

# Does higher-than-usual stress predict nonsuicidal self-injury? Evidence from two prospective studies in adolescent and emerging adult females

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**Background:** Nonsuicidal self-injury (NSSI) is highly prevalent among adolescent and emerging adult females. Most studies examining the relationship between stress and NSSI largely have relied on aggregate self-report measures of stress and between-person models. Using data from two prospective samples, this manuscript tests the hypothesis that within-person models of NSSI provide better clinical markers of risk for NSSI than between-person models of NSSI. **Methods:** Two samples (Sample 1: 220 high-risk girls,  $M$  age = 14.68,  $SD$  = 1.36, baseline assessment and 3-month follow-ups for 18 months; Sample 2: 40 emerging adult females with a history of NSSI,  $M$  age = 21.55,  $SD$  = 2.14, 14 days with daily retrospective reports) were followed prospectively and completed validated measures of stress and NSSI. Models were adjusted for age and depression. **Results:** In Sample 1, a within-person model demonstrated that higher-than-usual (but not average) stress levels predicted NSSI within the same 3-month wave. In Sample 2, results from a within-person model with daily diary assessment data showed that higher-than-usual stress (but not average daily stress) predicted same-day NSSI. **Conclusions:** Together, our results suggest that higher-than-usual stress, relative to one's typical stress level, but not average stress levels, signals times of enhanced risk for NSSI. These results highlight the clinical utility of repeated assessments of stress. **Keywords:** Nonsuicidal self-injury; stress; within-person designs.

## Introduction

Nonsuicidal self-injury (NSSI) is the direct, intentional harm to one's own body performed without the intent to die. NSSI is a robust predictor of future suicidal behavior (Ribeiro et al., 2016). Rates of NSSI increase sharply in adolescence with a slight decline during the late adolescent and emerging adulthood years (Plener, Schumacher, Munz, & Groschwitz, 2015), and rates of NSSI are higher in females relative to males (Fox et al., 2015). Adolescent NSSI is associated with a fourfold increase in the odds of making a suicide attempt by emerging adulthood (Scott, Pilkonis, Hipwell, Keenan, & Stepp, 2015). Together, the period from adolescence through emerging adulthood represents the developmental period of highest risk for NSSI. In this multistudy, prospective investigation, we examined whether adolescents and emerging adults are at risk for NSSI when they experience periods of *higher-than-usual* stress.

A core feature across NSSI theories is that youth engage in NSSI as a self-regulatory mechanism to relieve distress secondary to stress, defined in the present manuscript as actual stressors or perceived stress. For example, the Four-Function Model of NSSI (Nock & Prinstein, 2004) posits that youth are

reinforced for NSSI through both relief of distress and unwanted interpersonal demands, as well as through increases in desirable emotional or cognitive states and social support following NSSI. Additionally, theories of NSSI strongly emphasize the emotion-regulation function (Chapman, Gratz, & Brown, 2006; Nock & Prinstein, 2004), positing that NSSI provides an effective, albeit maladaptive, means of reducing distress among youth who experience high stress reactivity and difficulty regulating distress. From a developmental perspective, the period from adolescence into emerging adulthood is characterized by both the highest risk for NSSI (Plener et al., 2015) and significant increases in stress (Rudolph, 2002). Thus, stress may be particularly relevant to understanding NSSI during this developmental period. Most prior research tests stress as a between-person risk factor for NSSI (Fox et al., 2015; Liu, Cheek, & Nestor, 2016), and prevailing models and extant research have not examined within-person dynamics of stress and NSSI.

Most previous research has conceptualized stress as a static, between-person NSSI risk factor (Liu et al., 2016). Most frequently, studies utilize research designs, assessment strategies, and statistical indices that are best suited to test whether individuals with high stress (actual or perceived) are at greater risk for NSSI, compared to others in the sample. Although helpful for identifying population-

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level risk factors, it is an ecological fallacy to assume that between-person risk factors translate to within-person risk. For example, the clinical utility of knowing stress is associated with risk for NSSI is less helpful for a clinician treating a caseload of chronically stressed adolescents. Increasingly, researchers have advocated for adopting within-person approaches to understanding the relationship between stress and NSSI (Hamza & Willoughby, 2014). A handful of studies using ecological momentary assessment (EMA) methodologies with adults have provided insight into within-person associations between affective states and NSSI (Rodríguez-Blanco, Carballo, & Baca-García, 2018), but these studies have not yet examined risk for NSSI in the context of within-person fluctuations in stress among adolescents and emerging adults.

No two individuals experience stress in exactly the same way. The stress-sensitization framework of depression (Hammen, Henry, & Daley, 2000) asserts individuals have different thresholds for stress that, when exceeded, lead to depressive episodes. A similar process may occur with NSSI. Two individuals, facing similar actual or perceived stress, may have very different thresholds that must be crossed before each engages in NSSI. Consistent with this sensitization framework, we expect that individuals may be at risk for NSSI when they experience higher-than-usual (relative to their own average) stress, regardless of their level of stress compared to others. Data from studies with typically developing adolescents have begun to demonstrate that within-person variation in stress is associated with lower positive mood and greater negative mood (Bai & Repetti, 2018; Timmons & Margolin, 2015), greater systemic inflammation (Fulgini et al., 2009), and altered HPA axis functioning (Lippold, Davis, McHale, Buxton, & Almeida, 2016). Together, these studies provide compelling evidence that higher-than-usual stress affects both psychological and biological processes. Thus, higher-than-usual stress is a promising candidate predictor of NSSI among adolescents and emerging adults.

The current study aimed to test whether within-person models of stress are more clinically useful in identifying periods of increased risk for NSSI compared to between-person models of stress. Here, we present results from two prospective studies of adolescent and emerging adult females. We focused on females given that the rates of NSSI (Fox et al., 2015) and reported effects of stress (Rose & Rudolph, 2006) are higher among females compared to males. These studies allow us to test a within-person, stress-threshold model of NSSI, which asserts that youth are at risk for engaging in NSSI during times they experience increased stress *relative to their own average stress level*. We hypothesized that higher-than-usual stress, relative to an individual's own typical stress level, would be associated with concurrent risk for NSSI thoughts (Study 2) and acts

(Study 1 and 2) over and above individuals' prior NSSI and between-person stress severity. We adjust for the effects of age and depression, given that these factors all are consistently associated with risk for NSSI (Fox et al., 2015). Procedures for all studies were approved by human subject review boards at the respective institutions.

## Study 1

### Methods

**Participants and procedures.** Participants were 220 adolescent females ( $M$  age = 14.69 years,  $SD = 1.37$ ). Participants were part of an 18-month multiwave study examining stress and trajectories of self-injurious thoughts and behaviors. We have previously examined different predictors of suicidal ideation and behaviors in this sample (for details, including rates of suicidal ideation and behavior see: Eisenlohr-Moul et al., 2018; Miller et al., 2017). Here, we examine NSSI as an outcome. Participants were recruited from local inpatient units (33%), outpatient facilities and practices (12%), local advertisements (40%), and mass emails to university employees (15%). Inclusion/exclusion criteria were assessed via caregiver report during a phone screening. Inclusion criteria were as follows: female sex, 12–16 years old, caregiver (parent or legal guardian) willing to take part in the study, and a history of at least one mental health concern in the prior 2 years. Mental health concerns (e.g. mood, anxiety disorders) were identified via caregivers' reports of previous mental health treatment, diagnosis, or symptomatology. Exclusion criteria were as follows: active psychosis, intellectual disability disorder, and any other developmental disorder identified via caregiver report on the phone screen. Diagnostic presentation at baseline, as assessed by caregiver report on the Behavioral Assessment System for Children, is presented in Table 1.

After consenting/assenting at baseline, adolescents and caregivers separately completed clinical interviews and a series of questionnaires described below. Approximately 3, 6, 9, 12, 15, and 18 months post-baseline, a trained research assistant re-administered a structural clinical interview by phone to assess NSSI and verbally administered questionnaires to assess depressive symptoms and stress. Retention across waves was high (see Table 2).

**Measures. Nonsuicidal self-Injury:** Adolescents completed the Self-Injurious Thoughts and Behaviors Interview (SITBI) (Nock, Holmberg, Photos, & Michel, 2007) at baseline and each follow-up assessment. The SITBI is a structured clinical interview. The current study focused on the presence (1) or absence (0) of NSSI (Have you ever purposefully hurt yourself without wanting to die?). At each follow-up, participants were asked this same question regarding the previous 3 months. The SITBI has strong

**Table 1** Demographic statistics (100% female)

	Study 1	Study 2
<i>N</i>	220	40
Race		
Black	24%	3%
White	64%	59%
Asian	1%	25%
Indigenous (Native American/Canadian)	0%	5%
Other/mixed race	10%	5%
Hispanic/Latinx	1%	3%
Age range	12–16	18–25
Mean age	14.69	21.55
Diagnostic presentation, current <sup>a</sup>	Clinically elevated symptoms	Diagnoses
Depression	10%	25%
Anxiety	11%	67%
Hyperactivity	17%	–
Attention	21%	–
Conduct	20%	–
Substance use	–	8%

<sup>a</sup>Study 1 = Behavioral Assessment Scale for Children, Study 2 = Structured Clinical Interview for DSM-IV.

**Table 2** Frequency of NSSI during follow-up periods and retention rates

	Nonsuicidal self-Injury (%)	Retention (%)
Study 1		
Baseline	41	100
3 months	15	91
6 months	14	88
9 months	11	91
12 months	13	84
15 months	10	84
18 months	8	80
Study 2		
14-days	61 <sup>a</sup>	73 <sup>b</sup>

Study 1 baseline reflects lifetime history of NSSI. For each subsequent wave, the time interval is NSSI within the prior three months.

<sup>a</sup>96% reported NSSI thoughts.

<sup>b</sup>Participants completed 88% of possible daily entries.

convergent validity, inter-rater reliability ( $K = .90$ ), and test–retest reliability ( $K = .70$ ) (Nock et al., 2007).

**Stress:** Stress was assessed with the Child Chronic Strain Questionnaire (Rudolph, Kurlakowsky, & Conley, 2001). Here, we focused on peer stress (11 items, e.g., ‘Do kids at school pick on or tease you?’), mother–child stress (7 items, e.g., ‘Do you have trouble getting along with your mom?’), and academic stress (6 items, e.g., ‘Do you need extra help or tutoring with your schoolwork?’). Participants responded to these questions with a 5-point Likert scale (1 = *Not at all*, 2 = *A little*, 3 = *Some*, 4 = *Much*, 5 = *Very Much*), and mean scores were computed. Adolescents completed this measure at each follow-up regarding the previous 3 months (Cronbach’s  $\alpha$ ’s = .86–.90).

**Depression:** The Moods and Feelings Questionnaire (MFQ; Costello & Angold, 1988) is a 33-item self-report measure designed to assess depressive symptoms in children and adolescents. Participants rated on a 3-point Likert scale how true (0 = *not true*, 1 = *sometimes true*, 2 = *mostly true*) each depressive symptom (e.g. ‘I didn’t enjoy anything at all.’) was in the previous 2 weeks. Mean scores were computed for baseline and each follow-up time point (Cronbach’s  $\alpha$ ’s = .92–.95).

**Data analytic plan.** Data were prepared and analyzed in SAS. NSSI occurrence was modeled in log-link, binary outcome multilevel models in SAS PROC GLIMMIX, with observations nested within girls across the follow-up time period. All models were fit to the data using restricted maximum-likelihood estimation assuming incomplete data were missing at random (Singer, 1998). Repeated measures of stress were decomposed into *between-person differences* in mean stress and *within-person fluctuations* in stress relative to one’s longitudinal mean. Between-person mean (level 2) average stress was defined as a girl’s unique sample-standardized person longitudinal mean across all follow-up assessments. Within-person deviations in (level 1) stress were calculated as a given assessment’s value minus a girl’s unique person mean across all assessments divided by the girl’s unique standard deviation (i.e. person-standardized). Thus, these within-person deviation variables captured fluctuations in stress at each wave around a girl’s mean level of stress across all waves.

We ran three separate models predicting same-wave NSSI from current within-person deviations in each form of stress (time-varying). Each model controlled for within-person passage of time since baseline and between-person factors including age, sample-standardized mean depression, sample-standardized mean stress, psychotropic medication use, and reported exposure to abuse<sup>1</sup> (see Miller et al., 2017). Random intercepts and random effects of time-varying predictors were examined and included only when doing so improved model fit (–2 pseudo log-likelihood); of note, inclusion of all random effects regardless of model fit did not substantively alter fixed-effects results. Results of multilevel models are presented as gamma weights in tables, which are analogous to unstandardized beta weights in OLS logistic regression. Odds ratios and 95% confidence intervals are provided for significant effects. Because time-varying predictors were person-standardized, gamma coefficients and associated odds ratios can be interpreted as the effect of a one person-*SD* increase in the predictor relative to one’s person mean.

## Results

**Descriptive statistics.** Descriptive statistics for study variables are included in Tables 1 and 2.



Bivariate correlations are presented in Table S1. All predictor values were normally distributed. Of those reporting NSSI at each wave, most (approximately 70%) reported engaging in NSSI between 1 and 3 times. Attrition analyses revealed that individuals with missing NSSI data at any time point did not significantly differ from individuals with complete NSSI data across all time points on any predictor variable (all *p*'s > .05).

*Multilevel models.* Multilevel models examining same-wave associations with NSSI are presented in Table 3. Overall, the pattern of results across the three models with different types of stressors was similar. In all models, age (as a between-person factor) was not associated with risk of NSSI engagement across waves. The within-person passage of time across waves was associated with declining risk of NSSI. Between-person mean depression was associated with increased overall risk of NSSI. Lifetime history of NSSI was the strongest predictor of current NSSI. Between-person differences in stress across waves were not significantly associated with risk of NSSI. However, consistent with hypotheses, higher-than-usual stress at a given wave was associated with greater risk of NSSI within the same wave.

**Discussion**

Study 1 begins to clarify *when* an adolescent girl experiencing stress is at risk for engaging in NSSI. Consistent with study hypotheses, periods of higher-than-usual stress were associated with greatest risk for engaging in NSSI within the same 3-month wave. Interestingly, between-person mean stress was not associated with increased risk for engaging in NSSI. Rather, higher-than-usual stress (compared to one's typical level) was associated with same-wave NSSI. This pattern was consistent across three types of stressors: peer, mother-child, and academic stress. Prior work has shown different effects of stressors across these domains on mood (e.g. Timmons & Margolin, 2015). Interestingly, higher-than-usual stress across all three domains in the present study was associated with within-wave NSSI risk.

There was an overall decline in NSSI risk across time. This likely reflects regression to the mean given that our sample was recruited for high risk. We provided a list of mental health resources to all families in our study. Thus, the sample may have had higher rates of treatment engagement overall. Regardless, girls were more likely to engage in NSSI during periods of higher-than-usual stress within the same three-month wave. Theories of NSSI posit that the link between stress and engaging in NSSI is closer in space and time than months. Thus, we were interested in whether our results held when we examined the effects of stress and NSSI at the daily level in Study 2. Additionally, while a three-month

**Table 3** Results of within-person models predicting NSSI Acts across 3-month follow-ups

Predictor	Outcome: Nonsuicidal Self-Injury Acts											
	Model 1:Peer stress				Model 2:Academic stress				Model 3:Mother-child stress			
	$\gamma$	SE	OR	95% CI	$\gamma$	SE	OR	95% CI	$\gamma$	SE	OR	95% CI
Fixed effects												
Intercept	-0.86	1.36	-	-	-1.05	1.36	-	-	-0.97	1.39	-	-
Age	-0.12	0.22	-	-	-0.10	0.09	-	-	-0.10	0.10	-	-
Time	<b>-0.47***</b>	0.06	0.63	0.56, 0.70	<b>-0.46***</b>	0.06	0.63	0.57, 0.70	<b>-0.50***</b>	0.06	0.61	0.54, 0.68
Lifetime NSSI	<b>3.15***</b>	0.33	23.24	12.12, 44.59	<b>3.08***</b>	0.30	21.71	11.94, 39.47	<b>3.16**</b>	0.33	23.55	12.39, 44.75
Abuse exposure	-0.01	0.22	-	-	-0.02	0.22	-	-	-0.04	0.29	-	-
Psychotropic medication	0.34	0.25	-	-	0.35	0.25	-	-	0.30	0.23	-	-
Mean depression	<b>0.62***</b>	0.15	1.85	1.37, 2.50	<b>0.73***</b>	0.12	2.08	1.63, 2.65	<b>0.80***</b>	0.13	2.23	1.72, 2.89
Mean stress	0.27	0.15	-	-	0.02	0.12	-	-	-0.08	0.12	-	-
Within-person deviations in stress	<b>0.30**</b>	0.12	1.35	1.07, 1.70	<b>0.34**</b>	0.11	1.40	1.14, 1.73	<b>0.29***</b>	0.11	1.34	1.08, 1.66
	Covariance parameters				Covariance parameters				Covariance parameters			
	$\gamma$	SE			$\gamma$	SE			$\gamma$	SE		
Intercept	0.29	0.23			.28	0.20			0.32	0.13		
Within-person deviations in stress	0.27	0.36			0	0			0.13	0.24		

Bold values are significant, \*\**p* < .01; \*\*\**p* < .001.

retrospective report improves upon prior research, there is still a concern regarding recall bias between time points. Study 2 attempts to replicate the results from Study 1 with a more fine-grained assessment of stress and NSSI.

## Study 2 Methods

**Participants and procedures.** Participants for Study 2 were drawn from a larger sample of 60 emerging and young adults (aged 18–35,  $M$  age = 23.25,  $SD$  = 4.25, 85% female) with a history of NSSI (Turner, Cobb, Gratz, & Chapman, 2016). Previous studies with the larger sample have assessed differences in interpersonal relationship quality between those with and without NSSI (Turner, Wakefield, Gratz, & Chapman, 2017), differences in engaging in disordered eating and NSSI (Turner, Yiu, Claes, Muehlenkamp, & Chapman, 2016), and predictors of resisting urges to engage in NSSI (Turner, Baglole, Chapman, & Gratz, 2019). Almost half of the participants (48%) reported engaging in NSSI within 30 days of study participation, and 40% reported engaging in NSSI within 2 weeks prior to study participation. Here, we were primarily interested in examining the relationship between stress and NSSI among adolescent and emerging adult females; thus, we restricted analyses to females aged 18–25 ( $N$  = 40,  $M$  age = 21.55,  $SD$  = 2.14). Sociodemographic characteristics between those included and excluded did not differ. Detailed procedures have been reported elsewhere (Turner, Cobb et al., 2016). In brief, participants were recruited from the community via online advertisements and community flyers. Inclusion criteria were as follows: (a) age 18–35; (b) 10 or more lifetime episodes of NSSI, (c) one or more NSSI episode in the past year, (d) at least 1 thought or urge for NSSI in the past 2 weeks, and (e) regular internet access to complete surveys. Given the transdiagnostic nature of NSSI, exclusion criteria were limited to conditions that could interfere with the daily diary protocol, including current psychotic disorders, mania, or substance dependence. Inclusion/exclusion criteria were assessed via the Structured Clinical Interview for DSM-IV (SCID) (First, Spitzer, Gibbon, & Williams, 1997) and the Deliberate Self-Harm Inventory (Gratz, 2001). Rates of current psychiatric disorders for the sample are in Table 2.

**Daily diary procedures.** Participants completed a baseline assessment and then completed daily diary entries for 14 days. To increase reliability and validity, a modified day reconstruction method was used to characterize presence or absence of NSSI thoughts and acts and perceived stress. Participants complete a single daily report at the end of the day during which they retrospectively report on different ‘episodes’ within the day. Participants rated NSSI

thoughts and acts and perceived stress separately within three predefined periods each day: morning (defined as first waking to noon), afternoon (defined as noon to 6 p.m.), and evening (defined as 6 p.m. until the diary entry). While this method may introduce recall biases compared to more frequent collections, the day reconstruction method is preferred to a single daily aggregate rating and may reduce participant burden (Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004).

Participants were provided with reminders every day at 5 p.m. with a link to complete the daily survey as close to bedtime as possible. Participants were given until 11 a.m. the next morning to complete a missed survey. Participants were also asked to report any NSSI that happened between submitting the previous evenings’ survey and the next morning’s.

Participants completed 735 out of 840 possible daily entries, with an average of 12.10 per person ( $SD$  = 3.39, Range = 1–15).<sup>2</sup> Compliance did not vary as a function of age, gender, or psychiatric diagnosis,  $p$ ’s > .12. Thirty-one participants reported engaging in NSSI on a total of 90 days, consistent with NSSI rates observed in previous microlongitudinal studies (Nock, Prinstein, & Sterba, 2009).

**Measures.** *NSSI:* Consistent with Study 1, NSSI thoughts and acts were assessed with two items based on the SITBI (Nock et al., 2007): ‘Did you think about purposefully injuring yourself without intending to die (NSSI)?’ and ‘Did you engage in NSSI today?’

*Stress:* The Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1994) is a 10-item measure that assesses how frequently participants experienced stress on a scale of 0 (*never*) to 4 (*very often*). Example items include: ‘how often have you found that you could not cope with all the things that you had to do?’ and ‘how often have you felt difficulties were piling up so high that you could not overcome them?’ Participants provided three retrospective reports of stress for the morning, afternoon, and evening. Items were summed within period and then averaged across periods, creating an average daily perceived stress score ranging from 0 (*no perceived stress*) to 38 (*high perceived stress*) (Cronbach’s  $\alpha$  = .92).

*Depression:* Major depressive disorder was diagnosed via the SCID (First et al., 1997) at baseline.

**Data analytic plan.** We used the same multilevel modeling procedures from Study 1. Here, between-person mean (level 2) perceived stress was defined as a participant’s unique sample-standardized longitudinal person mean across all days, while within-person deviations were person-standardized deviations around this mean. We ran one model predicting same-day NSSI thoughts and one model predicting same-day NSSI acts from current

within-person deviations in daily perceived stress (time-varying). Each model controlled for the effects of within-person passage of time since initial assessment and between-person factors, including age, depression diagnosis,<sup>3</sup> and standardized mean perceived stress. Although we expected the association between higher-than-usual stress to be most strongly associated with same-day NSSI risk, we conducted exploratory analyses to examine associations between higher-than-usual stress today ( $t$ ) and risk for NSSI tomorrow ( $t + 1$ ) after accounting for NSSI today ( $t$ ) and higher-than-usual stress tomorrow ( $t + 1$ ).

## Results

**Descriptive statistics.** Descriptive statistics can be found in Tables 1 and 2. Bivariate correlations of between-person, average stress across all days, and any NSSI thoughts or acts across all days were examined. Higher average perceived stress was associated with experiencing NSSI thoughts,  $r = .30$ ,  $p < .001$ , but not NSSI acts,  $r = .05$ ,  $p = .18$ . NSSI thoughts were positively associated with NSSI acts,  $r = .38$ ,  $p < .001$ .

**Multilevel models.** Models examining same-day NSSI thoughts and acts are presented in Table 4. Neither age nor depression diagnosis (between-person factors) was associated with risk of NSSI thoughts across days. Between-person mean perceived stress was not associated with increased risk of NSSI thoughts. However, higher-than-usual perceived stress on a given day was associated with greater risk of NSSI thoughts on the same day.

A similar pattern emerged with regard to NSSI acts. Age (between-person factor) was not associated with greater risk of NSSI acts across days. Between-person mean perceived stress was not associated with increased risk of NSSI acts.

Consistent with hypotheses, higher-than-usual perceived stress on a given day was associated with greater risk of NSSI acts on the same day. As expected, exploratory analyses examining whether higher-than-usual stress predicted next-day NSSI after accounting for next-day higher-than-usual stress and NSSI today yielded no statistically significant prospective effects.

## Discussion

Results from Study 2 replicate results from Study 1 and provide further support for our study hypothesis that periods of higher-than-usual stress are associated with NSSI risk. Similar to Study 1, mean levels of daily stress were not associated with increased NSSI risk. Rather, participants were more likely to think about and engage in NSSI when they reported higher-than-usual daily perceived stress relative to their own average perceived stress.

Study 2 provides an important extension of Study 1 as it demonstrates that this stress-threshold model functions similarly in two independent samples. Results suggest that young people may have a unique stress threshold wherein an upward shift in stress may be associated with NSSI risk regardless of mean stress levels relative to others. Further, results are consistent with previous EMA studies that show how increased within-person negative affect predicts NSSI over the course of next few hours (Rodríguez-Blanco et al., 2018).

## General discussion

Taken together, these two studies provide initial support for a within-person, stress-threshold model of NSSI among adolescents and emerging adults. Previous research has demonstrated consistent concurrent associations between stress and NSSI. However, the current studies together demonstrate that

**Table 4** Results of within-person models predicting NSSI thoughts and acts across days

	Outcome: Nonsuicidal self-injury thoughts				Outcome: Nonsuicidal self-injury acts			
	$\gamma$	SE	OR	95% CI	$\gamma$	SE	OR	95% CI
Study 2	Fixed effects				Fixed effects			
Intercept	0.58	3.05	–	–	<b>–7.53**</b>	<b>3.31</b>	–	–
Age	0.02	0.14	–	–	0.27	0.15	–	–
Time	–0.06	0.03	–	–	–0.06	0.04	–	–
Depression diagnosis	–0.40	0.66	–	–	–0.55	0.68	–	–
Mean perceived stress	0.09	0.06	–	–	–0.03	0.05	–	–
Within-person deviations in perceived stress	<b>1.00***</b>	0.16	2.72	2.00, 3.70	<b>0.71***</b>	0.17	2.04	1.46, 2.84
	Covariance parameters				Covariance parameters			
	$\gamma$	SE			$\gamma$	SE		
Intercept	<b>2.70**</b>	0.90			<b>2.34**</b>	0.96		
Within-person deviations in stress	0.14	0.19			0	0		

Bold values are significant, \*\* $p < .01$ ; \*\*\* $p < .001$ .

simply knowing how a young person's stress level compared to others (between-person) may not provide enough information to predict within-wave or same-day NSSI risk. Rather, knowledge about when an adolescent or emerging adult exceeds their own typical stress level (within-person) may be more useful for informing clinical care. Importantly, we use the term stress threshold as it best captures the unique within-person effects we observed. However, it is important to note that this stress threshold is not necessarily an absolute, quantifiable threshold within-person, but more so when an individual exceeds their typical stress level.

Based on stress-sensitization literature, we hypothesized that examining within-person deviations in stress may provide more clinically useful results. Indeed, having an overall higher stress level relative to others was not associated with NSSI, but, consistent with a stress-sensitization framework (Hammen et al., 2000), increased stress levels relative to one's typical levels were helpful for predicting concurrent NSSI risk. We did not hypothesize that higher-than-usual stress would predict NSSI risk in the next wave (study 1: next 3-month follow-up; Study 2: next day) after accounting for that wave's stress. Indeed, exploratory analyses from Study 2 confirmed that higher-than-usual stress did not predict next-day NSSI risk after accounting for today's NSSI and next-day stress. Theories of NSSI posit that adolescents and emerging adults engage in NSSI to relieve proximal, intolerable distress (Chapman et al., 2006). Further, studies examining physiological arousal following a stressor document temporary increase in indices of stress response systems (e.g. cortisol as a marker of HPA axis) that subside within minutes and hours for most (Gunnar & Quevedo, 2007). As a result, we believe that data on the level of minutes and hours, as gathered from EMA or passive data collection, are better suited to examine whether higher-than-usual stress now predicts NSSI risk in the next few minutes or hours, similar to work on negative affect (Rodríguez-Blanco et al., 2018). Importantly, across all studies, findings were over and above the effects of prior NSSI (Study 1), age, and depression (symptom or diagnosis; Studies 1 and 2).

Findings from typically developing samples of adolescents and emerging adults help contextualize our findings and point to important areas for future research. Within-person variations in daily stress have been associated with both same-day (Bai & Repetti, 2018) and next-day (Timmons & Margolin, 2015) psychological functioning and altered same-day biological stress responses (Fuligni et al., 2009; Lippold et al., 2016). Interestingly, some of these studies point to important interactions between within-person variations in stress and available coping strategies (Sladek, Doane, Luecken, & Eisenberg, 2016) or social support (Lippold et al., 2016) as potential buffers against increased stress. An

important future direction will be to examine mechanisms linking higher-than-usual stress with risk for NSSI.

There are several important clinical implications from the present studies. Overall, results underscore the potential utility of within-person assessment of stress and NSSI using evidence-based tools with ongoing, repeated administrations. Clinicians may benefit from transitioning from solely assessing stress during an intake assessment (where risk is compared relative to the population) to ongoing monitoring of stress in order to capture individual stress fluctuations. This personalized approach does not rely on previously established clinical cutoffs and allows for tailored treatment approaches for a specific patient. This approach can enhance safety planning, signal the need for increased monitoring for patients during high stress periods, and aid in tracking treatment progress. Ongoing assessment is consistent with the routine safety monitoring in dialectical behavior therapy (Linehan et al., 2006; McCauley et al., 2018) as well as outcomes monitoring approaches to treatment (Boswell, Kraus, Miller, & Lambert, 2015). Given that our results were consistent in the sample of late adolescents and emerging adults (Study 2), our results also highlight the potential importance of helping adolescents strategically apply therapeutic tools during periods of higher-than-usual stress in order to prevent NSSI during emerging adulthood.

Strengths across both studies include use of longitudinal methods with rigorous analytic methods. Both studies benefited from the use of multilevel modeling to simultaneously assess between- and within-person effects of stress on NSSI. Retention and compliance were also high across studies. Nevertheless, there are important considerations when interpreting results across studies. Both samples were not representative from the general population, and it is unclear how results would generalize to diverse groups of young people, particularly boys. Across studies, the relationship between stress and NSSI was assessed concurrently. Thus, causality cannot be determined, and effects could be bidirectional. Given the focus of our study on NSSI, we did not examine differential prediction of NSSI from other forms of suicidal thoughts and behaviors. Our previous work has found that higher-than-usual stress was associated with risk for suicidal ideation with a similar pattern emerging for suicidal behavior but only among girls exposed to childhood abuse (Miller et al., 2017). Future research may wish to consider examining whether higher-than-usual stress differentially predicts various forms of self-injurious thoughts and behaviors. Stress is a broad term encompassing many subtle differences and important distinctions within this broad category. In the current manuscript, each study captured two different types of stress, actual stressors and



perceived stress. While this is a limitation in that results are not comparable in an absolute sense, it could be considered a strength showing that results may generalize between actual stressors (Study 1) and perceived stress (Study 2). Nevertheless, future work may benefit from testing differences between actual stressors or perceived stress. Despite increasingly short assessment periods for each study, recall bias is a concern. All studies assessed the presence or absence of NSSI. While this is a coarse way to examine prospective risk, this is a consistent challenge in the NSSI literature given the low base rates of NSSI (relative to other health risk behaviors). Regardless, assessing the link between stress and NSSI in two, prospective investigations significantly contributes to the literature, given the paucity of prospective studies in this domain (Fox et al., 2015).

Ultimately, our study results encourage a shift in NSSI research to assess not only between-person risk factors, but also within-person changes in risk factors. Such work shifts from focusing on *who* is at risk for NSSI to *when* a specific at-risk person will engage in NSSI. Our study finds that, while between-person differences in stress are not robustly associated with NSSI risk, young people are most likely to

engage in NSSI when stress increases above their own typical levels.

### Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

**Table S1.** Correlations among Study 1 variables.

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### Key points

- Theoretical models and past research link life stress with risk for nonsuicidal self-injury (NSSI).
- Yet, recent meta-analytic evidence suggests that life stress inconsistently predicts NSSI.
- This might be because most work focuses on between-person differences in life stress.
- Here, we investigate whether a person is at risk for NSSI when they exceed their own typical levels of life stress.
- Our findings suggest that clinicians may be better able to predict NSSI by monitoring for periods when their adolescent and emerging adult patients experience higher-than-usual life stress.

### Notes

1. Abuse did not predict NSSI, and the within-person effect of stress remained significant in models with or without abuse as a covariate.
2. One participant continued diary participation for an extra day.
3. We did not have a daily measure of depression symptoms.

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