).

3.3 Potential dose-responsive relationship per smoking intensity

Regarding suicidal ideation, fully adjusted effect sizes were found to increase in individuals with greater pack-years in both ex-smoker and current smokers: for ex-smoker (<10 pack-years: OR 1.390, 95% CI 1.298 to 1.488; 10 to 15 pack-years: OR 1.810, 95% CI 1.604 to 2.042; >15 pack-years: OR 1.896, 95% CI 1.744 to 2.060) and for current smoker (<10 pack-years: OR 1.946, 95% CI 1.818 to 2.084; 10 to 15 pack-years: OR 1.955, 95% CI 1.763 to 2.168; >15 pack-years: OR 2.255, 95% CI 2.096 to 2.427) (Table 3).

For suicidal planning, individuals with 10 to 15 pack-years had the largest effect sizes when fully adjusted for both ex-smokers (<10 pack-years: OR 0.839, 95% CI 0.713 to 0.986; 10 to 15 pack-years: OR 1.704, 95% CI 1.341 to 2.165; >15 pack-years: OR 1.393, 95% CI 1.160 to 1.674) and current smokers (<10 pack-years: OR 1.986, 95% CI 1.761 to 2.240; 10 to 15 pack-years: OR 3.466, 95% CI 2.959 to 4.059; >15 pack-years: OR 2.005, 95% CI 1.740 to 2.311) (Table 3).

For suicide attempts, after full adjustment, individuals with >15 pack-years exhibited the largest effect sizes in both ex-smokers (<10 pack-years: OR 1.424, 95% CI 1.304 to 1.556; 10 to 15 pack-years: OR 1.942, 95% CI 1.683 to 2.241; >15 pack-years: OR 1.955, 95% CI 1.763 to 2.167) and current smokers (<10 pack-years: OR 1.825,

95% CI 1.671 to 1.994; 10 to 15 pack-years: OR 1.482, 95% CI 1.284 to 1.711; >15 pack-years: OR 2.773, 95% CI 2.540 to 3.026) (Table 3).

3.4 Subgroup analysis

Regarding age groups among ex-smokers, individuals aged 40 to 49 had the highest estimated odds for suicidal ideation (OR 2.487, 95% CI 2.120 to 2.918). The highest estimated odds for suicidal planning were found in those aged 50 to 79 (50 to 59: OR 2.240, 95% CI 1.860 to 2.699; 60 to 69: OR 2.224, 95% CI 1.849 to 2.675; 70 to 79: OR 2.342, 95% CI 1.907 to 2.876), while the largest estimate for suicide attempts was observed in the 50 to 59 age group (OR 4.360, 95% CI 2.880 to 6.602). Among current smokers, individuals aged 40 to 59 showed the largest estimates for suicidal ideation (40 to 49: OR 2.644, 95% CI 2.258 to 3.095; 50 to 59: OR 2.638, 95% CI 2.312 to 3.011). Notably, those aged 50 to 59 exhibited the greatest estimated odds for suicidal planning (OR 4.375, 95% CI 3.696 to 5.179) and suicide attempts (OR 14.159, 95% CI 9.985 to 20.077) (Table 4, Figure 1). In terms of sex, males exhibited a higher risk of suicidal ideation, planning, and attempts compared to females among both ex-smokers and current smokers (Table 4). Additionally, individuals with a Q2 income level, those who consumed alcohol heavily, engaged in no active physical activity, experienced higher perceived stress, and had perceived symptoms of depression showed higher estimates of these risks compared to other groups (Table 4).

4 Discussion

This observational study investigated the association of smoking status with suicidal ideation, planning, and attempts, respectively, using a population-based cross-sectional survey of South Korea. After accounting for potential confounders, ex-smokers and current smokers were found to be associated with a higher risk of suicidal ideation, planning, and attempts compared to never-smokers, except that ex-smokers showed a non-significant result on suicidal planning. These findings were in line with prior studies reporting a significant association of current smoking with suicide that was not observed in ex-smokers (9). Of note, the effect sizes tended to be greater among current smokers than ex-smokers across all associations that were examined in the main analysis. Moreover, our findings suggested a potential dose-dependent relationship based on the individual's smoking intensity. A Nepal study also demonstrated that smoking exhibited a dose-response relationship with suicide ideation (10).

The observational associations between smoking and suicide-related behaviors have been firmly established from previous studies, including meta-analyses (6, 7), reporting an approximately two-fold increased risk of suicide-related behaviors in ex-smokers or current smokers when compared to never-smokers. However, the evidence was primarily based on case-control or cross-sectional studies; specifically, a meta-analysis of

TABLE 1 Participants characteristics.

Study variables	Total participants	Never-smoker	Ex-smoker	Current smoker	P	Post-hoc†
N	32837	20225	7313	5299		
Age (yrs: mean, SD; N, %)	52.3 ± 0.09	52.2 ± 0.12	55.8 ± 0.19	47.8 ± 0.21	<0.001	2-1:3-1:3-2
20-29	3628 (11.0)	2370 (11.7)	483 (6.6)	775 (14.6)		
30-39	4816 (14.7)	2915 (14.4)	914 (12.5)	987 (18.6)		
40-49	5920 (18.0)	3575 (17.7)	1210 (16.5)	1135 (21.4)		
50-59	6266 (19.1)	3858 (19.1)	1313 (18.0)	1095 (20.7)		
60-69	6175 (18.8)	3727 (18.4)	1635 (22.4)	813 (15.3)		
70-79	4550 (13.9)	2827 (14.0)	1318 (18.0)	405 (7.6)		
80+	1482 (4.5)	953 (4.7)	440 (6.0)	89 (1.7)		
Sex (N, %)					<0.001	2-1:3-1
Male	13869 (42.2)	3337 (16.5)	6139 (83.9)	4393 (82.9)		
Female	18968 (57.8)	16888 (83.5)	1174 (16.1)	906 (17.1)		
BMI (mean, SD)	24 ± 0.02	23.7 ± 0.03	24.4 ± 0.04	24.3 ± 0.05	<0.001	2-1:3-1:3-2
Income level (N, %)					<0.001	3-1
Q1	8012 (24.4)	4629 (22.9)	1766 (24.1)	1617 (30.5)		
Q2	8231 (25.1)	5045 (24.9)	1795 (24.5)	1391 (26.3)		
Q3	8286 (25.2)	5189 (25.7)	1850 (25.3)	1247 (23.5)		
Q4	8308 (25.3)	5362 (26.5)	1902 (26.0)	1044 (19.7)		
Education level (N, %)					<0.001	2-1:3-1
Elementary school or below	6769 (20.6)	4759 (23.5)	1303 (17.8)	707 (13.3)		
Middle school graduate	3341 (10.2)	1943 (9.6)	835 (11.4)	563 (10.6)		
High school graduate	10482 (31.9)	5989 (29.6)	2330 (31.9)	2163 (40.8)		
College graduate or above	12245 (37.3)	7534 (37.3)	2845 (38.9)	1866 (35.2)		
Active physical activity (N, %)					0.071	2-1
Yes	14124 (43.0)	8625 (42.6)	3231 (44.2)	2268 (42.8)		
No	18713 (57.0)	11600 (57.4)	4082 (55.8)	3031 (57.2)		
Alcohol consumption (N, %)*					<0.001	2-1:3-1
Heavy consumption	27421 (83.5)	18667 (92.3)	5475 (74.9)	3279 (61.9)		
Non-heavy consumption	5416 (16.5)	1558 (7.7)	1838 (25.1)	2020 (38.1)		
Comorbid conditions (N, %)						
Perceived stress					<0.001	2-1:3-1
Severe	1520 (4.6)	876 (4.3)	277 (3.8)	367 (6.9)		
Moderate	7085 (21.6)	4276 (21.1)	1356 (18.5)	1453 (27.4)		
Mild	18657 (56.8)	11600 (57.4)	4282 (58.6)	2775 (52.4)		
None	5575 (17.0)	3473 (17.2)	1398 (19.1)	704 (13.3)		
Perceived symptoms of depression					<0.001	2-1

(Continued)

TABLE 1 Continued

Study variables	Total participants	Never-smoker	Ex-smoker	Current smoker	P	Post-hoc[†]
Comorbid conditions (N, %)						
Yes	2278 (6.9)	1457 (7.2)	409 (5.6)	412 (7.8)		
No	30559 (93.1)	18768 (92.8)	6904 (94.4)	4887 (92.2)		
Hypertension					<0.001	2-1:3-1
Yes	7731 (23.5)	4646 (23.0)	2088 (28.6)	997 (18.8)		
No	25106 (76.5)	15579 (77.0)	5225 (71.4)	4302 (81.2)		
Dyslipidemia					<0.001	3-1
Yes	4798 (14.6)	3113 (15.4)	1139 (15.6)	546 (10.3)		
No	28039 (85.4)	17112 (84.6)	6174 (84.4)	4753 (89.7)		
Diabetes mellitus					<0.001	2-1:3-1
Yes	3360 (10.2)	1860 (9.2)	973 (13.3)	527 (9.9)		
No	29477 (89.8)	18365 (90.8)	6340 (86.7)	4772 (90.1)		
Smoking intensity (pack-years: mean, SD)	6.9 ± 0.08	–	17.3 ± 0.23	18.8 ± 0.21	<0.001	2-1:3-1:3-2
Outcomes of interest (N, %)						
Suicidal ideation	924 (2.8)	494 (2.4)	199 (2.7)	231 (4.4)	<0.001	
Suicidal planning	499 (1.5)	253 (1.3)	107 (1.5)	139 (2.6)	<0.001	
Suicidal attempt	183 (0.6)	91 (0.4)	29 (0.4)	63 (1.2)	<0.001	

BMI, body mass index; N, number of participants; SD, standard deviation.
[†]N_1-N_2 indicates that Group N_1 is greater than Group N_2 (Group 1 = never-smoker; Group 2 = ex-smoker; Group 3 = current smoker).
Definitions of included variables are described in Methods section.

prospective cohort studies identified only three studies for suicidal ideation and suicide attempts, respectively. Furthermore, previous evidence could not robustly determine the magnitude of the associations stratified by age and sex, despite these variables being important moderators. Herein, this study observed the association by participants' age and sex, using the data from a population-based survey in South Korea. Our findings indicated that current smokers exhibited a similar two-fold increase in suicidal ideation, planning, and attempts, whereas ex-smokers demonstrated reduced effect sizes. Notably, our subgroup analyses identified the most vulnerable age group for each association. The results indicated that individuals aged 40 to 59 were associated with the highest risk for suicidal ideation, planning, and attempts among all age groups. Additionally, males were associated with a higher risk compared to females for all outcomes. The Japan Public Health Center-based Prospective Study demonstrated that smoking was a major predictor of suicide in middle-aged people with average ages ranging from 49 to 57 years old (11). Given these findings, we suggested that clinicians and policymakers should be alerted to the heightened risk of suicide-related behaviors among males aged 40 to 59.

Some previous studies suggested the potential causal relationship between smoking and suicide-related behaviors. Specifically, biological and behavioral mechanisms have been proposed. Regarding the biological mechanism, the current evidence indicates that smoking may lead to reduced serotonin levels and disruption of the hypothalamic-pituitary-adrenal (HPA) axis, both of which potentially impact an individual's mood and increase the risk of suicide-related behaviors (4, 12, 13). The previous findings further corroborated this explanation that exposure to secondhand smoke was associated with suicide-related behaviors in certain populations, albeit with smaller effect sizes compared to direct smoking (14, 15). When considering both the reduction in serotonin levels and disruption of the HPA axis due to smoking were reported to have a proportional relationship with the amount of smoking (4, 12), our findings that 1) the magnitude of associations were greater in current smokers than ex-smokers and 2) observed potential dose-dependent relationship based on the individual's smoking intensity may also support the possible biological link.

Nicotine represents a strong activator of the HPA axis, then, is related to an attenuated responsiveness of the HPA axis to psychological stress (13). The HPA alteration, also referred to as blunted axis activity, was demonstrated to increase risk for suicide attempt (16). In addition, most depressed patients have a dysregulation of corticotropin and cortisol secretory activity, as well as a tendency to show a high slope increase in the evening, when compared to the daytime (17, 18). An adolescent suicide

TABLE 2 Association between smoking status and suicide-related behaviors in the adult population.

	Smoking status			Nagelkerke R-squared values
	Never-smoker	Ex-smoker	Current smoker	
N (total participants)	20225	7313	5299	
Suicidal ideation				
N (number of cases)	494	199	231	
Model 1 (OR, 95% CI)	1 (reference)	1.067 (1.022 to 1.114)	1.887 (1.817 to 1.960)	0.009
Model 2 (OR, 95% CI)	1 (reference)	1.867 (1.774 to 1.964)	3.580 (3.414 to 3.753)	0.026
Model 3 (OR, 95% CI)	1 (reference)	1.789 (1.700 to 1.882)	2.881 (2.744 to 3.025)	0.058
Model 4 (OR, 95% CI)	1 (reference)	1.553 (1.467 to 1.644)	2.022 (1.913 to 2.137)	0.365
Suicidal planning				
N (number of cases)	253	107	139	
Model 1 (OR, 95% CI)	1 (reference)	0.849 (0.763 to 0.945)	2.709 (2.504 to 2.931)	0.01
Model 2 (OR, 95% CI)	1 (reference)	1.564 (1.387 to 1.764)	5.004 (4.542 to 5.512)	0.025
Model 3 (OR, 95% CI)	1 (reference)	1.371 (1.215 to 1.547)	3.318 (3.003 to 3.667)	0.057
Model 4 (OR, 95% CI)	1 (reference)	1.087 (0.963 to 1.228)	2.138 (1.930 to 2.368)	0.179
Suicidal attempt				
N (number of cases)	91	29	63	
Model 1 (OR, 95% CI)	1 (reference)	1.209 (1.140 to 1.283)	2.103 (1.996 to 2.217)	0.019
Model 2 (OR, 95% CI)	1 (reference)	1.996 (1.859 to 2.143)	3.873 (3.626 to 4.138)	0.031
Model 3 (OR, 95% CI)	1 (reference)	1.876 (1.748 to 2.014)	3.043 (2.844 to 3.256)	0.077
Model 4 (OR, 95% CI)	1 (reference)	1.567 (1.458 to 1.684)	2.082 (1.942 to 2.232)	0.195

CI, confidence interval; OR, odds ratio.
Our multivariable logistic regression adjusted for the following potential confounders: Model 1 (crude analysis), Model 2 (age and sex), Model 3 (age, sex, income level, body mass index [BMI], education level, active physical activity, and alcohol consumption), and Model 4 (age, sex, BMI, income level, education level, active physical activity, alcohol consumption, comorbid conditions [perceived stress, perceived symptoms of depression, hypertension, diabetes mellitus, and dyslipidemia]).

TABLE 3 Stratified analysis based on smoking intensity for the associations between smoking status and suicide-related behaviors.

Suicide-related behaviors	Smoking intensity (pack-years)	OR (95% CI)			
		Model 1	Model 2	Model 3	Model 4
Suicide-related behaviors	Non-smoker	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Ex-smoker				
	<10	0.992 (0.937 to 1.050)	1.686 (1.586 to 1.793)	1.635 (1.538 to 1.739)	1.390 (1.298 to 1.488)
	10 to 15	0.875 (0.790 to 0.969)	1.754 (1.573 to 1.955)	1.820 (1.631 to 2.030)	1.810 (1.604 to 2.042)
	>15	1.266 (1.191 to 1.345)	2.486 (2.308 to 2.678)	2.287 (2.122 to 2.465)	1.896 (1.744 to 2.060)
	Current smoker				
	<10	1.827 (1.733 to 1.926)	3.396 (3.202 to 3.601)	2.650 (2.496 to 2.814)	1.946 (1.818 to 2.084)
	10 to 15	1.842 (1.695 to 2.002)	3.672 (3.360 to 4.013)	3.129 (2.860 to 3.423)	1.955 (1.763 to 2.168)
	>15	1.957 (1.862 to 2.056)	3.998 (3.757 to 4.255)	3.297 (3.092 to 3.515)	2.255 (2.096 to 2.427)
Suicidal planning	Non-smoker	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Ex-smoker				
	<10	0.701 (0.601 to 0.817)	1.156 (0.986 to 1.355)	1.039 (0.886 to 1.219)	0.839 (0.713 to 0.986)

(Continued)

TABLE 3 Continued

Suicide-related behaviors	Smoking intensity (pack-years)	OR (95% CI)			
		Model 1	Model 2	Model 3	Model 4
	10 to 15	0.987 (0.788 to 1.236)	2.274 (1.793 to 2.884)	2.197 (1.731 to 2.787)	1.704 (1.341 to 2.165)
	>15	1.005 (0.860 to 1.173)	2.541 (2.120 to 3.045)	1.983 (1.654 to 2.378)	1.393 (1.160 to 1.674)
	Current smoker				
	<10	2.745 (2.474 to 3.046)	4.438 (3.954 to 4.982)	2.875 (2.554 to 3.236)	1.986 (1.761 to 2.240)
	10 to 15	3.920 (3.417 to 4.497)	7.874 (6.773 to 9.153)	5.766 (4.950 to 6.716)	3.466 (2.959 to 4.059)
	>15	2.298 (2.065 to 2.557)	5.399 (4.726 to 6.169)	3.508 (3.058 to 4.025)	2.005 (1.740 to 2.311)
Suicidal attempt	Non-smoker	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Ex-smoker				
	<10	1.043 (0.962 to 1.131)	1.782 (1.634 to 1.943)	1.701 (1.560 to 1.855)	1.424 (1.304 to 1.556)
	10 to 15	1.136 (0.996 to 1.295)	2.222 (1.930 to 2.558)	2.263 (1.965 to 2.606)	1.942 (1.683 to 2.241)
	>15	1.487 (1.370 to 1.614)	2.790 (2.521 to 3.088)	2.501 (2.259 to 2.769)	1.955 (1.763 to 2.167)
	Current smoker				
	<10	1.746 (1.616 to 1.886)	3.326 (3.055 to 3.621)	2.553 (2.342 to 2.782)	1.825 (1.671 to 1.994)
	10 to 15	1.461 (1.280 to 1.667)	2.904 (2.528 to 3.336)	2.409 (2.095 to 2.769)	1.482 (1.284 to 1.711)
	>15	2.633 (2.470 to 2.806)	5.250 (4.833 to 5.703)	4.210 (3.868 to 4.583)	2.773 (2.540 to 3.026)10 to 15

CI, confidence interval; OR, odds ratio.
Our multivariable logistic regression adjusted for the following potential confounders: Model 1 (crude analysis), Model 2 (age and sex), Model 3 (age, sex, income level, body mass index [BMI], education level, active physical activity, and alcohol consumption), and Model 4 (age, sex, BMI, income level, education level, active physical activity, alcohol consumption, comorbid conditions [perceived stress, perceived symptoms of depression, hypertension, diabetes mellitus, and dyslipidemia]).

TABLE 4 Subgroup analysis for the associations between smoking status and suicide-related behaviors.

Subgroup		Smoking status	Suicidal ideation	Suicidal planning	Suicidal attempt
			OR (95% CI)	OR (95% CI)	OR (95% CI)
Age	20-29	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.255 (1.099 to 1.433)	1.134 (0.952 to 1.352)	0.779 (0.607 to 1.001)
		Current smoker	1.434 (1.282 to 1.603)	1.148 (0.988 to 1.335)	1.419 (1.179 to 1.708)
	30-39	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.048 (0.897 to 1.225)	1.219 (1.003 to 1.481)	0.367 (0.244 to 0.551)
		Current smoker	1.730 (1.502 to 1.993)	1.796 (1.507 to 2.141)	1.895 (1.480 to 2.425)
	40-49	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	2.487 (2.120 to 2.918)	0.997 (0.805 to 1.234)	1.634 (1.192 to 2.239)
		Current smoker	2.644 (2.258 to 3.095)	1.768 (1.467 to 2.130)	2.206 (1.643 to 2.962)
	50-59	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.538 (1.337 to 1.770)	2.240 (1.860 to 2.699)	4.360 (2.880 to 6.602)
		Current smoker	2.638 (2.312 to 3.011)	4.375 (3.696 to 5.179)	14.159 (9.985 to 20.077)
	60-69	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.672 (1.412 to 1.979)	2.224 (1.849 to 2.675)	1.220 (0.878 to 1.694)
		Current smoker	2.266 (1.908 to 2.691)	2.654 (2.201 to 3.202)	2.555 (1.886 to 3.461)

(Continued)

TABLE 4 Continued

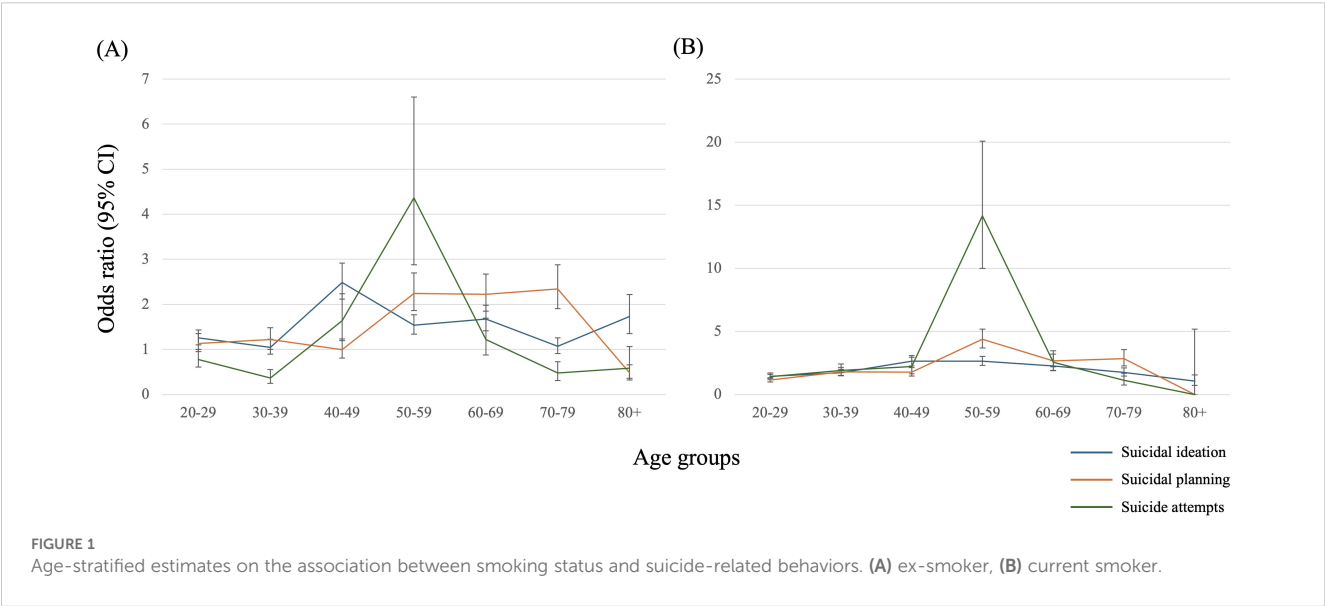| Subgroup		Smoking status	Suicidal ideation	Suicidal planning	Suicidal attempt
			OR (95% CI)	OR (95% CI)	OR (95% CI)
	70-79	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.068 (0.907 to 1.257)	2.342 (1.907 to 2.876)	0.476 (0.312 to 0.725)
		Current smoker	1.746 (1.452 to 2.101)	2.839 (2.266 to 3.556)	1.115 (0.740 to 1.681)
	80+	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.731 (1.351 to 2.217)	0.486 (0.359 to 0.658)	0.586 (0.323 to 1.063)
		Current smoker	1.057 (0.722 to 1.547)	0 (0 to inf.)	0 (0 to inf.)
Sex	Male	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.531 (1.408 to 1.664)	1.454 (1.297 to 1.629)	1.239 (1.044 to 1.472)
		Current smoker	2.013 (1.865 to 2.172)	3.129 (2.864 to 3.419)	2.424 (2.134 to 2.754)
	Female	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.281 (1.172 to 1.399)	1.001 (0.904 to 1.108)	0.531 (0.446 to 0.632)
		Current smoker	1.856 (1.703 to 2.023)	1.148 (1.038 to 1.270)	1.310 (1.128 to 1.522)
Income level	Q1	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.306 (1.187 to 1.436)	1.520 (1.356 to 1.704)	0.826 (0.691 to 0.988)
		Current smoker	1.938 (1.776 to 2.115)	2.239 (2.015 to 2.488)	1.475 (1.267 to 1.717)
	Q2	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	2.243 (2.009 to 2.504)	1.930 (1.691 to 2.201)	2.096 (1.624 to 2.707)
		Current smoker	2.213 (1.977 to 2.476)	1.909 (1.670 to 2.181)	5.436 (4.414 to 6.696)
	Q3	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.568 (1.377 to 1.786)	1.124 (0.948 to 1.333)	1.488 (1.14 to 1.942)
		Current smoker	2.509 (2.214 to 2.843)	1.442 (1.218 to 1.708)	1.122 (0.85 to 1.480)
	Q4	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.348 (1.176 to 1.546)	1.734 (1.401 to 2.145)	0 (0 to inf.)
		Current smoker	1.525 (1.317 to 1.766)	3.734 (3.018 to 4.619)	5.474 (4.131 to 7.255)
Alcohol consumption	Heavy consumption	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.544 (1.448 to 1.646)	1.749 (1.615 to 1.894)	1.257 (1.002 to 1.577)
		Current smoker	2.302 (2.162 to 2.450)	2.270 (2.098 to 2.456)	2.007 (1.665 to 2.420)
	Non-heavy consumption	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.269 (1.116 to 1.443)	0.880 (0.746 to 1.039)	0.895 (0.773 to 1.036)
		Current smoker	1.249 (1.110 to 1.406)	1.418 (1.226 to 1.640)	2.037 (1.808 to 2.296)
Active physical activity	Yes	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.244 (1.137 to 1.361)	1.393 (1.250 to 1.553)	0.709 (0.583 to 0.861)
		Current smoker	2.074 (1.909 to 2.254)	1.613 (1.452 to 1.794)	2.040 (1.757 to 2.369)
	No	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.855 (1.723 to 1.998)	1.697 (1.542 to 1.868)	1.486 (1.273 to 1.734)
		Current smoker	2.071 (1.922 to 2.231)	2.487 (2.267 to 2.728)	2.199 (1.914 to 2.526)
Perceived stress	Severe	Never-smoker	1 (reference)	1 (reference)	1 (reference)

(Continued)

TABLE 4 Continued

Subgroup		Smoking status	Suicidal ideation	Suicidal planning	Suicidal attempt
			OR (95% CI)	OR (95% CI)	OR (95% CI)
		Ex-smoker	4.845 (3.549 to 6.615)	2.084 (1.507 to 2.883)	1.077 (0.868 to 1.337)
		Current smoker	8.920 (6.536 to 12.174)	1.661 (1.141 to 2.418)	2.396 (2.023 to 2.838)
	Moderate	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	2.627 (2.370 to 2.911)	2.027 (1.778 to 2.311)	0.454 (0.349 to 0.590)
		Current smoker	2.449 (2.194 to 2.734)	1.353 (1.161 to 1.576)	1.691 (1.425 to 2.007)
	Mild	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.084 (0.992 to 1.185)	1.459 (1.285 to 1.657)	1.896 (1.536 to 2.342)
		Current smoker	1.995 (1.843 to 2.160)	3.266 (2.924 to 3.648)	2.766 (2.261 to 3.384)
	None	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.104 (0.974 to 1.252)	0.904 (0.787 to 1.039)	1.527 (0.730 to 3.195)
		Current smoker	1.237 (1.101 to 1.390)	1.405 (1.246 to 1.584)	0 (0 to inf.)
Perceived symptoms of depression	Yes	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.619 (1.481 to 1.769)	1.947 (1.731 to 2.191)	1.442 (1.223 to 1.699)
		Current smoker	2.205 (2.018 to 2.410)	2.347 (2.101 to 2.622)	3.884 (3.388 to 4.452)
	No	Never-smoker	1 (reference)	1 (reference)	1 (reference)
		Ex-smoker	1.518 (1.411 to 1.635)	1.376 (1.256 to 1.507)	0.777 (0.648 to 0.932)
		Current smoker	1.940 (1.808 to 2.081)	1.955 (1.788 to 2.137)	1.042 (0.892 to 1.217)

CI, confidence interval; inf., infinite; OR, odds ratio.
Definitions of included variables are described in Methods section.

prediction model suggested that depressive disorder is the main predictor of suicidal behaviors [19]. In summary, smoking can be estimated to cause suicidal behavior directly or indirectly through HPA alteration.

However, recent studies suggest that behavioral mechanisms should also be addressed. Indeed, a previous study that utilized bidirectional Mendelian randomization and single nucleotide polymorphism analysis reported non-significant results (OR for lifetime smoking on suicidal ideation: 0.050; 95% CI -0.027 to 0.127; OR on suicide attempts: 0.053; 95% CI -0.003 to 0.110) [20]. These previous findings implied that behavioral components might at least partially moderate the observed association between smoking

FIGURE 1
Age-stratified estimates on the association between smoking status and suicide-related behaviors. (A) ex-smoker, (B) current smoker.

and suicide-related behaviors. One possible hypothesis is that smoking status may indicate an individual's impulsivity, which is also related to suicide-related behaviors (20, 21). This is further supported by our findings that observed effect sizes among current smokers were greater than those among ex-smokers (i.e., ex-smokers possibly had less impulsivity than current smokers). Meanwhile, the Mendelian randomization of smoking with depression (OR 1.00, 95% CI 0.95 to 1.05), anxiety (OR 1.02, 95% CI 0.97 to 1.07), and psychological distress (OR 1.02, 95% CI 0.98 to 1.06) also reported non-significance (22), refuting the previously suggested explanation that association between smoking and suicide-related behaviors was moderated by mental illnesses (5). However, the proportion of biological (e.g., nicotine-mediated) and behavioral (e.g., impulsivity-mediated) components for this association still needed to be investigated. With an effort to elucidate the underlying mechanisms, clinicians and policymakers should endeavor to promote smoking cessation, considering the evidence that smoking is a modifiable risk factor for not only mental illness, including suicide-related behaviors (3, 23, 24), but also numerous physical diseases (25–27).

Our findings have some limitations. First, identified cases of suicidal ideation, planning, and attempts may be underreported since the KNHANES data primarily relies on self-reporting, which implies that the odds in real-world practice could be higher. Second, the majority of data from KNHANES relied on self-reporting, implying that important variables such as smoking habits were inevitably susceptible to recall bias. Third, this study used the data with a population-based cross-sectional design, indicating that some confounding factors, such as the scale for participants' impulsivity, could not be evaluated. However, we endeavored to include all accessible variables from the KNHANES database that could potentially influence the investigated associations. We also utilized multivariable logistic regression analysis to mitigate confounding effects and enhance the robustness of our findings. Fourth, since the associations in this study were derived from observational evidence, causality could not be established based on our findings. Further studies are warranted that employ prospective designs to investigate the moderators influencing the observed associations. Recently, albeit cross-sectional design, Mendelian randomization, which utilizes single-nucleotide polymorphisms as instrumental variables, has been employed to assess causal relationships between candidate features (20, 22).

Despite these limitations, this study re-affirmed the significant association between smoking and increased risk of suicidal ideation, planning, and attempts, with current smokers exhibiting stronger associations than ex-smokers. We further provided the stratified association by age and sex, of which the results indicated that males aged 40 to 59 should gain more attention. Our findings indicated a potential dose-dependent relationship between smoking and suicide-related behaviors. Despite limitations, including reliance on self-reported data, our results emphasized the importance of smoking cessation as a modifiable risk factor for suicide-related behaviors. Future studies should aim to elucidate the causality and consider prospective studies to better understand the complex interplay between smoking and suicide-related behaviors.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: Participant data used for this study cannot be publicly opened due to patient privacy concerns but can be shared by corresponding authors (J-WK: jwkim2011@naver.com) if a researcher provides a reasonable request. Requests to access these datasets should be directed to J-WK, jwkim2011@naver.com.

Ethics statement

The studies involving humans were approved by Institutional Review Board of Wonju Severance Christian Hospital. The studies were conducted in accordance with the local legislation and institutional requirements. The ethics committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because we used deidentified and retrospective data.

Author contributions

JK: Conceptualization, Investigation, Methodology, Visualization, Writing – original draft. TL: Data curation, Formal Analysis, Investigation, Methodology, Validation, Writing – review & editing. HP: Supervision, Writing – review & editing. SK: Supervision, Writing – review & editing. J-WK: Conceptualization, Investigation, Methodology, Supervision, Validation, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2025.1440792/full#supplementary-material

References

1. Turecki G, Brent DA, Gunnell D, O'Connor RC, Oquendo MA, Pirkis J, et al. Suicide and suicide risk. *Nat Rev Dis Primers*. (2019) 5:74. doi: 10.1038/s41572-019-0121-0

2. GBD 2021 Suicide Collaborators. Global, regional, and national burden of suicide, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet Public Health*. (2025) 10(3):e189–202. doi: 10.1016/S2468-2667(25)00006-4

3. Favril L, Yu R, Geddes JR, Fazel S. Individual-level risk factors for suicide mortality in the general population: an umbrella review. *Lancet Public Health*. (2023) 8:e868–77. doi: 10.1016/S2468-2667(23)00207-4

4. Malone KM, Waternaux C, Haas GL, Cooper TB, Li S, Mann JJ. Cigarette smoking, suicidal behavior, and serotonin function in major psychiatric disorders. *Am J Psychiatry*. (2003) 160:773–9. doi: 10.1176/appi.ajp.160.4.773

5. Green M, Turner S, Sareen J. Smoking and suicide: biological and social evidence and causal mechanisms. *J Epidemiol Community Health*. (2017) 71:839–40. doi: 10.1136/jech-2016-207731

6. Echeverria I, Cotaina M, Jovani A, Mora R, Haro G, Benito A. Proposal for the inclusion of tobacco use in suicide risk scales: results of a meta-analysis. *Int J Environ Res Public Health*. (2021) 18(11):6103. doi: 10.3390/ijerph18116103

7. Poorolajal J, Darvishi N. Smoking and suicide: A meta-analysis. *PloS One*. (2016) 11:e0156348. doi: 10.1371/journal.pone.0156348

8. Nagelkerke NJ. A note on a general definition of the coefficient of determination. *biometrika*. (1991) 78:691–2. doi: 10.1093/biomet/78.3.691

9. Lucas M, O'Reilly EJ, Mirzaei F, Okereke OI, Unger L, Miller M, et al. Cigarette smoking and completed suicide: results from 3 prospective cohorts of American adults. *J Affect Disord*. (2013) 151:1053–8. doi: 10.1016/j.jad.2013.08.033

10. Sathian B, Menezes RG, Asim M, Mekkodathil A, Sreedharan J, Banerjee I, et al. Cigarette smoking dose-response and suicidal ideation among young people in Nepal: a cross-sectional study. *Nepal J Epidemiol*. (2020) 10:821–9. doi: 10.3126/nje.v10i1.28277

11. Iwasaki M, Akechi T, Uchitomi Y, Tsugane S. Cigarette smoking and completed suicide among middle-aged men: a population-based cohort study in Japan. *Ann Epidemiol*. (2005) 15:286–92. doi: 10.1016/j.annepidem.2004.08.011

12. Mendelson JH, Sholar MB, Goletiani N, Siegel AJ, Mello NK. Effects of low- and high-nicotine cigarette smoking on mood states and the HPA axis in men. *Neuropsychopharmacology*. (2005) 30:1751–63. doi: 10.1038/sj.npp.1300753

13. Rohleder N, Kirschbaum C. The hypothalamic-pituitary-adrenal (HPA) axis in habitual smokers. *Int J Psychophysiol*. (2006) 59:236–43. doi: 10.1016/j.ijpsycho.2005.10.012

14. Lange S, Koyanagi A, Rehm J, Roerecke M, Carvalho AF. Association of tobacco use and exposure to secondhand smoke with suicide attempts among adolescents: findings from 33 countries. *Nicotine Tob Res*. (2020) 22:1322–9. doi: 10.1093/ntr/ntz172

15. Suzuki D, Wariki WMV, Suto M, Yamaji N, Takemoto Y, Rahman MM, et al. Association of secondhand smoke and depressive symptoms in nonsmoking pregnant Women: A systematic review and meta-analysis. *J Affect Disord*. (2019) 245:918–27. doi: 10.1016/j.jad.2018.11.048

16. Melhem NM, Keilp JG, Porta G, Oquendo MA, Burke A, Stanley B, et al. Blunted HPA axis activity in suicide attempters compared to those at high risk for suicidal behavior. *Neuropsychopharmacology*. (2016) 41:1447–56. doi: 10.1038/npp.2015.309

17. Doane LD, Mineka S, Zinbarg RE, Craske M, Griffith JW, Adam EK. Are flatter diurnal cortisol rhythms associated with major depression and anxiety disorders in late adolescence? The role of life stress and daily negative emotion. *Dev Psychopathol*. (2013) 25:629–42. doi: 10.1017/S0954579413000060

18. Van den Bergh BR, Van Calster B. Diurnal cortisol profiles and evening cortisol in post-pubertal adolescents scoring high on the Children's Depression Inventory. *Psychoneuroendocrinology*. (2009) 34:791–4. doi: 10.1016/j.psyneuen.2008.12.008

19. Lee J, Jang H, Kim J, Min S. Development of a suicide index model in general adolescents using the South Korea 2012–2016 national representative survey data. *Sci Rep*. (2019) 9:1846. doi: 10.1038/s41598-019-38886-z

20. Harrison R, Munafò MR, Davey Smith G, Wootton RE. Examining the effect of smoking on suicidal ideation and attempts: triangulation of epidemiological approaches. *Br J Psychiatry*. (2020) 217:701–7. doi: 10.1192/bjp.2020.68

21. Karlsson Linnér R, Biroli P, Kong E, Meddens SFW, Wedow R, Fontana MA, et al. Genome-wide association analyses of risk tolerance and risky behaviors in over 1 million individuals identify hundreds of loci and shared genetic influences. *Nat Genet*. (2019) 51:245–57. doi: 10.1038/s41588-018-0309-3

22. Taylor AE, Fluharty ME, Bjørngaard JH, Gabrielsen ME, Skorpen F, Marioni RE, et al. Investigating the possible causal association of smoking with depression and anxiety using Mendelian randomisation meta-analysis: the CARTA consortium. *BMJ Open*. (2014) 4:e006141. doi: 10.1136/jech-2014-204726.94

23. Dragioti E, Radua J, Solmi M, Arango C, Oliver D, Cortese S, et al. Global population attributable fraction of potentially modifiable risk factors for mental disorders: a meta-umbrella systematic review. *Mol Psychiatry*. (2022) 27:3510–9. doi: 10.1038/s41380-022-01586-8

24. Lee PH, Tervo-Clemmens B, Liu RT, Gersten MB, Jung JY, Janes AC, et al. Use of tobacco products and suicide attempts among elementary school-aged children. *JAMA Netw Open*. (2024) 7:e240376. doi: 10.1001/jamanetworkopen.2024.0376

25. Holtjer JCS, Bloemsma LD, Beijers R, Cornelissen MEB, Hilvering B, Houweling L, et al. Identifying risk factors for COPD and adult-onset asthma: an umbrella review. *Eur Respir Rev*. (2023) 32(168):230009. doi: 10.1183/16000617.0009-2023

26. Kim JH, Kim JY, Lee J, Jeong GH, Lee E, Lee S, et al. Environmental risk factors, protective factors, and peripheral biomarkers for ADHD: an umbrella review. *Lancet Psychiatry*. (2020) 7:955–70. doi: 10.1016/S2215-0366(20)30312-6

27. Mentis AA, Dardiotis E, Efthymiou V, Chrousos GP. Non-genetic risk and protective factors and biomarkers for neurological disorders: a meta-umbrella systematic review of umbrella reviews. *BMC Med*. (2021) 19:6. doi: 10.1186/s12916-020-01873-7

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