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Research paper

The associations between non-suicidal self-injury and first onset suicidal thoughts and behaviors

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ABSTRACT

Background: Theoretical and empirical literature suggests that non-suicidal self-injury (NSSI) is an important correlate of suicide risk. The present study was designed to evaluate: (a) whether NSSI is associated with increased odds of subsequent onsets of suicidal thoughts and behaviors (STB) independent of common mental disorders, (b) whether NSSI is associated with increased risk of transitioning from suicide ideation to attempt, and (c) which NSSI characteristics are associated with STB after NSSI.

Method: Using discrete-time survival models, based on retrospective age of onset reports from college students (n = 6,393, 56.8% female), we examined associations of temporally prior NSSI with subsequent STB (i.e., suicide ideation, plan, and attempt) controlling mental disorders (i.e., MDD, Broad Mania, GAD, Panic Disorder, and risk for Alcohol Dependence). NSSI characteristics associated with subsequent STB were examined using logistic regressions.

Results: NSSI was associated with increased odds of subsequent suicide ideation (OR = 2.8), plan (OR = 3.0), and attempt (OR = 5.5) in models that controlled for the distribution of mental disorders. Further analyses revealed that NSSI was associated with increased risk of transitioning to a plan among those with ideation, as well as attempt among those with a plan (ORs = 1.7–2.1). Several NSSI characteristics (e.g., automatic positive reinforcement, earlier onset NSSI) were associated with increased odds of experiencing STB.

Limitations: Surveys relied on self-report, and thus, there is the potential for recall bias.

Conclusions: This study provides support for the conceptualization of NSSI as a risk factor for STB. Investigation of the underlying pathways accounting for these time-ordered associations is an important avenue for future research.

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1. Introduction

Non-suicidal self-injury (NSSI), the direct and deliberate damage to one's body tissue for reasons other than to end one's life (Nock and Favazza, 2009), is a significant public health concern in young people. In community samples, 17% of adolescents and 12–20% of young adults report having engaged in NSSI at least once in their lifetime (Swannell et al., 2014). NSSI typically starts in mid-adolescence between 14 and 16 years (Gandhi et al., 2018; Plener et al., 2015), can take many forms (e.g., skin cutting, burning and self-hitting), and is most often used to escape aversive moods (e.g., sadness, anger) and cognitive states (e.g., worry, criticism; Bentley et al., 2014; Taylor et al., 2017).

NSSI is a behavior distinct from a suicide attempt. People who engage in NSSI aim to modify, rather than terminate, consciousness, and do not expect that their self-injury will result in death (Hamza et al., 2012; Walsh, 2012). Researchers have also found considerable differences in epidemiological features. NSSI is more prevalent than suicide attempts (i.e., 3–4%; Mortier et al., 2018; Nock et al., 2013), has an onset at an earlier age, and tends to occur more frequently (Gandhi et al., 2018; Glenn et al., 2017; Hamza et al., 2012; Muehlenkamp, 2014; Plener et al., 2015). Further, NSSI typically involves low-lethality methods (e.g., scratching, cutting, self-battery) that may not require medical attention compared to high-lethality methods (e.g., hanging, poising/overdose, firearms) used in suicide attempts (Hamza et al., 2012; Muehlenkamp, 2014). Despite meaningful differences in intention, epidemiology and lethality, these behaviors frequently co-occur (Benjet et al., 2017; Glenn et al., 2017; Hamza et al., 2012). For example, in a population study of young adults, Benjet and colleagues (2017) observed that more than two thirds of those who attempted suicide also reported a history of NSSI.

Several theories have been proposed to explain the link between NSSI and attempted suicide (for a detailed overview see Hamza et al., 2012; Grandclerc et al., 2016). Importantly, these theories conceptualize NSSI as a precursor of a suicide attempt. Indeed, a dozen studies over the past decade have consistently shown that NSSI is prospectively associated with increased risk for a suicide attempt (e.g., Guan et al., 2012; Hamza and Willoughby, 2016; Whitlock et al., 2013), and might even outpace other significant risk factors (Franklin et al., 2017; Ribeiro et al., 2016). Despite this knowledge, several important questions remain regarding the role of mental disorders in this association, the extent to which NSSI is associated with increased risk of transitioning from suicide ideation to attempt, and the NSSI characteristics that might identify those at greatest suicide risk.

First, NSSI commonly co-occurs with mental disorders (especially internalizing disorders; Bentley et al., 2015; Kiekens et al., 2018; Taliaferro and Muehlenkamp, 2015), and thus these disorders could confound the true association between NSSI and attempted suicide. Although there is some evidence to suggest that the association between NSSI and attempted suicide cannot be fully explained by co-existing psychopathology (Klonsky et al., 2013), this has not been rigorously tested in a time-ordered framework that accounts for the distribution of comorbid mental disorders. Similarly, it is currently unclear whether NSSI is a risk factor for a suicide attempt among people without mental disorders, rather than simply a marker of disorder severity (Selby et al., 2015). Alternatively, it may be that the association between NSSI and risk for a subsequent suicide attempt is stronger among persons with mental disorders (Hamza et al., 2012). Obtaining a clearer picture regarding the effect of mental disorders in the temporal association between NSSI and attempted suicide could provide valuable information for prevention efforts and clinical risk assessment.

Second, although most research has focused on the association between NSSI and a subsequent suicide attempt, a growing body of research suggests that NSSI might increase risk for a broad range of suicidal thoughts and behaviors (STB); including suicide ideation and plans (Chu et al., 2017b; Guan et al., 2012; Hamza and Willoughby, 2016; Mortier et al., 2017). These distinct stages of the progression to attempted suicide develop in closer temporal proximity to NSSI (Giletta et al., 2015; Glenn et al., 2017), and can precede as well as follow an onset of NSSI (Bryan et al., 2015; Glenn et al., 2015). If NSSI is used as a means of averting thoughts and plans about suicide (c.f. the anti-suicide function of NSSI; Edmondson et al., 2016), NSSI may decrease the risk of a subsequent suicide attempt. Yet, a recent study among a sample of military personnel reporting suicide ideation suggests that NSSI increases risk of a subsequent suicide attempt (Nock et al., 2018). If this initial finding is replicated in other samples, an important question is whether NSSI thoughts, as distinct from NSSI behavior, might also be useful in predicting who, among people with suicide ideation or plans, will subsequently make attempts. If NSSI thoughts have predictive validity beyond NSSI behavior they could provide useful information from a preventive point of view, potentially signaling risk before the manifestation of any self-injury (Hasking et al., 2013).

Third, it is important to acknowledge that not all people who engage in NSSI will experience STB. In fact, among community samples, more than half of the people who self-injure report no STB (Benjet et al., 2017; Muehlenkamp and Gutierrez, 2007). This raises the crucial question as to what differentiates these individuals from their peers who do develop suicide thoughts and make plans and attempts to end their lives. Prior studies demonstrated that several NSSI characteristics are associated with the presence of STB. Specifically, higher NSSI frequency, longer history of NSSI, greater variety of NSSI methods, automatic functions of NSSI (i.e., affect regulation), higher subjective pain experience during NSSI, medical treatment for NSSI, and a history of self-cutting have all been suggested to increase risk of STB (e.g., Ammerman et al, 2016; Burke et al., 2018; Nock et al., 2006; Paul et al., 2015; Stewart et al., 2017; Victor and Klonsky, 2014). However, because these NSSI characteristics have been identified separately across studies, and only few studies considered these characteristics in multivariate prediction models (Burke et al., 2018), it is currently unclear which NSSI characteristics clinicians need to consider when conducting risk assessments. Research studies that compare people who self-injure with different STB trajectories could provide information that may better enable us to identify those at greatest risk of subsequent suicide.

In the present study, we sought to replicate and extend previous research by evaluating whether: (a) NSSI is associated with increased risk of subsequent STB independent of common mental disorders, (b) NSSI thoughts and/or NSSI is associated with increased odds of transitioning from suicide ideation to attempt, and c) particular NSSI characteristics are associated with subsequent STB trajectories when controlling other aspects of NSSI.

2. Method

2.1. Procedures and sample description

We used data from the Leuven College Surveys and the Curtin Wellbeing Surveys, which are part of the World Mental Health International College Student Project (WMH-ICS, 2018). For the purpose of the current study, baseline data collected between 2014 and 2017 at KU Leuven (Belgium) and between 2016 and 2017 at Curtin University (Australia) was analyzed. These web-based self-report health surveys assessed the occurrence of emotional and behavioral mental health problems, unmet needs, and a range of potential correlates (e.g., stressors,

social support). All first-year students in each cohort were invited to participate and non-respondents were sent up to seven reminder emails containing unique electronic links to the survey. Informed consent was obtained before administering the questionnaires and conditional incentives were applied (credit coupons and movie tickets). Procedures for obtaining informed consent and protecting human participants were approved and monitored for compliance by the institutional review boards of both universities. In total, 6,393 students (56.8% female, M_{age} = 18.9, *SD* = 2.6; see supplementary Table 1) completed all relevant sections (Response Rate = 23.8%). To assess the representativeness of our data, representativeness indicators (R-indicators) were calculated at each site on a broad range of sociodemographic variables. R-indicator values range between 0 and 1, with the latter indicating sample data are fully representative of the population under study (Schouten et al., 2009). R-indicators were in the 0.87–0.95 range, suggesting a high sociodemographic representativeness of the respondent data for both samples.

2.2. Measures

Non-suicidal self-injurious thoughts and behaviors were assessed with the self-report version of the well-validated Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock et al., 2007). The NSSI section of the SITBI shows strong psychometric properties including good construct validity (κ = 0.74–1.0) and excellent test-retest reliability (κ = 1.0; Nock et al., 2007). The self-report version used in the current study showed excellent test-retest reliability (κ = 1.0) and external validity (κ = 1.0) in a comparison study of self-report questionnaires (Latimer et al., 2013). Respondents were asked whether they ever had "*thoughts of purposely hurting themselves, without wanting to die*?" to assess NSSI thoughts. To assess presence of NSSI, respondents were asked to report, via a checklist of 13 behaviors and an 'other' category, all behaviors that they engaged in '*to hurt themselves on purpose, without wanting to die*' (e.g., cutting, scratching, burning, hitting, head-banging, etc.). Follow-up questions assessed the age of onset, lifetime frequency, number of NSSI methods, functions of NSSI, medical treatment history for NSSI, and subjective pain experienced during NSSI (expressed on a 0 to 100 visual analogue scale). Respondents rated the functions of NSSI based on the four-factor model (Bentley et al., 2014): automatic negative reinforcement (i.e., *to get rid of negative feelings*), automatic positive reinforcement (i.e., *to feel something*), social negative reinforcement (i.e., *to get away from others/out of doing something*), and social positive reinforcement (i.e., *to communicate with others/get attention*). Each function was assessed by one question that asked respondents, when they self-injured, how much they did it to achieve each function (0 = little; 4 = very much; Nock et al., 2007). Number of NSSI methods was calculated by summing the total number of behaviors reported.

Table 1
Prevalence and co-occurrence of suicidal thoughts and behaviors.

	Lifetime w(%)	SE	OR (95% CI) relative to controls	OR (95% CI) relative to NSSI thoughts
Controls[a] (*w*(n) = 4,799)				
Lifetime suicide ideation	13.4	0.5	Reference	–
Lifetime suicide plan	3.8	0.3	Reference	–
Lifetime suicide attempt	0.4	0.1	Reference	–
NSSI thoughts[b] (*w*(n) = 134)				
Lifetime suicide ideation	58.7	4.4	9.2*** (6.4–13.3)	Reference
Lifetime suicide plan	25.3	4.1	8.5*** (5.4–13.3)	Reference
Lifetime suicide attempt	2.1	1.5	4.7* (1.0–21.5)	Reference
NSSI (*w*(n) = 1,460)				
Lifetime suicide ideation	55.6	1.3	8.1*** (7.1–9.3)	0.9 (0.6–1.3)
Lifetime suicide plan	33.6	1.3	12.7*** (10.5–15.4)	1.5 (1.0–2.3)
Lifetime suicide attempt	11.5	0.9	29.1*** (16.9–50.0)	6.2** (1.9–20.4)

Note: [a] Controls = respondents without a prior history of NSSI thoughts and NSSI, [b] NSSI Thoughts = respondents with NSSI thoughts but not NSSI. NSSI = Non-Suicidal Self-Injury, SE = Standard Error, w(n) = weighted number of cases, w% = weighted percentage, OR = Odds Ratio, CI = Confidence Interval.
* p < .05, ** p < .01, *** p < .001, two-sided tested.

Suicidal thoughts and behaviors were also assessed with the self-report version of the SITBI (Nock et al., 2007). Construct validity of the SITBI ranges from substantial to good for STB (κ = 0.48–0.65), with test-retest reliability ranging from good to excellent (κ = 0.70–1.00; Nock et al., 2007). STB was conceptualized as a continuum and included suicide ideation (i.e., *wishing you were dead or having thoughts of killing yourself*), suicide plan (i.e*., thinking about how you might kill yourself or working out a plan of how to kill yourself*), and a suicide attempt (i.e., *purposefully hurt yourself with at least some intent to die*). Follow-up questions assessed the age of onset for each STB.

Mental disorders were assessed using the Screening Scales of the Composite International Diagnostic Interview (CIDI-SC; Kessler and Ustün, 2004). We assessed two mood disorders (i.e., Major Depressive Disorder, and [Hypo]mania), and two anxiety disorders (Generalized Anxiety Disorder, and Panic Disorder). The CIDI-SC was developed by the World Health Organization to deliver reliable estimates of DSM-IV mental disorders. Previous research indicates good concordance between CIDI-SC and independent clinical diagnoses based on blinded structured clinical interviews (AUC = 0.70–0.78; Kessler et al., 2013b). Using the well-validated Alcohol Use Disorders Identification Test (AUDIT; DeMartini and Carey, 2012; Saunders et al., 1993), participants at risk for alcohol dependence were also identified. Using follow-up questions, participants were again asked to report the age at which they first experienced symptoms of each disorder.

2.3. Statistical analyses

All analyses were performed with SAS (version 9.3) and SPSS (version 23), and data were weighted for potential non-response bias (Lee, 2006). Descriptive statistics are reported as weighted numbers (n), weighted proportions (%) and associated standard errors. Discrete-time survival models with person year as the unit of analysis and a logistic link function was used to analyze the data (Efron, 1988). In this approach, each year in the life of each respondent is treated as a separate observation, with years prior to the onset of the outcome (e.g., suicide attempt) coded 0 and the year of onset coded 1. Person-years were set to begin at age 4, the youngest age evaluated for possible onset of mental disorders and self-injurious thoughts and behaviors (Gandhi et al., 2018; Green et al., 2010). For respondents who never experienced the outcome, all person-years up to the age at assessment were

included. For those who experienced the outcome under examination, all years of life after the age of onset of the outcome were excluded from that analysis. Predictor variables were considered time-varying, and coded 1 from the year of onset. Following a conservative approach, the predictor variable was coded 0 in cases where the predictor and outcome occurred in the same year. To examine the unique effect of NSSI thoughts and avoid multicollinearity, NSSI thoughts were coded 0 from the year NSSI occurred.

This data array was then analyzed using logistic regressions, which yield survival coefficients because of the exclusion of person-years after the onset of the outcome. These coefficients were exponentiated to yield odds ratios for ease of interpretation. Each model included time up to a fourth order polynomial specification if required ($p < .05$), and was adjusted for age, gender, and university. Multivariate additive models controlled for the main effects of pre-existing mental disorders, and multivariate interactive models evaluated all two-way NSSI*Mental disorder interactions in predicting STB. To evaluate whether NSSI thoughts/NSSI might be useful in predicting which people with thoughts or plans about suicide subsequently attempt suicide, we investigated whether NSSI thoughts/NSSI was associated with an increased risk for a suicide attempt within respondents with lifetime suicide ideation and plans. Standard errors were estimated with the Taylor series method (Wolter, 1985) and adjusted odds ratios and 95% confidence intervals were provided with statistical significance evaluated with Wald χ^2 tests based on design-corrected coefficient-covariance matrices.

Finally, using logistic regression analyses, we examined whether we could identify NSSI characteristics that may increase risk for STB onsets among people who self-injure. Nagelkerke pseudo-R^2 was used as a measure of total effect size.

3. Results

3.1. Descriptive analyses and temporal patterns

Lifetime suicide ideation, plan, and attempt were reported by 24.0% (SE = 0.6), 11.1% (SE = 0.4), and 3.0% (SE = 0.2) of the sample, respectively. Females reported higher rates of suicide ideation (25.3% vs. 22.2%; Rho $\chi^2_{1df} = 7.8$, p = .005) and suicide attempt (3.7% vs. 2.1%; Rho $\chi^2_{1df} = 10.1$, p = .002) than males. Lifetime NSSI was reported by 22.8% (SE = 0.5), with higher rates reported among females (25.4%, SE = 0.7) than males (19.5%, SE = 0.8), Rho $\chi^2_{1df} = 26.9$, p < .001). Of those who engaged in NSSI, 35.8% (SE = 1.3) used one method, 21.9% (SE = 1.1) used two methods, 14.4% (SE = 0.9) used three methods, and 27.9% (SE = 1.2) used four or more methods of NSSI. The three most common methods were smashing hands or feet against the wall or other objects (50.8%, SE = 1.3), self-cutting (37.6%, SE = 1.3), and hitting oneself (35.4%, SE = 1.3). An additional 2.1% (SE = 0.2) reported NSSI thoughts only, with similar rates across gender (Rho $\chi^2_{1df} = 0.0$, p = .922).

We first examined the occurrence of STB among respondents with and without NSSI thoughts and NSSI regardless of the temporal order (Table 1). Compared to respondents without a prior history of NSSI thoughts and NSSI, those with NSSI thoughts (ORs in the 4.7–9.2 range) and NSSI (ORs in the 8.1–29.1 range) had significantly higher odds of reporting all STB outcomes. Respondents who engaged in NSSI were equally likely to report suicide ideation and suicide plans as those who had NSSI thoughts but did not act on them; however this group had significantly higher odds of having made a suicide attempt (OR = 6.2, 95%CI = 1.9–20.4). Table 2 summarizes the temporal sequence between ages at onset of NSSI compared with NSSI thoughts and STB within the subset of respondents who reported both outcomes. Whereas most respondents (89.6%) reported an onset of NSSI within the same year as NSSI thoughts emerged, for most people NSSI occurred prior to each STB outcome (55.8–80.1% range). On average, NSSI ($M_{age\ of\ onset}$ = 12.6 years, SD = 4.0) had an onset 2 months after NSSI thoughts emerged, 10 months prior to suicide ideation, 1.6 years prior to a suicide plan, and 3.2 years before the first suicide attempt occurred.

3.2. Associations between non-suicidal self-injurious thoughts and behaviors and subsequent onset of suicidal thoughts and behaviors

Bivariate survival models revealed that an onset of NSSI was significantly associated with increased odds of subsequent suicide ideation (OR = 3.3, 95%CI = 2.9–3.7), suicide plan (OR = 4.2, 95%CI = 3.5–5.0), and suicide attempt (OR = 9.0, 95%CI = 6.2–13.0). In contrast, NSSI thoughts were significantly associated with increased odds of subsequent suicide ideation (OR = 3.1, 95%CI = 2.3–4.2) and suicide plan (OR = 2.5, 95%CI = 1.7–3.6), but not attempted suicide (OR = 0.8, 95%CI = 0.3–2.3). A very similar pattern of results is seen within the subset of respondents without mental disorders (Table 3).

Compared to respondents with no history of NSSI thoughts or NSSI (16.5%, SE = 0.5), individuals reporting NSSI thoughts (41.5%, SE = 4.5, Rho $\chi^2_{1df} = 52.4$, p < .001) or NSSI (53.2%, SE = 1.3, Rho $\chi^2_{1df} = 732.2$, p < .001) were more likely to report at least one lifetime mental disorder (Supplementary Table 2). Even after controlling for comorbid mental disorders in multivariate models, NSSI thoughts and NSSI remained significantly associated with increased risk for an onset of suicide ideation and suicide plan (ORs in the 2.8–3.5 range; Table 4). NSSI also remained significantly associated with increased risk for a subsequent suicide attempt (OR = 5.5, 95%CI = 3.6–8.6).

We subsequently examined the extent to which NSSI thoughts and NSSI predict the transition from suicide ideation to a suicide plan and attempt. As can be seen in Table 4, NSSI thoughts was a nonsignificant predictor in multivariate models. In contrast, NSSI remained a signifi-

Table 2
Mean onset ages and temporal priorities among respondents with non-suicidal self-injury.

	Mean age of onset (SD)	Mean time-lag from NSSI[a] (SD)	Onset NSSI first *w%* (SE)	Onset in same year *w%* (SE)	Onset NSSI last *w%* (SE)
NSSI thoughts (*w*(n) = 1459)	12.4 (4.0)	- 0.2 (0.6)	-	89.6 (0.8)	10.4 (0.8)
Suicide ideation (*w*(n) = 811)	13.5 (4.0)	0.8 (4.7)	55.8 (1.8)	18.6 (1.4)	25.6 (1.6)
Suicide plan (*w*(n) = 491)	14.3 (3.7)	1.6 (4.7)	62.5 (2.3)	18.6 (1.8)	18.9 (1.8)
Suicide attempt (*w*(n) = 168)	15.6 (3.3)	3.2 (3.8)	80.1 (3.1)	12.2 (2.6)	7.7 (2.1)

Note: [a] Mean age of onset = 12.6 (4.0), NSSI = Non-Suicidal Self-Injury, SD = Standard Deviation, SE = Standard Error, w(n) = weighted number of cases, w% = weighted percentage.

Table 3
Survival models predicting the onset of suicidal thoughts and behaviors within respondents without lifetime mental disorders.

	Suicide ideation OR (95% CI)	Suicide plan OR (95% CI)	Suicide attempt OR (95% CI)
NSSI thoughts	3.0*** (1.8–5.1)	3.3** (1.5–7.3)	0.8 (0.1–6.2)
NSSI	2.5*** (2.0–3.2)	3.1*** (2.1–4.6)	5.3*** (2.2–13.1)
n(person-years)	71,734	73,966	74,917

Note: Each cell represents a separate bivariate model in a survival framework, with NSSI thoughts or NSSI in the row as predictors and suicide ideation, suicide plan, or suicide attempt in the columns, as dependent variables, including the following covariates: age, gender, and university. NSSI = Non-Suicidal Self-Injury, OR = Odds Ratio, CI = Confidence Interval.
* p< .05, ** p< .01, *** p< .001, two-sided tested.

cant, although weaker, predictor in models predicting transitions to a suicide plan and attempt within the subset of respondents with suicide ideation (ORs in the 1.7–2.9 range). Similarly, NSSI remained significant in the model that evaluated which respondents with a suicide plan subsequently made an attempt (OR = 2.1, 95%CI = 1.4–3.2).

Finally, we investigated the possibility of interactive associations between NSSI and each of the mental disorders in the prediction of STB (Supplementary Table 3). These exploratory analyses revealed a sub-additive interaction between NSSI and Major Depressive Disorder in the prediction of suicide ideation (β = -0.47, SE = 0.17, p = .007) and suicide plan (β = -0.53, SE = 0.22, p = .015). As can be seen in Fig. 1, respondents with both NSSI and Major Depressive Disorder have a substantially greater likelihood of a subsequent onset of suicide ideation (Fig. 1a) and suicide plan (Fig. 1b) than those with either NSSI or Major Depressive Disorder alone. However, the combined effect of NSSI and Major Depressive Disorder in an interactive model (solid black line) is less than the individual effects together in an additive model (dotted gray line).

3.3. NSSI characteristics and subsequent suicidal thoughts and behavior trajectories

Among respondents with a lifetime history of NSSI, 44.4% (SE = 1.3) reported no history of STB. Table 5 summarizes the multivariate associations between NSSI characteristics and subsequent STB trajectories within the subset of respondents who self-injure. Using NSSI to obtain automatic positive reinforcement was significantly associated with greater odds of having experienced each of the STB trajectories (ORs in the 1.5–1.7 range). Conversely, a later age of onset of NSSI was consistently significantly associated with lower odds of subsequent STB (all ORs = 0.9). Results also revealed some divergent associations across STB trajectories. Using a greater variety of NSSI methods was significantly associated with a subsequent STB trajectory characterized by the development of suicide ideation, or the transition to a suicide plan, but not attempt. Respondents who transitioned to a suicide plan and attempt after NSSI reported more frequent NSSI and were significantly more likely to report a history of cutting than those without subsequent STB. Finally, respondents who required medical treatment for NSSI were more likely to have experienced only suicide ideation as well as transitions to attempts.

4. Discussion

Despite mounting evidence that links NSSI to increased risk of attempted suicide (Franklin et al., 2017; Ribeiro et al., 2016), important questions remain regarding the effects of comorbid mental disorders, the extent to which NSSI plays a role in the transition from suicide ideation to attempt, and the identification of those at risk for subsequent STB. In the present study, we aimed to address these questions within a large sample of college students.

As expected, people who reported NSSI were at increased odds of a subsequent suicide attempt. Importantly, this remained the case in a multivariate time-ordered framework that accounted for the distribution of common mental disorders. These findings extend previous work (Klonsky et al., 2013), and suggest that NSSI increases risk of a suicide attempt beyond the effects of mental disorders. Consistent with this, NSSI also conferred risk for a suicide attempt among respondents without a history of mental disorders; suggesting that NSSI is more than a severity marker of mental disorders in the prediction of attempted sui-

Table 4
Multivariate survival models predicting the onset of suicidal thoughts and behaviors.

	In the total sample			Among respondents with suicide ideation		Among respondents with a suicide plan
	Suicide ideation OR (95% CI)	Suicide plan OR (95% CI)	Suicide attempt OR (95% CI)	Suicide plan OR (95% CI)	Suicide attempt OR (95% CI)	Suicide attempt OR (95% CI)
NSSI thoughts	3.5***(2.6–4.8)	3.0***(1.9–4.5)	1.6 (0.6–4.9)	1.3 (0.8–1.9)	0.8 (0.3–2.3)	0.7 (0.2–2.1)
NSSI	2.8***(2.4–3.2)	3.0***(2.4–3.7)	5.5***(3.6–8.6)	1.7***(1.4–2.0)	2.9***(2.0–4.3)	2.1***(1.4–3.2)
Mental Disorders:						
Major Depressive Disorder	4.4***(3.7–5.2)	4.8***(3.8–6.0)	4.9***(3.3–7.2)	1.9***(1.5–2.3)	2.3***(1.6–3.2)	1.7**(1.2–2.5)
Broad mania	1.8**(1.1–2.7)	1.8**(1.1–2.7)	2.0**(1.2–3.2)	1.4 (0.9–2.0)	1.7*(1.1–2.6)	1.5 (0.9–2.4)
Generalized Anxiety Disorder	1.4**(1.1–1.7)	1.3 (1.0–1.7)	0.9 (0.6–1.3)	1.0 (0.8–1.3)	0.8 (0.6–1.1)	0.8 (0.5–1.1)
Panic Disorder	1.0 (0.7–1.5)	1.0 (0.7–1.5)	1.3 (0.8–2.1)	1.1 (0.7–1.5)	1.3 (0.8–2.2)	1.4 (0.9–2.3)
Risk for Alcohol Dependence	0.6 (0.4–1.1)	0.6 (0.3–1.2)	1.7 (0.9–3.4)	0.6 (0.3–1.0)	1.7 (0.9–3.2)	1.6 (0.9–3.1)
n(person-years)	92,646	97,492	100,600	21,435	24,526	11,274

Note: Each column represents a separate multivariate model in a survival framework, with all variables in the rows as predictors and suicide ideation, suicide plan, or suicide attempt in the columns, as dependent variables, including the following covariates: age, gender, and university. NSSI = Non-Suicidal Self-Injury, OR = Odds Ratio, CI = Confidence Interval.
* p< .05, ** p< .01, *** p< .001, two-sided tested.

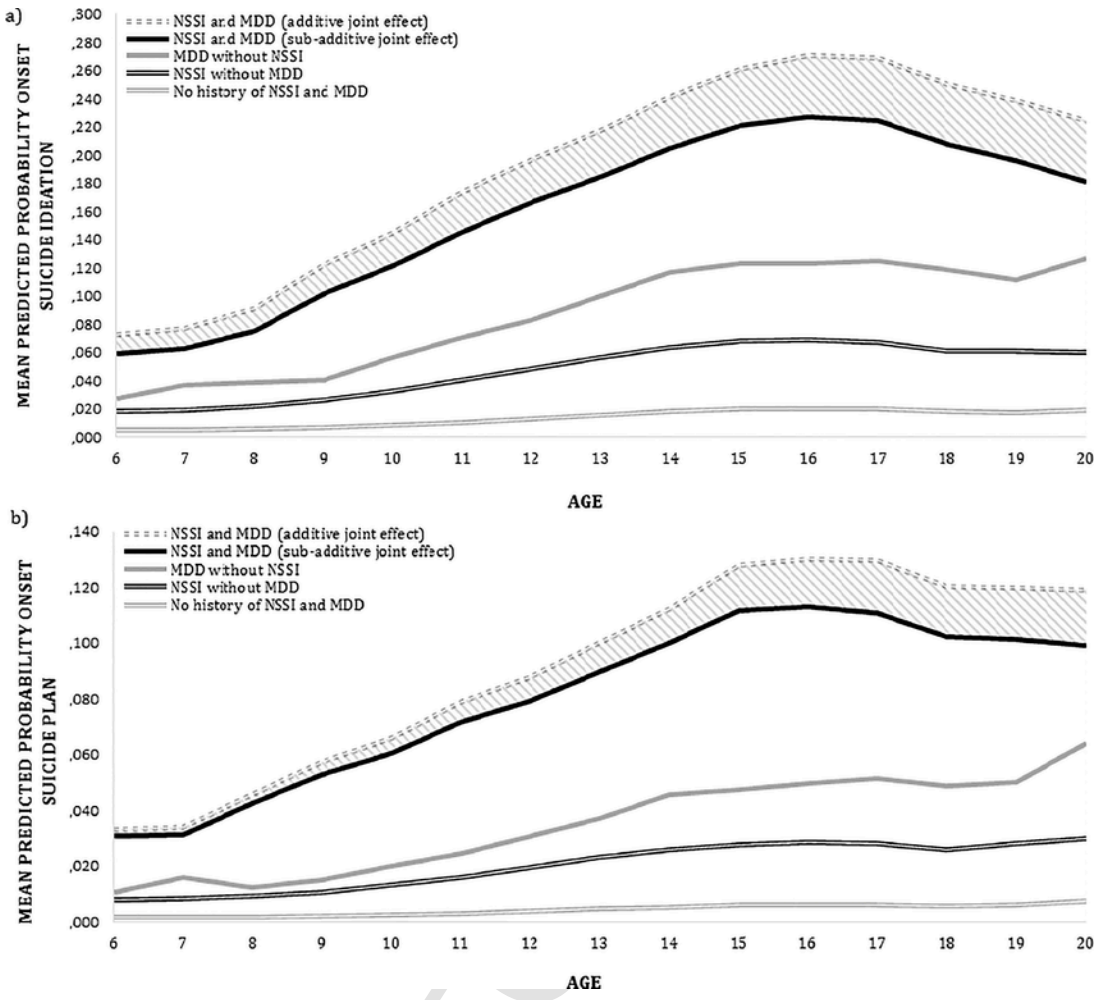

Fig. 1. Mean Predicted probability curves for an onset of suicide ideation (a) and suicide plan (b)[aa] The marked area indicates the difference of the joint effect of NSSI and Major Depressive Disorder in the prediction of onset suicide ideation and plan between an additive and interactive model (i.e., sub-additive interaction). The onset curves for the main effects and group without major depressive disorder and NSSI are drawn from the multivariate interactive models.

cide. In line with emerging evidence (Chu et al., 2017b; Guan et al., 2012; Hamza and Willoughby, 2016; Mortier et al., 2017), we found that this association may not be specific to suicide attempt alone. Indeed, NSSI also conferred risk for an onset of suicide ideation and suicide plan. We observed sub-additive interactive effects of NSSI and Major Depressive Disorder in the prediction of suicide ideation and suicide plan. Specifically, although young people who reported depression were more likely to subsequently develop suicidal thoughts and plans when they also self-injured, we observed that the combined effect conferred less than additive risk. One potential explanation may be that NSSI and Major Depressive Disorder confer risk for suicidal desires though partially similar pathways (e.g., affect-dysregulation, rumination; Hofmann et al., 2012; Law et al., 2015; Miranda and Nolen-Hoeksema, 2007; Selby et al., 2016). Evaluating this hypothesis represents an important avenue for future experience sampling studies.

To rule out the possibility that the temporal-order association between NSSI and suicide attempt is merely an artifact of an association between NSSI and suicide ideation (Klonsky et al., 2014), we evaluated whether NSSI increases risk of transitioning from suicide ideation to attempt. Consistent with one recent study (Nock et al., 2018), people who reported suicide ideation or a suicide plan were at higher risk of a subsequent suicide attempt when they had previously engaged in NSSI. Although our data cannot speak about mechanisms underlying these associations, these findings are in line with the Interpersonal Theory of Suicide (Joiner, 2005; Van Orden et al., 2010), and emerging evidence (Chu et al., 2017a; Willoughby et al., 2015), that repeated tissue damage might contribute to an acquired capability for suicide. Consequently, we suggest clinicians be mindful that NSSI increases, rather than decreases, the risk of acting on suicidal urges, even though clients might report engaging in NSSI to avert suicide (Brausch and Muehlenkamp, 2018; Paul et al., 2015; Victor et al., 2015). Taken together, the current findings support the view that NSSI might be a particularly salient factor in the prevention of suicide (Klonsky et al., 2013; Klonsky et al., 2014).

Building upon previous findings (Bryan et al., 2015; Glenn et al., 2017), we evaluated whether NSSI thoughts, as separate from NSSI behavior, are associated with increased risk of STB. Although NSSI thoughts did not determine who, among those with suicide ideation or a plan, subsequently attempted suicide, we found evidence that beyond the effects of NSSI behavior and comorbid mental disorders, NSSI thoughts increase risk of subsequent suicide ideation and a suicide plan. These findings add to the literature that NSSI thoughts alone may be insufficient to increase one's capacity to attempt suicide. However, assessment of NSSI thoughts, even if there is no history of NSSI, may provide a brief window of opportunity - on average one year between onset of NSSI thoughts and suicide ideation - to intervene and mitigate risk of developing suicidal thoughts.

Table 5
Multivariate logistic regressions predicting subsequent onsets of suicidal thought and behaviors among respondents with lifetime NSSI.

	Trajectory1: Suicide ideation only after NSSI	Trajectory2: Suicide ideation and plan after NSSI	Trajectory3: Suicide ideation, plan, and attempt after NSSI
	OR[a] (95% CI)	OR[a] (95% CI)	OR[a] (95% CI)
NSSI frequency:			
1–5 acts	Reference	Reference	Reference
6–20	1.1 (0.7–1.7)	1.7*(1.0–2.8)	1.7 (0.6–4.6)
21–50	1.5 (0.8–2.9)	2.4*(1.2–4.9)	4.1*(1.3–13.1)
51 +	0.9 (0.5–1.9)	2.6**(1.3–5.0)	4.3*(1.3–13.7)
χ^2 (*p*-value)[b]	0.0 (.884)	9.0 (.003)	7.5 (.006)
Number of methods:	1.2**(1.1–1.4)	1.2** (1.1-1.4)	1.2 (1.0–1.5)
Functions:			
Automatic negative reinforcement	1.1 (1.0–1.3)	1.2*(1.0–1.4)	1.2 (0.9–1.6)
Automatic positive reinforcement	1.5***(1.3–1.7)	1.6***(1.3–1.9)	1.7***(1.3–2.2)
Social negative reinforcement	1.1 (0.9–1.3)	1.0 (0.8–1.3)	1.4 (0.9–2.0)
Social positive reinforcement	0.9 (0.8–1.1)	1.0 (0.8–1.2)	0.8 (0.6–1.1)
Required medical treatment for NSSI (yes vs. no)	2.7*(1.1–6.4)	0.7 (0.3–2.0)	8.2***(2.9–23.5)
10% increase in subjective pain during NSSI	1.0*(1.0–1.2)	1.1 (1.0–1.2)	1.1 (1.0–1.3)
Age of onset NSSI	0.9***(0.9–0.9)	0.9**(0.9–1.0)	0.9*(0.8–1.0)
History of cutting skin (yes vs. no)	1.1 (0.7–1.8)	3.2***(1.9–5.3)	5.2***(2.0–13.9)
$R^2_{(Nagelkerke)}$	.25	.45	.70
n(w)	174	181	86

Note: [a] Relative to respondents with NSSI but no subsequent suicidal thoughts and behaviors [w(n) = 637], [b] Linear trend test. Each binary logistic regression controlled for the effects of gender, age and university. OR = Odds Ratio, CI = Confidence Interval. NSSI = Non-Suicidal Self-Injury. * p< .05, ** p< .01, *** p< .001, two-sided tested.

Previous research has shown that several NSSI characteristics (e.g., higher frequency and number of methods) are associated with the co-occurrence of STB (Ammerman et al, 2016; Paul et al., 2015; Stewart et al., 2017; Victor and Klonsky, 2014). However, more research is needed to illuminate which NSSI characteristics may be most important to consider for clinicians (Burke et al., 2018). Extending this work, we examined the extent to which particular NSSI characteristics were associated with three meaningful trajectories of STB after NSSI when controlling other aspects of NSSI [(1) onset of suicide ideation only, (2) onset of suicide ideation and suicide plan, and (3) onset of suicide ideation, suicide plan, and suicide attempt]. Our findings show that individuals who use NSSI to "feel something" were at elevated odds of experiencing each STB trajectory. This is consistent with a growing body of research documenting that positive automatic reinforcement is related to more severe and persistent NSSI (Kiekens et al., 2017; Paul, et al., 2015; Selby et al., 2014). Also in line with prior research, individuals who reported more frequent NSSI (Paul et al., 2015; Victor and Klonsky, 2014) or needed medical treatment for NSSI (Burke et al., 2018) were more likely to have subsequently attempted suicide. However, in contrast with prior findings (Stewart et al., 2017; Victor and Klonsky, 2014), this was not necessarily the case for those who engaged in a greater variety of NSSI methods. Although these individuals were found at heightened risk of developing suicidal ideation, a specific history of cutting was more salient in identifying those who transitioned to a suicide plan or attempt. Finally, we observed that those with a later onset of NSSI were less likely to develop STB. This is consistent with recent research showing that an earlier onset is related to more severe NSSI (Ammerman et al., 2017), and suggests that risk for subsequent STB might be reduced by an intervention that delays the onset of NSSI. Consistent with the Interpersonal Theory of Suicide (Joiner, 2005; Van Orden et al., 2010), these findings indicate that people who engage in repetitive and severe self-injury are more likely to subsequently attempt suicide.

4.1. Limitations and further research directions

Our findings should be interpreted in the context of the following limitations. First and foremost, although using discrete-time survival models allowed us to test theory-driven hypotheses between NSSI and STB within a time-ordered framework, it should be noted that this was based on retrospective age of onset reports which may be subject to biased recall. However, it is important to keep in mind that we adopted a conservative approach by coding time-varying predictors as 0 when onsets were reported in the same year. Second, whether NSSI thoughts and NSSI simply precede (i.e., risk factor) or cause STB (i.e., causal risk factor) cannot be resolved with our current approach (Kraemer et al., 1997). Prospective, process-oriented research - guided by contemporary theories of suicide (Joiner, 2005; Van Orden et al., 2010) - is needed to shed light on potential mechanisms underlying these associations. Similarly, although our findings show that assessing characteristics of NSSI might be useful in identifying which individuals who engage in NSSI are at risk for subsequent STB, it is important to note that several characteristics, such as NSSI frequency, were not time stamped, and thus could have changed since the onset of STB. Future studies should examine the predictive utility of these characteristics in models that also account for other clinical risk factors (e.g., history of abuse) of STB. Third, given that for a significant proportion of participants both NSSI and STB had their onset in the same year, experience sampling studies may provide a unique opportunity to study these relationships with greater temporal specificity (Nock et al., 2009). Relatedly, although the current data show that NSSI more often precedes than follows STB (especially suicide attempt), STB outcomes, might also predict a subsequent onset of NSSI for some individuals. Future research needs to evaluate this and examine pathways through which suicidal individuals may be at increased risk of subsequent NSSI.

Fourth, the response rate was relatively low, yielding the possibility for non-response bias. R-indicators suggested a high sociodemographic representativeness of the respondent data and all analyses were non-response propensity weighted; however, this limitation remains a concern. Fifth, we used screeners rather than full diagnostic interviews to assess mental disorders. Although these screeners have shown high concordance in general population surveys with blinded clinical diagnoses in clinical reappraisal studies (Kessler et al., 2013a, b), they are not a substitute for in-depth clinical interviews. Further, some comorbid mental disorders (e.g., eating disorders, borderline personality disorder, and post-traumatic stress disorder) were not controlled in the current analyses, and thus warrant additional research. Finally, our findings are based on data from college students; replicating the cur-

rent findings in other populations represents an important goal for future research.

Despite these limitations, the current findings suggest that NSSI may be a particularly important risk factor to consider in terms of (subsequent) suicide risk. Prioritizing the identification of young people who self-injure, and providing them with timely and effective interventions, might be one fruitful strategy to offset future suicidal thoughts and plans, as well as subsequent suicide attempts.

Authors' contributions

Kiekens, G: study design, data-collection, data-analysis, interpretation of results, writing initial drafts of the manuscript and critical revision for important intellectual content.

Hasking P: study design, data-collection, interpretation of results, and critical revision for important intellectual content

Boyes, M: study design, data-collection, interpretation of results critical revision for important intellectual content

Claes, L: interpretation of results and critical revision for important intellectual content

Mortier, P: data-analysis and critical revision for important intellectual content

Auerbach, R. P: study design and critical revision for important intellectual content

Cuijpers, P: critical revision for important intellectual content

Demyttenaere, K: critical revision for important intellectual content

Green J. G: critical revision for important intellectual content

Kessler, R. C: study design and critical revision for important intellectual content

Myin-Germeys, I: critical revision for important intellectual content

Nock M. K: study design, interpretation of the results and critical revision for important intellectual content

Bruffaerts, R: study design, interpretation of results and critical revision for important intellectual content

Role of the sponsor

The funding sources had no role in the design and conduct of the study; collection, management, analysis, interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Conflict of interest

In the past 3 years, Dr. Kessler received support for his epidemiological studies from Sanofi Aventis, he was a consultant for Johnson & Johnson Wellness and Prevention, Shire and Takeda, and served on an advisory board for the Johnson & Johnson Services Inc. Lake Nona Life Project. Dr. Kessler is a co-owner of DataStat, Inc., a market research firm that carries out healthcare research. The other authors report no biomedical financial interests or potential conflicts of interest.

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Supplementary materials

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References

Ammerman, B.A., Burke, T.A., Alloy, L.B., McCloskey, M.S., 2016. Subjective pain during NSSI as an active agent in suicide risk. Psychiatry Res. 236, 80–85. https://doi.org/10.1016/j.psychres.2015.12.028.

Ammerman, B.A., Jacobucci, R., Kleiman, E.M., Uyeji, LL., McCloskey, M.S., 2017. The relationship between nonsuicidal self-Injury age of onset and severity of self-harm. Suicide. Life. Threat. Behav. https://doi.org/10.1111/sltb.12330.

Benjet, C., González-Herrera, I., Castro-Silva, E., Méndez, E., Borges, G., Casanova, L., Medina-Mora, M.E., 2017. Non-suicidal self-injury in Mexican young adults: Prevalence, associations with suicidal behavior and psychiatric disorders, and DSM-5 proposed diagnostic criteria. J. Affect. Disor. 215, 1–8. https://doi.org/10.1016/j.jad.2017.03.025.

Bentley, K.H., Cassiello-Robbins, C.F., Vittorio, L., Sauer-Zavala, S., Barlow, D.H., 2015. The association between nonsuicidal self-injury and the emotional disorders: A meta-analytic review. Clin. Psychol. Rev. 37, 72–88. https://doi.org/10.1016/j.cpr.2015.02.006.

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. https://doi.org/10.1177/2167702613514563.

Brausch, A.M., Muehlenkamp, J.J., 2018. Perceived effectiveness of NSSI in achieving functions on severity and suicide risk. Psychiatry. Res. 265, 144–150. https://doi.org/10.1016/j.psychres.2018.04.038.

Bryan, C.J., Bryan, A.O., May, A.M., Klonsky, E.D., 2015. Trajectories of suicide ideation, nonsuicidal self-injury, and suicide attempts in a nonclinical sample of military personnel and veterans. Suicide Life Threat Behav. 45, 315–325. https://doi.org/10.1111/sltb.12127.

Burke, T.A., Jacobucci, R., Ammerman, B.A., Piccirillo, M., McCloskey, M.S., Heimberg, R.G., Alloy, L.B., 2018. Identifying the relative importance of non-suicidal self-injury features in classifying suicidal ideation, plans, and behavior using exploratory data mining. Psychiatry. Res. 262, 175–183. https://doi.org/10.1016/j.psychres.2018.01.045.

Chu, C., Buchman-Schmitt, J.M., Stanley, I.H., Hom, M.A., Tucker, R.P., Hagan, C.R., Rogers, M.L., Podlogar, M.C., Chiurliza, B., Ringer, F.B., Michaels, M.S., Patros, C.H.G., Joiner, T.E., 2017. The interpersonal theory of suicide: a systematic review and meta-analysis of a decade of cross-national research. Psychol. Bull. 143, 1313–1345. https://doi.org/10.1037/bul0000123.

Chu, C., Hom, M.A., Stanley, I.H., Gai, A.R., Nock, M.K., Gutierrez, P.M., Joiner, T.E., 2017. Non-suicidal self-injury and suicidal thoughts and behaviors: a study of the explanatory roles of the interpersonal theory variables among military service members and veterans. J. Consult. Clin. Psychol.https://doi.org/10.1037/ccp0000262.

DeMartini, K.S., Carey, K.B., 2012. Optimizing the use of the AUDIT for alcohol screening in college students. Psychol Assess. 24, 954–963. https://doi.org/10.1037/a0028519.

Edmondson, A.J., Brennan, C.A., House, A.O., 2016. Non-suicidal reasons for self-harm: a systematic review of self-reported accounts. J. Affect Disor. 191, 109–117. https://doi.org/10.1016/j.jad.2015.11.043.

Efron, B., 1988. Logistic regression, survival analysis, and the Kaplan-Meier curve. J. Am. Stat. Assoc. 83, 414–425.

Franklin, J.C., Ribeiro, J.D., Fox, K.R., Bentley, K.H., Kleiman, E.M., Huang, X., Musacchio, K.M., Jaroszewski, A.C., Chang, B.P., Nock, M.K., 2017. Risk factors for suicidal thoughts and behaviors: a meta-analysis of 50 years of research. Psychol. Bull. 143, 187–232. https://doi.org/10.1037/bul0000084.

Gandhi, A., Luyckx, K., Baetens, I., Kiekens, G., Sleuwaegen, E., Berens, A., Maitra, S., Claes, L., 2018. Age of onset of non-suicidal self-injury in Dutch-speaking adolescents and emerging adults: an event history analysis of pooled data. Compr. Psychiatry. 80, 170–178. https://doi.org/10.1016/j.comppsych.2017.10.007.

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. https://doi.org/10.1037/a0038652.

Glenn, C.R., Lanzillo, E.C., Esposito, E.C., Santee, A.C., Nock, M.K., Auerbach, R.P., 2017. Examining the course of suicidal and nonsuicidal self-injurious thoughts and behaviors in outpatient and inpatient adolescents. J. Abnorm. Psychol. 45, 971–983. https://doi.org/10.1007/s10802-016-0214-0.

Grandclerc, S., De Labrouhe, D., Spodenkiewicz, M., Lachal, J., Moro, M.R., 2016. 016. Relations between nonsuicidal self-injury and suicidal behavior in adolescence: A systematic review. PloS One 11, e0153760https://doi.org/10.1371/journal.pone.0153760.

Green, J.G., McLaughlin, K.A., Berglund, P.A., Gruber, M.J., Sampson, N.A., Zaslavsky, A.M., Kessler, R.C., 2010. Childhood adversities and adult psychiatric disorders in the national comorbidity survey replication I: associations with first onset of DSM-IV disorders. Arch. Gen. Psychiatry 67, 113–123. https://doi.org/10.1001/archgenpsychiatry.2009.186.

Guan, K., Fox, K.R., Prinstein, M.J., 2012. Nonsuicidal self-injury as a time-invariant predictor of adolescent suicide ideation and attempts in a diverse community sample. J. Consult. Clin Psychol. 80, 842–849. https://doi.org/10.1037/a0029429.

Hamza, C.A., Willoughby, T., 2016. Nonsuicidal self-injury and suicidal risk among emerging adults. J. Adolesc. Health. 59, 411–415. https://doi.org/10.1016/j.jadohealth.2016.05.019.

Hamza, C.A., Stewart, S.L., Willoughby, T., 2012. Examining the link between nonsuicidal self-injury and suicidal behavior: a review of the literature and an integrated model. Clin. Psychol. Rev. 32, 482–495. https://doi.org/10.1016/j.cpr.2012.05.003.

Hasking, P., Andrews, T., Martin, G., 2013. The role of exposure to self-injury among peers in predicting later self-injury. J. Youth. Adolesc. 42, 1543–1556. https://doi.org/10.1007/s10964-013-9931-7.

Hofmann, S.G., Sawyer, A.T., Fang, A., Asnaani, A., 2012. Emotion dysregulation model of mood and anxiety disorders. Depress. Anxiety. 29, 409–416. https://doi.org/10.1002/da.21888.

Joiner, T., 2005. Why People Die by Suicide. Harvard University Press, Cambridge.

Kessler, R.C., Calabrese, J.R., Farley, P.A., Gruber, M.J., Jewell, M.A., Katon, W., Wittchen, H.U., 2013. Composite International diagnostic interview screening scales for DSM-IV anxiety and mood disorders. Psychol. Med. 43, 1625–1637. https://doi.org/10.1017/S0033291712002334.

Kessler, R.C., Santiago, P.N., Colpe, L.J., Dempsey, C.L., First, M.B., Heeringa, S.G., Ursano, R.J., 2013. Clinical reappraisal of the Composite International Diagnostic Interview Screening Scales (CIDI-SC) in the army study to assess risk and resilience in Servicemembers (Army STARRS). Int. J Methods Psychiatr. Res. 22, 303–321. https://doi.org/10.1002/mpr.1398.

Kessler, R.C., Üstün, TB., 2004. The world mental health (WMH) survey initiative version of the world health organization (WHO) composite international diagnostic interview (CIDI). Int. J Methods Psychiatr. Res. 13, 93–118.

Kiekens, G., Hasking, P., Claes, L., Mortier, P., Auerbach, R.P., Boyes, M., Cuijpers, P., Demyttenaere, K., Green, J.G., Kessler, R.C., Nock, M.K., Bruffaerts, R., 2018. 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. https://doi.org/10.1002/da.22754.

Kiekens, G., Hasking, P., Bruffaerts, R., Claes, L., Baetens, I., Boyes, M., Mortier, P., Demyttenaere, K., Whitlock, J., 2017. What predicts ongoing nonsuicidal self-injury? A comparison between persistent and ceased self-injury in emerging adults. J. Nerv. Ment. Dis. 205, 762–770. https://doi.org/10.1097/NMD.0000000000000726.

Klonsky, E.D., May, A.M., Glenn, C.R., 2013. The relationship between nonsuicidal self-injury and attempted suicide: converging evidence from four samples. J. Abnorm. Psychol. 122, 231–237.

Klonsky, E.D., May, A.M., Glenn, C.R., 2014. Differentiating suicide attempters from suicide ideators: a critical frontier for suicidology research. Suicide. Life. Threat. Behav. 44, 1–5. https://doi.org/10.1111/sltb.12068.

Kraemer, H.C., Kazdin, A.E., Offord, D.R., Kessler, R.C., Jensen, P.S., Kupfer, D.J., 1997. Coming to terms with the terms of risk. Arch. Gen. Psychiatry 54, 337–343.

Latimer, S., Meade, T., Tennant, A., 2013. Measuring engagement in deliberate self-harm behaviours: psychometric evaluation of six scales. BMC. Psychiatry. 13, 4. https://doi.org/10.1186/1471-244X-13-4.

Law, K.C., Khazem, L.R., Anestis, M.D., 2015. The role of emotion dysregulation in suicide as considered through the ideation to action framework. Curr. Opin. Psychol. 3, 30–35. https://doi.org/10.1016/j.copsyc.2015.01.014, 2015.

Lee, S., 2006. Propensity score adjustment as a weighting scheme for volunteer panel web surveys. J. Off. Stat. 22, 329–349.

Miranda, R., Nolen-Hoeksema, S., 2007. Brooding and reflection: Rumination predicts suicidal ideation at 1-year follow-up in a community sample. Behav. Res. Ther. 45, 3088–3095. https://doi.org/10.1016/j.brat.2007.07.015.

Mortier, P., Auerbach, R.P., Alonso, J., Bantjes, J., Benjet, C., Cuijpers, P., Ebert, D.D., Green, J.G., Hasking, P., Nock, M.K., O'Neill, S., Pinder-Amaker, S., Sampson, N.A., Vilagut, G., Zaslavsky, A.M., Bruffaerts, R., Kessler, R.C., WHO WMH-ICS Collaborators, 2018. Suicidal Thoughts and Behaviors Among First-Year College Students: Results From the WMH-ICS Project. J. Am. Acad. Child. Adolesc. Psychiatry. 57, 263–273. https://doi.org/10.1016/J.JAAC.2018.01.018.

Mortier, P., Demyttenaere, K., Auerbach, R.P., Cuijpers, P., Green, J.G., Kiekens, G., Kessler, R.C., Nock, M.K., Zaslaysky, A.M., Bruffaerts, R., 2017. First onset of suicidal thoughts and behaviours in college. J. Affect. Disor. 207, 291–299. https://doi.org/10.1016/j.jad.2016.09.033.

Muehlenkamp, J.J., 2014. Distinguishing between suicidal and nonsuicidal self-injury (Ed). Nock, M.K. (Ed.), The Oxford Handbook of Suicide and Self-Injury. Oxford University Press, New York, pp. 23–46.

Muehlenkamp, J.J., Gutierrez, PM., 2007. Risk for suicide attempts among adolescents who engage in non-suicidal self-injury. Arch. Suicide. Res. 11, 69–82. https://doi.org/10.1080/13811110600992902.

Nock, M.K., Green, J.G., Hwang, I., McLaughlin, K.A., Sampson, N.A., Zaslavsky, A.M., Kessler, R.C., 2013. Prevalence, correlates, and treatment of lifetime suicidal behavior among adolescents: results from the National Comorbidity Survey Replication Adolescent Supplement. JAMA Psychiatry 70, 300–310. https://doi.org/10.1001/2013.jamapsychiatry.55.

Nock, M.K., Favazza, A.R., 2009. Nonsuicidal self-injury: Definition and classification (Ed). Nock, M.K. (Ed.), Understanding Nonsuicidal Self-Injury: Origins, Assessment, and Treatment. American Psychological Association, Washington, pp. 9–18.

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. https://doi.org/10.1037/1040-3590.19.3.309.

Nock, M.K., Joiner, T.E., Gordon, K.H., Lloyd-Richardson, E., Prinstein, M.J., 2006. Non-suicidal self-injury among adolescents: diagnostic correlates and relation to suicide attempts. Psychiatry Res 144, 65–72. https://doi.org/10.1016/j.psychres.2006.05.010.

Nock, M.K., Millner, A.J., Joiner, T.E., Gutierrez, P.M., Han, G., Hwang, I., King, A., Naifeh, J.A., Sampson, N.A., Zaslavsky, A.M., Stein, M.B., Ursano, R.J., Kessler, R.C., the STARRS-LS collaborators., 2018. Risk factors for the transition from suicide ideation to suicide attempt: Results from the Army Study to assess risk and resilience in servicemembers (Army STARSS). J. Abnorm. Psychol. 127, 139–149. https://doi.org/10.1037/abn0000317.

Nock, M.K., Prinstein, M.J., Sterba, S.K., 2009. Revealing the form and function of self-injurious thoughts and behaviors: a real-time ecological assessment study among adolescents and young adults. J. Abnorm. Psychol. 118, 816–827. https://doi.org/10.1037/a0016948.

Paul, E., Tsypes, A., Eidlitz, L., Ernhout, C., Whitlock, J., 2015. Frequency and functions of non-suicidal self-injury: associations with suicidal thoughts and behaviors. Psychiatry Res. 225, 276–282. https://doi.org/10.1016/j.psychres.2014.12.026.

Plener, P.L., Schumacher, T.S., Munz, L.M., Groschwitz, R.C., 2015. The longitudinal course of non-suicidal self-injury and deliberate self-harm: a systematic review of the literature. Bord. Person. Dis. Emo. Dysreg. 30, 2. https://doi.org/10.1186/s40479-014-0024-3.

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. https://doi.org/10.1017/S0033291715001804.

Saunders, J.B., Aasland, O.G., Babor, T.F., de la Fuente, J.R., Grant, M., 1993. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption–II. Addiction 88, 791–804.

Schouten, B., Cobben, F., Bethlehem, J., 2009. Indicators for the representativeness of survey response. Surv Methodol. 35, 101–113.

Selby, E.A., Kranzler, A., Fehling, K.B., Panza, E., 2015. Nonsuicidal self-injury disorder: The path to diagnostic validity and final obstacles. Clin Psychol Rev 38, 79–91. https://doi.org/10.1016/j.cpr.2015.03.003.

Selby, E.A., Kranzler, A., Panza, E., Fehling, K.B., 2016. Bidirectional-compounding effects of rumination and negative emotion in predicting impulsive behavior: implications for emotional cascades. J. Pers. 84, 139–153. https://doi.org/10.1111/jopy.12147.

Selby, E.A., Nock, M.K., Kranzler, A., 2014. How does self-injury feel? Examining automatic positive reinforcement in adolescent self-injurers with experience sampling. Psychiatry Res. 215, 417–423. https://doi.org/10.1016/j.psychres.2013.12.005.

Stewart, J.G., Esposito, E.C., Glenn, C.R., Gilman, S.E., Pridgen, B., Gold, J., Auerbach, R.P., 2017. Adolescent self-injurers: comparing non-ideators, suicide ideators, and suicide attempters. J. Psychiatr. Res. 84, 105–112. https://doi.org/10.1016/j.jpsychires.2016.09.031.

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. https://doi.org/10.1111/sltb.12070.

Taliaferro, L.A., Muehlenkamp, J.J., 2015. Risk factors associated with self-injurious behavior among a national sample of undergraduate college students. J. Am. Coll. Health. 63, 40–44. https://doi.org/10.1080/07448481.2014.953166.

Taylor, P.J., Jomar, K., Dhingra, K., Forrester, R., Shahmalak, U., Dickson, J.M., 2017. A meta-analysis of the prevalence of different functions of non-suicidal self-injury. J. Affect. Disor. https://doi.org/10.1016/j.jad.2017.11.073.

The WHO World Mental Health Surveys International College Student Project (WMH-ICS), n. d. https://www.hcp.med.harvard.edu/wmh/college_student_survey.php

Van Orden, K.A., Witte, T.K., Cukrowicz, K.C., Braithwaite, S.R., Selby, E.A., Joiner, T.E., 2010. The interpersonal theory of suicide. Psychol. Rev. 117, 575–600. https://doi.org/10.1037/a0018697.

Victor, S.E., Klonsky, E.D., 2014. Correlates of suicide attempts among self-injurers: a meta-analysis. Clin. Psychol. Rev. 34, 282–297. https://doi.org/10.1016/j.cpr.2014.03.005.

Victor, S.E., Styer, D., Washburn, J.J., 2015. Characteristics of nonsuicidal self-injury associated with suicidal ideation: evidence from a clinical sample of youth. Child. Adolesc. Psychiatry. Ment. Health. 9, 20. https://doi.org/10.1186/s13034-015-0053-8.

Walsh, B.W., 2012. Treating Self-Injury: A Practical Guide. Guilford Press, New York.

Whitlock, J., Muehlenkamp, J.J., Eckenrode, J., Purington, A., Abrams, G.B., Barreira, P., Kress, V., 2013. Nonsuicidal self-injury as a gateway to suicide in young adults. J. Am. Coll. Health. Assoc. 52, 486–492. https://doi.org/10.1016/j.jadohealth.2012.09.010.

Willoughby, T., Heffer, T., Hamza, C.A., 2015. The link between nonsuicidal self-injury and acquired capability for suicide: a longitudinal study. J. Abnorm. Psychol. 124, 1110–1115. https://doi.org/10.1037/abn0000104.

Wolter, K.M, 1985. Introduction to Variance Estimation. Springer-Verlag, New York.