



Identifying the relative importance of non-suicidal self-injury features in classifying suicidal ideation, plans, and behavior using exploratory data mining



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ARTICLE INFO

Keywords:

Non-suicidal self-injury
Suicidal ideation
Suicide plan
Suicide attempt
Exploratory data mining
Elastic net regression
Decision trees

ABSTRACT

Individuals with a history of non-suicidal self-injury (NSSI) are at alarmingly high risk for suicidal ideation (SI), planning (SP), and attempts (SA). Given these findings, research has begun to evaluate the features of this multifaceted behavior that may be most important to assess when quantifying risk for SI, SP, and SA. However, no studies have examined the wide range of NSSI characteristics *simultaneously* when determining which NSSI features are most salient to suicide risk. The current study utilized three exploratory data mining techniques (elastic net regression, decision trees, random forests) to address these gaps in the literature. Undergraduates with a history of NSSI ($N = 359$) were administered measures assessing demographic variables, depression, and 58 NSSI characteristics (e.g., methods, frequency, functions, locations, scarring) as well as current SI, current SP, and SA history. Results suggested that depressive symptoms and the anti-suicide function of NSSI were the most important features for predicting SI and SP. The most important features in predicting SA were the anti-suicide function of NSSI, NSSI-related medical treatment, and NSSI scarring. Overall, results suggest that NSSI functions, scarring, and medical lethality may be more important to assess than commonly regarded NSSI severity indices when ascertaining suicide risk.

1. Introduction

Suicide is a major public health problem, ranking as the second leading cause of death among adolescents and adults ages 15–24 (Centers for Disease Control, 2014). Although a large body of research has identified numerous risk factors for suicidal behavior, a recent meta-analysis suggests that these risk factors are weak predictors of suicidal thoughts and behaviors, resulting in a relatively poor ability to predict its occurrence (Franklin et al., 2017). In turn, rates of suicide have continued to increase (Curtin et al., 2016). However, exploratory data mining (EDM) techniques recently have allowed researchers to examine risk factors simultaneously in multivariate predictive models that can meaningfully augment the prediction of suicidal behavior (e.g., Kessler et al., 2017; Kessler et al., 2015; Walsh et al., 2017). Indeed, such procedures have recently significantly improved accuracy (e.g., AUC = 0.84; Walsh et al., 2017) in predicting suicidal behavior and have resulted in substantially larger effect sizes than studies of singular risk factors (Franklin et al., 2017).

One population exhibiting elevated suicide risk that may particularly benefit from the application of these novel techniques comprises individuals who engage in non-suicidal self-injury (NSSI). NSSI is the direct, deliberate destruction of one's body tissue performed without suicidal intent (Nock, 2009). The behavior is often carried out based on its interpersonal (e.g., interpersonal influence) and/or intrapersonal (e.g., affect regulation) functions (Nock et al., 2006). Although without suicidal intent, engagement in NSSI significantly increases one's risk for subsequent engagement in suicidal behaviors (Hamza et al., 2012; Klonsky et al., 2013). Indeed, among individuals with a history of NSSI, a staggering percentage also has engaged in suicidal behavior (up to 70%; Brausch and Gutierrez, 2010; Cheung et al., 2013; Nock et al., 2006; Paul et al., 2015). Despite the clear high-risk nature of this population, EDM techniques have yet to be employed to improve suicide risk prediction among individuals with a history of NSSI.

A recent meta-analysis of risk factors for suicide attempts (SA) among those with a history of NSSI found that NSSI features (i.e.,

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frequency of engagement, number of methods employed) were the most potent predictors of SAs, second only to suicidal ideation (SI; Victor and Klonsky, 2014). This provides strong evidence that the characteristics of NSSI itself may be more important in quantifying suicide risk among self-injurers, compared to other clinical indices (e.g., depression, impulsivity, borderline personality disorder) considered important risk factors for suicidal behaviors in the general population (Victor and Klonsky, 2014). Overall, this research underscores the importance of confirming the relationships between NSSI characteristics previously demonstrated to be associated with SI and SA. Furthermore, it sheds light on the importance of exploring the potential risk associated with more varied and understudied facets of NSSI, as they may further augment our ability to predict SI and SA in this population.

Given the consistent findings of a risk relationship between NSSI and suicide-related outcomes, a small, but growing, body of research has begun to evaluate what features of this multi-faceted behavior may be most important to assess when quantifying risk for SI and SA. This research has identified the following NSSI features as potentially important: frequency (Paul et al., 2015), method of cutting (Victor and Klonsky, 2014), experience of pain (Ammerman et al., 2016; Nock et al., 2006), medical severity (Burke et al., 2015), scarring (Burke et al., 2015), and engaging in NSSI alone as opposed to with others (Glenn and Klonsky, 2009). Research also has suggested that motivations (e.g., functions) for NSSI may be important predictors of SI and SA (Nock and Prinstein, 2005; Paul et al., 2015); however, this research has been somewhat mixed, likely due to variability in operationalizing NSSI functions. For example, one study examining the relationships between 17 specific NSSI functions and SI/SA found that most of the functions were predictive of SA, whereas only the interpersonal communication and anti-dissociation (i.e., feeling generation) functions were predictive of SI (Paul et al., 2015). In another study examining four classes of functions, as opposed to individual functions, only intrapersonal negative reinforcement (i.e., reducing negative affect) was associated with recent SA (Nock and Prinstein, 2005). These findings were further supported through research utilizing latent class analysis, which identified a subgroup of self-injurers characterized by high levels of intrapersonal functions as well as SI and SA (Klonsky and Olin, 2008). Generally, the small body of research examining NSSI functions and SI/SA suggests the importance of intrapersonal functions, yet, it remains unclear which intrapersonal functions are most important and the extent to which interpersonal functions also play a role. Thus, research is needed to clarify which functions may be most associated with SI and SA.

Despite the growing body of research examining the association between NSSI features and SI/SA, several NSSI features remain understudied (Victor and Klonsky, 2014). For example, no studies, to our knowledge, have directly examined whether NSSI location is associated with SI or SA. However, a recent study found that individuals with borderline personality disorder (BPD), a population at increased risk for SI/SA (Oldham, 2006), engaged in self-injury in locations that are more visible/exposed than self-injurers without BPD (Stroehmer et al., 2015), offering indirect support for the idea that location may be related to SI/SA. Additional features deserving further attention with respect to prediction of suicide-related outcomes are NSSI medical severity and scarring from NSSI (Burke et al., 2015), as well as time from urge to action, desire to cease NSSI, likelihood of engaging in future NSSI, and age of NSSI onset (Ammerman et al., 2017). Given the limited research examining these characteristics coupled with their promise in improving SI/SA predictive models, the current study aimed to investigate the importance of such NSSI features in the occurrence of suicide-related outcomes.

1.1. The current study

Although research has begun to utilize EDM techniques to improve the ability to predict suicidal behavior, no studies, to our knowledge, have applied these techniques to improve suicide risk prediction among individuals with a history of NSSI. Moreover, no studies have examined the previously identified NSSI characteristics simultaneously within a predictive model to determine which features are most salient to consider when performing suicide risk assessment. Such information would be useful to researchers and providers who currently have minimal guidance on which NSSI features among many may denote high suicide risk classification. Investigating these NSSI characteristics simultaneously is important given their significant shared variance. The current study aimed to identify which NSSI features are most important in predicting SI, suicide planning (SP), and SA, considering a total of 58 NSSI features. In order to be able to comment on the relative importance of NSSI features as compared to well-established predictors of SI, SP, and SA, we also included depressive symptoms and demographic variables in all predictive models, in addition to including SI and SP as indicators when predicting SA. Based on prior literature (Victor and Klonsky, 2014), we hypothesized that the NSSI characteristics of frequency and number of methods would emerge as important predictors of SI, SP, and SA. Additionally, we hypothesized that the intrapersonal functions of anti-suicide and anti-dissociation would also emerge as important predictors of SI, SP, and SA (Paul et al., 2015). We predicted that these NSSI features would emerge as important, even after considering depressive symptom severity in all models and SI and SP in the SA model.

2. Method

2.1. Participants and procedures

Participants ($N = 1082$) were undergraduate students enrolled in a large, northeastern university recruited from psychology classes in exchange for class credit; participants completed all study procedures online. All procedures were reviewed and approved by the university Institutional Review Board. Participants were eligible for the study if they were able to complete study measures (i.e., read and speak proficiently in English, maintain normal or corrected vision) and if they were age 18 or older. Validity items were included in the online study to ensure data integrity. Participants ($n = 3$) who failed greater than 50% of these data integrity items were excluded from the analyses.

The final sample consisted of 359 (33.2%) participants who completed the online screening survey and reported a history of NSSI. There were no significant demographic differences between individuals who reported a history of NSSI and individuals who did not. Participants who reported a history of NSSI also reported elevated SI, 90 (25.1%), as measured by the Beck Scale for Suicidal Ideation (BSS; Beck and Steer, 1991) compared to those who did not report a history of NSSI, 53 (7.4%), and this difference was statistically significant, $X^2(1) = 65.34$, $p < .001$. Additionally, participants who reported a history of NSSI, 33 (9.2%), were significantly more likely than those without a history of NSSI, 7 (1.0%), to report having a SP, $X^2(1) = 45.34$, $p < .001$. Likewise, participants with a history of NSSI, 51 (14.2%), were significantly more likely to report a past SA compared to 15 (2.17%) participants without a history of NSSI, $X^2(1) = 61.31$, $p < .001$. Demographic characteristics (age, gender, race) for the sample are reported in Table 1. Of the 359 participants who endorsed a history of NSSI, 14 participants evidenced a small portion of missing data (a total of 2% missingness among the 14 participants). Because the rate of missingness was low, we opted for single imputation using default methods from the

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