Journal of Affective Disorders 358 (2024) 302–308

Contents lists available at ScienceDirect

Journal of Affective Disorders

journal homepage: www.elsevier.com/locate/jad

Research paper

An evaluation of emotion recognition, emotion reactivity, and emotion dysregulation as prospective predictors of 12-month trajectories of non-suicidal self-injury in an adolescent psychiatric inpatient sample

Ching-Hua Julie Lee [a,b], Jesús M. Hernández Ortiz [f], Catherine R. Glenn [c,d], Evan M. Kleiman [e], Richard T. Liu [f,g,h,*]

[a] Harvard T.H. Chan School of Public Health, United States of America
[b] Tsaotun Psychiatric Center, Ministry of Health and Welfare, Taiwan
[c] Department of Psychology, Old Dominion University, United States of America
[d] Virginia Consortium Program in Clinical Psychology, United States of America
[e] Department of Psychology, Rutgers University, United States of America
[f] Department of Psychiatry, Massachusetts General Hospital, United States of America
[g] Department of Psychiatry, Harvard Medical School, United States of America
[h] Stanley Center for Psychiatric Research, Broad Institute of MIT and Harvard, United States of America

ARTICLE INFO

Keywords:
Non-suicidal self-injury
Emotion recognition
Emotion reactivity
Emotion dysregulation
Trajectories

ABSTRACT

Background: Little is known about trajectories of NSSI. We aimed to identify NSSI trajectories in adolescent psychiatric inpatients and emotional processes that differentiate between trajectories.

Methods: Participants were 180 adolescents (71.7 % female; mean age of 14.89 years, SD = 1.35) from a psychiatric inpatient facility. NSSI was assessed at their index hospitalization, as well as 6, and 12 months after discharge. Emotion recognition, emotion reactivity, and emotion dysregulation were assessed at baseline. Latent class mixture modeling was used to identify different NSSI trajectories and ANOVAs were used to evaluate predictors of the trajectories.

Results: Analyses yielded three NSSI trajectories. These included a stable low-frequency class (90.53 % of sample), a stable moderate-frequency class, and a class characterized by high-frequency NSSI at baseline but that largely resolves by 6-month follow-up. After adjustments for multiple comparisons were made, only emotion regulation at baseline differentiated between the trajectories, with greater overall emotion dysregulation and greater emotional non-acceptance (a facet of emotion dysregulation) characterizing the initially high-frequency class and the stable moderate-frequency class more than the stable low-frequency class ($ps < .05$). Difficulties engaging in goal-directed behavior when distressed characterized the stable moderate-frequency NSSI class more than the stable low-frequency class ($p < .05$).

Limitations

The study sample consists predominantly of female and White adolescents and thus may not generalize to other demographic groups.

Conclusions: The current findings suggest that interventions involving emotion regulation with adolescents who engage in NSSI would particularly benefit from a focus on increasing acceptance of emotional experiences.

1. Introduction

Non-suicidal self-injury (NSSI) is defined as the direct and deliberate destruction of one's own body tissue without suicidal intent and for purposes that are not socially sanctioned (Swannell et al., 2014). The high prevalence of NSSI in adolescents is a significant public health concern (Hawton et al., 2012; Swannell et al., 2014). A meta-analysis found the global lifetime prevalence of NSSI in adolescents to be 22.0 % (Xiao et al., 2022). In clinical samples, over 60 % of adolescents engage in NSSI (Adrian et al., 2011; Adrian et al., 2019; Hawton et al.,

* Corresponding author at: Department of Psychiatry, Harvard Medical School, 55 Fruit Street, Boston, MA 02114, United States of America.
E-mail address: rtliupsych@gmail.com (R.T. Liu).

https://doi.org/10.1016/j.jad.2024.02.086
Received 13 June 2023; Received in revised form 1 February 2024; Accepted 26 February 2024
Available online 27 February 2024

2012). NSSI's high prevalence in school-aged youth is associated with high healthcare costs (Goldman-Mellor et al., 2020). NSSI in adolescents is significantly associated with social impairments and deleterious consequences for mental health (e.g., anxiety and depression; Adrian et al., 2019; Klonsky, 2007). In fact, NSSI is an even stronger predictor of suicidal behavior than is past history of this behavior (Ribeiro et al., 2016).

Numerous studies have examined correlates of NSSI cross-sectionally (Fox et al., 2015; Hankin and Abela, 2011), but few have examined the course (Adrian et al., 2019) of NSSI across multiple time points, especially in adolescents. To understand the developmental course of NSSI, several studies have identified the existence of distinct subgroups of NSSI. A study with a community sample of Chinese adolescents, assessed every three months over two years with a self-report measure, identified three distinct trajectory classes of NSSI: consistently low NSSI (69.2 %), moderate and slightly decreasing NSSI (26.1 %), and chronic and increasing NSSI (4.7 %; Barrocas et al., 2015). Another study followed a community sample of Chinese adolescents for two years. Three different NSSI trajectory groups were identified (low, moderately declining, and stable high NSSI; Giletta et al., 2015). A more recent study followed 3600 Chinese secondary school students every six months for one year and identified four distinct NSSI trajectories (negligible [low], experimental NSSI engagement, moderate decreasing, and high fluctuating; Wang et al., 2017). Finally, Adrian and colleagues examined adolescent girls admitted to a child and adolescent psychiatry inpatient unit and followed across three time-points (during hospitalization, six months later, and 2.5 years; Adrian et al., 2019). Three NSSI trajectories were identified: low-but-increasing, moderate, and high groups.

These studies revealed the presence of significant heterogeneity in the trajectories of NSSI, but most studies were consistent in identifying three distinct trajectories. Apart from recognizing these distinct trajectories, identifying the characteristics that differentiate these trajectories is important. For clinicians to improve treatment plans for psychiatrically acute youth, accurate prediction of NSSI trajectories is needed, particularly for differentiating between severe baseline presentations of NSSI that resolve over time versus those that remain clinically severe.

Emotional processes have a central role in current conceptualizations of the etiology of NSSI (Andover and Morris, 2014; Gratz, 2003; Hasking et al., 2017; Linehan, 1993) and thus may hold promise in predicting membership in different NSSI trajectories. The broad concept of emotional processes includes emotion recognition, emotion reactivity, and emotion regulation.

Emotion recognition, the ability to recognize emotions and their meaning accurately (Booth et al., 2019), is a precursor to emotional regulation. Accurate inference of facial emotion expressions is key to regulating one's own emotional state in different social contexts (Marsh et al., 2007). Misinterpretation of facial emotions may result in social skills problems and related behavior (Booth et al., 2019). A few studies have examined deficits in facial emotion recognition with NSSI, mostly with adolescent patients (In-Albon et al., 2015; Koenig et al., 2023; Laghi et al., 2021; Ziebell et al., 2020). These studies yielded mixed results, with evidence of bias towards interpreting happy facial expressions as less positive (In-Albon et al., 2015), mistaking angry as happy (Ziebell et al., 2020), less accuracy in both positive and negative emotions (Laghi et al., 2021), and a fourth study finding no evidence of emotion recognition bias, albeit without examining different emotions separately (Koenig et al., 2023). Potentially accounting for these mixed findings are limitations in the ability to detect significant differences stemming from the practice across all these studies of dichotomizing participants based on NSSI status, rather than adopting a dimensional approach with analyses based on frequency of NSSI (Cohen, 1983; MacCallum et al., 2002). Furthermore, to our knowledge, all studies to date have been cross-sectional, and cross-sectional associations may not necessarily apply to predictions of NSSI trajectories.

Emotion reactivity consists of three components: emotion sensitivity, emotion intensity, and emotion persistence (Nock et al., 2008). Emotion sensitivity refers to responsiveness to a range of stimuli. Emotion intensity is the degree of the magnitude of the response. Lastly, emotion persistence is the duration of the response before returning to baseline arousal. Prior research has shown that increased emotion reactivity is associated with the likelihood of NSSI among those with psychiatric disorders (Kandsperger et al., 2021; Nock et al., 2008). Moreover, previous cross-sectional studies showed evidence of a significant positive correlation between emotional reactivity and engagement in NSSI (Dawkins et al., 2019; Kandsperger et al., 2021; Liu et al., 2022). Higher emotion reactivity differentiates those who currently still engage in NSSI behavior and those who have had no episode of NSSI in the previous 12 months (Kim and Hur, 2022). In contrast, a recent longitudinal study found that emotion reactivity was not predictive of NSSI (Kandsperger et al., 2022). However, this study employed analyses with a small sample ($n = 97$) and found frequency of NSSI was relatively constant over this period (i.e., lack of significant variability to predict), suggesting that longer follow-ups or larger samples may be required to detect meaningful changes in NSSI behavior over time.

Emotion regulation is broadly defined as an individual's ability to explicitly and implicitly modulate an emotion or set of emotions (Cole et al., 2004; Thompson, 1994). It involves both extrinsic and intrinsic processes that enable an individual to monitor, assess, and adjust their emotional responses, especially their intensity and duration, to accomplish their goals (Thompson, 1994). It occurs when the goal to influence the emotion-generative process is activated (Gross and Jazaieri, 2014). Several theoretical models (e.g., Linehan's biosocial theory (Linehan, 1993)) proposed that certain individuals engage in NSSI as a maladaptive emotion regulation strategy. Indeed, emotion regulation has been consistently found as a primary motivation for NSSI behavior across age groups and clinical severity (Bentley et al., 2014; Klonsky, 2007; Nock, 2009). A meta-analysis showed a robust association between multiple aspects of emotion regulation and NSSI, with strongest associations found for limited access to emotion regulation strategies (You et al., 2018). Most studies have relied on cross-sectional data, so knowledge of how emotion regulation affects the development and persistence of NSSI is limited. To our knowledge, only one study has assessed the relationship between emotion regulation and NSSI trajectories in clinically acute adolescents (Adrian et al., 2019). This study found high emotion dysregulation was positively associated with NSSI trajectories in youth with moderate levels of NSSI at baseline. However, the study included a small sample of adolescent girls ($n = 99$), which may have limited the ability to detect unique trajectories. The paucity of studies of emotion regulation as predictors of NSSI trajectories with clinical samples is also important because they may yield very different trajectories from those in community samples, and individuals in clinical samples are at greater risk for future NSSI.

In addition to the lack of longitudinal studies examining emotional processes in relation to NSSI, especially in terms of NSSI trajectories in clinical samples, there are several other notable limitations of previous research. For instance, most studies measure NSSI engagement as a binary outcome and/or used self-report questionnaires to measure the frequency of NSSI. Treating NSSI as a dichotomous variable artificially reduces variance and thus the ability to detect meaningfully different trajectories. Moreover, the level of endorsement for NSSI can vary depending on the number of self-injurious behavior being evaluated. When only a single item is used to assess NSSI, the level of endorsement tends to be lower compared to when multiple behaviors are assessed using a checklist (Muehlenkamp et al., 2012). Additionally, even though self-report assessments yield reliable measures for NSSI, interview-based assessments provide better validity differentiating NSSI from suicidal behavior (Nock et al., 2007).

The overall goal of this study was to identify NSSI trajectories in clinically acute adolescents post-discharge from inpatient care and to identify emotional processes that predict distinct NSSI trajectories. This study had two aims. The first aim was to identify distinct NSSI trajectories in a clinical sample of adolescents. Based on prior studies of NSSI

trajectories, we hypothesized that there would be three distinct NSSI trajectories. Through a comprehensive assessment of emotional processes (including emotion recognition, emotion reactivity, and emotion regulation), the second aim of this study was to determine which emotional processes differentiated these trajectories. We hypothesized that emotion recognition difficulties, greater emotion reactivity, and emotion dysregulation would be associated with a more severe NSSI trajectory.

2. Method

2.1. Participants and procedure

Participants were recruited from a pediatric psychiatric inpatient facility in the northeastern United States. The sample consisted of 180 adolescents, mostly female (71.7 %) and with a mean age of 14.89 (SD = 1.35). The racial and ethnic composition of the sample was: 78.9 % White, 8.9 % Black, 8.9 % multiracial, 3.3 % Asian, and 17.8 % Hispanic. Participants were assessed at three time-points, during their index inpatient hospitalization, as well as at six and 12 months post-discharge. At baseline, participants completed measures of emotion recognition, emotion reactivity, emotion regulation, suicidal ideation (SI), and depressive symptoms. Past 30-day NSSI was assessed at all three time-points. Retention rates at follow-up were 88.40 % for six-month follow-ups and 88.27 % for 12-month follow-ups.

2.2. Measures

2.2.1. Non-suicidal self-injury

The Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock et al., 2007) was used to determine the frequency of past-30-day NSSI at each time point. Using the Timeline Follow-back method, participants were asked to retrospectively estimate the number of times of NSSI in the past 30 days prior to the interview date. The SITBI has demonstrated good reliability and validity in clinical adolescent samples (Nock et al., 2007).

2.2.2. Suicidal ideation

Current SI was assessed with the Suicidal Ideation Questionnaire-JR (Reynolds, 1987), a 15-item, self-report questionnaire. This measure assesses SI for the past month, and item responses were summed with higher scores indicating greater severity of SI. The SIQ-JR demonstrated excellent internal consistency reliability at baseline ($\omega = 0.95$).

2.2.3. Depressive symptoms

The 28-item, self-report Children's Depression Inventory-2 (CDI-2; Kovacs, 2011) was used to measure the severity of depressive symptom during the past two weeks. Higher scores indicated more severe depressive symptoms. Internal consistency ($\omega = 0.91$) was high at baseline in the current sample.

2.2.4. Facial emotion recognition

Diagnostic Analysis of Nonverbal Accuracy (DANVA-2; Nowicki and Duke, 2008) is a computer-based behavioral task used to assess the facial emotion recognition ability. It comprises a subtest for child faces and a subtest for adult faces, with each subtest including 24 standardized photographs of four facial emotions (i.e., happiness, sadness, anger, and fear). In this task, participants view each photograph for two seconds before pressing a button to indicate which emotion they believed was expressed. Both subtests have been found to demonstrate adequate construct validity, internal reliability, and test-retest reliability (Nowicki and Duke, 2008).

2.2.5. Emotional reactivity

Emotion Reactivity Scale (ERS; Nock et al., 2008) is a 21-item self-report to characterize subjective experiences of emotional sensitivity, intensity, and persistence. At baseline, the internal consistency of this measure was high for the three subscales (sensitivity: $\omega = 0.94$, intensity: $\omega = 0.95$, persistence: $\omega = 0.88$). The full-scale internal consistency in the current sample was acceptable $\omega = 0.76$.

2.2.6. Emotion regulation

Emotion Regulation was assessed with the Difficulties in Emotion Regulation Scale (DERS; Gratz and Roemer, 2004), a 36-item self-report questionnaire. It assesses emotion dysregulation across six subscales: nonacceptance of negative emotions, difficulties engaging in goal-directed behaviors when distressed, difficulties controlling impulsive behaviors when distressed, limited access to emotional regulation strategies perceived as effective, lack of emotional awareness, and lack of emotional clarity (Gratz and Roemer, 2004). Higher scores reflect greater difficulty with emotion regulation. In the current sample, the DERS at baseline demonstrated good full scale internal consistency ($\omega = 0.87$) and good subscale internal consistency (nonacceptance: $\omega = 0.92$, strategies: $\omega = 0.89$, goals: $\omega = 0.91$, impulse: $\omega = 0.94$, clarity: $\omega = 0.88$, and awareness: 0.91).

2.3. Data analysis

Our analysis was conducted in two steps. First, we conducted a set of latent class linear mixture models to determine the optimal number of trajectories in NSSI over time. Second, we conducted a series of ANOVAs to examine how the trajectories differed. To conduct the latent class mixture model, we used the *lcmm* R package (Proust-Lima et al., 2017). We estimated models with successive numbers of classes, stopping at a four-class model because the five-class model produced classes of just one participant. To determine the optimal model, we compared measures of fit across the 1 to 4 class models including log likelihood (greater is better) and Bayesian information criterion (BIC, lower is better), which adjusts model fit for model complexity. We also compared entropy (higher is better) which reflects the probability of an individual being assigned to just one class, versus possibly belonging to more than one class. All models adjusted for sex assigned at birth, age, baseline depressive symptom severity, and baseline suicidal ideation. We then used one-way ANOVAs to examine class differences in facial emotion recognition (DANVA), emotion reactivity (ERS) and emotion regulation (DERS). We used all full-scale and subscales for each measure. When there were significant omnibus differences, we conducted Games-Howell post-hoc analyses, which are robust to sets of groups with largely different sample sizes.

3. Results

3.1. Latent class analyses

Table 1 shows the fit statistics and population share by class. The three-class model presented the best balance of model fit, as it had lower log likelihood and BIC than the two-class model and far better entropy than the four-class model. The four-class model had one class with one participant, further supporting the three-class model as the best option.

Fig. 1 shows the trajectories of the three classes across the study follow-up period. The classes included a low-frequency class (90.53 % of the sample) that had a low occurrence of NSSI at baseline and remained at a low frequency throughout the follow-up period; a stable moderate-frequency class (5.79 % of the sample); and a class characterized by high frequency of NSSI at baseline that largely resolved by the six-month follow-up (3.68 % of the sample). A repeated measures (time X class) ANOVA showed a large difference between the classes on past 30-day NSSI engagement (time X class interaction $F = 220.29$, $p < .011$, partial $\eta 2 = 0.46$).

Table 1
Fit statistics and sample share by non-suicidal self-injury trajectory class.

Classes in model	Fit statistics			Population share			
	loglik	BIC	Entropy	Class 1	Class 2	Class 3	Class 4
1	−1404.25	2860.96	1	100 %	–	–	–
2	−1316.2	2700.61	0.99	7.37 %	92.63 %	–	–
3	−1251.55	2587.06	0.99	90.53 %	3.68 %	5.79 %	–
4	−1222.64	2544.98	0.97	5.26 %	85.26 %	2.11 %	7.37 %

Note: This table shows all models tested, including the model which was n + 1 classes from the final accepted model (i.e., providing a comparator of one more class than the final model). Population share may not add to 100 % in a row due to rounding. Class names across models are arbitrary (e.g., class 2 in the two-class model may not be the same as class 2 in the three-class model).

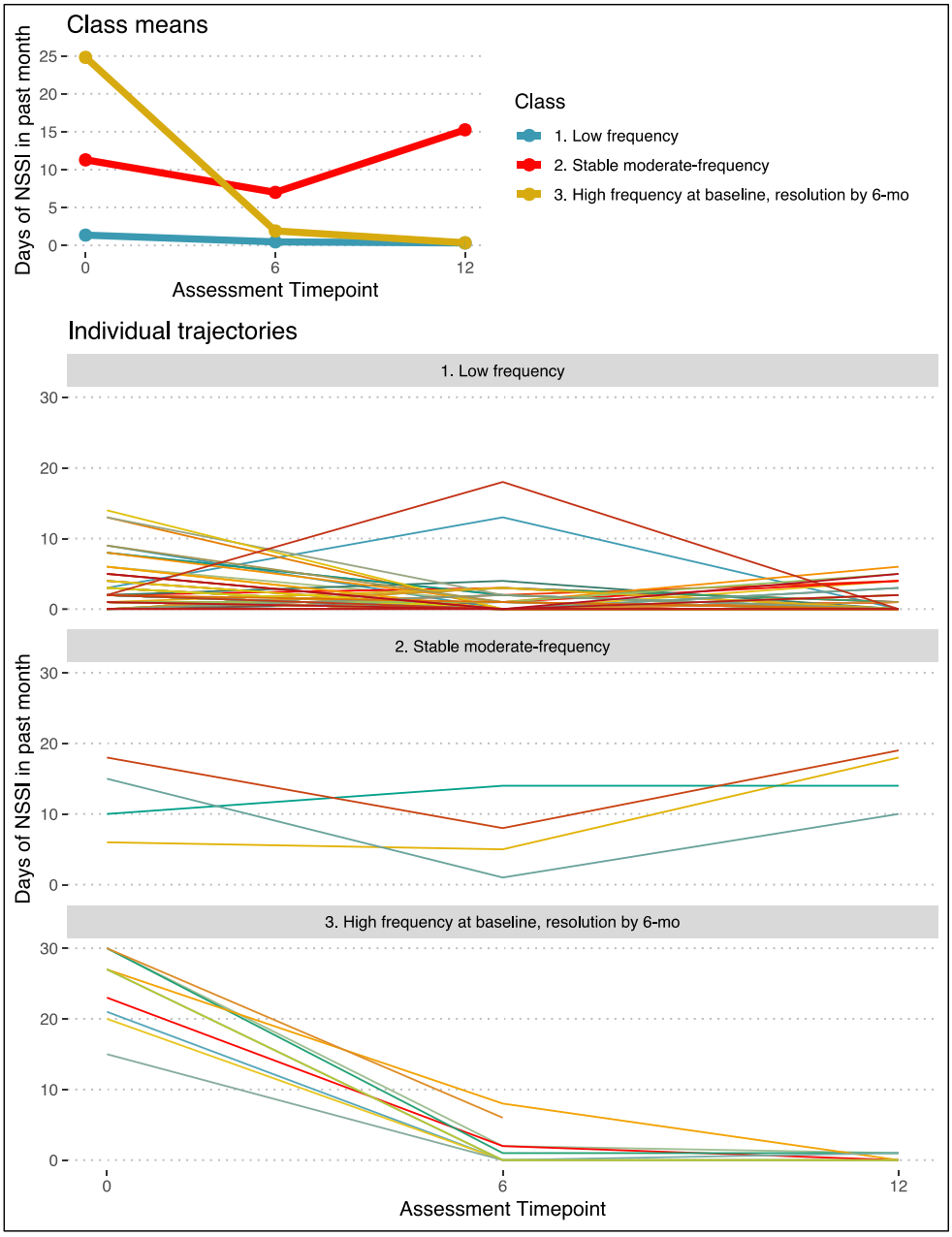

Fig. 1. Class-level and individual 12-month non-suicidal self-injury trajectories.

3.2. ANOVAs comparing classes

Table 2 shows the means, omnibus ANOVA tests, and post-hoc comparisons for all baseline variables across the three classes. Fig. 2 visualizes these differences. We found differences in the DERS and its non-acceptance subscale, with the class with high frequency of NSSI at baseline that largely resolved by the six-month follow-up and the class with moderate-frequency NSSI, respectively, having higher baseline

Table 2
Results of ANOVAs for emotion process variables differentiating between non-suicidal self-injury trajectories.

Variable	Mean (SD) by class			ANOVA results		
	Class 1	Class 2	Class 3	f	*p*	Post-hoc
DANVA child all error rate	10.96 (6.86)	7.87 (4.86)	14.88 (8.28)	0.46	.500	
Child happy	7.78 (6)	7.41 (3.93)	9.52 (5.28)	0.33	.564	
Child sad	3.08 (4.28)	1.23 (2.45)	3.17 (4.37)	0.28	.594	
Child angry	0.74 (2.28)	0.62 (1.85)	0.00 (0.00)	0.69	.408	
Child fearful	3.01 (4.24)	1.23 (2.45)	7.14 (6.96)	2.51	.115	
DANVA adult all error rate	19.85 (8.44)	19.44 (6.91)	19.05 (12.23)	0.08	.783	
Adult happy	8.78 (7.89)	11.73 (9.8)	13.49 (10.57)	3.24	.073	
Adult sad	5.24 (6.98)	3.7 (2.78)	1.59 (2.71)	2.33	.129	
Adult angry	8.03 (7.02)	6.17 (3.34)	9.52 (8.31)	0.02	.902	
Adult fearful	4.42 (4.98)	4.32 (3.7)	0.79 (2.1)	2.91	.090	
DERS	110.83 (23.75)	130.6 (17.46)	135.20 (9.09)	10.95	.001	3 & 2 > 1
Non-acceptance	16.4 (6.41)	22.00 (6.38)	24.60 (6.07)	14.24	<.001	3 & 2 > 1
Goal-directed behavior	18.52 (5.17)	21.50 (3.10)	22.00 (3.00)	4.99	.027	2 > 1
Impulse control	17.94 (6.29)	20.90 (4.48)	22.60 (2.88)	4.72	.031	N/A
Emotional awareness	19.29 (5.14)	21.90 (2.47)	22.00 (6.28)	3.34	.069	
Limited access to strategies	26.35 (7.38)	31.20 (6.48)	29.80 (5.26)	3.86	.051	
Emotional clarity	15.06 (4.49)	16.80 (4.39)	17.60 (6.19)	2.74	.100	
ERS	49.08 (20.55)	58.78 (19.44)	61.40 (16.24)	3.37	.068	
Intensity	17.35 (7.54)	19.90 (6.23)	22.40 (5.59)	3.23	.074	
Sensitivity	22.41 (10.04)	28.30 (10.08)	29.80 (7.53)	5.38	.022	N/A
Persistence	8.96 (4.18)	11.56 (3.05)	9.20 (5.40)	1.14	.287	

Note. Class 1 = low-frequency trajectory; Class 2 = stable moderate-frequency; Class 3 = high frequency at baseline, resolution by six-month follow-up. Post-hoc differences with N/A in column had no significant pairwise differences that survived the family-wise error correction in the Tukey's HSD test. All analyses adjusted for sex assigned at birth, age, baseline depressive symptom severity, and baseline suicidal ideation.
DANVA: Diagnostic Analysis of Nonverbal Accuracy.
DERS: Difficulties in Emotion Regulation Scale.
ERS: Emotion Reactivity Scale.

DERS scores than the low-frequency NSSI class. For the goal-directed behavior subscale of the DERS, the class with moderate-frequency NSSI had higher scores at baseline than did the low-frequency NSSI class.

4. Discussion

We found three different trajectories of NSSI, which is generally consistent with previous research (Adrian et al., 2019; Barrocas et al., 2015; Giletta et al., 2015), but there were also some differences in the nature of these classes. Whereas past studies generally found relatively stable low, medium and high NSSI trajectories, our high-frequency NSSI class showed general resolution by the 6-month follow-up. This deviation from prior studies is likely a function of differences in study samples. That is, most prior studies featured community samples, whereas ours was a psychiatric inpatient sample where NSSI at baseline may be at a high point and observed changes over time among patients with initially high levels of NSSI may be a reflection of regression to the mean.

In the case of the one prior NSSI trajectory study with an all-female psychiatric inpatient sample (Adrian et al., 2019), it is possible that sex differences may be a more relevant explanation of differences between their trajectory findings and ours (i.e., their sample included a persistently high-frequency class and an initially low but escalating class, whereas our initially high-frequency class improved over time and we had a stable low-frequency class). That is, this earlier study included an all-female sample, whereas ours was roughly 30 % male and it is possible that differences across studies indicate that females and males differ in their NSSI trajectories, a possibility worth evaluating in future research. The higher prevalence of NSSI in this earlier study's initially high- and low-frequency classes is consistent with findings of sex differences in NSSI found for psychiatric populations (Bresin and Schoenleber, 2015), in which females are more likely to engage in NSSI. Another important study design consideration that may account for differences between our trajectory findings and that of this prior study is that whereas we examined past-30-day NSSI frequency at each assessment, the prior study operationalized baseline NSSI as mean frequency of NSSI over the lifetime up to the index hospitalization. Given that lifetime mean frequency of NSSI is likely to be significantly lower on average than during a point of particular clinical acuteness (i.e., in the days leading up to psychiatric admission), the baseline assessment of NSSI in this prior study may complicate the interpretation of longitudinal patterns of NSSI.

As for predictors of NSSI trajectories, our findings that facial emotion recognition and emotion reactivity were not prospectively associated with trajectory membership contrasts with past cross-sectional findings of difficulties in these emotion processes related to NSSI (Dawkins et al., 2019; In-Albon et al., 2015; Kandsperger et al., 2021; Laghi et al., 2021; Liu et al., 2022; Ziebell et al., 2020) When considered together with the findings of these prior studies, the current findings suggest that emotion recognition difficulties and emotion reactivity may be concomitants rather than risk factors for NSSI, at least in clinically acute individuals who have already initiated engagement in this behavior (i.e., in cases of recurrence rather than first onset).

In contrast to findings for emotion recognition and emotion reactivity, this study found that emotion regulation predicted NSSI trajectory membership, differentiating between the initially high-frequency class from the stable low-frequency class. Although the aforementioned study with a psychiatric female inpatient sample (Adrian et al., 2019) also examined overall emotion regulation in relation to NSSI trajectories, the current study extends this prior work in finding that the predictive power of emotion regulation may be driven by emotional non-acceptance and difficulty engaging in goal-directed behavior during distress. That is, the first facet of emotion regulation differentiated the stable moderate-frequency NSSI class and the initially high-frequency class, respectively, from the stable low-frequency NSSI class. Our finding of specificity to emotion non-acceptance is noteworthy because it is consistent with prior experimental work demonstrating that females with borderline personality disorder were less likely to experience self-injurious urges after being assigned to engage in emotional acceptance when exposed to a negative mood induction (Svaldi et al., 2012). It also lends support for acceptance-based emotion regulation therapy (Gratz and Gunderson, 2006) as an intervention for those at risk for future engagement in NSSI.

Although the current study has several strengths, (e.g., serving as the first study with a comprehensive, multi-method evaluation emotional processes in relation to NSSI trajectories in a clinical sample using gold-standard interview-based measures of NSSI), the findings should be interpreted within the context of the study's limitations. First, the sample was predominantly White (78.9 %), which may limit

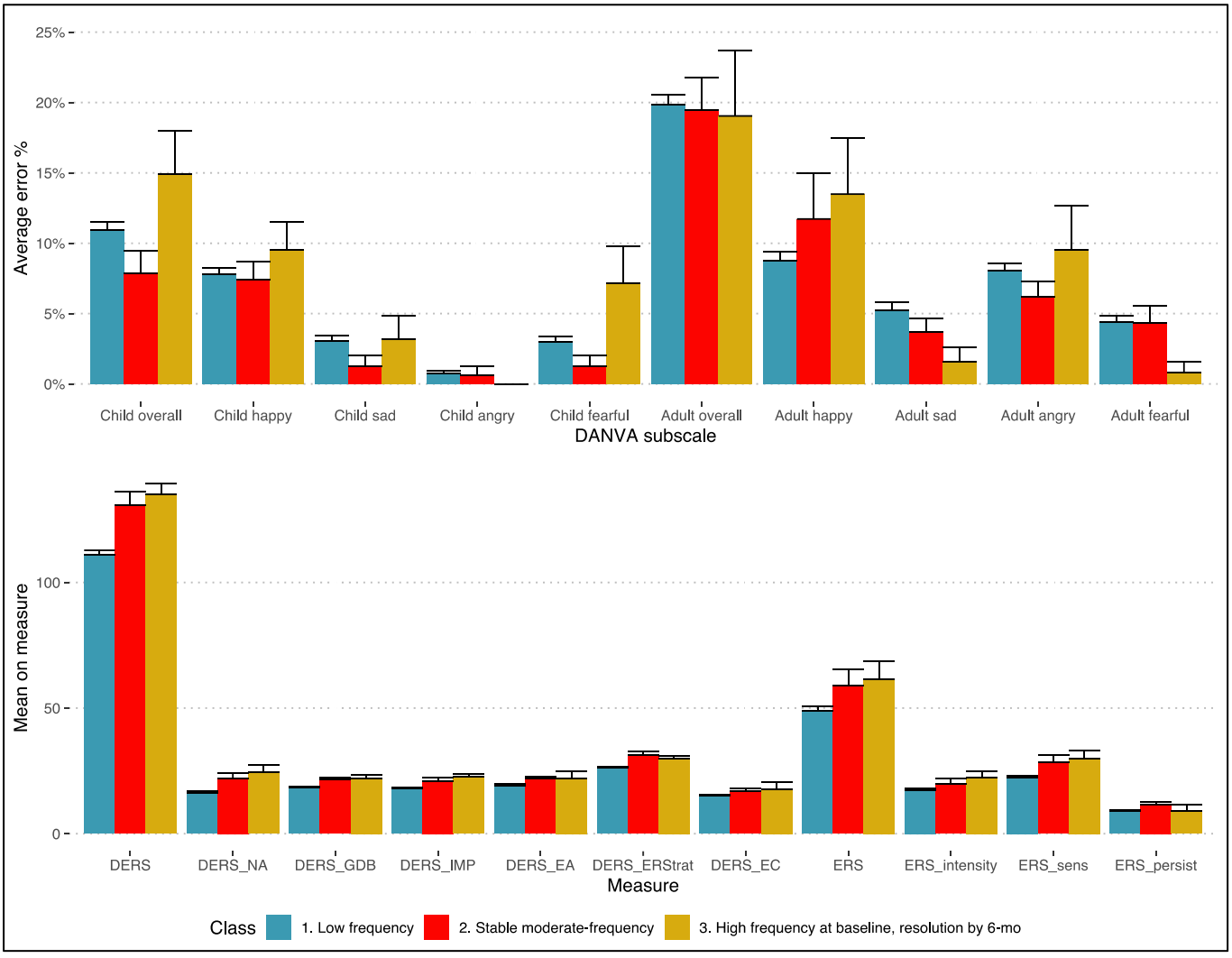

Fig. 2. Non-suicidal self-injury class differences across predictor variables.
Note. DERS = Difficulties in Emotion Regulation Scale. DERS_NA = non-acceptance subscale. DERS_GDB = goal-directed behavior subscale. DERS_IMP = impulse control difficulties subscale. DERS_EA = emotional awareness subscale. DERS_ERStrat = emotion regulation strategies subscale. DERS_EC = emotional clarity subscale. ERS = emotion reactivity scale. ERS_sens = sensitivity subscale. ERS_persist = persistence subscale.

generalizability to other racial and ethnic groups. Although findings from prior studies (Kuentzel et al., 2012; Liu, 2021) have been inconsistent with regards to whether racial and ethnic differences in NSSI exist, future research with more diverse samples are needed. Second, in contrast to the prior study limited to female samples (Adrian et al., 2019), our current sample includes approximately 30 % males, potentially enhancing generalizability to the inpatient adolescent population. However, the sample size was not sufficiently large to discern the influence of sex on trajectories. Third, two of our trajectory classes were relatively modest in size (i.e., the stable moderate-frequency NSSI class, and the class characterized by high frequency of NSSI at baseline that largely resolved by the six-month follow-up). Fourth, we were unable to evaluate the degree to which treatment utilization after discharge may have affected individual trajectories. To the extent that treatment received post-discharge focus on developing emotion regulation skills, they may have diminished observed association between emotion regulation variables and NSSI trajectories at 6- and 12-month follow-ups. Fifth, the sample in this study was relatively small. Although the current sample size is less of a concern, in that the large separation between groups on the primary class indictor lends confidence in the findings, future studies could examine larger groups that contain 300 or more participants (Sinha et al., 2021). Finally, the primary class indictor, NSSI frequency, is a count variable that followed an approximately zero-inflated negative binomial distribution. There do not currently exist robust methods to conduct latent class mixture modeling using these distributions. However, should such a method become available in the future, it would be important to replicate these findings using the new method.

In summary, the current findings help to advance our understanding of variations in the longitudinal course of NSSI in clinical youth populations. They indicate that emotion dysregulation – emotion non-acceptance in particular – rather than emotion recognition and emotion reactivity, may differentiate trajectories in NSSI. These findings provide preliminary support for evaluating emotion non-acceptance during inpatient hospitalization to aid NSSI risk identification and discharge planning. Specifically, they suggest that therapies that target this aspect of emotion dysregulation may have benefit for improving NSSI trajectories in those identified during their inpatient stay as at-risk for NSSI post-discharge.

CRediT authorship contribution statement

Ching-Hua Julie Lee: Investigation, Writing – original draft, Writing – review & editing. **Jesús M. Hernández Ortiz:** Writing – original draft.

Catherine R. Glenn: Writing – original draft, Writing – review & editing. **Evan M. Kleiman:** Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Richard T. Liu:** Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

Preparation of this manuscript was supported in part by the National Institute of Mental Health of the National Institutes of Health under Award Numbers RF1MH120830, R01MH101138, R01MH115905, R01MH124899 and R21MH130767. RTL currently serves as a consultant to Relmada Therapeutics. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agency or Relmada Therapeutics. The authors report no conflict of interest.

References

Adrian, M., Zeman, J., Erdley, C., Lisa, L., Sim, L., 2011. Emotional dysregulation and interpersonal difficulties as risk factors for nonsuicidal self-injury in adolescent girls. J. Abnorm. Child Psychol. 39, 389–400.
Adrian, M., Zeman, J., Erdley, C., Whitlock, K., Sim, L., 2019. Trajectories of non-suicidal self-injury in adolescent girls following inpatient hospitalization. Clin. Child Psychol. Psychiatry 24, 831–846.
Andover, M.S., Morris, B.W., 2014. Expanding and clarifying the role of emotion regulation in nonsuicidal self-injury. Can. J. Psychiatr. 59, 569–575.
Barrocas, A.L., Giletta, M., Hankin, B.L., Prinstein, M.J., Abela, J.R., 2015. Nonsuicidal self-injury in adolescence: longitudinal course, trajectories, and intrapersonal predictors. J. Abnorm. Child Psychol. 43, 369–380.
Bentley, K.H., Nock, M.K., Barlow, D.H., 2014. The four-function model of nonsuicidal self-injury: key directions for future research. Clin. Psychol. Sci. 2, 638–656.
Booth, A.J., Rodgers, J.D., Volker, M.A., Lopata, C., Thomeer, M.L., 2019. Psychometric characteristics of the DANVA-2 in high-functioning children with ASD. J. Autism Dev. Disord. 49, 4147–4158.
Bresin, K., Schoenleber, M., 2015. Gender differences in the prevalence of nonsuicidal self-injury: a meta-analysis. Clin. Psychol. Rev. 38, 55–64.
Cohen, J., 1983. The cost of dichotomization. Appl. Psychol. Meas. 7, 249–253.
Dawkins, J.C., Hasking, P.A., Boyes, M.E., Greene, D., Passchier, C., 2019. Applying a cognitive-emotional model to nonsuicidal self-injury. Stress. Health 35, 39–48.
Fox, K.R., Franklin, J.C., Ribeiro, J.D., Kleiman, E.M., Bentley, K.H., Nock, M.K., 2015. Meta-analysis of risk factors for nonsuicidal self-injury. Clin. Psychol. Rev. 42, 156–167.
Giletta, M., Prinstein, M.J., Abela, J.R., Gibb, B.E., Barrocas, A.L., Hankin, B.L., 2015. Trajectories of suicide ideation and nonsuicidal self-injury among adolescents in mainland China: peer predictors, joint development, and risk for suicide attempts. J. Consult. Clin. Psychol. 83, 265–279.
Goldman-Mellor, S., Phillips, D., Brown, P., Gruenewald, P., Cerda, M., Wiebe, D., 2020. Emergency department use and inpatient admissions and costs among adolescents with deliberate self-harm: a five-year follow-up study. Psychiatr. Serv. 71, 136–143.
Gratz, K.L., 2003. Risk factors for and functions of deliberate self-harm: an empirical and conceptual review. Clin. Psychol. Sci. Pract. 10, 192–205.
Gratz, K.L., Gunderson, J.G., 2006. Preliminary data on an acceptance-based emotion regulation group intervention for deliberate self-harm among women with borderline personality disorder. Behav. Ther. 37, 25–35.
Gratz, K.L., Roemer, L., 2004. Multidimensional assessment of emotion regulation and dysregulation: development, factor structure, and initial validation of the difficulties in emotion regulation scale. J. Psychopathol. Behav. Assess. 26 (1), 41–54.
Gross, J.J., Jazaieri, H., 2014. Emotion, emotion regulation, and psychopathology: an affective science perspective. Clin. Psychol. Sci. 2, 387–401.
Hankin, B.L., Abela, J.R., 2011. Nonsuicidal self-injury in adolescence: prospective rates and risk factors in a 2(1/2) year longitudinal study. Psychiatry Res. 186, 65–70.
Hasking, P., Whitlock, J., Voon, D., Rose, A., 2017. A cognitive-emotional model of NSSI: using emotion regulation and cognitive processes to explain why people self-injure. Cognit. Emot. 31, 1543–1556.
Hawton, K., Saunders, K.E., O'Connor, R.C., 2012. Self-harm and suicide in adolescents. Lancet 379, 2373–2382.
In-Albon, T., Ruf, C., Schmid, M., 2015. Facial emotion recognition in adolescents with nonsuicidal self-injury. Psychiatry Res. 228, 332–339.
Kandsperger, S., Jarvers, I., Ecker, A., Schleicher, D., Madurkay, J., Otto, A., Brunner, R., 2021. Emotional reactivity and family-related factors associated with self-injurious behavior in adolescents presenting to a child and adolescent psychiatric emergency service. Front. Psychol. 12, 634346.
Kandsperger, S., Schleicher, D., Ecker, A., Keck, F., Bentheimer, S., Brunner, R., Jarvers, I., 2022. Emotional reactivity in adolescents with non-suicidal self-injury and its predictors: a longitudinal study. Front. Psychol. 13, 902964.
Kim, H., Hur, J.W., 2022. What's different about those who have ceased self-injury? Comparison between current and lifetime nonsuicidal self-injury. Arch. Suicide Res. 1–16.
Klonsky, E.D., 2007. The functions of deliberate self-injury: a review of the evidence. Clin. Psychol. Rev. 27, 226–239.
Koenig, J., Lischke, A., Bardtke, K., Heinze, A.L., Kröller, F., Pahnke, R., Kaess, M., 2023 Mar. Altered psychobiological reactivity but no impairment of emotion recognition following stress in adolescents with non-suicidal self-injury. Eur. Arch. Psychiatry Clin. Neurosci. 273 (2), 379–395. https://doi.org/10.1007/s00406-022-01496-4.
Kovacs, M., 2011. Children's Depression Inventory-2 (CDI-2), 2nd edition. Multi-Health System, Inc.
Kuentzel, J.G., Arble, E., Boutros, N., Chugani, D., Barnett, D., 2012. Nonsuicidal self-injury in an ethnically diverse college sample. Am. J. Orthop. 82, 291–297.
Laghi, F., Cerutti, R., Terrinoni, A., Lonigro, A., Pongetti, A., Ferrara, M., Fantini, F., 2021. Evaluation of the "Reading the Mind in the Eyes Test" with Non-Suicidal Self-Injury (NSSI) adolescents: a pilot study. Curr. Psychol. 40, 5471–5477.
Linehan, M.M., 1993. Cognitive–Behavioral Treatment of Borderline Personality Disorder. Guliford Press.
Liu, R.T., 2021. The epidemiology of non-suicidal self-injury: lifetime prevalence, sociodemographic and clinical correlates, and treatment use in a nationally representative sample of adults in England. Psychol. Med. 1–9.
Liu, J., Gao, Y., Wang, H., Liu, X., 2022. Emotional reactivity and inhibitory control in nonsuicidal self-injury adolescence: divergence between positive and negative emotions. J. Youth Adolesc. 51, 1720–1732.
MacCallum, R.C., Zhang, S., Preacher, K.J., Rucker, D.D., 2002. On the practice of dichotomization of quantitative variables. Psychol. Methods 7, 19–40.
Marsh, A.A., Kozak, M.N., Ambady, N., 2007. Accurate identification of fear facial expressions predicts prosocial behavior. Emotion 7, 239–251.
Muehlenkamp, J.J., Claes, L., Havertape, L., Plener, P.L., 2012 Mar 30. International prevalence of adolescent non-suicidal self-injury and deliberate self-harm. Child Adolesc. Psychiatry Ment. Health 6 (10). https://doi.org/10.1186/1753-2000-6-10. PMID: 22462815; PMCID: PMC3348041.
Nock, M.K., 2009. Why do people hurt themselves? New insights into the nature and functions of self-injury. Curr. Dir. Psychol. Sci. 18, 78–83.
Nock, M.K., Holmberg, E.B., Photos, V.I., Michel, B.D., 2007. Self-Injurious Thoughts and Behaviors Interview: development, reliability, and validity in an adolescent sample. Psychol. Assess. 19, 309–317.
Nock, M.K., Wedig, M.M., Holmberg, E.B., Hooley, J.M., 2008. The emotion reactivity scale: development, evaluation, and relation to self-injurious thoughts and behaviors. Behav. Ther. 39, 107–116.
Nowicki, S., Duke, M.P., 2008. Manual for the Receptive Tests of the Diagnostic Analysis of Nonverbal Accuracy 2 (DANVA2). Department of Psychology, Emory University, Atlanta, GA, USA.
Proust-Lima, C., Philipps, V., Liquet, B., 2017. Estimation of extended mixed models using latent classes and latent processes: the R package lcmm. J. Stat. Softw. 78, 1–56.
Reynolds, W.M., 1987. Suicidal Ideation Questionnaire. Psychological Assessment Resources.
Ribeiro, J.D., Franklin, J.C., Fox, K.R., Bentley, K.H., Kleiman, E.M., Chang, B.P., Nock, M.K., 2016. Self-injurious thoughts and behaviors as risk factors for future suicide ideation, attempts, and death: a meta-analysis of longitudinal studies. Psychol. Med. 46, 225–236.
Sinha, P., Calfee, C.S., Delucchi, K.L., 2021. Practitioner's Guide to Latent Class Analysis: Methodological Considerations and Common Pitfalls. Crit. Care Med. 49 (1), e63–e79. https://doi.org/10.1097/CCM.0000000000004710.
Svaldi, J., Dorn, C., Matthies, S., Philipsen, A., 2012. Effects of suppression and acceptance of sadness on the urge for non-suicidal self-injury and self-punishment. Psychiatry Res. 200, 404–416.
Swannell, S.V., Martin, G.E., Page, A., Hasking, P., St John, N.J., 2014. Prevalence of nonsuicidal self-injury in nonclinical samples: systematic review, meta-analysis and meta-regression. Suicide Life Threat. Behav. 44, 273–303.
Thompson, R.A., 1994. Emotion regulation: a theme in search of definition. Monogr. Soc. Res. Child Dev. 59, 25–52.
Wang, B., You, J., Lin, M.P., Xu, S., Leung, F., 2017. Developmental trajectories of nonsuicidal self-injury in adolescence and intrapersonal/interpersonal risk factors. J. Res. Adolesc. 27, 392–406.
Xiao, Q., Song, X., Huang, L., Hou, D., Huang, X., 2022. Global prevalence and characteristics of non-suicidal self-injury between 2010 and 2021 among a non-clinical sample of adolescents: a meta-analysis. Front. Psychol. 13, 912441.
You, J., Ren, Y., Zhang, X., Wu, Z., Xu, S., Lin, M.-P., 2018. Emotional Dysregulation and Nonsuicidal Self-injury: A Meta-analytic Review.
Ziebell, L., Collin, C., Rainville, S., Mazalu, M., Weippert, M., 2020. Using an ideal observer analysis to investigate the visual perceptual efficiency of individuals with a history of non-suicidal self-injury when identifying emotional expressions. PLoS One 15, e0227019.