TOWARDS A BETTER UNDERSTANDING OF NON-SUICIDAL SELF-INJURY AMONG COLLEGE STUDENTS

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This thesis is dedicated to the millions of college students who struggle with non-suicidal self-injury and the researchers and clinicians who understand that this behavior warrants attention in its own right.

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Abbreviations

AUC = Area Under the Curve

AUDIT = Alcohol Use Disorders Identification Test

APA = American Psychiatric Association

CI = Confidence/Credibility Interval

CIDI-3.0 = Composite International Diagnostic Interview 3.0

CIDI-SC = Composite International Diagnostic Interview Screening Scales

ddf = denominator degrees of freedom

DSEM = Dynamic Structural Equation Modeling

DSM = Diagnostic and Statistical Manual of Mental Disorders

ESM = Experience Sampling Methods

FFM = Four-Function Model

GAD = Generalized Anxiety Disorder

ICC = Intra-Class Correlation

IPTS = Interpersonal Theory of Suicide

KR-20 = Kuder-Richardson Formula 20

LCS = Leuven College Surveys

MDD = Major Depressive Disorder

ndf = numerator degrees of freedom

NSSI = Non-Suicidal Self-Injury

NSSI-D = Non-Suicidal Self-Injury Disorder

OR = Odds Ratio

PANAS = Positive and Negative Affect Schedule

PARP = Population Attributable Risk Proportion

PD = Panic Disorder

PPV = Positive Predictive Value

RR = Response Rate

SD = Standard Deviation

SE = Standard Error

SITBI = Self-Injurious Thoughts and Behaviors Interview

STB = Suicidal Thoughts and Behaviors

WHO = World Health Organization

WMH-ICS = World Mental Health International College Student

w% = weighted percentage

w(n) = weighted number

SUMMARY

Non-suicidal self-injury (NSSI) is posing significant public health challenges among young people. While an increasing subpopulation of young people in today's society consists of college students, there is limited knowledge of the prevalence and course, risk estimation, and significance of NSSI for college mental health. This doctoral project describes six empirical studies that were conducted to provide a better understanding of NSSI among college students.

In the **first study**, with a sample of 20,842 first-year college students from 9 countries, the pooled prevalence of lifetime, 12-month NSSI, and positive screen for DSM-5 NSSI disorder was estimated at 17.7%, 8.4%, and 2.3%, respectively. Findings further revealed that the association between NSSI and mental disorders is likely reciprocal, with the presence of a mental disorder being associated with the subsequent onset of NSSI, and NSSI also predicting future mental disorders. A **second study** revealed that only a small subgroup (0.8%) of students meets full diagnostic criteria for NSSI disorder. While we observed that students diagnosed with the proposed disorder report a high level of comorbid mental disorders, NSSI disorder remained associated with severe role impairment in daily life when controlling for the presence of mental disorders. In the **third study**, we evaluated the extent to which NSSI is associated with increased risk of suicidal thoughts and behaviors, over and above the effect of mental disorders. Findings revealed that NSSI is uniquely associated with increased risk for subsequent suicide attempt (on average three years later), as well as suicide ideation and suicide plans. Further analyses also linked NSSI to key transitions between suicidal ideation and suicide attempt, including (1) transitioning from ideation to developing a plan and (2) transitioning from having a plan to making an attempt. Those who engaged in repetitive and severe NSSI were most likely to attempt suicide.

In the **fourth study**, we estimated the incidence of NSSI at 10.3% in year 1 and 6.0% in year 2 of college, with 7.0% of students reporting repetitive NSSI (≥ 5 times per year) for the first time during the college period. A range of distal and proximal risk factors (i.e., childhood or adolescent trauma, 12-month stressors, and mental disorders) were prospectively associated with the onset of NSSI, and combining these into an integrative prediction model enabled us to accurately detect college entrants at high cumulative risk for incident NSSI. In the **fifth study**, we found that NSSI severity indicators (e.g., higher lifetime frequency) differentiated college students who continue to self-injure from those that cease NSSI during the college period. We also observed that emotional distress had no significant effect

beyond perceived emotion regulatory capability, which was uniquely related to NSSI cessation. Finally, in a **sixth study**, we explored short-term predictors of NSSI thoughts and behaviors in daily life. Using assessments up to eight times per day from students who engage in NSSI revealed that NSSI thoughts occurred in situations with high momentary levels of negative affect and low levels of positive affect. Acute risk of NSSI behavior was elevated in these situations when students perceived low ability to resist NSSI.

Taken together, these findings indicate that NSSI is relatively prevalent among college students, although few meet diagnostic criteria for NSSI disorder. In light of these findings, we recommend that researchers evaluate the potential of a stepped-care approach in responding to NSSI on college campuses. Importantly, our findings highlight the feasibility of incorporating prevention into such a framework as we demonstrated the potential of web-based risk-screening for detecting students at high risk of new-onset NSSI. Counselors and academic staff should take NSSI seriously in order to avoid the development or a further escalation of suicidal thoughts and behavior. For policymakers, our data indicate that providing timely and effective interventions for young people who engage in NSSI might be one fruitful strategy to prevent significant future impairment and loss of life. Future studies in this area, as well as research that develops personalized prediction models for acute risk of NSSI, have the potential to deliver cost-effective tools for the prevention and intervention of NSSI among college students.

Populaire samenvatting

Zelfverwondend gedrag (ZVG) of het zichzelf opzettelijk fysiek schade toebrengen zonder een aanwezige doodswens (bijv., zichzelf krassen, slaan) vormt een maatschappelijk gezondheidsprobleem en komt tijdens de adolescentie frequent voor met andere ernstige psychische problemen. Tot op heden is er echter weinig geweten over ZVG na de adolescentie periode. Voor een groeiende groep jongeren in onze samenleving eindigt de adolescentie, en begint de ontluikende volwassenheid, met de overgang naar het hoger onderwijs. Deze doctoraatsthesis heeft tot doel om wetenschappelijke kennis te vergaren over ZVG tijdens de universiteitsperiode.

In een **eerste studie**, bij meer dan 20,000 eerstejaarsstudenten uit 24 verschillende universiteiten wereldwijd, vonden we dat 17.7% aangeeft zichzelf ooit te hebben verwond en 8.4% dit deed in het afgelopen jaar. Daarnaast toonden we aan dat het ontstaan van ZVG gelinkt kon worden met eerdere psychische stoornissen. Omgekeerd vonden we ook dat ZVG een risicofactor is voor het ontwikkelen van nieuwe psychische stoornissen. In een **tweede studie** schatte we het voorkomen van het DSM-5 Zelfverwondingssyndroom op 0.8%. Om hieraan te voldoen moeten studenten zichzelf vijf of meer dagen in het afgelopen jaar hebben verwond en ernstig lijden onder het voorkomen van ZVG. In diezelfde studie vonden we dat studenten met het Zelfverwondingssyndroom vaak ook andere psychische stoornissen hebben en ernstige beperkingen in het dagelijkse leven ervaren. Hoewel ZVG soms ongewild levensgevaarlijk kan zijn, is er geen primaire intentie aanwezig om zichzelf van het leven te benemen. Desondanks suggereren theorieën dat ZVG een risico kan vormen voor de ontwikkeling van suïcidale gedachten en gedragingen. Dit onderzochten we in een **derde studie** waarin we vonden dat diegenen die ZVG rapporteerden een 5.5 keer hoger risico hadden om een eerste suïcidepoging te ondernemen (gemiddeld drie jaar later). Verdere analyses toonden aan dat de aanwezigheid van ZVG ook een voorspellende factor is in de transitie van suïcidale gedachten en suïcidale plannen naar een suïcidepoging. Tot slot leerde dit onderzoek ons dat individuen die repetitief en ernstigere vormen van ZVG rapporteren, het hoogste risico lopen om suïcidaal te worden.

In een **vierde studie** onderzochten we het ontstaan van ZVG tijdens de universiteitsperiode bij studenten die dit gedrag als adolescent nooit hadden gesteld. Het voorkomen van ZVG werd in deze groep geschat op 10.3% in jaar 1 en 6.0% in jaar 2, waarbij 7.0% aangaf zichzelf minstens 5 keer te hebben verwond in het afgelopen jaar. Het ontstaan van ZVG tijdens de eerste twee jaren aan de universiteit kon in verband worden gebracht met traumatische ervaringen tijdens de kindertijd en/of

adolescentie, met psychische stoornissen en recente stressvolle ervaringen. Vervolgens berekenden we voor elke student een risicoscore op basis van meer dan 50 psychosociale factoren dat toeliet om met redelijke accuraatheid hoog-risicostudenten te identificeren. Voor velen ontstaat ZVG echter al in de adolescentie. Daarom onderzochten we bij deze groep studenten, in een **vijfde studie**, factoren die differentiëren tussen wie stopt en wie doorgaat met ZVG. Adolescenten die ernstig ZVG (bijv. hogere frequentie) rapporteren gaan vaker door met ZVG tijdens de universiteitsperiode. Verder vonden we ook dat de persoonlijke overtuiging dat men zijn emoties kan reguleren een belangrijke factor is in het bepalen dat studenten stopten met ZVG tijdens de universiteitsperiode. Tenslotte onderzochten we in een **zesde studie** factoren die op korte termijn voorspellen wanneer studenten met ZVG een risico hebben om dit gedrag te stellen in het dagelijkse leven. Deze studie toonde aan dat gedachten over ZVG voorkomt in situaties waarin meer negatieve (bijv., zich somber en gestrest voelen) en minder positieve emoties ervaren worden (bijv. zich ontspannen en tevreden voelen). Risico voor het stellen van ZVG was acuut wanneer men op dergelijke momenten eveneens de overtuiging had niet te kunnen weerstaan aan de drang voor ZVG.

Concluderend kunnen we stellen dat ZVG bij universiteitsstudenten vaak voorkomt, maar voor de meeste studenten vooral sporadisch van aard is. Zo is het voorkomen van het Zelfverwondingssyndroom zeldzaam. Deze bevindingen illustreren de relevantie voor het evalueren van een trapsgewijs zorgmodel voor ZVG bij universiteitsstudenten. Clinici dienen waakzaam te zijn voor de ontwikkeling van verdere psychische stoornissen en suïcidale gedachten en gedragingen bij studenten met ZVG. Voor beleidsmakers impliceren onze bevindingen dat het investeren in preventie- en interventiestrategieën voor ZVG een gunstig effect kan hebben op de suïcidecijfers bij jongvolwassenen. Een innovatief aspect van ons onderzoek was de implementatie van een algoritme waarmee we aantoonden dat preventief screenen voor ZVG een beloftevolle strategie is om tijdig hoog-risicostudenten te identificeren bij aanvang van de universiteitsperiode. Verdere studies in dit domein alsook het ontwikkelen van accurate detectiemethoden voor ZVG in het dagelijkse leven zijn noodzakelijk om op een wetenschappelijke basis preventie en interventie van ZVG bij universiteitsstudenten mogelijk te maken.

Author Statement

This thesis is presented as a hybrid thesis which includes papers which are prepared or accepted for publication in different journals during the doctoral research project. As each chapter is a standalone manuscript there are some inconsistencies in formatting across chapters and there is some unavoidable repetition throughout the thesis, particularly when describing the background and methodology of each chapter. Considering this, effort has been made to reduce repetition throughout the literature review and general discussion. Each empirical chapter is presented with a short introduction linking the individual chapters to create a cohesive body of work. Additionally, reference lists have been removed from all papers and presented collaboratively at the end of the thesis to increase cohesiveness. Throughout the thesis, the term "we" is consistently used to reflect that the work presented is the result of several scientific collaborations. The doctoral candidate has been responsible for the acquisition of data, drafting of the research articles, statistical analysis, and interpretation of results included in the dissertation. Supervisors, co-supervisors, and co-authors provided feedback and study supervision of all aspects of the research.

Chapter 1

General Introduction

"Self-injurious behaviors are one of the most concerning - and perplexing - of all human behaviors

… If not to die, why would people do such a thing?"

(Nock, 2009, p. 3)

What is non-suicidal self-injury (NSSI)?

Definition

Human behavior is geared towards survival and most of what we do in life is driven by the organizing principle to maximize pleasure and minimize pain. Yet, people are capable of behaving in ways that are inconsistent with this principle and, in some cases, do things that are seemingly at odds with this innate drive. One of the most puzzling of these behaviors is non-suicidal self-injury (NSSI), which refers to *the direct and deliberate, self-inflicted damage of one's body tissue without suicidal intent and for purposes not culturally or socially accepted* (International Society for the Study of Self-Injury, 2020). NSSI includes behaviors such as cutting, scratching or burning the skin, self-battery, biting the self, or any other self-inflicted means of injuring the self. The definition of NSSI excludes harmful behaviors that occur indirectly (e.g., fasting or excessive drinking), non-deliberately (e.g., accidents), are culturally approved (e.g., body piercing and tattoos) or engaged in with any suicidal desire (i.e., suicide attempt). Research in the past two decades has pushed NSSI to the top of the research agenda among young populations (Glenn, Jaroszewski, Milner, Kearns, & Nock, 2015), a viewpoint that the American Psychiatric Association emphasized with its inclusion of the Non-suicidal Self-Injury Disorder (NSSI-D) as a "condition requiring further study" in the DSM-5 (American Psychiatric Association, 2013). To meet diagnosis of this newly proposed disorder, individuals need to report more frequent NSSI (i.e., at least five days in the past year) and significant distress or interference in one or more areas of life due to NSSI.

Epidemiology

NSSI typically starts in mid-adolescence between 14 and 16 years (Gandhi et al., 2018; Plener, Schumacher, Munz, & Groschwitz, 2015), and one in five individuals engage in NSSI at least once before the age of 25 (Gandhi et al., 2018). Pooled prevalence rates of NSSI approximate 17-18% among adolescents and 12-20% among emerging adults (Muehlenkamp, Claes, Havertape, & Plener, 2012; Swannell, Martin, Page, Hasking, & St John, 2014). In college students, lifetime prevalence estimates in the 5-47% range have been reported, with a pooled lifetime estimate of 20%, suggesting that students may be more likely to self-injure than young adults who do not attend college (i.e., 12%; Swannell et al., 2014). Reported gender differences in the prevalence of NSSI have been inconsistent; however, a recent meta-analysis found higher rates of NSSI in females in clinical samples and a small but significant gender difference in community and college samples (Bresin & Schoenleber, 2015).

These authors also observed gender differences in NSSI methods with females being more likely to use cutting, biting, and scratching as methods of NSSI and males more often using pinching as NSSI method.

Why do people engage in NSSI?

Given the strong association with mental disorders (Brunner et al., 2014; Nock, Joiner, Gordon, Lloyd-Richardson, & Prinstein, 2006; Selby, Kranzler, Fehling, & Panza, 2015), NSSI has historically been conceptualized as a symptom of mental illness. Yet, such a perspective is inappropriate and unsatisfying as NSSI is not symptomatic of any particular disorder, and it does not explain why people self-injure (Bentley, Cassiello-Robbins, Vittorio, Sauer-Zavala, & Barlow, 2015; Nock, 2009). According to the Four-Function Model (FFM), negative and positive reinforcement processes maintain NSSI on interpersonal and intrapersonal levels (Bentley, Nock, & Barlow, 2014; Nock & Prinstein, 2004). When NSSI is engaged in to fill intrapersonal functions, it could be used to relieve or distract from negative or unwanted thoughts and feelings (automatic negative reinforcement) or as a form of stimulation or emotion generation (automatic positive reinforcement). When NSSI is engaged in for interpersonal reasons, it may be used to escape from uncomfortable social situations (social negative reinforcement) or to seek help from others (social positive reinforcement). Studies have consistently shown that most people report engaging in NSSI to relieve or distract from negative or unwanted thoughts and feelings (Bentley et al., 2014; Taylor et al., 2018), however a broad range of functions have been reported in the literature (Edmondson, Brennan, & House, 2016).

What increases risk for NSSI?

In line with the FFM, theoretical models include both intrapersonal and interpersonal risk factors to explain the developmental risk of NSSI. Although still scarce, the available prospective research supports the multi-determined nature of NSSI (Fox et al., 2015). According to Nock's (2009) diathesis-stress model, risk for NSSI is increased by a combination of distal factors (e.g., family abuse, high emotion reactivity), leading to problems with emotion regulation and interpersonal communication, and proximal factors (e.g., self-criticism, social modeling) that explain why NSSI is used to serve the functions mentioned earlier. Recent theories have begun to incorporate cognitive processes in explaining why people specifically chose NSSI rather than other behaviors (Hasking, Whitlock, Voon, & Rose, 2017; Hooley & Franklin, 2017). According to the Cognitive-Emotional Model of NSSI (Hasking et al., 2017), NSSI-related cognitions determine whether someone who is experiencing an aversive emotional situation will, or will not, engage in NSSI. Researchers, for instance, observed

that people who self-injure - compared to peers who do not - hold more favorable outcome expectancies from NSSI (i.e., affect regulation) and have the perception of being less able to resist NSSI (Dawkins, Hasking, Boyes, Greene, & Passchier, 2019; Hasking & Boyes, 2018b; Hasking & Rose, 2016; Hasking et al., 2017). While these initial findings provide support for the role of NSSI-specific cognitions in NSSI engagement, longitudinal work is warranted in determining whether these beliefs might have clinical utility in preventing NSSI.

How non-suicidal is NSSI?

As the term implies, NSSI is engaged without any conscious desire to end life and should be differentiated from a suicide attempt. Other factors differentiating NSSI from suicide attempts include epidemiological features, the lethality of the methods used, and the level of distress experienced (Hamza, Stewart, & Willoughby, 2012; Walsh, 2012). Additionally, NSSI can reduce arousal levels for those who engage in it, and some people use it as a way of averting thoughts and plans about suicide (cf. the anti-suicide function of NSSI; Edmondson et al., 2016). However, both forms of self-injury frequently co-occur, and research suggests that NSSI may increase risk for suicide attempts (Grandclerc, De Labrouhe, Spodenkiewicz, Lachal, & Moro, 2016; Hamza et al., 2012). According to the Gateway theory, NSSI directly increases risk for a suicide attempt among people experiencing high levels of intrapersonal distress (Hamza et al., 2012). Alternatively, the Interpersonal Theory of Suicide (IPTS) posits that an individual will only attempt suicide if there is the desire to attempt suicide – originating from thwarted belongingness and perceived burdensomeness - *and* the capability to attempt suicide (Joiner, 2005; Van Orden et al., 2010). Having a suicidal desire is thus not sufficient in itself. The IPTS laid out an ideation-to-action framework that sparked a revolution in the suicide literature by arguing that the development of suicide ideation and suicide attempts are two different processes that come with different sets of predictors. According to this theory, NSSI may confer risk to suicide because repeated tissue damage would prepare an individual to make a suicide attempt by building up a capability for suicide. Willoughby and colleagues (2015) tested this among college students and found that a higher frequency of NSSI predicted an increase in the capability for suicide one year later. Yet, unlike most other risk factors, it has been argued that NSSI might present "double trouble" concerning suicide risk (Klonsky, May, & Glenn, 2013). There is emerging evidence that NSSI may not only increase the capability to end one's own life, but also the desire to die (Chu et al., 2018; Hamza & Willoughby, 2016). This has led scholars, counselors, and policy-makers to recognize NSSI as a pressing public health concern and relevant research topic among young individuals. In response to

this call, the current doctoral research project aims to make significant contributions to our understanding of NSSI during the college period.

Why study NSSI during the college period?

There are three important reasons to study NSSI during the college period. First, a significant subpopulation of young people in today's society consists of college students, with up to 70% of high school graduates entering tertiary education (Bureau of Labor Statistics, 2017). The number of young individuals pursuing a college or university degree has grown continuously over the past decades and is expected to keep rising in the next decades (Organisation for Economic Co-operation and Development, 2019). The 20th-century technological revolution marked a shift from manufacturing towards an information-based economy that necessitates post-secondary education for most professions. This economic-societal shift has resulted in a new developmental period from the late teens through the twenties that Arnett (2000) termed "Emerging Adulthood" and constitutes a period of continued transition, exploration, and evaluation. Rather than entering the workforce, getting married, and having children, emerging adults are still finding their way and trying different experiences before settling on steady career choices and long term relationships. Arnett (2015) described the college period as the "emerging adult environment par excellence" (p. 140), with college entrance marking the transition from adolescence to emerging adulthood.

Second, while the college years are a time filled with new opportunities and excitement in academic, personal, and social areas of life (Arnett, 2015), research shows it is also a time of heightened risk for the onset and persistence of mental disorders and risky behaviors (Auerbach et al., 2018; Bruffaerts et al., 2018; Mortier, Demyttenaere, et al., 2017; Zivin, Eisenberg, Gollust, & Golberstein, 2009). From a developmental perspective, college students are caught in the middle - no longer adolescents but not yet in a position to fulfill the responsibilities of adulthood. Relationship concerns, uncertainty about future employment, financial difficulties, and academic pressure can all combine to make this a stressful period (American College Health Association, 2018; Arnett, 2015; Robotham, 2008) and increase susceptibility for NSSI to alleviate high levels of distress. Researchers have observed that 25-63% of those with adolescent-onset NSSI continue to self-injure in young adulthood (Glenn & Klonsky, 2011; Hamza & Willoughby, 2014). In addition, while NSSI onset peaks in mid-adolescence (Plener et al., 2015), recent evidence suggests a second peak around the age of 20 (Gandhi et al., 2018). This implies that there is an unexplored potential to reach out to students before NSSI and associated negative outcomes occur. Students who engage in NSSI are at higher risk of a

broad range of adverse mental health outcomes such as academic failure (Kiekens et al., 2016) and suicide attempts (Whitlock et al., 2013). Moreover, college studies also related these behaviors with stigmatization, shame, or social isolation (Burke, Piccirillo, Moore-Berg, Alloy, & Heimberg, 2019; Mahtani, Hasking, & Melvin, 2019; Stänicke, Haavind, & Gullestad, 2018), and found that students who self-injure report low levels of disclosure and help-seeking (Gollust, Eisenberg, & Golberstein, 2008; Macrynikola, Miranda, & Soffer, 2018; Rosenrot & Lewis, 2018; Whitlock et al., 2011). Together, these findings illustrate the relevance of a good understanding of NSSI among college students.

Third, the practical aspects of the college environment facilitate the reachability and cost-effectiveness of prevention and intervention efforts with regards to implementing risk-screening (Auerbach et al., 2018; Bruffaerts et al., 2018; Mortier, Kiekens, et al., 2017), reducing barriers for help-seeking (Ebert et al., 2018; Lewis et al., 2019), and providing intervention and treatment (Franklin et al., 2016; Hooley, Fox, Wang, & Kwashie, 2018). Students often live together with peers, have easy access to the internet, and typically study for several years at the same campus, which makes it possible to follow them over time and offer and evaluate highly scalable interventions. Most colleges also have on-campus student health centers, enabling professional skills training and affordable specialized mental health treatment. In sum, studying NSSI among college students is relevant from a societal, clinical, and pragmatic perspective. Yet, to fully exploit the potential of the college period as a window of opportunity in which we can intervene to reduce NSSI, and associated adverse outcomes (e.g., increased capability for suicide - Willoughby et al., 2015), requires scientifically-derived knowledge to help guide prevention and intervention efforts. Unfortunately, although many colleges have begun to implement risk assessment and prevention programs for mental health problems (Bendtsen, Bendtsen, Karlsson, White, & McCambridge, 2015; Harrer et al., 2018), NSSI is not yet included in these efforts due to several essential barriers of knowledge.

Towards a better understanding of NSSI among college students

We identified five research gaps that, if addressed, will help guide prevention and intervention for NSSI among college students. First, lifetime prevalence rates as wide as 5-47% indicate that we need a clearer epidemiological picture of NSSI among college students (Swannell et al., 2014). Better understanding the prevalence and developmental course of NSSI should be considered a necessary first step in clarifying predictive factors for risk screening and evaluating new interventions (Glenn, Jaroszewski, Milner, et al., 2015). Yet, most of what we know about NSSI among college students comes from cross-sectional studies that utilize college students - usually female psychology

undergraduates - because they are easy to recruit (Swannell et al., 2014). Although such studies may be useful in examining correlates of NSSI among specific subpopulations of students, these designs do not allow us to clarify the risk and protective factors of different meaningful NSSI trajectories and may not be representative of the entire college student population (Hanel & Vione, 2016; Kraemer et al., 1997).

Second, it is unclear what proportion of students require professional treatment for self-injury. While colleges have an obligation to address and respond to NSSI, prevalence rates are prohibitively high to feasibly offer specialized clinical care to all incoming college students with a history of NSSI. Further, the majority of students with a history of NSSI are unlikely to need intensive treatment for NSSI. To better understand NSSI severity and the need for services, the most recent edition of the Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition (DSM-5) included NSSI-D (APA, 2013). Emerging evidence in representative community samples of (emerging) adults suggests that few meet criteria for NSSI-D (less than 1%; Benjet et al., 2017; Plener et al., 2016), suggesting that assessing NSSI-D might help to identify a specific subgroup of college students in need of clinical services. However, as no epidemiological study has evaluated the full DSM-5 criteria in a representative sample of college students, the prevalence of NSSI-D remains unclear among college students. Addressing this gap would provide valuable information about the need for treatment and the utility of NSSI-D for college mental health.

Third, we need a better understanding of the clinical significance of NSSI concerning risk of other mental health problems, particularly mental disorders and suicidal thoughts and behaviors (STB). Although it is understood that mental disorders increase risk of NSSI (Fox et al., 2015), we lack a detailed picture of the risk factor status of NSSI for later mental disorders. Researchers have linked NSSI to adverse developmental trajectories in psychopathological processes, such as rumination and emotion dysregulation (Buelens, Luyckx, Gandhi, Kiekens, & Claes, 2019; Robinson et al., 2018), and emerging evidence indicates that NSSI may also function as a behavioral marker of newly emerging mental disorders (Wilkinson, Qiu, Neufeld, Jones, & Goodyer, 2018). Relatedly, a growing body of research suggests that NSSI might increase risk for STB generally, including also suicide ideation and plans (Chu et al., 2018; Hamza & Willoughby, 2016; Mortier, Demyttenaere, et al., 2017). However, as prior studies did not consider pre-existing mental disorders when evaluating these associations, we need to know if NSSI uniquely predicts the onset of mental disorders and STB. Clarifying the incremental predictive utility of NSSI for later mental disorders and STB is essential from a public health

perspective to determine whether prioritizing the identification of those who engage in NSSI, and providing them with timely and effective interventions, might be a fruitful strategy to help offset future mental health-related burden and prevent loss of life among college students.

Fourth, there is no evidence-based method for identifying students at high risk for NSSI during the college period. Optimizing the potential of risk screening that enables preventative and early intervention initiatives requires longitudinal studies to identify risk and protective factors that clarify *who* - within the entire student population - is at high risk of NSSI. However, most of what is known about potential risk factors stems from cross-sectional approaches investigating correlates among convenience samples. Whereas these studies can provide clues about potential predictors of interest, the nature of the designs and samples limit the generality of the findings (Kraemer et al., 1997). From a methodological viewpoint, there is a need for more prospective studies that can identify risk and protective factors for NSSI (Fox et al., 2015). In line with the proposition that NSSI is a complex behavior that is determined by a multitude of factors (Nock, 2010), these studies must include a sufficiently broad range of developmentally relevant factors to delineate subgroups of students at high cumulative risk effectively. While there are more prospective studies conducted with adolescents (Buelens et al., 2019; Gandhi, Luyckx, Maitra, et al., 2017; Giletta et al., 2015; Plener et al., 2015; Tatnell, Kelada, Hasking, & Martin, 2014), longitudinal data on NSSI trajectories into emerging adulthood is scarce (Hamza & Willoughby, 2014). As emerging adulthood represents a unique developmental period (Arnett, 2015), it is unclear to what extent knowledge garnered from adolescent samples is transferable to emerging adulthood. Therefore, future prospective studies must provide a better understanding of the risk and protective factors of most relevance to college students. Relatedly, it may be crucial to differentiate between meaningfully different NSSI trajectories (Hamza & Willoughby, 2014), as the factors that predict between-person risk for NSSI onset (i.e., first occurrence of NSSI in emerging adulthood among those without a history of NSSI at college entrance) may be different from those that predict NSSI persistence (i.e., ongoing NSSI among those with a history of NSSI in childhood-adolescence). Addressing this gap of knowledge is critical to developing appropriate screening and intervention for NSSI on campus during the college period.

Finally, we also need to understand better *when* college students who do engage in NSSI are at acute risk of thinking about, and engaging in NSSI. If we are to prevent instances of NSSI in the moment when it is happening, we also need to clarify short-term factors that signal imminent risk of NSSI in the next minutes-to-hours. While traditional longitudinal studies are required to illuminate

developmental between-person risk throughout the college period, it is an ecological fallacy to believe that such between-person knowledge about the entire student population translates to the individual-level (Fisher, Medaglia, & Jeronimus, 2018). For instance, while students who report a history of abuse are at greater risk of NSSI (Fox et al., 2015), this does not allow us to determine when a particular student with a history of abuse is at risk of engaging in NSSI in the next minutes-to-hours. Providing greater clarity about predictors of acute risk of NSSI requires an ideographic approach in which factors are assessed intensively over short periods and risk stratification for NSSI occurs within students who report NSSI (Stange, Kleiman, Mermelstein, & Trull, 2019). Over the past 50 years, nearly all of the longitudinal research studies have used observation windows from months-to-years (Franklin et al., 2017; Rodriguez-Blanco, Carballo, & Baca-Garcia, 2018). However, retrospectively aggregating data over months-to-years (e.g., "Have you self-injured since last year?") throughout the academic career of students lacks temporal precision to predict acute risk. Fortunately, the proliferation of new technologies have now made it feasible, using experience sampling methods (Myin-Germeys et al., 2018), to start clarifying risk and protective factors of NSSI thoughts and behaviors in daily life (Rodriguez-Blanco et al., 2018), thereby also laying the empirical foundation for the development of real-time preventive interventions.

In sum, this doctoral research project aims to make significant contributions and advances to both science and practice for college student NSSI by directly targeting the outlined limitations in the literature. Clarifying the prevalence and course, clinical significance, and developmental and short-term risk and protective factors of NSSI should be considered a necessary first step and prerequisite for the advancement of innovative prevention and intervention initiatives for NSSI on college campuses.

Chapter 2

## Objectives and Data Used for Thesis

Chapter 2 presents an overview of the research objectives of the doctoral research project and data that were used to address the shortcomings outlined in **Chapter 1**. The first four research objectives take a developmental perspective and have a primary focus of providing a better understanding of the epidemiology, the clinical significance, and between-person risk of non-suicidal self-injury (NSSI) during the college period. Figure 2.1. presents a graphical overview of the conceptual framework of these objectives. In contrast, the fifth objective is to provide a better understanding of factors that predict short-term risk of NSSI within college students who report NSSI (Figure 2.2).

Objectives of the doctoral research project

The first research objective, addressed in **Chapter 3**, is to estimate the pooled prevalence of NSSI among college students worldwide, and investigate the reciprocal relationships between NSSI and six common mental disorders (i.e., major depressive disorder, generalized anxiety disorder, panic disorder, bipolar disorder, alcohol use disorder, and substance use disorder). Addressing this objective will make significant contributions to the field by improving knowledge regarding the epidemiology of NSSI and the extent to which mental disorders increase susceptibility for NSSI, and NSSI could be considered a behavioral marker of future mental disorder vulnerability. The second research objective, addressed in **Chapter 4**, is to investigate the prevalence of the NSSI disorder among a representative college student sample, using the full newly proposed DSM-5 criteria. This will provide the first point of reference regarding the number of students that require specialized treatment for NSSI relative to general mental health interventions. Chapter 4 also aims to inform the debate regarding the number of NSSI occurrences for diagnosis and the validity of the NSSI disorder for college students. To this end, results are presented that explore the optimal frequency threshold as a function of interference in functioning, and evaluate comorbidity with mental disorders and suicidal thoughts and behaviors (STB).

The third research objective is to provide a better understanding of the unique risk factor status of NSSI for future mental health problems. While **Chapter 3** investigates the clinical significance of NSSI concerning risk for future mental disorders, **Chapter 5** presents the results of an investigation into the extent to which NSSI may be considered a robust risk factor for STB.
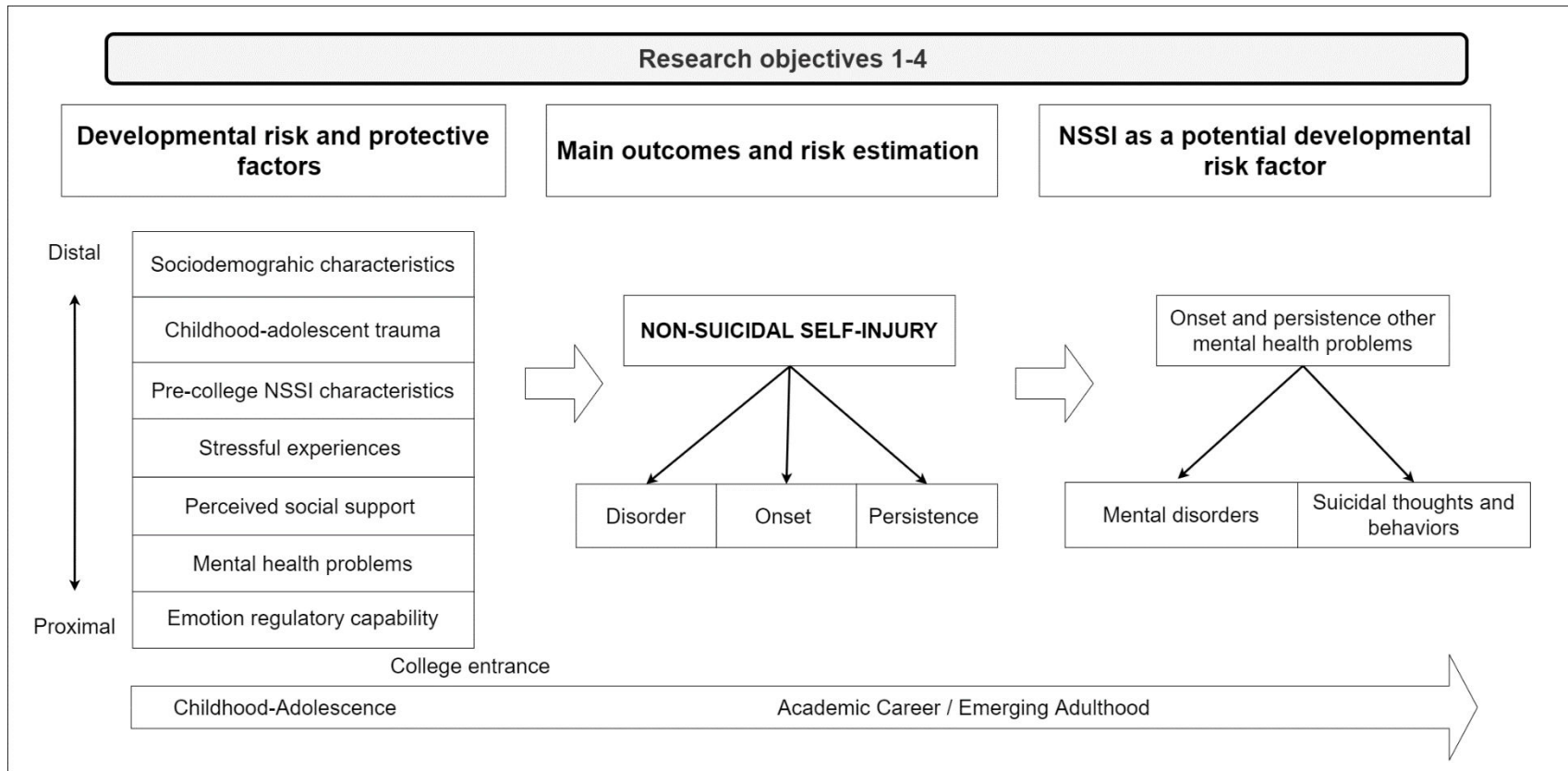
Figure 2.1. Conceptual framework research objectives 1-4 of the doctoral research project.

Specifically, we aim to examine whether NSSI is associated with increased odds of future onset of STB independent of common mental disorders, and evaluate whether NSSI predicts critical transitions between suicidal ideation and suicide attempt, including (1) transitioning from ideation to developing a plan and (2) transitioning from having a plan to making a suicide attempt. Finally, we examine the extent to which specific NSSI characteristics are associated with subsequent STB among students who report NSSI.

The fourth research objective is to clarify risk and protective factors for NSSI during the college period. In **Chapter 6**, we estimate the incidence of NSSI during the first two years of college (i.e., the occurrence of NSSI among those with no history of NSSI at college entrance) and evaluate the accuracy and replicability of a multivariate prediction model for detecting students at high risk for onset of NSSI. **Chapter 7** subsequently describes the analysis of predictors of NSSI persistence (i.e., ongoing NSSI among those with a history of NSSI at college entrance) during the college period. Potential predictors that we included are well-established correlates of NSSI among college students, including sociodemographic characteristics (Kiekens et al., 2016; Whitlock et al., 2011), childhood-adolescent trauma (Liu, Scopelliti, Pittman, & Zamora, 2018; Martin et al., 2016; Taliaferro & Muehlenkamp, 2015a), pre-college NSSI characteristics (Glenn & Klonsky, 2011; Hamza & Willoughby, 2014), stressful experiences and perceived social support (Taliaferro & Muehlenkamp, 2015a; Wilcox et al., 2012), mental health problems (Bentley et al., 2015; Taliaferro & Muehlenkamp, 2015b), and cognitive processes such as emotion regulatory capability (Hasking et al., 2017; Zelkowitz, Cole, Han, & Tomarken, 2016). These correlates include a broad range of potentially relevant risk and protective factors for the development of prospective risk screening models for NSSI during the college period.

The fifth research objective, addressed in **Chapter 8**, is to investigate short-term (minutes to-hours) risk of NSSI thoughts and behaviors within students who report frequent NSSI. Drawing on contemporaneous theories of NSSI (Hasking et al., 2017; Hooley & Franklin, 2017; Nock & Prinstein, 2004), we evaluate whether within-person fluctuations in negative affect, positive affect, and self-efficacy to resist NSSI predict NSSI thoughts within the same observation window, as well as from one observation window to the next. Inspired by the concept of ideation-to-action (Klonsky, Saffer, & Bryan, 2018), we evaluate whether within-person variation in affective states and self-efficacy to resist NSSI, relative to their individual

average, predict NSSI behavior above and beyond NSSI thoughts at the previous assessment (Figure 2.2). Addressing this objective will provide a better understanding of the factors that determine when college students who engage in NSSI are at acute risk of, considering and, engaging in NSSI behavior.

The thesis is concluded in **Chapter 9**, which reviews the insights that were derived from the doctoral research project in relation to the objectives and reflects on the implications and future research directions.
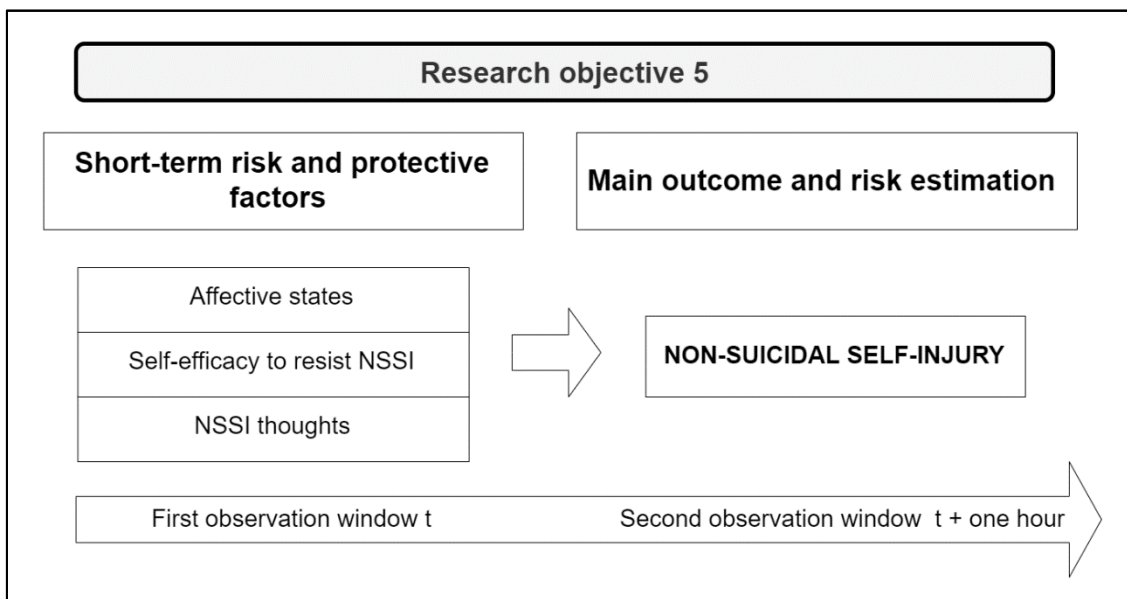
Figure 2.2. Conceptual framework research objective 5 of the doctoral research project.

Data used in the doctoral research project

To address these objectives, data comes from three different data sets. First, we have been collecting data from college students at KU Leuven in Belgium. This project, called the Leuven College Surveys is part of the World Health Organization's (WHO) World Mental Health Surveys International College Student Initiative (WMH-ICS, n. d.). The overall aim of the WMH-ICS is to obtain accurate cross-national prospective information about the prevalence, correlates and risk factors of mental, substance, and behavioral disorders among college students with the goals of assessing unmet need for treatment, targeting students in need of outreach, and evaluating model preventive and clinical interventions (Auerbach et al., 2018; Bruffaerts et al., 2018). All first-year students are targeted (i.e., census sampling) and followed-up annually

throughout the college period. The main e-survey developed by the WMH consortium assesses a broad range of psychosocial factors. In 2014, we extended the assessment of NSSI using the self-report version of the well-validated Self-Injurious Thoughts and Behaviors Interview (Nock, Holmberg, Photos, & Michel, 2007) to include assessment of 14 NSSI methods, frequency, functions, psychological precipitants, interference in functioning, medical severity, the subjective likelihood of future engagement in NSSI, and specific questions to address the proposed DSM-5 criteria. As part of an international collaboration, we also set-up the Australian arm of the WMH-ICS project (i.e., Curtin Wellbeing Surveys). National and cross-national (Belgian and Australian) data from the WMH-ICS have been used in Chapters 3-6. Second, data from the Surveys of Student Wellbeing in the USA were provided to us for secondary analysis to investigate developmental risk and protective factors of NSSI persistence during the college period (Chapter 7). Third, we conducted an Experience Sampling Method Study to investigate short-term risk and protective factors of NSSI among college students who engage in NSSI (Chapter 8).

Chapter 3

Non-Suicidal Self-Injury Among First-Year College Students: Results from the WMH-ICS Initiative

ABSTRACT

Objective: The objectives of the present study were to: (1) present the first cross-national data on Non-Suicidal Self-Injury (NSSI) among first-year college students, and (2) carry out an initial investigation of the reciprocal relationship with common mental disorders.

Method: As part of the World Mental Health International College Student (WMH-ICS) initiative, web-based self-report surveys were obtained from 20,842 first-year students in nine countries. Using retrospective age of onset reports, time-ordered associations between NSSI and major depressive disorder, generalized anxiety disorder, panic disorder, bipolar disorder, alcohol use disorder, and substance use disorder were evaluated.

Results: Prevalence estimates of lifetime NSSI, 12-month NSSI, and positive screen for DSM-5 NSSI disorder were, respectively, 17.7%, 8.4%, and 2.3%. The odds of NSSI increased with the number of mental disorders, but at a decreasing rate. Each disorder was significantly associated with the subsequent onset of NSSI (Median OR = 2.4), but not 12-month NSSI among the sample with lifetime NSSI. Conversely, even after controlling for the effects of pre-existing mental disorders, NSSI consistently predicted the onset of later mental disorders (Median OR = 1.8) as well as 12-month generalized anxiety disorder (OR = 1.6) and bipolar disorder (OR = 4.6) among students with these lifetime disorders.

Conclusions: These findings provide a clearer picture of the epidemiology of NSSI among first-year college students and indicate that NSSI is both an outcome, and behavioral marker, of mental disorders. Future prospective studies are needed to shed light on the causal mechanisms underlying these time-ordered associations.

Keywords: non-suicidal self-injury, mental disorders, adolescence, emerging adulthood, college students

Introduction

Non-suicidal self-injury, defined as the direct and deliberate damage to one's body tissue for reasons other than to end one's life (International Society for the Study of Self-Injury, 2020), is a significant public health issue among young people worldwide. The onset of NSSI peaks in adolescence around the age of 14-16 (Gandhi et al., 2018), with pooled lifetime prevalence rates close to 17-18% (Muehlenkamp et al., 2012; Swannell et al., 2014). While NSSI is often episodic (Plener, Libal, Keller, Fegert, & Muehlenkamp, 2009), 12-month rates remain in the 2-14% range among emerging adults (Benjet et al., 2017; Kiekens, Hasking, Claes, et al., 2018; Serras, Saules, Cranford, & Eisenberg, 2010; Whitlock et al., 2011). For approximately 70% of adolescents in developed countries the transition to emerging adulthood (18-29 years) coincides with the entrance to college (Bureau of Labor Statistics, 2017). A period filled with new opportunities and unique challenges and stressors (e.g., academic demands, abrupt changes in social circles; Arnett, 2015) that may give rise to intense or unwanted emotion and increase susceptibility for NSSI. Researchers have observed that 25-63% of those with adolescent-onset NSSI continue to self-injure (Glenn & Klonsky, 2011; Hamza & Willoughby, 2014), and 7% begin repetitive NSSI for the first time during the first two college years (Kiekens et al., 2019). Recent studies also suggest that rates of NSSI among college student samples have increased over the past decade (Duffy, Twenge, & Joiner, 2019; Wester, Trepal, & King, 2018). Yet, to date, we still lack a representative cross-national point of reference regarding the prevalence of NSSI in college students. NSSI has previously not been included in large-scale epidemiological surveys, and prior studies have found rates as variable as 5-47% relying primarily on non-representative samples of psychology students (Swannell et al., 2014). Better understanding the prevalence and developmental course of NSSI should be considered a necessary first step in clarifying predictive factors for risk screening and evaluating new interventions (Glenn, Jaroszewski, Milner, et al., 2015). Relative to students who do not self-injure, students who engage in NSSI are at higher risk of experiencing suicidal thoughts and behaviors (Hamza & Willoughby, 2016; Kiekens, Hasking, Boyes, et al., 2018), stigmatization (Burke et al., 2019), or academic failure (Kiekens et al., 2016). Together, these findings call for a better understanding of the epidemiology and clinical significance of NSSI for college mental health.

Numerous studies have highlighted the strong association between NSSI and the presence of a mental disorder among college students (Kiekens, Hasking, Claes, et al., 2018; Taliaferro &

Muehlenkamp, 2015a, 2015b). While historically considered a symptom of mental illness, NSSI is now recognized as a transdiagnostic phenomenon that occurs in a variety of diagnostic contexts and warrants research in its own right (Nock, 2009; Selby et al., 2015). The American Psychiatric Association formally emphasized this viewpoint in 2013 with the inclusion of NSSI as a "condition requiring further study" in section III of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; APA, 2013). However, the high co-occurrence between NSSI and mental disorders raises several critical questions regarding the nature of this association, particularly whether NSSI functions as a correlate, risk factor, or outcome of mental illness. Prospective studies show that mental disorders predict the onset of NSSI (Fox et al., 2015; Kiekens et al., 2019), but more work is needed teasing apart whether *specific* mental disorders increase risk for NSSI. Conversely, there is emerging evidence that the presence of NSSI may increase risk for newly emerging mental disorders (Wilkinson et al., 2018). However, as prior research has not considered pre-existing disorders when evaluating the effect of NSSI, we need to know if NSSI uniquely predicts the onset of *specific* mental disorders after controlling pre-existing disorders. Clarifying the developmental directionality between NSSI and mental disorders is not only crucial for scientific purposes but also for developing appropriate screening and prevention of mental disorders (Auerbach et al., 2018).

In the present study, we investigate: (1) the pooled prevalence of NSSI among a representative cross-national sample of college students, and (2) the reciprocal developmental relationship between NSSI and DSM-IV mental disorders. The data presented here were obtained from a census of the entering class across 24 colleges from 9 countries participating in the WHO World Mental Health International College Student Initiative (WMH-ICS; Cuijpers et al., 2019). The WMH-ICS is a coordinated series of ongoing epidemiological surveys that aim to generate accurate data on adverse mental health outcomes among college students and develop cost-effective, evidence-based prevention and clinical interventions using precision medicine procedures. Given that the WMH-ICS assesses the age of onset for its primary outcomes, we were able to carry out a first exploration of the reciprocal time-ordered associations between NSSI and mental disorders, including major depressive disorder, generalized anxiety disorder, panic disorder, bipolar disorder, alcohol use disorder, and substance use disorder.

Methods

Sample

The first wave of WMH-ICS surveys was administered to first-year students in 24 colleges and universities (henceforth referred to as "colleges") in nine middle- to high-income countries (Australia, Belgium, Germany, Hong Kong, Mexico, Northern Ireland, South Africa, Spain, and the United States). Web-based self-report questionnaires were administered to representative samples (i.e., census) of first-year students in each college (8 private and 16 public) across these countries between October 2014 and February 2018. Compared to earlier reports (e.g., Auerbach et al., 2018; Mortier, Auerbach, Alonso, Bantjes, et al., 2018), the current sample includes 5 additional colleges, one additional country (Hong Kong), and 6,998 additional students. A total of 21,369 questionnaires were completed, with sample sizes ranging from 208 in Hong Kong to 8,076 in Mexico. The weighted (by achieved sample size) mean response rate across surveys was 45.6%. Supplementary Table 3.1. presents an overview of the sample design in each country. The sample for the analyses reported here are restricted to students identifying as male or female who were full-time students (n = 20,842). Students excluded from analyses (n = 527) were: (a) those with missing information on gender or student status (n = 39); and/or (b) those that did not identify as male or female (n = 79); and/or (c) those that reported not being a full-time student (n = 413).

Procedure

All first-year students were invited to participate in a web-based self-report survey. The mode of contact varied across colleges, with the survey part of a health evaluation in some colleges, as part of the registration process in others, and as a stand-alone survey advertised via student e-mail addresses in still others. In all cases other than in Mexico, all first-year students were invited to participate and initial non-respondents were re-contacted through a series of personalized reminder e-mails containing unique electronic links to the survey. In Mexico, students were invited to participate in conjunction with mandatory activities, which varied between colleges (e.g., student health evaluations, tutoring sessions), with time set aside for completing the survey during these sessions. In Hong Kong, all respondents who completed the survey were given a store credit coupon as an incentive. In other countries, conditional incentives were offered in the final stages of refusal

conversion (e.g., movie passes). In Spain an "end-game strategy" was used in which a random sample of non-respondents was offered an incentive for participation. Respondents to these end-game surveys were given a weight equal to 1/p, where p represents the proportion of non-respondents at the end of the standard recruitment period that was included in the end-game, to adjust for the undersampling of difficult-to-recruit students. Informed consent was obtained from all students before administering the questionnaires and institutional review boards approved the study procedures of all participating colleges.

Measures

Non-suicidal self-injury. The self-report version of the well-validated Self-Injurious Thoughts and Behaviors Interview (SITBI) was used to assess lifetime and 12-month NSSI (Nock et al., 2007). In Australia and Belgium, lifetime NSSI was assessed with a checklist from the SITBI that asks respondents to indicate each NSSI behavior (e.g., cutting, hitting, burning) they ever did to hurt themselves on purpose, without wanting to die. In all other countries, lifetime NSSI was assessed with a single-item taken from the SITBI: "Did you ever do something to hurt yourself on purpose, without wanting to die (e.g., cutting yourself, hitting yourself, or burning yourself)?". Follow-up questions assessed the age of onset and frequency of NSSI. Consistent with the proposed DSM-5 frequency criterion (i.e., self-injury on five or more days in the past year), students screened positively for NSSI disorder if they reported at least five instances of NSSI in the past 12-months (using available past-year response categories this was operationalized as ≥ 5 acts in Australia and Belgium and > 5 acts in other countries). The SITBI has good construct validity (κ = 0.74-1.0) and excellent test-retest reliability for the presence of NSSI (κ = 1.0; Nock et al., 2007). The self-report version has also demonstrated excellent test-retest reliability (κ = 1.0) and external validity (κ = 1.0; Latimer, Meade, & Tennant, 2013).

Sociodemographic and college-related variables. Gender was assessed by asking respondents whether they identified themselves as male, female, transgender (male-to-female, female-to-male), or "other." Respondent age at the survey was categorized as 18 years, 19 years, 20 or more years old. Parental educational level was assessed for father and mother (none, elementary, secondary, some postsecondary, college graduate, doctoral degree), and was categorized into low (secondary school or less), medium (some postsecondary education), and high (college graduate or more), based on the highest-of-both parents' educational level. Respondents were also asked where they ranked

academically (from top 5% to bottom 10%) compared with other students at the time of their high school graduation and was categorized into top 10%, top 30-10%, and bottom 70%. Parental marital status was dichotomized into "parents not married or at least one parent deceased" versus "parents married and both alive". The religious background was categorized as "Christian", "other religion", and "no religion". Similar to previous WMH-ICS reports (Auerbach et al., 2018; Mortier, Auerbach, Alonso, Bantjes, et al., 2018), sexual orientation was classified as: heterosexual with no same-sex attraction, heterosexual with same-sex attraction, non-heterosexual without same-sex sexual intercourse, and non-heterosexual with same-sex sexual intercourse.

Mental disorders. The self-administered questionnaire included short validated self-report screening scales for lifetime and 12-month prevalence of six DSM-IV mental disorders among first-year college students (Auerbach et al., 2018). These included four internalizing disorders (major depressive disorder, generalized anxiety disorder, panic disorder, and bipolar disorder) and two externalizing disorders (alcohol abuse or dependence and drug abuse or dependence, involving either cannabis, cocaine, any other street drug, or a prescription drug either used without a prescription or used more than prescribed to get high, buzzed, or numbed out). The assessment of these mental disorders, except for Alcohol Use Disorder (AUD), was based on the Composite International Diagnostic Interview Screening Scales (CIDI-SC). The CIDI-SC was developed by the WHO to deliver reliable estimates of DSM-IV mental disorder diagnosis, with clinical reappraisal studies generally indicating good concordance between CIDI-SC and independent clinical diagnoses based on structured clinical interviews, with area under the curve (AUC) in the range 0.70-0.78 (Kessler, Calabrese, et al., 2013; Kessler, Santiago, et al., 2013). An initial validation study among Spanish college students confirmed that all diagnostic outcomes show good AUCs (> 0.7), except panic disorder which demonstrates fair concordance with clinical diagnosis (AUC = 0.6; Ballester et al., 2019). Assessment of AUD was based on the Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, de la Fuente, & Grant, 1993). The version of AUDIT that we used (Babor, Higgings-Biddle, Saunders, & Monteiro, 2001), which defines alcohol use disorder as either a total score of 16+ or a score 8-15 with 4+ on the AUDIT dependence questions, has been shown to have good concordance with clinical diagnoses (AUCs in the 0.78-0.91 range; Reinert & Allen, 2002). Additional items from the CIDI were used to assess age of onset of each disorder (Kessler & Ustun, 2004).

Statistical Analysis

Data were weighted to adjust for differences between survey respondents and non-respondents on socio-demographic information made available about the student body by college officials. In addition, multiple imputation by chained equations was used to adjust for within-survey item non-response, random internal sub-sampling of survey sections, and missing data due to skip logic error that occurred in a few surveys (van Buuren, 2007). Prevalence estimates are reported as pooled proportions in the total sample with associated ML-adjusted standard errors obtained through the Taylor series linearization method.

A series of models were estimated to provide a better understanding of the reciprocal associations between NSSI and mental disorders. First, discrete-time survival models, with person-year as the unit of analysis and a logistic link function (Efron, 1988), was used to investigate time-lagged associations between mental disorders/NSSI and the subsequent *onset* of NSSI/mental disorders. A person-year data set was created such that each year in the life of each respondent (up to and including the age at onset of the outcome disorder or age at survey, whichever came first) was treated as a separate observational record. Person-years began at age 4, the youngest age evaluated for possible disorder and NSSI onset (Gandhi et al., 2018; Green et al., 2010). Predictor variables were considered time-varying, with predictors lagged relative to the outcome. We estimated models that examined bivariate associations between NSSI and only one common mental disorder at a time (with adjustment for country, gender, age, education, marital status parents, religion, sexual orientation, and person-year) as well as multivariate models that included information on all temporally prior mental disorders.

Second, we investigated the associations between temporally prior mental disorders/NSSI and recency of NSSI/mental disorders, using logistic regression models with person as the unit of analysis. *Recency* was defined as the ratio of 12-month (i.e., presence in the year before the survey) to lifetime prevalence. Predictor variables were only considered present in these models if the predictor occurred before the outcome or the outcome did not occur after the predictor. We again considered bivariate and multivariate models that were both adjusted for sociodemographic variables already mentioned and also included dummy variables for age of onset, time since onset, and high-school ranking. In light of the included NSSI disorder in DSM-5 (APA, 2013), we additionally investigated associations between temporally prior mental disorders and meeting the diagnostic frequency criterion (i.e., at least five

instances of NSSI in the past year) among those reporting 12-month NSSI. This comparison gives us an indication of the predictive value of mental disorders in determining *clinical severity* among those reporting 12-month NSSI at college entrance. Coefficients in all these models were exponentiated to create odds ratios (ORs) with 95% confidence intervals.

All results were pooled across participating countries using fixed-effects modeling (FEM) by including dummy control variables for country membership. Due to considerable variation in country sample sizes, no attempt was made to explore between-country variation in associations. Given that our focus is on pooled within-group associations between individual-level predictors and outcomes rather than geographic variation in mean associations, we chose FEM instead of multilevel modeling to account for the nested structure of the data. FEM is preferable in this particular situation because it does not have the restrictive, and in our case inappropriate, assumption that the aggregate units (i.e., countries and colleges within countries) represent random samples from the population of all such units (Goldstein, 2010). All significance tests were evaluated using $\alpha = 0.05$, two-sided test. Analyses were conducted with SAS version 9.4.

Results

Prevalence of NSSI among first-year college students (Objective 1)

The lifetime and 12-month prevalence of NSSI was 17.7% (SE = 0.3) and 8.4% (SE = 0.2), respectively. Of those reporting 12-month NSSI, 28.0% (SE = 1.1) screened positively for DSM-5 NSSI disorder. This corresponds to 2.3% (SE = 0.1) of the entire sample. Among those with an onset longer than one year ago, the NSSI recency (12-month-to-lifetime) ratio was 44% (SE = 0.9). The median age of onset of lifetime NSSI was 13.7 years (IQR = 11.7-15.4). Figure 1 displays the hazard function and the projected cumulative lifetime probability curve for the age of onset of NSSI up to the age of 25 years. As can be seen, the probability of NSSI is low in childhood, starts to increase in early-adolescence, peaks in mid-adolescence between 15-16 years, and then declines again across the age range 17 to 22 years[1]. When considering the sociodemographic risk profile for each NSSI outcome (a

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[1] The hazard function increases again between 23-25 years, but this finding should be interpreted with caution in this first-year college sample.

detailed presentation of these analyses can be found in supplementary Table 3.2), there are three notable findings. First, compared to male students, female students had slightly higher odds for onset of NSSI (OR = 1.6), but a lower probability of 12-month NSSI among those reporting lifetime NSSI (OR = 0.8). Second, recency of NSSI was positively associated with an early-onset (11 or younger versus 15-17 years; OR=1/0.6 = 1.7) or onset in the year before college (OR = 5.0). Third, non-heterosexual orientation consistently predicted onset, recency, and clinical severity of NSSI (ORs in the 1.6-2.9 range).

Preliminary analyses: Co-occurrence and temporal priorities between NSSI and DSM-IV mental disorders

We first examined the prevalence of lifetime mental disorders among respondents with and without a history of NSSI regardless of the temporal order (Table 3.1). This confirmed that respondents reporting NSSI had significantly higher prevalence rates than those with no history of NSSI for all six common disorders (ORs in the 1.7-5.0 range). We then considered the temporal sequence between ages at onset of NSSI compared with mental disorders within the subset of respondents who reported both NSSI and particular mental disorders. Table 3.1 presents the proportion of respondents with: 1) NSSI onset before particular mental disorder onset, 2) NSSI onset in the same year as the mental disorder, and 3) NSSI onset after the mental disorder onset. Goodness-of-fit tests evaluated whether the proportions with NSSI onset before or after mental disorders differ significantly (those with onset in the same year were excluded from these comparisons). This revealed that NSSI occurred more often before than after four out of six mental disorders (i.e., panic disorder, bipolar disorder, alcohol use disorder, and substance use disorder). By contrast, major depressive disorder occurred more often before (44.1%) than after NSSI onset (32.7%; $X^2 = 22.5$, *p* <.001), while there was no difference in temporal sequence for generalized anxiety disorder.
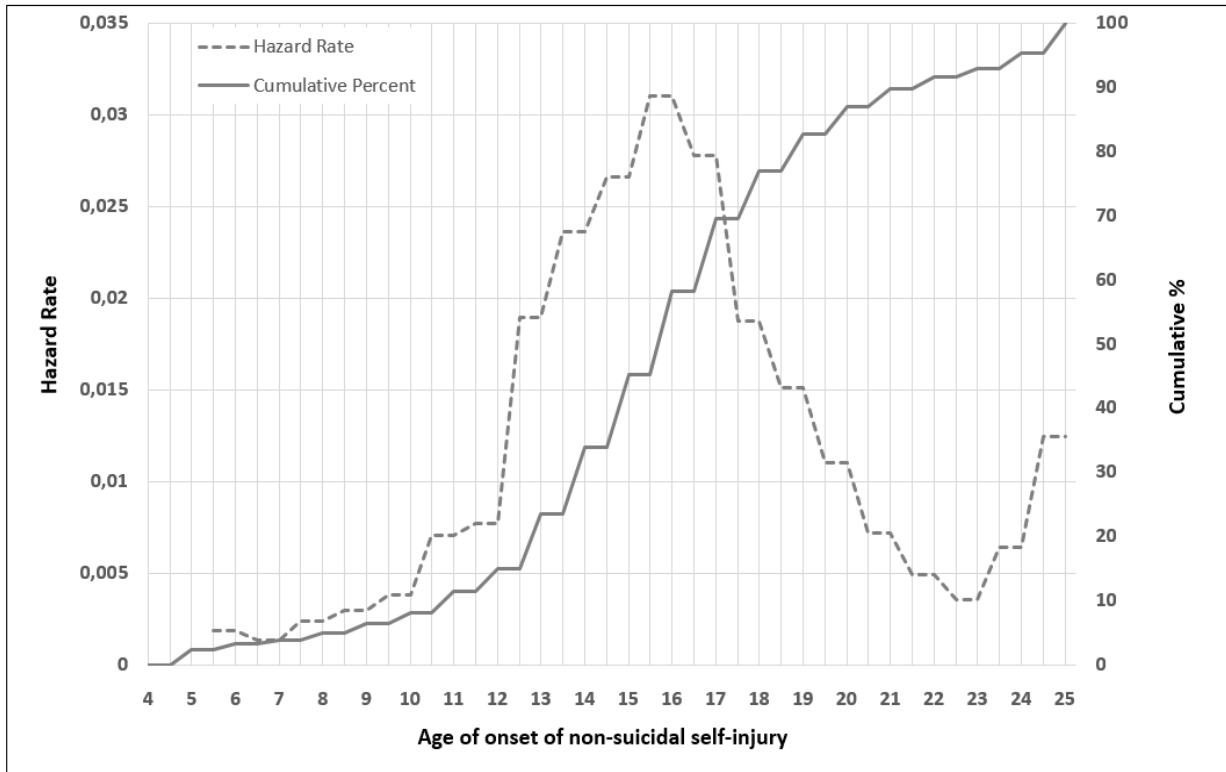
Figure 3.1. Hazard rate and cumulative age of onset distribution for non-suicidal self-injury in WMH-ICS. Note: Projected age of onset are based on first-year students, limiting the representativeness of the estimated distributions above age 18 to 19 years (i.e., the typical age of entering college).

Table 3.1. Lifetime prevalence of DSM-IV mental disorders and temporal priorities with non-suicidal self-injury in the WMH-ICS (n = 20,842).

DSM-IV mental disorders	Lifetime prevalence			Respondents with both lifetime mental disorder of interest and lifetime non-suicidal self-injury				
	Respondents with no history of lifetime NSSI %(SE)	Respondents reporting lifetime NSSI %(SE)	Odds Ratio between lifetime NSSI and lifetime mental disorder	Weighted number of respondents	NSSI onset prior to disorder onset %(SE)	NSSI onset and disorder onset in the same year %(SE)	NSSI onset after disorder onset %(SE)	Goodness-of-Fit Test for Equal Proportion F-value [p-value][a]
Major depressive disorder	11.6 (0.3)	35.2 (0.8)	4.2 (3.8-4.5)*	1303	32.7 (1.3)	23.2 (1.2)	44.1 (1.4)	22.54 [0.00]*
Generalized anxiety disorder	10.8 (0.3)	33.2 (0.8)	4.1 (3.7-4.5)*	1229	42.7 (1.5)	18.4 (1.2)	38.9 (1.4)	2.24 [0.13]
Panic disorder	2.5 (0.2)	11.4 (0.6)	5.0 (4.3-5.9)*	422	48.3 (2.8)	17.5 (2.1)	34.2 (2.7)	7.96 [0.01]*
Bipolar disorder	2.3 (0.1)	9.3 (0.5)	4.4 (3.8-5.2)*	345	52.4 (2.7)	16.9 (2.1)	30.7 (2.5)	20.53 [0.00]*
Alcohol use disorder	6.3 (0.2)	10.3 (0.6)	1.7 (1.5-2.0)*	382	68.9 (2.7)	11.3 (1.7)	19.8 (2.2)	95.53 [0.00]*
Substance use disorder	2.6 (0.2)	7.3 (0.5)	2.9 (2.5-3.5)*	270	69.8 (3.1)	15.6 (2.4)	14.6 (2.4)	89.10 [0.00]*

Note: [a] F-test to evaluate significance of pooled Chi-square goodness-of-fit test across 20 imputed datasets on a reduced subset of respondents comparing percent with onset of non-suicidal self-injury prior to disorder onset versus percent with onset of non-suicidal self-injury after mental disorder onset. NSSI = non-suicidal self-injury. *Significant at the .05 level, two-sided test.

Associations between temporally prior DSM-IV mental disorders and subsequent onset, recency and severity of NSSI (Objective 2)

We then examined the associations between mental disorders and subsequent NSSI, taking into account the onset distribution of all six mental disorders relative to NSSI (Table 3.2). Bivariate survival models revealed that each of the examined disorders were significantly associated with the subsequent onset of NSSI, with ORs ranging from 1.7 for substance use disorder to 3.3 for major depressive disorder (Median OR = 2.8). Four out of six mental disorders were also significant, although weaker, predictors of recency (Median OR = 1.6) and severity of NSSI (Median OR = 1.8). Subsequently, we evaluated the association between number of mental disorders and onset, recency, and severity of NSSI by estimating models in which the only substantive predictors were dummy variables for the number of prior mental disorders (Table 3.2). These models revealed a dose-response relationship between number of disorders and each of the NSSI outcomes. For NSSI onset, odds ratios increased from 2.7 for those with one primary preceding disorder (relative to those with zero disorders) to 4.2 for those with two of more preceding mental disorders. As was generally the case for the associations between type of disorder and recency and severity of NSSI, the odds ratios for number of disorders become smaller in models that predict 12-month NSSI among those reporting lifetime NSSI (ORs in the 1.3-3.0 range) and meeting the 5+ diagnostic frequency criterion among those reporting 12-month NSSI (ORs in the 1.5-2.3 range), respectively.

To better understand the unique associations between mental disorders, number of mental disorders, and NSSI, we considered two types of multivariate models (Table 3.3): one that included all types of mental disorders simultaneously (multivariate additive), and one that included type and number of mental disorders experienced by each respondent as dummy variables (multivariate interactive). Examining model coefficients in these models, we see that the most potent effects are for the prediction of NSSI onset in the multivariate interactive model (ORs in the 1.3-3.4 range). The odds ratios associated with number of disorders in this model were significantly lower than 1.0 and became smaller as the number of disorders becomes larger, indicating a sub-additive interaction whereby the relative odds of NSSI onset increases at a decreasing rate with the number of temporally prior disorders. A similar pattern of results was not observed when predicting recency and severity of NSSI, indicating additive effects for type of mental disorders. The relationship with most disorders, however,

became non-significant in these multivariate models, except for the association between panic disorder and 12-month NSSI among the sample with lifetime NSSI (OR = 2.4) and major depressive disorder and meeting the 5+ diagnostic frequency criterion among those reporting 12-month NSSI (OR = 1.5).

Table 3.2. Bivariate associations between temporally prior DSM-IV mental disorders and subsequent non-suicidal self-injury in the WMH-ICS.

	Onset: Lifetime NSSI[a] among the entire sample	Recency: 12-month NSSI[b] among sample reporting lifetime NSSI	Severity: 5+ frequency criterion[c] among sample reporting 12-month NSSI
	Bivariate aOR (95%CI)	Bivariate aOR (95%CI)	Bivariate aOR (95%CI)
Temporally prior mental disorder			
Major depressive disorder	3.3 (3.0-3.7)*	1.3 (1.0-1.6)*	1.5 (1.1-2.1)*
Generalized anxiety disorder	2.7 (2.5-3.1)*	1.4 (1.1-1.7)*	1.7 (1.2-2.3)*
Panic disorder	2.8 (2.2-3.5)*	2.5 (1.6-3.9)*	1.8 (1.0-3.1)*
Bipolar disorder	3.0 (2.4-3.7)*	1.6 (1.1-2.5)*	1.8 (1.0-3.4)
Alcohol use disorder	1.6 (1.2-2.0)*	1.8 (1.1-3.2)*	2.1 (1.0-4.5)*
Substance use disorder	1.7 (1.1-2.4)*	1.4 (0.6-3.3)	1.0 (0.3-3.1)
Any mental disorder	3.1 (2.8-3.4)*	1.5 (1.2-1.8)*	1.7 (1.3-2.3)*
Number of temporally prior mental disorders			
None	(ref)	(ref)	(ref)
Exactly one mental disorder	2.7 (2.5-3.0)*	1.3 (1.1-1.7)*	1.5 (1.1-2.1)*
Exactly two mental disorders	4.2 (3.7-4.9)*	1.7 (1.2-2.3)*	2.1 (1.4-3.3)*
Three or more mental disorders	4.2 (3.0-5.7)*	3.0 (1.5-6.4)*	2.3 (1.0-5.6)
F(ndf,ddf)[p value][d]	220.96(3,1806)[0.00]*	8.69(3,14742)[0.00]*	6.10(3,1872)[0.00]*

Note: [a] NSSI at least once in lifetime, [b] NSSI at least once in past 12-months, [c] NSSI at least five times in past 12-months, [d] F-test to evaluate joint significance of number of mental disorders across 20 imputed datasets. Each cell displays the result of a separate bivariate model within a person-period survival (onset models) or person-level time-order (recency and severity models) framework, including the disorder specified in the row as predictor controlling for the following covariates: country membership, gender, age (onset models), education, marital status parents, religion, sexual orientation, person-year (onset models), high-school ranking (recency and severity models), age of onset NSSI (recency and severity models), and time since onset NSSI (recency and severity models). NSSI = Non-Suicidal Self-Injury, ndf = numerator degrees of freedom, ddf = denominator degrees of freedom.
*Significant at the .05 level, two-sided test.

Table 3.3. Multivariate associations between temporally prior DSM-IV mental disorders and subsequent non-suicidal self-injury in the WMH-ICS.

	Onset: Lifetime NSSI[a] among the entire sample		Recency: 12-month NSSI[b] among sample reporting lifetime NSSI		Severity: 5+ frequency criterion[c] among sample reporting 12-month NSSI	
	Multivariate additive aOR (95%CI)	Multivariate interactive aOR (95%CI)	Multivariate additive aOR (95%CI)	Multivariate interactive aOR (95%CI)	Multivariate additive aOR (95%CI)	Multivariate interactive aOR (95%CI)
Temporally prior mental disorder						
Major depressive disorder	2.8 (2.5-3.2)*	3.3 (2.9-3.8)*	1.2 (1.0-1.5)	1.3 (1.0-1.6)	1.4 (1.0-2.0)*	1.5 (1.0-2.2)*
Generalized anxiety disorder	1.6 (1.4-1.9)*	2.2 (1.9-2.6)*	1.2 (0.9-1.5)	1.2 (0.9-1.7)	1.4 (1.0-2.0)	1.6 (1.0-2.5)
Panic disorder	1.7 (1.3-2.1)*	2.6 (2.0-3.4)*	2.3 (1.4-3.6)*	2.4 (1.4-4.0)*	1.4 (0.8-2.6)	1.7 (0.9-3.4)
Bipolar disorder	2.8 (2.2-3.5)*	3.4 (2.7-4.2)*	1.4 (0.9-2.2)	1.5 (0.9-2.4)	1.6 (0.9-3.0)	1.8 (1.0-3.5)
Alcohol use disorder	1.2 (0.9-1.6)	1.6 (1.2-2.1)*	1.7 (1.0-2.9)	1.7 (1.0-3.1)	1.9 (0.9-4.0)	2.2 (1.0-4.8)
Substance use disorder	1.2 (0.8-1.8)	1.7 (1.1-2.5)*	1.2 (0.5-2.9)	1.2 (0.5-3.1)	0.7 (0.2-2.4)	0.9 (0.3-2.9)
F(ndf,ddf)[p value][d]	114.06(6,737) [0.00]*	70.90(6,1817) [0.00]*	5.09(6,1671) [0.00]*	2.30(6,531) [0.03]*	3.60(6,4067) [0.00]*	1.71(6,1855) [0.11]
F(ndf,ddf)[p value][e]	-	6.89(5,5940) [0.00]*	-	1.25(5,448) [0.28]	-	0.48(5,2028) [0.79]
Number of temporally prior mental disorders						
None	-	(ref)	-	(ref)	-	(ref)
Exactly one mental disorder	-	(ref)	-	(ref)	-	(ref)
Exactly two mental disorders	-	0.6 (0.5-0.8)*	-	0.9 (0.6-1.5)	-	0.9 (0.4-1.7)
Three or more mental disorders	-	0.2 (0.1-0.4)*	-	0.9 (0.3-2.5)	-	0.5 (0.1-2.0)
F(ndf,ddf)[p value][g]	-	20.29(2,1182) [0.00]*	-	0.11(2,496) [0.90]	-	0.42(2,410) [0.66]

Note: [a] NSSI at least once in lifetime, [b] NSSI at least once in past 12-months, [c] NSSI at least five times in past 12-months, [d] F-test to evaluate joint significance of six types of mental disorders across 20 imputed datasets, [e] F-test to evaluate significant between-disorder differences in estimates across 20 imputed datasets. Each column of each model displays the result of a separate multivariate model within a person-period survival (onset models) or person-level time-order (recency and severity models) framework, with type of mental disorders (additive models) and type and number of mental disorders (interactive models) that occurred prior to NSSI as predictors, controlling for the following covariates: country membership, gender, age (onset models), education, marital status parents, religion, sexual orientation, person-year (onset models), high-school ranking (recency and severity models), age of onset NSSI (recency and severity models), and time since onset NSSI (recency and severity models). NSSI = Non-Suicidal Self-Injury, ndf = numerator degrees of freedom, ddf = denominator degrees of freedom.
*Significant at the .05 level, two-sided test.

Associations between NSSI and subsequent onset and recency of DSM-IV mental disorders (Objective 2)

We also examined the associations between NSSI and the subsequent onset and recency of particular mental disorders (Table 3.4). In bivariate survival models, NSSI predicted the subsequent onset of all included mental disorders (Median OR = 2.3). Controlling for pre-existing mental disorders, these associations became weaker but remained significant with odds ratios ranging from 1.3 for major depressive disorder to 2.0 for bipolar disorder (Median OR = 1.8). Bivariate- and multivariate models revealed that temporally prior NSSI was also associated with elevated odds of 12-month bipolar disorder (ORs in the 4.6-5.0 range) and generalized anxiety disorder (ORs in the 1.6-1.7 range) among college students who met criteria for these lifetime disorders.

Table 3.4. Associations between temporally prior non-suicidal self-injury and onset and recency of DSM-IV mental disorders in the WMH-ICS.

DSM-IV Mental Disorders	Onset:		Recency:	
	Bivariate aOR (95%CI)	Multivariate aOR (95%CI)	Bivariate aOR (95%CI)	Multivariate aOR (95%CI)
Major depressive disorder	1.5 (1.3-1.7)*	1.3 (1.1-1.5)*	1.1 (0.8-1.5)	1.1 (0.7-1.5)
Generalized anxiety disorder	2.1 (1.9-2.3)*	1.4 (1.3-1.6)*	1.7 (1.1-2.4)*	1.6 (1.1-2.3)*
Panic disorder	2.6 (2.1-3.2)*	1.7 (1.4-2.1)*	1.0 (0.4-2.7)	1.1 (0.4-2.8)
Bipolar disorder	3.1 (2.5-3.8)*	2.0 (1.6-2.5)*	5.0 (1.5-16.4)*	4.6 (1.4-15.4)*
Alcohol use disorder	2.1 (1.7-2.5)*	1.8 (1.5-2.3)*	1.3 (0.7-2.5)	1.2 (0.6-2.5)
Substance use disorder	2.5 (2.1-3.1)*	1.8 (1.5-2.3)*	1.1 (0.7-1.9)	1.0 (0.6-1.8)

Note: Each cell in the first and third column displays the result of a separate bivariate model within a person-period survival (onset models) or person-level time-order (recency models) framework, including temporally prior non-suicidal self-injury as predictor controlling for the following covariates: country membership, gender, age (onset models), education, marital status parents, religion, sexual orientation, person-year (onset models), high-school ranking (recency models) age of onset (recency models), and time since onset (recency models) of mental disorders. The second and fourth column display the result of a separate multivariate model controlling all sociodemographic variables of the bivariate models and all temporally primary mental disorders shown in the table, and the number of temporally mental disorders (not shown here, see supplementary tables 3.3-3.4).*Significant at the .05 level, two-sided test.

Discussion

The objective of this study was to provide a better understanding of the epidemiology of college student NSSI and the developmental relationship with DSM-IV mental disorders. Several noteworthy findings were revealed. Fist, consistent with meta-analytic findings in adolescent samples, we found a pooled cross-national lifetime NSSI prevalence of 17.7% with a typical onset in mid-adolescence (Gandhi et al., 2018; Swannell et al., 2014). In addition, we observed that NSSI persisted for 44% of students, of whom approximately one-quarter met the proposed 5+ diagnostic frequency criterion. On the one hand, it is encouraging to learn that the vast majority of adolescents entering college with a history of NSSI (~87%) have either not self-injured or only did so sporadically in the preceding 12-months. On the other hand, the fact that a subgroup of incoming students (~2.3%) screen positively for the proposed DSM-5 NSSI disorder, and may need specialized care for self-injury (Kiekens, Hasking, Claes, et al., 2018), remains a cause for concern. The current study also replicates that associations between sociodemographic characteristics and NSSI outcomes are generally weak (Bresin & Schoenleber, 2015; Kiekens et al., 2019) - illustrating that NSSI occurs across all segments of the population. Only identifying as non-heterosexual moderately increased risk of onset of NSSI (Batejan, Jarvi, & Swenson, 2015), as well as maintaining clinically severe levels of NSSI at college entrance.

Second, our temporally-ordered analyses confirm that the presence of a mental disorder predicts the subsequent onset of NSSI (Fox et al., 2015; Kiekens et al., 2019; Wilkinson et al., 2018). We observed a consistent increased risk for beginning NSSI after all of the mental disorders we examined - indicating that varied diagnostic contexts increase risk of NSSI. Considering different types of mental disorders, our findings provide further evidence that the presence of a mood disorder is most strongly associated with future risk of NSSI (Fox et al., 2015; Bentley et al., 2015). Extending earlier work, we also observed a dose-response relationship with the number of mental disorders, that became smaller as the number of preceding disorders increased. One potential explanation for this ceiling effect in predictive utility of mental disorder comorbidity may be shared etiological pathways through which disorders govern risk for onset of NSSI (Bentley et al., 2015; Caspi et al., 2014). Alternatively, it may be that the predictive power of mental illness has an upper limit, and additional specific factors, such as NSSI-related cognitions (Hasking et al., 2017) or self-criticism (Hooley & Franklin, 2017), are needed in determining who utilizes NSSI to resolve high levels of distress and

impairment. Future studies that illuminate the psychological mechanisms leading to NSSI are sorely needed to clarify the pathways through which mental disorders confer risk for onset of NSSI. Of note, however, while the presence and accumulation of mental disorders are associated with the subsequent onset of NSSI, multivariate analyses suggest that they are less useful in predicting recency and severity of NSSI. This finding is consistent with emerging evidence (Kiekens et al., 2017; Kiekens, Hasking, Claes, et al., 2018), and highlights the need to understand better what other (i.e., non-diagnostic) factors predict ongoing self-injury among college students with a history of NSSI. Ecological momentary assessment studies that study such relationships with high temporal specificity may provide a unique opportunity to clarify factors that govern proximal risk of NSSI among those at high risk (Kiekens et al., 2020; Nock, Prinstein, & Sterba, 2009; Rodriguez-Blanco et al., 2018).

Third, and perhaps most importantly, the current findings also suggest new insights into the predictive status of NSSI for subsequent mental disorders. We found that NSSI frequently occurs before mental disorders (32.7-69.8%), and is associated with higher odds for the onset of each examined mental disorder. The fact that this relationship was still present when controlling for the effects of other mental disorders provides solid evidence that NSSI is a salient behavioral marker of future mental illness (Wilkinson et al., 2018). In addition, we also observed that preceding NSSI predicted recency of generalized anxiety disorder and bipolar disorder in this first-year college student sample. Taking these results together adds to a growing body of evidence that forces us to rethink the historical perception that NSSI is only a symptom or outcome of mental illness. These findings underscore the importance of obtaining better insight into the developmental consequences of engaging in NSSI in order to clarify whether NSSI simply precedes (i.e., risk factor) or causes mental disorders (i.e., causal risk factor). This cannot be determined with the current approach, but requires future longitudinal process-oriented studies to shed light on the potential mechanisms underlying these time-ordered associations.

While this study has many strengths (e.g., large sample size, range of countries), several limitations should be kept in mind when interpreting these results. First, the cross-national prevalence estimates are based on a convenience sample of colleges with variable response rates, potentially limiting the generalizability of results. Second, the retrospective self-report nature of the data may introduce potential problems such as underreporting or biased recall. We attempted to limit this latter

concern by adopting a conservative approach in which predictor variables were lagged in person-year analyses and coded absent when the outcome occurred in the same year in person-level analyses. Third, we used screening scales instead of full diagnostic interviews to assess risk for mental disorders; hence, these prevalence rates should be interpreted cautiously. In addition, as diagnostic assessments were based on definitions and criteria of DSM-IV, replication is needed using disorder definitions and criteria of DSM-5. Fourth, the reciprocal associations between NSSI and other relevant mental disorders (e.g., eating disorders, post-traumatic stress disorder) were not assessed, and thus warrant additional research. Fifth, although 5+ NSSI days is one of the central criteria for the recently proposed NSSI disorder in DSM-5, this was operationalized as five or more NSSI acts in the past year and we did not assess full diagnostic criteria and had no information on the age of onset of NSSI disorder. Hence, we could not determine to what extent the presence of NSSI without meeting diagnostic criteria for NSSI disorder remains associated with later risk of mental disorders. Future prospective cohort studies should, therefore, consider the risk factor status of NSSI disorder versus behavior in predicting secondary mental disorders.

These limitations notwithstanding, the present study presents the first cross-national data on NSSI among first-year college students and provides novel evidence suggesting that NSSI may function as an outcome, and behavioral marker, of mental disorders throughout development. These findings have implications for our understanding of how NSSI relates to psychopathology and suggests that targeting adolescents with a history of NSSI in prevention interventions may hold potential to help offset significant future impairment and disease burden in college student populations. Prior to implementing such interventions, future studies that use prospective designs are needed to replicate these findings and also evaluate whether NSSI has any predictive value in determining first onset and persistence of mental disorders during the college years. Fortunately, the WMH-ICS initiative will also collect prospective data on large samples of college students that will allow us to explore these and other related hypotheses in future analyses.

In **Chapter 3**, we estimated the pooled prevalence of NSSI among first-year students worldwide and documented how NSSI relates to common mental disorders from a developmental perspective (Objective 1). This empirical study revealed a pooled lifetime and 12-month prevalence of 17.7% and 8.4% and showed that NSSI functions as both an outcome, and behavioral marker, of mental disorders. While we did also found that 2.3% meets the 5+ frequency criterion (criterion A) of the proposed DSM-5 NSSI disorder, we did not assess full diagnostic criteria. The empirical study described in **Chapter 4** addresses this, and investigates the prevalence and comorbidity patterns of NSSI disorder as well as its potential utility for college mental health (Objective 2).

Chapter 4

The DSM-5 Non-Suicidal Self-injury Disorder among First-Year College Students

ABSTRACT

Background: Approximately one in five college students report a history of non-suicidal self-injury (NSSI). However, it is unclear how many students meet criteria for the recently proposed DSM-5 Non-Suicidal Self-Injury-Disorder (NSSI-D). In this study, we used full NSSI-D criteria to identify those students most in need of clinical care.

Methods: Using data from the Leuven College Surveys (n = 4,565), we examined the 12-month prevalence of DSM-5 NSSI-D in a large and representative sample of incoming college students. We also explored the optimal frequency threshold as a function of interference in functioning due to NSSI, and examined comorbidity patterns with other 12-month mental disorders and suicidal thoughts and behaviors (STB).

Results: Twelve-month NSSI-D prevalence was 0.8% and more common among females (1.1%) than males (0.4%). The proposed 5+ diagnostic threshold was confirmed as yielding highest discrimination between threshold and subthreshold cases in terms of distress or disability due to NSSI. A dose-response relationship was observed for NSSI recency-severity (i.e., 12-month NSSI-D, subthreshold 12-month NSSI-D, past NSSI, no history of NSSI) with number of 12-month mental disorders and STB. NSSI-D occurred without comorbid disorders for one in five individuals, and remained associated with severe role impairment when controlling for the number of comorbid disorders.

Conclusions: These findings offer preliminary evidence that DSM-5 NSSI-D is uncommon among incoming college students, but may help improve the deployment of targeted resource allocation to those most in need of services. More work examining the validity of NSSI-D is required.

Keywords: college students, DSM-5, mental disorders, non-suicidal self-injury, suicide

Introduction

College entrance often marks the transition between adolescence and emerging adulthood (Arnett, 2015), a crucial developmental period for the occurrence of mental health problems (Auerbach et al., 2017; Hunt & Eisenberg, 2010). Non-suicidal self-injury (NSSI), the intentional destruction of one's body tissue with no intent to die (Nock & Favazza, 2009), including behaviors such as skin cutting, burning and self-battery, is eliciting increased concern on college campuses worldwide. International pooled prevalence estimates indicate ~20% of college students report engaging in any self-injury in their lifetime (Swannell et al., 2014), and 12-month rates range between 2-14% (Serras et al., 2010; Wilcox et al., 2012). NSSI is most often used to escape emotional turmoil (Bentley et al., 2014), and has been associated with greater risk of subsequent suicidal thoughts and behaviors (STB; Hamza & Willoughby, 2016; Mortier, Kiekens, et al., 2017; Whitlock et al., 2013), low levels of help-seeking (Gollust et al., 2008; Whitlock et al., 2011), and poorer academic performance (Kiekens et al., 2016). This has led researchers, clinicians, and policy-makers to argue that clinical services should be offered to college students with a history of NSSI.

However, in a resource-limited environment, addressing NSSI effectively necessitates accurate identification of those students most in need of services. Indeed, there are likely important differences in clinical severity among students who have ever engaged in NSSI. For instance, college students who engage in more frequent and ongoing NSSI may be at greater risk of adverse outcomes than those who have ceased their self-injury, or have only experimented with NSSI once or twice (Hamza & Willoughby, 2014; Kiekens et al., 2017; Whitlock, Muehlenkamp, & Eckenrode, 2008). To better understand NSSI severity and need for services among people who self-injure, the most recent edition of the Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition (DSM-5) includes Non-Suicidal Self-Injury-Disorder (NSSI-D) as a 'condition requiring further study' (American Psychiatric Association, 2013). This newly proposed disorder identifies those with more frequent NSSI (i.e., at least five days in the past year) who experience significant distress or interference in one or more areas of life due to their self-injury. Other diagnostic criteria include presence of a psychological precipitant (e.g., negative feelings), urge that is difficult to control prior to NSSI or frequent thoughts about NSSI, and the expectation that self-injury will provide emotional or cognitive relief, resolve interpersonal difficulties, or lead to positive feelings.

To date, studies that have examined NSSI-D using full DSM-5 criteria are scarce (see Zetterqvist, 2015), but emerging evidence from epidemiological studies suggests that the prevalence of NSSI-D may be quite low in community samples of (emerging) adults (less than 1%; Benjet et al., 2017; Plener et al., 2016). However, as no prior study has assessed the full DSM-5 criteria in a representative sample of college students, it remains unclear whether rates are also low among college students, or whether the high rate of NSSI engagement translates to an elevated rate of NSSI-D. The proposed study was designed to address this gap. In addition, more work is needed regarding the diagnostic correlates of NSSI-D. Prior research has shown that NSSI commonly co-occurs with other mental health problems (Benjet et al., 2017; Bentley et al., 2015; Taliaferro & Muehlenkamp, 2015b), yet is not pathognomonic of any particular condition (see Selby et al., 2015). Initial studies among clinical samples confirm the diagnostic heterogeneity of NSSI-D, but also observed that individuals who meet disorder criteria present with a more clinical profile than those not meeting criteria (Glenn & Klonsky, 2013; In-Albon, Ruf, & Schmid, 2013; Washburn, Potthoff, Juzwin, & Styer, 2015). Building upon these findings, we considered comorbidity patterns with other 12-month mental disorders and STB, and explored differences compared to those who engage in NSSI but do not meet criteria (i.e., subthreshold NSSI-D) and those who may once have engaged in, but have subsequently ceased, their self-injury (i.e., past NSSI). This will provide meaningful information about how NSSI-D corresponds to other mental health problems and inform discussions regarding the potential clinical relevance of DSM-5 NSSI-D for college mental health.

Here, we report data from the Leuven College Surveys (LCS, n.d.) - part of the World Mental Health International College Student Project (WMH-ICS, n.d.) - which includes representative samples of college students, surveyed to assess a wide range of mental health outcomes. Our main objectives were to: (1) estimate the 12-month prevalence of DSM-5 NSSI-D, (2) and examine associations with other 12-month mental disorders (i.e., major depressive disorder, generalized anxiety disorder, panic disorder, broad mania, and alcohol dependence) and 12-month STB (i.e., suicide ideation, plan, and attempt). Given debate regarding the clinically meaningful number of NSSI occurrences for diagnosis (Ammerman, Jacobucci, Kleiman, Muehlenkamp, & McCloskey, 2017; Muehlenkamp, Brausch, & Washburn, 2017), we also explored the association between number of NSSI occurrences in the past year and experience of distress or disability due to NSSI. Finally, to inform discussions about the validity of NSSI-D as a unique mental disorder (Selby et al., 2015), we tested whether NSSI-D is associated with severe role impairment in daily life when controlling comorbid disorders.

Methods

Procedures and sample

KU Leuven is Belgium's largest university with an enrollment of over 40,000 students. Between 2014 and 2016, all 8,530 freshmen were eligible for inclusion in the study (i.e. *census sampling*). Recruitment involved different strategies to increase the response rate. In the first phase, all incoming students were sent a standard invitation letter to a routine psycho-medical checkup organized by the university student health center, which included the survey. In the second phase, secured electronic links were sent to non-respondents using customized e-mails. The third phase was identical to the second, but included an additional incentive (i.e., a raffle for store coupons). Each phase included reminders, with eight as default maximum amount of contacts. In total, 4,565 freshmen (56.8% female, M_{age} = 18.3, SD = 1.1) completed all relevant sections (Response Rate = 53.5%). All procedures were in accordance with the 1964 Helsinki declaration and its later amendments. The study was approved by the university hospital and by the Belgian commission for the protection of privacy.

Measures

Non-suicidal self-injury. NSSI history was assessed using items from the self-report version of the Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock et al., 2007). The original SITBI has strong psychometric properties including good construct validity for NSSI (κ = 0.74-1.0) and excellent test-retest reliability for the presence of NSSI (κ = 1.0; Nock et al., 2007). The self-report version used in the current study also showed excellent test-retest reliability (κ = 1.0) and external validity (κ = 1.0) in a study designed to compare self-report measures of self-harm (Latimer et al., 2013). Respondents were presented with a behavior checklist, including 13 non-suicidal self-injurious behaviors (e.g., cutting or carving skin) and an 'other' category.

Using the SITBI and additional questions that map onto each of the *DSM-5* criteria (see Supplementary Table 4.1), students were classified as belonging to one of the four following groups: (1) NSSI-D (i.e., those meeting all *DSM-5* criteria), (2) subthreshold NSSI-D (i.e., NSSI in past 12-months without meeting all *DSM-5* criteria required for diagnosis), (3) past NSSI (i.e., NSSI history, but not in past 12-months), or (4) controls (i.e. respondents without prior NSSI). Additional questions assessed age of onset, and medical treatment history for NSSI.

Twelve-month suicidal thoughts and behaviors. STB within the preceding 12 months were also assessed with the self-report version of the SITBI (Nock et al., 2007). STB was conceptualized as a continuum, and included suicide ideation (i.e., 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). Construct validity of the SITBI ranged from substantial to good for STB (κ = 0.48-0.65), with test-retest reliability ranging from good to excellent for the presence of STB (κ = 0.70-1.00; Nock et al., 2007).

Twelve-month mental disorders. The Screening Scales of the Composite International Diagnostic Interview (CIDI-SC; Kessler & Ustun, 2004) were used to assess two 12-month 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 WHO to deliver reliable estimates of DSM-IV mental disorder diagnosis, with previous research indicating good concordance for the assessed disorders (AUC = .70-.78) between CIDI-SC and independent clinical diagnoses based on blinded structured clinical interviews (Kessler, Santiago, et al., 2013). Using the well-validated Alcohol Use Disorders Identification Test (Demartini & Carey, 2012; Saunders et al., 1993), students with 12-month risk for alcohol dependence were also identified.

Severe role impairment. Role impairment in daily life was assessed with a revised version of the Sheehan Disability Scale from the CIDI (Kessler & Ustun, 2004). This measure asks respondents the extent to which problems with physical or mental health in the past year interfered with home management, quality of work, social life, and close personal relationships. Severe role impairment was defined as a 7 to 10 rating in one or more domains (cf. Kessler et al., 2014)

Statistical analyses

To assess the representativeness of our data, a representativeness indicator (R-indicator) was calculated on a range of socio-demographic characteristics available for all students in the population: gender, age, nationality, parental financial situation, parental educational level, family composition, secondary school type, and current field of study (cf. Kiekens et al., 2016). R-indicator values range between 0 and 1, with the latter indicating sample data are fully representative with respect to the population characteristics considered (Schouten, Cobben, & Bethlehem, 2009). Potential residual non-response bias was taken into account using non-response propensity weighting techniques (Lee, 2006). This approach enables us to obtain more representative estimates for the entire student population.

Prevalence estimates are reported as weighted proportions with associated standard errors. Associations between categorical variables were analyzed using cross-tabulations and the Rao-Scott chi square statistic. Differences between groups on continuous variables were analyzed using ANOVA or Welch *F* statistic, and Bonferroni or Games-Howell post-hoc tests were performed, as appropriate. Using penalized maximum likelihood estimation (Heinze, 2006), Odds Ratios (OR) with 95% confidence intervals were estimated to: (1) examine whether NSSI-D captures individuals at increased risk for 12-month mental disorders and STB, (2) assess the optimal threshold for diagnosis (criterion A) as a function of experience of distress or disability due to NSSI (criterion E) using dummy variables for past-year NSSI frequency response categories, and (3) examine the residual association between NSSI-D and severe role impairment when controlling for the number of comorbid disorders. Analyses were performed with SAS (v9.4) and SPSS (v23).

Results

Sample representativeness

Table 4.1 shows the characteristics of the sample. An R-indicator of 0.87 was observed, indicating good representativeness of the respondent data based on these characteristics relative to the entire population of first-year college students.

Table 4.1. Charactertics of the sample (n = 4,565).

	% (*w*)	SE
Female Sex	56.8	0.7
Age:		
17 or younger	5.5	0.3
18 years	71.1	0.7
19 years	18.1	0.6
20 years or more	5.3	0.4
Belgian Nationality	95.3	0.3
Parents' Financial Situation Difficult	17.3	0.6
Parental Education:		
Both parents high	62.1	0.7
Only one parent high	22.6	0.6
None of parents high	15.3	0.5
Non-intact Familial Composition	23.3	0.6
University Group Membership:		
Biomedical Sciences	19.3	0.6
Human Sciences	54.6	0.7
Science & Technology	26.1	0.6
General Secondary Education	94.5	0.3

Note: % (*w*) = Weighted percetage, SE = Standard Error

Prevalence rates and descriptive analyses

Across the sample, 17.7% (SE = 0.6) reported engaging in NSSI at some point in their lifetime and 9.5% (SE = 0.4) reported that they did so in the past 12-months. The three most common forms of self-injury included 'smashing hands or feet against the wall or other objects' (8.7%, SE = 0.4), 'cutting or carving the skin' (6.1%, SE = 0.4), and 'scraping the skin' (5.0%, SE = 0.3). Prevalence of past NSSI, subthreshold NSSI-D and NSSI-D were estimated at 8.2% (SE = 0.4), 8.8% (SE = 0.4) and 0.8% (SE = 0.1), respectively. Table 4.2 presents an overview of NSSI-D criteria endorsed across each group. Prevalence rates of NSSI-D were significantly higher in females (1.1% SE = 0.2) than males (0.4% SE = 0.1, χ^2_{1df} = 6.7, *p* = .010).

Individuals meeting proposed criteria for NSSI-D (M = 5.4, SD = 2.6, F_{welch} 2,87 = 31.9, p < .001) utilized more NSSI methods than those reporting past NSSI (M = 1.9, SD = 1.4, p < .001), or subthreshold NSSI-D (M = 2.3, SD = 1.7, p <.001). Age of onset of NSSI (M = 13.8, SD = 3.4) was not significantly different across groups (F_{welch} 2,96 = 0.6, p = .558). Students meeting NSSI-D criteria more often required medical treatment for injuries (22.9%, SE = 7.1), than past or subthreshold cases (5.1-5.6% range, χ^2_{2df} = 17.2, p < .001).

The optimal frequency threshold (Criterion A) as a function of interference (Criterion E)

The currently proposed diagnostic threshold of 5 or more NSSI occurrences in the past year was most strongly associated with NSSI-specific interference (OR = 3.1, 95%CI = 1.2-8.1, p = .010; Figure 4.1). Increasing the diagnostic threshold did not result in higher proportions reporting interference above and beyond the *DSM-5* proposed criteria.
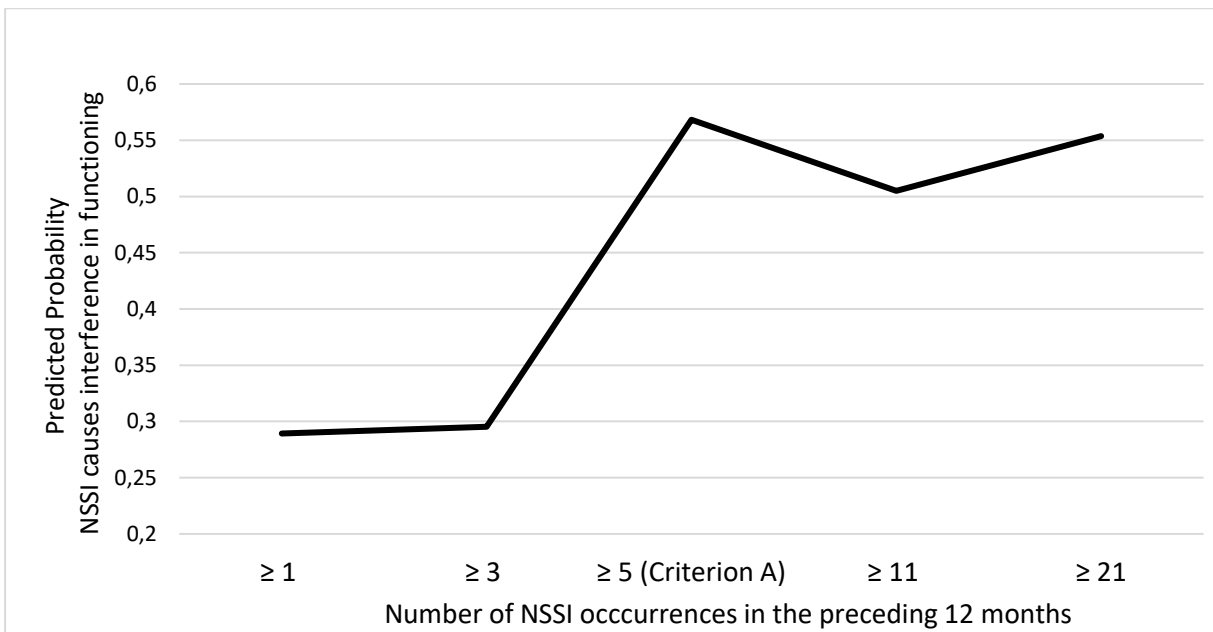
Figure 4.1. Associations between number of NSSI occurrences in the preceding 12 months (criterion A) and reported interference due to NSSI (criterion E) among students who self-injured in the past year and meet all other DSM-5 criteria (B, C, D, and F).

Table 4.2. DSM-5 criteria of non-suicidal self-injury disorder among college sample.

		Past NSSI $n(w)$ = 373 % (w) (SE)	Subthreshold NSSI-D $n(w)$ = 401 % (w) (SE)	NSSI-D $n(w)$ = 34 % (w) (SE)
Criterion A:	In the last year, the individual has on 5 or more days in the 12-months engaged in intentional self-inflicted damage to the surface of his or her body without suicidal intent.	0	16.9 (1.9)	100
Criterion B:	The individual engages in the self-injurious behavior with one or more of the following expectations:	83.6 (1.9)	74.7 (2.2)	100
	B1) To relieve negative thoughts or feelings	74.4 (2.3)	70.2 (2.3)	96.8 (3.2)
	B2) To resolve an interpersonal difficulty	27.3 (2.3)	21.1 (2.1)	38.3 (8.3)
	B3) To induce a positive state	35.3 (2.5)	34.5 (2.4)	66.3 (8.0)
Criterion C:	The intentional self-injury is associated with at least one of the following:	83.5 (1.9)	79.9 (2.0)	100
	C1) Negative thoughts or feelings or interpersonal problems occurring in the period immediately prior to the self-injurious act.	82.3 (2.0)	76.0 (2.2)	100 (0.0)
	C2) Prior to engaging in NSSI, there is a period of preoccupation with NSSI that is difficult to control.	14.2 (1.8)	17.5 (1.9)	64.3 (8.2)
	C3) Thinking about self-injury that occurs frequently, even when it is not acted upon.	2.6 (0.8)	15.7 (1.8)	80.7 (7.0)
Criterion D:	The behavior is not socially sanctioned (e.g., part of religious ritual) and is not restricted to picking a scab or nail biting.	98.9 (0.5)	97.5 (0.8)	100
Criterion E:	The behavior or its consequences cause:	25.3 (2.3)	19.7 (2.0)	100
	clinically significant distress (E1), and/or	13.1 (1.7)	9.7 (1.5)	39.9 (8.3)
	interference in interpersonal (E2),	14.9 (1.9)	9.9 (1.5)	65.3 (8.1)
	academic (E3), or	9.8 (1.6)	7.4 (1.3)	42.3 (8.4)
	other important areas of functioning (E4).	13.9 (1.8)	9.8 (1.5)	37.6 (8.3)
Criterion F:	The behavior does not occur exclusively in the context of another syndrome (e.g., substance intoxication) and cannot be explained better by another medical syndrome (e.g., trichotillomania or excoriation disorder).	97.8 (0.8)	96.4 (0.9)	100
Criteria Met:	1 or more	100 (0.0)	100 (0.0)	100
	2 or more	98.8 (0.6)	98.4 (0.6)	100
	3 or more	92.1 (1.4)	90.6 (1.5)	100
	4 or more	75.6 (2.2)	71.8 (2.3)	100
	5	22.7 (2.2)	24.3 (2.2)	100

Note: NSSI = Non-suicidal self-injury NSSI-D = Non-suicidal self-injury disorder.

Table 4.3. Prevalence rates of other 12-month mental disorders and suicidal thoughts and behaviors and comparisons with non-suicidal self-injury disorder.

	Prevalence rates				Comparisons		
	Controls	**Past NSSI**	**Subthreshold NSSI-D**	**NSSI-D**	**Controls vs. NSSI-D**	**Past NSSI vs. NSSI-D**	**Subthreshold vs. NSSI-D**
	%(*w*) (SE)	%(*w*) (SE)	%(*w*) (SE)	%(*w*) (SE)	OR (95%CI)	OR (95%CI)	OR (95%CI)
12-Month Mental Disorders:							
Major Depressive Disorder	7.1 (0.4)	21.1 (2.1)	33.8 (2.4)	63.8 (8.1)	**22.7** (11.3-45.5)	**6.4** (3.1-13.4)	**3.4** (1.7-6.9)
Broad mania	0.6 (0.1)	1.9 (0.7)	4.2 (1.0)	20.4 (6.9)	**46.5** (18.5-117.1)	**12.8** (4.2-38.9)	**6.0** (2.3-15.6)
Generalized Anxiety Disorder	5.0 (0.4)	17.6 (2.0)	19.5 (2.0)	54.1 (8.5)	**22.1** (11.2-43.6)	**5.5** (2.7-11.1)	**4.8** (2.4-9.8)
Panic Disorder	1.2 (0.2)	5.6 (1.2)	5.8 (1.2)	22.2 (7.0)	**25.0** (10.8-58.2)	**4.9** (2.0-12.2)	**4.8** (1.9-11.7)
Alcohol Dependence	3.4 (0.3)	6.1 (1.3)	5.5 (1.2)	16.1 (6.6)	**5.7** (2.3-14.1)	**3.1** (1.2-8.3)	**3.4** (1.3-9.2)
Any positive screen	13.4 (0.6)	35.5 (2.5)	44.4 (2.5)	80.7 (6.6)	**25.6** (11.2-58.6)	**7.9** (3.1-16.8)	**5.0** (2.1-11.6)
Number of Mental Disorders:							
None	86.6 (0.6)	64.5 (2.5)	55.6 (2.5)	19.3 (6.6)	Ref	Ref	Ref
Exactly 1	10.1 (0.5)	21.9 (2.2)	25.5 (2.2)	19.6 (6.7)	**8.7** (3.1-24.7)	**3.0** (1.0-8.7)	2.2 (0.8-6.4)
Exactly 2	2.8 (0.3)	10.3 (1.6)	15.0 (1.8)	34.4 (8.1)	**53. 2** (20.6-136.8)	**10.7** (4.0-28.7)	**6.4** (2.4-16.8)
3 or more	0.5 (0.1)	3.3 (0.9)	4.0 (1.0)	26.7 (7.6)	**224.8** (76.7-658.4)	**25.6** (8.2-79.7)	**18.6** (6.2-56.1)
χ² (*p*-value)					462.6 (*p*<.001)	60.1 (*p*<.001)	45.7 (*p*<.001)
12-Month Suicidal Thoughts and Behaviors:							
Suicide Ideation	4.2 (0.3)	10.9 (1.6)	24.3 (2.2)	61.8 (8.3)	**36.3** (18.1-72.9)	**12.9** (6.1-27.4)	**4.9** (2.4-10.1)
Suicide Plan	0.9 (0.2)	3.1 (0.9)	11.0 (1.6)	51.6 (8.5)	**115.9** (55.0-244.1)	**31.6** (13.0-76.3)	**8.5** (4.1-17.7)
Suicide Attempt	0.0 (0.0)	0.0 (0.0)	1.7 (0.7)	10.5 (5.0)	**331.9** (40.5-2719.6)	**97.8** (3.5-2759.2)	**6.9** (1.9-25.8)

Note: Associations shown in bold are significant (*p* < .05). NSSI = Non-suicidal self-injury NSSI-D = Non-suicidal self-injury disorder.

Associations with other 12-month mental disorders and suicidal thoughts and behaviors

Table 4.3 summarizes the associations with other 12-month mental disorders and STB across NSSI categories. Of those meeting proposed criteria for NSSI-D, 80.7% (SE = 6.6) also met criteria for at least one mental disorder in the last 12 months, with more than half having two or more comorbid disorders. Conversely, of those with at least one mental disorder, only 3.3% (SE = 0.6) met criteria for NSSI-D. NSSI-D co-occurred most frequently with 12-month MDD (63.8%, SE = 8.1), but was associated with higher odds of all examined 12-month disorders relative to controls (ORs in the 5.7-46.5 range), past NSSI (ORs in the 3.1-12.8 range), and subthreshold NSSI-D (ORs in the 3.4-6.0 range). Further, more than half of college students meeting proposed criteria for NSSI-D reported 12-month suicide ideation (61.8%, SE = 8.3) and suicide plans (51.6%, SE = 8.5). One in ten students with NSSI-D also reported a suicide attempt in the past 12 months. Meeting NSSI-D criteria was associated with higher odds of STB when compared to controls (ORs in the 36.3-331.9 range), students with past NSSI (ORs in the 12.9-97.8 range), and with subthreshold NSSI-D (ORs in the 4.9-8.5 range).

Severe role impairment in daily life

Severe role impairment in daily life, as assessed with the Sheehan Disability Scale, was reported by 10.3% (SE = 0.5), and was substantially more common among students with (58.9%, SE = 8.3) than without NSSI-D (10.0%, SE = 0.5; χ^2_{1df} = 89.5, p < .001). When controlling for the number of comorbid disorders[2], NSSI-D remained significantly associated with severe role impairment (Table 4.4).

Table 4.4. Associations with severe role impairment in daily life.

	OR (95%CI)	*p*
NSSI Disorder[a]	2.9 (1.3-6.6)	.010
Number of Comorbid Disorders:		
None	Ref	
Exactly 1	4.9 (3.9-6.3)	.002
Exactly 2	12.4 (9.1-16.8)	<.001
3 or more	40.6 (21.9-75.1)	<.001

Note: [a] Odds of impairment associated with NSSI disorder after controlling for number of comorbid disorders.

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[2] Post-hoc analyses revealed that NSSI-D was also associated with severe role impairment in daily life in the subsample without 12-month mental disorders (OR = 8.6, 95%CI = 1.7-43.5). However, due to low number of cases with NSSI-D in this subsample (n = 7), caution is needed in interpreting these findings.

Discussion

To the best of our knowledge, this is the first study that uses the full *DSM-5* criteria to provide information about the prevalence and diagnostic correlates of NSSI-D among college students. Several important findings warrant brief comment. First, consistent with recent work among young adults in the general population (Benjet et al., 2017), the proposed *DSM-5* criteria lead to more conservative prevalence estimates when considering severe NSSI. Although approximately one in six reported a history of self-injury, and one in ten reported past year NSSI, only 0.8% met criteria for NSSI-D. Given that most studies focus on lifetime or 12-month NSSI, which does not capture NSSI severity and need for clinical services, this is an important epidemiological finding. This shows that assessment of NSSI-D might help identify realistic proportions – i.e., an estimated 32 individuals out of more than 4,000 incoming students each year in our university - needing specialized care for NSSI. In line with previous studies (Plener et al., 2016; Zetterqvist, 2015), NSSI-D was more common among females.

Second, the proposed 5+ threshold was confirmed as yielding highest discrimination between threshold and subthreshold cases in terms of distress or disability due to NSSI. While this is in line with other work in college students (Ammerman et al., 2017), derived thresholds were higher in clinical samples (Muehlenkamp et al., 2017). However, given the characteristics of such data, empirically derived thresholds can always be assumed to yield higher cutoffs in clinical samples. Arguably, establishing accurate thresholds requires representative population data capturing the full range of NSSI severity. It will be important for future prospective studies to evaluate whether the currently proposed diagnostic accurately predict a more severe course of self-injury.

Third, in line with emerging evidence (Glenn & Klonsky, 2013; In-Albon et al., 2013; Washburn et al., 2015), students who meet diagnostic criteria for NSSI-D had a more clinical profile than those not meeting criteria. While this confirms a high level of clinical severity and need for services (Merikangas & Kalaydjian, 2007), it also raises questions regarding the reasons for these high rates of comorbid 12-month mental disorders and STB. One potential explanation may be shared risk factors and etiological pathways (e.g., childhood adversities, internalizing coping strategies, difficulties in emotion-regulation; Bentley et al., 2015; Kiekens et al., 2015; Nock, 2009). Such findings would support a unified approach to prevention and treatment. A second possibility is that the presence of one condition increases risk of another. For example, people with mental disorders may use NSSI to regulate strong aversive internal and social experiences (Klonsky, Glenn, Styer, Olino, & Washburn,

2015; Nock & Prinstein, 2004). However, over time, NSSI itself may also lead to significant distress (e.g., feelings of shame; Mahtani, Melvin, & Hasking, 2017) and disability (e.g., social isolation; Stänicke et al., 2018). Relatedly, theoretical accounts suggest that frequent NSSI may gradually prepare an individual to make a suicide attempt, by building-up an acquired capability for suicide through simultaneously lowering fear of death and heightening pain tolerance (Van Orden et al., 2010; Willoughby et al., 2015). That said, we also found that NSSI-D is not simply a marker of any particular disorder (Selby et al., 2015). Only 3% of people with mental disorders meet diagnostic criteria for NSSI-D, and for a small, but significant, group of young people (approximately 20%), NSSI-D occurred outside the context of a comorbid 12-month mental disorder. Further, our analyses indicated that NSSI-D is related to severe role impairment in daily life, over and above the presence of other debilitating mental disorders. Building upon these findings, future work should consider whether NSSI-D is prospectively associated with greater risk for adverse outcomes (e.g., college dropout, lower quality of life, higher risk for a suicide attempt) throughout the academic career.

Finally, while findings show that incoming college students with NSSI-D are most in need of clinical interventions, students with ongoing NSSI who do not meet *DSM-5* criteria, and even some with past NSSI behavior, remain at elevated risk for other 12-month mental disorders and STB. This shows that students with infrequent or less severe NSSI should not be overlooked when planning mental health promotion programs. Future research is warranted considering a stepped care approach to responding to self-injury on college campuses. Perhaps, less intensive forms of care (e.g., e-mental health) might be more appropriate to target less severe NSSI; addressing such questions in future research will ultimately inform appropriate resource allocation among the millions of college students who self-injure each year.

Limitations and future directions

Several limitations of the study should be noted. First, the response rate was relatively low (i.e., 53.5%), yielding the possibility of non-response bias that may limit the external validity of our findings. The observed R-indicator suggested a good sociodemographic representativeness of the respondent data and all analyses were non-response propensity weighted; however, this remains a concern. Second, although we used full DSM-5 criteria, it should be noted that we assessed the number of NSSI occurrences in the past year as opposed to the number of days (as stated in Criterion A). Future studies would benefit from using a measure specifically developed to assess NSSI-D (e.g., Victor, Davis,

& Klonsky, 2016). Further, we used screeners rather than full diagnostic interviews to assess comorbid 12-month mental disorders. Although these screeners have shown good concordance in clinical reappraisal studies (Kessler, Calabrese, et al., 2013; Kessler, Santiago, et al., 2013), they are not a substitute for in-depth clinical interviews. Therefore, it will be important for future research to examine the consistency of the findings obtained here with those in studies using clinical interviews.

Third, due to the low prevalence of NSSI-D, our analyses of psychiatric comorbidity were restricted to bivariate models. It is therefore likely that some associations are actually effects of other comorbid disorders. Relatedly, we controlled the number of comorbid disorders when examining the association between NSSI-D and severe role impairment in daily life. This assumes that the effect of comorbid mental disorders is additive and independent of disorder type. Future studies with larger sample sizes should relax these constraints in more complex models that also include disorder type and allow for interactions. Fourth, some comorbid mental disorders (e.g., eating disorders, post-traumatic stress disorder, and borderline personality disorder) were not included and warrant more research. Borderline personality disorder (BPD) is relevant in this context, as NSSI is included in DSM-5 as a symptom of BPD (APA, 2013). More work is warranted that specifically investigates variation in etiological mechanisms, as well as prognosis and treatment response, of persons with different disorder profiles (e.g., NSSI-D with vs. without comorbid BPD). Studies that conceptualize personality disorders from a dimensional approach, as currently listed in section III of DSM-5 (APA, 2013), will be particularly useful in providing a thorough understanding of personality traits that may underlie NSSI-D for some individuals, irrespective of whether an actual personality disorder is present. Despite these limitations, the present study adds valuable information to the emerging literature about NSSI-D.

Conclusion

NSSI prevalence rates are prohibitively high to feasibly offer specialized clinical care to all incoming college students who have engaged in this behavior. Our data suggest that the proposed DSM-5 criteria could help improve the deployment of targeted resource allocation for a small group of incoming college students who engage in frequent, and clinically severe, NSSI that causes distress or disability. These students will often present with a more clinical profile which emphasizes the need for a thorough clinical assessment. We found evidence that the proposed 5+ diagnostic threshold meaningfully distinguishes students who experience distress or disability due to their self-injury, and observed that NSSI-D is associated with severe role impairment in daily life above and beyond number

of comorbid mental disorders. While these findings provide preliminary support for the validity and utility of NSSI-D, future studies should advance our understanding of the risk factors, course and potential burden of this newly proposed disorder to determine its relative merit for college mental health.

The empirical **Chapters 3-4** provided a clearer epidemiological picture of NSSI (Objective 1) and NSSI disorder (Objective 2) among first-year college students. While **Chapter** 3 also identified NSSI as a behavioral marker indicating heightened risk of common mental disorders, **Chapter 5** presents the results of an investigation into the extent to which NSSI thoughts and NSSI behavior can be considered a robust risk factor for developing suicidal thoughts and behaviors, including first onset suicide ideation, plan, and attempt (Objective 3).

Chapter 5

The Associations between Non-Suicidal Self-Injury and the Onset of Suicidal Thoughts and Behaviors

ABSTRACT

Background: Theoretical and empirical literature suggest 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, GAD, Panic Disorder, Broad Mania, and 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 among students reporting NSSI.

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.

Keywords: non-suicidal self-injury, suicidal thoughts and behaviors, mental disorders

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 & Favazza, 2009), is a significant public health concern in young people. In community samples, 17-18% of adolescents and 12-20% of emerging adults report having engaged in NSSI at least once in their lifetime (Muehlenkamp et al., 2012; 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., 2018)

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, Auerbach, Alonso, Axinn, 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 Grandclerc et al., 2016; Hamza et al., 2012). 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, Fox, & Prinstein, 2012; Hamza & 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., 2015; Taliaferro & Muehlenkamp, 2015b), 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., 2018; Hamza & Willoughby, 2016; Mortier, Demyttenaere, 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, Bryan, May, & Klonsky, 2015). If NSSI is used as a means of averting thoughts and plans about suicide (cf. 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, Andrews, & Martin, 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 & 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 (Ammerman, Burke, Alloy, & McCloskey, 2016; Burke, Jacobucci, et al., 2018; Nock et al., 2006; Paul, Tsypes, Eidlitz, Ernhout, & Whitlock, 2015; Stewart et al., 2017; Victor & Klonsky, 2014). However, because these NSSI characteristics have been identified separately across studies, and few studies considered these characteristics in multivariate models (Burke, Jacobucci, 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 youth 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.

Methods

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, n. d.). For the purpose of the current study, baseline data collected between 2014-2017 at KU Leuven (Belgium) and between 2016-2017 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; Supplementary Table 5.1) 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 good sociodemographic representativeness of the respondent data for both samples.

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-function 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.

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 & Ustun, 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 (Kessler, Santiago, et al., 2013). Using the well-validated Alcohol Use Disorders Identification Test (Demartini & 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.

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 reporting 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.

Results

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 χ^2_{1df} = 7.8, p = .005) and suicide attempt (3.7% vs. 2.1%; Rho χ^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 χ^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 χ^2_{1df} = 0.0, *p* = .922).

Table 5.1. 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

We first examined the occurrence of STB among respondents with and without NSSI thoughts and NSSI regardless of the temporal order (Table 5.1). Compared to respondents without a prior history of NSSI thoughts or 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 5.2 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.

Table 5.2. Mean onset ages and temporal priorities among respondents with non-suicidal self-injury.

	Mean age of onset (SD)	*M* time-lag (SD) from NSSI[a]	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.

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 5.3).

Table 5.3. 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

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 $\chi^2_{1\text{df}}$ = 52.4, *p* < .001) or NSSI (53.2%, SE = 1.3, Rho $\chi^2_{1\text{df}}$ = 732.2, *p* < .001) were more likely to report at least one lifetime mental disorder (Supplementary Table 5.2). Even after controlling for comorbid mental disorders in multivariate

models, NSSI thoughts and NSSI remained significantly associated with increased risk of onset of suicide ideation and suicide plan (ORs in the 2.8-3.5 range; Table 5.4). 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 5.4, NSSI thoughts were nonsignificant predictors in multivariate models. In contrast, NSSI remained a significant, 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 5.3). 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 Figure 5.1, respondents with both NSSI and Major Depressive Disorder have a substantially greater likelihood of a subsequent onset of suicide ideation (Figure 5.1a) and suicide plan (Figure 5.1b) 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).

Table 5.4. 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
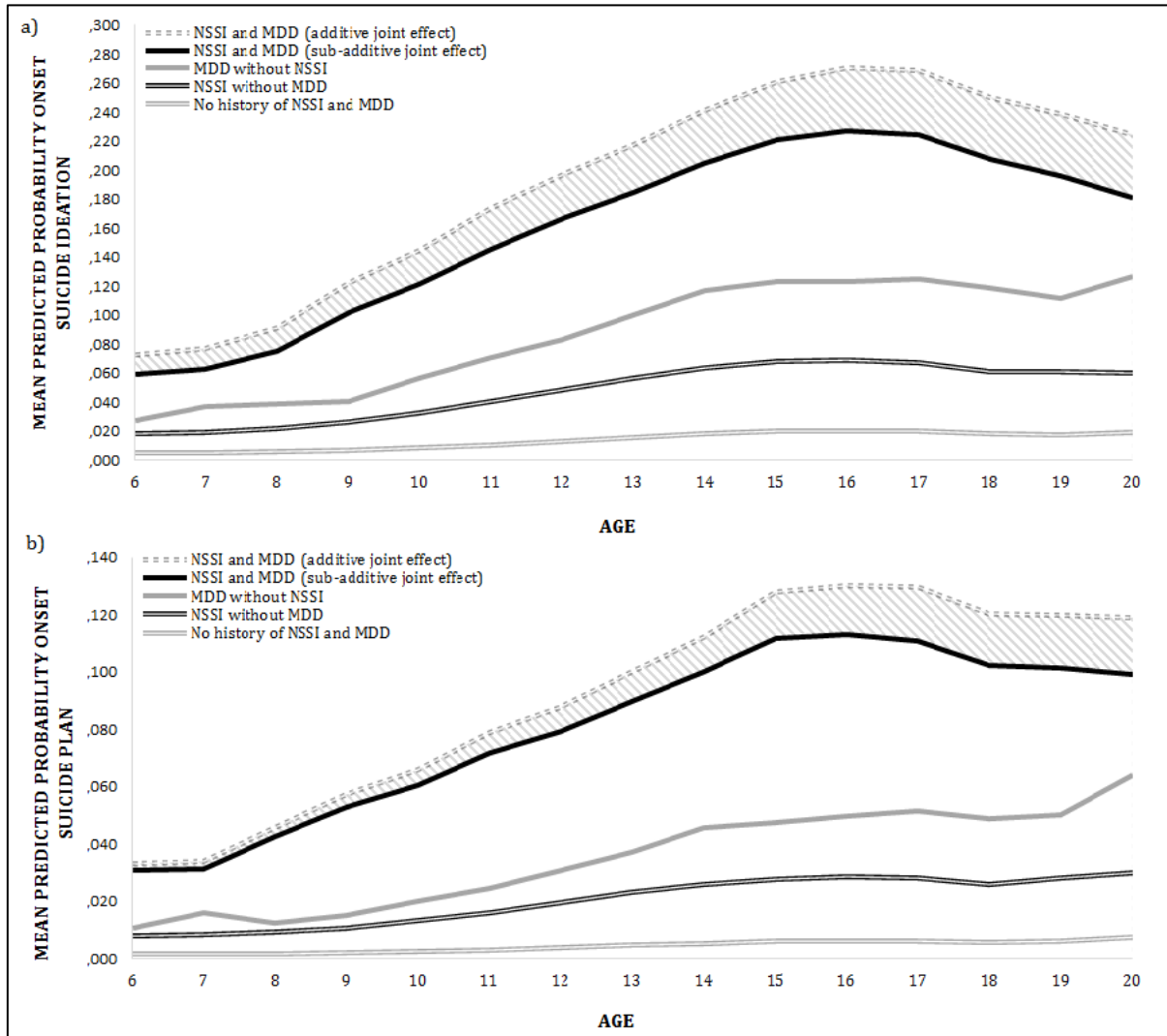
Figure 5.1. Mean Predicted probability curves for an onset of suicide ideation (a) and suicide plan (b). The marked area indicates the difference of the joint effect of NSSI and Major Depressive Disorder in the prediction of onset suicide ideation and plan between an additive and interactive model (i.e., 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.

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 5.5 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 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 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 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 more likely to report a history of cutting. Finally, respondents who required medical treatment for NSSI were more likely to have experienced only suicide ideation as well as transitions to attempts.

Table 5.5. 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, 95%CI = 95% confidence interval. NSSI = Non-Suicidal Self-Injury. * *p* < .05, ** *p* < .01, *** *p* < .001

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 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 suicide. In line with emerging evidence (Chu et al., 2018; Guan et al., 2012; Hamza & Willoughby, 2016), 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 through partially similar pathways (Hofmann, Sawyer, Fang, & Asnaani, 2012; Law, Khazem, & Anestis, 2015; Miranda & Nolen-Hoeksema, 2007; Selby, Kranzler, Panza, & Fehling, 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 & May, 2014), we evaluated whether NSSI increases risk of transitioning from 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., 2017; 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 & Muehlenkamp, 2018; Paul et al., 2015; Victor, Styer, & Washburn, 2015). Taken together, the current findings support the view that NSSI might be a particularly salient factor in the prevention of suicide (Klonsky & May, 2014; Klonsky et al., 2013).

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.

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 & Klonsky, 2014). However, more research is needed to illuminate which NSSI characteristics may be most important to consider for clinicians (Burke, Jacobucci, 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, Nock, & Kranzler, 2014). Also in line with prior research, individuals who reported more frequent NSSI (Paul et al., 2015; Victor & Klonsky, 2014) or needed medical treatment for NSSI (Burke, Jacobucci, et al., 2018) were more likely to have subsequently attempted suicide. However, in contrast with prior findings (Stewart et al., 2017; Victor & 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 a particularly salient factor 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, Jacobucci, Kleiman, Uyeji, & McCloskey, 2018), 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.

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, Prinstein, & Sterba, 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, Calabrese, et al., 2013; Kessler, Santiago, et al., 2013), 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 current 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.

In **chapter 5**, we investigated the time-ordered associations between NSSI and first onset suicidal thoughts and behaviors. This revealed that the presence of NSSI is associated with increased risk for onset suicide attempt (on average three years later), as well as suicide ideation and suicide plans, over and above the effect of common mental disorders. Coupled with the findings from **Chapter 3** that NSSI also uniquely predicts later mental disorders provides novel insight into the clinical significance of NSSI for college student mental health (Objective 3). While this highlights the importance of adequately responding to NSSI, and the underlying psychosocial vulnerabilities, on college campuses, there is no evidence-based method of identifying students at high risk of beginning NSSI during the college period. This limitation is addressed in the next study. The empirical study described in **Chapter 6** estimates the incidence of NSSI during the first two years of college, examines a range of risk and protective factors, and evaluates the accuracy of a multivariate prediction model for the onset of NSSI among college students (Objective 4).

Chapter 6

Predicting the Onset of Non-Suicidal Self-Injury during the College Period

ABSTRACT

Background: Despite increased awareness that non-suicidal self-injury (NSSI) poses a significant public health concern on college campuses worldwide, few studies have prospectively investigated the incidence of NSSI in college and considered targeting college entrants at high risk for onset of NSSI.

Methods: Using data from the Leuven College Surveys (n = 4,565; 56.8%female, M_{age} = 18.3, SD = 1.1), students provided data on NSSI, sociodemographics, traumatic experiences, stressful events, perceived social support, and mental disorders. A total of 2,163 baseline responders provided data at a two-year annual follow-up assessment (63.2% conditional response rate).

Results: One-year incidence of first onset NSSI was 10.3% in year 1 and 6.0% in year 2, with a total of 8.6% reporting sporadic NSSI (1-4 times per year) and 7.0% reporting repetitive NSSI (≥ 5 times per year) during the first two years of college. Many hypothesized proximal and distal risk factors were associated with the subsequent onset of NSSI (ORs = 1.5-18.2). Dating violence prior to age 17 and severe role impairment in daily life were the strongest predictors. Multivariate prediction suggests that an intervention focused on the 10% at highest risk would reach 23.9% of students who report sporadic, and 36.1% of students who report repetitive NSSI during college (cross-validated AUCs = .70-.75).

Discussion: The college period carries high risk for the onset of NSSI. Individualized web-based screening may be a promising approach for detecting emerging adults at high risk for self-injury and offering timely intervention.

Keywords: non-suicidal self-injury, incidence, prediction, emerging adults, prevention

Introduction

The college years mark the transition from adolescence to emerging adulthood; a unique developmental period characterized by increasing opportunities in academic, personal, and social areas of life (Arnett, 2015). Yet, this period also is one of heightened risk for mental disorders and risky behaviors (Auerbach et al., 2018; Bruffaerts et al., 2018; Mortier, Demyttenaere, et al., 2017; Zivin et al., 2009). Non-suicidal self-injury (NSSI), the intentional damage to one's body tissue (e.g., scraping the skin; self-battery) without suicidal intent (Nock & Favazza, 2009), is becoming increasingly recognized as a public health concern on college campuses. While NSSI has historically been conceptualized as a symptom of mental disorders, there is now increased awareness that NSSI is not symptomatic of any particular disorder and should be conceptualized as a behavior that warrants research and intervention in its own right (Bentley et al., 2015; Glenn, Jaroszewski, Millner, Kearns, & Nock, 2015; Kiekens, Hasking, Claes, et al., 2018; Nock, 2009; Nock et al., 2006; Selby et al., 2015). International pooled lifetime prevalence estimates of NSSI are around 20% in college students (Swannell et al., 2014), with 12-month estimates in the 2-14% range (Serras et al., 2010; Wilcox et al., 2012). Although not always associated with suicide risk, NSSI (especially repetitive and severe self-injury) is one of the strongest independent predictors of future suicide attempts (Hamza & Willoughby, 2016; Kiekens, Hasking, Boyes, et al., 2018; Mortier, Demyttenaere, et al., 2017; Ribeiro et al., 2016; Whitlock et al., 2013), and is associated with severe role impairment in daily life (Kiekens, Hasking, Claes, et al., 2018), stigma and feelings of shame (Burke, Piccirillo, Moore-Berg, Alloy, & Heimberg, 2019; VanDerhei, Rojahn, Stuewig, & McKnight, 2014), low levels of help-seeking (Gollust et al., 2008; Whitlock et al., 2011), and poorer academic performance (Kiekens et al., 2016). These findings underscore the necessity to address and respond to NSSI among college students (Lewis et al., 2019).

Although many colleges have begun to implement risk assessment and prevention programs for mental health problems (Bendtsen et al., 2015; Harrer et al.), NSSI is rarely included in these efforts. Importantly, however, although NSSI onset peaks in mid-adolescence (Plener et al., 2015), recent evidence suggests a second peak around the age of 20 (Gandhi et al., 2018). Hence, there is potential to reach out to students *before* NSSI and associated negative outcomes occur. Franklin and colleagues recently demonstrated a reduction in frequency of NSSI through use of a mobile app that focuses on the barriers to NSSI (e.g., by increasing self-worth; Franklin et al., 2016). It is possible that similar initiatives may be effective in preventing onset among at risk students. However, there is not yet any

evidence-based method of identifying students at risk for onset of NSSI. This is in part due to two important limitations in the literature. First, most of what is known about potential risk factors stems from cross-sectional approaches investigating correlates among convenience samples. Whereas these studies can provide clues about potential predictors of interest, the nature of the designs and samples limit the generality of the findings (Kraemer et al., 1997). Second, the prospective studies available focused primarily on risk factors for NSSI persistence (i.e., ongoing vs. ceased NSSI; Glenn & Klonsky, 2011; Hamza & Willoughby, 2014; Kiekens et al., 2017; Riley, Combs, Jordan, & Smith, 2015; Wilcox et al., 2012). While these studies provide valuable information to aid clinical decision making for persons who already engage in NSSI, it does not provide means to detect emerging adults who are likely to start engaging in NSSI. Two earlier studies reported 9-12-month onset rates in the 2-4% range in college students (Hamza & Willoughby, 2014; Riley et al., 2015). However, these studies may have failed to include a representative college sample (e.g., only college women, convenience sampling) and incorporated a narrow set of predictors, precluding the development of integrative prediction models to detect students at highest risk for NSSI onset. We aimed to address these gaps in the literature making use of a large longitudinal sample of college students from the Leuven College Surveys (LCS, n.d.), part of the WHO World Mental Health International College Student initiative (WMH-ICS, n.d.).

Our objectives were to: 1) estimate the incidence of NSSI during the first two years of college, 2) examine a broad range of proximal and distal risk factors, and 3) evaluate the accuracy of a multivariate risk prediction model for the onset of NSSI. In line with the proposition that NSSI is a complex behavior that is determined by a multitude of factors (Nock, 2010), we did not anticipate a clear set of risk factors for onset NSSI. Potential predictors we assessed are well-established correlates of NSSI in college students, including sociodemographic and college-related characteristics (Kiekens et al., 2016; Whitlock et al., 2011), childhood-adolescent trauma (Liu et al., 2018; Martin et al., 2016; Taliaferro & Muehlenkamp, 2015a), recent stressful experiences and perceived social support (Kiekens et al., 2017; Taliaferro & Muehlenkamp, 2015a; Wilcox et al., 2012), and mental disorders (Bentley et al., 2015; Kiekens, Hasking, Claes, et al., 2018; Taliaferro & Muehlenkamp, 2015b). Consistent with the proposed DSM-5 frequency criterion (i.e., self-injury on 5 or more days in the past year; American Psychiatric Association, 2013,) we determined the predictive value of risk factors separately for the onset of both sporadic and repetitive NSSI (i.e., ≥ 5 times per year), occurring during the first two years of college.

Methods

Procedures and sample description

Detailed recruitment strategies of the LCS have previously been described (Kiekens et al., 2016; Mortier, Demyttenaere, et al., 2017). Recruitment involved different strategies to increase the response rate. In the first phase, all incoming students were sent a standard invitation letter to a routine psycho-medical checkup organized by the university student health center, which included the survey. In the second phase, secured electronic links were sent to non-respondents using customized e-mails. The third phase was identical to the second, but included an additional incentive (i.e., a raffle for store coupons). Each phase included reminders, with eight as default maximum amount of contacts. In the academic years 2014-2015 and 2015-2016, all 8,530 first-year students were invited to participate, and a total of 4,565 students completed the baseline survey (56.8% female, M_{age} = 18.3, SD = 1.1; Response Rate = 53.5%). Baseline responders were invited via email, to participate in the follow-up surveys 12 and 24 months after the baseline assessment. A total of 2,163 of the baseline respondents participated in at least one follow-up survey (63.2% conditional response rate after adjusting for non-participation due to college attrition). Informed consent was obtained from all participants at each wave and the study's protocol was approved by the University's Ethical Review Board.

Measures

Sociodemographic and college-related variables included gender, age, nationality, perceived parental financial situation, parental educational level, family composition, subject area enrollment (e.g., biomedical sciences, science and technology), and type of secondary school attended (i.e., vocational vs. academic track).

Non-suicidal self-injury was assessed with the self-report version of the well-validated Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock et al., 2007). The self-report version showed excellent test-retest reliability and external validity in a comparison study of self-report questionnaires (Latimer et al., 2013). To assess lifetime NSSI thoughts, we asked respondents whether they ever had "thoughts of purposely hurting themselves, without wanting to die". Incident NSSI was assessed via a checklist of 13 NSSI methods (e.g., cutting, burning, hitting) and an 'other' category that asked respondents whether they used that NSSI method to 'hurt themselves on purpose, without wanting to

die.' Using follow-up questions, we assessed whether students engaged in 12-month sporadic (i.e., 1-4 times) or repetitive NSSI (i.e., ≥ 5 times).

Traumatic experiences prior to the age of 17 were assessed using 19 items from the Composite International Diagnostic Interview-3.0 (CIDI; Kessler & Ustun, 2004), the Adverse Childhood Experience Scale (Felitti et al., 1998), and the Bully Survey (Swearer & Cary, 2003). Items assessed parental psychopathology (i.e., any serious mental health problems, criminal activities, or interpersonal violence), physical abuse (e.g., family member hit you so hard that it left bruises), emotional abuse (e.g., family member repeatedly said hurtful or insulting things), sexual abuse (e.g., family member touched or made you touch them in a sexual way against your will), neglect (i.e., nobody took care of you, or protected you, or made sure you had the things you needed), dating violence (i.e., you were in a romantic relationship where your partner repeatedly hit you or hurt you) and bully victimization (including verbal, physical, and cyberbullying). Items were rated on a five-point Likert scale ("never," "rarely," "sometimes," "often," and "very often"). Previous research using confirmatory factor analysis showed an excellent fit of the factor structure of the used items (Mortier, Demyttenaere, et al., 2017). In order to obtain dichotomously coded variables for the calculation of population attributable risk proportions, "rarely" was used as the cutoff for experiencing each traumatic event, except bully victimization where "sometimes" was used as cutoff (Nansel et al., 2001).

Stressful experiences and perceived social support. Making use of well-validated screeners (Bray & Hourani, 2007; Brugha & Cragg, 1990; Vogt, Proctor, King, King, & Vasterling, 2008), we assessed a range of 12-month stressful experiences (e.g., life-threatening illness or injury of family member or close friend). Using the Social Network section of the CIDI-3.0 (Kessler & Ustun, 2004), participants indicated whether they felt they could rely on family, friends, and partner (when present) if they had a serious problem. Items were rated on a four-point scale ("a lot", "some", "a little", and "not at all"). To allow the calculation of population attributable risk proportions, networks that were perceived as unavailable for support "a lot" were coded as unsatisfactory.

Risk for mental disorders and associated impairment. The CIDI Screening Scales (Kessler, Calabrese, et al., 2013; Kessler & Ustun, 2004), developed by the World Health Organization to deliver prevalence estimates of DSM-IV mental disorders, were used to assess 12-month Major Depressive Disorder, Broad Mania (mania/hypomania), Generalized Anxiety Disorder, and Panic Disorder. The Alcohol Use Disorders Identification Test was used to identify students engaging in "risky or hazardous

drinking" and students with "risk for alcohol dependence" (Demartini & Carey, 2012). Using additional items from the CIDI-3.0, we also screened students for intermittent explosive disorder (i.e., history of repeated attacks of anger when suddenly you lost control and either broke or smashed something, hit or tried to hurt someone, or threatened someone), eating disorders (i.e., binges at least twice a week or history of vomiting or taking laxatives or other things to avoid gaining weight), psychotic disorder (i.e., history of seeing things other people couldn't see or hear, or having thoughts like believing your mind was being controlled by outside forces) and post-traumatic stress disorder (i.e., times lasting 1 month or longer after an extremely stressful experience when you had repetitive upsetting memories or dreams, felt emotionally distant or depressed, and had trouble sleeping or concentrating). Finally, using the Sheehan Disability Scale, 12-month severe role impairment in daily life was assessed (Kessler et al., 2014; Kessler & Ustun, 2004).

Twelve-month suicidal thoughts and behaviors were assessed with a modified version of the Columbia Suicidal Severity Rating Scale and included suicide ideation (i.e., 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) (Posner et al., 2011).

Statistical analyses

Appropriate missing data strategies were used to ensure that findings are representative for the entire student population. Specifically, non-response propensity weights were calculated based on sociodemographic and college-related variables available for the entire first-year cohort (Kiekens et al., 2016), and multivariate imputation by chained equations was used to adjust for survey attrition and within-survey item non-response (van Buuren, 2007). Using the package mice() in R (van Buuren & Groothuis-Oudshoorn, 2011), the final data consisted of 200 imputed datasets obtained after 100 iterations. For the purpose of this study, analyses were restricted to students reporting no prior history of NSSI at baseline (n = 3,761). Descriptive statistics and incidence estimates are reported as weighted numbers (n), and weighted proportions (%) with associated standard errors. One-year NSSI incidence proportions were calculated by using first onset NSSI follow-up cases as the numerator, and cases without NSSI at the previous wave as the denominator. Logistic regression analysis was used to test the strength of associations between risk indicators recorded at baseline and incident NSSI. Measures of association were reported as odds ratios and associated 95% confidence intervals. Each risk factor

was evaluated in bivariate and multivariate models within risk domains. Population-level effect sizes were estimated using population attributable risk proportions (PARPs; Kessler et al., 2012). PARPs provide an estimate of the proportion of cases that would potentially be prevented if it were possible to fully eliminate causal risk factor(s) under examination.

Based on multivariate equations including all risk factors in the study (>50 coefficients), we then calculated individual cumulative risk probabilities. Resulting Area Under the Curve (AUC) values close to .56, .64, and .71 are considered, respectively, as small, moderate, and large effects (Rice & Harris, 2005). Predicted probabilities were discretized into deciles (10 groups of equal size ordered by percentiles) and cross-classified with observed cases to visualize the concentration of risk associated with high composite predicted probabilities. Sensitivity was defined as the proportion of cases found among pre-defined proportions of respondents with the highest predicted probabilities. Positive predictive value (PPV) was defined as the probability of students developing NSSI when estimated among predefined proportions of respondents with the highest predicted probabilities. We used the method of leave-one-out cross-validation to correct for the over-estimation of prediction accuracy when both estimating and evaluating model fit in a single sample (Efron & Gong, 1993). Firth's penalized likelihood estimation was applied to avoid overfitting and inconsistent estimators due to data sparseness (Heinze, 2006). All analyses were performed with SAS (version 9.4) and R (version 3.5.1).

Results

Incidence of NSSI during college

The 12-month incidence of NSSI was estimated at 10.3% (SE = 0.8) in year 1, and 6.0% (SE = 0.7) in year 2. Aggregated rates of onset of NSSI were estimated at 15.6% (SE = 0.9) during the first two college years, with 8.6% (SE = 0.8) reporting sporadic NSSI and 7.0% (SE = 0.6) reporting repetitive NSSI. The three most commonly reported methods were smashing hand or foot against the wall or other objects (52.0%, SE = 3.5), scraping the skin (37.3%, SE = 3.3), and hitting oneself (35.1%, SE = 3.1).

Bivariate and multivariate risk factors for onset of NSSI

The investigation of different risk factor domains revealed the following key findings at the individual-level. First, the most important sociodemographic and college-related variable that predicted NSSI onset was vocational secondary school track (Table 6.1). Second, while a variety of

traumatic experiences prior to the age of 17 predicted both sporadic and repetitive NSSI (Table 6.2), in multivariate models only dating violence, emotional abuse, and bully victimization were significant predictors of both forms of NSSI.

Third, in bivariate models, an examination of the temporal associations between 12-month stressful experiences and incident NSSI revealed that several proximal interpersonal stressors (e.g., serious betrayal by someone other than partner) were predictive of sporadic and/or repetitive NSSI (Table 6.3). However, in multivariate models only unsatisfactory peer support predicted both forms of NSSI. Repetitive NSSI was also significantly associated with unsatisfactory family support, serious ongoing arguments or break-ups, and other stressful events. Fourth, mental disorders and symptoms of psychopathology were consistently associated with increased risk for sporadic and/or repetitive onset of NSSI, with the only exception being alcohol use disorder (Table 6.4). In multivariate models, however, only 12-month suicidal ideation and severe role impairment in daily life were uniquely predictive of both forms of NSSI.

Next, we determined the potential population-level impact of the examined risk domains for the onset of NSSI. Assuming a causal association, we estimated that one third of sporadic NSSI (PARP = 32.9%), and nearly one half of repetitive NSSI (PARP = 46.0%), occurring for the first time in college, might have been preventable if it were possible to prevent any childhood-adolescent traumatic experiences. Somewhat smaller PARPs were observed for 12-month stressful experiences for onset of sporadic (PARP = 21.5%) and repetitive (PARP = 34.9%) NSSI. The highest PARPs (sporadic = 37.8%; repetitive = 51.1%), however, were found for mental disorders and symptoms of psychopathology. The single most important risk factors at the population-level were bullying victimization for sporadic NSSI (PARP = 11.3%) and unsatisfactory peer support for repetitive NSSI (PARP = 14.0%).

Table 6.1. Sociodemographic and college-related variables as baseline predictors for onset of non-suicidal self-injury.

	Prevalence[a]			Sporadic NSSI			Repetitive NSSI		
				Bivariate model[b]	Multivariate model[c]		Bivariate model[b]	Multivariate model[c]	
	w(n)	w(%)	SE	OR (95% CI)	OR (95% CI)	PARP (%)	OR (95% CI)	OR (95% CI)	PARP (%)
Sex (male)	1,658	44.1	0.8	1.0 (0.7-1.4)	1.0 (0.7-1.4)	0.5	0.9 (0.6-1.3)	0.9 (0.7-1.3)	-3.3
Age > 18 years	855	22.8	0.7	1.4 (1.0-2.0)	1.2 (0.8-1.7)	3.4	**1.5 (1.0-2.2)**	1.2 (0.9-1.8)	3.9
Non-Belgian nationality	172	4.6	0.3	**2.3 (1.2-4.2)**	1.9 (1.0-3.7)	3.5	**2.5 (1.4-4.6)**	1.9 (1.0-3.6)	3.8
Parents' financial situation difficult	609	16.2	0.6	1.4 (0.9-2.1)	1.2 (0.7-1.9)	2.0	**1.8 (1.2-2.7)**	1.4 (0.9-2.2)	5.8
Parental educational level[d]									
Both parents high education	2,358	62.8	0.8	ref	ref	ref	ref	ref	Ref
One parent high education	817	21.7	0.7	1.1 (0.8-1.6)	1.0 (0.7-1.5)	0.6	1.1 (0.7-1.7)	0.9 (0.6-1.4)	-1.2
Neither parents high education	582	15.5	0.6	1.2 (0.8-1.9)	1.0 (0.6-1.6)	-0.1	1.5 (1.0-2.3)	1.1 (0.7-1.8)	1.7
Non-intact family composition[e]	816	21.7	0.7	1.3 (0.9-2.0)	1.2 (0.8-1.8)	2.6	**1.6 (1.1-2.3)**	1.2 (0.8-1.9)	4.5
Area of enrolment									
Human Sciences	1,989	52.9	0.8	ref	ref	ref	ref	ref	ref
Science and Technology	997	26.5	0.7	0.8 (0.6-1.2)	0.9 (0.6-1.3)	-3.0	**0.6 (0.4-1.0)**	0.7 (0.5-1.1)	-6.8
Biomedical Sciences	771	20.5	0.7	0.8 (0.5-1.2)	0.8 (0.5-1.2)	-3.8	0.7 (0.5-1.1)	0.7 (0.5-1.2)	-5.2
Vocational secondary school track	180	4.8	0.4	**2.3 (1.1-4.5)**	2.0 (1.0-4.0)	3.1	**3.1 (1.7-5.6)**	**2.5 (1.4-4.7)**	**5.5**

Note: [a] Prevalence estimate of potential risk factors among those without a history of NSSI at baseline, [b] Bivariate associations are based on separate models for each row, with the variable in the row as predictor, [c] defined as parents divorced or separated, [d] Multivariate associations are based on all factors shown in the table, [e] high education level was defined as holding at least a bachelor's degree. w(n) = weighted number of cases, w(%) = weighted percentage of sample, OR = Odds Ratio; PARP = Population Attributable Risk Proportion; Significant odds ratios and PARPs are shown in bold (α=.05).

Table 6.2. Childhood-adolescent traumatic experiences (< 17 years) as baseline predictors for onset of non-suicidal self-injury.

| | Prevalence[a] | | | Sporadic NSSI | | | Repetitive NSSI | | |
| | | | | Bivariate model[b] | Multivariate model[c] | | Bivariate model[b] | Multivariate model[c] | |
II. Traumatic experiences	w(n)	w(%)	SE	OR (95% CI)	OR (95% CI)	PARP (%)	OR (95% CI)	OR (95% CI)	PARP (%)
Parental psychopathology	1,156	30.8	0.8	**1.7 (1.3-2.4)**	1.4 (0.9-2.1)	7.5	**2.2 (1.6-3.1)**	1.6 (1.0-2.7)	13.9
Physical abuse	162	4.3	0.4	**3.1 (1.7-5.7)**	1.9 (0.9-4.0)	3.0	**4.1 (2.3-7.5)**	1.8 (0.9-3.8)	3.1
Emotional abuse	547	14.6	0.6	**2.4 (1.6-3.4)**	**1.8 (1.0-3.2)**	**8.2**	**3.1 (2.1-4.6)**	**1.9 (1.0-3.6)**	**11.1**
Sexual abuse	32	0.8	0.2	3.5 (0.8-16.0)	1.7 (0.3-9.7)	0.2	**8.1 (2.7-24.5)**	2.8 (0.7-11.3)	1.6
Neglect	222	5.9	0.4	**2.4 (1.4-4.0)**	1.5 (0.8-3.0)	2.4	**3.3 (1.9-5.5)**	1.6 (0.8-3.3)	3.3
Dating violence	151	4.0	0.4	**3.3 (1.7-6.3)**	**2.9 (1.4-6.1)**	**3.8**	**6.4 (3.8-11.0)**	**5.3 (2.7-10.3)**	**10.1**
Bully victimization	976	26.0	0.8	**1.9 (1.3-2.6)**	**1.6 (1.1-2.5)**	**11.3**	**2.1 (1.5-3.0)**	**1.6 (1.0-2.6)**	**11.9**
Number of traumatic experiences									
None or exactly one	2,982	79.4	0.7	ref	ref	ref	ref	ref	ref
Exactly 2	440	11.7	0.6	**2.2 (1.5-3.2)**	1.0 (0.6-1.9)	1.7	**2.5 (1.6-3.9)**	0.9 (0.5-1.9)	-0.2
3 or more	335	8.9	0.5	**3.3 (2.1-5.1)**	0.7 (0.2-1.9)	-4.6	**5.3 (3.5-8.3)**	0.8 (0.3-2.3)	-3.3

Note: [a] Prevalence estimate of potential risk factors among those without a history of NSSI at baseline, [b] Bivariate associations are based on separate models for each row, with the variable in the row as predictor, [c] Multivariate associations are based on all factors shown in the table. w(n) = weighted number of cases, w(%) = weighted percentage of sample, OR = Odds Ratio; PARP = Population Attributable Risk Proportion; Significant odds ratios and PARPs are shown in bold (α=.05).

Table 6.3. Twelve-month stressful experiences and perceived social support as baseline predictors for onset of non-suicidal self-injury.

III. 12-month stressful experiences and social support	Prevalence[a] w(n)	w(%)	SE	Sporadic NSSI Bivariate model[b] OR (95% CI)	Multivariate model[c] OR (95% CI)	PARP (%)	Repetitive NSSI Bivariate model[b] OR (95% CI)	Multivariate model[c] OR (95% CI)	PARP (%)
Life-threatening illness of a friend or family member	745	19.8	0.8	1.3 (0.9-1.9)	1.2 (0.7-2.0)	3.4	1.3 (0.9-2.0)	1.1 (0.6-1.9)	1.0
Death of a friend or family member	697	18.5	0.8	1.2 (0.8-1.8)	1.1 (0.7-2.0)	1.2	1.4 (0.9-2.1)	1.4 (0.8-2.4)	5.4
Breakup with a romantic partner	617	16.4	0.7	1.4 (0.9-2.1)	1.2 (0.7-2.0)	2.0	**1.8 (1.2-2.7)**	1.5 (0.9-2.4)	6.3
Romantic partner cheated	123	3.3	0.3	1.9 (0.9-4.0)	1.3 (0.5-3.3)	0.7	**2.7 (1.3-6.0)**	1.5 (0.6-4.0)	1.8
Serious betrayal by someone other than partner	338	9.0	0.5	**1.8 (1.1-3.0)**	1.3 (0.7-2.2)	2.1	**2.5 (1.6-4.0)**	1.4 (0.8-2.5)	4.1
Serious ongoing arguments or breakup with friend or family member	449	12.0	0.6	**2.1 (1.4-3.2)**	1.7 (1.0-2.8)	5.8	**2.7 (1.8-4.1)**	**1.8 (1.0-3.2)**	**8.3**
Life-threatening accident	45	1.2	0.2	2.4 (0.6-9.5)	1.8 (0.4-9.5)	0.5	**5.2 (1.7-15.7)**	3.5 (0.8-14.7)	2.4
Seriously physically assaulted	75	2.0	0.3	**3.2 (1.2-8.4)**	2.8 (1.0-8.0)	2.3	**3.5 (1.2-10.3)**	2.8 (0.8-9.4)	2.4
Sexually assaulted or raped	7	0.2	0.1	6.9 (0.5-93.3)	5.8 (0.4-93.3)	0.4	7.6 (0.5-121.7)	4.9 (0.1-366.2)	0.4
Serious legal problem	104	2.8	0.3	2.2 (0.9-5.4)	1.8 (0.7-4.8)	1.6	**2.7 (1.0-7.1)**	2.0 (0.7-5.8)	2.2
Another stressful event	291	7.7	0.5	1.7 (1.0-2.9)	1.4 (0.7-2.7)	2.2	**2.5 (1.5-4.1)**	**1.9 (1.0-3.7)**	**6.0**
Number of 12-month stressful experiences									
None or exactly one	2,916	77.6	0.8	ref	ref	ref	ref	ref	ref
Exactly 2	553	14.7	0.7	1.5 (1.0-2.3)	0.9 (0.5-1.9)	-0.2	**1.9 (1.2-3.0)**	1.0 (0.5-2.0)	0.2
3 or more	289	7.7	0.5	**2.6 (1.6-4.3)**	0.9 (0.3-2.8)	-0.3	**4.0 (2.5-6.4)**	0.9 (0.3-2.9)	-1.6
Unsatisfactory family support	638	17.0	0.8	**1.7 (1.1-2.5)**	1.3 (0.8-2.0)	3.8	**2.3 (1.5-3.4)**	**1.6 (1.1-2.5)**	**9.2**
Unsatisfactory peer support	1,012	26.9	0.9	**1.7 (1.2-2.3)**	**1.5 (1.1-2.2)**	**10.0**	**2.0 (1.4-2.9)**	**1.7 (1.2-2.6)**	**14.0**
Unsatisfactory or absent partner support	2,414	64.2	0.9	1.1 (0.8-1.5)	1.0 (0.7-1.4)	0.3	1.2 (0.8-1.8)	1.1 (0.7-1.6)	3.3

Note: [a] Prevalence estimate of potential risk factors among those without a history of NSSI at baseline, [b] Bivariate associations are based on separate models for each row, with the variable in the row as predictor, [c] Multivariate associations are based on all factors shown in the table. w(n) = weighted number of cases, w(%) = weighted percentage of sample, OR= Odds Ratio; PARP = Population Attributable Risk Proportion; Significant odds ratios and PARPs are shown in bold (α = .05).

Table 6.4. Risk for 12-month mental disorders, 12-month suicidal thoughts and behaviors, and associated impairment as baseline predictors for onset of non-suicidal self-injury.

IV. Mental disorders and other serious mental health symptoms	Prevalence[a]			Sporadic NSSI			Repetitive NSSI		
				Bivariate model[b]	Multivariate model[c]		Bivariate model[b]	Multivariate model[c]	
	w(n)	w(%)	SE	OR (95% CI)	OR (95% CI)	PARP (%)	OR (95% CI)	OR (95% CI)	PARP (%)
Major depressive disorder	265	7.1	0.4	**3.3 (2.1-5.1)**	1.8 (0.9-3.4)	4.0	**4.8 (3.0-7.6)**	1.6 (0.8-3.0)	4.5
Generalized anxiety disorder	189	5.0	0.4	**2.7 (1.5-4.7)**	1.3 (0.6-2.8)	0.5	**4.5 (2.7-7.5)**	1.7 (0.9-3.5)	4.6
Panic disorder	44	1.2	0.2	**4.1 (1.4-12.0)**	2.0 (0.6-7.2)	0.9	**6.2 (2.4-15.8)**	1.8 (0.6-5.8)	1.2
Broad Mania	21	0.6	0.1	**6.9 (1.3-36.3)**	2.3 (0.3-16.9)	0.0	**18.2 (5.2-63.9)**	4.0 (0.9-18.5)	1.6
Alcohol use disorder									
Low risk for alcohol use disorder	2,777	73.9	0.7	ref	ref	ref	ref	ref	ref
Risky or hazardous drinking	889	23.7	0.7	1.2 (0.8-1.7)	1.2 (0.7-1.8)	2.0	1.1 (0.7-1.6)	1.0 (0.6-1.6)	-0.2
Risk for alcohol dependence	92	2.4	0.3	1.9 (0.8-4.6)	1.4 (0.5-3.9)	0.8	2.2 (0.9-5.1)	1.2 (0.4-3.6)	0.6
Intermittent explosive disorder item positive	608	16.2	0.6	**1.5 (1.0-2.3)**	1.2 (0.7-2.0)	1.3	**2.1 (1.4-3.1)**	1.4 (0.8-2.3)	5.2
Any eating disorder item positive	335	8.9	0.5	**2.0 (1.3-3.2)**	1.4 (0.8-2.6)	2.0	**3.3 (2.2-5.1)**	1.7 (1.0-3.1)	6.9
Any psychotic item positive	280	7.5	0.8	**2.6 (1.4-4.7)**	**2.0 (1.0-4.0)**	**5.0**	**3.1 (1.6-5.9)**	2.0 (0.9-4.1)	5.8
Post-traumatic stress disorder item positive	1,044	27.8	0.7	**1.8 (1.3-2.5)**	1.2 (0.7-1.9)	2.8	**2.7 (1.9-3.8)**	1.3 (0.8-2.1)	8.5
No suicidal thoughts and behaviors	3,605	95.9	0.3	ref	ref	ref	ref	ref	ref
Suicidal ideation	121	3.2	0.3	**3.5 (1.9-6.5)**	**2.3 (1.1-4.9)**	**2.7**	**4.7 (2.6-8.5)**	**2.6 (1.2-5.5)**	**4.1**
Suicide plans and/or attempts	31	0.8	0.2	**3.6 (1.0-12.8)**	1.4 (0.3-5.9)	0.1	**7.5 (2.6-21.0)**	2.3 (0.6-7.9)	1.3
Non-suicidal self-injury thoughts	57	1.5	0.2	**2.9 (1.2-7.0)**	2.1 (0.7-5.7)	1.3	**3.1 (1.2-8.1)**	1.5 (0.4-5.3)	0.8
Number of positive screens									
None or exactly one	2,706	72.0	0.8	ref	ref	ref	ref	ref	ref
Exactly 2	615	16.4	0.7	**1.9 (1.3-2.8)**	1.1 (0.6-2.1)	4.0	**2.5 (1.6-3.9)**	1.4 (0.7-2.6)	5.5
3 or more	436	11.6	0.6	**3.6 (2.4-5.4)**	1.0 (0.3-2.8)	3.2	**6.5 (4.3-9.8)**	1.3 (0.4-3.8)	5.1
Severe role impairment in daily life	277	7.4	0.4	**3.3 (2.1-5.3)**	**2.0 (1.2-3.5)**	**5.7**	**5.0 (3.2-7.7)**	**2.3 (1.3-4.1)**	**8.6**

Note: [a] Prevalence estimate of potential risk factors among those without a history of NSSI at baseline, [b] Bivariate associations are based on separate models for each row, with the variable in the row as predictor, [c] Multivariate associations are based on all factors shown in the table. w(n) = weighted number

Evaluation of the accuracy of an integrative risk prediction model for onset of NSSI

We constructed multivariate models that included all factors in the study to predict NSSI onset. Most risk factors became non-significant in these integrative prediction models (see supplementary Table 6.1), with the exception of dating violence prior to age 17 (for repetitive NSSI; OR = 3.1) and severe role impairment in daily life (ORs in the 1.8-1.9 range). The generated cumulative risk probabilities showed reasonable-to-good performance for detecting onset of both sporadic and repetitive NSSI (Table 6.5). Cross-validated sensitivity estimates for different proportions of students at highest predicted risk show that an intervention that, for instance, targets the 10% at highest risk would effectively reach 23.9% (SE = 3.3) of students who report sporadic, and 36.1% (SE = 3.9) of students who report repetitive NSSI, for the first-time during college. The incidence of NSSI in these subgroups would be 26.8% and 31.7%, respectively.

Table 6.5. Concentration of risk for onset of NSSI in different proportions of first-year students at highest predicted risk based on the final multivariate risk model.

% at highest predicted risk	Sporadic NSSI		Repetitive NSSI	
	Sensitivity	PPV	Sensitivity	PPV
	% (SE)	% (SE)	% (SE)	% (SE)
100	100.0 (0.0)	8.6 (0.8)	100.0 (0.0)	7.0 (0.6)
90	94.7 (1.8)	9.8 (0.9)	96.4 (1.6)	8.3 (0.7)
80	89.8 (2.4)	10.5 (1.0)	92.9 (2.2)	9.0 (0.8)
70	84.2 (3.0)	11.3 (1.1)	88.8 (2.8)	9.9 (0.9)
60	78.0 (3.4)	12.3 (1.2)	83.9 (3.1)	11.0 (1.0)
50	70.7 (3.6)	13.6 (1.4)	78.1 (3.5)	12.4 (1.2)
40	62.3 (3.8)	15.2 (1.6)	71.2 (3.9)	14.3 (1.4)
30	52.2 (3.9)	17.4 (2.0)	62.6 (4.0)	17.1 (1.8)
20	40.1 (3.9)	20.8 (2.6)	51.7 (4.2)	21.7 (2.4)
10	23.9 (3.3)	26.8 (4.0)	36.1 (3.9)	31.7 (4.0)

Note: see the multivariate models including all predictors across risk domains in supplementary materials. Model-based AUC values were 0.73 (0.02) for sporadic onset NSSI and 0.79 (0.02) for repetitive onset of NSSI. Cross-validated AUC values were 0.70 (0.03) for sporadic onset and 0.75 (0.02) for repetitive onset of NSSI. Sensitivity = proportion of onset cases found among row% of responders at highest predicted risk, based on cross-validated predicted probabilities. Positive Predictive Value = probability of effectively developing onset when being among row% of responders at highest predicted risk, based on cross-validated predicted probabilities.

Discussion

This study presents a comprehensive examination of incident NSSI in college students. Three main findings stand out. First, the incidence of NSSI was estimated at 10.3% in year 1 and 6.0% in year 2, with 7.0% reporting onset of repetitive NSSI during the first two years of college. Second, as expected, there was no single stand-out risk factor for NSSI onset. Rather, a broad range of distal and proximal risk factors were prospectively associated with both sporadic and repetitive NSSI onset. Third, our findings show that it is possible to develop risk assessment algorithms, focused on a broad, yet feasible, range of clinically meaningful risk factors, to identify and potentially provide targeted interventions to students at high risk for onset of NSSI during college.

This is the first European study to investigate the incidence of NSSI in emerging adults. Despite evidence that emerging adulthood is a sensitive period for the onset of mental disorders and risky behaviors (Auerbach et al., 2018; Bruffaerts et al., 2018; Mortier, Demyttenaere, et al., 2017; Zivin et al., 2009), the incidence of NSSI has rarely been studied outside of adolescence. The reported incidence rates are higher than two earlier American-Canadian estimates (2-4% range; Hamza & Willoughby, 2014; Riley et al., 2015). Possible explanations may include geographical or methodological differences (i.e., we used a representative sample and made use of an exhaustive NSSI checklist; Kimbrel et al., 2018), cohort effects (i.e., increasing rate of NSSI; Gillies et al., 2018; Wester et al., 2018), or a combination of these. On balance, our findings confirm recent work in finding a second NSSI onset peak in emerging adulthood (Gandhi et al., 2018), and suggest that - although the majority of students who report onset of NSSI will not meet DSM-5 disorder criteria (Kiekens, Hasking, Claes, et al., 2018) - a large number of emerging adults will self-injure for the first time in college. Consistent with studies that show that the transition to college can be a particularly stressful event (Bruffaerts et al., 2018; Dyson & Renk, 2006; Robotham, 2008), our findings suggest that incoming college students are at high risk for onset of NSSI. Interestingly, although our rates of cutting were similar to other studies (Hamza & Willoughby, 2014), self-cutting was not among the most frequently reported methods. We speculate that because most individuals in our onset sample report sporadic NSSI, more severe NSSI methods such as self-cutting might be less frequently reported as early methods of NSSI. We found some evidence for this as self-cutting was more prevalent among those who reported repetitive NSSI (sporadic NSSI = 11.8% vs. repetitive NSSI = 29.0%).

With respect to prospective risk factors for first onset NSSI, there are three findings that require brief comment. First, we found evidence that the pathogenic effect of early trauma extends vulnerability for NSSI into emerging adulthood (Liu et al., 2018). Previous research has shown that early trauma is associated with neurobiological and psychological changes that impede intrapersonal (e.g., self-critical attribution style) and interpersonal functioning (e.g., relational schemas of mistrust) (Crawford & Wright, 2007; Dye, 2018; Serafini et al., 2015). It is worth mentioning within this context that the effect of neglect and all subtypes of abusive family relationships were attenuated when bullying victimization and dating violence were taken into account, suggesting that the former may increase risk through re-victimization in peer and partner relationships (Capaldi, Knoble, Shortt, & Kim, 2012; Crawford & Wright, 2007; van Geel, Goemans, & Vedder, 2015). Second, findings from this study also highlight the significance of proximal negative interactions for incident NSSI. Consistent with recent work showing the importance of positive peer relationships in mitigating risk for NSSI in emerging adults (Kiekens et al., 2017; Turner, Wakefield, Gratz, & Chapman, 2017), we found that limited peer support was associated with the onset of sporadic and repetitive NSSI for approximately one in ten students who self-injured. Third, supporting the conceptualization of NSSI as a trans-diagnostic behavior (Bentley et al., 2015), most mental health problems were prospectively associated with sporadic and repetitive NSSI. Multivariate models suggest that the associated role impairment might partially account for these associations.

A novel and perhaps the most important contribution of our study was the development of an integrative multivariate prediction model that yields reasonable prediction accuracy for detecting students at high risk of beginning NSSI during their academic career. Consistent with recent advances in depression and suicide prevention research (Ebert et al., 2019; Mortier, Demyttenaere, et al., 2017), risk screening at college entrance may provide a unique approach to identify those at risk for *future* NSSI and offer timely intervention. Specifically, by offering evidence-based intervention to the top 10% at greatest risk of NSSI onset, our data suggest that we could theoretically prevent nearly one in four sporadic and two in five repetitive onset cases. This figure would increase to more than half of students who report repetitive NSSI if we target the top 20% at risk, although this would also increase the risk of identifying false positives (i.e., students who would never have self-injured). However, it could also be argued that these students may still benefit from a general mental health promotion intervention because of their constellation of clinically significant risk factors. While these findings are promising,

further research will almost certainly be able to improve these models by including protective factors (e.g., emotion regulatory capability), NSSI-related cognitions (e.g., self-efficacy to resist NSS), and allowing for interactions in larger samples. Building upon these findings, the next logical step would then be to determine how preventive interventions could best be delivered (e.g., making use of the high scalability of internet- and mobile-based applications) and which type of interventions (i.e., trans-diagnostic vs. NSSI-specific) work best for students at varying levels of risk. Addressing these questions in future research will be extremely important to help guide and fully exploit the potential of individualized screening and preventive approaches for NSSI in college. Taken together, the current findings show that effectively dividing college entrants into low and high-risk groups by means of an empirically-derived prediction model has the potential to help optimize the deployment of preventive interventions aimed at reducing the incidence of NSSI and its potentially negative consequences (e.g., increased capability for suicide; Willoughby et al., 2015).

Several limitations deserve attention in interpreting the results of this study. First, response rates in the 54-63% range are sub-optimal. We used state-of-the-art missing data handling techniques to tackle potential residual non-response bias, however, this remains a concern. Second, we used validated clinical screening scales instead of full diagnostic interviews to assess risk for mental disorders; hence, these prevalence rates should be interpreted cautiously. Third, the extent to which the identified risk factors are also causally predictive of NSSI onset cannot be resolved with our current approach. The best way to resolve this uncertainty is to carry out randomized trials that evaluate the effectiveness of targeting the identified risk factors. Finally, because our results are based on data from one college, replicating the findings represents an important goal for future research.

Conclusion

The current study makes significant advances to both science and practice by estimating the incidence of NSSI in college students and examining clinically useful prediction models that can identify students at risk for *future* NSSI. Results show that the college years are a sensitive period for the onset of NSSI. While our findings shed light on many risk factors for sporadic and repetitive incident NSSI, effect sizes of individual prospective associations were weak to moderate. Importantly, however, combining risk factors from multiple domains into an integrative prediction model enabled us to detect college entrants at high cumulative risk for incident NSSI with a reasonable degree of accuracy. Further

research in this area has the potential to deliver a powerful and cost-beneficial tool that will be valuable in planning future preventive interventions for NSSI in college populations worldwide.

In **chapter 6**, we focused on the estimation and prospective prediction of first onset NSSI during the college period. Findings confirmed that a multitude of intrapersonal and interpersonal factors predict incident NSSI, and the derived risk prediction model outlined the potential of web-based screening for detecting students at high cumulative risk for beginning NSSI in college. Importantly, however, 17-18% of first-year students enter college with a history of NSSI. **Chapter 7** therefore describes the analysis of predictors of NSSI persistence (i.e., ongoing NSSI among those with a history of NSSI at college entrance) by clarifying intrapersonal and interpersonal factors that differentiate students with adolescent-onset NSSI who continue NSSI from those who cease NSSI during the college period.

Chapter 7

Predicting Persistent Non-Suicidal Self-Injury

during the College Period

ABSTRACT

Although non-suicidal self-injury (NSSI) peaks in adolescence, a significant proportion of young people continue to self-injure into emerging adulthood. Yet, little is known about factors prospectively associated with persistent NSSI. Using data from a three-year longitudinal study (n = 1,466), we compared 51 emerging adults (67.3% female; average age = 20.0) who continued to self-injure from adolescence and 50 emerging adults (83.7% female; average age = 20.3) who had ceased NSSI, on a broad range of psychosocial factors. More frequent NSSI, use of a greater number of methods, specific NSSI functions, academic and emotional distress, and lack of perceived emotion regulatory capability differentiated emerging adults who continued with NSSI and those who had ceased the behavior. Further, the relationships between social support, life satisfaction and NSSI were mediated by perceived ability to regulate emotion. Findings from this study point to the role of personal belief in the ability to effectively regulate emotion in the cessation of NSSI. Future research directions and clinical implications are discussed.

Keywords: non-suicidal self-injury, persistence, cessation, emotion regulatory capability, emerging adulthood

Introduction

Non-suicidal self-injury (NSSI) refers to the deliberate and direct injury to one's own body tissue without suicidal intent, and includes behaviors such as cutting and burning oneself (Nock & Favazza, 2009). Lifetime prevalence estimates are close to 8% in children, 17-18% in adolescents, and between 12-20% in emerging adults (Barrocas, Hankin, Young, & Abela, 2012; Muehlenkamp et al., 2012; Swannell et al., 2014). While NSSI typically has its onset in early to mid-adolescence (Plener et al., 2015; Whitlock & Selekman, 2014), previous epidemiological studies report 12-month prevalence rates in the 2-14% range in emerging adults (Serras et al., 2010; Wilcox et al., 2012). This is consistent with the finding that a significant proportion of young people continue to self-injure past adolescence (Glenn & Klonsky, 2011; Hamza & Willoughby, 2014; Riley et al., 2015). Emerging adulthood represents a unique and important developmental period, characterized by rapid personal, social, and academic changes (Arnett, 2015). Emerging adults who self-injure potentially face additional challenges including psychiatric illnesses (Gollust et al., 2008; Taliaferro & Muehlenkamp, 2015b), suicidal thoughts and behaviors (Hamza & Willoughby, 2016; Mortier, Kiekens, et al., 2017; Whitlock et al., 2013), and lower academic performance (Kiekens et al., 2016). From a preventative viewpoint, this raises the crucial, but understudied, question as to what differentiates these individuals from peers who cease their NSSI.

Inter- and intrapersonal factors that might drive NSSI

Previous research shows that emerging adults who self-injure are more likely to be female and non-heterosexual, experience significant distress and emotion regulation difficulties, and report low life satisfaction and support from parents and peers (Kiekens et al., 2016; Muehlenkamp, Brausch, Quigley, & Whitlock, 2013; Whitlock, Prussien, & Pietrusza, 2015; Wilcox et al., 2012). However, longitudinal data on NSSI trajectories into emerging adulthood is scarce, meaning little is known about young people who continue to self-injure past adolescence compared to those who cease their NSSI. The few prospective studies suggest that persistent NSSI among emerging adults is predicted by more severe NSSI (i.e., higher lifetime frequency and greater number of methods), own prediction of future NSSI, suicidal ideation, borderline personality features, lack of perseverance, and emotional distress (Glenn & Klonsky, 2011; Hamza & Willoughby, 2014; Riley et al., 2015).

While limited work has focused on emerging adulthood, there are several studies that have examined persistence of NSSI in clinical, and non-clinical samples of adolescents. Overall, low levels of

family support and self-esteem (Tatnell et al., 2014), cognitive vulnerability (Guerry & Prinstein, 2010), maladaptive emotion regulation strategies (Andrews, Martin, Hasking, & Page, 2013), and engaging in NSSI primarily to generate feelings or emotions (Yen et al., 2016), all increase the likelihood of persistent NSSI. Although these studies shed light on predictors of ongoing NSSI in adolescents, it is unclear to what extent these are also salient factors in predicting the continuation of NSSI into emerging adulthood. This is key, as developmentally appropriate intervention initiatives demand an understanding of the risk and protective factors of most relevance to the specific age group of interest.

Emotional distress, perceived emotion regulatory capability, and NSSI

Individuals who engage in NSSI often report significant emotional distress which is proposed to be a key mechanism underlying NSSI (Claes, Luyckx, Baetens, Van de Ven, & Witteman, 2015; Glenn & Klonsky, 2011; Kiekens et al., 2015; You, Lin, & Leung, 2015), particularly for people who have difficulties in managing such distress. Given the emotion regulatory function of NSSI (Chapman, Gratz, & Brown, 2006; Klonsky, 2007; Nock & Prinstein, 2004; Whitlock et al., 2011), a significant body of work has explored how people who self-injure and those who do not differ in their emotion regulation strategies (see Hasking et al., 2017). Researchers examining this relationship have primarily relied on the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004), with converging evidence indicating that the 'limited access to emotion regulation strategies' subscale of the DERS most strongly and uniquely differentiates individuals who self-injure from those who do not (Emery, Heath, & Mills, 2016; Perez, Venta, Garnaat, & Sharp, 2012; Zelkowitz et al., 2016). According to Gratz and Roemer (2004), this subscale assesses the *belief* that little can be done to regulate one's inner state when emotionally upset. Thus, higher scores on this scale do not necessarily indicate that people who self-injure lack strategies to regulate emotion, but rather *perceive* themselves as less competent in this process. This underscores the importance of cognitive processes in emotional models of NSSI (Hasking, 2017; Hasking et al., 2017). Importantly, perceived emotion regulatory capability may represent an important pathway through which risk factors (e.g., lack of support, academic stress, low self-esteem) exert their effect on NSSI (e.g., Gratz & Roemer, 2008). Conversely, a belief in one's ability to regulate negative emotional states could serve to protect against NSSI, or facilitate cessation of the behavior. However, to date, this proposition has not been examined.

The current study

In the current study, we aim to examine a broad range of inter- and intrapersonal factors that may confer risk, or protect against, NSSI which persists beyond adolescence and into emerging adulthood. First, we hypothesized that persistent NSSI would be predicted by more frequent NSSI, use of a greater number of methods, and functions related to the stimulation of affective states (e.g., '*to feel something*'). Second, we anticipated that persistent NSSI would be predicted by higher levels of academic stress, emotional distress, and less perceived emotion regulatory capability. Conversely, we expected higher levels of family and peer support, self-esteem, and life satisfaction to predict cessation of NSSI. Third, we explored whether emotional distress and perceived emotion regulatory capability might underlie these relationships.

Methods

Participants and procedures

The data used in this study come from the Surveys of Student Wellbeing, a three-year longitudinal study of health risk behaviors in American college students. Participants were sent an annual invitation that contained a secure link to the online survey and an information sheet that explained the purpose of the survey, confidentiality of responses, and participation requirements. A detailed description of the sample and procedures has been reported elsewhere (Whitlock et al., 2013). The larger three-wave longitudinal sample (n = 1,466) from which participants for the current study were drawn did not differ from the representative baseline sample of students in terms of age, ethnicity, sexual orientation, socioeconomic status and NSSI history (cf. Whitlock et al., 2013). The survey was approved by institutional review boards, and links to local mental health resources were provided to all participants.

For the current study, we restricted our sample to participants reporting an onset of NSSI before age 20, who either reported ongoing NSSI in *at least* two waves of data collection (persistent trajectory)[3], or reported cessation of NSSI in all three measurement waves (cessation trajectory). Of the total sample, 51 participants with persistent (Mage$_{t1}$ = 20.0, SD = 3.0; 67.3% female), and 50

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[3] *There was some unit-missingness at follow-up one (n = 3) and two (n = 8).*

participants (Mage$_{t1}$ = 20.3, *SD* = 2.4; 83.7% female) with ceased NSSI were included in the analyses. Of those in the persistent group, 82.4% engaged in NSSI at baseline, 89.6% engaged in NSSI at follow-up one, and 81.4% engaged in NSSI at follow-up two. The mean age and sex did not differ between the groups (*p* > .05)*.*

Measured constructs

NSSI characteristics were assessed with the Non-Suicidal Self-Injury Assessment Tool, (NSSI-AT), a reliable and valid measure of NSSI (Whitlock, Exner-Cortens, & Purington, 2014). An initial screening question for NSSI "*Have you ever done any of the following with the purpose of intentionally hurting yourself?*" was followed by a list of 19 NSSI methods (e.g., cutting oneself). Participants were considered to have engaged in NSSI if they reported engaging in at least one of the specified behaviors within the past year. Participants were then asked questions about NSSI characteristics including, but not limited to, NSSI frequency (coded as 1-5, 6-20, 21-50, and more than 50) and age of onset. Number of NSSI methods used was assessed by summing the total number of self-injurious behaviors (e.g., cutting, burning, hitting) reported by participants.

The NSSI-AT also differentiates 18 functions, or motives, for NSSI that were developed through iterative analyses of qualitative interviews with emerging adults who self-injured, treatment specialists, and a review of the research literature (Whitlock et al., 2014). The functions were assessed using a dichotomous (yes/no) format, and have high test-retest reliability (ICC = 0.79). These 18 functions load onto five higher-order dimensions: Affective Imbalance, Low Pressure (e.g., "I hurt myself to cope with uncomfortable feelings"; Kuder-Richardson Formula 20 (*KR-20*) = 0.62), Affective Imbalance, High Pressure (e.g., "I hurt myself to deal with frustration"; *KR-20* = 0.55), Social Communication and Expression (e.g., "I hurt myself in hopes that someone would notice that something is wrong or pay attention to me"; *KR-20* = 0.28), Self-Retribution and Deterrence (e.g., "I hurt myself as a self-punishment or to atone for sins"; *KR-20* = 0.49), and Sensation-Seeking (e.g., "I hurt myself to get a rush or surge of energy"; *KR-20* = 0.58; Whitlock et al., 2014). Although similar to those reported by Whitlock and colleagues (2014; range 0.38-0.64), in light of the low Kuder-Richardson values, we examined the individual functions assessed by the NSSI-AT rather than analyzing data at the dimensional level.

Interpersonal factors at time 1

Perceived Social Support was assessed using 3 items based on the Friends subscale of the Multidimensional Scale of Perceived Social Support (e.g., "I can open up to my friends if I need to talk about my worries"), which is a reliable and valid measure of perceived social support (Zimet, Dahlem, Zimet, & Farley, 1988). Items are assessed on a four-point rating scale that ranges from 'never true to 'often true'. The internal consistency of the scale was good in the current sample (α = 0.79).

Perceived Family Support was assessed using selected key items from psychometrically sound measures such as the McMaster Family Assessment Device (Epstein, Baldwin, & Bishop, 1983). Participants responded to 4 items (e.g., "There was usually someone in my family who noticed when I was upset") on a five-point Likert scale ranging from 'very untrue' to 'very true'. Together these items tap into perceptions of family support when the respondent still resided with caregivers (α = 0.83).

Intrapersonal factors at time 1

Non-heterosexual orientation was assessed with the Kinsey Scale (Kinsey, Pomeroy, & Martin, 1948) that asked respondents whether they are sexually attracted to, or aroused by, individuals of the same and/or opposite sex. Respondents were considered non-heterosexual if indicated to be sexually attracted or aroused to some degree by members of the same sex.

Perceived Emotion Regulatory Capability was assessed with the Limited Access to Emotion Regulation Strategies subscale of the Difficulties in Emotion Regulation Scale (Gratz & Roemer, 2004). This subscale consists of 8 items (e.g., "When I am upset, I believe there is nothing I can do to make myself feel better"), with five-point Likert response options that range from 'almost always' to 'almost never'. This scale is highly correlated with negative mood regulation expectancies (i.e., the belief that something can be done to alleviate negative affect; r =.69) and is no longer significantly associated with NSSI once the latter is taken into account (Gratz & Roemer, 2004), indicating that the scale taps into the belief in one's emotion regulatory capability. For the purpose of the current study, the scale was reversed scored, so that higher scores reflect a greater belief in one's emotion regulatory capability. The internal consistency of the scale was excellent in the current sample (α = 0.90).

Emotional Distress was assessed with the K-6 scale (Kessler et al., 2002), a valid measure to assess current emotional distress and screen for the presence of non-specific mental disorders (Kessler

et al., 2003; Kessler et al., 2010). The internal consistency of the K-6 was good in the current sample (α = 0.81).

Academic Stress was assessed with a single item similar to those used in the Annual National College Health Assessment Surveys (American College Health Association National College Health Assessment, n.d.). Participants were asked to indicate, on a 10 point scale, the overall level of academic stress experienced in the current school year (i.e., "Within the current school year, how would you rate the overall level of academic stress you have experienced?").

Self-Esteem was assessed with the Single-Item Self-Esteem Scale, a reliable and valid alternative to longer questionnaires in the target population (Robins, Holly, & Kali, 2001). Using this five-point item that ranges from 'not at all' to 'extremely', respondents were asked to report the degree to which they feel the statement "I have high self-esteem" accurately describes them.

Life Satisfaction was assessed with the 6 item Satisfaction With Life Scale (Diener, Emmons, Larsen, & Griffin, 1985). Items are assessed on a seven-point rating scale that ranges from 'strongly disagree' to 'strongly agree', and showed excellent internal consistency in our sample (α = 0.91).

Statistical analyses

Descriptive statistics are reported for the primary study variables as proportions (%) and associated standard errors (SE), or mean values (M) and associated standard deviations (SD). The χ^2/t statistic, together with associated measures of effect size, were used to examine associations between the persistence/cessation trajectory of NSSI and categorical/continuous variables respectively. The Cochran-Armitage test, which tests for linear trends in binomial proportions across the levels of an ordinal variable, was used to examine whether persistent, relative to ceased, NSSI was associated with more frequent NSSI reported at baseline. The predictive value of NSSI functions, and inter- and intrapersonal factors, was assessed using bivariate and multivariate logistic regressions (odds ratios and 95% confidence intervals are reported). Nagelkerke pseudo R^2 and the concordance (c-static) are reported as measures of the explained variability and discriminant ability in group membership of the multivariate model. Finally, using multiple mediation models with 10,000 bootstrap samples, we calculated 95% bias-corrected confidence intervals to test the indirect effects of inter- and intrapersonal variables on NSSI, via emotional distress and perceived emotion regulatory capability.

All continuous inter- and intrapersonal factors were standardized, and the analyses were conducted using SPSS 23.0 (macro PROCESS 2.15; Hayes, 2013) and SAS 9.4.

Results

NSSI characteristics that differentiate persistent and ceased NSSI

Severely scratching and pinching oneself were the most commonly reported methods of NSSI in both groups (Table 7.1). At baseline, emerging adults who continued with NSSI reported having used more NSSI methods than those who ceased NSSI (M_{t1} = 3.29, SD = 2.24 vs M_{t1} = 2.48, SD = 1.60, t(99) = 2.10, p = .039, Cohen's d = 0.42), and continued to expand the number of methods used over the three-year study period (M_{t3-t1} = 0.90, *SD* = 1.23, *t*(50) = 5.21 *p* <.001, Cohen's d=0.73). Participants who persisted to self-injure over the course of the study reported more frequent NSSI at baseline than those who ceased NSSI (Table 7.2). Age of onset did not differ between groups (Persistent group: *M* = 14.56, *SD* = 2.57; Ceased group: *M* = 13.86, *SD* = 3.36, *t*(97) = 1.16, *p* = .249).

Table 7.1. Methods of non-suicidal self-injury.

	Ceased NSSI group % (S.E.)	Persistent NSSI group % (S.E.)	χ^2	Phi
Severely scratched or pinched with finger nails or other objects to the point that bleeding occurs or marks remain on the skin	60.0% (7.0)	78.4% (5.8)	4.03*	0.20
Cut wrists, arms, legs, torso or other areas of the body	50.0% (7.1)	45.1% (7.0)	0.24	0.05
Banged or punched *objects* to the point of bruising or bleeding	16.0% (5.2)	37.3% (6.8)	5.82*	0.24
Banged or punched *oneself* to the point of bruising or bleeding	14.0% (4.9)	27.5% (6.3)	2.77	0.17
Bitten yourself to the point that bleeding occurs or marks remain on skin	14.0% (4.9)	43.1% (7.0)	10.47**	0.32
Carved words or symbols into skin	18.0% (5.5)	17.6% (5.4)	0.00	0.00
Intentionally prevented wounds from healing	10.0% (4.3)	51.0% (7.0)	19.93***	0.44
Ripped or torn Skin	14.0% (4.9)	31.4% (6.5)	4.33*	0.21
Pulled out hair, eyelashes or eyebrows (with the intention of hurting yourself**)**	14.0% (4.9)	17.6% (5.4)	0.25	0.05
Burned wrists, hands, arms, legs, torso, or other areas of the body	12.0% (4.6)	13.7% (4.8)	0.07	0.03
Rubbed glass into skin or stuck sharp objects such as needles or pins into or underneath the skin (with the intention of hurting yourself**)**	8.0% (3.9)	21.6% (5.8)	3.68	0.19
Other methods	18.0% (5.5)	35.3% (6.7)	3.86*	0.20

Note: NSSI = Non-suicidal self-injury, S.E. = Standard error. ** p < .05, ** p < .01, *** p <.001, two-sided tested*

Table 7.2. Lifetime frequency of non-suicidal self-injury.

	Ceased NSSI group % (S.E.)	Persistent NSSI group % (S.E.)	Odds Ratio (95% confidence interval)	Cochran-Armitage test	*p*
1- 5 times	60.0% (7.1)	33.3% (6.6)	(ref)	3.23*	.001
6-20 times	22.0% (4.3)	25.5% (6.1)	2.09 (0.77-5.67)		
21-50 times	12.0% (4.7)	11.8% (4.5)	1.77 (0.49-6.33)		
More than 50 times	6.0% (3.4)	29.4% (6.4)	8.82 (2.23-34.90)		

Note: NSSI = Non-suicidal self-injury, S.E. = Standard error. **p <.01, two-sided tested*

Among participants who had ceased their NSSI, the most commonly reported functions of NSSI were related to the affective imbalance dimensions of the NSSI-AT (Table 7.3; range 44-66%). While the same trend was observed for participants who persisted to self-injure (range 58.8-76.5%), participants in this group also reported more frequent engagement in NSSI because 'they get the urge and cannot stop it' (56.9% versus 20.0%), an item loading on the sensation-seeking dimension of the NSSI-AT. As can be seen in Table 7.4, this function was uniquely related to persistent NSSI. In addition, engaging in NSSI 'to get a rush or surge of energy' (19.6% versus 2%) significantly differentiated participants who persisted rather than ceased their NSSI (Table 7.4).

Table 7.3. The five most frequently reported functions of non-suicidal self-injury.

Ceased NSSI group		Persistent NSSI group	
	% (S.E.)		% (S.E.)
1. … to deal with frustration	66.0 (6.7)	1. … to cope with uncomfortable feeling	76.5 (6.0)
2. … to cope with uncomfortable feeling	64.0 (6.8)	2. … to deal with anger	74.5 (6.1)
3. … to relieve stress or pressure	64.0 (6.8)	3. … to relieve stress or pressure	74.5 (6.1)
4. … to change my emotional pain into something physical	62.0 (6.9)	4. … to change my emotional pain into something physical	58.8 (6.9)
5. … to deal with anger	44.0 (7.0)	5. … because I get the urge and cannot stop	56.9 (7.0)

Note: NSSI = Non-suicidal self-injury, S.E. = Standard error.

Inter- and intrapersonal factors that differentiate persistent and ceased NSSI

In bivariate models, persistent NSSI was related to higher levels of academic stress and emotional distress (Table 7.5). Cessation of NSSI was related to higher levels of perceived social support, life satisfaction, and perceived emotion regulatory capability. In the multivariate model, however, only perceived emotion regulatory capability explained unique variance in group membership (R^2nagelkerke = 0.41, c-statistic = 0.82).

Table 7.4. Functions associated with persistent non-suicidal self-injury.

	Bivariate		Multivariate	
	OR	95% CI	OR	95% CI
Affective imbalance, low pressure dimension			-	-
… to cope with uncomfortable feeling	1.83	0.77-4.35	-	-
…to change my emotional pain into something physical	0.88	0.39-1.95	-	-
… to feel something	1.53	0.66-3.53	-	-
… to get control over myself or my life	1.25	0.57-2.82	-	-
Affective imbalance, high pressure dimension			-	-
… to relieve stress or pressure	1.64	0.70-3.86	-	-
… to deal with frustration	1.51	0.64-3.56	-	-
… to deal with anger	0.97	0.44-2.12	-	-
Social communication and expression dimension			-	-
…in hopes that someone would notice that something is wrong or pay attention to me	1.77	0.73-4.30	-	-
… to shock or hurt someone	0.98	0.27-3.61	-	-
…because my friends hurt themselves	0.47	0.08-2.69	-	-
Self-retribution and deterrence dimension				
… as a self-punishment or to atone for sins	2.29	0.96-5.48	-	-
… because of my self-hatred	2.16	0.93-5.00	-	-
…so I do not hurt myself in other ways	5.85[*]	1.21-28.26	4.93	0.92-26.42
… to avoid committing suicide	6.53	0.76-56.39	-	-
Sensation-seeking dimension				
…because I get the urge and cannot stop it	5.27[***]	2.17-12.81	4.36[**]	1.64-11.62
… because it feels good	3.19[*]	1.28-7.94	1.27	0.42-3.80
…to get a rush or surge of energy	11.95[*]	1.47-97.31	12.25[*]	1.36-110.01
…because I like the way it looks	3.20	0.61-16.68	-	-
Total number of functions	1.19[**]	1.05-1.36	0.95	0.77-1.17

Note: the multivariate analyses included only significant bivariate functions. OR = Odds ratio, CI = Confidence interval. *p < .05, ** p < .01, *** p <.001, two-sided tested*

**Table 7.5.** Inter- and intrapersonal factors differentiating persistent and ceased non-suicidal self-injury.

	Bivariate		Multivariate	
	OR	95% CI	OR	95% CI
Interpersonal factors				
Perceived family support	0.81	0.54-1.21	1.00	0.59-1.69
Perceived social support	0.57*	0.36-0.90	0.86	0.44-1.68
Intrapersonal factors				
Non-hetero sexual feelings	0.72	0.32-1.60	0.57	0.20-1.60
Academic stress	1.83**	1.19-2.82	1.62	0.92-2.85
Self esteem	0.68	0.45-1.03	1.04	0.58-1.86
Life satisfaction	0.64*	0.42-0.97	1.65	0.76-3.58
Emotional distress	2.47***	1.52-4.02	1.14	0.48-2.72
Perceived emotion regulatory capability	0.28***	0.16-0.49	0.23**	0.10-0.57

Note: All continues measures were standardized. Reference = ceased group. OR = Odds ratio, CI = Confidence interval.
* p < .05, ** p < .01, *** p < .001, two-sided tested

Emotional distress and perceived emotion regulatory capability as mediators between inter- and intrapersonal factors and group membership

Perceived social support, academic stress, and life satisfaction were each indirectly related to persistent NSSI via perceived emotion regulatory capability, but not through emotional distress (Figure 1a-c, respectively). Higher levels of social support and life satisfaction, and lower levels of academic stress were associated with an enhanced belief in one's emotion regulatory capability, which was, in turn, negatively and uniquely predictive of persistent NSSI. When controlling for shared variance between the predictors, effects remained significant for social support (β* = 0.23, *SE* = 0.10, *p* = .025, Indirect effect = -0.26, *SE* = 0.16, 95% *BCCI* = -0.65;-0.02) and life satisfaction (β* = 0.38, *SE* = 0.10, *p* < .001, Indirect effect = -0.47, *SE* = 0.20, 95% *BCCI* = -0.93;-0.18), but not academic stress (β* = - 0.10, *SE* = 0.09, *p* = .243, Indirect effect = 0.13, *SE* = 0.16, 95% *BCCI* = -0.14;0.50).
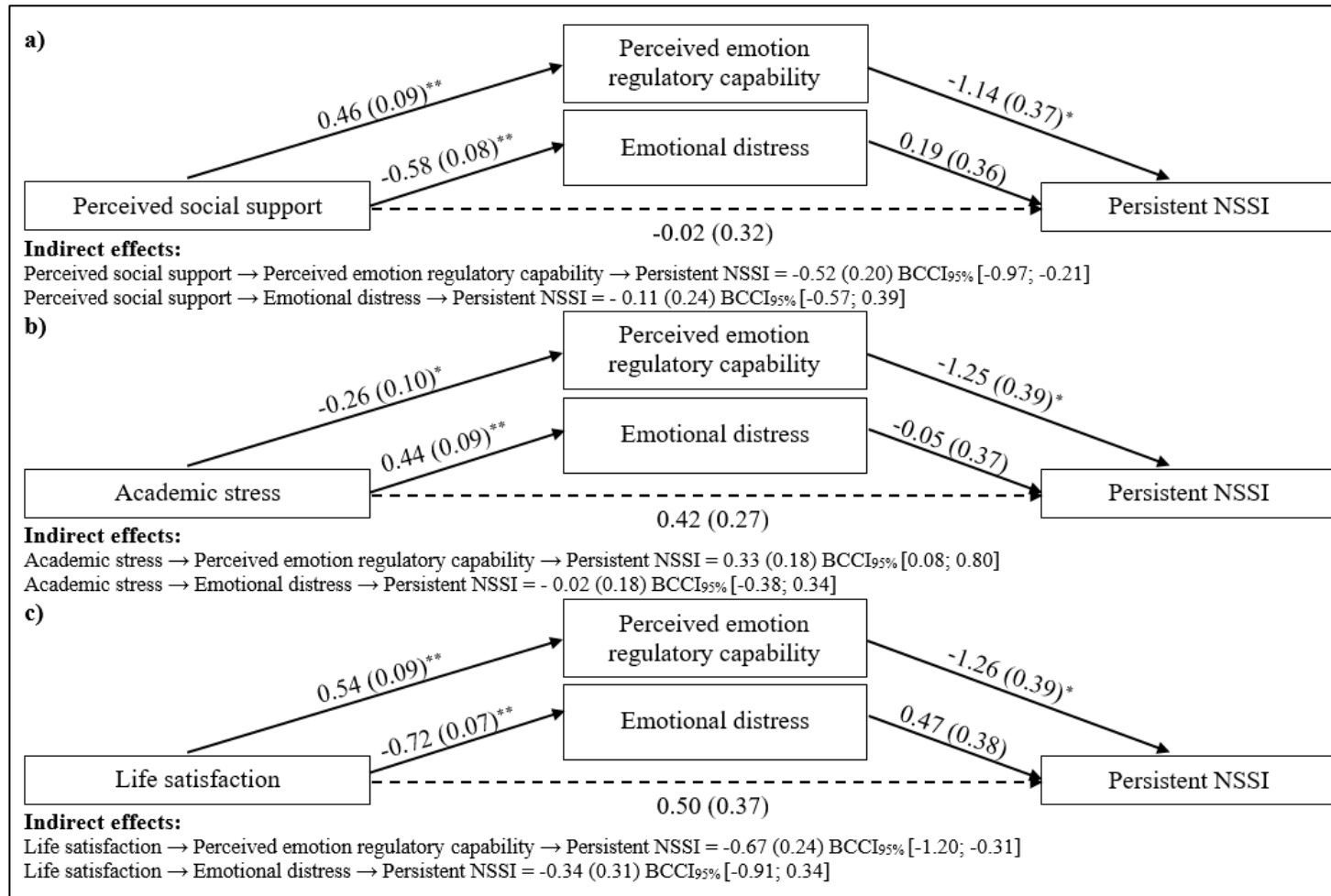
Figure 7.1. Multiple mediation models from perceived social support, academic stress, and life satisfaction via emotional distress and perceived emotion regulatory capability to persistent non-suicidal self-injury.

Standardized coefficients and standard errors between parentheses are presented. Associations between the predictor variable and the mediators are controlled for sex. Indirect point estimates are shown together with Bias-Corrected 95% Confidence Intervals (BCCI) using 10,000 bootstrap samples. NSSI = Non-suicidal self-injury. *p < .01, ** p < . 001, two-sided tested

Discussion

This study is one of the first to address the need for a more detailed understanding of factors related to NSSI persistence in emerging adulthood. Two main findings stand out. First, more severe NSSI (i.e., higher frequency and number of methods) and specific functions predicted persistence of NSSI past adolescence. Second, while both inter- and intrapersonal factors differentiated participants, perceived emotion regulatory capability was confirmed as a potentially important pathway to NSSI cessation.

The first aim of the study was to examine NSSI characteristics that differentiate emerging adults who have continued to self-injure since adolescence, and those who have ceased the behavior during the college period. More frequent engagement in NSSI, and relying on a broader range of methods predicted persistent NSSI, which aligns with previous longitudinal research (Glenn & Klonsky, 2011; Hamza & Willoughby, 2014; Riley et al., 2015). Of note, the number of NSSI methods used has been related to suicide attempts above and beyond frequency of the behavior (Anestis, Khazem, & Law, 2015; Turner, Layden, Butler, & Chapman, 2013). Thus, it may be important for future work to consider the co-occurrence of suicide attempts and heightened suicide risk among emerging adults who continue to self-injure. Further, in line with previous research (Klonsky, 2007; Whitlock et al., 2011), participants most often reported negative affective imbalance motives (assessed by the NSSI-AT) for NSSI. Although we anticipated that NSSI functions that relate to the positive automatic reinforcement domain (i.e., stimulation of affect and cognitions) would be more frequently reported by emerging adults persisting with NSSI (Yen et al., 2016), the function 'to feel something' did not differentiate groups. However, engaging in NSSI to 'get a rush or surge of energy' was associated with persistent NSSI, suggesting that, for some people, NSSI is associated, not only with negative reinforcement, but also with positive automatic reinforcement. Interestingly, emerging adults who continued to self-injure also reported engaging in NSSI because they cannot resist the urge to self-injure. This might indicate that, for some students, NSSI may have become a conditioned behavior, with little volitional control, which emerges after repeated negative reinforcement (Chapman et al., 2006; Hasking, 2017). These features, such as an inability to reduce NSSI, increase the risk that young people engage in more severe NSSI than anticipated (Buser, Buser, & Rutt, 2017). Taken together, we

found that emerging adults who continue to self-injure have a more severe NSSI history, and report both positive arousal-eliciting contingencies and a perceived inability to control their NSSI.

A second aim of the study was to examine inter- and intrapersonal factors that differentiated young people who continue to self-injure into emerging adulthood and those who had ceased the behavior. As expected, students who continued to self-injure reported more academic and emotional distress, and less peer support, life satisfaction, and belief in their emotion regulatory capability than those who ceased the behavior. Interestingly, however, non-heterosexuality and perceived family support were not related to persistent NSSI. This might mean that these factors are only predictive of lifetime history of NSSI (e.g., non-hetero sexuality; Wilcox et al., 2012), rather than being related to persistent NSSI among emerging adults. Alternatively, it might be that the factors that predict persistent NSSI change over time. Compared to adolescence, emerging adulthood represents an accelerated period of independence from parents (e.g., many leave their home context to live on campus), and a further increased interest in social relationships (especially romantic relationships; Arnett, 2015; Guarnieri, Smorti, & Tani, 2014). As such, while family support is noted as important in adolescent samples (Tatnell et al., 2014), social support was the more salient protective factor in our sample of emerging adults. To examine this hypothesis, future cohort studies could examine the differential roles of specific support networks through different developmental periods by operationalizing family, peer and partner relationships as time-variant protective factors against NSSI.

The last aim of our study was to examine emotional distress and perceived emotion regulatory capability as potential pathways between inter- and intrapersonal factors and NSSI. Overall, our findings revealed that less perceived social support and life satisfaction predicted persistent NSSI, working through an enhanced belief in one's lack of emotion regulatory capability. These findings support previous work that found that the relationships between risk factors and lifetime NSSI were mediated by emotion regulation (Adrian, Zeman, Erdley, Lisa, & Sim, 2011; Duggan, Toste, & Heath, 2013; Gratz & Roemer, 2008; Yurkowski et al., 2015). Arguably, greater life satisfaction and stronger social relationships are associated with positive emotional experiences, which prior work suggests might counter negative self-beliefs and induce behavioral flexibility, resilience, and emotion regulation efforts (Diamond & Asminwall, 2003; Garland et al., 2010). Conversely, it might also be that ongoing NSSI contributes to less quality of life and poorer social relationships over time (Burke, Hamilton, Abramson, & Alloy, 2015).

Surprisingly, emotional distress had no predictive value above and beyond perceived emotion regulatory capability. This suggests that *perceiving* oneself to be competent to downregulate emotion in the face of adversity, rather than experiencing low levels of emotional distress, might be key to successfully cease NSSI. Experience sampling studies would provide a unique opportunity to examine these tentative hypotheses.

The role of cognition in NSSI has largely been ignored, with a primary focus on the importance of emotion and emotion regulation. However, researchers have recently drawn attention to the importance of cognitions, particularly those related to perceived ability to cease NSSI (Hasking, 2017; Hasking et al., 2017). Future work exploring specific emotion regulation self-efficacy beliefs has potential to significantly advance our understanding of factors related to the continuation and cessation of NSSI. While we used one subscale of an emotion regulation measure to assess perceived emotion regulatory capability, use of specific emotion regulation self-efficacy scales is warranted to explore this possibility further. Caprara et al's (2008) Regulatory Emotional Self-Efficacy scale makes a distinction between perceived self-efficacy in expressing positive and managing negative affect (anger/irritation and despondency/distress). Use of such a measure would allow a more fine-grained examination of how belief in ability to regulate emotions is related to NSSI.

Limitations and further research directions

The findings of this study should be interpreted within the context of several limitations. First, because factors were assessed at baseline as predictors of a persistent relative to a ceased NSSI trajectory, our mediational analyses lack the temporal precedence criteria of causality. Future cohort studies that follow young individuals from early adolescence into adulthood will be able to elucidate the time-dynamics and developmental specificity of the examined models. Such studies would also allow more complex models to be tested, including invariance across sexes, which the current sample size precluded. Second, while we relied on a validated measure to detect non-specific emotional distress and serious mental illness, it may be that specific psychiatric comorbidities (e.g., major depressive disorder) hold incremental value for the prediction of persistent NSSI above and beyond emotion regulatory capability. Third, in an effort to assess multiple constructs, while reducing demand on participants, we used brief or single-item measures to assess some constructs; replication using

more extended measures is warranted. In a similar vein, future research should consider a broader range of NSSI severity indicators such as medical severity and location of injury, as well as the newly proposed DSM-5 NSSI disorder (American Psychiatric Association, 2013). For instance, an important avenue for future research might be to examine whether adolescents who meet disorder criteria are more likely to continue to self-injure into emerging adulthood. In addition, several inter- (e.g., romantic relationships) and intrapersonal factors (e.g., gender identity; Marshall, Claes, Bouman, Witcomb, & Arcelus, 2016) that were not examined are subject to future empirical scrutiny.

Fourth, while the use of a three-year study period means that we can be more confident that participants in our cessation group really had ceased their NSSI than studies using 6-12 month cessation (Glenn & Klonsky, 2011; Hamza & Willoughby, 2014; Riley et al., 2015), it is possible that some individuals in this group relapsed after the study. Kelada and colleagues (2016) recently showed that young people who ceased NSSI often remain ambivalent about their recovery. This demonstrates that recovery is a multifaceted construct that not only refers to the behavioral outcome (i.e., cessation of NSSI over a certain time period), but also entails a psychological component (i.e., an individuals' own perception). To get a better insight into the latter, future longitudinal work would benefit from a mixed-method approach. Finally, as these data are based on college students, replication is warranted in community samples of emerging adults to ensure the generalizability of findings.

Clinical implications

These limitations notwithstanding, the current findings have some important clinical implications. First, preventative interventions in emerging adults, for instance at college entrance, could include screening questions related not just to NSSI characteristics but also to perceptions of emotion regulatory capability. This might identify emerging adults most likely to persist with NSSI, and potentially at elevated risk for suicidal thoughts and behaviors and psychiatric comorbidity (Groschwitz et al., 2015; Hamza & Willoughby, 2016; Mortier, Kiekens, et al., 2017). Second, clinicians could assess the belief their clients have in their own emotion regulation strategies; addressing these negative self-focused cognitions may be a pre-cursor to the successful acquisition of effective emotion regulation skills. Behavioral functional analysis may be particularly suited to map the environmental situations, feelings, and cognitions that precede and follow NSSI acts (Andover, Schatten, Morris, & Miller, 2015).

In the same way, clinicians could assess whether strong positive arousal-eliciting contingencies are involved and/or engagement in NSSI has become conditioned, which would also necessitate learning more adaptive ways to increase positive affect and ways to alter the environmental context that triggers NSSI.

Conclusion

Given the adverse outcomes associated with persistent NSSI, there is a need for a more detailed understanding of factors that differentiate emerging adults who continue to self-injure from those who successfully cease the behavior. Such information is necessary to inform early intervention initiatives and facilitate cessation of NSSI among emerging adults. Awaiting future research on this important topic, our findings suggest that adolescents with a history of NSSI are more likely to follow a persistent NSSI trajectory into emerging adulthood when: a) they engage in more frequent and varied forms of self-injury, b) report strong positive arousal-eliciting reasons for NSSI or an inability to resist the urge to self-injure, c) and hold negative beliefs about their emotion regulatory capability. This intrapersonal factor was not only uniquely predictive of persistent NSSI, but might also operate as an underlying pathway driving NSSI past adolescence into emerging adulthood. Future studies examining the role of these emotion regulation self-efficacy beliefs have considerable potential to provide clues to help guide interventions targeted at the cessation of NSSI.

The empirical **Chapters 3-7** took a developmental perspective to yield a better understanding of the epidemiology of NSSI (objective 1), the severity and clinical significance of NSSI for college mental health (objectives 2-3), and the risk and protective factors that explain *who* - within the entire college student population - is at relatively high risk of engaging in this behavior during the college period (objective 4). To address these objectives, we surveyed samples of college students at college entrance and followed these students annually during their academic career. The final empirical study of this thesis, described in **Chapter 8**, uses new technologies to collect longitudinally intensive data collected in the realm of everyday life to provide complementary knowledge about factors that predict acute risk of NSSI thoughts and NSSI behavior within college students who report NSSI (Objective 5).

Chapter 8

Short-Term Predictors of Non-Suicidal Self-Injurious Thoughts and Behaviors

ABSTRACT

Introduction: Although research over the past decade has resulted in significantly increased knowledge about distal risk factors for non-suicidal self-injury (NSSI), little is known about short-term (proximal) factors that predict NSSI thoughts and behaviors. Drawing on contemporaneous theories of NSSI, as well as the concept of ideation-to-action, the present study clarifies (a) real-time factors that predict NSSI thoughts and (b) the extent to which theoretically important momentary factors (i.e., negative affect, positive affect, and self-efficacy to resist NSSI) predict NSSI behavior in daily life, beyond NSSI thoughts.

Methods: Using Experience Sampling Methodology, intensive longitudinal data was obtained from 30 young adults with frequent NSSI episodes in the last year. Participants completed assessments up to eight times per day for 12 consecutive days (signal-contingent sampling). This resulted in the collection of 2,222 assessments (median compliance = 79.2%) during which 591 NSSI thoughts and 270 NSSI behaviors were recorded. Using the dynamic structural equation modeling framework, multilevel vector autoregressive models were constructed.

Results: Within the same assessment, negative affect was positively associated with NSSI thoughts, whereas positive affect and self-efficacy to resist NSSI were each negatively associated with NSSI thoughts. Across assessments, higher-than-usual negative affect and self-efficacy to resist NSSI were predictive of short-term change in NSSI thoughts. While fluctuations in both negative affect and positive affect prospectively predicted NSSI behavior, these factors became non-significant in models that controlled for the predictive effect of NSSI thoughts. In contrast, self-efficacy to resist NSSI incrementally predicted a lower probability of engaging in NSSI, above and beyond NSSI thoughts.

Discussion: This study provides preliminary evidence that affective fluctuations may uniquely predict NSSI thoughts but not NSSI behaviors, and point to the role of personal belief in the ability to resist NSSI in preventing NSSI behavior. These findings illustrate the need to differentiate between the development of NSSI thoughts and the progression from NSSI thoughts to behavior, as these are likely distinct processes, with different predictors.

Keywords: non-suicidal self-injury, real-time prediction, ideation-to-action, intensive longitudinal assessment, young adults, ecological momentary assessment

Introduction

Non-suicidal self-injury (NSSI), defined as the deliberate, self-inflicted damage of one's own body tissue without suicidal intent (e.g., cutting, scratching, and hitting oneself), is a worrisome behavior among adolescents and emerging adults (Gillies et al., 2018; Self-Injury, 2018). Pooled lifetime prevalence estimates of NSSI are close to 17-18% among adolescents and 12-20% among emerging adults (Muehlenkamp et al., 2012; Swannell et al., 2014). NSSI behaviors are an important predictor of future suicidal thoughts and behaviors (Hamza & Willoughby, 2016; Kiekens, Hasking, Boyes, et al., 2018; Mortier, Demyttenaere, et al., 2017; Ribeiro et al., 2016) and psychopathology (Riley, Davis, Combs, Jordan, & Smith, 2016; Wilkinson et al., 2018), and are associated with stigma and feelings of shame (Burke et al., 2019; Hasking & Boyes, 2018a; Mahtani et al., 2019), low levels of disclosure and help-seeking (Gollust et al., 2008; Macrynikola et al., 2018; Whitlock et al., 2011), and other negative outcomes (e.g., poorer academic performance; Kiekens et al., 2016). Together, these findings underscore the importance of a good understanding of the factors that underlie NSSI, with a view to informing preventive and intervention initiatives.

The short-term prediction problem in existing research on NSSI

While NSSI and its correlates have traditionally been studied using cross-sectional designs, over the past decade concerted efforts have been made to clarify long-term (distal) predictors (Buelens et al., 2019; Fox et al., 2015; Kiekens et al., 2019; Tatnell et al., 2014). These longitudinal studies typically take a population-level nomothetic approach (i.e., risk stratification at the between-person level), involving few measurement occasions (usually 2-5) that are spaced over long observation windows (e.g., yearly). Although such an approach may be useful in revealing who - within the entire population - is at relatively high risk of engaging in NSSI in the next months or years, it lacks temporal resolution to reliably tell us when individuals at high risk are most likely to contemplate, or engage in, NSSI in the next minutes and hours. Providing greater clarity regarding short-term (proximal) predictors requires a specific research design that takes an individualized ideographic approach (i.e., risk stratification at the within-person level) as well as intensive monitoring to capture momentary processes that explain imminent risk of NSSI. Fortunately, the recent proliferation of new technologies

and smartphone-based apps have now made it feasible to use experience sampling methods to study NSSI and its real-time predictors in daily life (Myin-Germeys et al., 2018).

Affective disturbances and NSSI

A central focus of most theoretical models is that NSSI most often serves an affect regulation function (Chapman et al., 2006; Hasking et al., 2017; Hooley & Franklin, 2017; Nock & Prinstein, 2004). Empirical work supports that affect regulation is the most common reported reason for NSSI (Taylor et al., 2018), and, consequently, many studies have focused on the predictive value of affective traits at the between-person level (Turner, Jin, Anestis, Dixon-Gordon, & Gratz, 2018). This work revealed that both higher trait negative affect (i.e., tendency to experience more negative emotions) and lower trait positive affect (i.e., tendency to experience less positive emotions) are associated with risk of lifetime (Arens, Gaher, & Simons, 2012; Armey & Crowther, 2008; Brown, Williams, & Collins, 2007) and future NSSI behavior (Burke, Anne McArthur, Daryanani, Abramson, & Alloy, 2018; Nicolai, Wielgus, & Mezulis, 2016). In line with this, emotional problems (especially anxiety and depressive symptoms) have been identified as risk factors of NSSI at the between-person level (Bentley et al., 2015; Fox et al., 2015; Kiekens et al., 2019). Unfortunately, fewer studies have focused on the role of affect in determining short-term risk for NSSI at the within-person level (for an overview see Rodriguez-Blanco et al., 2018). One consistent finding across studies is that negative affect increases prior to NSSI (Andrewes, Hulbert, Cotton, Betts, & Chanen, 2017; Armey, Crowther, & Miller, 2011; Muehlenkamp et al., 2009), and predicts a higher probability of NSSI in the next hours (Houben et al., 2017; Hughes et al., 2019; Kranzler et al., 2018; Nock, Prinstein, et al., 2009). For instance, using ecological momentary assessment, Kranzler and colleagues observed that a momentary increase in negative affect positively predicted NSSI in the following 2-3 hours for adolescents and young adults (Kranzler et al., 2018). Similarly, Houben and colleagues, demonstrated that higher-than-usual negative affect increased the likelihood of NSSI in the next 30-120 minutes among a sample of inpatients (Houben et al., 2017). While these findings are important and support the affect regulation function of NSSI, future work is required beyond these initial studies to clarify the specificity of affective fluctuations in the short-term prediction of NSSI at the within-person level.

Of note, more research is warranted investigating the potential utility of positive affect as a protective factor against NSSI, as evidence to date has yielded inconclusive results. While some researchers have observed a decrease in positive affect in the hours prior to engagement in NSSI (Andrewes et al., 2017; Muehlenkamp et al., 2009), others failed to confirm such a time trend (Armey et al., 2011), and found that lower-than-usual positive affect is not prospectively predictive of NSSI (Houben et al., 2017; Kranzler et al., 2018). It may be that momentary lowered positive affect is more tolerable than increased negative affect, and therefore less relevant in eliciting NSSI (Kranzler et al., 2018). In any case, better understanding the role of affect requires thorough examination of specific emotions (e.g., relaxed, stressed), as well as composite constructs (e.g., positive affect). Retrospective studies, for instance, have demonstrated that people who self-injure report increased levels of positive emotions low in arousal (e.g., satisfied, relaxed) as well as decreased levels of negative emotions high in arousal (e.g., anxious, stressed) from prior to post NSSI (Claes, Klonsky, Muehlenkamp, Kuppens, & Vandereycken, 2010; Klonsky, 2009). However, because these studies are susceptible to memory biases that may distort these findings, experience sampling studies are warranted to evaluate whether low-arousal positive emotions, and/or high-arousal negative emotions, are most relevant in predicting NSSI within the next few hours. Providing greater clarity regarding the specificity of affective states as short-term predictors of NSSI would provide valuable information for the development of novel preventive interventions.

Affective disturbances predictive of NSSI thoughts or NSSI behavior?

Surprisingly little is known about the extent to which affective fluctuations predict NSSI behavior, beyond NSSI thoughts. Originating from studies on suicidal thoughts and behaviors (Klonsky & May, 2015; Klonsky et al., 2018; O'Connor & Kirtley, 2018), the ideation-to-action framework argues that the factors that lead people to contemplate about a behavior (i.e., in this case thoughts concerning suicide) may not necessarily be the same factors that govern whether people act on their thoughts (i.e., attempt suicide). In a similar vein, it may be equally important to differentiate between the process of developing NSSI thoughts and engaging in NSSI behavior. NSSI thoughts are an important near-term precursor of NSSI behavior (Hughes et al., 2019; Nock, Prinstein, et al., 2009), and a growing body of evidence suggests that momentary increased negative affect and lowered positive affect are salient factors in predicting NSSI thoughts (Hughes et al., 2019; Kranzler et al., 2018; Victor, Scott,

Stepp, & Goldstein, 2019). As such, similar to the observation that affective disturbances are robust predictors of suicide ideation but not attempt (Khazem & Anestis, 2016; Klonsky et al., 2018; May & Klonsky, 2016; Nock, Hwang, et al., 2009), the possibility exists that affective fluctuations are relevant in predicting short-term change in NSSI thoughts but are not uniquely predictive of making the transition from NSSI thoughts to behavior. While emerging evidence suggests that fluctuations in positive affect might be more useful in predicting thoughts than behavior (Kranzler et al., 2018), it is currently unclear whether negative and positive affective states hold predictive value beyond NSSI thoughts in determining short-term risk of NSSI behavior. Addressing this important gap in knowledge requires that future experience sampling studies carefully consider NSSI thoughts when evaluating affective states in the prediction of NSSI behavior.

If affective fluctuations are more useful in explaining short-term change in NSSI thoughts than in predicting the occurrence of NSSI behavior, an important question is whether we can identify momentary factors that provide added insight into whether someone will transition from NSSI thoughts to behavior. Contemporaneous models of NSSI have begun to incorporate cognitive processes in explaining when people are at heightened risk of engaging in NSSI (Hasking et al., 2017; Hooley & Franklin, 2017). According to the Cognitive-Emotional Model of NSSI (Hasking et al., 2017), NSSI-related cognitions determine whether someone who is experiencing an aversive emotional situation will, or will not, engage in NSSI in the next minutes and hours. Specifically, this model postulates that personal belief in the ability to resist NSSI will be a unique protective factor against NSSI behavior. While findings confirm that people who engage in NSSI report lower self-efficacy to resist NSSI than peers who do not self-injure (Dawkins, Hasking, Boyes, Greene, & Passchier, 2019; Hasking & Rose, 2016; Hasking et al., 2017), experience sampling studies are warranted to evaluate whether these beliefs have clinical utility in determining risk of NSSI behavior.

The present study

We designed the present study to clarify the extent to which momentary fluctuations in affective states and self-efficacy to resist NSSI are real-time predictors of NSSI thoughts and behaviors. Specifically, there were two major objectives at the within-person level. The first main objective was to evaluate whether within-person fluctuations in negative affect, positive affect, and self-efficacy to

resist NSSI predict NSSI thoughts within the same observation window (i.e., contemporaneous associations reflecting processes occurring in the moment; objective 1a in Figure 8.1), as well as from one observation window to the next (i.e., temporal associations reflecting processes that unfold within hours; objective 1b in Figure 8.1). Based on existing knowledge (Hughes et al., 2019; Kranzler et al., 2018; Victor et al., 2019), we hypothesized that higher-than-usual negative affect, and lower-than-usual positive affect, would each be contemporaneously and temporally associated with NSSI thoughts. However, as we expected that momentary fluctuations in affective states would trigger NSSI thoughts more strongly within minutes than hours, stronger effects were anticipated in contemporaneous than temporal models (Epskamp et al., 2018).
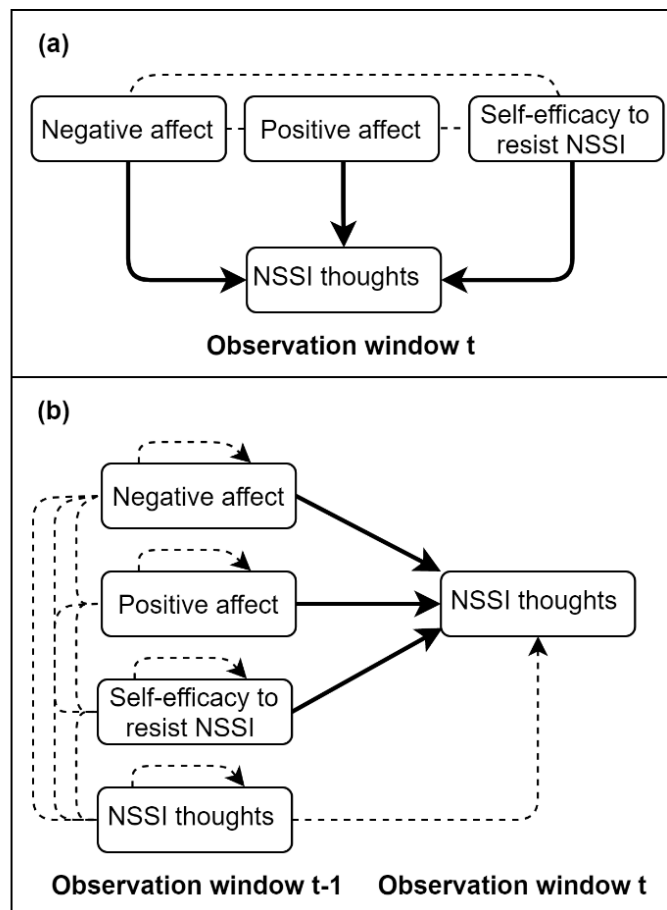
Figure 8.1. Graphical illustration of the first research objective of the study in which NSSI thoughts are predicted within (Objective 1a) and across measurement windows (Objective 1b) at the within-person level. Solid arrows indicate effects of interest. Dotted arrows represent autoregressive effects and dotted lines associations within the same observation window.

The second main objective was to evaluate whether within-person variation in affective states and self-efficacy to resist NSSI, relative to their own average levels, predict NSSI behavior above and beyond NSSI thoughts (Figure 8.2). Building upon previous research from the suicide literature (Khazem & Anestis, 2016; Klonsky et al., 2018; May & Klonsky, 2016), we hypothesized that fluctuations in affective states would not further increase the risk for NSSI behavior, after accounting for NSSI thoughts. To explore the utility of specific emotions, results were also analyzed using emotions as units of analyses rather than composite measures of negative and positive affect. As suggested by the Cognitive-Emotion Model of NSSI (Hasking et al., 2017), we expected that self-efficacy to resist NSSI would negatively predict the occurrence of NSSI behavior above and beyond NSSI thoughts. Finally, in keeping with empirical work at the between-person level (Bentley et al., 2015; Burke, Anne McArthur, et al., 2018; Fox et al., 2015; Kiekens et al., 2019; Nicolai et al., 2016), an additional aim of the study was to evaluate trait negative affect, trait positive affect, self-efficacy to resist NSSI, and anxiety and depressive symptoms assessed at baseline as prospective predictors of NSSI thoughts and behaviors (Objective 3). Consistent with previous research and the ideation-to-action framework (Fox et al., 2015; Khazem & Anestis, 2016; Kiekens et al., 2019; Klonsky et al., 2018; May & Klonsky, 2016), we hypothesized that depressive symptoms would uniquely predict mean-level of NSSI thoughts over time but not probability of NSSI behavior, whereas the opposite pattern of results was expected for self-efficacy to resist NSSI.
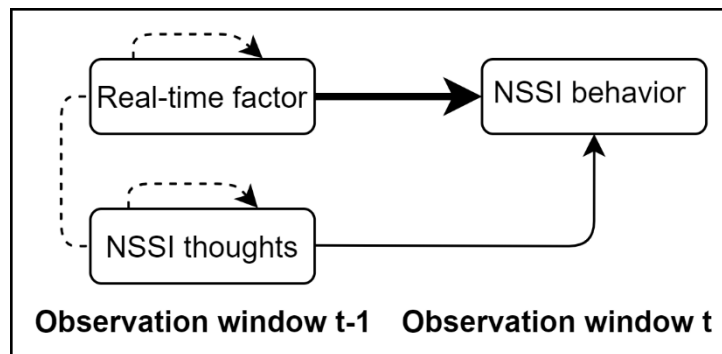
Figure 8.2. Graphical illustration of the second research objective of the study in which NSSI behavior in daily life is predicted by real-time factors (i.e., negative affect, positive affect, and self-efficacy to resist NSSI), beyond NSSI thoughts. Solid arrows indicate effects of interest. Dotted arrows represent autoregressive effects and dotted lines associations within the same observation window.

Methods

Participants and procedure

Participants were 30 young adults (M_{age} = 20.1, SD = 1.1; 80.0% female) selected from an ongoing longitudinal survey study of college students (Kiekens et al., 2019), meeting inclusion criteria of: (a) NSSI on 5 or more days in the last year, and (b) reported urges to self-injure in the past month. Participants were invited to the laboratory to complete self-report questionnaires and a diagnostic interview, and to receive training on completing the experience sampling protocol via "ExpiWell", a widely used smart-phone app for real-time, and real-world, data collection (https://app.expiwell.com/). The presence of 12-month mental disorders was assessed by means of the Structured Clinical Interview for DSM-5 (First, Williams, Karg, & Spitzer, 2015). A clinical psychologist administered the following sections: mood disorders, anxiety disorders, obsessive-compulsive and related-disorders, substance use disorders, externalizing disorders, post-traumatic stress-disorder, and eating disorders. Non-suicidal self-injury characteristics and suicidal thoughts and behaviors were assessed with the Self-Injurious Thoughts and Behaviors Interview (Nock et al., 2007). Table 8.1 presents an overview of the diagnostic features of the sample. Participants met diagnostic criteria for a median of two mental disorders in the last 12 months, with DSM-5 anxiety and mood disorders being most prevalent (range 33.3-50%; Table 8.1). Participants reported a median of NSSI on 17.5 days in the past year (range 5-360 days), and used a median of 5 NSSI methods (ranging between 2 to 10). Two thirds of the sample (66.7%) also reported having suicidal thoughts in the preceding 12 months, and 20% reported having made at least one suicide attempt in their life (Median = 2.5 attempts).

Table 8.1. Diagnostic characteristics of the sample (n = 30)

	% / Median (min; max)
Mood disorders	33.3
Major depressive disorder	26.7
Persistent depressive disorder	20.0
Anxiety disorders	50.0
Panic disorder	13.3
Agoraphobia	6.7
Specific phobia	16.7
Social Anxiety disorder	20.0
Generalized Anxiety disorder	23.3
Obsessive-compulsive disorders	16.7
Alcohol use disorder (mild-moderate)	13.3
ADHD	6.7
Post-traumatic stress disorder	13.3
Eating disorders	20.0
Anorexia nervosa	13.3
Bulimia nervosa	3.3
Binge-eating disorder	3.3
Any current mental disorder	70.0
Number of current disorders	2.0 (0; 7)
NSSI frequency	
Number of days NSSI past year	17.5 (5; 360)
Number of acts past month	2.0 (0; 60)
Number of methods	5 (2; 10)
Top-three reported NSSI behaviors	
Scratched oneself	86.7
Cut oneself	66.7
Hit hand/foot against wall/other objects	56.7
Medically treated for NSSI	26.7
Suicidal thoughts and behaviors	
12-month suicide ideation	66.7
Lifetime suicide attempt	20.0

Note: Mental disorders were defined as having met diagnostic criteria within the past year, with the exception of generalized anxiety disorder and attention deficit hyperactivity disorder which were *defined* as having met diagnostic criteria within the past 6 months.

Following initial screening, participants were enrolled in a 12-day signal-contingent experience sampling protocol in which they were prompted randomly eight times per day, between 9 a.m. and 9 p.m., in blocks of 1.5 hour segments (minimum 15 minutes apart from prior assessments). Participants without a smart-phone were provided with a personal device by the research team. To ensure that we captured people in their ongoing activities, and to avoid retrospective reporting, participants were required to register their response within 15 minutes of each prompt. Reimbursement for participation was structured to encourage compliance (Nock, Prinstein, et al., 2009), with a financial compensation of €25 if compliance ranged between 25-50%, €50 between 50-85%, and €75 if compliance exceeded 85%. Overall compliance was good (Median = 79.2%) with, on average, 74 randomly registered recordings per participant (range 36-95), resulting in 2,222 randomly registered recordings for the entire sample. Prior to enrolment, all participants were briefed about the procedures and the voluntary and confidential nature of the study and were provided with contact details of responsible clinicians (including the first and last author, both clinical psychologists). One item of the experience sampling protocol also assessed suicide ideation and activated a popup screen within the app with additional resources when participants reported experiencing suicidal thoughts. Written informed consent was provided by all participants and the study's protocol was approved by the University's Ethical Review Board and by the Belgian commission for the protection of privacy. All procedures were in accordance with the 1964 Helsinki declaration and its later amendments.

Laboratory measures

Trait positive and negative affect was assessed using the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The PANAS presents 10 positive (e.g., excited, attentive) and 10 negative emotions (e.g., distressed, nervous), and participants were asked to rate the extent to which they "generally" experience each emotion on a five-point Likert scale ranging from 1 (Very slightly or not at all) to 5 (Extremely). The PANAS is a reliable and valid measure that is invariant across demographic variables (Crawford & Henry, 2004), and the internal consistency coefficients of both scales were also good in the current sample (α_{PA} = 0.78, α_{NA} = 0.88).

Self-efficacy to resist NSSI was assessed using the 6-item measure adapted from the Self-Efficacy to Avoid Suicidal Action Scale (Czyz et al., 2014). In this study, participants reported from 1

(Very uncertain) to 10 (Very certain) whether they believe they can resist engaging in NSSI in the next two weeks (e.g., "How certain are you that you will not self-injure in the next two weeks?"), with higher scores indicating a higher personal belief in the ability to resist NSSI. The adapted NSSI version has shown good internal consistency coefficients in previous research (Dawkins et al., 2019; Hasking & Rose, 2016) as well as the current sample (α = 0.74).

Anxiety and depressive Symptoms in the past Week were measured using the 21-item Depression Anxiety Stress Scales (Henry & Crawford, 2005). The anxiety (e.g., "I felt I scared without any good reason") and depression (e.g., "I felt down-hearted and blue") scales include seven four-point items ranging from 1 (Did not apply to me at all) to 4 (Applied to me very much or most of the time) that assess symptoms in the preceding week. Both scales have demonstrated good internal consistency and convergent and discriminant validity in previous research (Henry & Crawford, 2005). The internal consistency of the scales in the current sample was acceptable for the Anxiety scale (α = 0.61) and good for the Depressive scale (α = 0.89).

Ecological Momentary Assessment

Momentary positive and negative affect was assessed by asking respondents at each prompt to what extent they currently experience 4 positive (i.e., excited, cheerful, satisfied, relaxed,) and 6 negative emotions (i.e., stressed, irritated, anxious, sad, hopeless, insecure): "*Right now, I feel* [emotion]". These specific emotions were selected because they represent a conceptual range of both activated (e.g., excited, stressed) and deactivated (e.g., relaxed, sad) emotions within all quadrants of the affective circumplex defined by the dimensions of valence and arousal (Russell, 2003). Each emotion was rated on a 7-point Likert scale ranging from 0 (Not at all) to 6 (Very much), with the order in which emotions were presented randomized within persons, across beeps. Each affective state was calculated as a weighted mean across items. Using methods described by Shrout and Lane (Nezlek, 2017), both scales demonstrated excellent between-person reliability (RKR_{PA} = 0.98, RKR_{NA} = 0.99), and good within-person reliability (RC_{PA} = 0.83, RC_{NA} = 0.77).

Momentary NSSI thoughts and occurrence of NSSI behavior. At each prompt, participants were asked to indicate whether they were currently thinking of engaging in NSSI ("*Right now, I think about self-injuring without suicidal intent*") using a 7-point Likert scale ranging from 0 (Not at all) to 6

(A lot). Additionally, participants were asked to indicate whether or not they engaged in NSSI since their last registration ("*Have you self-injured without wanting to die since the last beep*?"). If answered affirmatively, a list of NSSI behaviors was presented including cutting/carving, scratching, hitting, burning, biting, head-banging, wound interfering, and an 'other' category.

Momentary self-efficacy to resist NSSI was measured by asking participants how confident they felt in their ability to resist NSSI ("*How confident are you that you will not engage in NSSI till the next beep*") using a 7-point Likert scale ranging from 0 (Not confident at all) to 6 (Very much confident).

Statistical analyses

To accommodate the two-level structure of the data (i.e., observations nested within persons), and to provide understanding of the value of real-time predictors of NSSI thoughts and behavior, multilevel vector autoregressive models were constructed within the Dynamic Structural Equation Modeling Framework (DSEM) in Mplus 8.3 (Asparouhov, Hamaker, & Muthén, 2017; Hamaker, Asparouhov, Brose, Schmiedek, & Muthen, 2018). Contemporaneous associations between factors of interest and NSSI thoughts within the same window of measurement (Objective 1a) were examined using Residual DSEM, which is closely related to the regular DSEM framework, but allows modeling of the autoregressive part of the model while preserving the structural part on the contemporaneous relationships (Asparouhov & Muthén, 2019). Temporal relationships between factors of interest and both NSSI thoughts and behavior (Objective 1b and 2) were examined using regular DSEM. This allowed us to investigate the extent to which extent time-varying variables at t-1 (e.g., negative affect) predict NSSI thoughts and NSSI behavior at t*,* above and beyond the lagged version of the outcome variable (i.e., the autoregressive parameter) and/or a confound variable at t-1 (e.g., NSSI thoughts in the prediction of NSSI behavior). Latent person-mean centering was used to allow interpretation of predictor variables at the within-person level in a relative fashion for each person while accounting for sampling error. At the between-person level, we considered trait negative affect, trait positive affect, baseline self-efficacy, and anxiety and depressive symptoms in the past week as prospective predictors of NSSI thoughts and NSSI behaviors during the 12-day experience sampling protocol (Objective 3). These between-person variables were grand-mean centered to allow interpretation relative to the overall sample mean.

In all models, we used Bayesian estimation based on Markov Chain Monte Carlo using Gibbs sampling. Bayesian estimation has several advantages over a frequentist approach in this context, such as better performance in small samples (i.e., posterior distributions are not required to have asymptotically normal distributions). Non-informative priors were used in all analyses. Point estimates were obtained by taking the median of the posterior distributions for each parameter. Statistical significance was determined by estimating a 95% credibility interval (CI) around each point estimate. A 1-hour transformed time interval was specified using the "TINTERVAL" statement to account for unequally-spaced intervals due to missing data and random sampling within blocks. This procedure creates a new time variable (measured in hours since first assessment in this study) and inserts based on the defined metric missing data records when no observation is present (for a detailed overview of this approach see Asparouhov et al., 2017). Missing data in (R)DSEM is handled using a Kalman filter approach. Due to this procedure, all observations can be used in the analyses and a constant interpretation of lagged relations is maintained (McNeish & Hamaker, 2019). Given that treating covariates as exogenous variables in time-series settings may yield biased estimates (Asparouhov & Muthén, 2019), autoregressive effects of covariates were included in both DSEM and RDSEM models. Bayesian linear regressions were used to predict continuous variables, such as NSSI thoughts, whereas Bayesian probit regression was used to predict the occurrence of NSSI behavior, which was modeled as a categorical variable (present/absent). Each model was specified using a random intercept model with all other within-level parameters fixed, and was estimated using a minimum of 2,500 iterations with a thinning parameter of 20. Model convergence was ensured by checking that the potential scale reduction was close to 1 and trace plots did not contain trends, spikes, or other irregularities.

Results

Preliminary descriptive and variability analyses

During the 12-day experience sampling protocol, 591 NSSI thoughts (i.e., score higher than 0; mean intensity = 0.72; SD = 1.48) were reported. Among those reporting NSSI thoughts (90%), on average 21.9 (SD = 21.4; Median = 16.0; range 1-70) NSSI thoughts were reported. Of the sample, 53.3% of the participants engaged in NSSI, with an average of 10.4 episodes during the 12-day experience sampling protocol (SD = 10.7; Median = 6.0; range 1-37). In total, 270 NSSI behaviors were

recorded across 167 assessments (7.5% of all sampled time points). Table 8.2 presents the descriptive and variability statistics for all within and between-person variables. These findings show that approximately half of the variability in negative affect and NSSI thoughts is due to within-person variance (vs. between person-variance). Figure 8.3 illustrates the within-person variability of NSSI thoughts on an hourly basis for participants. Although self-efficacy to resist NSSI varied more between than within individuals, positive affect showed considerably more variation at the within-person level.

Table 8.2. Descriptive and variability statistics of negative affect, positive affect, self-efficacy to resist NSSI, and NSSI thoughts and behaviors during 12-day experience sampling protocol.

Within-person variables	M/N	SD/%	Range	Total variance[a]	ICC[b]	95% CI
NSSI thoughts	0.72	1.48	0-6	2.38	.51	.38-.65
Negative affect	1.74	1.19	0-6	1.52	.46	.34-.61
Positive affect	2.94	1.28	0-6	1.73	.33	.23-.47
Self-efficacy to resist NSSI next hours	4.79	1.74	0-6	3.34	.70	.59-.80
Number of assessments NSSI behavior reported	167	7.52	0-1	-	-	-
Between-person variables	**M**	**SD**	**Range**	-	-	-
Trait negative affect	29.33	7.88	5-50			
Trait positive affect	30.13	5.21	5-50			
Self-efficacy to resist NSSI next two weeks	31.93	10.73	6-60			
Anxiety symptoms past week	13.60	3.66	7-28			
Depressive symptoms past week	14.53	5.24	7-28			

Note: [a] Total variance represents the sum of variance within individuals across time (i.e., within-person variance) and variance in within-person means across individuals (i.e., between-person variance); [b] The Intra-Class Correlation represents the proportion of the total variance that is accounted for by between-person variance. NSSI = Non-Suicidal Self-Injury; ICC = Intra-Class Correlation; 95% CI = Credibility Interval, M = Mean, SD = Standard Deviation, N = Total Number.

Contemporaneous Associations Between Affect, Self-Efficacy to Resist NSSI, and NSSI thoughts (Objective 1a)

We first investigated how variables were contemporaneously associated within the same timeframe after partialing out temporal associations (Table 8.3). In univariate analyses, negative affect was significantly positively associated with NSSI thoughts, whereas positive affect and self-efficacy to resist NSSI were each negatively associated with NSSI thoughts. After controlling for shared variance within a multivariate modeling framework, each factor remained significantly associated, although weaker, with NSSI thoughts. Together, these contemporaneous associations explained 41% of the within-person variance of NSSI thoughts in this sample.
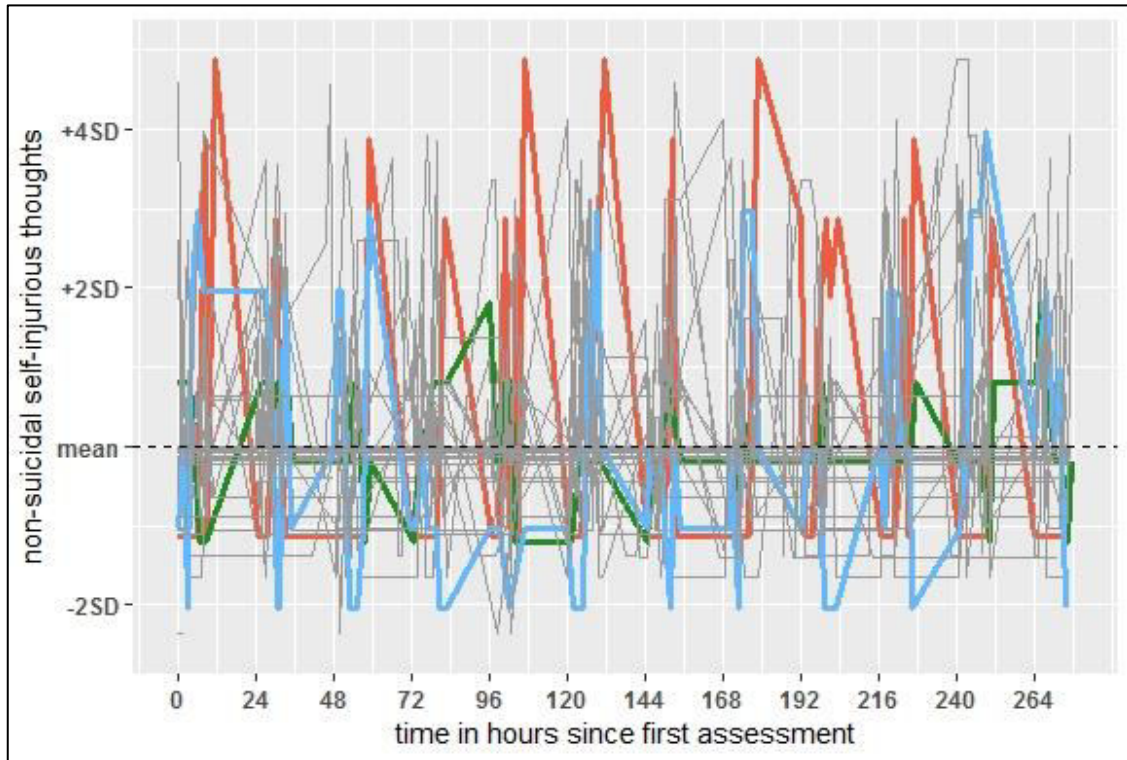
Figure 8.2. Times series plot of non-suicidal self-injurious thoughts during the 12-day assessment.
Values are person-mean centered (comparing each's participants hourly level of non-suicidal self-injurious thoughts to that individual's overall average across time; dashed line). The colored lines represent three randomly selected participants to illustrate within-person variability across time points.

Table 8.3. Contemporaneous (moment-to-moment) associations between affective states, self-efficacy to resist NSSI, and non-suicidal self-injurious thoughts.

	Univariate analyses[a]		Full multivariate analyses[b]	
	B (SD)	95% CI	B (SD)	95% CI
Contemporaneous within-person associations				
Negative affect *t*	**0.48 (0.02)**	**0.43; 0.53**	**0.28 (0.03)**	**0.22; 0.33**
Positive affect *t*	**-0.33 (0.02)**	**-0.37; -0.29**	**-0.05 (0.02)**	**-0.09; -0.00**
Self-efficacy to resist NSSI *t*	**-0.58 (0.02)**	**-0.61; -0.53**	**-0.48 (0.02)**	**-0.52; -0.45**

Note: [a] Univariate analyses are based on separate multilevel regression models for each row, with the variable in the row as predictor. [b] The multivariate model includes all within-person level variables in one multilevel regression model (cf. Figure 8.1a). B = median unstandardized point estimate; SD = posterior standard deviation; CI = Credibility Interval. Bolded cells indicate that there is a 95% probability that the true population value is not-null.

Fluctuations in Affective States and Self-Efficacy to Resist NSSI as Real-Time Predictors of NSSI Thoughts (Objective 1b)

We constructed temporal models to determine the utility of negative affect, positive affect, and self-efficacy to resist NSSI as predictors of short-term change in NSSI thoughts (Table 4). Higher-than-usual negative affect at t-1 positively predicted NSSI thoughts at t, whereas higher-than-usual positive affect and self-efficacy to resist NSSI at t-1 negatively predicted NSSI thoughts at t. In a next step, we evaluated the unique value of these factors in a multivariate prediction model that simultaneously included all cross-regressive parameters at t-1. As can be seen in Table 4, higher-than-usual positive affect at t-1 became non-significant in predicting short-term change in NSSI thoughts at t. Fluctuations in negative affect and self-efficacy to resist NSSI at t-1 remained significantly predictive of short-term change in NSSI thoughts at t. Together, these temporal associations explained 18% of the variance of NSSI thoughts within persons, across time.

Table 8.4. Temporal within-person associations between affective states, self-efficacy to resist NSSI, and non-suicidal self-injurious thoughts.

	Analyses controlling NSSI thoughts at t-1h[a]		Full multivariate analyses[b]	
	B (SD)	95% CI	B (SD)	95% CI
Temporal within-person associations				
NSSI thoughts *t-1h*	**0.47 (0.02)**	**0.43; 0.52**	**0.26 (0.03)**	**0.20; 0.33**
Negative affect *t-1h*	**0.17 (0.03)**	**0.11; 0.23**	**0.09 (0.04)**	**0.02; 0.17**
Positive affect *t-1h*	**-0.10 (0.02)**	**-0.15; -0.05**	0.00 (0.03)	-0.05; 0.06
Self-efficacy to resist NSSI *t-1h*	**-0.23 (0.03)**	**-0.30; -0.17**	**-0.18 (0.03)**	**-0.24; -0.12**

Note: [a] Analyses are based on separate multilevel regression models for each row, with the variable in the row as predictor and controlling the autoregressive parameter of NSSI thoughts. [b] The multivariate model includes all within-person variables in one multilevel regression model (cf. Figure 8.1b). B = median unstandardized point estimate; SD = posterior standard deviation; CI = Credibility Interval. Bolded cells indicate that there is a 95% probability that the true population value is not-null.

Fluctuations in Affective States and Self-Efficacy to Resist NSSI as Real-Time Predictors of NSSI Behavior (Objective 2)

To investigate the utility of fluctuations in affective states and self-efficacy to resist NSSI in predicting the occurrence of NSSI behavior beyond NSSI thoughts, we compared temporal models that included the autoregressive parameter of NSSI behavior to models that controlled the cross-regressive parameter of NSSI thoughts (Table 8.5). As expected, a very similar pattern of results as above was observed in models that included the lagged version of NSSI behavior. Higher-than-usual negative

affect at t-1 was significantly positively predictive of the occurrence of NSSI behavior, whereas higher-than-usual positive affect and self-efficacy to resist NSSI at t-1 were significantly negatively predictive of NSSI behavior in the next time interval. However, when we controlled the cross-regressive parameter of NSSI thoughts at t-1, fluctuations in negative affect and positive affect at t-1 both became non-significant predictors of NSSI behavior at t. In contrast, higher-than-usual belief in one's ability to resist NSSI at t-1 remained significantly predictive of a lower probability of NSSI behavior at t.

Table 8.5. Temporal within-person associations between affective states, self-efficacy to resist NSSI, and NSSI behavior.

	Analyses controlling NSSI behavior t-1h[a]		Analyses controlling NSSI thoughts t-1h[b]	
	B (SD)	95% CI	B (SD)	95% CI
Temporal within-person associations				
NSSI behavior *t-1h*	**0.31 (0.10)**	**0.07; 0.49**	0.04 (0.14)	-0.23; 0.28
NSSI thoughts *t-1h*	**0.32 (0.07)**	**0.20; 0.45**	**0.32 (0.05)**	**0.21; 0.43**
Negative affect *t-1h*	**0.26 (0.08)**	**0.12; 0.41**	0.14 (0.10)	-0.06; 0.33
Positive affect *t-1h*	**-0.19 (0.06)**	**-0.32; -0.09**	-0.12 (0.07)	-0.26; 0.03
Self-efficacy to resist NSSI *t-1h*	**-0.43 (0.08)**	**-0.58; -0.29**	**-0.33 (0.08)**	**-0.49; -0.19**

Note: [a] Analyses are based on separate multilevel regression analyses for each risk and protective factor, with the factor in the row as predictor and controlling the autoregressive parameter of NSSI behavior; [b] Analyses are based on multilevel regression analyses for each risk and protective factor, with the variable in the row as predictor and controlling the cross-regressive parameter of NSSI thoughts (cf. Figure 8.2). B = median unstandardized point estimate; SD = posterior standard deviation; CI = Credibility Interval. Bolded cells indicate that there is a 95% probability that the true population value is not-null.

Next, we evaluated whether specific emotions, rather than affective composite scores, hold incremental predictive value in predicting NSSI behavior (Table 8.6). All assessed negative emotions at t-1 (except for feeling irritated) were predictive of NSSI behavior at t in models including the lagged version of NSSI behavior. However, when controlling the cross-regressive parameter of NSSI thoughts at t-1, again, all negative emotions at t-1 became non-significant in predicting NSSI behavior at t. Conversely, all assessed positive emotions at t-1 were consistently negatively predictive of NSSI behavior at t in models including the lagged version of NSSI behavior at t-1. However when controlling the cross-regressive parameter of NSSI thoughts at t-1, the feeling 'relaxed' at t-1 remained negatively predictive of NSSI behavior at t.

Table 8.6. Temporal within-person associations between specific emotions and NSSI behavior.

Temporal within-person associations	Analyses controlling NSSI behavior t-1h[a]		Analyses controlling NSSI thoughts t-1h[b]	
	B (SD)	95% CI	B (SD)	95% CI
Negative Emotions High-Arousal				
Anxious *t-1h*	**0.21 (0.07)**	**0.08; 0.35**	0.10 (0.08)	-0.05; 0.27
Irritated *t-1h*	0.09 (0.06)	-0.03; 0.20	0.06 (0.06)	-0.07; 0.18
Stressed *t-1h*	**0.13 (0.05)**	**0.03; 0.23**	0.09 (0.06)	-0.02; 0.21
Negative Emotions Low-Arousal				
Sad *t-1h*	**0.13 (0.05)**	**0.04; 0.23**	0.08 (0.06)	-0.04; 0.19
Hopeless *t-1h*	**0.11 (0.05)**	**0.01; 0.21**	0.02 (0.06)	-0.11; 0.14
Insecure *t-1h*	**0.17 (0.07)**	**0.05; 0.31**	0.08 (0.07)	-0.05; 0.22
Positive Emotions High-Arousal				
Cheerful *t-1h*	**-0.17 (0.06)**	**-0.28; -0.07**	-0.12 (0.06)	-0.24; 0.00
Excited *t-1h*	**-0.13 (0.05)**	**-0.23; -0.04**	-0.05 (0.06)	-0.18; 0.07
Positive Emotions Low-Arousal				
Satisfied *t-1h*	**-0.11 (0.05)**	**-0.21; -0.01**	-0.05 (0.06)	-0.17; 0.08
Relaxed *t-1h*	**-0.19 (0.06)**	**-0.30; -0.08**	**-0.14 (0.07)**	**-0.27; -0.01**

Note: [a] Analyses are based on separate multilevel regression analyses for each risk and protective factor, with the factor in the row as predictor and controlling the autoregressive parameter of NSSI behavior; [b] Analyses are based on multilevel regression analyses for each risk and protective factor, with the variable in the row as predictor and controlling the cross-regressive parameter of NSSI thoughts (cf. Figure 8.2). B = median unstandardized point estimate; SD = posterior standard deviation; CI = Credibility Interval. Bolded cells indicate that there is 95% probability that the true population value is not-null.

Trait Affect, Self-Efficacy to Resist NSSI and Anxiety and Depressive Symptoms as Predictors of NSSI Thoughts and NSSI Behaviors (Objective 3)

Finally, we examined the utility of baseline measures of trait affect, self-efficacy to resist NSSI, and past-week anxiety and depressive symptoms as between-person predictors of NSSI thoughts and NSSI behavior (Supplementary tables 8.1-8.2). This revealed that individuals with lower mean scores on trait positive affect (β = -0.09, 95%CI = -0.16; -0.02) and higher mean scores on past week depressive symptoms (β = 0.11, 95%CI = 0.04; 0.18) reported higher mean levels of NSSI thoughts across the 12-day experience sampling protocol. Yet, only depressive symptoms uniquely predicted a higher mean level of NSSI thoughts across time (β = 0.11, 95%CI = 0.01; 0.22). In contrast, high self-efficacy to resist NSSI at baseline was the only factor that significantly predicted engagement in NSSI behavior during the 12-day experience sampling protocol. (β = -0.06, 95%CI = -0.15; -0.00).

Discussion

Obtaining a better understanding of the factors that determine when individuals at high risk are most likely to contemplate, or engage in, NSSI behavior represents a challenging but critical research frontier (Glenn, Jaroszewski, Milner, et al., 2015; Rodriguez-Blanco et al., 2018). To this end, using smart-phone based assessment of young adults who frequently self-injure, the present study provides a preliminary investigation into the extent to which affective states and self-efficacy to resist NSSI are real-time predictors of NSSI thoughts and behaviors. To our knowledge, this is the first experience sampling study to differentiate between the process of experiencing NSSI thoughts and engaging in NSSI behavior. Results suggest that affective fluctuations (especially negative affect) may be more useful in predicting NSSI thoughts than behavior per se, and point to the role of cognitive factors (i.e., belief in one's ability to resist NSSI) in preventing NSSI behavior among people experiencing NSSI thoughts.

NSSI thoughts varied considerably across hours, illustrating the need for intensive monitoring to capture these fluctuations in daily life. The first aim of the study was to identify real-time factors that explain variability in NSSI thoughts. Consistent with previous work (Hughes et al., 2019; Kranzler et al., 2018; Victor et al., 2019), higher-than-usual negative affect co-occurred with NSSI thoughts and uniquely predicted a stronger intensity of NSSI thoughts from one observation window to the next. The latter provides further evidence that increased negative affect is a short-term risk factor for NSSI thoughts. In contrast, while lower-than-usual positive affect was negatively associated with NSSI thoughts, this association did not transcend uniquely across time periods. There are two explanations for this: a) positive affect is only relevant in identifying NSSI thoughts as they occur, or b) positive affect also acts as a buffer against NSSI thoughts, but this protective effect occurs on a shorter timescale than the hourly scale used in this study. In line with the latter, we observed substantial within-person variability (ICC = 0.33) in positive affect from hour to hour. However, future research with even greater temporal resolution is needed to rule out one of these explanations. Finally, we found evidence that individuals were less likely to consider NSSI when they had high momentary belief in their ability to resist NSSI, which, in turn, prospectively predicted a lower intensity of NSSI thoughts one hour later.

Importantly, associations between affective states and NSSI thoughts were considerably weaker in temporal than contemporaneous models. Although the temporal precedence of associations cannot be determined in contemporaneous models (i.e., whether affect changes NSSI thoughts, or vice versa), researchers have advocated that contemporaneous relationships, which represent a snapshot in time, may uncover fast-moving causal processes (Epskamp et al., 2018). Given the timeframe of measurement in this study, this likely suggests that the connection between momentary affect and the manifestation of NSSI thoughts is a fast occurring process that operates within seconds and minutes rather than hours. Again, this implies that better understanding the timeframe of these relationships represents an important avenue for future research, as this will provide unique insight into effects that may unfold across shorter and/or longer time intervals.

The second aim of the study was to evaluate the extent to which fluctuations in affective states and self-efficacy to resist NSSI predict NSSI behavior beyond the effect of NSSI thoughts. In line with previous work (Houben et al., 2017; Hughes et al., 2019; Kranzler et al., 2018), we found that fluctuations in negative affect prospectively predicted NSSI behavior when NSSI thoughts were not accounted for. When accounting for NSSI thoughts, however, negative affect was no longer significantly predictive of NSSI behavior. Following an ideation-to action framework (Klonsky & May, 2015; Klonsky et al., 2018; O'Connor & Kirtley, 2018), we do not believe this pattern of findings to indicate that negative affect is unimportant in the manifestation of NSSI behavior - indeed it leads people at high risk to more intensively contemplate engaging in NSSI - but only that it will not exert an additional effect beyond intensity of thoughts in determining whether someone will progress and engage in NSSI. We found similar findings for positive affect: higher-than usual positive affect was not uniquely predictive of a lower probability of engaging in NSSI behavior when taking into consideration NSSI thoughts. Further analyses showed similar findings for all but one emotion (i.e., feeling relaxed), which reflects - relative to feeling satisfied - an absence of arousal within the low positive valence quadrant (Gilbert et al., 2008; Russell, 2003). Although caution is needed interpreting this finding, it suggests that focusing on the down-regulation of physiological hyper-arousal (Fernandez-Aranda et al., 2012; Paret et al., 2016), when thoughts of NSSI occur, may be one useful strategy to interrupt the transition to NSSI behavior. Taken together, these findings provide preliminary evidence that affective states may be unique real-time predictors of NSSI thoughts but not behavior.

If replicated, the implications are far-reaching as it would reflect the necessity of treating the development of thoughts and the subsequent transition from NSSI thoughts to behavior as separate processes that may come with separate sets of predictors. Making the distinction between NSSI thoughts/behaviors may not only be important from a theoretical, but also from a clinical viewpoint. Researchers observed that it typically takes people who self-injure between 1 and 30 minutes to transition from thoughts to behavior (Fitzpatrick, Kranzler, Fehling, Lindqvist, & Selby, 2020; Nock, Prinstein, et al., 2009). This implies that, in most instances, there will be a brief window of opportunity to intervene and interrupt the transition to behavioral action. Ecological momentary interventions using mobile devices might have particular merit in this context (Armey, 2012; Franklin et al., 2016; Myin-Germeys et al., 2018), as these can be delivered when people report experiencing NSSI thoughts, and facilitate relapse prevention techniques. In line with the Cognitive-Emotional Model of NSSI (Hasking et al., 2017), we found evidence that low self-efficacy to resist NSSI may be particularly relevant in identifying high-risk situations among people experiencing NSSI thoughts.

The third aim of the study was to investigate population-level predictors at the between-person level. In line with findings in suicide research (Khazem & Anestis, 2016; Klonsky et al., 2018; May & Klonsky, 2016) and the Cognitive-Emotional Model of NSSI (Hasking et al., 2017), people with higher levels of depressive symptoms at baseline reported more intense thoughts over the course of the study, but only low self-efficacy to resist NSSI in the next two weeks explained who, in our student sample, engaged in NSSI. This is consistent with the concept of capability for suicide (Van Orden et al., 2010), which specifies that a person must hold beliefs about their ability to self-injure (i.e., low self-efficacy to resist) in order to act on self-injurious thoughts. In sum, these findings provide evidence for the clinical utility of NSSI-related cognitions in determining relative risk of future NSSI behavior, and suggest that boosting self-efficacy to resist NSSI might be an important step in equipping people who self-injure with the confidence to handle high risk aversive emotional situations in everyday life.

Limitations and Future Research Directions

Several limitations should be considered in interpreting the findings of this study. First, and foremost, as this sample comprised 30 (mostly female) young adults, replication is warranted in larger samples including more males. Second, and relatedly, the generalizability of the findings to clinical

samples is unclear and should be studied. It might be that clinical samples show stronger temporal relationships between affective states and NSSI thoughts and behaviors. The current findings should therefore be considered as preliminary. In fact, a major future research avenue will be to allow subject-specific effects (for which the current sample was too small) to clarify how these within-person relationships differ between people, as a function of person-level features, such as diagnostic status, gender, personality traits, and differences in experienced life events. Third, all participants within the sample had already engaged in NSSI. This is in contrast to the majority of ideation-to-action research on suicidal thoughts and behaviors, where ideation is considered only in the absence of behavior and separate groups of individuals with ideation and those with behavior are compared. It is possible that factors predicting NSSI thoughts may differ between individuals who have and have not already engaged in NSSI behavior. Contemporary ideation-to-action models of suicide have not explicitly considered factors associated with ideation among individuals who have already engaged in suicidal behavior (Joiner, 2005; Klonsky & May, 2015; O'Connor & Kirtley, 2018; Van Orden et al., 2010). Consequently, a fruitful direction for future research could be to compare ideation-to-action pathways between those who have and have not already engaged in NSSI. Fourth, while the experience sampling protocol we implemented is among the most longitudinally intensive studies conducted thus far (assessments every 90 minutes), this did not allow us to track dynamic processes that happen in the moments that lead up to NSSI To address this shortcoming, future experience sampling studies could incorporate burst assessments (i.e., multiple beeps over shorter time periods) when individuals report NSSI thoughts. Given that NSSI typically occurs within a narrow timeframe following NSSI thoughts (Fitzpatrick et al., 2020; Nock, Prinstein, et al., 2009), such studies would also provide a unique opportunity to clarify the immediate affective-cognitive consequences of engaging in NSSI.

Fifth, although experience sampling reduces recall bias, it still relies on self-report and the ability of participants to accurately describe their thoughts, feelings, and behaviors. Future studies may want to investigate if incorporating wearable devices that detect information about people's movement and activity and psychophysiology (e.g., electrodermal activity and heart rate variability) could augment the short-term prediction of NSSI thoughts and behavior beyond self-report. Use of wearable technology for these purposes is already emerging in suicide research (see Allen, Nelson, Brent, & Auerbach, 2019; Kleiman et al., 2019). Sixth, although overall compliance was high,

considering the intensive sampling protocol, on average participants failed to respond to one in five prompts, and it is unclear to what extent this may have impacted the results. Finally, to reduce participant burden, we decided to operationalize NSSI thoughts using a single item similar to previous studies (Nock, Prinstein, et al., 2009). Building upon these findings, future studies may want to evaluate different qualitative aspects relating to NSSI thoughts (i.e., intensity, duration, controllability; Fitzpatrick et al., 2020; Turner, Baglole, Chapman, & Gratz, 2019), and explore whether meaningful patterns can be identified in relationship to risk for NSSI behavior. In suicide research, for instance, scholars have identified different phenotypes of suicidal thinking, and were able to associate a thought profile characterized by severe persistent suicidal thoughts to a recent suicide attempt (Kleiman et al., 2018).

Conclusion

The present study provides novel evidence that affective fluctuations may be more central to the prediction of NSSI thoughts than NSSI behavior, and suggests that perceiving oneself to be able to resist NSSI, might be key in determining risk of NSSI behavior among people experiencing NSSI thoughts. We believe these findings illustrate the merit of carefully delineating between the processes of developing thoughts and making the transition to behavior, and we hope it encourages researchers to further investigate the relative importance of momentary factors for the different stages towards engagement in NSSI.

Chapter 9

Concluding Discussion and Future Perspectives

The main goal of the present doctoral research project was to significantly improve empirical knowledge of non-suicidal self-injury (NSSI) in college students. Figure 9.1 presents a graphical overview of the main findings of the doctoral research project. In this final chapter, we review the main insights that were derived in relation to the research objectives and reflect on the implications for research, prevention and clinical practice. We finish by discussing the broader limitations of the research and provide several directions for further research.

Towards a better understanding of NSSI among college students

NSSI on college campuses. The first objective of the doctoral research project was to provide a better understanding of the epidemiology of college student NSSI. We found that one in six students enters college with a history of NSSI – a finding that is consistent with pooled prevalence rates among adolescent samples (17-18%; Muehlenkamp et al., 2012; Swannell et al., 2014). Of these, less than half reports at least one instance of self-injury in the past year, and only a small proportion engaged in repetitive NSSI and meets full diagnostic criteria (i.e., less than 1 % of the population) of the proposed NSSI disorder (NSSI-D). Putting the latter into a developmental perspective, studies in adolescence find NSSI-D rates around 6.7-7.6% (Buelens et al., 2020; Zetterqvist, Lundh, Dahlstrom, & Svedin, 2013) whereas a similarly low prevalence rate has been observed among representative samples of emerging adults not attending college (i.e., 0.2; Benjet et al., 2017) and adults in the general population (i.e., 0.3%; Plener et al., 2016). This pattern of findings confirms that adolescence carries the highest risk for NSSI (Gandhi et al., 2018), and documents that while many incoming students with a history of NSSI report ongoing NSSI (Hamza & Willoughby, 2014; Serras et al., 2010; Whitlock et al., 2011b), most do not engage in repetitive NSSI. Consistent with studies that show that the transition to college can be particularly stressful (Bruffaerts et al., 2018; Dyson & Renk, 2006; Robotham, 2008), incidence rates of 10.3% in year 1 and 6.0% in year 2 were observed. At the same time, however, the data also indicates that most of these students (8.6%) engage in sporadic relative to repetitive NSSI (7.0%).

This pattern of findings shows substantial variation in clinical severity, and highlights for colleges the meaningfulness of considering the effectiveness of *a stepped-care approach* to address NSSI on college campuses appropriately. A stepped-care approach provides a framework for matching the intensity level of the intervention to the profile of students (Cornish et al., 2017). Students could

then be appropriately referred to online self-help or therapist-assisted e-mental health solutions, to college counselors, or to emergency services where appropriate. Given that most students who self-injure engage in the behavior episodically and do not meet criteria for the proposed DSM-5 disorder, this would allow a resource-saving treatment option in the face of the high numbers and severity of mental health problems among college students (Auerbach et al., 2018; Bruffaerts et al., 2018). Developing and evaluating the effectiveness of such a framework represents an important avenue for future research. Importantly, our findings highlight the feasibility of incorporating prevention into such a framework as we demonstrated the potential of web-based screening for detecting students at high risk of new-onset NSSI. (Hamza & Willoughby, 2014; Riley et al., 2015). In the absence of specific sociodemographic- and college-related risk factors, appropriate prevention could include mandatory online annual screenings for a range of mental health concerns among the entire student body, and identifying students most at risk of NSSI. Such an approach would improve the identification of students at risk, and enable timely intervention, before NSSI and related problems emerge and/or escalate.

NSSI disorder: to be or not to be? The second objective was to explore the relative merit of NSSI-D for college mental health. We found that those who meet diagnostic criteria had a more clinical profile than those not meeting criteria (Glenn & Klonsky, 2013; In-Albon et al., 2013; Washburn et al., 2015), but found novel evidence that NSSI-D is not symptomatic of any particular disorder that we assessed, and may also occur outside the context of a comorbid 12-month mental disorder. In addition, it was observed that first-year students who meet NSSI-D criteria report severe impairment in daily life beyond comorbid 12-month (mood and anxiety) disorders. Building upon our findings, prospective work is needed to evaluate whether NSSI-D explains unique variance in prognosis and treatment response, including also other diagnostically relevant mental disorders (e.g., eating disorders, post-traumatic stress disorder, and borderline personality disorder) that we did not assess. Awaiting these future scientific endeavors, the current findings add to a growing body of evidence that supports the validity of NSSI as a separate disorder which could lead to better assessment and promote treatment of NSSI (Hooley, Fox, & Boccagno, 2020; Selby et al., 2015). Coupled with the fact that lifetime and 12-month prevalence rates of NSSI are prohibitively high to feasibly offer specialized clinical care to all students who have engaged in this behavior, we believe the assessment of disorder relative to

behavior is clinically useful to identify students that are most in need of specialized treatment for NSSI. Scientifically, these findings also imply that only comparing students who report lifetime and/or 12-month NSSI to those without a history of NSSI without considering heterogeneity in frequency and impairment represents a missed opportunity to provide a more detailed picture of the significance of NSSI for college mental health.

An interesting point of discussion pertains to whether the proposed NSSI-D criteria should be modified. Our findings provide preliminary evidence that the proposed 5+ threshold discriminates students with past year NSSI in terms of distress or disability due to NSSI. While these findings are consistent with other work among college students (Ammerman et al., 2017), other studies have suggested increasing the frequency threshold to as high as 25 days in the past year among clinical samples (Muehlenkamp et al., 2017). The observed discrepancy is likely the result of meaningful differences in severity between clinical populations and college students. While the former risks identifying a very severe subgroup of patients seeking treatment for NSSI and missing individuals who are also struggling with NSSI, the latter may yield too low cut-offs for high-risk populations (Zetterqvist, Mayo, Perini, & Gustafsson, 2020). Some researchers have argued that a dimensional rather than a categorical approach might be more useful in identifying individuals requiring different levels of intervention to avoid an escalating negative trajectory (Washburn et al., 2015). This highlights the relevance of investigating, in future research, whether introducing specifiers based on severity (i.e., minor, moderate, severe) and developmental course of NSSI (i.e., adolescent-restricted or not) could improve the utility of NSSI-D for the field. For instance, it may be that the presence of NSSI-D outside of adolescence, when risk is normatively highest, is related to a worse prognosis.

NSSI as a developmental risk factor. The third objective was to provide a better understanding of the temporal relationships between NSSI, mental disorders, and suicidal thoughts and behaviors (STB). Findings provided novel evidence indicating NSSI is not merely a correlated symptom or outcome of mental disorders (Fox et al., 2015), but also predicts future mental disorders. The latter is consistent with a recent cohort study among adolescents (Wilkinson et al., 2018), and highlights the need to understand how NSSI may increase vulnerability for future mental disorders. Given that we found that this relationship was only partially attenuated when controlling for the presence of other common mental disorders, an underlying psychiatric liability may not fully explain this relationship.

Recent studies have linked NSSI to increased interpersonal stressors and conflict (Burke et al., 2015; Turner et al., 2017; Waals et al., 2018), shame and stigmatization (Burke et al., 2019), as well as longer-term adverse trajectories in emotional and cognitive functioning (Buelens et al., 2019; Robinson et al., 2018) that may lead to increased susceptibility for new mental disorders. Examining the extent to which these factors explain the observed association would be informative for both researchers and clinicians. Assuming this pattern of findings can be replicated, these data hold important implications for public health efforts aimed at preventing mental disorders among young people. Specifically, it implies that prevention aimed at screening and treating emerging mental health problems among those who self-injure in high school may be a particularly timely strategy to prevent mental disorders among college students (Auerbach et al., 2018; Bruffaerts et al., 2018).

Our findings also add to the literature that the presence of NSSI predicts onset of a first suicide attempt (on average three years later) beyond mental disorder comorbidity. Interestingly, as postulated by the Gateway theory (Hamza et al., 2012), we could not find evidence that NSSI increases risk of attempting suicide more strongly among those with co-existing mental disorders. Rather, the incremental predictive utility of NSSI was attenuated for onset of suicide ideation and plan among those diagnosed with major depressive disorder. A novel contribution was that we have shown that NSSI is uniquely associated with onset of suicide ideation, plan, and attempt as well as transitioning from suicidal ideation to a future suicide attempt. Recent suicide theories and converging evidence argue that thinking and making plans about suicide and subsequently attempting suicide are different processes that may come with meaningfully different risk factor sets (Klonsky et al., 2018; O'Connor & Kirtley, 2018). In light of these findings, our data support the claim of Klonsky and colleagues (Klonsky et al., 2013), that concerning risk for suicide, NSSI means *double trouble* in that it increases both the risk that young people develop suicidal desires and, then, subsequently also act upon such thoughts. However, 44% of students with a history of NSSI did not report any STB – again illustrating considerable heterogeneity with respect to future suicide risk.

Building upon previous research (Ammerman et al., 2016; Burke, Jacobucci, et al., 2018; Stewart et al., 2017; Victor & Klonsky, 2014), we provided new evidence that assessing NSSI characteristics – i.e., early age of onset, higher NSSI frequency and number of methods, needing medical treatment for NSSI, a specific history of cutting - might be clinically useful in weighing future

suicide risk. Consistent with the Interpersonal Theory of Suicide (Joiner, 2005; Van Orden et al., 2010), and emerging evidence (Chu et al., 2017; Willoughby et al., 2015), our findings indicate that repeated tissue damage is a potent risk factor for a future suicide attempt. In an era where prevention of suicide among college students stands high on the research agenda (Mortier, Cuijpers, et al., 2018; Mortier, Kiekens, et al., 2017), the current findings imply that enhancing screening and treatment efforts of NSSI might represent a particularly useful strategy to prevent loss of life. Scientifically, it highlights that the clarification of the mechanisms that underlie the relationship with STB should be at the forefront of research efforts. Research, for instance, suggests that NSSI frequency is associated with increased capability for suicide (Willoughby et al., 2015), but it remains to be examined whether this is because repeated engagement in NSSI increases pain tolerance or fearlessness of death (i.e., the two underlying facets of capability for suicide). Relatedly, future research also needs to determine potential mechanisms between NSSI and suicide ideation (e.g., increased hopelessness, isolation, rumination). That said, these findings clearly document that college counselors should be mindful that students who engage in NSSI are at heightened risk for developing STB, and it is good practice to question NSSI characteristics and suicidal desires routinely when working with students who self-injure.

Risk of NSSI onset during the college period. The fourth objective was to provide a better understanding of developmental between-person risk and protective factors of NSSI. Concerning NSSI onset, we found that a broad range of previously reported correlates were prospectively associated with beginning both sporadic and repetitive NSSI, including childhood-adolescent trauma (Martin et al., 2016; Taliaferro & Muehlenkamp, 2015a), recent stressful experience, low levels of perceived social support (Taliaferro & Muehlenkamp, 2015a; Wilcox et al., 2012), and 12-month mental disorders and suicidality (Bentley et al., 2015; Taliaferro & Muehlenkamp, 2015b). The findings support theoretical models that postulate that NSSI is determined by a multitude of psychosocial determinants (Nock, 2010), and extend the limited range of prospective studies among college studies in finding that both intrapersonal (i.e., severe role impairment in daily life) and interpersonal factors (i.e., dating violence) uniquely explain between-person risk of NSSI onset (Hamza & Willoughby, 2014; Riley et al., 2015). Of note, however, individual-level effect sizes were relatively weak, indicating that considering a narrow set of predictors will never accurately identify who begins NSSI during the college period.

In light of these findings, a significant contribution of our research is that we have shown that is possible to conduct risk screening for NSSI, focused on a broad, yet feasible, range of psychosocial risk factors, to identify and provide targeted interventions. With cross-validated AUCs in the .70-.75 range, our models are already as effective as risk screening algorithms for detecting other multifactorial mental (e.g., major depressive disorder) and physical (e.g., diabetes) health conditions (Ebert et al., 2019; Liu et al., 2016). For university officials and college healthcare centers, it illustrates that risk screening at college entrance has substantial potential to identify students at higher risk, and offer timely intervention to prevent onset of NSSI during the college period. While the number of false positives among those at highest cumulative risk is still considerable, we are hopeful that future research will be able to further improve the prediction accuracy by also including NSSI-specific risk factors (i.e., NSSI outcome expectancies, peers who self-injure, self-criticism; Dawkins et al., 2019; Hasking et al., 2017; Hooley & Franklin, 2017; Nock, 2009) and allowing for interactions with a broader range of protective factors (e.g., resilience, and emotion regulatory capability) using new machine learning approaches (Fox et al., 2019).

Interpreting our findings from a population-level perspective, we also found evidence indicating that preventive interventions need to target multiple risk factor domains. Indeed, focusing on mental disorders and psychopathological symptoms (i.e., the most vital population-level risk domain) would, in the most optimistic scenario that all assessed conditions could be avoided or fully treated, prevent less than half the new instances of NSSI. Two particular risk factors that deserve special attention are bullying victimization and perceived unsatisfactory peer support. Although the individual level-effect sizes were weak, these factors were independently associated with the onset of both sporadic and repetitive NSSI for approximately one in ten students who began NSSI. These findings extend previous findings from adolescent samples (Claes et al., 2015; Esposito, Bacchini, & Affuso, 2019; Tatnell et al., 2014), by showing that targeting bullying victimization in high school and enhancing peer support at college entrance could meaningfully decrease the likelihood of new-onset NSSI for some emerging adults. For colleges, the latter implies that facilitating social connectedness via peer groups in the first year of college may be a non-specific, yet useful intervention to reduce the risk of NSSI by making the transition to college less stressful to some students.

Risk of NSSI persistence during the college period. While the above findings clarify risk for beginning NSSI, research indicates that 25-63% of those with adolescent-onset NSSI continue to self-injure in college (Glenn & Klonsky, 2011; Hamza & Willoughby, 2014). Among college students who have a history of NSSI, we found that pre-college NSSI characteristics determine risk for NSSI persistence during the college years. Specifically, reporting a higher lifetime NSSI frequency and number of methods differentiated students who continued from those who ceased NSSI. Consistent with these findings, emerging evidence indicates that both NSSI characteristics are relevant in determining the clinical profile of students who engage in NSSI (Ammerman, Jacobucci, Turner, Dixon-Gordon, & McCloskey, 2019). In addition, while negative automatic reinforcement is the driving function of NSSI for most individuals (Chapman et al., 2006; Nock & Prinstein, 2004; Taylor et al., 2018), we observed that students with a persistent, relative to ceased, NSSI trajectory more frequently endorsed positive arousal-eliciting functions or loss of control over NSSI. Given that the potential of screening at college entrance for NSSI persistence remains to be established, the current findings provide evidence that including NSSI frequency, number of methods, and NSSI functions in such models in future research has substantial merit.

In line with the pattern of findings described earlier for NSSI onset, we also observed that both intrapersonal (e.g., academic and emotional distress) and interpersonal factors (i.e., peer support) were relevant factors in differentiating a persistent from a ceased NSSI trajectory during the first two college years. Remarkably, however, emotional distress had no significant effect beyond perceived emotion regulatory capability, and found that higher emotion regulation abilities also indirectly linked protective factors to NSSI persistence. Clinically, these findings imply that the addition of modules to boost self-efficacy to existing treatments could prove successful (Bjureberg et al., 2017; Sahlin et al., 2017). Building upon these findings, recent studies provide additional evidence that cognitions concerning *self-efficacy* about an individual's ability to regulate emotion as well as behavior-specific self-efficacy to resist NSSI may have considerable predictive utility in clarifying between-person risk of future NSSI (Hasking, Boyes, & Greves, 2018; Kiekens et al., 2017). Scientifically, this highlights the importance of also including these cognitions in future studies that aim to optimize risk screening for NSSI persistence. In addition to optimizing the detection of *who* - within the entire population - is at risk of engaging in NSSI during his/her academic career, complementary knowledge is needed about

when students who engage in NSSI are at risk of contemplating and engaging in NSSI in the next minutes and hours (Glenn, Jaroszewski, Milner, et al., 2015).

Short-term risk of NSSI thoughts and behavior. The fifth objective of the doctoral research project was to provide such understanding and illuminate short-term predictors that govern acute risk of NSSI thoughts and behavior. We observed that NSSI thoughts varied considerably across hours among students who engage in NSSI - a finding that was recently also observed for suicide ideation among suicidal individuals (Kleiman et al., 2017). Scientifically, these findings illustrate the need for intensive monitoring to capture this variability and enable the identification of factors that predict these changes. While negative affect was identified as a unique short-term risk factor of NSSI thoughts, it prospectively predicted NSSI behavior only when NSSI thoughts were not accounted for. Given that most theoretical models of NSSI propose a direct role for negative affect in the maintenance of NSSI behavior, this finding challenges our fundamental understanding of NSSI. In line with ideation-to-action thinking, we believe this pattern of findings illustrates the merit of carefully delineating between the processes of developing thoughts and making the transition to behavior. Researchers demonstrated that it typically takes people between 1 and 30 minutes to transition from NSSI thoughts to behavior (Fitzpatrick et al., 2020; Nock, Prinstein, et al., 2009) - meaning that there is a brief window of opportunity to intervene. Conversely, momentary belief in one's ability to resist NSSI was predictive of NSSI behavior (in the next 90 minutes) when NSSI thoughts were taken into account. From an intervention perspective, the current findings imply that novel interventions capable of boosting self-efficacy to resist NSSI may be particularly useful in helping students to resist the urge to self-injure.
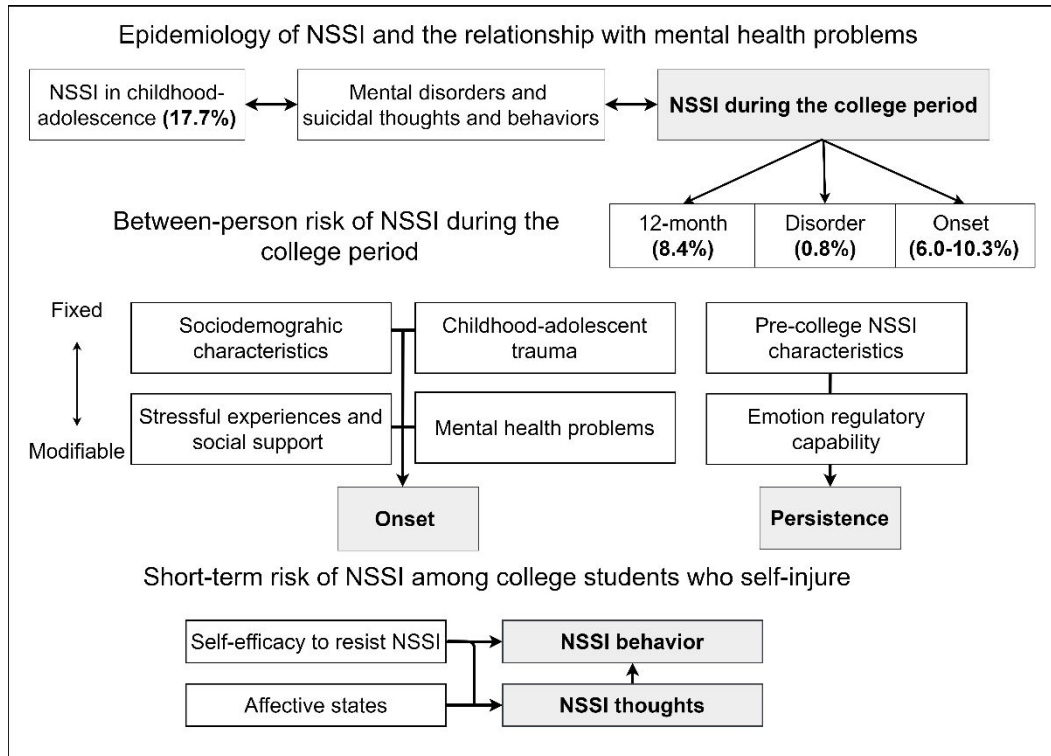
Figure 9.1. Overview figure of the main findings of the doctoral research project.

General limitations and directions for future research

Even though the Ph.D. project yields novel insights with regards to our understanding of NSSI among college students and represents a small step in the right direction, significant future efforts are needed to prevent NSSI among college students and its associated adverse outcomes. While specific limitations have been discussed in each empirical chapter and are not repeated here, we finish the thesis by discussing several broader limitations and provide five critical avenues for future research.

First, while our research provides a clearer picture of the prevalence, severity, and incidence of NSSI among representative samples of college students, our data do not allow us to conclude that students are at higher risk of engaging in NSSI than peers not attending college. Recent accounts suggest that NSSI rates are increasing among undergraduates (Duffy et al., 2019; Wester et al., 2018), and are potentially elevated compared to same-aged peers not attending college (Swannell et al., 2014). Population-level cohort studies are however needed to confirm whether these initial findings are correct or the result of a methodological artifact such as decreasing response rates resulting in

higher prevalence estimates over time (Mortier, Cuijpers, et al., 2018), or different assessment procedures leading to inconsistent estimates between studies (Robinson & Wilson, 2020; Swannell et al., 2014). Relatedly, prospective studies need to provide insight in the course of NSSI onset and persistence during emerging adulthood. Addressing this gap of knowledge would clarify whether college students are truly at higher risk of NSSI than peers not attending college.

Second, even though we and others have shown the feasibility of risk screening models that enable timely prevention and intervention by including relevant distal and proximal risk and protective factors (Fox et al., 2019; Kiekens et al., 2019), future research needs to continue this work to increase the accuracy of the derived models further. Relatedly, it is essential that colleges can also offer evidence-based interventions to students at risk for NSSI. Although interventions for NSSI are being developed (Franklin et al., 2016; Hooley et al., 2018), there are currently no evidence-based interventions that target onset and persistence among college students. Given the wide range of risk and protective factors that were identified, we could speculate that such interventions could be largely trans-diagnostic focusing on interpersonal and intrapersonal targets (e.g., including social support, reducing stress, etc.), but include NSSI-specific modules (e.g., focusing on boosting self-efficacy to regulate emotion and resist NSSI) for those at high risk for NSSI during the college years. The best way to resolve this uncertainty is to carry out randomized trials that evaluate how interventions can best be delivered (e.g., making use of the high scalability of internet- and mobile-based applications) and which type (i.e., trans-diagnostic vs. NSSI-specific) works best for students at varying levels of risk. Addressing these questions in future research, as well as evaluating the practicality of a myriad of new technical possibilities (Ebert, Cuijpers, Munoz, & Baumeister, 2017), will be pivotal for translating the potential of risk screening for NSSI into the field of college mental health.

Third, while our findings indicate that NSSI is associated with subsequent onsets of mental disorders and STB, more work is needed to determine whether students who engage in NSSI are also uniquely at risk for adverse outcomes during the college period. We previously observed that the presence of NSSI is associated with reduced academic functioning in the first year of college (Kiekens et al., 2016), but it remains to be investigated whether students who engage in NSSI are less likely to graduate and find jobs when leaving college. In addition, it would be meaningful to know whether students who self-injure experience more difficulties in realizing developmental tasks of emerging

adulthood (i.e., identity formation, finding a meaningful life, and stable romantic relationship; Arnett, 2015). There is evidence from adolescence samples that the relationship between NSSI and identity formation may be bidirectional (Gandhi et al., 2017), with NSSI potentially leading to identity disturbances. Providing greater clarity about these issues among emerging adults would provide a more comprehensive understanding of the potential negative impact of NSSI on the normative developmental process.

Fourth, in order to clarify the developmental and clinical specificity of risk and protective factors, it would be valuable if future prospective studies cover both adolescence and emerging adulthood and continue to investigate the relative predictive utility of intra- and interpersonal factors for beginning and continuing NSSI. While we found evidence that some factors (e.g., childhood-adolescent trauma) might extend vulnerability for NSSI into emerging adulthood, other factors might become more or less salient in predicting NSSI across different developmental stages. For instance, while family support has been found to be protective against NSSI among adolescents (Tatnell et al., 2014), our findings indicate that peer relationships may be more salient among emerging adults. Similarly, as particular factors might be relevant in the prediction of a highly persistent NSSI trajectory (e.g., prior NSSI profile) versus onset of NSSI (e.g., high levels of emotional distress in the transition to college), it is likely that much can be learned from future studies that evaluate the developmental-variant aspect of risk estimation for NSSI.

Fifth, building upon the pioneering work that used experience sampling methodology to study NSSI (Rodriguez-Blanco et al., 2018), researchers should begin developing individual prediction models for NSSI thoughts and behaviors based on theoretically-relevant situational, emotional, and cognitive factors (Hasking et al., 2017; Hooley & Franklin, 2017; Nock, 2010). In doing so, it will be necessary to evaluate the sensitivity and specificity of these models before translating findings into personalized interventions (Stange et al., 2019). Another critical research frontier is the clarification of real-time factors that increase (or decrease) the risk that someone who is thinking about NSSI transitions to NSSI behavior. Finally, making use of new sophisticated data-analytical techniques (i.e., Group Iterative Multiple Model Estimation; Lane, Gates, Pike, Beltz, & Wright, 2019), researchers should also start exploring what short-term factors increase acute risk of NSSI thoughts and behaviors for everyone, a subgroup of individuals, or a specific individual. Such knowledge would essentially uncover shared and

person-specific risk and protective processes and would be highly valuable for building personalized models (Wright & Woods, 2020). While these are all challenging future research endeavors, pursuing this line of research could be groundbreaking and facilitate real-time interventions for NSSI that assist students in resisting the urge to self-injure.

Conclusion

This doctoral research project aimed to make significant contributions and advances to our understanding of NSSI among college students. We showed that approximately one in six first-year students report a history of NSSI, of whom more than half did not self-injure in the past year, and a small subgroup (0.8%) meets DSM-5 NSSI disorder criteria. A further investigation into the incidence of NSSI revealed that 8.6% engaged in sporadic (1-4 times per year) and 7.0% in repetitive NSSI ($\geq$ 5 times per year) for the first time, during the first two years of college. In light of these findings, we recommend that researchers evaluate the potential of a stepped-care approach in responding to NSSI on college campuses. Importantly, our findings highlight the feasibility of incorporating prevention into such a framework. This might be a cost-effective strategy when implemented at developmentally critical moments (i.e., early adolescence and transition to college). As we have shown that NSSI robustly predicts mental disorders and transitioning from non-suicidal to suicidal forms of self-injury, counselors and academic staff should take NSSI seriously to avoid the development or a further escalation of suicidal forms of self-injury. For policymakers, our data indicate that targeting adolescents and emerging adults who self-injure might be one fruitful strategy to prevent significant mental health burden and loss of life among young people. Future studies in this area, as well as research that develops personalized prediction models for acute risk of NSSI, have the potential to deliver cost-beneficial tools for the prevention and intervention of NSSI in college populations worldwide.

Bibliography

American College Health Association National College Health Assessment (ACHA-NCHA). (n.d). Retrieved from https://www.acha.org/NCHA/ACHA-NCHA_Data/Publications_and_Reports/NCHA/Data/Reports_ACHA-NCHAIIc.aspx

American College Health Association (ACHA). (2018). *American College Health Association-National College Health Assessment II: Undergraduate student reference group executive summary*. Retrieved from: https://www.acha.org/documents/ncha/NCHA-II_Spring_2018_Undergraduate_Reference_Group_Executive_Summary.pdf

Adrian, M., Zeman, J., Erdley, C., Lisa, L., & Sim, L. (2011). Emotional dysregulation and interpersonal difficulties as risk factors for nonsuicidal self-injury in adolescent girls. *Journal of Abnormal Child Psychology , 39*, 389-400. doi:10.1007/s10802-010-9465-3

Allen, N. B., Nelson, B. W., Brent, D., & Auerbach, R. P. (2019). Short-term prediction of suicidal thoughts and behaviors in adolescents: Can recent developments in technology and computational science provide a breakthrough? *Journal of Affective Disorders, 250*, 163-9. doi:10.1016/j.jad.2019.03.044

American Psychiatric Association (APA). (2013). *The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*. Arlington, VA: American Psychiatric Association.

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 Research, 236*, 80-5. doi:10.1016/j.psychres.2015.12.028

Ammerman, B. A., Jacobucci, R., Kleiman, E. M., Muehlenkamp, J. J., & McCloskey, M. S. (2017). Development and validation of empirically derived frequency criteria for NSSI disorder using exploratory data mining. *Psychological Assessment, 29*, 221-31. doi:10.1037/pas0000334

Ammerman, B. A., Jacobucci, R., Kleiman, E. M., Uyeji, L. L., & McCloskey, M. S. (2018). The relationship between nonsuicidal self-injury age of onset and severity of self-harm. *Suicide and Life-Threatening Behavior, 48*, 31-7. doi:10.1111/sltb.12330

Ammerman, B. A., Jacobucci, R., Turner, B. J., Dixon-Gordon, K. L., & McCloskey, M. S. (2019). Quantifying the importance of lifetime frequency versus number of methods in conceptualizing nonsuicidal self-injury severity. *Psychology of Violence*. doi:10.1037/vio0000263

Andover, M. S., Schatten, H. T., Morris, B. W., & Miller, I. W. (2015). Development of an Intervention for nonsuicidal self-injury in young adults: An open pilot trial. *Cognitive and Behavioral Practice, 22*, 491-503. doi:10.1016/j.cbpra.2014.05.003

Andrewes, H. E., Hulbert, C., Cotton, S. M., Betts, J., & Chanen, A. M. (2017). Ecological momentary assessment of nonsuicidal self-injury in youth with borderline personality disorder. *Personality Disorders: Theory, Research, and Treatment, 8*, 357-65. doi:10.1037/per0000205

Andrews, T., Martin, G., Hasking, P., & Page, A. (2013). Predictors of continuation and cessation of nonsuicidal self-injury. *Journal of Adolescent Health, 53*, 40-46. doi:10.1016/j.jadohealth.2013.01.009

Anestis, M. D., Khazem, L. R., & Law, K. C. (2015). How many times and how many ways: the impact of number of nonsuicidal self-injury methods on the relationship between nonsuicidal self-injury frequency and suicidal behavior. *Suicide and Life-Threatening Behavior, 45*, 164-77. doi:10.1111/sltb.12120

Bibliography

Arens, A. M., Gaher, R. M., & Simons, J. S. (2012). Child maltreatment and deliberate self-harm among college students: Testing mediation and moderation models for impulsivity. *American Journal of Orthopsychiatry, 82*, 328-37. doi:10.1111/j.1939-0025.2012.01165.x

Armey, M. F. (2012). Ecological momentary assessment and intervention in nonsuicidal self-injury: A novel approach to treatment. *Journal of Cognitive Psychotherapy, 26*, 299-317. doi:10.1891/0889-8391.26.4.299

Armey, M. F., & Crowther, J. H. (2008). A comparison of linear versus non-linear models of aversive self-awareness, dissociation, and non-suicidal self-injury among young adults. *Journal of Consulting and Clinical Psychology, 76*, 9-14. doi:10.1037/0022-006x.76.1.9

Armey, M. F., Crowther, J. H., & Miller, I. W. (2011). Changes in ecological momentary assessment reported affect associated with episodes of nonsuicidal self-injury. *Behavior Therapy, 42*, 579-88. doi:10.1016/j.beth.2011.01.002

Arnett, J. J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist, 55*, 469-80. doi:10.1037/0003-066x.55.5.469

Arnett, J. J. (2015). *Emerging Adulthood: The winding road from the late teens through the twenties* (2nd ed. ed.). New York: Oxford University Press.

Asparouhov, T., Hamaker, E. L., & Muthén, B. (2017). Dynamic structural equation models. *Structural Equation Modeling: A Multidisciplinary Journal, 25*, 359-88. doi:10.1080/10705511.2017.1406803

Asparouhov, T., & Muthén, B. (2019). Comparison of models for the analysis of intensive longitudinal data. *Structural Equation Modeling: A Multidisciplinary Journal*. doi:10.1080/10705511.2019.1626733

Auerbach, R. P., Alonso, J., Axinn, W. G., Cuijpers, P., Ebert, D. D., Green, J. G., . . . Bruffaerts, R. (2017). Mental disorders among college students in the World Health Organization World Mental Health Surveys. *Psychological Medicine, 46*, 2955-70*. doi: 10.1037/abn0000362

Auerbach, R. P., Mortier, P., Bruffaerts, R., Alonso, J., Benjet, C., Cuijpers, P., . . . Kesser, R. (2018). WHO World Mental Health Surveys International College Student Project: Prevalence and distribution of mental disorders. *Journal of Abnormal Psychology, 127*, 623-38. doi:10.1037/abn0000362

Babor, T. F., Higgings-Biddle, J. C., Saunders, J. B., & Monteiro, M. G. (2001). *The alcohol use disorders identification test. Guidelines for use in Primary Care (Second).* Switzerland, Geneva: World Health Organisation,

Ballester, L., Alayo, I., Vilagut, G., Almenara, J., Cebria, A. I., Echeburua, E., . . . Alonso, J. (2019). Accuracy of online survey assessment of mental disorders and suicidal thoughts and behaviors in Spanish university students. Results of the WHO World Mental Health-International College Student initiative. *PLoS One, 14*:9, e0221529. doi:10.1371/journal.pone.0221529

Barrocas, A. L., Hankin, B. L., Young, J. F., & Abela, J. R. (2012). Rates of nonsuicidal self-injury in youth: age, sex, and behavioral methods in a community sample. *Pediatrics, 130*, 39-45. doi:10.1542/peds.2011-2094

Batejan, K. L., Jarvi, S. M., & Swenson, L. P. (2015). Sexual orientation and non-suicidal self-injury: a meta-analytic review. *Archives of Suicide Research, 19*, 131-50. doi:10.1080/13811118.2014.957450

Bendtsen, P., Bendtsen, M., Karlsson, N., White, I. R., & McCambridge, J. (2015). Online alcohol assessment and feedback for hazardous and harmful drinkers: Findings from the AMADEUS-2 randomized controlled trial of routine practice in Swedish universities. *Journal of Medical Internet Research, 17*, e170. doi:10.2196/jmir.4020

Benjet, C., Gonzalez-Herrera, I., Castro-Silva, E., Mendez, 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. *Journal of Affective Disorders, 215*, 1-8. doi: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. *Clinical Psychology Review, 37*, 72-88. doi: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. *Clinical Psychological Science, 2*, 638-56. doi:10.1177/2167702613514563

Bjureberg, J., Sahlin, H., Hellner, C., Hedman-Lagerlöf, E., Gratz, K. L., Bjärehed, J., . . . Ljótsson, B. (2017). Emotion regulation individual therapy for adolescents with nonsuicidal self-injury disorder: A feasibility study. *BMC Psychiatry, 17*:1. doi:10.1186/s12888-017-1527-4

Bureau of Labor Statistics (BLS). (2017). College enrollment and work activity of 2016 high school graduates. Retrieved from https://www.bls.gov/news.release/archives/hsgec_04272017.pdf

Brausch, A. M., & Muehlenkamp, J. J. (2018). Perceived effectiveness of NSSI in achieving functions on severity and suicide risk. *Psychiatry Research, 265*, 144-50. doi:10.1016/j.psychres.2018.04.038

Bray, R. M., & Hourani, L. L. (2007). Substance use trends among active duty military personnel: Findings from the United States Department of Defense Health Related Behavior Surveys, 1980-2005. *Addiction, 102*, 1092-1101. doi:10.1111/j.1360-0443.2007.01841.x

Bresin, K., & Schoenleber, M. (2015). Gender differences in the prevalence of nonsuicidal self-injury: A meta-analysis. *Clinical Psychology Review, 38*, 55-64. doi:10.1016/j.cpr.2015.02.009

Brown, S. A., Williams, K., & Collins, A. (2007). Past and recent deliberate self-harm: Emotion and coping strategy differences. *Journal of Clinical Psychology, 63*, 791-803. doi:10.1002/jclp.20380

Bruffaerts, R., Mortier, P., Kiekens, G., Auerbach, R. P., Cuijpers, P., Demyttenaere, K., . . . Kessler, R. C. (2018). Mental health problems in college freshmen: Prevalence and academic functioning. *Journal of Affective Disorders, 225*, 97-103. doi:10.1016/j.jad.2017.07.044

Brugha, T. S., & Cragg, D. (1990). The list of threatening experiences: The reliability and validity of a brief life events questionnaire. *Acta Psychiatrica Scandinavica, 82*, 77-81. doi:10.1111/j.1600-0447.1990.tb01360.x

Brunner, R., Kaess, M., Parzer, P., Fischer, G., Carli, V., Hoven, C. W., . . . Wasserman, D. (2014). Life-time prevalence and psychosocial correlates of adolescent direct self-injurious behavior: A comparative study of findings in 11 European countries. *Journal of Child Psychology and Psychiatry, 55*, 337-48. doi:10.1111/jcpp.12166

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 and Life-Threatening Behavior, 45*, 315-25. doi:10.1111/sltb.12127

Buelens, T., Luyckx, K., Gandhi, A., Kiekens, G., & Claes, L. (2019). Non-suicidal self-injury in adolescence: Longitudinal associations with psychological distress and rumination. *Journal of Abnormal Child Psychology, 47*, 1569-81. doi:10.1007/s10802-019-00531-8

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

Burke, T. A., Anne McArthur, B., Daryanani, I., Abramson, L. Y., & Alloy, L. B. (2018). Latent classes of trait affect and cognitive affective regulation strategies are associated with depression, non-suicidal self-injury, and well-being. *Journal of Affective Disorders, 225*, 180-7. doi:10.1016/j.jad.2017.08.015

Burke, T. A., Hamilton, J. L., Abramson, L. Y., & Alloy, L. B. (2015). Non-suicidal self-injury prospectively predicts interpersonal stressful life events and depressive symptoms among adolescent girls. *Psychiatry Research, 228*, 416-24. doi:10.1016/j.psychres.2015.06.021

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 Research, 262*, 175-83. doi:10.1016/j.psychres.2018.01.045

Burke, T. A., Piccirillo, M. L., Moore-Berg, S. L., Alloy, L. B., & Heimberg, R. G. (2019). The stigmatization of nonsuicidal self-injury. *Journal of Clinical Psychology, 75*, 481-98. doi:10.1002/jclp.22713

Buser, T. J., Buser, J. K., & Rutt, C. C. (2017). Predictors of unintentionally severe harm during nonsuicidal self-injury. *Journal of Counseling & Development, 95*, 14-23.

Capaldi, D. M., Knoble, N. B., Shortt, J. W., & Kim, H. K. (2012). A Systematic Review of Risk Factors for Intimate Partner Violence. *Partner Abuse, 3*, 231-80. doi:10.1891/1946-6560.3.2.231

Caprara, G. V., Di Giunta, L., Eisenberg, N., Gerbino, M., Pastorelli, C., & Tramontano, C. (2008). Assessing regulatory emotional self-efficacy in three countries. *Psychological Assessment, 20*, 227-37. doi:10.1037/1040-3590.20.3.227

Caspi, A., Houts, R. M., Belsky, D. W., Goldman-Mellor, S. J., Harrington, H., Israel, S., . . . Moffitt, T. E. (2014). The p Factor: One general psychopathology factor in the structure of psychiatric disorders? *Clinical Psychological Science, 2*, 119-37. doi:10.1177/2167702613497473

Chapman, A. L., Gratz, K. L., & Brown, M. Z. (2006). Solving the puzzle of deliberate self-harm: The experiential avoidance model. *Behaviour Research and Therapy, 44*, 371-94. doi:10.1016/j.brat.2005.03.005

Chu, C., Buchman-Schmitt, J. M., Stanley, I. H., Hom, M. A., Tucker, R. P., Hagan, C. R., . . . Joiner, T. E. (2017). The interpersonal theory of suicide: A systematic review and meta-analysis of a decade of cross-national research. *Psychological Bulletin, 143*, 1313-45. doi:10.1037/bul0000123

Chu, C., Hom, M. A., Stanley, I. H., Gai, A. R., Nock, M. K., Gutierrez, P. M., & Joiner, T. E. (2018). 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. *Journal of Consulting and Clinical Psychology, 86*, 56-68. doi:10.1037/ccp0000262

Claes, L., Klonsky, E. D., Muehlenkamp, J. J., Kuppens, P., & Vandereycken, W. (2010). The affect-regulation function of nonsuicidal self-injury in eating-disordered patients: Which affect states are regulated? *Comprehensive Psychiatry, 51*, 386-92. doi:10.1016/j.comppsych.2009.09.001

Claes, L., Luyckx, K., Baetens, I., Van de Ven, M., & Witteman, C. (2015). Bullying and victimization, depressive mood, and non-suicidal self-injury in adolescents: The moderating role of parental support. *Journal of Child and Family Studies, 24*, 3363-71. doi:10.1007/s10826-015-0138-2

Cornish, P. A., Berry, G., Benton, S., Barros-Gomes, P., Johnson, D., Ginsburg, R., . . . Romano, V. (2017). Meeting the mental health needs of today's college student: Reinventing services through Stepped Care 2.0. *Psychological Services, 14*, 428-42. doi:10.1037/ser0000158

Crawford, E., & Wright, M. O. D. (2007). The impact of childhood psychological maltreatment on interpersonal schemas and subsequent experiences of relationship aggression. *Journal of Emotional Abuse, 7*, 93-116. doi:10.1300/J135v07n02_06

Crawford, J. R., & Henry, J. D. (2004). The positive and negative affect schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *Britisch Journal of Clinical Psychology, 43*, 245-65. doi:10.1348/0144665031752934

Cuijpers, P., Auerbach, R. P., Benjet, C., Bruffaerts, R., Ebert, D. D., Karyotaki, E., & Kessler, R. C. (2019). The WHO World Mental Health International College Student (WMH-ICS) initiative: An overview. *International Journal of Methods in Psychiatric Research, 28*:e1762. doi: 10.1002/mpr.1762

Czyz, E. K., Bohnert, A. S., King, C. A., Price, A. M., Kleinberg, F., & Ilgen, M. A. (2014). Self-efficacy to avoid suicidal action: Factor structure and convergent validity among adults in substance use disorder treatment. *Suicide and Life-Threatening Behavior, 44*, 698-709. doi:10.1111/sltb.12101

Dawkins, J. C., Hasking, P. A., Boyes, M. E., Greene, D., & Passchier, C. (2019). Applying a cognitive-emotional model to nonsuicidal self-injury. *Stress & Health, 35*, 39-48. doi:10.1002/smi.2837

Demartini, K. S., & Carey, K. B. (2012). Optimizing the use of the AUDIT for alcohol screening in college students. *Psychological Assessment, 24*, 954-63. doi:10.1037/a0028519

Diamond, L. M., & Asminwall, G. L. (2003). Emotion regulation across the life span: An integrative perspective emphasizing self-regulation, positive affect, and dyadic processes. *Motivation and Emotion, 27*, 125-56.

Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment, 49*, 71-75.

Duffy, M. E., Twenge, J. M., & Joiner, T. E. (2019). Trends in mood and anxiety symptoms and suicide-related outcomes among U.S. undergraduates, 2007-2018: Evidence from two national surveys. *Journal of Adolescent Health, 65,* 590-8. doi: 10.1016/j.jadohealth.2019.04.033

Duggan, J. M., Toste, J. R., & Heath, N. L. (2013). An examination of the relationship between body image factors and non-suicidal self-injury in young adults: the mediating influence of emotion dysregulation. *Psychiatry Research, 206*, 256-64. doi:10.1016/j.psychres.2012.11.016

Dye, H. (2018). The impact and long-term effects of childhood trauma. *Journal of Human Behavior in the Social Environment, 28*, 381-92. doi:10.1080/10911359.2018.1435328

Dyson, R., & Renk, K. (2006). Freshmen adaptation to university life: depressive symptoms, stress, and coping. *Journal of Clinical Psychology, 62*, 1231-44. doi:10.1002/jclp.20295

Ebert, D. D., Buntrock, C., Mortier, P., Auerbach, R., Weisel, K. K., Kessler, R. C., . . . Bruffaerts, R. (2019). Prediction of major depressive disorder onset in college students. *Depression & Anxiety, 36*, 294-304. doi:10.1002/da.22867

Ebert, D. D., Cuijpers, P., Munoz, R. F., & Baumeister, H. (2017). Prevention of mental health disorders using internet- and mobile-based interventions: A narrative review and recommendations for future research. *Frontiers in Psychiatry, 8*, 116. doi:10.3389/fpsyt.2017.00116

Ebert, D. D., Franke, M., Kahlke, F., Kuchler, A. M., Bruffaerts, R., Mortier, P., . . . Kessler, R. (2018). Increasing intentions to use mental health services among university students. Results of a pilot randomized controlled trial within the World Health Organization's World Mental Health International College Student Initiative. *International Journal of Methods Psychiatric Research*, e1754. doi:10.1002/mpr.1754

Edmondson, A. J., Brennan, C. A., & House, A. O. (2016). Non-suicidal reasons for self-harm: A systematic review of self-reported accounts. *Journal of Affective Disorders, 191*, 109-117. doi:10.1016/j.jad.2015.11.043

Efron, B. (1988). Logistic regression, survival analysis, and the Kaplan-Meier curve. *Journal of the American Statistical Association, 83*, 414-25.

Efron, B., & Gong, G. (1993). A Leisurely Look at the Bootstrap, the Jackknife, and Cross-Validation. *The American Statistician 1*, 36-48.

Emery, A. A., Heath, N. L., & Mills, D. J. (2016). Basic psychological need satisfaction, emotion dysregulation, and non-suicidal self-injury engagement in young adults: An application of self-determination theory. *Journal of Youth and Adolescence, 45*, 612-23. doi:10.1007/s10964-015-0405-y

Epskamp, S., van Borkulo, C. D., van der Veen, D. C., Servaas, M. N., Isvoranu, A. M., Riese, H., & Cramer, A. O. J. (2018). Personalized network modeling in psychopathology: The importance of contemporaneous and temporal connections. *Clinical Psychological Science, 6*, 416-27. doi:10.1177/2167702617744325

Epstein, B. N., Baldwin, L. M., & Bishop, D. S. (1983). The McMaster Family Assessment Device. *Journal of Marital and Family Therapy, 9*, 171-180.

Esposito, C., Bacchini, D., & Affuso, G. (2019). Adolescent non-suicidal self-injury and its relationships with school bullying and peer rejection. *Psychiatry Research, 274*, 1-6. doi:10.1016/j.psychres.2019.02.018

Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., . . . Marks, J. S. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. *American Journal of Preventive Medicine, 14*, 245-58.

Fernandez-Aranda, F., Jimenez-Murcia, S., Santamaria, J. J., Gunnard, K., Soto, A., Kalapanidas, E., . . . Penelo, E. (2012). Video games as a complementary therapy tool in mental disorders:

PlayMancer, a European multicentre study. *Journal of Mental Health, 21*, 364-74. doi:10.3109/09638237.2012.664302

First, M. B., Williams, J. B. W., Karg, R. S., & Spitzer, R. L. (Eds.). (2015). *Structured clinical interview for DSM-5 Research version (SCID-5 for DSM-5, research version; SCID-5-RV).* Arlington, VA: American Psychiatric Association.

Fisher, A. J., Medaglia, J. D., & Jeronimus, B. F. (2018). Lack of group-to-individual generalizability is a threat to human subjects research. *PNAS, 115*, E6106-E6115. doi:10.1073/pnas.1711978115

Fitzpatrick, S., Kranzler, A., Fehling, K., Lindqvist, J., & Selby, E. A. (2020). Investigating the role of the intensity and duration of self-injury thoughts in self-injury with ecological momentary assessment. *Psychiatry Research.* doi:10.1016/j.psychres.2020.112761

Fox, K. R., Franklin, J. C., Ribeiro, J. D., Kleiman, E. M., Bentley, K. H., & Nock, M. K. (2015). Meta-analysis of risk factors for nonsuicidal self-injury. *Clinical Psychology Review, 42*, 156-67. doi:10.1016/j.cpr.2015.09.002

Fox, K. R., Huang, X., Linthicum, K. P., Wang, S. B., Franklin, J. C., & Ribeiro, J. D. (2019). Model complexity improves the prediction of nonsuicidal self-injury. *Journal of Consulting and Clinical Psychology, 87*, 684-92. doi:10.1037/ccp0000421

Franklin, J. C., Fox, K. R., Franklin, C. R., Kleiman, E. M., Ribeiro, J. D., Jaroszewski, A. C., . . . Nock, M. K. (2016). A brief mobile app reduces nonsuicidal and suicidal self-injury: Evidence from three randomized controlled trials. *Journal of Consulting and Clinical Psychology, 84*, 544-57. doi:10.1037/ccp0000093

Franklin, J. C., Ribeiro, J. D., Fox, K. R., Bentley, K. H., Kleiman, E. M., Huang, X., . . . Nock, M. K. (2017). Risk factors for suicidal thoughts and behaviors: A meta-analysis of 50 years of research. *Psychological Bulletin, 143*, 187-232. doi:10.1037/bul0000084

Gandhi, A., Luyckx, K., Baetens, I., Kiekens, G., Sleuwaegen, E., Berens, A., . . . 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. *Comprehensive Psychiatry, 80*, 170-8. doi:10.1016/j.comppsych.2017.10.007

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

Garland, E. L., Fredrickson, B., Kring, A. M., Johnson, D. P., Meyer, P. S., & Penn, D. L. (2010). Upward spirals of positive emotions counter downward spirals of negativity: Insights from the broaden-and-build theory and affective neuroscience on the treatment of emotion dysfunctions and deficits in psychopathology. *Clinical Psychology Review, 30*, 849-64. doi:10.1016/j.cpr.2010.03.002

Gilbert, P., McEwan, K., Mitra, R., Franks, L., Richter, A., & Rockliff, H. (2008). Feeling safe and content: A specific affect regulation system? Relationship to depression, anxiety, stress, and self-criticism. *The Journal of Positive Psychology, 3*, 182-191. doi:10.1080/17439760801999461

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. *Journal of Consulting and Clinical Psychology, 83*, 265-79. doi:10.1037/a0038652

Gillies, D., Christou, M. A., Dixon, A. C., Featherston, O. J., Rapti, I., Garcia-Anguita, A., . . . Christou, P. A. (2018). Prevalence and characteristics of self-harm in adolescents: Meta-analyses of community-based studies 1990-2015. *Journal of the American Academy of Child & Adolescent Psychiatry, 57*, 733-41. doi:10.1016/j.jaac.2018.06.018

Glenn, C. R., Jaroszewski, A. C., Millner, A. J., Kearns, J., C., & Nock, M. K. (2015). Nonsuicidal self-injury: Old problem, new disoder, limited data. In E. J. Bromet (Ed.), *Long-Term Outcomes in Psychopathology Research: Rethinking the Scientific Agenda* (pp. 253-276): Oxford University Press.

Glenn, C. R., & Klonsky, E. D. (2011). Prospective Prediction of Nonsuicidal Self-Injury: A I-Year Longitudinal Study in Young Adults. *Behavior Therapy, 42*, 751-62.

Glenn, C. R., & Klonsky, E. D. (2013). Nonsuicidal self-injury disorder: An empirical investigation in adolescent psychiatric patients. *Journal of Clinical Child & Adolescent Psychology, 42*, 496-507. doi:10.1080/15374416.2013.794699

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. *Journal of Abnormal Child Psychology, 45*, 971-83. doi:10.1007/s10802-016-0214-0

Goldstein, H. (2010). *Multilevel statistical models (4th ed.)*. NY: New York.

Gollust, S. E., Eisenberg, D., & Golberstein, E. (2008). Prevalence and correlates of self-injury among university students. *Journal of American College Health, 56*, 491-8. doi:10.3200/JACH.56.5.491-498

Grandclerc, S., De Labrouhe, D., Spodenkiewicz, M., Lachal, J., & Moro, M. R. (2016). Relations between nonsuicidal self-injury and suicidal behavior in adolescence: A systematic review. *PLoS One, 11*, e0153760. doi:10.1371/journal.pone.0153760

Gratz, K. L., & Roemer, L. (2004). Multidimensional assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the difficulties in emotion regulation scale. *Journal of Psychopathology and Behavioral Assessment, 26*, 41-54. doi:10.1023/b:Joba.0000007455.08539.94

Gratz, K. L., & Roemer, L. (2008). The relationship between emotion dysregulation and deliberate self-harm among female undergraduate students at an urban commuter university. *Cognitive Behaviour Therapy, 37*, 14-25. doi:10.1080/16506070701819524

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. *Archives of General Psychiatry, 67*, 113-23. doi:10.1001/archgenpsychiatry.2009.186

Groschwitz, R. C., Plener, P. L., Kaess, M., Schumacher, T., Stoehr, R., & Boege, I. (2015). The situation of former adolescent self-injurers as young adults: A follow-up study. *BMC Psychiatry, 15*:160. doi:10.1186/s12888-015-0555-1

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. *Journal of Consulting and Clinical Psychology, 80*, 842-49. doi:10.1037/a0029429

Guarnieri, S., Smorti, M., & Tani, F. (2014). Attachment relationships and life satisfaction during emerging adulthood. *Social Indicators Research, 121*, 833-47. doi:10.1007/s11205-014-0655-1

Guerry, J. D., & Prinstein, M. J. (2010). Longitudinal prediction of adolescent nonsuicidal self-injury: Examination of a cognitive vulnerability-stress model. *Journal of Clinical Child & Adolescent Psychology, 39*, 77-89. doi:10.1080/15374410903401195

Hamaker, E. L., Asparouhov, T., Brose, A., Schmiedek, F., & Muthen, B. (2018). At the frontiers of modeling intensive longitudinal data: Dynamic structural equation models for the affective measurements from the COGITO study. *Multivariate Behavior Research, 53*, 820-41. doi:10.1080/00273171.2018.1446819

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. *Clinical Psychology Review, 32*, 482-95. doi:10.1016/j.cpr.2012.05.003

Hamza, C. A., & Willoughby, T. (2014). A longitudinal person-centered examination of nonsuicidal self-injury among university students. *Journal of Youth and Adolescence, 43*, 671-85. doi:10.1007/s10964-013-9991-8

Hamza, C. A., & Willoughby, T. (2016). Nonsuicidal self-injury and suicidal risk among emerging adults. *Journal of Youth and Adolescence, 59*, 411-15. doi:10.1016/j.jadohealth.2016.05.019

Hanel, P. H., & Vione, K. C. (2016). Do student samples provide an accurate estimate of the general public? *PLoS One,* e0168354. doi:10.1371/journal.pone.0168354

Harrer, M., Adam, S. H., Fleischmann, R. J., Baumeister, H., Auerbach, R., Bruffaerts, R., . . . Ebert, D. D. (2018). Effectiveness of an internet- and app-based intervention for college students with elevated stress: Randomized controlled trial. *Journal of Medical Internet Research, 20*, e136. doi:10.2196/jmir.9293

Hasking, P. (2017). Differentiating non-suicidal self-injury and risky drinking: a role for outcome expectancies and self-efficacy beliefs. *Prevention Science, 18*, 694-703. doi:10.1007/s11121-017-0755-7

Hasking, P., Andrews, T., & Martin, G. (2013). The role of exposure to self-injury among peers in predicting later self-injury. *Journal of Youth and Adolescence, 42*, 1543-56. doi:10.1007/s10964-013-9931-7

Hasking, P., & Boyes, M. (2018a). Cutting words: A commentary on language and stigma in the context of nonsuicidal self-injury. *Journal of Nervous Mental Disease, 206*, 829-33. doi:10.1097/NMD.0000000000000899

Hasking, P., & Boyes, M. (2018b). The non-suicidal self-injury expectancy questionnaire: Factor structure and initial validation. *Clinical Psychologist, 22*, 251-61. doi:10.1111/cp.12127

Hasking, P., Boyes, M., & Greves, S. (2018). Self-efficacy and emotionally dysregulated behaviour: An exploratory test of the role of emotion regulatory and behaviour-specific beliefs. *Psychiatry Research, 270*, 335-40. doi:10.1016/j.psychres.2018.09.045

Hasking, P., & Rose, A. (2016). A preliminary application of social cognitive theory to nonsuicidal self-injury. *Journal of Youth and Adolescence, 45*, 1560-74. doi:10.1007/s10964-016-0449-7

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

Heinze, G. (2006). A comparative investigation of methods for logistic regression with separated or nearly separated data. *Statistics in Medicine, 25*, 4216-26. doi:10.1002/sim.2687

Henry, J. D., & Crawford, J. R. (2005). The short-form version of the Depression Anxiety Stress Scales (DASS-21): Construct validity and normative data in a large non-clinical sample. *Britisch Journal of Clinical Psychology, 44*, 227-39. doi:10.1348/014466505X29657

Hofmann, S. G., Sawyer, A. T., Fang, A., & Asnaani, A. (2012). Emotion dysregulation model of mood and anxiety disorders. *Depression & Anxiety, 29*, 409-16. doi:10.1002/da.21888

Hooley, J. M., Fox, K. R., & Boccagno, C. (2020). Nonsuicidal self-injury: Diagnostic challenges and current perspectives. *Neuropsychiatric Disease and Treatment, 16*, 101-12. doi:10.2147/ndt.S198806

Hooley, J. M., Fox, K. R., Wang, S. B., & Kwashie, A. N. D. (2018). Novel online daily diary interventions for nonsuicidal self-injury: A randomized controlled trial. *BMC Psychiatry, 18*:264. doi:10.1186/s12888-018-1840-6

Hooley, J. M., & Franklin, J. C. (2017). Why do people hurt themselves? A new conceptual model of nonsuicidal self-injury. *Clinical Psychological Science, 6*, 428-51. doi:10.1177/2167702617745641

Houben, M., Claes, L., Vansteelandt, K., Berens, A., Sleuwaegen, E., & Kuppens, P. (2017). The emotion regulation function of nonsuicidal self-injury: A momentary assessment study in inpatients with borderline personality disorder features. *Journal of Abnormal Psychology, 126*, 89-95. doi:10.1037/abn0000229

Hughes, C. D., King, A. M., Kranzler, A., Fehling, K., Miller, A., Lindqvist, J., & Selby, E. A. (2019). Anxious and overwhelming affects and repetitive negative thinking as ecological predictors of self-injurious thoughts and behaviors. *Cognitive Therapy and Research, 43*, 88-101. doi:10.1007/s10608-019-09996-9

Hunt, J., & Eisenberg, D. (2010). Mental health problems and help-seeking behavior among college students. *Journal of Adolescent Health, 46*, 3-10. doi:10.1016/j.jadohealth.2009.08.008

In-Albon, T., Ruf, C., & Schmid, M. (2013). Proposed diagnostic criteria for the DSM-5 of nonsuicidal self-injury in female adolescents: Diagnostic and clinical correlates. *Psychiatry Journal, 2013*:159208. doi:10.1155/2013/159208

International Society for the Study of Self-injury. What is self-injury? (2020). Available from: https://itriples.org/about-self-injury/what-is-self-injury/

Joiner, T. E. (2005). *Why people die by suicide*. Cambridge: Harvard University Press.

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

Kessler, R. C., Andrews, G., Colpe, L. J., Hiripi, E., Mroczek, D. K., Normand, S. L., . . . Zaslavsky, A. M. (2002). Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological Medicine, 32*, 959-76. doi:10.1017/s0033291702006074

Kessler, R. C., Barker, P. R., Colpe, L. J., Epstein, J. F., Gfroerer, J. C., Hiripi, E., . . . Zaslavsky, A. M. (2003). Screening for serious mental illness in the general population. *Archives of General Psychiatry, 60*, 184-9. doi:10.1001/archpsyc.60.2.184

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. *Psychological Medicine, 43*, 1625-37. doi:10.1017/S0033291712002334

Kessler, R. C., Green, J. G., Gruber, M. J., Sampson, N. A., Bromet, E., Cuitan, M., . . . Zaslavsky, A. M. (2010). Screening for serious mental illness in the general population with the K6 screening scale: Results from the WHO World Mental Health (WMH) survey initiative. *International Journal of Methods Psychiatric Research, 19*, 4-22. doi:10.1002/mpr.310

Kessler, R. C., Harkness, J., Heeringa, S. G., Pennell, B. E., Zaslavsky, A. M., Borges, G., . . . Nock, M. K. (2012). Methods of the World Mental Health Surveys. In M. K. Nock, G. Borges, & Y. Ono (Eds.), *Suicide: Global perspectives from the WHO World Mental Health Surveys* (pp. 77-85). Cambridge, United Kingdom: Cambridge University Press.

Kessler, R. C., Heeringa, S. G., Stein, M. B., Colpe, L. J., Fullerton, C. S., Hwang, I., . . . Army, S. C. (2014). Thirty-day prevalence of DSM-IV mental disorders among nondeployed soldiers in the US Army: Results from the army study to assess risk and resilience in servicemembers (Army STARRS). *JAMA Psychiatry, 71*, 504-13. doi:10.1001/jamapsychiatry.2014.28

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). *International Journal of Methods Psychiatric Research, 22*, 303-21. doi:10.1002/mpr.1398

Kessler, R. C., & Ustun, T. B. (2004). The World Mental Health (WMH) survey initiative version of the World Health Organization (WHO) Composite International Diagnostic Interview (CIDI). *International Journal of Methods Psychiatric Research, 13*, 93-121.

Khazem, L. R., & Anestis, M. D. (2016). Thinking or doing? An examination of well-established suicide correlates within the ideation-to-action framework. *Psychiatry Research, 245*, 321-26. doi:10.1016/j.psychres.2016.08.038

Kiekens, G., Bruffaerts, R., Nock, M. K., Van de Ven, M., Witteman, C., Mortier, P., . . . Claes, L. (2015). Non-suicidal self-injury among Dutch and Belgian adolescents: Personality, stress and coping. *European Psychiatry, 30*, 743-9. doi:10.1016/j.eurpsy.2015.06.007

Kiekens, G., Claes, L., Demyttenaere, K., Auerbach, R. P., Green, J. G., Kessler, R. C., . . . Bruffaerts, R. (2016). Lifetime and 12-month nonsuicidal self-injury and academic performance in college freshmen. *Suicide and Life-Threatening Behavior, 46*, 563-76. doi:10.1111/sltb.12237

Kiekens, G., Hasking, P., Boyes, M., Claes, L., Mortier, P., Auerbach, R. P., . . . Bruffaerts, R. (2018). The associations between non-suicidal self-injury and first onset suicidal thoughts and behaviors. *Journal of Affective Disorders, 239*, 171-9. doi:10.1016/j.jad.2018.06.033

Kiekens, G., Hasking, P., Bruffaerts, R., Claes, L., Baetens, I., Boyes, M., . . . Whitlock, J. (2017). What predicts ongoing nonsuicidal self-injury?: A comparison between persistent and ceased self-injury in emerging adults. *Journal of Nervous and Mental Disease, 205*, 762-70. doi:10.1097/NMD.0000000000000726

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

Kiekens, G., Hasking, P., Claes, L., Mortier, P., Auerbach, R. P., Boyes, M., . . . 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. *Depression & Anxiety, 35*, 629-37. doi:10.1002/da.22754

Kiekens, G., Hasking, P., Nock, M. K., Boyes, M., Kirtley, O., Bruffaerts, R., Myin-Germeys, I., Claes, L. (2020) Fluctuations in affective states and self-efficacy to resist non-suicidal self-injury as real-time predictors of non-suicidal self-injurious thoughts and behaviors. *Frontiers in Psychiatry, 11*:214. doi: 10.3389/fpsyt.2020.00214

Kimbrel, N. A., Thomas, S. P., Hicks, T. A., Hertzberg, M. A., Clancy, C. P., Elbogen, E. B., . . . Beckham, J. C. (2017). Wall/object punching: An important but under-recognized form of nonsuicidal self-injury. *Suicide and Life-Threatening Behavior, 48*, 501-11. doi:10.1111/sltb.12371

Kinsey, A. C., Pomeroy, W. B., & Martin, C. E. (1948). *Sexual behavior in the human male.* Philadelphia, PA: Saunders.

Kleiman, E. M., Miller, A., Joyce, V. W., Nash, C. C., Buonopane, R. J., & Nock, M. K. (2019). Using wearable physiological monitors with suicidal adolescent inpatients: Feasibility and acceptability study. *JMIR Mhealth and Uhealth, 7*:e13725. doi:10.2196/13725

Kleiman, E. M., Turner, B. J., Fedor, S., Beale, E. E., Huffman, J. C., & Nock, M. K. (2017). Examination of real-time fluctuations in suicidal ideation and its risk factors: Results from two ecological momentary assessment studies. *Journal of Abnormal Psychology, 126*, 726-38. doi:10.1037/abn0000273

Kleiman, E. M., Turner, B. J., Fedor, S., Beale, E. E., Picard, R. W., Huffman, J. C., & Nock, M. K. (2018). Digital phenotyping of suicidal thoughts. *Depression & Anxiety, 35*, 601-8. doi:10.1002/da.22730

Klonsky, E. D. (2007). The functions of deliberate self-injury: A review of the evidence. *Clinical Psychology Review, 27*, 226-39. doi:10.1016/j.cpr.2006.08.002

Klonsky, E. D. (2009). The functions of self-injury in young adults who cut themselves: Clarifying the evidence for affect-regulation. *Psychiatry Research, 166*, 260-8. doi:10.1016/j.psychres.2008.02.008

Klonsky, E. D., Glenn, C. R., Styer, D. M., Olino, T. M., & Washburn, J. J. (2015). The functions of nonsuicidal self-injury: Converging evidence for a two-factor structure. *Child & Adolescent Psychiatry & Mental Health, 9*:44. doi:10.1186/s13034-015-0073-4

Klonsky, E. D., & May, A. M. (2014). Differentiating suicide attempters from suicide ideators: A critical frontier for suicidology research. *Suicide and Life-Threatening Behavior, 44*, 1-5. doi:10.1111/sltb.12068

Klonsky, E. D., & May, A. M. (2015). The Three-Step Theory (3ST): A new theory of suicide rooted in the "ideation-to-action" framework. *International Journal of Cognitive Therapy, 8*, 114-219.

Klonsky, E. D., May, A. M., & Glenn, C. R. (2013). The relationship between nonsuicidal self-injury and attempted suicide: Converging evidence from four samples. *Journal of Abnormal Psychology, 122*, 231-7. doi:10.1037/a0030278

Klonsky, E. D., Saffer, B. Y., & Bryan, C. J. (2018). Ideation-to-action theories of suicide: A conceptual and empirical update. *Current Opinion in Psychology, 22*, 38-43. doi:10.1016/j.copsyc.2017.07.020

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. *Archives of General Psychiatry, 54*, 337-43. doi:10.1001/archpsyc.1997.01830160065009

Kranzler, A., Fehling, K. B., Lindqvist, J., Brillante, J., Yuan, F., Gao, X., . . . Selby, E. A. (2018). An ecological investigation of the emotional context surrounding nonsuicidal self-injurious thoughts and behaviors in adolescents and young adults. *Suicide and Life-Threatening Behavior, 48*, 149-59. doi:10.1111/sltb.12373

Lane, S. T., Gates, K. M., Pike, H. K., Beltz, A. M., & Wright, A. G. C. (2019). Uncovering general, shared, and unique temporal patterns in ambulatory assessment data. *Psychological Methods, 24*, 54-69. doi:10.1037/met0000192

Latimer, S., Meade, T., & Tennant, A. (2013). Measuring engagement in deliberate self-harm behaviours: Psychometric evaluation of six scales. *BMC Psychiatry, 13*:4. doi: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. *Current Opinion in Psychology, 3*, 30-35. doi:10.1016/j.copsyc.2015.01.014

Lee, S. (2006). Propensity score adjustment as a weighting scheme for volunteer panel web surveys. *Journal of Official Statistics, 22*, 329-49.

The Leuven College Surveys (LCS). (n.d.). Retrieved from http://www.mindmates.be/page.phpid28

Lewis, S. P., Heath, N. L., Hasking, P. A., Whitlock, J. L., Wilson, M. S., & Plener, P. L. (2019). Addressing self-injury on college campuses: Institutional recommendations. *Journal of College Counselling, 22*, 70-82. doi:10.1002/jocc.12115

Liu, R. T., Scopelliti, K. M., Pittman, S. K., & Zamora, A. S. (2018). Childhood maltreatment and non-suicidal self-injury: A systematic review and meta-analysis. *Lancet Psychiatry, 5*, 51-64. doi:10.1016/S2215-0366(17)30469-8

Liu, X., Chen, Z., Fine, J. P., Liu, L., Wang, A., Guo, J., . . . Guo, X. (2016). A competing-risk-based score for predicting twenty-year risk of incident diabetes: The Beijing Longitudinal Study of Ageing study. *Scientific Reports, 6*:37248. doi:10.1038/srep37248

Macrynikola, N., Miranda, R., & Soffer, A. (2018). Social connectedness, stressful life events, and self-injurious thoughts and behaviors among young adults. *Comprehensive Psychiatry, 80*, 140-9. doi:10.1016/j.comppsych.2017.09.008

Mahtani, S., Hasking, P., & Melvin, G. A. (2019). Shame and non-suicidal self-injury: Conceptualization and preliminary test of a novel developmental model among emerging adults. *Journal of Youth and Adolescence, 48*, 753-70. doi:10.1007/s10964-018-0944-0

Mahtani, S., Melvin, G. A., & Hasking, P. (2017). Shame proneness, shame coping, and functions of nonsuicidal self-injury (NSSI) among emerging adults. *Emerging Adulthood, 6*, 159-71. doi:10.1177/2167696817711350

Marshall, E., Claes, L., Bouman, W. P., Witcomb, G. L., & Arcelus, J. (2016). Non-suicidal self-injury and suicidality in trans people: A systematic review of the literature. *International Review of Psychiatry, 28*, 58-69. doi:10.3109/09540261.2015.1073143

Martin, J., Bureau, J. F., Yurkowski, K., Fournier, T. R., Lafontaine, M. F., & Cloutier, P. (2016). Family-based risk factors for non-suicidal self-injury: Considering influences of maltreatment, adverse family-life experiences, and parent-child relational risk. *Journal of Adolescence, 49*, 170-80. doi:10.1016/j.adolescence.2016.03.015

May, A. M., & Klonsky, E. D. (2016). What distinguishes suicide attempters from suicide ideators? A meta-analysis of potential factors. *Clinical Psychology: Science and Practice, 23*, 5-20. doi:10.1111/cpsp.12136

McNeish, D., & Hamaker, E. L. (2019). A primer on two-level dynamic structural equation models for intensive longitudinal data in Mplus. *Psychological Methods*. doi:10.1037/met0000250

Merikangas, K. R., & Kalaydjian, A. (2007). Magnitude and impact of comorbidity of mental disorders from epidemiologic surveys. *Current Opinion in Psychiatry, 20*, 353-8. doi:10.1097/YCO.0b013e3281c61dc5

Miranda, R., & Nolen-Hoeksema, S. (2007). Brooding and reflection: Rumination predicts suicidal ideation at 1-year follow-up in a community sample. *Behaviour Research and Therapy, 45*, 3088-95. doi:10.1016/j.brat.2007.07.015

Mortier, P., Auerbach, R. P., Alonso, J., Axinn, W. G., Cuijpers, P., Ebert, D. D., . . . Bruffaerts, R. (2018). Suicidal thoughts and behaviors among college students and same-aged peers: Results from the World Health Organization World Mental Health Surveys. *Social Psychiatry and Psychiatric Epidemiology, 53*, 279-88. doi:10.1007/s00127-018-1481-6

Mortier, P., Auerbach, R. P., Alonso, J., Bantjes, J., Benjet, C., Cuijpers, P., . . . Collaborators, W. W.-I. (2018). Suicidal thoughts and behaviors among first-year college students: Results from the WMH-ICS project. *Journal of the American Academy of Child & Adolescent Psychiatry, 57*, 263-73 e261. doi:10.1016/j.jaac.2018.01.018

Mortier, P., Cuijpers, P., Kiekens, G., Auerbach, R. P., Demyttenaere, K., Green, J. G., . . . Bruffaerts, R. (2018). The prevalence of suicidal thoughts and behaviours among college students: A meta-analysis. *Psychological Medicine, 48*, 554-65. doi:10.1017/S0033291717002215

Mortier, P., Demyttenaere, K., Auerbach, R. P., Cuijpers, P., Green, J. G., Kiekens, G., . . . Bruffaerts, R. (2017). First onset of suicidal thoughts and behaviours in college. *Journal of Affective Disorders, 207*, 291-9. doi:10.1016/j.jad.2016.09.033

Mortier, P., Kiekens, G., Auerbach, R. P., Cuijpers, P., Demyttenaere, K., Green, J. G., . . . Bruffaerts, R. (2017). A risk algorithm for the persistence of suicidal thoughts and behaviors during college. *Journal of Clinical Psychiatry, 78*, e828-e836. doi:10.4088/JCP.17m11485

Muehlenkamp, J., Brausch, A., Quigley, K., & Whitlock, J. (2013). Interpersonal features and functions of nonsuicidal self-injury. *Suicide and Life-Threatening Behavior, 43*, 67-80. doi:10.1111/j.1943-278X.2012.00128.x

Muehlenkamp, J. J. (2014). Distinguishing between suicidal and nonsuicidal self-injury. In M. K. Nock (Ed.), *The Oxford handbook of suicide and self-injury* (pp. 23-46). New York: Oxford University Press.

Muehlenkamp, J. J., Brausch, A. M., & Washburn, J. J. (2017). How much is enough? Examining frequency criteria for NSSI disorder in adolescent inpatients. *Journal of Consulting and Clinical Psychology, 85*, 611-9. doi:10.1037/ccp0000209

Muehlenkamp, J. J., Claes, L., Havertape, L., & Plener, P. L. (2012). International prevalence of adolescent non-suicidal self-injury and deliberate self-harm. *Child and Adolescent Psychiatry and Mental Health, 6*:10. doi:10.1186/1753-2000-6-10

Muehlenkamp, J. J., Engel, S. G., Wadeson, A., Crosby, R. D., Wonderlich, S. A., Simonich, H., & Mitchell, J. E. (2009). Emotional states preceding and following acts of non-suicidal self-injury in bulimia nervosa patients. *Behaviour Research and Therapy, 47*, 83-87. doi:10.1016/j.brat.2008.10.011

Muehlenkamp, J. J., & Gutierrez, P. M. (2007). Risk for suicide attempts among adolescents who engage in non-suicidal self-injury. *Archives of Suicide Research, 11*, 69-82. doi:10.1080/13811110600992902

Myin-Germeys, I., Kasanova, Z., Vaessen, T., Vachon, H., Kirtley, O., Viechtbauer, W., & Reininghaus, U. (2018). Experience sampling methodology in mental health research: New insights and technical developments. *World Psychiatry, 17*, 123-32. doi:10.1002/wps.20513

Nansel, T. R., Overpeck, M., Pilla, R. S., Ruan, W. J., Simons-Morton, B., & Scheidt, P. (2001). Bullying behaviors among US youth: Prevalence and association with psychosocial adjustment. *JAMA, 285*, 2094-2100. doi:10.1001/jama.285.16.2094

Nezlek, J. B. (2017). A practical guide to understanding reliability in studies of within-person variability. *Journal of Research in Personality, 69*, 149-55. doi:10.1016/j.jrp.2016.06.020

Nicolai, K. A., Wielgus, M. D., & Mezulis, A. (2016). Identifying risk for self-harm: Rumination and negative affectivity in the prospective prediction of nonsuicidal self-injury. *Suicide and Life-Threatening Behavior, 46*, 223-33. doi:10.1111/sltb.12186

Nock, M. K. (2009). Why do people hurt themselves? New insights into the nature and functions of self-injury. *Current Directions in Psychological Science, 18*, 78-83. doi:10.1111/j.1467-8721.2009.01613.x

Nock, M. K. (2010). Self-injury. *Annual Review of Clinical Psychology, 6*, 339-63. doi:10.1146/annurev.clinpsy.121208.131258

Nock, M. K., & Favazza, A. R. (2009). Nonsuicidal self-injury: Definition and classification. In M. K. Nock (Ed.), *Understanding nonsuicidal self-injury: Origins, assessment and treatment*. Washington, DC: American Psychological Association.

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*, 300-10. doi:10.1001/2013.jamapsychiatry.55

Nock, M. K., Han, G., Millner, A. J., Gutierrez, P. M., Joiner, T. E., Hwang, I., . . . Kessler, R. C. (2018). Patterns and predictors of persistence of suicide ideation: Results from the army study to assess risk and resilience in servicemembers (Army STARRS). *Journal of Abnormal Psychology, 127*, 650-8. doi:10.1037/abn0000379

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. *Psychological Assessment, 19*, 309-17. doi:10.1037/1040-3590.19.3.309

Nock, M. K., Hwang, I., Sampson, N., Kessler, R. C., Angermeyer, M., Beautrais, A., . . . Williams, D. R. (2009). Cross-national analysis of the associations among mental disorders and suicidal behavior: Findings from the WHO World Mental Health Surveys. *PLoS Med, 6*:e1000123. doi:10.1371/journal.pmed.1000123

Nock, M. K., Joiner, T. E., Jr., Gordon, K. H., Lloyd-Richardson, E., & Prinstein, M. J. (2006). Non-suicidal self-injury among adolescents: Diagnostic correlates and relation to suicide attempts. *Psychiatry Research, 144*, 65-72. doi:10.1016/j.psychres.2006.05.010

Nock, M. K., & Prinstein, M. J. (2004). A functional approach to the assessment of self-mutilative behavior. *Journal of Consulting and Clinical Psychology, 72*, 885-90. doi:10.1037/0022-006X.72.5.885

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. *Journal of Abnormal Psychology, 118*, 816-27. doi:10.1037/a0016948

O'Connor, R. C., & Kirtley, O. J. (2018). The integrated motivational-volitional model of suicidal behaviour. *Philosophical Transactions of the Royal Society B: Biological Sciences, 373*(1754). doi:10.1098/rstb.2017.0268

Organisation for Economic Co-operation and Development (OECD). (2019). *Education at a glance 2019: OECD indicators*. Retrieved from https://www.oecd.org/education/education-at-a-glance/

Paret, C., Kluetsch, R., Zaehringer, J., Ruf, M., Demirakca, T., Bohus, M., . . . Schmahl, C. (2016). Alterations of amygdala-prefrontal connectivity with real-time fMRI neurofeedback in BPD patients. *Social Cognitive and Affective Neuroscience, 11*, 952-60. doi:10.1093/scan/nsw016

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 Research, 225*, 276-82. doi:10.1016/j.psychres.2014.12.026

Perez, J., Venta, A., Garnaat, S., & Sharp, C. (2012). The difficulties in emotion regulation scale: Factor structure and association with nonsuicidal self-injury in adolescent inpatients. *Journal of Psychopathology and Behavioral Assessment, 34*, 393-404. doi:10.1007/s10862-012-9292-7

Plener, P. L., Allroggen, M., Kapusta, N. D., Brahler, E., Fegert, J. M., & Groschwitz, R. C. (2016). The prevalence of nonsuicidal self-injury (NSSI) in a representative sample of the German population. *BMC Psychiatry, 16*, 353. doi:10.1186/s12888-016-1060-x

Plener, P. L., Libal, G., Keller, F., Fegert, J. M., & Muehlenkamp, J. J. (2009). An international comparison of adolescent non-suicidal self-injury (NSSI) and suicide attempts: Germany and the USA. *Psychological Medicine, 39*, 1549-58. doi:10.1017/S0033291708005114

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. *Borderline Personality Disorder and Emotion Dysregulation, 2*:2. doi:10.1186/s40479-014-0024-3

Posner, K., Brown, G. K., Stanley, B., Brent, D. A., Yershova, K. V., Oquendo, M. A., . . . Mann, J. J. (2011). The Columbia-suicide severity rating scale: Initial validity and internal consistency findings from three multisite studies with adolescents and adults. *American Journal of Psychiatry, 168*, 1266-77. doi:10.1176/appi.ajp.2011.10111704

Reinert, D. F., & Allen, J. P. (2002). The alcohol use sisorders identification test (AUDIT): A review of recent research. *Alcoholism Clinical & Experimental Research, 26*, 272-9.

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. *Psychological Medicine, 46*, 225-36. doi:10.1017/S0033291715001804

Rice, M. E., & Harris, G. T. (2005). Comparing effect sizes in follow-up studies: ROC Area, Cohen's d, and r. *Law and Human Behavior, 29*, 615-20. doi:10.1007/s10979-005-6832-7

Riley, E. N., Combs, J. L., Jordan, C. E., & Smith, G. T. (2015). Negative urgency and lack of perseverance: Identification of differential pathways of onset and maintenance risk in the longitudinal prediction of nonsuicidal self-injury. *Behavior Therapy, 46*, 439-48. doi:10.1016/j.beth.2015.03.002

Riley, E. N., Davis, H. A., Combs, J. L., Jordan, C. E., & Smith, G. T. (2016). Nonsuicidal self-injury as a risk factor for purging onset: Negatively reinforced behaviours that reduce emotional distress. *European Eating Disorders Review, 24*, 78-82. doi:10.1002/erv.2407

Robins, W. R., Holly, M. H., & Kali, H. T. (2001). Measuring global self-esteem: Construct validation of a single-item measure and the Rosenberg self-esteem scale. *Personality and Social Psychology Bulletin, 27*, 151-61.

Robinson, K., Garisch, J. A., Kingi, T., Brocklesby, M., O'Connell, A., Langlands, R. L., . . . Wilson, M. S. (2018). Reciprocal risk: The longitudinal relationship between emotion regulation and non-suicidal self-injury in adolescents. *Journal of Abnormal Child Psychology, 47*, 325-32. doi:10.1007/s10802-018-0450-6

Robinson, K., & Wilson, M. S. (2020). Inconsistent reporting of lifetime non-suicidal self-injury across two common assessments. Preprint from:https://psyarxiv.com/75z2w/

Robotham, D. (2008). Stress among higher education students: Towards a research agenda. *Higher Education, 56*, 735-46. doi:10.1007/s10734-008-9137-1

Rodriguez-Blanco, L., Carballo, J. J., & Baca-Garcia, E. (2018). Use of ecological momentary assessment (EMA) in non-suicidal self-injury (NSSI): A systematic review. *Psychiatry Research, 263*, 212-9. doi:10.1016/j.psychres.2018.02.051

Rosenrot, S. A., & Lewis, S. P. (2018). Barriers and responses to the disclosure of non-suicidal self-injury: A thematic analysis. *Counselling Psychology Quarterly*, 1-21. doi:10.1080/09515070.2018.1489220

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*, 145-72. doi: /10.1037/0033-295X.110.1.145

Sahlin, H., Bjureberg, J., Gratz, K. L., Tull, M. T., Hedman, E., Bjarehed, J., . . . Hellner, C. (2017). Emotion regulation group therapy for deliberate self-harm: A multi-site evaluation in routine care using an uncontrolled open trial design. *BMJ Open, 7*:10, e016220. doi:10.1136/bmjopen-2017-016220

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. *Survey Methodology, 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. *Clinical Psychology Review, 38*, 79-91. doi: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. *Journal of Personality, 84*, 139-53. doi: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 Research, 215*, 417-23. doi:10.1016/j.psychres.2013.12.005

Serafini, G., Muzio, C., Piccinini, G., Flouri, E., Ferrigno, G., Pompili, M., . . . Amore, M. (2015). Life adversities and suicidal behavior in young individuals: A systematic review. *European Child & Adolescent Psychiatry, 24*, 1423-46. doi:10.1007/s00787-015-0760-y

Serras, A., Saules, K. K., Cranford, J. A., & Eisenberg, D. (2010). Self-injury, substance use, and associated risk factors in a multi-campus probability sample of college students. *Psychology of Addictive Behaviors, 24*, 119-28. doi:10.1037/a0017210

Stange, J. P., Kleiman, E. M., Mermelstein, R. J., & Trull, T. J. (2019). Using ambulatory assessment to measure dynamic risk processes in affective Disorders. *Journal of Affective Disorders, 259*, 325-36. doi:10.1016/j.jad.2019.08.060

Stänicke, L. I., Haavind, H., & Gullestad, S. E. (2018). How do young people understand their own self-harm? A meta-synthesis of adolescents' subjective experience of self-harm. *Adolescent Research Review, 3*, 173-91. doi:10.1007/s40894-018-0080-9

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. *Journal of Psychiatric Research, 84*, 105-12. doi: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 and Life-Threatening Behavior, 44*, 273-303. doi:10.1111/sltb.12070

Swearer, S. M., & Cary, P. T. (2003). Perceptions and attitudes toward bullying in middle school youth. *Journal of Applied School Psychology, 19*, 63-79. doi:10.1300/J008v19n02_05

Taliaferro, L. A., & Muehlenkamp, J. J. (2015a). Factors associated with current versus lifetime self-injury among high school and college students. *Suicide and Life-Threatening Behavior, 45*, 84-97. doi:10.1111/sltb.12117

Taliaferro, L. A., & Muehlenkamp, J. J. (2015b). Risk factors associated with self-injurious behavior among a national sample of undergraduate college students. *Journal of American College Health, 63*, 40-48. doi:10.1080/07448481.2014.953166

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

Taylor, P. J., Jomar, K., Dhingra, K., Forrester, R., Shahmalak, U., & Dickson, J. M. (2018). A meta-analysis of the prevalence of different functions of non-suicidal self-injury. *Journal of Affective Disorders, 227*, 759-69. doi:10.1016/j.jad.2017.11.073

Turner, B. J., Baglole, J. S., Chapman, A. L., & Gratz, K. L. (2019). Experiencing and resisting nonsuicidal self-injury thoughts and urges in everyday life. *Suicide and Life-Threatening Behavior, 49, 1332-46*. doi:10.1111/sltb.12510

Turner, B. J., Jin, H. M., Anestis, M. D., Dixon-Gordon, K. L., & Gratz, K. L. (2018). Personality pathology and intentional self-harm: Cross-cutting insights from categorical and dimensional models. *Current Opinion in Psychology, 21*, 55-59. doi:10.1016/j.copsyc.2017.09.009

Turner, B. J., Layden, B. K., Butler, S. M., & Chapman, A. L. (2013). How often, or how many ways: Clarifying the relationship between non-suicidal self-injury and suicidality. *Archives of Suicide Research, 17*, 397-415. doi:10.1080/13811118.2013.802660

Turner, B. J., Wakefield, M. A., Gratz, K. L., & Chapman, A. L. (2017). Characterizing interpersonal difficulties among young adults who engage in nonsuicidal self-injury using a daily diary. *Behavior Therapy, 48*, 366-79. doi:10.1016/j.beth.2016.07.001

van Buuren, S. (2007). Multiple imputation of discrete and continuous data by fully conditional specification. *Statistical Methods in Medical Research, 16*, 219-42. doi:10.1177/0962280206074463

van Buuren, S., & Groothuis-Oudshoorn, C. G. M. (2011). mice: Multivariate imputation by chained equations in R. *Journal of Statistical Software, 45*, 1-67.

van Geel, M., Goemans, A., & Vedder, P. (2015). A meta-analysis on the relation between peer victimization and adolescent non-suicidal self-injury. *Psychiatry Research, 230*, 364-8. doi:10.1016/j.psychres.2015.09.017

Van Orden, K. A., Witte, T. K., Cukrowicz, K. C., Braithwaite, S. R., Selby, E. A., & Joiner, T. E., Jr. (2010). The interpersonal theory of suicide. *Psychological Review, 117*, 575-600. doi:10.1037/a0018697

VanDerhei, S., Rojahn, J., Stuewig, J., & McKnight, P. E. (2014). The effect of shame-proneness, guilt-proneness, and internalizing tendencies on nonsuicidal self-injury. *Suicide and Life-Threatening Behavior, 44*, 317-30. doi:10.1111/sltb.12069

Victor, S. E., Davis, T., & Klonsky, E. D. (2016). Descriptive characteristics and initial psychometric properties of the non-suicidal self-injury disorder scale. *Archives of Suicide Research*, 1-14. doi:10.1080/13811118.2016.1193078

Victor, S. E., & Klonsky, E. D. (2014). Correlates of suicide attempts among self-injurers: A meta-analysis. *Clinical Psychology Review, 34*, 282-97. doi:10.1016/j.cpr.2014.03.005

Victor, S. E., Scott, L. N., Stepp, S. D., & Goldstein, T. R. (2019). I want you to want me: Interpersonal stress and affective experiences as within-person predictors of nonsuicidal self-injury and suicide urges in daily life. *Suicide and Life-Threatening Behavior, 49*, 1157-77. doi:10.1111/sltb.12513

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 and Adolescent Psychiatry and Mental Health, 9*:20. doi:10.1186/s13034-015-0053-8

Vogt, D. S., Proctor, S. P., King, D. W., King, L. A., & Vasterling, J. J. (2008). Validation of scales from the deployment risk and resilience inventory in a sample of pperation Iraqi freedom veterans. *Assessment, 15*, 391-403. doi:10.1177/1073191108316030

Waals, L., Baetens, I., Rober, P., Lewis, S., Van Parys, H., Goethals, E. R., & Whitlock, J. (2018). The NSSI family distress cascade theory. *Child and Adolescent Psychiatry and Mental Health, 12*:52. doi:10.1186/s13034-018-0259-7

Walsh, B. W. (2012). *Treating self-injury: A practical guide., 2nd ed*. New York, NY: Guilford Press.

Washburn, J. J., Potthoff, L. M., Juzwin, K. R., & Styer, D. M. (2015). Assessing DSM-5 nonsuicidal self-injury disorder in a clinical sample. *Psychological Assessment, 27*, 31-41. doi:10.1037/pas0000021

Watson, D., Clark, L. A., & Tellegen, A. (1988). Devlopment and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063-70.

Wester, K., Trepal, H., & King, K. (2018). Nonsuicidal self-injury: Increased prevalence in engagement. *Suicide and Life-Threatening Behavior, 48*, 690-8. doi:10.1111/sltb.12389

Whitlock, J., Exner-Cortens, D., & Purington, A. (2014). Assessment of nonsuicidal self-injury: Development and initial validation of the non-suicidal self-injury-assessment tool (NSSI-AT). *Psychological Assessment, 26*, 935-46. doi:10.1037/a0036611

Whitlock, J., Muehlenkamp, J., & Eckenrode, J. (2008). Variation in nonsuicidal self-injury: Ddentification and features of latent classes in a college population of emerging adults. *Journal of Clinical Child & Adolescent Psychology, 37*, 725-35. doi:10.1080/15374410802359734

Whitlock, J., Muehlenkamp, J., Eckenrode, J., Purington, A., Baral Abrams, G., Barreira, P., & Kress, V. (2013). Nonsuicidal self-injury as a gateway to suicide in young adults. *Journal of Adolescent Health, 52*, 486-92. doi:10.1016/j.jadohealth.2012.09.010

Whitlock, J., Muehlenkamp, J. J., Purington, A., Eckenrode, J., Barreira, P., Baral Abrams, G., . . . Knox, K. (2011). Nonsuicidal self-injury in a college population: General trends and sex differences. *Journal of American College Health, 59*, 691-8. doi:10.1080/07448481.2010.529626

Whitlock, J., Prussien, K., & Pietrusza, C. (2015). Predictors of self-injury cessation and subsequent psychological growth: Results of a probability sample survey of students in eight universities and colleges. *Child and Adolescent Psychiatry and Mental Health, 9*:19. doi:10.1186/s13034-015-0048-5

Whitlock, J., & Selekman, M. D. (2014). Nonsuicidal self-injury across the life span. In M. K. Nock (Ed.), *The Oxford handbook of suicide and self-injury* (pp. 133-154). New York: Oxford University Press.

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

Wilcox, H. C., Arria, A. M., Caldeira, K. M., Vincent, K. B., Pinchevsky, G. M., & O'Grady, K. E. (2012). Longitudinal predictors of past-year non-suicidal self-injury and motives among college students. *Psychological Medicine, 42*, 717-26. doi:10.1017/S0033291711001814

Wilkinson, P. O., Qiu, T., Neufeld, S., Jones, P. B., & Goodyer, I. M. (2018). Sporadic and recurrent non-suicidal self-injury before age 14 and incident onset of psychiatric disorders by 17 years: Prospective cohort study. *Britisch Journal of Psychiatry, 212*, 222-6. doi:10.1192/bjp.2017.45

Willoughby, T., Heffer, T., & Hamza, C. A. (2015). The link between nonsuicidal self-injury and acquired capability for suicide: A longitudinal study. *Journal of Abnormal Psychology, 124*, 1110-15. doi:10.1037/abn0000104

Wolter, K. M. (1985). *Introduction to variance estimation.* NY: New York: Springer-Verlag.

Wright, A. G. C., & Woods, W. C. (2020). Personalized models of psychopathology. *Annual Review of Clinical Psychology*. doi: 10.1146/annurev-clinpsy-102419-125032

Yen, S., Kuehn, K., Melvin, C., Weinstock, L. M., Andover, M. S., Selby, E. A., . . . Spirito, A. (2016). Predicting persistence of nonsuicidal self-injury in suicidal adolescents. *Suicide and Life-Threatening Behavior, 46*, 13-22. doi:10.1111/sltb.12167

You, J., Lin, M. P., & Leung, F. (2015). A longitudinal moderated mediation model of nonsuicidal self-injury among adolescents. *Journal of Abnormal Child Psychology, 43*, 381-90. doi:10.1007/s10802-014-9901-x

Yurkowski, K., Martin, J., Levesque, C., Bureau, J. F., Lafontaine, M. F., & Cloutier, P. (2015). Emotion dysregulation mediates the influence of relationship difficulties on non-suicidal self-injury behavior in young adults. *Psychiatry Research, 228*, 871-8. doi:10.1016/j.psychres.2015.05.006

Zelkowitz, R. L., Cole, D. A., Han, G. T., & Tomarken, A. J. (2016). The Incremental Utility of Emotion regulation but not emotion reactivity in nonsuicidal self-injury. *Suicide and Life-Threatening Behavior, 46*, 545-62. doi:10.1111/sltb.12236

Zetterqvist, M. (2015). The DSM-5 diagnosis of nonsuicidal self-injury disorder: A review of the empirical literature. *Child and Adolescent Psychiatry and Mental Health, 9*, 31. doi:10.1186/s13034-015-0062-7

Zetterqvist, M., Lundh, L. G., Dahlstrom, O., & Svedin, C. G. (2013). Prevalence and function of non-suicidal self-injury (NSSI) in a community sample of adolescents, using suggested DSM-5 criteria for a potential NSSI disorder. *Journal of Abnormal Child Psychology, 41*, 759-73. doi:10.1007/s10802-013-9712-5

Zetterqvist, M., Mayo, L., Perini, I., & Gustafsson, P. A. (2020). Nonsuicidal self-injury disorder in adolescents: Clinical utility of the diagnosis using the clinical assessment of nonsuicidal self-injury disorder index. *Frontiers in Psychiatry, 11*:8. doi: 10.3389/fpsyt.2020.00008

Zimet, G. D., Dahlem, N. W., Zimet, S. G., & Farley, G. K. (1988). The multidimensional scale of perceived social support. *Journal of Personality Assessment, 52*, 30-41.

Zivin, K., Eisenberg, D., Gollust, S. E., & Golberstein, E. (2009). Persistence of mental health problems and needs in a college student population. *Journal of Affective Disorders, 117*, 180-5. doi:10.1016/j.jad.2009.01.001

Supplementary Materials

Supplementary Table 3.1. WMH-ICS sample characteristics.

Country	Number of participating universities	Total size of the universities	Number of first-year students eligible	Number of first-year students participated	Response Rate	Survey Field Dates	Sampling and procedures
Australia	1 public	~ 45,000	13,752	1,202	8.7%	2016-17	All first-year students were invited to participate through e-mail. Five reminder emails were sent with personalized links to the survey. Conditional incentives were applied (movie passes).
Belgium	1 public	~ 45,000	13,103	5,844	44.6%	2014-17	All first-year students between 2014-2016 were invited for a psycho-medical check-up in the student mental health center. Surveys were completed in the waiting room. Students who did not show up for the psycho-medical check-up received up to eight reminder emails. Conditional incentives were applied (store credit coupons). In 2016-2017, all first-year students were invited to participate through e-mail (up to eight emails).
Germany	2 public	~ 40,000	11,210	1,757	15.7%	2016-18	All first-year students were invited to participate through e-mail. Six reminder emails were sent with personalized links to the survey. Conditional incentives were applied (store credit coupons).
Hongkong	1 public	~ 3,000	519	208	40.1%	2017	All first-year full-time students were invited to participate through email and campus posters with QR codes for electronically registering for participation by providing university email address. After verification by university research team of the email addresses being provided, individual survey links were sent to the students. Up to 5 reminder emails, each 1 week apart, were sent for non-responding or incomplete surveys. All respondents who completed surveys were given HKD100 (=USD 12.8) shopping coupons as incentives.

Mexico	5 private/4 public	~28,000	10,747	8,076	75.1%	2016-18	All first-year students were eligible for the survey. Initial contact differed by university: survey included in an obligatory health evaluation (2 universities), as part of obligatory group tutoring sessions (1 university), or as part of required classes (3 universities) or teacher evaluations (2 universities) and direct invitations from university administrators (1). Two universities sent reminder emails (tutors sent out emails to their tutees; in a required class of personal development, reminders were sent out by faculty). No incentives were applied for baseline surveys, while incentives in the form of a movie ticket voucher were given for follow-up surveys.
Northern-Ireland	1 public	~25,000	4,359	739	17.0%	2015	All first-year students due to register were invited to participate. Following registration, ID numbers and links to the survey were provided. Five reminder emails/text messages were sent with personalized links to the survey. A 6th reminder involved a researcher telephoning non-responders. All responders were entered into a number of draws to win an iPad.
South-Africa	1 public	~30,000	5,338	686	12.9%	2015	All first-year students were invited to participate through e-mail. Eight reminder emails and one text message were sent with personalized links to the survey. Conditional incentives were applied (5x R1000 draw).
Spain	5 public	~96,000	16,332	2,118	13.0%	2014-15	All first-year students were eligible for the survey. Initial contact differed by university (information stands, information sessions in classrooms, through the university's website). Four reminder emails were sent with personalized links to the survey. Conditional monetary incentives were applied. Additionally, an end-game strategy was implemented by selecting a random proportion of non-respondents and offering all of them a monetary incentive.
United States	3 private	~21,800	4,382	739	16.9%	2015-16	All first-year students were invited to participate through e-mail. Three reminder emails were sent with personalized links to the survey. Conditional incentives were applied (gift cards).
Total	8 private/ 16 public	~333,800	79,746	21,369	45.6%*	2014-18	

Note: * weighted by achieved sample size.

Supplementary Table 3.2. Associations between sociodemographic characteristics and non-suicidal self-injury in the WMH-ICS.

	Predictor distribution[a]	Onset: Lifetime NSSI[b] among entire sample	Recency Model1: 12-month NSSI[c] among sample with lifetime NSSI	Recency Model2: 12-month NSSI[c] among sample with lifetime NSSI	Severity Model1: 5+ frequency criterion[d] among sample with 12-month NSSI	Severity Model2: 5+ frequency criterion[d] among sample with 12-month NSSI
	%(SE)	Multivariate aOR (95%CI)	Multivariate aOR (95%CI)	Multivariate aOR (95%CI)	Multivariate aOR (95%CI)	Multivariate aOR (95%CI)
Being female	54.7 (0.4)	1.6 (1.4-1.7)*	0.8 (0.7-1.0)*	0.8 (0.7-1.0)*	1.3 (1.0-1.7)*	1.3 (1.0-1.6)
Age at interview 18	57.6 (0.4)	(ref)	(ref)	-	(ref)	-
Age at interview 19	24.6 (0.3)	1.0 (0.9-1.1)	1.1 (0.9-1.4)	-	0.8 (0.6-1.1)	-
Age at interview 20+	17.8 (0.3)	0.8 (0.7-0.9)*	0.9 (0.7-1.1)	-	0.9 (0.6-1.2)	-
F(ndf,ddf)[p value][e]		10.63(2,5260) [0.00]*	2.32(2,35399) [0.10]		1.01(2,207638) [0.36]	
Parental education high	55.9 (0.5)	(ref)	(ref)	(ref)	(ref)	(ref)
Parental education medium	25.1 (0.4)	1.1 (0.9-1.2)	0.9 (0.8-1.2)	0.9 (0.8-1.2)	0.9 (0.6-1.2)	0.9 (0.6-1.3)
Parental education low	19.0 (0.4)	1.0 (0.9-1.1)	0.7 (0.6-0.9)*	0.7 (0.6-0.9)*	0.9 (0.6-1.3)	0.9 (0.6-1.3)
F(ndf,ddf)[p value][e]		0.47(2,150) [0.63]	4.78(2,211) [0.01]*	4.61(2,197) [0.01]*	0.58(2,224) [0.56]	0.50(2,198) [0.61]
Parents not married or parent(s) deceased	24.6 (0.4)	1.2 (1.1-1.3)*	0.9 (0.7-1.1)	0.9 (0.7-1.1)	1.1 (0.8-1.5)	1.1 (0.8-1.5)
Christian	70.6 (0.4)	(ref)	(ref)	(ref)	(ref)	(ref)
No religion	25.2 (0.4)	1.4 (1.3-1.6)*	1.2 (1.0-1.5)*	1.2 (1.0-1.5)	1.3 (0.9-1.7)	1.3 (1.0-1.7)
Another religion	4.2 (0.2)	1.3 (1.1-1.6)*	1.3 (0.9-1.8)	1.3 (0.9-1.9)	1.2 (0.7-2.2)	1.2 (0.7-2.2)
F(ndf,ddf)[p value][e]		23.16(2,139) [0.00]*	2.64(2,224) [0.07]	2.33(2,221) [0.10]	1.44(2,426) [0.24]	1.65(2,392) [0.19]
Heterosexual - not attracted to same gender	76.2 (0.4)	(ref)	(ref)	(ref)	(ref)	(ref)
Heterosexual - somewhat or more attracted to same gender	12.7 (0.3)	2.0 (1.8-2.2)*	1.1 (0.9-1.4)	1.1 (0.9-1.4)	1.3 (0.9-1.8)	1.3 (0.9-1.9)
Non-heterosexual - no same-gender sex	6.9 (0.2)	2.7 (2.4-3.1)*	2.1 (1.7-2.8)*	2.1 (1.7-2.8)*	1.6 (1.1-2.3)*	1.6 (1.1-2.3)*

Non-heterosexual and/or same-gender sex	4.2 (0.2)	2.9 (2.5-3.3)*	1.7 (1.2-2.4)*	1.7 (1.2-2.4)*	1.6 (1.0-2.5)*	1.6 (1.0-2.6)*
F(ndf,ddf)[p value][e]		119.90(3,112) [0.00]*	13.76(3,198) [0.00]*	13.59(3,188) [0.00]*	2.95(3,228) [0.03]*	3.03(3,237) [0.03]*
Self-reported ranking high school top 10%	46.4 (0.4)	-	(ref)	(ref)	(ref)	(ref)
Self-reported ranking high school top 30% to 10%	29.2 (0.4)	-	1.1 (0.9-1.3)	1.1 (0.9-1.3)	0.9 (0.7-1.2)	0.9 (0.7-1.2)
Self-reported ranking high school bottom 70%	24.4 (0.4)	-	1.1 (0.9-1.3)	1.1 (0.9-1.3)	1.3 (0.9-1.8)	1.3 (0.9-1.8)
F(ndf,ddf)[p value][e]			0.30(2,699) [0.74]	0.29(2,700) [0.75]	2.41(2,289) [0.09]	2.35(2,269) [0.10]
NSSI onset 11 or younger	17.9 (0.7)	-	-	(ref)	-	(ref)
NSSI onset ages 12-14	36.5 (0.8)	-	-	0.7 (0.5-1.0)*	-	0.8 (0.5-1.3)
NSSI onset ages 15-17	37.9 (0.8)	-	-	0.6 (0.4-0.9)*	-	0.6 (0.3-1.1)
NSSI onset ages 18-19	6.6 (0.5)	-	-	1.0 (0.6-1.7)	-	0.3 (0.2-0.8)*
NSSI onset ages 20 or older	1.1 (0.2)	-	-	0.6 (0.3-1.3)	-	0.3 (0.1-1.3)
F(ndf,ddf)[p value][e]				3.58(4,26199) [0.01]*		1.82(4,45002) [0.12]
NSSI onset 8 or more years ago	20.0 (0.7)	-	(ref)	(ref)	(ref)	(ref)
NSSI onset 6-7 years ago	18.8 (0.7)	-	0.8 (0.6-1.0)	1.0 (0.7-1.3)	0.5 (0.4-0.8)*	0.6 (0.4-1.0)*
NSSI onset 4-5 years ago	26.6 (0.8)	-	0.8 (0.7-1.1)	1.1 (0.8-1.5)	0.6 (0.5-0.9)*	0.9 (0.5-1.4)
NSSI onset 2-3 years ago	24.9 (0.7)	-	1.0 (0.8-1.2)	1.5 (1.0-2.1)*	0.4 (0.3-0.6)*	0.7 (0.4-1.2)
NSSI onset year before college	9.7 (0.5)	-	4.1 (2.9-5.6)*	5.0 (3.2-7.8)*	0.3 (0.2-0.5)*	0.7 (0.4-1.5)
F(ndf,ddf)[p value][e]			28.33(4,64406) [0.00]*	17.69(4,78378) [0.00]*	9.07(4,26568) [0.00]*	1.57(4,57157) [0.18]

Note: [a] estimates among entire sample except for age of onset and time since onset of NSSI, [b] NSSI at least once in lifetime, [c] NSSI at least once in past 12-months, [d] NSSI at least five times in past 12-months, [e] F-test to evaluate joint significance of categorical predictor levels across 20 imputed datasets. Each column displays the result of a separate multivariate model analyzed within a person-period survival (onset model) or person-level time-order (recency and severity models) framework, with all variables specified in the rows as predictors. All models control country membership and the onset model also controls person-year. Empty cells indicate the predictor specified in the row was not included in the model. The recency severity model 1 include age and time since onset but exclude age of onset. The recency and severity model 2 include age of onset and time since onset but exclude age. NSSI = Non-Suicidal Self-Injury, ndf = numerator degrees of freedom, ddf = denominator degrees of freedom. *Significant at the .05 level, two-sided test.

Supplementary Table 3.3. Multivariate associations between temporally prior non-suicidal self-injury and onset of DSM-IV mental disorders in the WMH-ICS.

Temporally prior predictors	Onset Major depressive disorder	Onset Generalized anxiety disorder	Onset Panic disorder	Onset Bipolar disorder	Onset Alcohol use disorder	Onset Substance use disorder
	Multivariate aOR (95%CI)	Multivariate aOR (95%CI)	Multivariate aOR (95%CI)	Multivariate aOR (95%CI)	Multivariate aOR (95%CI)	Multivariate aOR (95%CI)
Non-suicidal self-injury	1.3 (1.1-1.5)*	1.4 (1.3-1.6)*	1.7 (1.4-2.1)*	2.0 (1.6-2.5)*	1.8 (1.5-2.3)*	1.8 (1.5-2.3)*
Major depressive disorder	-	4.0 (3.5-4.6)*	3.0 (2.3-4.1)*	-	1.3 (1.0-1.6)*	2.1 (1.5-2.9)*
Generalized anxiety disorder	2.8 (2.4-3.2)*	-	4.4 (3.2-6.0)*	4.6 (3.7-5.7)*	1.3 (0.9-1.9)	1.3 (0.8-2.3)
Panic disorder	1.6 (1.0-2.4)*	3.9 (3.0-5.1)*	-	3.5 (2.1-5.9)*	1.7 (1.1-2.4)*	1.6 (1.1-2.5)*
Bipolar disorder	-	3.9 (3.1-4.9)*	3.8 (2.5-5.8)*	-	2.4 (1.8-3.2)*	2.6 (1.7-4.0)*
Alcohol use disorder	1.4 (1.0-2.0)*	2.3 (1.7-3.0)*	1.7 (1.0-2.9)	3.1 (2.0-4.8)*	-	5.0 (3.7-6.7)*
Substance use disorder	1.3 (0.8-2.0)	1.3 (0.9-2.0)	1.5 (0.8-2.8)	1.9 (1.1-3.3)*	2.3 (1.6-3.4)*	-
Number of temporally prior mental disorders						
None or exactly one mental disorder	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Two or more mental disorders	0.4 (0.2-0.7)*	0.5 (0.3-0.7)*	0.4 (0.2-0.5)*	0.5 (0.3-0.9)*	0.6 (0.4-1.0)	0.7 (0.4-1.4)

Note: Each column displays the result of a separate multivariate model within a person-period survival framework, with temporally prior non-suicidal self-injury and mental disorders in the table as predictors controlling for the following covariates: gender, age, education, marital status parents, religion, sexual orientation, and person-year (not shown here). *Significant at the .05 level, two-sided test.

Supplementary Table 3.4. Multivariate associations between temporally prior non-suicidal self-injury and recency of DSM-IV mental disorders in the WMH-ICS.

Temporally prior predictors	Recency Major depressive disorder Multivariate aOR (95%CI)	Recency Generalized anxiety disorder Multivariate aOR (95%CI)	Recency Panic disorder Multivariate aOR (95%CI)	Recency Bipolar disorder Multivariate aOR (95%CI)	Recency Alcohol use disorder Multivariate aOR (95%CI)	Recency Substance use disorder Multivariate aOR (95%CI)
Non-suicidal self-injury	1.1 (0.7-1.5)	1.6 (1.1-2.3)*	1.1 (0.4-2.8)	4.6 (1.4-15.4)*	1.2 (0.6-2.5)	1.0 (0.6-1.8)
Major depressive disorder	-	1.0 (0.6-1.5)	1.2 (0.3-4.4)	-	1.5 (0.6-3.7)	1.2 (0.6-2.6)
Generalized anxiety disorder	1.0 (0.7-1.5)	-	1.1 (0.3-4.2)	0.9 (0.4-2.3)	2.6 (0.9-7.3)	1.0 (0.5-2.3)
Panic disorder	1.8 (0.6-5.5)	1.8 (0.6-4.8)	-	/	1.2 (0.3-5.4)	0.9 (0.4-2.4)
Bipolar disorder	-	4.9 (1.2-19.1)*	2.2 (0.3-17.6)	-	1.2 (0.5-3.3)	1.6 (0.6-4.2)
Alcohol use disorder	1.9 (0.6-5.9)	0.9 (0.3-2.9)	/	1.1 (0.2-6.1)	-	1.8 (0.9-3.4)
Substance use disorder	1.3 (0.4-4.2)	1.6 (0.4-7.4)	0.8 (0.1-5.0)	0.3 (0.0-3.6)	0.5 (0.2-1.4)	-
Number of temporally prior mental disorders						
None or exactly one mental disorder	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Two or more mental disorders	1.1 (0.2-5.3)	0.8 (0.2-3.4)	0.5 (0.1-3.1)	8.9 (0.7-112.8)	0.5 (0.1-2.2)	1.0 (0.3-3.1)

Note: Each column displays the result of a separate multivariate model within a person-level time-order framework, with temporally prior non-suicidal self-injury and mental disorders in the table as predictors controlling for the following covariates: gender, age, education, marital status parents, religion, sexual orientation, and high-school ranking (except for panic disorder as the model did not converge), age of onset, and time since onset (not shown here). / effect could not be estimated.
*Significant at the .05 level, two-sided test.

Supplementary Table 4.1. Assessed survey questions that map onto each criteria of DSM-5 Non-Suicidal Self-Injury-Disorder.

Criteria	Survey question	Type variable	Criteria present
Criterion A	How many times in the past year did you engage in any of the behaviors you mentioned?	Ordinal variable with following categories: 0, 1-2, 3-4, 5-10, 11-20, 21-30, 31-50, 51-100, 101 or more	5 NSSI occurrences or more in past 12-months
Criterion B: B1 B2 B3	When you have hurt yourself, how much did you do it … … as a way to get rid of bad feelings? … to communicate with someone else or to get attention or get out of doing something of get away from others? … in order to feel something, because you were feeling numb or empty	Ordinal variable going from 0 (little) to 4 (very much)	At least one of contingent responses is present to some extent (≥ 1).
Criterion C: C1 C2 C3	To what extent did the problems below led to hurting yourself on purposes, without wanting to die? Problems with family, problems with friends, problems with romantic partner, problems with peers, mental state at the time. Before engaging in hurting myself on purpose, I experience a period of time during which I have difficulties resisting the behavior? How many times in the past year have you experienced thoughts of purposely hurting yourself, without wanting to die?	Ordinal variable going 0 (little) to 4 (very much) 5-point Likert Scale ranging from 1 (strongly disagree) to 5 (strongly agree) Ordinal variable with following categories: 0, 1-2, 3-4, 5-10, 11-20, 21-30, 31-50, 51-100, 101 or more	At least one psychological precipitant is present to some extent (≥ 1), or participant agrees (≥ 4), that there is an urge to self-injure, or indicates a preoccupation with NSSI (5 thoughts ≥ in past 12-months)
Criterion D	From the list below, please mark all the specified behavior(s) that you have ever done in your life to hurt yourself on purpose, without wanting to die: cut or carved skin, scraped skin, erased skin, hit yourself, smashed hand or foot against the wall or other objects, head banging, burned your skin, picked a scab, inserted objects under nails or skin, picked areas of the body to the point of drawing blood, gave oneself a tattoo, bit yourself, pulled your hair out, other(s).	Dichotomous variable (yes/no)	Not restricted to picking a scab

Criterion E: E1 E2 E3 E4	Hurting myself on purpose, without wanting to die causes … distress … interference in my interpersonal life … interference in my academic curriculum … interference in other important areas of life	5-point Likert Scale ranging from 1 (strongly disagree) to 5 (strongly agree)	Participant agrees (≥ 4) NSSI or its consequences causes distress or has a negative impact in one or more domains of life.
Criterion F: Substance intoxication Trichotillomania Excoriation disorder	During what percent of the time were you using drugs or alcohol when you hurt yourself on purpose, without wanting to die? From the list below, please mark all the specified behavior(s) that you have ever done in your life to hurt yourself on purpose, without wanting to die.	Slide bar going from 0% to 100% Dichotomous variables (yes/no)	NSSI not exclusively under the influence of drugs or alcohol (< 100%), and not restricted to hair pulling and skin picking

Note: NSSI = Non-suicidal self-injury.

Supplementary Table 5.1. Sociodemographic characteristics of the total sample and within respondents with self-injurious thoughts and behaviors.

	Total sample w(n) = 6,393		NSSI thoughts[a] w(n) = 134		NSSI w(n) = 1,460		Any STB w(n) = 1,522	
	w(%)	SE	w(%)	SE	% w(%)	SE	w(%)	SE
Gender:								
Female	56.8	0.6	57.3	4.6	63.1	1.3	60.1	1.3
Male	43.2	0.6	42.7	4.6	36.9	1.3	39.9	1.3
Age:								
17 or younger	4.3	0.2	5.6	1.8	3.9	0.4	4.1	0.4
18 years	61.7	0.6	54.5	4.5	52.0	1.3	50.7	1.3
19 years	22.4	0.6	25.8	4.2	24.6	1.2	23.9	1.2
20 or more	11.5	0.4	14.1	3.2	19.5	1.1	21.4	1.1
Country:								
Australia	16.6	0.5	39.0	4.5	33.4	1.3	33.6	1.3
Belgium	83.4	0.5	61.0	4.5	66.6	1.3	66.4	1.3
Socio-economic status[b]:								
Low	16.8	0.5	18.5	3.7	18.7	1.1	18.8	1.0
Middle	27.0	0.6	37.5	4.4	31.6	1.3	33.6	1.3
High	56.2	0.6	44.0	4.5	49.7	1.3	47.6	1.3
Familial composition:								
Intact	77.3	0.5	75.7	3.8	70.7	1.2	69.6	1.2
Broken	22.7	0.5	24.3	3.8	29.3	1.2	30.4	1.2

Note: [a] NSSI Thoughts = respondents with NSSI thoughts but not NSSI, [b] Parental education was used as a proxy for socio-economic status in the data from the Leuven College Surveys. NSSI = Non-Suicidal Self-Injury, STB = Suicidal Thoughts and Behaviors, SE = Standard Error, w(n) = weighted number of cases, w(%) = weighted percentage

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Supplementary Table 5.2. Prevalence and co-occurrence of non-suicidal self-injurious thoughts and behaviors and mental health disorders.

	Controls[a] (w(n) = 4,799) w% (SE)	NSSI thoughts[b] (w(n) = 134) w% (SE)	NSSI (w(n) = 1,460) w% (SE)	OR (95% CI) Controls vs. NSSI thoughts	OR (95% CI) Controls vs. NSSI
Major Depressive Disorder	9.3 (0.4)	35.2 (4.4)	40.1 (1.3)	5.3***(3.6-7.8)	6.0*** (5.2-7.0)
Broad Mania	0.9 (0.1)	4.5 (1.9)	8.4 (0.8)	5.0***(2.0-12.6)	8.8*** (6.2-12.5)
Generalized Anxiety Disorder	7.0 (0.4)	23.3 (3.9)	30.7 (1.2)	4.0*** (2.6-6.3)	5.5*** (4.7-6.5)
Panic Disorder	1.6 (0.2)	2.5 (1.5)	11.7 (0.9)	1.6 (0.5-5.3)	8.1***(6.1-10.8)
Risk for Alcohol Dependence	3.4 (0.3)	2.5 (1.5)	6.9 (0.7)	0.7 (0.2-2.5)	2.1*** (1.6-2.8)
Any Mental Disorder	16.5 (0.5)	41.5 (4.5)	53.2 (1.3)	3.6***(2.5-5.2)	5.5***(4.8-6.3)

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.
* $p < .05$, ** $p < .01$, *** $p < .001$

Supplementary Table 5.3. Multivariate interactive survival models predicting the onset of suicidal thoughts and behaviors.

	Suicide ideation		Suicide plan		Suicide attempt	
	β	SE	β	SE	β	SE
NSSI thoughts	1.21***	.17	0.96***	.23	0.11	.54
NSSI	1.17***	.07	1.35***	.11	2.09***	.27
Mental Disorders:						
Major Depressive Disorder	1.67***	.11	1.84***	.17	2.10***	.34
Broad mania	0.54*	.27	1.00**	.30	1.58***	.47
Generalized Anxiety Disorder	0.39**	.15	0.31	..21	0.10	.40
Panic Disorder	0.38	.27	0.32	.31	-0.29	.73
Risk for Alcohol Dependence	-0.21	.34	-0.34	.45	0.97	.63
NSSI*Mental disorder interactions:						
NSSI*Major Depressive Disorder	-0.47**	.17	-0.53*	.22	-0.72	.41
NSSI*Broad mania	0.07	.43	-0.66	.40	-1.03	.54
NSSI*Generalized Anxiety Disorder	-0.16	.22	-0.13	.27	-0.30	.46
NSSI*Panic Disorder	-0.46	.36	-0.34	.39	0.69	.77
NSSI*Risk for Alcohol Dependence	-0.40	.52	-0.14	.60	-0.51	.74
n(person-years)	92,646		97,492		100,600	

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, SE = Standard Error.
* *p* < .05, ** *p* < .01, *** *p* < .001

Supplementary Table 6.1. Multivariate associations between all risk factors under study and onset of non-suicidal self-injury during college.

	Sporadic NSSI	Repetitive NSSI
I. Sociodemographic and college-related variables	OR (95% CI)	OR (95% CI)
Sex (male)	1.0 (0.6-1.4)	0.9 (0.6-1.5)
Age > 18 years	1.0 (0.7-1.5)	1.0 (0.6-1.6)
Non-Belgian nationality	1.7 (0.8-3.5)	1.7 (0.8-3.6)
Parents' financial situation difficult	1.0 (0.6-1.7)	1.1 (0.7-1.9)
Parental educational level		
Both parents high education	Ref	ref
One parent high education	1.0 (0.7-1.5)	1.0 (0.6-1.6)
Neither parents high education	1.0 (0.6-1.6)	1.1 (0.7-1.8)
Non-intact family composition	1.0 (0.6-1.6)	1.0 (0.7-1.7)
Area of enrolment		
Human Sciences	ref	ref
Science and Technology	1.0 (0.6-1.4)	0.9 (0.5-1.4)
Biomedical Sciences	0.9 (0.6-1.4)	0.9 (0.6-1.5)
Non-GSE pre-educational level	1.7 (0.8-3.7)	1.7 (0.8-3.8)
II. Traumatic experiences		
Parental psychopathology	1.2 (0.7-1.9)	1.3 (0.8-2.2)
Physical abuse	1.7 (0.7-3.9)	1.6 (0.7-3.8)
Emotional abuse	1.4 (0.8-2.6)	1.2 (0.6-2.4)
Sexual abuse	1.4 (0.2-10.9)	1.9 (0.3-10.7)
Neglect	1.2 (0.6-2.6)	1.2 (0.5-2.6)
Dating violence	2.0 (0.8-4.6)	**3.1 (1.4-6.9)**
Bully victimization	1.3 (0.9-2.1)	1.3 (0.8-2.0)
Number of traumatic experiences		
None or exactly one	ref	ref
Exactly 2	1.1 (0.6-2.0)	1.0 (0.5-2.1)
3 or more	0.7 (0.2-2.1)	0.8 (0.2-2.6)
III. Twelve-month stressful experiences and unavailability of social support		
Life-threatening illness of a friend or family member	1.1 (0.7-1.9)	1.0 (0.5-1.9)
Death of a friend or family member	1.0 (0.6-1.8)	1.3 (0.7-2.3)
Breakup with a romantic partner	1.0 (0.6-1.8)	1.3 (0.7-2.2)
Romantic partner cheated	1.3 (0.5-3.5)	1.4 (0.4-4.3)
Serious betrayal by someone other than partner	1.0 (0.6-1.9)	1.0 (0.5-1.9)
Serious ongoing arguments or breakup with friend or family member	1.2 (0.7-2.2)	1.1 (0.6-2.2)
Life-threatening accident	1.5 (0.3-8.8)	3.0 (0.6-16.0)
Seriously physically assaulted	2.2 (0.7-7.0)	2.2 (0.6-8.7)
Sexually assaulted or raped	4.8 (0.2-95.0)	4.2 (0.1-130.5)
Serious legal problem	1.6 (0.6-4.4)	1.8 (0.6-5.9)
Another stressful event	1.0 (0.5-2.0)	1.2 (0.6-2.5)
Number of 12-month stressful experiences		
None or exactly one	ref	ref
Exactly 2	1.0 (0.5-2.0)	1.0 (0.5-2.2)
3 or more	1.0 (0.3-3.3)	0.9 (0.3-3.4)
Unsatisfactory family support	1.0 (0.6-1.6)	1.1 (0.7-1.9)
Unsatisfactory peer support	1.4 (0.9-2.0)	1.4 (0.9-2.2)
Unsatisfactory partner support	1.0 (0.7-1.5)	1.1 (0.7-1.7)

IV. Risk for 12-month mental disorders, 12-month suicidal thoughts and behaviors, and associated impairment

Major depressive disorder	1.6 (0.8-3.1)	1.4 (0.7-2.8)
Generalized anxiety disorder	1.2 (0.6-2.7)	1.5 (0.7-3.2)
Panic disorder	1.7 (0.5-6.5)	1.5 (0.4-5.4)
Broad Mania	2.1 (0.1-42.6)	3.8 (0.7-19.5)
Alcohol use disorder		
Low risk for alcohol use disorder	Ref	ref
Risky or hazardous drinking	1.1 (0.7-1.8)	1.0 (0.6-1.7)
Risk for alcohol dependence	1.3 (0.4-3.7)	1.0 (0.3-3.3)
Intermittent explosive disorder item positive	1.1 (0.6-1.8)	1.2 (0.7-2.0)
Any eating disorder item positive	1.3 (0.7-2.5)	1.4 (0.7-2.7)
Any psychotic item positive	1.6 (0.7-3.3)	1.4 (0.6-3.2)
Post-traumatic stress disorder item positive	1.0 (0.6-1.6)	1.1 (0.6-1.9)
No suicidal thoughts and behaviors	Ref	ref
Suicidal ideation	1.9 (0.9-4.2)	1.9 (0.8-4.3)
Suicide plans and/or attempts	1.4 (0.3-6.3)	2.3 (0.6-9.0)
Non-suicidal self-injury thoughts	2.0 (0.7-5.7)	1.5 (0.4-5.3)
Number of positive screens		
None or exactly one	Ref	Ref
Exactly 2	1.1 (0.6-2.0)	1.3 (0.7-2.6)
3 or more	1.0 (0.3-3.0)	1.3 (0.4-4.2)
Severe role impairment in daily life	**1.8 (1.0-3.3)**	**1.9 (1.1-3.6)**

Note: Multivariate associations are based on all factors shown in the table. OR = Odds Ratio; Significant odds ratios are shown in bold (α = .05).

Supplementary Table 8.1. Temporal between-person associations between trait affect, self-efficacy to resist NSSI, anxious and depressive symptoms and NSSI thoughts during the 12-day experience sampling protocol.

	Univariate analyses[a]		Full multivariate analyses[b]	
	B (SD)	95% CI	B (SD)	95% CI
Temporal between-person associations				
Trait negative affect	0.02 (0.03)	-0.04; 0.07	-0.02 (0.04)	-0.09; 0.05
Trait positive affect	**-0.09 (0.04)**	**-0.16; -0.02**	-0.04 (0.04)	-0.13; 0.04
Self-efficacy to resist NSSI during study	-0.03 (0.02)	-0.07; 0.01	-0.01 (0.02)	-0.05; 0.03
Anxiety symptoms past week	0.04 (0.06)	-0.07; 0.15	-0.04 (0.07)	-0.19; 0.11
Depressive symptoms past week	**0.11 (0.03)**	**0.04; 0.18**	**0.11 (0.05)**	**0.01; 0.22**

Note: [a] Analyses are based on separate multilevel regression models for each row, with the variable in the row as predictor and controlling the autoregressive parameter of NSSI thoughts at the within-person level (not shown here). [b] The multivariate model includes all between-person level variables in one multilevel regression model. B = median unstandardized point estimate; SD = posterior standard deviation; CI = Credibility Interval. Bolded cells indicate that there is a 95% probability that the true population value is not-null.

Supplementary Table 8.2. Temporal between-person associations between trait affect, self-efficacy to resist NSSI, anxious and depressive symptoms and NSSI during the 12-day experience sampling protocol.

	Univariate analyses	
	B (SD)	95% CI
Temporal between-person associations		
Trait negative affect	-0.01 (0.05)	-0.11; 0.08
Trait positive affect	-0.07 (0.09)	-0.26; 0.07
Self-efficacy to resist NSSI at baseline	**-0.06 (0.04)**	**-0.15; -0.00**
Anxiety symptoms past week	0.05 (0.10)	-0.13; 0.27
Depressive symptoms past week	0.09 (0.07)	-0.03; 0.25

Note: Analyses are based on separate multilevel regression models for each row, with the variable in the row as predictor and controlling the autoregressive parameter of NSSI behavior at the within-person level (not shown here). B = median unstandardized point estimate; SD = posterior standard deviation; CI = Credibility Interval. Bolded cells indicate that there is a 95% probability that the true population value is not-null.

Personal Contribution

The work presented in this thesis is the result of several scientific collaborations. The doctoral candidate has been responsible for the coordination of the Australian and Belgian arm of the WMH-ICS between 2014 and 2019. Data for chapters 4-6 and 8 was acquired by the PhD candidate. Chapter 3 included also data from other countries of the WHM-ICS and data for chapter 7 was collected before the launch of the doctoral research project. All statistical analyses were performed by the doctoral candidate. Interpretation of results was conducted in consultation with supervisors, co-supervisors, and co-authors. The doctoral candidate drafted the thesis and research articles included in the dissertation, while supervisors, co-supervisors, and co-authors provided critical feedback. A detailed overview of the contribution of each author can be found below.

Study concept and design: **Kiekens, G.,** Hasking, P., Claes, L., Boyes, M., Auerbach, R.P., Cuijpers, P., Demyttenaere, K., Green, J.G., Kessler, R.C., Mortier, P., Nock, M.K., and Bruffaerts, R.

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Drafting of the thesis, including research articles: **Kiekens, G.**

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Scientific Acknowledgements and Conflict of Interest

Copyright Clearance of Published Material

Chapter 4

Chapter 5

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

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Chapter 6

Predicting the incidence of non-suicidal self-injury in college students

Author: G. Kiekens,P. Hasking,L. Claes,M. Boyes,P. Mortier,R.P. Auerbach,P. Cuijpers,K. Demyttenaere,J.G. Green,R.C. Kessler,I. Myin-Germeys,M.K. Nock,R. Bruffaerts

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Chapter 7

What Predicts Ongoing Nonsuicidal Self-Injury?: A Comparison Between Persistent and Ceased Self-Injury in Emerging Adults

Author: Glenn Kiekens, Penelope Hasking, Ronny Bruffaerts, et al

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Chapter 8

Curriculum Vitae

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EDUCATION AND TRAINING

2020	**Doctor of Psychology** School of Psychology Faculty of Health Sciences, Curtin University, Perth, Australia.
2020	**Doctor of Biomedical Sciences** Patient-Related and Public Health Research Faculty of Medicine, KU Leuven, Leuven, Belgium.
2016	**Master of Science in Statistics** (Magna Cum Laude) Faculty of Science, KU Leuven, Leuven, Belgium.
2014	**Clinical and Scientific Internship** (Summa Cum Laude) Emergency Psychiatry Service, University Hospital Leuven, Leuven, Belgium.
2014	**Master of Science in Health and Clinical Psychology** (Magna Cum Laude) Faculty of Psychology and Educational Sciences, KU Leuven, Leuven, Belgium.
2012	**Bachelor of Science in Psychology** (Cum Laude) Faculty of Psychology and Educational Sciences, KU Leuven, Leuven, Belgium.

ACADEMIC AND TEACHING POSITIONS

2019	**Visiting Research Scholar** (World Mental Health International Student College Initiative) Harvard Medical School, Boston, The United States of America. Responsible faculty: Prof. Dr. R. Kessler
2019	**Teaching: Scientific Research** (MCG03a) University College Leuven Limburg (UCLL), Leuven, Belgium. Responsible faculty: Prof Dr. Bruffaerts
2015	**Teaching: Clinical Assessment** (B-KUL-P0N41A) and **Scientific Writing** (B-KUL-P0T69A) Faculty of Psychology and Educational Sciences, KU Leuven, Leuven, Belgium. Responsible faculty: Prof Dr. Claes and Prof Dr. Raes

AWARDED FUNDING AND SUPPORT

1. **Ph.D. fellowship Research Fund Flanders** (1114717N, 1114719N; €150,000).
   Towards a better understanding of non-suicidal self-injury (NSSI) in college students: Predictive factors, triggering mechanisms, and risk for suicidal thoughts and behaviors. Funded 1/10/2016- 30/9/2020

2. **Health Sciences Faculty International Research Scholarship Award** (Open Bid Category 2016; AUD $100,000). Investigating non-suicidal self-injury in university students and implementing the Australian arm of the WHO World Mental Health International College Student Project. Funded 1/8/2016- 1/06/2020

3. **International Mobility Grant** (€8,000).
   Research Fund Flanders, June 2019.
4. **Best Conference Presentation** ($500).
   Annual International meeting of the Society for the Study of Self-injury, June 2019.
5. **Travel Award** (€1,000).
   Research Fund Flanders, April 2019.
6. **Best Student Presentation Award** ($500).
   Annual International meeting of the Society for the Study of Self-injury, June 2018.
7. **Travel Award** (€1,000).
   Research Fund Flanders, April 2017.
8. **Travel Award** (€1,000).
   Research Fund Flanders, April 2016.

INTERNATIONAL PUBLICATIONS IN PREPARATION AND UNDER REVIEW

1. **Kiekens G.,** Hasking, P., Auerbach, R. P., Alonso, J., Bantjes, J., Benjet, C., Bruffaerts, R., Cuijpers, P., Ebert, D. D., Green, J. G., Mak, A. D., Mortier, P., O'Neill, S., Pinder-Amaker, S., Sampson, N. A., Vilagut, G., Kessler, R. C., & Nock, M. K. on behalf of the WHO World Mental Health – International College Student collaborators. Non-suicidal self-injury among first-year college students and the reciprocal relationship with DSM-IV mental disorders: Results from the World Mental Health International College Student (WMH-ICS) Initiative. In preparation.
2. Preece, D., **Kiekens, G.**, Boyes, M., Mortier, P., Nock, M., Kessler, R., Bruffaerts, R., & Hasking, P. Acquired Capability for Suicide Among Belgian and Australian University Students: Psychometric Properties of the German Capability for Suicide Questionnaire and a Test of the Interpersonal Theory of Suicide. *Revise and resubmit*
3. Benjet, C., Mortier, P., **Kiekens G.**, Ebert, D. D., Auerbach, R. P., Kessler, R., Cuijpers, P., Green, J, G., Ebert, D. D., Tartsitani, L., Green, J, G., Kessler, R., Nock, M. K., Demyttenaere, K., Albor, J., & Bruffaerts, R. A risk algorithm that predicts alcohol use disorders among college students. *Under Review*

INTERNATIONAL AND NATIONAL PUBLICATIONS

1. Tonta, K., Hasking, P., Boyes, M., Howell, J., McEvoy, P., & **Kiekens, G.** (in press). Measurement invariance of three brief measures of rumination in young adults with and without a history of self-injury. *European Journal of Psychological Assessment*
2. Baetens, I., Decruy, C., Vatandoost, S., Vanderhaegen, B., & **Kiekens, G.** (in press). School-based prevention targeting non-suicidal self-injury: A pilot study. *Frontiers in Psychiatry*
3. **Kiekens, G.**, Hasking, P., Nock, M. K., Boyes, M., Kirtley, O., Bruffaerts, R., Myin-Germeys, I., & Claes, L. (2020) Fluctuations in affective states and self-efficacy to resist non-suicidal self-injury as real-time predictors of non-suicidal self-injurious thoughts and behaviors. *Frontiers in Psychiatry, 11*:214*.* doi: 10.3389/fpsyt.2020.00214

4. Serra, R., **Kiekens, G.**, Tartsitani, L., Vrieze, E., Bruffaerts, R. Loriedo, C., Andriaens, A., & Vanderlinden, J. (2020): A 6-month prospective observational study The effect of trauma and dissociation on cognitive behavioral therapy for Binge Eating Disorder. *European Eating Disorders Review*. doi: 10.1002/erv.2722

5. Serra, R., **Kiekens, G.**, Vanderlinden, J., Vrieze, E., Auerbach, R. P., Benjet, C., Claes, L., Cuijpers, P., Demyttenaere, K., Ebert, D. D., Tartsitani, L., Green, J, G., Kessler, R., Nock, M. K., Mortier, P., & Bruffaerts, R. (2020) Twelve-month binging and purging behaviors in college freshmen: Prevalence, psychiatric comorbidity, and academic performance. *International Journal of Eating Disorders, 53,* 339-48. doi: 10.1002/eat.23211

6. **Kiekens, G.**, Hasking, P., Claes, L., Boyes, M., Mortier, P., Auerbach, R. P., Cuijpers, P., Demyttenaere, K., Green, J, G., Kessler, R., Myin-Germeys, I., Nock, M. K., & Bruffaerts, R. (2019). Predicting the incidence of non-suicidal self-injury in college students. *European Psychiatry, 59,* 44-51. doi: 10.1016/j.eurpsy.2019.04.002

7. Buelens, T., Luyckx, K., **Kiekens, G.**, Gandhi, A., Muehlenkamp, J., & Claes, L. (2019). Investigating the DSM-5 criteria for non-suicidal self-injury disorder in a community sample of adolescents. *Journal of affective disorders*. doi: 10.1016/j.jad.2019.09.009

8. Ebert, D., Buntrock, C., Mortier, P., Auerbach, R., Weisel, K, K., Cuijpers, P., Kessler, R., Demyttenaere, K., **Kiekens, G.**, Green, J. G., Nock, M. K., & Bruffaerts, R. (2019). Prediction of major depressive disorder onset in college students. *Depression and Anxiety, 36*, 294-304*.* doi: 10.1002/da.22867

9. Buelens, T., Luyckx, K., Gandhi, A., **Kiekens, G**., & Claes, L. (2019). Non-suicidal self-injury in adolescence: Longitudinal associations with psychological distress and rumination*. Journal of Abnormal Child Psychology.* doi: 10.1007/s10802-019-00531-8

10. **Kiekens, G**., Hasking, P., Boyes, M., Claes, L., Mortier, P., Auerbach, R. P., Cuijpers, P., Demyttenaere, K., Green, J, G., Kessler, R., Myin-Germeys, I., Nock, M. K., & Bruffaerts, R. (2018). The associations between non-suicidal self-injury and first onset suicidal thoughts and behaviors. *Journal of Affective Disorders*, *239*, 171-179. doi:10.1016/j.jad.2018.06.033

11. **Kiekens, G**., Hasking, P., Claes, L., Mortier, P., Auerbach, R. P., Boyes, M., Cuijpers, P., Demyttenaere, K., Green, J, G., Kessler, R., Nock, M. K., & Bruffaerts, R. (2018). The DSM-5 non-suicidal self-injury disorder among incoming college students: Prevalence and associations with mental disorders and suicidal thoughts and behaviors. *Depression and Anxiety, 35*, 629-637. doi: 10.1002/da.22754

12. Cassels, M., Baetens, I., Wilkinson, P., Pieters, C., Wiersema, R. J., Van Leeuwen, K., & **Kiekens, G**. (2018). Attachment and non-suicidal self-injury among young adolescents: The indirect role of behavioral problems. *Archives of Suicide Research*. doi: 10.1080/13811118.2018.1494651

13. **Kiekens, G**., Hasking, P., & Boyes, (2018). Measurement invariance of three brief emotion regulation instruments in young adults with and without a history of non-suicidal self-injury. *European Journal of Psychological Assessment*. doi: 10.1027/1015-5759/a000464

14. 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. *Comprehensive Psychiatry, 80*, 170-8, doi: 10.1016/j.comppsych.2017.10.007

15. Bruffaerts, R., Mortier, P., **Kiekens, G**., Auerbach, R. P., Cuijpers, P., Demyttenaere, K., Green, J, G., Nock, M, K., & Kessler, R. C. (2018). Mental health problems in college freshmen: Prevalence and academic functioning. *Journal of Affective Disorders, 225*, 97-103, doi: doi.org/10.1016/j.jad.2017.07.044

16. Mortier, P., Cuijpers, P., **Kiekens, G**., Auerbach, R. P., Demyttenaere, K., Green, J. G., Kessler, R. C., Nock, M. K., & Bruffaerts, R. (2018). The prevalence of suicidal thoughts and behaviours among college students: A meta-analysis. *Psychological Medicine, 1-12*, doi: DOI: 10.1017/S0033291717002215

17. Mortier, P., **Kiekens, G**., Auerbach, R. P., Cuijpers, P., Demyttenaere, K., Green, J. G., Kessler, R., Nock, M. K., & Bruffaerts, R. (2017). A risk algorithm for the persistence of suicidal thoughts and behaviors during college. *The Journal of Clinical Psychiatry, 78*, e828-e836, doi: 10.4088/JCP.17m11485

18. **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. *The Journal of Nervous and Mental Disease,' 205, 762-770*, doi: 10.1097/NMD.0000000000000726

19. Gandhi, A., Luyckx, K., Maitra, S., **Kiekens, G**., Verschueren, M., & Claes, L. (2017). Directionality of effects between non-suicidal self-injury and identity formation: A prospective study in adolescents. *Personality and Individual Differences, 109*, 124-129, doi: 10.1016/j.paid.2017.01.003

20. Mortier, P., Demyttenaere, K., Auerbach, R. P., Cuijpers, P., Green, J. G., **Kiekens, G**., Kessler, R., Nock, M. K., & Bruffaerts, R. (2017). First onset of suicidal thoughts and behaviours in college. *Journal of Affective Disorders, 207, 291-9*, doi: 10.1016/j.jad.2016.09.033

21. Demyttenaere, K., Mortier, P., **Kiekens, G**., & Bruffaerts, R. (2017). Is there enough "interest in and pleasure in" the concept of depression? The development of the Leuven Affect and Pleasure Scale (LAPS). *CNS Spectrums*, 1-10, doi: 10.1017/S1092852917000578

22. **Kiekens, G**., Claes, L., Demyttenaere, K., Auerbach, P. R., Green, G. J., Kessler, C. R., Mortier, P., Nock, M. K., & Bruffaerts, R. (2016). Lifetime and 12-month non-suicidal self-injury and academic performance in college freshmen. *Suicide and Life-Threatening Behavior, 46, 563-76*, doi: 10.1111/sltb.12237.

23. Gandhi, A., Claes, L., Bosmans, G., Baetens, I., Maitra, S., Wilderjans, T. F., **Kiekens, G**., & Luyckx, K. (2016) Non-suicidal self-injury and adolescents relationships with peers and mother: The mediating role of identity synthesis and confusion. *Journal of Child and Family Studies, 25*, 1735-45, doi: 10.1007/s10826-015-0350-0

24. Gandhi, A., Luyckx, K., Maitra, S., **Kiekens, G**., & Claes, L. (2016). Reactive and regulative temperament and non-suicidal self-injury in Flemish adolescents: The intervening role of identity formation. *Personality and Individual Differences*, 99, 254-9, doi: 10.1016/j.paid.2016.05.007

25. **Kiekens, G**., Bruffaerts, R., Nock, M. K., Van de Ven, M., Witteman, C., Mortier, P., Demyttenaere, K., & Claes, L. (2015). Non-suicidal Self-injury among Dutch and Belgian Adolescents: Personality, stress and coping. *European Psychiatry, 30, 743-749.* doi: 10.1016/j.eurpsy.2015.06.007

26. Mortier, P., Demyttenaere, K., Auerbach, R. P., Green, J. G., Kessler, R. C., **Kiekens, G**., Nock, M. K., Bruffaerts, R. (2015). The impact of lifetime suicidality on academic performance in college freshmen. *Journal of Affective Disorders*, *186*, 254–260. doi: 10.1016/j.jad.2015.07.030

27. **Kiekens, G**. Zelfverwondend gedrag en risico voor het ontstaan van suïcidale gedachten en gedrag (2018). *Tijdschrift Klinische Psychologie, 48, 263-266.*

28. Mortier P., **Kiekens G**., Demyttenaere K., & Bruffaerts R. (2017). Een eerste lifetime-episode van suïcidaliteit aan de universiteit. *Tijdschrift Klinische Psychologie, 47*, 1-2*.

29. **Kiekens, G**., Bruffaerts, R., Demyttenaere, K., Mortier, P., & Claes, L. (2015). Zelfverwondend gedrag bij adolescenten: De relatie met persoonlijkheid, stress en coping. *Caleidoscoop, 27, 22-29*.

30. **Kiekens, G**., Bruffaerts, R., Demyttenaere, K., Sabbe, M, Claes, L, Mortier, P., & Van Tricht, K. (2015) Suïcidale patiënten op de psychiatrische spoedgevallendienst: Epidemiologische, psychiatrische en psychosociale perspectieven. *Tijdschrift Klinische Psychologie, 45,* 199-213.

31. **Kiekens, G**., Claes, L., Demyttenaere, Mortier, P., & Bruffaerts, R. (2015). Niet-suïcidaal zelfverwondend gedrag bij adolescenten. *Neuron, 20,* 1-4

CONFERENCE ABSTRACTS AND PRESENTATIONS

1. Buelens, T., Luyckx, K. **Kiekens, G.**, Gandhi, A. Muehlenkamp, J. J., & Claes, L. (2019, September). Het zelfverwondingssyndroom in DSM-5: Een bijdrage aan de ontwikkeling en verfijning van klinisch relevante criteria. Het Vlaams Congres Kinder- en Jeugdpsychiatrie en -Psychotherapie. Leuven, Belgium.

2. **Kiekens, G**., Hasking, P., Claes, L., Boyes, M., Mortier, P., Auerbach, R. P., Cuijpers, P., Demyttenaere, K., Green, J.G., Kessler, R. C., Myin-Germeys, I., Nock, M. K., & Bruffaerts, R. (2019, June). Can we predict who is at risk of starting self-injury in college? A longitudinal investigation of risk factors for the incidence of non-suicidal self-injury in college (**awarded best conference presentation**). *Presented at the Annual Conference of the International Society for the Study of Self-Injury.* Orlando, United States of America.

3. **Kiekens, G.**, Hasking, P., Bruffaerts, R., Boyes, M., Myin-Germeys, I., & Claes, L. (2019, June). Differential affective-cognitive dynamics in young adults with and without a history of non-suicidal self-injury: An ecologically valid investigation in everyday life. *Presented at the Annual Conference of the International Society for the Study of Self-Injury.* Orlando, United States of America.

4. **Kiekens, G**., Hasking, P., Boyes, M., Claes, L., Mortier, P., Demyttenaere, K., & Bruffaerts, R. (2018, July). The unique role of non-suicidal self-injury in the onset of suicidal thoughts and behaviors. *Presented at the World Congress of the International Association for Child and Adolescent Psychiatry*. Prague, Czech Republic.

5. **Kiekens G**., Hasking P., Boyes M., Claes L., Mortier P., Auerbach R. P., Cuijpers P., Demyttenaere K., Green JG., Kessler RC., Myin-Germeys I., Nock M. K., & Bruffaerts R. (2018, June). Non-suicidal self-injury and risk for a subsequent onset of suicidal thoughts and behaviors (**awarded best student presentation**). *Presented at the Annual Conference of the International Society for the Study of Self-Injury.* Brussels, Belgium.

6. Buelens T., Luyckx K., Gandhi A., **Kiekens G**., & Claes L. (2018, June). Non-Suicidal Self-Injury in Adolescence: Longitudinal associations with negative emotions and rumination. *Presented at the Annual Conference of the International Society for the Study of Self-Injury.* Brussels, Belgium.

7. **Kiekens G**., Hasking P., Claes L., Mortier P., Auerbach RP., Boyes M., Cuijpers P., Demyttenaere K., Green JG., Kessler RC., Nock MK., & Bruffaerts R. (2018, June). The DSM-5 Non-suicidal self-injury disorder in first-year college students. *Presented at the Annual Conference of the International Society for the Study of Self-Injury.* Brussels, Belgium.

8. **Kiekens G**. (2018, May). Non-suicidal self-injury: if not to die, why would people do such a thing? An emotion regulation perspective. *Presented at the BAPS-meeting*. Gent, Belgium.

9. **Kiekens G**., Mortier P., & Bruffaerts R. (2018, April). The potential of risk screening algorithms for mental health problems: An illustration from the Leuven College Surveys Project. *Presented at the European Society for Research on Internet Interventions*. Dublin, Ireland.

10. Demyttenaere K., Mortier P., **Kiekens G**., & Bruffaerts R. (2017, September). Is there enough 'interest in and pleasure in' the concept of depression - the development of the Leuven Affect and Pleasure Scale (LAPS). *Presented at the 30th Congress of the European-College-of-Neuropsychopharmacology (ECNP)*. Paris, France.

11. **Kiekens G.** (2017, July). Non-suicidal self-injury in university students: Predictive factors, mechanisms, and long-term suicidal risk. *Presented at the Denis Glenncross Memorial Seminar.* Perth, Australia.

12. **Kiekens G**., Claes L., Hasking P., Mortier P., Auerbach RP., Boyes M., Cuijpers P., Demyttenaere K., Green JG., Kessler RC., Nock MK., & Bruffaerts R. (2017, June). The bidirectional associations between first onset of non-suicidal self-injury and ill-mental health. *Presented at the Annual Conference of the International Society for the Study of Self-Injury.* Philadelphia, United States of America.

13. Gandhi A., Luyckx K., Maitra S., **Kiekens G.**, Verschueren M., & Claes L. (2017, May). Directionality of effects between non-suicidal self-injury and identity formation: A cross-lagged prospective study in adolescents. *Presented at The International Society Meeting for Research on Identity*. Groningen, The Netherlands.

14. Mortier P., **Kiekens G**., & Demyttenaere K., Bruffaerts R. (2016, September). Suicidality among college students. *Presented at the Vlaams Geestelijke Gezondheidscongres,* Antwerp, Belgium.

15. **Kiekens G**., Claes L., Mortier P., Auerbach R., Demyttenaere K., Green JG., Kessler RC., Nock MK., & Bruffaerts R. (2016, June). An examination of non-suicidal self-injury characteristics that differentiate college freshmen with and without lifetime suicide risk. *Presented at the Annual Conference of the International Society for the Study of Self-Injury.* Eau Claire, United States of America.

16. **Kiekens G**., Bruffaerts R., Nock MK., Van de Ven M., Witteman C., Demyttenaere K., Mortier P., & Claes L. (2016, May). Personality traits and non-suicidal self-injury in adolescents: An examination of coping strategies and perceived stress as mediators. *Presented at the BAPS-meeting*. Antwerp, Belgium.

17. Mortier P., **Kiekens G**., Auerbach RP., Green JG., Kessler RC., Nock MK., Demyttenaere K., & Bruffaerts R. (2016, March). Comorbid psychopathological symptoms and suicidality among college students. *Presented at the WPA section on Epidemiology and Public Health*. Münich, Germany.

18. Mortier, P., Demyttenaere, K., Auerbach, R., Green, J. G., Kessler, R. C., **Kiekens, G.**, Nock, M. K., & Bruffaerts, R. Individual- and population-level effects of childhood adversity and emotional problems on early-onset suicide plans and/or attempts (2015, September). Archives of Public Health 2015: vol. 73 (Suppl 1). *Presented at the Methods in Epidemiology Symposium*. Leuven, Belgium.

19. **Kiekens G**., Claes L., Demyttenaere K., Mortier P., Nock MK., Green JG., Kessler RC., & Bruffaerts R. (2015, June). The impact of non-suicidal self-injury on academic performance: A multilevel analysis. *Presented at the Annual Conference of the International Society for the Study of Self-Injury.* Heidelberg, Germany.

20. **Kiekens G**., Bruffaerts R., Nock MK., Van de Ven M., Witteman C., Demyttenaere K., Mortier P., & Claes L. (2015, June). Non-suicidal self-injury in adolescents: How personality may come into play. *Presented at the Annual Conference of the International Society for the Study of Self-Injury.* Heidelberg, Germany.

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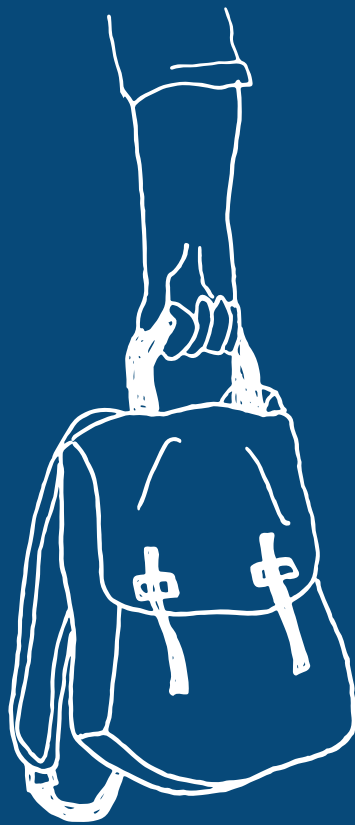
THANK YOU!

"*If you want to build a ship, don't drum up people together to collect wood and don't assign them*

tasks and work, but rather teach them to long for the endless immensity of the sea."

Antoine de Saint-Exupéry

*"The struggle is real as they say,
and yes, the adjustments are really hard."*

(Participant about the transition to college)