



Prospective prediction of first lifetime suicide attempts in a multi-site study of substance users



Zoë M. Trout^{a,*}, Evelyn M. Hernandez^a, Evan M. Kleiman^b, Richard T. Liu^a

^a Department of Psychiatry and Human Behavior, Alpert Medical School of Brown University, Bradley Hospital, 1011 Veterans Memorial Parkway, East Providence, RI 02915, United States

^b Department of Psychology, Harvard University, 33 Kirkland St, Cambridge, MA 02138, United States

ARTICLE INFO

Article history:

Received 8 June 2016

Received in revised form

12 September 2016

Accepted 20 September 2016

Keywords:

Longitudinal study

Suicide

Substance use

ABSTRACT

Although considerable empirical work has been devoted to identifying risk factors for suicide attempts, most longitudinal research has studied recurrent attempts rather than first lifetime attempts. The present study sought to examine prospective predictors of first lifetime suicide attempts among adults receiving treatment for substance use. Data were drawn from the National Treatment Improvement Evaluation Study, a study of addiction treatment programs. Data were collected at treatment intake, treatment exit, and one year post-treatment. Patients ($n = 3518$) with no lifetime history of suicide attempts at treatment intake were followed at treatment exit and one year post-treatment, when they reported on the occurrence of suicide attempts since the prior assessment. Prospective suicidal behavior was assessed using logistic regression in relation to sociodemographic variables, health-related work impairment, history of psychiatric treatment utilization, history of suicidal ideation, history of depressive symptoms, substance use, and childhood abuse, assessed at intake. Health-related work impairment, history of suicidal ideation, and childhood physical abuse significantly predicted first lifetime attempts in a multivariate analysis. Suicidal ideation, health-related functional impairments, and childhood physical abuse may be particularly important in assessing risk for first lifetime suicide attempts. Findings suggest that future clinical work and research would benefit from considering these factors when identifying individuals at heightened risk of making a first suicide attempt.

© 2016 Published by Elsevier Ltd.

1. Introduction

Suicide rates in the US have increased by 24% over the past 15 years (Curtin et al., 2016). This trend highlights the increasing importance of understanding risk factors for suicidal behavior. Although considerable empirical work has been devoted to identifying risk factors for suicide attempts, most longitudinal research in this area has studied recurrent attempts, with relatively few studies to date on the prospective prediction of first lifetime attempts. The distinction between first lifetime suicide attempts and repeated attempts is important, however, as empirical evidence suggests caution against assuming identical processes of risk for both. Although there are likely several risk factors of equal

relevance to first and recurrent suicide attempts, these behaviors may also be defined by notable differences in others. Specifically, cross-sectional studies have noted differences in sociodemographic characteristics, psychopathology, and history of childhood abuse among first versus repeat attempters, implying distinct psychological profiles between these groups (Clark and Fawcett, 1992; Forman et al., 2004; Maris, 1992; Rudd et al., 1996). Given these differences in first versus repeat attempts, it is imperative that research clarify risk factors that predict first lifetime attempts, specifically. Such work is clinically important insofar as it may inform efforts to better prevent first onset of suicidal behavior. These efforts may have considerable clinical impact as the often escalating course of recurrent suicide attempts (Goldston et al., 2015, 1999; Leon et al., 1990) makes the alternative of intervening later in this course substantially more difficult.

The notable paucity of studies examining first lifetime suicide attempts prospectively is largely due to the formidable challenges in collecting longitudinal data on this low base rate behavior in the general population. And yet, prospective analyses are necessary to

* Corresponding author.

E-mail addresses: zmtrout@email.wm.edu (Z.M. Trout), evelyn_hernandez@brown.edu (E.M. Hernandez), ekleiman@fas.harvard.edu (E.M. Kleiman), rtliupsych@gmail.com (R.T. Liu).

elucidate the temporal nature of the relation between suicide attempts and related risk factors (i.e., to distinguish predictors from correlates). One solution to this challenge is to examine first lifetime suicide attempts within a sample that has been identified as being at high risk for suicidality, such as substance users (Borges et al., 2000; Wilcox et al., 2004).

The present study therefore sought to examine prospective predictors of first lifetime suicide attempts in a large sample of adults receiving treatment for substance use problems. We evaluated sociodemographic characteristics, physical and mental health indicators, substance use characteristics, and early adversity in the form of childhood abuse as potential risk factors. Specifically, and based on prior research documenting associations with suicidality more generally, the current investigation focused particularly on gender (Nock et al., 2008), limitations in physical health functioning (Kaplan et al., 2007), mental health treatment use (Luoma et al., 2002), depression (Nock et al., 2009), suicidal ideation (Brown et al., 2000), intravenous drug use (Cheek et al., 2015; Liu et al., 2014), polysubstance use (Borges et al., 2000; Lynskey et al., 2006; Smith et al., 2011), childhood physical abuse (Norman et al., 2012), and childhood sexual abuse (Maniglio, 2011) as potential risk factors for first lifetime suicide attempts.

2. Methods

2.1. Participants and procedures

Data for the current study were drawn from the National Treatment Improvement Evaluation Study (NTIES; Gerstein et al., 1997), a large, five-year (1992–1997), multi-site study of addiction treatment programs receiving public funding in the United States. The NTIES study includes 4526 clients who completed all intake, treatment discharge, and follow-up interviews, and all participants provided informed consent following an explanation of study procedures. Participants were recruited from 78 treatment programs, and data were collected by the National Opinion Research Center (NORC) at the University of Chicago with assistance from Research Triangle Institute, Research Triangle Park, NC. While the sample is generally comparable to those of other large-scale treatment follow-up studies (e.g., in terms of distributions by gender, education, prior treatment experience), NTIES contains higher proportions of minority participants, specifically African-Americans and Latinos (Gerstein et al., 1997; Gerstein and Johnson, 2000). The sample for the present study consisted of a subset of individuals ($n = 3518$) who reported no lifetime history of suicide attempts at the intake assessment. Participants were 24.0% female, 30.4% Caucasian, and the mean age was 31.68 ($SD = 8.74$). Approximately 20.0% of participants were currently married, 63.1% had never been married, and 16.9% reported being divorced. Lastly, participants had completed an average of 11.24 years of school ($SD = 1.97$).

Data were collected at treatment intake, treatment exit, and one year following completion of treatment. At each time-point participants completed structured, computer-assisted, study-specific survey protocols administered by trained NTIES staff. Of relevance to this study, participants reported on sociodemographic characteristics, indices of physical health functioning and mental health, lifetime substance use characteristics, lifetime history of childhood abuse, and lifetime history of suicide attempts at the intake assessment. At each follow-up, participants reported on the occurrence of suicide attempts since the prior assessment. All procedures were approved by the Institutional Review Board of the Ann Arbor VA Medical Center, and carried out in accordance with the ethical principles outlined in the Third Revision of the Declaration of Helsinki.

2.2. Measures

2.2.1. Suicide attempts

A suicide attempt has been defined as any “self-inflicted, potentially injurious behavior with a non-fatal outcome for which there is evidence (either explicit or implicit) of intent to die (Silverman et al., 2007).” At treatment intake, lifetime history of attempted suicide was assessed with the question, “Have you ever attempted suicide?” This question was used to exclude individuals with a prior attempt history at the time of intake. At each follow-up, prospective suicide attempts were assessed with the question, “Since [prior assessment], have you attempted suicide?”

2.2.2. Sociodemographic characteristics

At treatment intake, participants reported on their gender, age, and race/ethnicity, as well as their highest completed grade or year of education (i.e., response options ranged on a scale from “6th grade or lower” to “4 years of college/technical school or more”), and their marital status (i.e., currently married, never married, or currently divorced).

2.2.3. Physical health functioning and mental health indices

The presence of health-related work impairment at intake was assessed with the question, “Right now, how much does your health limit the kind of work you can do?” Responses were on a three-point Likert scale (i.e., “not at all,” “somewhat,” “very much”). To assess lifetime history of depressive symptoms, participants were asked whether they had ever experienced a period of at least two weeks when they felt: (1) very sad or depressed, or (2) had lost interest and pleasure in things they used to care about; following other studies that have operationalized depressive symptoms using these data (Bohnert et al., 2011) individuals endorsing either of these items were classified as having a lifetime history of depressive symptoms. History of suicidal ideation was assessed with the question, “Have you ever thought seriously about committing suicide?” and a history of inpatient or outpatient psychiatric treatment was assessed with the following two items: “Have you ever stayed somewhere for at least 24 h for professional treatment of problems with your emotions, nerves, or mental health?” and “Have you ever received out-patient treatment for problems with your emotions, nerves, or mental health?”

2.2.4. Substance use characteristics

Two characteristics of substance use were assessed in the current study, lifetime injection drug use history and polysubstance use. To measure lifetime injection drug use history, participants were asked “Have you ever, even one time, used a needle to inject drugs to get high or for other non-medical effects?” A count variable for lifetime polysubstance use was generated by summing positive responses to items asking whether participants had ever tried drugs within twelve categories of substances: inhalants, marijuana/hashish, crack, cocaine, PCP/angel dust, hallucinogens, heroin, illegal methadone, other narcotics, illegal uppers, other downers, and any other drugs besides alcohol.

2.2.5. Childhood abuse history

Childhood physical abuse was assessed with an item asking whether participants were attacked, seriously hit, or beaten before the age of 18 years old. Childhood sexual abuse was assessed with an item asking whether participants were made to have vaginal, oral, or anal sex against their will before the age of 18 years old.

2.3. Data analyses

Spearman and Pearson correlations were calculated to examine

Table 1
Correlations between study variables.

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Sex	–										
2. Years of education at baseline	0.028 ^a	–									
3. Marital Status	–0.006	–0.008	–								
4. Health-related work impairment	0.013	–0.067 ^c	–0.021	–							
5. History of psychiatric service use	0.053 ^c	0.031 ^a	–0.048 ^b	0.104 ^c	–						
6. History of depressive symptoms	0.055 ^c	0.014	–0.011	0.092 ^c	0.183 ^c	–					
7. History of suicidal ideation	0.110 ^c	0.027	–0.013	0.087 ^c	0.136 ^c	0.219 ^c	–				
8. History of intravenous drug use	–0.016	–0.005	–0.064 ^c	0.131 ^c	0.058 ^c	0.095 ^c	0.068 ^c	–			
9. Polysubstance use	–0.046 ^b	0.056 ^c	–0.033 ^a	0.073 ^c	0.100 ^c	0.190 ^c	0.185 ^c	0.526 ^c	–		
10. Childhood physical abuse	–0.148 ^c	–0.100 ^c	–0.006	0.018	0.067 ^c	0.095 ^c	0.082 ^c	0.031 ^a	0.096 ^c	–	
11. Childhood sexual abuse	0.236 ^c	0.002	–0.008	0.042 ^b	0.090 ^c	0.086 ^c	0.124 ^c	0.037 ^b	0.062 ^c	0.078 ^c	–
12. Suicide attempt between baseline and follow up assessment	0.037 ^a	–0.021	–0.001	0.069 ^c	0.052 ^b	0.038 ^b	0.111 ^c	–0.007	0.011	0.043 ^a	0.039 ^a

^a $p < 0.05$, ^b $p < 0.01$, ^c $p < 0.001$.

Note. Spearman correlations are reported for: sex, marital status, history of psychiatric service use, history of depressive symptoms, history of suicidal ideation, history of intravenous drug use, childhood physical abuse, childhood sexual abuse, and suicide attempt between baseline and follow up assessment; and Pearson correlations are reported for: years of education at baseline, health-related work impairment, and polysubstance use.

associations between the study variables of interest and suicide attempts reported between the baseline and follow-up visits. A series of univariate logistic regression analyses were conducted, with prospective suicide attempts as the criterion variable, and with each sociodemographic (i.e., age, education, sex, race/ethnicity, and marital status), physical health functioning, mental health (i.e., psychiatric treatment utilization, depressive symptoms history, and suicidal ideation history), substance use (i.e., history of intravenous substance use, and history of polysubstance use), and childhood abuse (i.e., childhood physical abuse and childhood sexual abuse) predictor assessed individually. All significant predictors at $p < 0.05$ were included in a final multivariate logistic regression model with prospective suicide attempts as the criterion variable.

3. Results

3.1. Preliminary analyses

Correlations among the primary study variables are presented in Table 1. Prospectively occurring suicide attempts were correlated with sex, baseline health-related work impairment, history of psychiatric service use, history of depressive symptoms, history of suicidal ideation, childhood physical abuse, and childhood sexual abuse. Approximately 110 (3.1%) of the participants experienced their first lifetime suicide attempt within the longitudinal follow-up phase of the study. Additional descriptive statistics (i.e., frequency for each level of categorical variables, and means and standard deviations of continuous variables) are displayed in Table 2. In total, 80% of respondents completed the follow-up assessment at treatment exit, and 82% completed the follow-up assessment one year post treatment discharge. A series of independent-samples t -tests and χ^2 tests was conducted to assess potential differences between those who attrited from the study and those who completed all follow-ups on demographic and baseline study variables (i.e., gender, ethnicity, marital status, as well as history of: mental health treatment, depression, suicidal ideation, injection drug use, childhood physical abuse, and childhood sexual abuse). No differences were observed between those who remained in the study and those who attrited ($ps > 0.05$).

3.2. Univariate analyses

The results of univariate analyses prospectively predicting first lifetime suicide attempt are presented in Table 2. Females had 57% higher odds of this outcome than their male counterparts. Health-

related work impairment was also prospectively associated with 61% greater odds of first lifetime of suicide attempts. Additionally, history of psychiatric inpatient or outpatient service utilization, depressive symptoms, and suicidal ideation were each associated with greater odds of this outcome. Finally, history of childhood physical abuse and childhood sexual abuse were individually predictive of greater odds of first lifetime suicide attempts.

3.3. Multivariate analysis

In the multivariate logistic regression analysis prospectively predicting first lifetime suicide attempt, sex, health-related work impairment, psychiatric service utilization, history of depressive symptoms, suicidal ideation history, childhood physical abuse, and childhood sexual abuse were entered simultaneously as predictor variables. Of these predictors, only health-related work impairment, history of suicidal ideation, and childhood physical abuse remained significantly associated with greater odds of prospective first lifetime suicide attempts (Cohen and Cohen, 1983; Tzelgov and Henik, 1991).¹ These results are detailed in Table 3. The final multivariate model has a Nagelkerke R² value of 0.07 and $\chi^2(7) = 57.00$, $p < 0.001$.

4. Discussion

The goal of the present study was to prospectively examine risk factors specific to first lifetime suicide attempts in a large, high-risk sample (i.e., substance users). We found that physical health-related work impairment, history of suicidal ideation, and childhood physical abuse were each uniquely associated with the first occurrence of a suicide attempt. This study fills an important gap in the empirical literature on suicide; to date, there is a paucity of longitudinal studies on risk factors for first lifetime attempts, with the vast majority of prior studies involving recurrent attempts. However, prior research highlights the necessity of examining the

¹ A suppressor effect was observed for depressive symptoms. That is, it was positively associated with prospective first lifetime suicide attempts at the univariate level, but was negatively associated with this outcome in the multivariate model. Given this finding, the multivariate analysis was repeated with this variable excluded (for more details regarding suppressor effects and methods for addressing them, see Cohen and Cohen, 1983; Tzelgov and Henik, 1991), and the results remained essentially unchanged. Additionally, when the original multivariate analysis was repeated with suicidal ideation excluded, such that depressive symptoms retained their positive association with prospective first lifetime suicide attempts, depressive symptoms remained a non-significant predictor of this outcome.

Table 2
Descriptive statistics and univariate analyses prospectively predicting first lifetime suicide attempt.

	%/mean (SD)	b	SE b	Wald	OR	95% CI	p
Racial minority	69.6%	0.11	0.22	0.27	1.12	0.73–1.70	0.605
Sex (female)	24.0%	0.45	0.21	4.68	1.57	1.04–2.35	0.031
Age (years)	31.68 (8.74)	−0.02	0.01	2.29	0.98	0.96–1.01	0.130
Years of education at baseline	11.24 (1.97)	−0.07	0.05	2.08	0.93	0.85–1.03	0.149
Marital status							
Divorced	16.9%	0.02	0.33	<0.01	1.02	0.54–1.92	0.963
Never married	63.1%	0.07	0.25	0.08	1.07	0.65–1.76	0.782
Married (reference)	20.0%	—	—	—	1.00	—	—
Health-related work impairment	1.38 (0.66)	0.48	0.12	14.86	1.61	1.26–2.05	<0.001
History of psychiatric service use	17.2%	0.66	0.22	9.29	1.94	1.27–2.96	0.002
History of depressive symptoms	62.6%	0.48	0.22	4.92	1.62	1.06–2.48	0.027
History of suicidal ideation	25.7%	1.22	0.20	39.04	3.38	2.31–4.96	<0.001
History of intravenous drug use	32.8%	−0.09	0.21	0.18	0.92	0.61–1.38	0.672
Polysubstance use	4.16 (2.65)	0.02	0.04	0.25	1.02	0.95–1.09	0.614
Childhood physical abuse	31.3%	0.51	0.21	6.13	1.67	1.13–2.51	0.013
Childhood sexual abuse	6.5%	0.68	0.30	5.03	1.98	1.09–3.58	0.025

Note. Each row represents an individual logistic regression analysis.

Table 3
Multivariate analysis prospectively predicting first lifetime suicide attempt.

	b	SE b	Wald	OR	95% CI	p
Sex (female)	0.41	0.24	2.91	1.50	0.94–2.39	0.088
Health-related work impairment	0.37	0.13	7.41	1.44	1.12–1.88	0.006
History of psychiatric service use	0.37	0.24	2.29	1.44	0.90–2.32	0.130
History of depressive symptoms	−0.08	0.24	0.10	0.93	0.58–1.49	0.750
History of suicidal ideation	1.13	0.22	26.16	3.08	2.00–4.74	<0.001
Childhood physical abuse	0.44	0.22	3.94	1.55	1.01–2.37	0.047
Childhood sexual abuse	0.17	0.33	0.26	1.19	0.62–2.28	0.610

first lifetime occurrence of this behavior, as first attempts are often followed by subsequent attempts of increasing frequency and severity (Goldston et al., 2015), with some researchers suggesting that the process of risk may change over the course of first and subsequent attempts (Beck, 1996; Joiner, 2005; Neeleman et al., 2004; Van Orden et al., 2010; Wong et al., 2008).

While focusing on prospective first lifetime attempts specifically within an at-risk sample (i.e., substance users; Borges et al., 2000; Harris and Barraclough, 1997; Wilcox et al., 2004) facilitates the study of a low base rate event, it is also of clinical importance. That is, despite the strong association between substance use and suicidality, it remains difficult to identify which individuals within this at-risk population will make an attempt, as the majority of substance users never attempt suicide, and few studies have examined risk specific to first attempts rather than repeat attempts or suicidality more broadly. This study is therefore rare and instructive in its prospective evaluation of risk for first attempts among substance users. The findings provide an essential first step in understanding prospective predictors of first lifetime suicide attempts within this at-risk sample and better informing treatment and prevention efforts.

It is interesting to note that, although histories of both depression and suicidal ideation predicted first attempts at the univariate level, only suicidal ideation remained significant at the multivariate level after accounting for the effects of other predictors. Although this finding may initially appear to contradict the well-established link between depression and suicidality, it is in line with prior research demonstrating that depression, among many other well-known risk factors for suicide, is more strongly related to suicidal ideation than to suicide attempts (Klonsky and May 2014). Furthermore, findings from the current study suggest that ideation may have a greater role than depression in accounting for risk for first lifetime attempts, a finding of potential prognostic importance

within clinical contexts, given the frequent co-occurrence of depression and suicidal ideation (Nock et al., 2009).

Of note, prior psychiatric service utilization was relatively uncommon in this study (17.2%), and it was not significantly predictive of first lifetime suicide attempts in the multivariate analysis. This finding is consistent with previous research reporting a high proportion of suicide attempters with no prior history of contact with mental health providers (Bruffaerts et al., 2011). This finding implies that, even in a sample traditionally recognized as being at risk for suicidality, there is substantial underutilization of preventive services from mental health specialists. Given the aforementioned increasingly severe course of suicidality (Goldston et al., 2015), this finding is of particular clinical importance, as preventing the first onset of suicidal behavior may likely hold more promise than preventing its recurrence.

The presence of a physical health affliction limiting an individual's ability to work was also shown to be a significant predictor of first lifetime attempts among this sample. This outcome is consistent with findings that reduced income contributes to suicide risk among substance users (Yuodelis-Flores and Ries, 2015) and that functional limitations contribute to suicide risk within the general population (Kaplan et al., 2007). The present study supports and extends these findings by demonstrating a significant longitudinal association with first lifetime suicide attempts, with physical health-related limitations on work increasing the odds of making a first attempt by 44%. Furthermore, this finding provides indirect support for the interpersonal theory of suicide (Joiner, 2005; Van Orden et al., 2010), which highlights the importance of perceived burdensomeness in contributing to suicidality, as the inability to earn income due to physical health-related limitations likely creates for the perception of being a burden on those who care for and support such individuals financially.

Given the common co-occurrence of various child abuse

subtypes (Finkelhor et al., 2007), the present study helped to clarify the distinct effects of childhood physical and sexual abuse, respectively, by examining each of these subtypes concurrently within a multivariate regression model. Such work is important for determining whether an observed association with suicidal behavior for a childhood abuse subtype is not better accounted for by another frequently co-occurring form of childhood abuse. Consistent with prior research on childhood maltreatment and suicidal behavior (Bohnert et al., 2011; Brent et al., 1999, 1994; Lloyd et al., 2007; Marshall et al., 2013; Roy, 2010), childhood physical abuse and childhood sexual abuse were both significant predictors at the univariate level. However, only childhood physical abuse remained significant when both abuse subtypes were examined concurrently at the multivariate level. These findings suggest that childhood physical abuse may be a stronger prospective predictor of first lifetime suicide attempts, even after accounting for co-occurring childhood sexual abuse. Additional research is necessary to further refine our understanding of the specific characteristics of childhood abuse subtypes most relevant to risk of first attempts. For example, it would be important for future research to consider the specific timing of childhood abuse experiences, with there being growing evidence that this may have a critical role in the development of risk for negative mental health outcomes (McLaughlin et al., 2010) and potential underlying pathophysiology (Lupien et al., 2009; Pechtel et al., 2014).

Despite the strengths of the current study, several limitations should be acknowledged. First, this study used data exclusively from individuals receiving treatment for substance use, and caution should be exercised in generalizing the findings to less severe populations. Indeed, despite substantial evidence for the association between substance use and suicidal behavior in prior research (Nock et al., 2013, 2009), substance use, at least in the form of intravenous drug use and polysubstance use, was not found to be a risk factor for first lifetime attempts in the current study. However, a lack of significance may be explained by the reduced variability of substance use in the current sample; the general severity of substance use in this sample may have reduced the predictive power of associated characteristics. Additionally, individuals in the current sample were receiving psychiatric services at the time of data collection, and thus may differ from individuals with similar presentations who are not in treatment (i.e., community sample). Participants in this study were also predominantly male, reflecting the fact that substance abuse and dependence are more common among men than women (Fillmore et al., 1997; Greenfield et al., 2003). This study adds uniquely to the literature in that past studies of suicide attempts often feature a higher representation of females, as they have been found to be more likely to attempt suicide than males (Centers for Disease Control and Prevention, 2011). Nonetheless, caution should be taken in generalizing the current findings across genders.

Additionally, the current study sheds light on risk factors that serve as more long-standing or distal predictors. This design allows for meaningful evaluation of prospective risk over time, and although distal, long-term predictors of risk are clinically beneficial in identifying populations at risk of attempting suicide (i.e., *who* is at risk), short-term, time-sensitive factors are also important in identifying more immediate risk for suicide attempt (i.e., *when* individuals are at risk), and better informing clinical decisions regarding direct intervention. Ultimately, each of these temporal perspectives should inform clinical treatment in an integrated manner. It is thus important for future research to complement current findings by including an examination of proximal risk factors for first lifetime attempts, thereby informing our understanding of the complex, multi-determined nature of this behavior. Lastly, the current findings are based strictly on brief self-report

measures. Although single-item measures have been found to be valid for assessing suicidality (Desseilles et al., 2012), and such methodology is commonly used among large sample studies, future research employing more precise methodology could provide a more accurate estimate of the association between putative risk factors and suicidal behavior. Reliance on self-report, particularly in response to verbally administered items, also allows for the potential for underreporting, given the tendency to underreport sensitive personal information (Turner et al., 1998). However, there is likely reduced incentive to underreport psychopathology among this particular sample, particularly during the initial assessment at the time of intake, as the participants are already receiving treatment for substance use. Nevertheless, research incorporating a multi-method approach is needed to further a more nuanced understanding of risk across multiple levels of analysis (e.g., self-report, behavioral, and neural).

Despite its limitations, the current study serves an important initial step in examining prospective risk for first lifetime suicide attempts in a large at-risk sample. The current findings suggest future directions for both further research and clinical treatment, which would benefit from considering history of suicidal ideation, functional limitations on work due to physical health concerns, and childhood physical abuse in particular when identifying individuals at heightened risk of making a first suicide attempt.

Footnotes

None.

Contributors

The study was conceived by Zoë Trout and Richard Liu, both of whom were involved in the design of the study as well as interpretation of the data, with input from Evelyn Hernandez and Evan Kleiman. Zoë Trout composed the Introduction, Methods, and Discussion sections of the manuscript, Richard Liu conducted the analyses, Evan Kleiman composed the Results section and constructed the tables, and Evelyn Hernandez prepared the abstract and contributed to the tables. All authors were substantially involved in the editing and revision process and approval of the final manuscript.

Funding/support

Preparation of this manuscript was supported in part by the National Institute of Mental Health of the National Institutes of Health under Award Number R01MH101138. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agency.

Acknowledgements

None.

References

- Beck, A., 1996. *Beyond belief: a theory of modes, personality, and psychopathology*. In: Salkovskis, P. (Ed.), *Frontiers of Cognitive Therapy*. Guildford Press, New York, NY, pp. 1–25.
- Bohnert, A.S.B., Roeder, K.M., Ilgen, M.A., 2011. Suicide attempts and overdoses among adults entering addictions treatment: comparing correlates in a U.S. National study. *Drug Alcohol Depend.* 119, 106–112. <http://dx.doi.org/10.1016/j.drugalcdep.2011.05.032>.
- Borges, G., Walters, E.E., Kessler, R.C., 2000. Associations of substance use, abuse, and dependence with subsequent suicidal behavior. *Am. J. Epidemiol.* 151, 781–789.
- Brent, D.A., Baugher, M., Bridge, J., Chen, T., Chiappetta, L., 1999. Age- and sex-

- related risk factors for adolescent suicide. *J. Am. Acad. Child. Adolesc. Psychiatry* 38, 1497–1505. <http://dx.doi.org/10.1097/00004583-199912000-00010>.
- Brent, D.A., Perper, J.A., Moritz, G., Liotus, L., 1994. Familial risk factors for adolescent suicide: a case-control study. *Acta Psychiatr. Scand.* 89, 52–58. <http://dx.doi.org/10.1111/j.1600-0447.1994.tb01485.x>.
- Brown, G.K., Beck, A.T., Steer, R.A., Grisham, J.R., 2000. Risk factors for suicide in psychiatric outpatients: a 20-year prospective study. *J. Consult. Clin. Psychol.* 68, 371–377.
- Bruffaerts, R., Demyttenaere, K., Hwang, I., Chiu, W.-T., Sampson, N., Kessler, R.C., Alonso, J., Borges, G., de Girolamo, G., de Graaf, R., Florescu, S., Gureje, O., Hu, C., Karam, E.G., Kawakami, N., Kostyuchenko, S., Kovess-Masfety, V., Lee, S., Levinson, D., Matschinger, H., Posada-Villa, J., Sagar, R., Scott, K.M., Stein, D.J., Tomov, T., Viana, M.C., Nock, M.K., 2011. Treatment of suicidal people around the world. *Br. J. Psychiatry* 199, 64–70. <http://dx.doi.org/10.1192/bjp.bp.110.084129>.
- Centers for Disease Control and Prevention, 2011. *Web-based Injury Statistics Query and Reporting System (WISQARS)*. Centers for Disease Control and Prevention, Atlanta, GA.
- Cheek, S.M., Nestor, B.A., Liu, R.T., 2015. Substance use and suicidality: specificity of substance use by injection to suicide attempts in a nationally representative sample of adults with major depression. *Depress. Anxiety* 33, 541–548. <http://dx.doi.org/10.1002/da.22407>.
- Clark, D., Fawcett, J., 1992. An empirically based model of suicide risk assessment for patients with affective disorder. In: Jacobs, D. (Ed.), *Suicide and Clinical Practice*. American Psychiatric Press, Washington, DC, pp. 55–73.
- Cohen, J., Cohen, P., 1983. *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences*, second ed. Lawrence Erlbaum Associates, Hillsdale, NJ.
- Curtin, S., Warner, M., Hedegaard, H., 2016. Increase in Suicide in the United States, 1999–2014. NCHS data brief, no 241. Hyattsville, MD.
- Desseilles, M., Perroud, N., Guillaume, S., Jaussent, I., Genty, C., Malafosse, A., Courtet, P., 2012. Is it valid to measure suicidal ideation by depression rating scales? *J. Affect. Disord.* 136, 398–404. <http://dx.doi.org/10.1016/j.jad.2011.11.013>.
- Fillmore, K., Golding, J., Leino, E., Ferrer, H., 1997. Patterns and trends in women's and men's drinking. In: Wilsnack, R., Wilsnack, S. (Eds.), *Gender and Alcohol: Individual and Social Perspectives*. Center of Alcohol Studies, Rutgers University, New Brunswick, NJ, pp. 21–48.
- Finkelhor, D., Ormrod, R.K., Turner, H.A., 2007. Poly-victimization: a neglected component in child victimization. *Child. Abuse Negl.* 31, 7–26. <http://dx.doi.org/10.1016/j.chiabu.2006.06.008>.
- Forman, E.M., Berk, M.S., Henriques, G.R., Brown, G.K., Beck, A.T., 2004. History of multiple suicide attempts as a behavioral marker of severe psychopathology. *Am. J. Psychiatry* 161, 437–443. <http://dx.doi.org/10.1176/appi.ajp.161.3.437>.
- Gerstein, D., Datta, A., Ingels, J., Johnson, R., Rasinski, K., Schildhaus, S., Talley, K., Jordan, K., Phillips, D., Anderson, D., Condelli, W., Collins, J., 1997. *The National Treatment Improvement Evaluation Study (NTIES): Final Report* (Rockville, MD).
- Gerstein, D.R., Johnson, R.A., 2000. Nonresponse and selection bias in treatment follow-up studies. *Subst. Use Misuse* 35, 971–1014.
- Goldston, D.B., Daniel, S.S., Erkanli, A., Heilbron, N., Doyle, O., Weller, B., Sapyta, J., Mayfield, A., Faulkner, M., 2015. Suicide attempts in a longitudinal sample of adolescents followed through adulthood: evidence of escalation. *J. Consult. Clin. Psychol.* 83, 253–264. <http://dx.doi.org/10.1037/a0038657>.
- Goldston, D.B., Daniel, S.S., Reboussin, D.M., Reboussin, B.A., Frazier, P.H., Kelley, A.E., 1999. Suicide attempts among formerly hospitalized adolescents: a prospective naturalistic study of risk during the first 5 years after discharge. *J. Am. Acad. Child. Adolesc. Psychiatry* 38, 660–671. <http://dx.doi.org/10.1097/00004583-199906000-00012>.
- Greenfield, S.F., Manwani, S.G., Nargiso, J.E., 2003. Epidemiology of substance use disorders in women. *Obstet. Gynecol. Clin. North Am.* 30, 413–446.
- Harris, E.C., Barraclough, B., 1997. Suicide as an outcome for mental disorders. A meta-analysis. *Br. J. Psychiatry* 170, 205–228.
- Joiner, T.E., 2005. *Why People Die by Suicide*. Harvard University Press, Cambridge, MA.
- Kaplan, M.S., McFarland, B.H., Huguette, N., Newsom, J.T., 2007. Physical illness, functional limitations, and suicide risk: a population-based study. *Am. J. Orthopsychiatr.* 77, 56–60. <http://dx.doi.org/10.1037/0002-9432.77.1.56>.
- Klonsky, E.D., May, A.M., 2014. Differentiating suicide attempters from suicide ideators: a critical frontier for suicidology research. *Suicide Life Threat Behav.* 44, 1–5. <http://dx.doi.org/10.1111/sltb.12068>.
- Leon, A.C., Friedman, R.A., Sweeney, J.A., Brown, R.P., Mann, J.J., 1990. Statistical issues in the identification of risk factors for suicidal behavior: the application of survival analysis. *Psychiatry Res.* 31, 99–108.
- Liu, R.T., Case, B.G., Spirito, A., 2014. Injection drug use is associated with suicide attempts but not ideation or plans in a sample of adolescents with depressive symptoms. *J. Psychiatr. Res.* 56, 65–71. <http://dx.doi.org/10.1016/j.jpsychires.2014.05.001>.
- Lloyd, J.J., Ricketts, E.P., Havens, J.R., Cornelius, L.J., Bishai, D., Huettner, S., Latkin, C., Strathdee, S.A., 2007. The relationship between lifetime abuse and suicidal ideation in a sample of injection drug users. *J. Psychoact. Drugs* 39, 159–166. <http://dx.doi.org/10.1080/02791072.2007.10399874>.
- Luoma, J.B., Martin, C.E., Pearson, J.L., 2002. Contact with mental health and primary care providers before suicide: a review of the evidence. *Am. J. Psychiatry* 159, 909–916. <http://dx.doi.org/10.1176/appi.ajp.159.6.909>.
- Lupien, S.J., McEwen, B.S., Gunnar, M.R., Heim, C., 2009. Effects of stress throughout the lifespan on the brain, behaviour and cognition. *Nat. Rev. Neurosci.* 10, 434–445. <http://dx.doi.org/10.1038/nrn2639>.
- Lynskey, M.T., Agrawal, A., Bucholz, K.K., Nelson, E.C., Madden, P.A.F., Todorov, A.A., Grant, J.D., Martin, N.G., Heath, A.C., 2006. Subtypes of illicit drug users: a latent class analysis of data from an Australian twin sample. *Twin Res. Hum. Genet.* 9, 523–530. <http://dx.doi.org/10.1375/183242706778024964>.
- Maniglio, R., 2011. The role of child sexual abuse in the etiology of suicide and non-suicidal self-injury. *Acta Psychiatr. Scand.* 124, 30–41. <http://dx.doi.org/10.1111/j.1600-0447.2010.01612.x>.
- Maris, R.W., 1992. The relationship of nonfatal suicide attempts to completed suicides. In: *Assessment and Prediction of Suicide*, pp. 362–380.
- Marshall, B.D.L., Galea, S., Wood, E., Kerr, T., 2013. Longitudinal associations between types of childhood trauma and suicidal behavior among substance users: a cohort study. *Am. J. Public Health* 103, e69–75. <http://dx.doi.org/10.2105/AJPH.2013.301257>.
- McLaughlin, K.A., Green, J.G., 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 II: associations with persistence of DSM-IV disorders. *Arch. Gen. Psychiatry* 67, 124–132. <http://dx.doi.org/10.1001/archgenpsychiatry.2009.187>.
- Neeleman, J., de Graaf, R., Vollebergh, W., 2004. The suicidal process: prospective comparison between early and later stages. *J. Affect. Disord.* 82, 43–52. <http://dx.doi.org/10.1016/j.jad.2003.09.005>.
- Nock, M.K., Borges, G., Bromet, E.J., Cha, C.B., Kessler, R.C., Lee, S., 2008. Suicide and suicidal behavior. *Epidemiol. Rev.* 30, 133–154. <http://dx.doi.org/10.1093/epirev/mxn002>.
- Nock, M.K., Green, J.G., Hwang, I., McLaughlin, K.A., Sampson, N.A., Zaslavsky, A.M., Kessler, R.C., 2013. Prevalence, correlates, and treatment of lifetime suicidal behavior among adolescents: results from the National Comorbidity Survey Replication Adolescent Supplement. *JAMA psychiatry* 70, 300–310. <http://dx.doi.org/10.1001/2013.jamapsychiatry.55>.
- Nock, M.K., Hwang, I., Sampson, N., Kessler, R.C., Angermeyer, M., Beautrais, A., Borges, G., Bromet, E., Bruffaerts, R., de Girolamo, G., de Graaf, R., Florescu, S., Gureje, O., Haro, J.M., Hu, C., Huang, Y., Karam, E.G., Kawakami, N., Kovess, V., Levinson, D., Posada-Villa, J., Sagar, R., Tomov, T., Viana, M.C., 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–e1000123.
- Norman, R.E., Byambaa, M., De, R., Butchart, A., Scott, J., Vos, T., 2012. The long-term health consequences of child physical abuse, emotional abuse, and neglect: a systematic review and meta-analysis. *PLoS Med.* 9, e1001349. <http://dx.doi.org/10.1371/journal.pmed.1001349>.
- Pechtel, P., Lyons-Ruth, K., Anderson, C.M., Teicher, M.H., 2014. Sensitive periods of amygdala development: the role of maltreatment in preadolescence. *Neuroimage* 97, 236–244. <http://dx.doi.org/10.1016/j.neuroimage.2014.04.025>.
- Roy, A., 2010. Risk factors for attempting suicide in heroin addicts. *Suicide Life Threat Behav.* 40, 416–420. <http://dx.doi.org/10.1521/suli.2010.40.4.416>.
- Rudd, M.D., Joiner, T., Rajab, M.H., 1996. Relationships among suicide ideators, attempters, and multiple attempters in a young-adult sample. *J. Abnorm. Psychol.* 105, 541–550.
- Silverman, M.M., Berman, A.L., Sanddal, N.D., O'Carroll, P.W., Joiner, T.E., 2007. Rebuilding the Tower of Babel: a revised nomenclature for the study of suicide and suicidal behaviors: part II: suicide-related ideations, communications and behaviors. *Suicide Life Threat Behav.* 37, 264–277. <http://dx.doi.org/10.1521/suli.2007.37.3.264>.
- Smith, G.W., Farrell, M., Bunting, B.P., Houston, J.E., Shevlin, M., 2011. Patterns of polydrug use in Great Britain: findings from a national household population survey. *Drug Alcohol Depend.* 113, 222–228. <http://dx.doi.org/10.1016/j.drugalcdep.2010.08.010>.
- Turner, C.F., Ku, L., Rogers, S.M., Lindberg, L.D., Pleck, J.H., 1998. Adolescent sexual behavior, drug use, and violence: increased reporting with computer survey technology. *Science* 280, 867–873 (280), 867–873. <http://dx.doi.org/10.1126/science.280.5365.867>.
- Tzelgov, J., Henik, A., 1991. Suppression situations in psychological research: definitions, implications, and applications. *Psychol. Bull.* 109, 524–536. <http://dx.doi.org/10.1037/0033-2909.109.3.524>.
- Van Orden, K.A., Witte, T.K., Cukrowicz, K.C., Braithwaite, S.R., Selby, E.A., Joiner, T.E., 2010. The interpersonal theory of suicide. *Psychol. Rev.* 117, 575–600. <http://dx.doi.org/10.1037/a0018697>.
- Wilcox, H.C., Conner, K.R., Caine, E.D., 2004. Association of alcohol and drug use disorders and completed suicide: an empirical review of cohort studies. *Drug Alcohol Depend.* 76 (Suppl. 1), S11–S19. <http://dx.doi.org/10.1016/j.drugalcdep.2004.08.003>.
- Wong, J.P.S., Stewart, S.M., Claassen, C., Lee, P.W.H., Rao, U., Lam, T.H., 2008. Repeat suicide attempts in Hong Kong community adolescents. *Soc. Sci. Med.* 66, 232–241. <http://dx.doi.org/10.1016/j.socscimed.2007.08.031>.
- Yuodelis-Flores, C., Ries, R.K., 2015. Addiction and suicide: a review. *Am. J. Addict.* 24, 98–104. <http://dx.doi.org/10.1111/ajad.12185>.