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**Predicting 3-month risk for adolescent suicide attempts
among pediatric emergency department patients**

Running head: Predicting 3-month risk for suicide attempts

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Background: The incidence of adolescent suicide is rising in the U.S., yet we have limited information regarding short-term prediction of suicide attempts. Our aim was to identify predictors of suicide attempts within 3-months of an emergency department (ED) visit.

Methods: Adolescents, ages 12 – 17, seeking health care at 13 pediatric EDs (Pediatric Emergency Care Applied Research Network) and one Indian Health Service Hospital in the U.S. were consecutively recruited. Among approached patients, 6,654 (62%) completed a suicide risk survey. A subset of participants (n = 2,902) was assigned to a 3-month telephone follow-up, and 2,104 participants completed this follow-up (72% retention). Our primary outcome was a suicide attempt between the ED visit and 3-month follow-up. **Results:** One hundred four adolescents (4.9%) made a suicide attempt between enrollment and 3-month follow-up. A large number of baseline predictors of suicide attempt were identified in bivariate analyses. The final multivariable model for the full sample included the presence of suicidal ideation during the past week, lifetime severity of suicidal ideation, lifetime history of suicidal behavior, and school connectedness. For the subgroup of adolescents who did *not* report recent suicidal ideation at baseline, the final model included only lifetime severity of suicidal ideation and social connectedness. Among males, the final model included only lifetime severity of suicidal ideation and past week suicidal ideation. For females, the final model included past week suicidal ideation, lifetime severity of suicidal ideation, number of past-year nonsuicidal self-injury (NSSI) incidents, and social connectedness. **Conclusions:** Results indicate that the key risk factors for adolescent suicide attempts differ for subgroups of adolescents defined by sex and whether or not they report recent suicidal thoughts. Results also point to the importance of school and social connectedness as protective factors against suicide attempts. **Keywords:** Suicide risk; adolescence; suicide attempt; social connectedness; emergency department.

Introduction

Suicide rates among adolescents in the United States continue to rise (Centers for Disease Control and Prevention, 2019), despite a downturn in the incidence worldwide (World Health Organization, 2017). Moreover, 5.1% of male and 9.3% of female high school students in the U.S. report a suicide attempt (SA) in the past year (Kann et al., 2018).

Risk factors for adolescent SAs span demographic, clinical, and social domains, meaning that the risk profiles for suicidal adolescents are multidimensional and heterogeneous. Female adolescents and adolescents who self-identify as LGBTQ are at increased risk (Kann et al., 2018; O'Brien, Putney, Hebert, Falk, & Aguinaldo, 2016). Previous history of SA and suicidal ideation (SI) (Nock et al., 2013), presence, persistence, and severity of SI (Czyz & King, 2015), and nonsuicidal self-injury (NSSI) (e.g., Asarnow et al., 2011) have all been reported to be predictors of suicide attempts. Similarly, psychiatric symptom, such as depression and hopelessness, are consistent correlates and predictors of SA (King, Ewell Foster, & Rogalski, 2013), and symptoms of distress (e.g., anxiety and agitation) and impulse control (e.g., aggression, substance abuse) have emerged as the strongest predictors of attempts among adolescents who report ideation (Nock et al., 2013). Sleep disturbance has been reported as an imminent risk factor for SA and death by suicide (e.g., Koyawala, Stevens, McBee-Strayer, Cannon, & Bridge, 2015).

Interpersonal factors such as low social connectedness also have been related to the likelihood of suicidal ideation and behavior (Czyz, Liu, & King, 2012; Gunn, Goldstein, & Gager, 2018). Bully victims and perpetrators have reported an increased incidence of SAs (Borowsky, Taliaferro, & McMorris, 2013), and physical and sexual abuse have been prospectively associated with SAs (Castellví et al., 2017). Interpersonal conflicts and losses, and legal/disciplinary problems are acute stressors associated with SAs and suicide (e.g., Gould, Fisher, Parides, Flory, & Shaffer, 1996).

Given this heterogeneity of suicide risk factors, it is challenging for healthcare providers to assess level of risk and for intervention and prevention specialists to identify potent and potentially modifiable targets for risk reduction. Moreover, extant research has focused on single risk factors (Franklin et al., 2017), despite the growing recognition of the multidimensional nature of suicidal risk and current clinical practice, which attempts to integrate available information about multiple risk factors. Consequently, further research that takes into account multiple risk factors is sorely needed.

The challenge of suicide risk assessment and identification of potent prevention targets is exacerbated for males and for adolescents who conceal or deny their suicidal thoughts. Adolescent females are more likely than males to report SI and behavior (Kann et al., 2018) and to obtain mental health services (Rhodes et al., 2012); yet the rate of suicide is much higher

among adolescent males than females (Centers for Disease Control and Prevention, 2019). An improved understanding of the short-term risk factors for SAs among males may enable us to improve risk recognition and prevention. Similarly, although many of the most commonly used screening tools assess SI (e.g., Horowitz et al., 2012), recent SI is not a significant predictor of SAs for all subgroups of adolescents (e.g., King, Jiang, Czyz, & Kerr, 2014).

Our objective was to examine predictors of SAs during the 3-months following adolescents' ED visits in the Study One dataset of the Emergency Department Screening for Teens at Risk for Suicide (ED-STARS) Study. This large-scale study was implemented in collaboration with the Pediatric Emergency Care Applied Research Network (PECARN). Its primary aim was to develop the Computerized Adaptive Screen for Suicidal Youth (CASSY), a relatively brief suicide risk screen with the potential for widespread implementation in emergency departments (King et al., under review). Because our baseline assessment included a broad array of previously identified risk factors for SAs, this study also enabled us to examine predictors of SAs following ED visits using multi-variable models.

We examined predictors in the total follow-up sample and in subsamples defined by sex and the presence of recent SI. We hypothesized that predictors of SAs would include indicators of SI and behavior (e.g., past week suicidal ideation, lifetime history of suicidal behavior) and, reflecting a different domain, one or more interpersonal risk factors (e.g., peer victimization, low social or school connectedness). We expect interpersonal factors to be important in light of longitudinal studies (e.g., Gunn et al., 2018) and theoretical formulations about the salience of interpersonal processes to suicidal risk (e.g., Durkheim, 1897; Joiner, 2005).

Methods

Participants

Adolescents (ages 12-17) were recruited from 13 EDs in PECARN (June 2015-July 2016) and the Whiteriver Indian Health Service (IHS) Hospital, which serves the White Mountain Apache Tribe (November 2015–April 2017). Among 10,677 approached adolescents, 6,654 (62%) completed a suicide risk survey. A subset of patients (n=2,902, 45%) enriched for suicide risk (Figure 1 and Appendix S1 in the Supporting Information) was randomly assigned to a 3-month telephone follow-up; 2,104 participants completed this follow-up (72% retention). The sample

included 1,327 females (63.1%) and 777 males (36.9%) with a mean age of 15.1 years (SD=1.6). Additional demographic information is in Appendix S2.

Procedure

At PECARN sites, adolescents were recruited during screening shifts that were randomly selected for each site from time periods when research coordinators were on site (primarily afternoons and evenings due to higher volume of adolescent patients). At the IHS Hospital, recruitment was ED-linked with a daily admission review and IRB permission to contact at home for recruitment. Exclusion criteria were: previous study enrollment, ward of State, non-English speaking adolescents (non-English speaking parents enrolled), medically unstable, and severe cognitive impairment.

Adolescents completed a self-report survey assessing demographics and suicide risk factors in the ED (except for IHS site). Participants were included if adolescent and parent (n=1,799, 85.5%), adolescent only (n=183, 8.7%) or parent only (n=122, 5.8%) follow-up interviews were conducted. Follow-up informant (parent or youth versus both) was unrelated to participants' lifetime histories of suicidal ideation and behavior, and to the suicide attempt outcome. Participants with only youth or only parent follow-up interviews were, however, older than those with both interviews. ($p < .001$, Kruskal-Wallis test.). Written informed parent/guardian consent and adolescent assent were obtained, in addition to IRB approval from all sites. Adolescents who turned 18 prior to follow-up were reconsented.

Measures

This study incorporated adolescent data from the baseline self-report survey (92 primary, 27 follow-up questions; details in Appendix S3). Due to ED space and time constraints, a concern for respondent burden, and a need to assess a wide range of risk factors to develop CASSY algorithms, brief, adapted versions of standardized scales were used for many risk factors, all of which had been previously associated with adolescent SAs.

An adapted Columbia-Suicide Severity Rating Scale (CSSRS; Posner et al., 2008) was used to assess history of SAs at baseline and SAs between baseline and 3-month follow-up. SA was defined as a positive response to either of two questions: "In the past 3 months, have you

made a suicide attempt?” “In the past 3 months, have you tried to harm yourself because you were at least partly trying to end your life?” Past week SI was assessed with question #3 from the Ask Suicide-Screening Questions (ASQ; Horowitz et al., 2012): “In the past week, have you been having thoughts about killing yourself?” In defining subgroups of adolescents who did and did not report recent SI, we removed participants who selected “unknown” or did not respond to the question.

Additional suicide risk factors assessed at baseline included lifetime severity of SI and suicidal behavior, suicidal rumination, NSSI, depression, hopelessness, homicidal ideation, anxiety, agitation, sleep disturbance, adaptive functioning, alcohol and drug use, impulsivity, aggression, connectedness (family, school, social), peer victimization, physical and sexual abuse, negative life events, and identification as a sexual or gender minority.

Statistical analysis

Univariable associations between baseline demographic and clinical risk factors and SAs at 3-months were determined, and predictors with significant associations ($p < 0.1$) were candidates for inclusion in multivariable logistic regression models (Hosmer, Lemeshow, & Sturdivant, 2013). In stage one, demographics and variables pertaining to suicidal thoughts, suicidal behaviors, and NSSI were added to the model in a stepwise fashion; the model with the lowest Akaike Information Criterion (AIC) was carried forward. Remaining candidates, including all other clinical risk factors examined (see Table 1), were considered using forward stepwise selection. In the final stage, variables were dropped using backward selection ($p > 0.05$), such that all variables were statistically significant in the final model.

To account for the oversampling of higher risk groups for follow-up, a weight equal to the inverse of the sampling probability of each of the three risk groups was applied in analyses. For categorical variables, the reference level was ‘No’, ‘None’, or equivalent, when possible. White and non-Hispanic were used as reference populations. When model separation became an issue due to low counts, categories of predictor variables were combined. For each final model, we calculated the predictive performance of the model as the Area Under the Curve (AUC), with a 95% confidence interval (CI). As a sensitivity analysis, we conducted a 10-fold cross-validation of the final model for the full sample. Statistical analyses were performed using SAS software version 9.4 (SAS Institute Inc, 2013).

Results

Retention

Retention was greater for males than females (76.0% versus 70.6%; $p=.002$) and varied by race ($p < .001$) and ethnicity ($p < .001$), with higher retention rates for Whites (75.0%) and multi-racial youth (79.5%) than other races (range from 60.4-72.5%), and for non-Latinx than Latinx ethnicity (75.5% vs. 65.8%). Higher parental education was also associated with greater retention (p 's $< .001$). The retention rates for mothers and fathers, respectively, were: high school or less (67.9%, 68.0%), some college/technical (73.6%, 73.0%), college graduate (77.4%, 81.6%), unknown/not applicable (65.0%, 70.0%).

Descriptive statistics: suicidal thoughts, suicide attempts, and NSSI

At baseline, 1,090 adolescents (51.9%) reported a lifetime history of SI and 827 adolescents (39.7%) reported a lifetime history of suicidal behavior, including actual, aborted, and interrupted attempts. The mean number of lifetime SAs reported was 1.25 (SD=6.29; Median=0). Regarding number of past-year NSSI incidents, 1378 adolescents (65.7%) reported none, 339 adolescents (16.2%) reported 1-2, 121 (5.8%) reported 3-4, and 261 (12.4%) reported 5 or more (data missing, $n=5$). A SA between ED visit and 3-month follow-up, was reported for 104 adolescents (4.9%; 84 females, 6.3%; 20 males, 2.6%). There was one suicide death, which was included as a SA in analyses.

Spearman correlations among risk factors are reported in Tables S1, S2, S3, and S4. As examples of the strength of correlations, lifetime severity of SI was highly positively correlated with lifetime history of suicidal behavior (.70, $p < .001$) and moderately positively correlated with number of NSSI incidents during the past 12 months (.53, $p < .001$). Social and school connectedness were moderately positively correlated (.47, $p < .001$).

Site differences were identified in suicide risk predictors and outcomes. This information is provided in Tables S5, S6, S7, S8, and S9.

Predictors of suicide attempt during 3 months following ED visit

Univariable associations with suicide attempts (See Table 1). Sex, sexual and gender minority

status, and all of the examined psychosocial and clinical characteristics predicted SAs at 3-month follow-up.

Multivariable regression models. The final multivariable model for the total sample included past week SI (yes/no), lifetime severity of SI, history of suicidal behavior, and school connectedness (AUC=0.86, 95% CI: 0.82-0.89; Table 2). In the sensitivity analysis, the ORs, (CIs), and AUCs fitted from each of the 10 subsamples (each approximately 90% of full cohort) were similar, with a median AUC of 0.87 and IQR 0.84-0.90.

To examine replicability of this model across sites, we examined a model including site and the interaction between site and the final model risk score (fitted logit values for each patient). The interaction was non-significant ($p=0.55$), suggesting that the relationship between the predicted risk and SA outcome does not differ by site. Site was also unrelated to SA risk ($p=0.70$) after taking into account risk factors.

For adolescents *without* past week SI at baseline, the final model included lifetime SI severity and social connectedness (AUC =0.84, 95% CI: 0.78-0.90; Table 3). For adolescents *with* recent SI at baseline, the final model included family public assistance, suicidal rumination (repetitive thoughts) and social connectedness (AUC=0.69, 95% CI: 0.62-0.76; Table 3).

For male adolescents, the final model included past week SI and lifetime SI severity (AUC=0.89, 95% CI: 0.85-0.94; Table 4). For female adolescents, the model included past week SI, number of NSSI incidents during the past 12 months, and social connectedness (AUC=0.84, 95% CI: 0.81–0.87).

Discussion

In this prospective study of adolescent ED patients, we identified baseline predictors of SAs across a 3-month period of follow-up using multivariable models for the entire sample, and for subsamples defined by sex and the presence or absence of recent suicidal thoughts. These subgroups included two particularly vulnerable groups: adolescent males who receive fewer mental health services (Rhodes et al., 2012) and have a much higher rate of suicide than

adolescent females (Centers for Disease Control and Prevention, 2019), and adolescents who do not report recent suicidal thoughts, which challenges risk recognition.

Study results replicate the importance of previously identified suicide risk factors. Every clinical risk factor included in our baseline suicide risk survey was associated significantly with the likelihood of a SA between the baseline ED visit and 3-month follow-up. Concordant with hypotheses, past week SI, lifetime severity of SI, lifetime history of suicidal behavior, and an interpersonal factor, school connectedness, emerged as the key predictors of attempts for the total sample. Moreover, emphasizing the importance of connectedness to our understanding of risk, either school or social connectedness emerged as a key predictor for three of the four subgroups of adolescents studied. Contrary to hypotheses, however, the model for males included only two factors: recent SI and lifetime severity of SI.

Lifetime severity of SI was found to be a key predictor for the overall sample and three of the four subgroups of adolescents examined. This finding is consistent with previous studies indicating that adolescents who develop a suicide plan are more likely to make an attempt than ideators without a plan (Nock et al., 2013), that intensity of SI predicts SAs (Peters, Mereish, Solomon, Spirito, & Yen, 2018), and that “worst ever” SI is as strong a predictor of suicide risk as current ideation (Beck, Brown, Steer, Dahlsgaard, & Grisham, 1999). Similarly, the importance of lifetime history of suicidal behavior is consistent with studies showing that increased risk for subsequent self-harm and death by suicide persists for years after initially seeking health care for self-harm (Finkelstein et al., 2015).

School or social connectedness emerged as a key predictor for several subgroups of adolescents, which is consistent with a growing body of research (Gunn et al., 2018) indicating that higher levels of school connectedness were associated with less suicidal behavior in general school samples, high risk adolescents, and sexual minority adolescents (Marraccini & Brier, 2017). Social connections may have long-term consequences for mortality as well as morbidity. A 14-year follow-up of adolescent hospitalized for SI and behavior found that those assigned to an intervention to mobilize social support from adults had reduced self-injury mortality (King et al., 2019). Therefore, social and school connectness is likely to be an important target for risk assessment and preventive intervention.

Adolescents who do not report *recent* SI, who comprised nearly one-third of the youth who made SAs in this study, can be challenging to identify in EDs and other settings where the

focus is on current risk. In this subgroup, lifetime severity of SI and social connectedness were the primary risk indicators. The accuracy of prediction in this “hidden” subgroup provides particularly strong support for the need for suicide risk screening in the pediatric ED.

Surprisingly, the accuracy of prediction for this subgroup (AUC = 0.84) was higher than the accuracy of prediction for the subgroup of adolescents who reported recent suicidal ideation (AUC = 0.69). This may be due to the inconsistency of adolescents’ reports of SI across study measures, which will be the focus of a future study.

NSSI only emerged as a primary risk factor for females. It is unknown whether or not this relates to the different types of NSSI reported by females (Sornberger, Heath, Toste, & McLouth, 2012), social influences and interpersonal challenges associated with engagement in NSSI (Victor & Klonsky, 2018), or females’ higher likelihood of experiencing suicidal thoughts and engaging in suicidal behavior (Kann et al., 2018). The more limited statistical power for adolescent males, due to fewer SA outcomes, may also be important as NSSI was a predictor of SAs among males in univariable analyses.

The prediction model AUCs for the full sample, the sample of adolescents who did not report recent SI at baseline, and the subsamples of males and females each ranged between 0.84 and 0.89, which can be considered excellent classification accuracy (Hosmer et al., 2013), and contrasts with the disappointing performance of previous single risk factor approaches to suicide risk prediction (Franklin et al., 2017). Although the heterogeneity of suicide risk factors and the low base rates of SAs and suicide are challenges to risk stratification (Belsher et al., 2019), findings suggest that a multivariable prediction model can be useful for the short-term prediction of adolescent SAs. However, of equal or greater importance, these models identify potentially important targets for clinical risk evaluation and prevention. Screening tools for risk recognition can be developed using prediction algorithms developed from large data sources (Belsher et al., 2019). We used this strategy in developing the CASSY, is being validated in a new sample.

Results should be considered within the context of study limitations. We used brief and adapted scales to assess most suicide risk factors to reduce respondent burden and facilitate patient flow in EDs. Although each of the baseline clinical risk factors we assessed was found to be a significant univariable predictor of SAs, the use of brief scales may have reduced the reliability of measurement and our ability to fully capture each construct. Furthermore, this study was conducted primarily in pediatric EDs of academic health systems, which are not

representative of the range of EDs in the U.S. In addition, we had lower levels of retention for adolescents from racial and ethnic minority groups, females, and adolescents whose parents had less education. Although we considered weighting the sample for non-response, we chose to prioritize adjusting for the oversampling of higher risk groups because we had specific information pertinent to the oversampling and did not want to apply multiple weights to relatively small subgroups. Moreover, for the most part, these variables were not predictive of SA, and therefore our predictive models are most likely not biased due to non-response. Finally, despite the relatively large size of this study, the relatively low number of youth with SAs limited our statistical power for identifying multiple predictors, especially within critical subgroups such as males, for whom the number of attempts was smaller than for females. While in this study, our focus was on identifying key risk factors, in future reports we will describe how we also used study data to develop and validate an adaptive screening tool.

In summary, in this short-term prospective study of predictors of SAs in a large and diverse sample of adolescents recruited from pediatric EDs, we found that past week SI, lifetime severity of SI, lifetime history of suicidal behavior, and connectedness were critical risk and protective factors. We also documented variation in key risk factors across important subgroups, including adolescent males and adolescents who did not report recent SI. The risk and protective factors identified may be important to assess in clinical risk evaluations and can serve as important targets for intervention and prevention strategies.

Supporting information

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

Appendix S1. Baseline criteria for assignment to low, moderate, and high-risk groups.

Appendix S2. Study participants - additional demographic information.

Appendix S3. Study measures.**Table S1.** Spearman correlations among categorical suicide risk variables.**Table S2.** Spearman correlations among categorical suicide risk variables and social variables.**Table S3.** Spearman correlations among categorical suicide risk factors and other clinical risk variables.**Table S4.** Spearman correlations among clinical risk variables and social variables.**Table S5.** Baseline suicidal ideation and 3-month suicide attempt outcomes by site.**Table S6.** Baseline history of suicidal ideation & suicidal behavior by site.**Table S7.** Baseline school and social connectedness by site.**Table S8.** Baseline Non-Suicidal Self-Injury (NSSI) by site.**Table S9.** Public assistance (i.e., food stamps, Medicaid) by site.**Acknowledgements**

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Key points

What is known: A wide range of single demographic, psychiatric, and social risk factors for adolescent suicide attempts during a 6 month period or longer have been identified.

What is new: This multi-site, prospective study of 2,104 adolescent emergency department patients examined predictors of short-term (3-month) risk for suicide attempts. Using multivariable models, we identified predictors in the total sample and in critically important subgroups. Study findings highlight the importance of adolescents' social and school connectedness and provide new information regarding predictors of attempts for subgroups of males, females, and adolescents who do not report suicidal thoughts.

What is clinically relevant: Results regarding predictors of suicide attempts can inform the recognition of adolescents at risk and possible targets for prevention and intervention.

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Table 1. Univariable relations between baseline variables and suicide attempt/death

| | Suicide Attempt/Death | | P value ² | Unadjusted, weighted ³ Odds Ratio |
|--|-----------------------|------------------|-------------------------|--|
| | Yes (N = 104) | No (N = 2000) | | |
| Demographics | | | | |
| Gender: Female | 84 (80.8%) | 1243 (62.2%) | <.001 | 3.4 (1.8, 6.6) |
| Race | | | 0.710 | |
| American Indian or Alaska Native | 2 (1.9%) | 55 (2.8%) | | 0.7 (0.1, 4.0) |
| Asian/Native Hawaiian/Pacific Islander | 2 (1.9%) | 30 (1.5%) | | 1.0 (0.2, 6.9) |
| Black or African American | 22 (21.2%) | 464 (23.2%) | | 0.8 (0.4, 1.6) |
| White | 64 (61.5%) | 1058 (52.9%) | | |
| Multi-racial | 6 (5.8%) | 126 (6.3%) | | 0.9 (0.3, 2.7) |
| Unknown/unavailable | 8 (7.7%) | 267 (13.4%) | | 0.4 (0.2, 1.2) |
| Ethnicity | | | 0.256 | |
| Latinx | 18 (17.3%) | 439 (22.0%) | | 0.7 (0.3, 1.4) |
| Not Latinx | 70 (67.3%) | 1329 (66.5%) | | |
| Unknown/unavailable | 16 (15.4%) | 232 (11.6%) | | 1.5 (0.7, 3.0) |
| Childs grade in school | | | 0.939 | |
| 5th - 8th grade | 37 (36.6%) | 673 (34.9%) | | |
| 9th - High School graduate | 64 (63.4%) | 1247 (64.6%) | | 1.1 (0.6, 1.9) |
| Child does not attend school | 0 (0.0%) | 9 (0.5%) | | N/A |
| Mother/Stepmother education | | | 0.695 | |
| High school graduate or less | 27 (26.7%) | 559 (29.0%) | | |

| | | | | |
|--|------------|--------------|-------|-------------------|
| Some college/technical training | 28 (27.7%) | 553 (28.7%) | | 1.1 (0.5, 2.2) |
| College graduate/professional | 41 (40.6%) | 769 (39.9%) | | 1.1 (0.6, 2.1) |
| Don't know/Not applicable | 5 (5.0%) | 47 (2.4%) | | 2.2 (0.6, 8.1) |
| Father/Stepfather education | | | 0.374 | |
| High school graduate or less | 32 (32.0%) | 761 (39.6%) | | |
| Some college/technical training | 29 (29.0%) | 376 (19.6%) | | 1.7 (0.9, 3.4) |
| College graduate/professional training | 27 (27.0%) | 599 (31.2%) | | 1.1 (0.5, 2.1) |
| Don't know/Not applicable | 12 (12.0%) | 184 (9.6%) | | 1.5 (0.6, 3.7) |
| Family public assistance | 51 (51.0%) | 859 (44.8%) | 0.389 | 1.3 (0.7, 2.1) |
| Suicidal Ideation/Behavior/NSSI | | | | |
| Suicidal ideation – past week: ASQ #3 | | | <.001 | |
| Yes | 69 (66.3%) | 348 (17.4%) | | 22.0 (12.0, 40.2) |
| No | 27 (26.0%) | 1503 (75.3%) | | |
| No Response | 8 (7.7%) | 145 (7.3%) | | 5.9 (2.1, 17.0) |
| Suicide ideation severity - lifetime: C-SSRS; mean (sd) | 4.1 (1.28) | 1.9 (1.98) | <.001 | 2.2 (1.8, 2.6) |
| NSSI # methods (YRBS); mean (sd) | 2.4 (2.34) | 0.8 (1.50) | <.001 | 1.6 (1.5, 1.8) |
| NSSI # incidents (YRBS) | | | <.001 | |
| 0 times | 24 (23.1%) | 1354 (67.9%) | | |
| 1-2 times | 27 (26.0%) | 312 (15.6%) | | 9.7 (4.6, 20.2) |
| 3-4 times | 14 (13.5%) | 107 (5.4%) | | 15.2 (6.1, 37.9) |
| 5 or more times | 39 (37.5%) | 222 (11.1%) | | 21.1 (10.5, 42.3) |
| Suicide attempts/behavior - lifetime | | | <.001 | |
| None | 13 (13.0%) | 1243 (63.1%) | | |

| | | | |
|--|------------|--------------|----------------------|
| Aborted/Interrupted attempt only | 12 (12.0%) | 199 (10.1%) | 11.8 (4.2, 33.4) |
| 1 Previous suicide attempt | 12 (12.0%) | 152 (7.7%) | 15.5 (5.5, 43.9) |
| Multiple previous attempts | 63 (63.0%) | 377 (19.1%) | 32.8 (15.1, 71.1) |
| Self-Harm Thoughts (PHQ, #9) | | | <.001 |
| Not at all | 26 (25.0%) | 1447 (72.7%) | |
| Several days | 20 (19.2%) | 275 (13.8%) | 8.0 (3.6, 17.5) |
| More than half the days | 20 (19.2%) | 113 (5.7%) | 20.0 (9.0, 44.8) |
| Nearly every day | 38 (36.5%) | 156 (7.8%) | 27.0 (13.5, 54.0) |
| Suicidal thoughts – duration: C-SSRS | | | <.001 |
| Never had suicidal thoughts | 4 (3.9%) | 876 (44.3%) | |
| A few seconds or minutes | 6 (5.8%) | 362 (18.3%) | 8.2 (1.6, 41.8) |
| Less than 1 hour / some of the time | 19 (18.4%) | 330 (16.7%) | 29.5 (7.4, 117.7) |
| 1-4 hours / a lot of time | 32 (31.1%) | 205 (10.4%) | 83.3 (22.0, 316.0) |
| 4-8 hours / most of day | 19 (18.4%) | 100 (5.1%) | 103.0 (25.4, 417.3) |
| More than 8 hours / continuous | 23 (22.3%) | 105 (5.3%) | 118.6 (30.0, 469.4) |
| How likely...act on suicidal thoughts? | | | <.001 |
| No suicidal thoughts/not at all likely | 22 (21.4%) | 1411 (70.9%) | |
| Slightly possible | 29 (28.2%) | 345 (17.3%) | 10.9 (5.2, 22.9) |
| Somewhat likely | 23 (22.3%) | 158 (7.9%) | 19.3 (8.7, 42.9) |
| Almost for sure will act on them | 29 (28.2%) | 77 (3.9%) | 49.5 (22.5, 108.9) |
| Suicidal Rumination: mean (sd) | 7.2 (2.66) | 2.9 (3.20) | <.001 1.6 (1.4, 1.7) |
| Other Risk Factors | | | |
| Hopelessness item: MFQ | | | <.001 |
| Not true | 18 (17.3%) | 1178 (58.9%) | |

| | | | | |
|---------------------------------------|-------------|--------------|-------|-------------------|
| Sometimes | 49 (47.1%) | 613 (30.7%) | | 9.2 (4.5, 19.0) |
| True | 37 (35.6%) | 209 (10.5%) | | 24.2 (11.3, 52.0) |
| Depression: PHQ-9; mean (sd) | 15.5 (7.34) | 8.5 (7.04) | <.001 | 1.2 (1.1, 1.2) |
| Alcohol use: AUDIT-C score; mean (sd) | 0.5 (1.53) | 0.3 (1.12) | 0.047 | 1.2 (1.0, 1.4) |
| Cannabis use: DUS (adapted) | 20 (19.2%) | 187 (9.4%) | <.001 | 3.5 (1.8, 6.8) |
| Homicidal thoughts | 15 (14.6%) | 140 (7.0%) | <.001 | 3.9 (1.8, 8.4) |
| Agitation: BAM; mean (sd) | 13.9 (5.23) | 9.3 (5.72) | <.001 | 1.2 (1.1, 1.3) |
| Anxiety: SCARED-C; mean (sd) | 4.5 (2.18) | 3.0 (2.37) | <.001 | 1.4 (1.3, 1.5) |
| Sleep Disturbance: PROMIS; mean (sd) | 13.5 (3.89) | 11.6 (4.18) | <.001 | 1.2 (1.1, 1.3) |
| Physical abuse -family | 24 (23.3%) | 296 (14.9%) | 0.001 | 2.8 (1.5, 5.3) |
| Sexual abuse | 36 (36.0%) | 310 (15.7%) | <.001 | 5.2 (3.0, 9.1) |
| Gender minority | 13 (12.5%) | 125 (6.3%) | 0.009 | 2.9 (1.3, 6.5) |
| Sexual minority | 61 (58.7%) | 580 (29.0%) | <.001 | 6.1 (3.6, 10.3) |
| Functional Impairment (PHQ, #10) | 82 (79.6%) | 1016 (50.9%) | <.001 | 7.1 (3.7, 13.5) |
| Family Connectedness; mean (sd) | 6.5 (1.71) | 7.6 (1.84) | <.001 | 0.6 (0.6, 0.7) |
| Social connectedness scale: mean (sd) | 6.4 (2.45) | 7.7 (2.10) | <.001 | 0.7 (0.6, 0.8) |
| School connectedness scale: mean (sd) | 5.2 (2.04) | 6.8 (2.09) | <.001 | 0.6 (0.6, 0.7) |
| Impulsive aggression screen: mean(sd) | 0.7 (0.93) | 0.4 (0.81) | <.001 | 1.7 (1.3, 2.2) |
| Impulsivity: UPPS Subscale; mean(sd) | 2.9 (0.72) | 2.5 (0.88) | <.001 | 2.4 (1.8, 3.3) |
| Peer victimization; mean (sd) | 4.1 (2.41) | 3.2 (1.80) | <.001 | 1.3 (1.2, 1.5) |
| Peer bullying perpetration; mean (sd) | 2.6 (1.49) | 2.3 (0.97) | 0.002 | 1.3 (1.1, 1.6) |
| Physical fighting: YRBS | | | 0.016 | |
| 0 times | 68 (66.0%) | 1391 (69.6%) | | |
| 1 time | 11 (10.7%) | 279 (14.0%) | | 1.1 (0.5, 2.5) |

| | | | | |
|---------------------------------|------------|-------------|-------|----------------|
| 2 or 3 times | 11 (10.7%) | 208 (10.4%) | | 1.4 (0.6, 3.4) |
| 4 or more times | 13 (12.6%) | 121 (6.1%) | | 3.8 (1.7, 8.6) |
| Negative life events: mean (sd) | 0.6 (0.72) | 0.4 (0.60) | <.001 | 2.3 (1.6, 3.2) |

¹Missing participant data varies across measures from low (PROMIS, n = 1; YRBS fighting and negative life events, n = 2; PHQ-9, n = 3; past week suicidal ideation, n = 4; C-SSRS Severity Score, n = 5) to high (father education, n = 84; public assistance, n = 86).

² All p-values come from Wald Chi-squared tests.

³To account for the oversampling of higher risk groups for follow-up, a weight equal to the inverse of the sampling probability of each of the three risk groups was applied in analyses.

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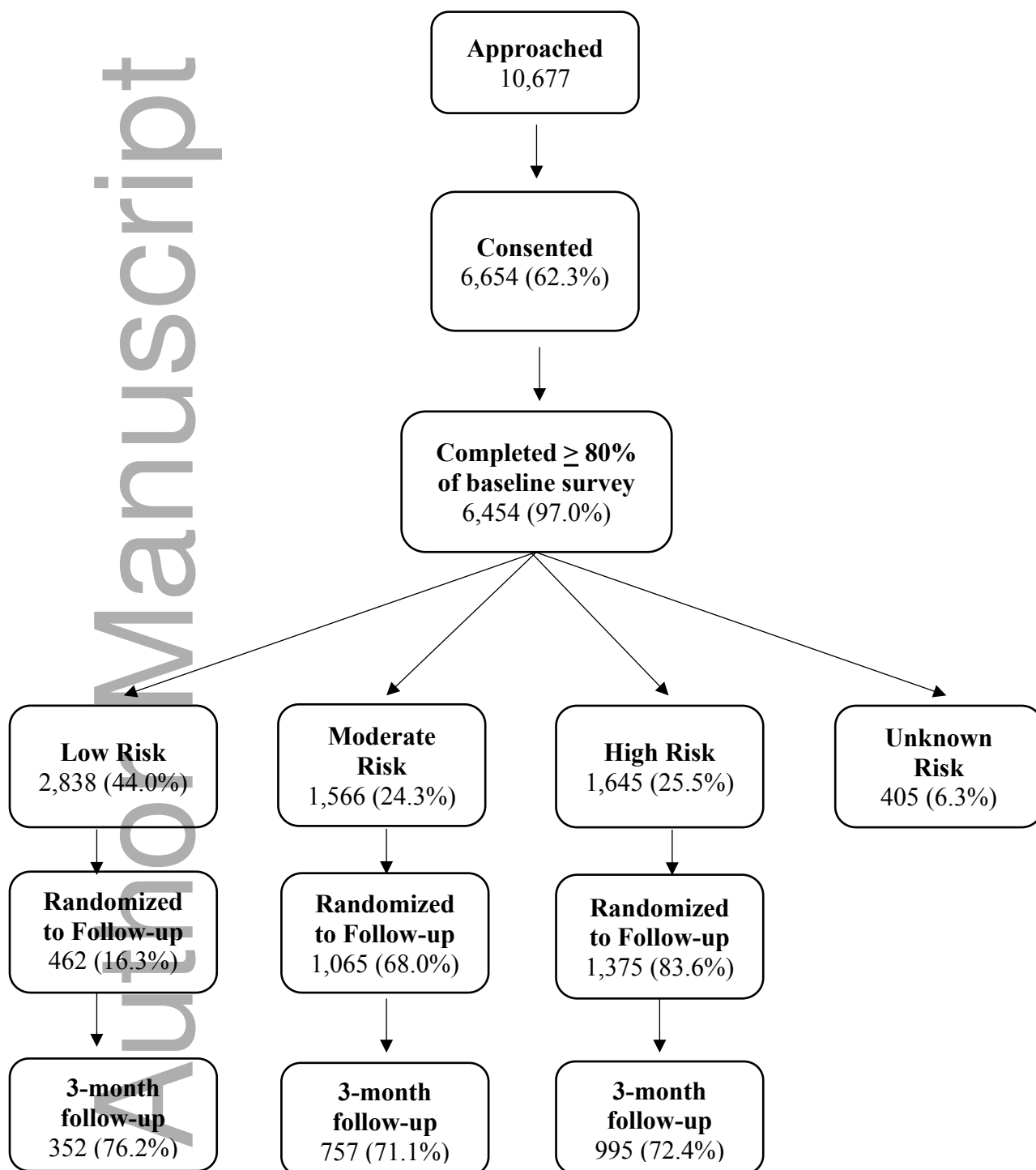
Table 2. Multivariable models for prediction of suicide attempt in total sample

| Characteristic | Suicide Attempt/Death | | OR (95% CI) | p |
|---|--------------------------------------|---|---|-------------------------|
| | Yes N = 98 (%) | No N = 1964 (%) | | |
| Suicidal Ideation – Past Week (ASQ Item #3) | | | | |
| No | 27 (27.6) | 1489 (75.8) | | |
| Yes | 64 (65.3) | 2035 (17.1) | 3.25 (1.56, 6.77) | |
| Suicidal Ideation – Past Week (ASQ Item #3) | | | | |
| No Response | 7 (7.1%) | 140 (7.1) | 1.37 (0.42, 4.46) | 0.020 |
| Suicide ideation severity - lifetime: Adolescents without Recent Suicidal Ideation C-SSRS: q1, median, q3 | 3,5,5 N = 27 (25.0) | 0,1,4 N = 1496 (87.5) | 1.35 (1.03, 1.76) | 0.031 |
| Lifetime Suicidal Ideation Severity Score: Lifetime History of Suicidal Behavior Social Connectedness q1, median, q3 No | 2,4,5 3,4,5 5,7,9 13 (13.3) | 0,0,2 0,0,3 7,8,10 1241 (63.2) | 2.02 (1.51, 2.69) 0.93 (1.04, 2.74) 0.76 (0.60, 0.96) | <.001 0.034 0.019 |
| Aborted or Interrupted Attempt Only Adolescents with Recent Suicidal Ideation One Suicide Attempt Family Public Assistance | 11 (11.2) N = 67 | 198 (10.1) N = 329 152 (7.7) | 2.59 (0.73, 8.97) 2.48 (0.66, 9.36) | 0.002 |
| Multiple Attempts Suicidal Ideation – Past Week (ASQ Item #3) | 63 (64.3) 28 (41.8) | 373 (19.0) 204 (62.0) | 4.69 (1.56, 14.07) 0.84 (0.73, 0.96) | 0.011 |
| School Connectedness: q1, median, q3 | 3,5,7 39 (58.2) | 6, 7, 8 125 (38.0) | 2.39 (1.38, 4.13) | 0.010 |
| Note. Lower levels of school connectedness indicate worse school connectedness. | | | | |
| Suicidal Rumination: q1, median, q3 | 7,9,10 54 (64.3) | 6,7,9 252 (20.4) | 1.22 (1.06, 1.39) 2.48 (1.24, 4.96) | 0.004 |
| Social Connectedness: q1, median, q3 NSSI Past 12 Months | 4,6,9 15 (17.9) | 5,8,9 770 (62.4) | 0.88 (0.79, 0.98) | 0.025 |
| Note. Lower connectedness scores indicate worse connectedness. | | | | |

| | | | | |
|--|-----------|------------|-------------------|-------|
| 1-2 times | 25 (29.8) | 202 (16.4) | 3.93 (1.61, 9.58) | |
| 3-4 times | 10 (11.9) | 81 (6.6) | 2.10 (0.66, 6.64) | |
| 5 or more times | 34 (40.5) | 181 (14.7) | 2.80 (1.11, 7.11) | |
| Lifetime Suicidal Ideation Severity Score: q1, median, q3 | 4,5,5 | 0,2,4 | 1.53 (1.20, 1.95) | <.001 |
| Social Connectedness: n (q1 median q3) | 4, 6, 8 | 6, 8, 10 | 0.83 (0.73, 0.93) | 0.001 |

Note. Lower connectedness scores indicate worse connectedness.

Figure 1. Participant flow



Note. High risk = suicidal ideation with intent/plan, history of suicide attempt, NSSI 5 or more times in past year, or homicidal ideation with intent/plan; Moderate risk = suicidal ideation, homicidal ideation (without plan/intent), or two or more other suicide risk factors (see Supplement for details). Low risk = does not meet criteria for High or Moderate risk.