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# Prediction of major depressive disorder onset in college students

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**Background:** Major depressive disorder (MDD) in college students is associated with substantial burden.

**Aims:** To assess 1-year incidence of MDD among incoming freshmen and predictors of MDD-incidence in a representative sample of students.

**Method:** Prospective cohort study of first-year college students (baseline: $n = 2,519$, 1-year follow-up: $n = 958$)

**Results:** The incidence of MDD within the first year of college was 6.9% (SE = 0.8). The most important individual-level predictors of onset were prior suicide plans and/or attempts (OR = 9.5). The strongest population-level baseline predictors were history of childhood–adolescent trauma, stressful experience in the past 12 months, parental psychopathology, and other 12-month mental disorder. Multivariate cross-validated prediction (cross-validated AUC = 0.73) suggest that 36.1% of incident MDD cases in a replication sample would occur among the 10% of students at highest predicted risk (24.5% predicted incidence in this highest-risk subgroup).

**Conclusions:** Screening at college entrance is a promising strategy to identify students at risk of MDD onset, which may improve the development and deployment of targeted preventive interventions.

**KEYWORDS**
depression, epidemiology, health services, mood disorders, suicide/self-harm

# 1 | INTRODUCTION

Major depressive disorder (MDD) is one of the leading causes of disability worldwide (Vos et al., 2012) and also one of the most common mental disorders among college students (Auerbach et al., 2016, 2018; Farabaugh et al., 2012). Depression in college students is associated with lower academic performance (Hysenbegasi, Hass, & Rowland, 2005), substantial role impairment (Alonso et al., 2018), increased risk for college dropout (Arria et al., 2013), increased levels of anxiety (Rawson, Bloomer, & Kendall, 1994), physical illness, decreased physical activity, unsafe sexual behavior, increased levels of smoking (Cranford, Eisenberg, & Serras, 2009), alcohol and drug dependency, poorer quality of life, self-harming behaviors (Serras, Saules, Cranford, & Eisenberg, 2010), and an increased risk of suicide (Eisenberg, Hunt, & Speer, 2013). Together, this underscores the importance of developing tools that identify students at greatest risk to develop MDD during this critical period of development.

Early identification of students at risk for MDD may allow to effectively deploy preventive interventions during college and thereby reduce the incidence, prevalence, severity, duration, and consequences of future depressive episodes as well as of other mental disorders (van Zoonen et al., 2014). To support clinical decision-making and resource allocation, universities need tools that accurately identify students at high risk of developing depression in the near future.

Although there is a fair amount of studies that estimate the prevalence of MDD among college students, studies on the incidence of MDD among representative incoming students are much scarcer. Zivin, Eisenberg, Gollust, & Golberstein (2009) estimated the incidence of depression in college students at approximately 5% per year, but they did not identify risk parameters that predict MDD incidence.

Several studies of risk indicators for MDD among college students have been carried out, but most of them were limited by being based on cross-sectional rather than prospective data and thus, cannot disentangle the cause from the effect (Brandy, Penckofer, Solari-Twadell, & Velsor-Friedrich, 2015; Leino & Kisch, 2005). Moreover all prior studies focused only on the coefficients of individual predictors rather than developing composite risk measures (Mahmoud, Staten, Hall, & Lennie, 2012). Furthermore, individual-level effect sizes merely identify specific risk indicators for individuals. However, for prevention purposes, it is important to select risk indicators that are associated with the largest potential health gain at population level. Risk indicators that will lead to the largest population health gain should not only be linked to heightened risk of developing a depression on an individual-level, but should also be prevalent in the target population. By estimating the population attributable risk proportion (PARP), it is possible to identify the number of cases that would not occur in the population, if a specific risk indicator were eliminated.

The aims of the current study were to: (1) estimate the 1-year incidence of MDD among college freshmen who were without MDD in the 12 months prior to college enrollment, and further, among these individuals to, (2) examine individual-level, and (3) population-level predictors of 1-year incidence of MDD. Finally, we aimed (4) to evaluate the prediction accuracy of a baseline multivariate risk prediction model

> **Key Points**
> - We investigated whether MDD during the first year of college can be predicted using baseline data.
> - Strongest predictors on the individual level were prior suicidal behaviors, but when taking also the prevalence of the risk factor into account (OR $\geq$ 2/PARP $\geq$ 15%), preventive approaches should focus on students with traumatic experiences, a recent break-up with a romantic partner, serious ongoing arguments with people close to them, and those with recent stressful life events. A multivariate risk prediction algorithm was able to predict the incidence of MDD, with 36.1% of all cases occuring in the 10% of students at the highest predicted risk.
> - Screening at college entrance is promising to identify students at high risk for MDD onset, which may improve the development and deployment of targeted preventive interventions.

aimed at identifying college freshmen at highest risk for MDD onset over the subsequent 12 months.

# 2 | METHOD

Longitudinal data were obtained from the Leuven College Surveys (LCS), which are part of the WHO World Mental Health Surveys International College Student project (WMH-ICS). Full procedures of the LCS have been reported elsewhere (Mortier et al., 2017). In the academic year 2014–2015, all 4,130 Dutch-speaking incoming freshmen aged 18 years or older were invited to participate in the baseline survey. The inclusion of the baseline sample consisted of three consecutive stages, with different refusal conversion strategies to increase final response rates: In the first stage, the baseline survey was part of a routine psychomedical check-up. All incoming freshmen (i.e., complete enumeration or census sampling) were sent a standard invitation letter for this check-up. This means that all units of the freshmen population were eligible to complete the survey on a desktop computer in the waiting room of the students' mental health center. One reminder letter for the medical check-up was sent by mail by the students' mental health center. In a second stage, nonrespondents to the first stage were personally contacted using customized emails containing unique electronic links to the survey. Two reminder emails were sent with a 1-week interval. By implementing this stage, we removed the physical barrier between the initial nonrespondents and the mental health center, since the survey could then be completed on a personal computer at home. The third stage was identical to the second stage, but additionally included an incentive, that is, a raffle for store credit coupons. Two reminder emails were sent with a 1-week interval. When including the reminder (e)mails used in each stage, the maximum amount of contacts was set to eight attempts. A total of 2,519 students completed

the baseline survey, equivalent to a baseline response rate (RR) of 61%. Students were contacted for a follow-up survey 12 months after the baseline assessment, using a similar sampling design to the one used at baseline. Personalized emails with unique electronic links to the survey were sent, including up to seven reminder emails. Beginning with the fifth reminder email, emphasis was put on a store credit coupon raffle. The survey was delivered fully digital and all survey sections were presented in a precise predetermined order.

Of the students who responded at baseline, 958 (38%) responded to the follow-up survey (57.5% response rate after adjusting for nonparticipation due to college dropout). Earlier reports of the WMH-ICS initiative have shown that lifetime- (22.4%, 95%CI: 21.2–23.7) and 12-month mental disorders (19.1%, 95%CI: 17.9–20.2) are somewhat lower in the LCS sample, than average prevalence rates of the countries included in the first prevalence estimates assessed in eight participating WMH-ICS countries (Auerbach et al., 2018). The study's protocol was approved by the University Hospital Leuven Biomedical Ethical Board (B322201215611). Informed consent was obtained from all subjects who participated in the study. Students who reported any past year STB or nonsuicidal self-injury were presented with links to local mental health resources.

## 3 | MEASURES

The WMH-ICS survey instrument includes multiple screening instruments measuring a wide range of mental health outcomes. The included assessments are described below.

### 3.1 | Socio-demographic variables

Socio-demographic characteristics of freshmen were obtained from the KU Leuven student administration office, including gender, age, nationality, parent financial situation, parent education, familial composition, university group membership, and secondary school educational type.

### 3.2 | Parental psychopathology and traumatic experiences in childhood–adolescence

Traumatic experiences in childhood and adolescence (i.e., prior to the age of 17) were assessed using 19 items adapted from the Composite International Diagnostic Interview (CIDI) (Kessler & Üstün, 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 or emotional problems, substance abuse, suicidal thoughts and behaviors or death by suicide, criminal activities or interpersonal violence), physical abuse, emotional abuse, sexual abuse, neglect, bully victimization (i.e., direct verbal or physical bullying, indirect bullying or cyberbullying), and dating violence. Items were rated on a 5-point Likert scale ("never," "rarely," "sometimes," "often," and "very often"). Confirmatory factor analysis using our data showed a strong unidimensional structure of responses (Comparative Fit Index = 0.991; Tucker–Lewis = 0.988; root mean square of approximation = 0.019). To obtain dichotomously coded

variables, "rarely" was used for all items, except bully victimization which had a cut-off of "sometimes" (Nansel et al., 2001).

### 3.3 | Stressful events experienced in the past 12 months

Stressful events were assessed using 12 items taken from well-validated screeners (Bray & Hourani, 2007; Brugha & Cragg, 1990; Vogt, Proctor, King, King, & Vasterling, 2008). Items assessed life-threatening illness, accidents or death of a family member or close friend, interpersonal events (i.e., break-up with a romantic partner, serious betrayal by someone else than partner), physical or sexual assault, and legal problems (i.e., time spent in jail).

### 3.4 | Twelve-month mental disorder

The CIDI Screening Scales (CIDI-SC) (Kessler & Üstün, 2004; Kessler et al., 2013) were used to assess two mood disorders (major depressive disorder and [hypo]manic episodes), two anxiety disorders (generalized anxiety disorder and panic disorder), and drug use disorder (abuse or dependence either on cannabis, cocaine, or any other street drug, or on a prescription drug either used without a prescription or used more than prescribed to get high, buzzed, or numbed out). The CIDI-SC consists of a range of DSM-IV-based screening scales containing well-validated self-report items that were developed to deliver reliable estimates of mental disorder diagnoses. Concordance with blinded clinical diagnoses in clinical reappraisal studies were in the range AUC = 0.70–0.78 (Kessler et al., 2013). Information on lifetime and 12-month MDD was assessed by asking respondents about age, age of onset of MDD, and most recent age with MDD.

The Alcohol Use Disorders Identification Test (AUDIT) (Saunders, Aasland, Babor, De la Fuente, & Grant, 1993) is a 10-item screening tool developed by the WHO to determine alcohol consumption, risk for alcohol dependence, and alcohol-related harm. The AUDIT is well-validated in college students (DeMartini & Carey, 2012). Consistent with prior recommendations (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001), the AUDIT was used to identify students with 12-month "risky or hazardous drinking" and students with 12-month "risk for alcohol dependence."

A modified version of the Columbia Suicidal Severity Rating Scale (Posner et al., 2011) was used to assess 12-month suicidal thoughts and behaviors (STB), including suicidal ideation, suicide plans, and suicide attempts. After the assessment of outcomes with suicidal intent, 12-month nonsuicidal self-injury (NSSI) also was assessed (Nock, Holmberg, Photos, & Michel, 2007).

### 3.4.1 | Analyses

All analyses were performed with SAS version 9.4, Mplus version 7.4, and R version 3.3.2. Nonresponse propensity weights (Rosenbaum & Rubin, 1983) were used to adjust for possible bias caused by final nonresponse. Multiple imputation by chained equations (van Buuren, 2007) was used to adjust for survey attrition and within-survey item nonresponse. All analyses were conducted in the subsample without 12-month MDD at baseline. Lifetime MDD was added as

a covariate in all analyses. Incidence was reported as a weighted proportion (%) and associated standard error (SE). Logistic regression analysis was used to test the individual-level strength of the association between baseline risk indicators and the onset of MDD. All analyses were adjusted for lifetime history of MDD. Measures of association were reported as odds ratios (OR) and associated 95% confidence intervals (95%CI). Firth's penalised likelihood estimation was applied to avoid overfitting and inconsistent estimators due to data sparseness (Firth, 1993). The population-level impact of baseline risk indicators on the onset of MDD was estimated by population attributable risk proportions (PARPs) (Krysinska & Martin, 2009) using the predicted probabilities resulting from the logistic regression equations as a summary predictor (Nock, Borges, & Ono, 2012). PARPs could be interpreted as the proportion of cases that would be prevented if the targeted risk indicator were fully blocked in the population.

Finally, a multivariate model was estimated, including socio-demographic variables, childhood–adolescent traumatic events, 12-month stressful experiences, 12-month risk for mental disorders, and lifetime history of MDD. Nagelkerkes pseudo-R2 was used as a measure of total effect size. Based on the multivariate equation, individual-level predicted probabilities were created, receiver operating characteristic (ROC) curves were generated, and to evaluate prediction accuracy area under the curve (AUC) values were calculated. Predicted probabilities were then 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. We defined sensitivity as the proportion of cases found among predefined proportions of respondents (e.g., 10%) with the highest predicted probabilities. Positive predictive value (PPV) was defined as the probability of actually developing an MDD when estimated among the 10% of respondents with the highest predicted probabilities. We used the method of leave-one-out cross-validation (Efron & Gong, 1983) to correct for the over-estimation of prediction accuracy when both estimating and evaluating model fit in a single sample. Although leave-one-out cross-validation shows a downward bias of true prediction accuracy compared to other cross-validation techniques (Smith, Seaman, Wood, Royston, & White, 2014), this method was preferred as it allows for the straightforward cross-validation of multiple imputed datasets.

# 4 | RESULTS

## 4.1 | Sample description

Descriptive characteristics of the sample can be found in Table 1. The majority of the sample was female (54.5%), only few participants (6%) were of non-Belgian nationality and 15.3% of the students indicated that they were raised in households, in which their parents financial situation was difficult. Parental education was high for both parents for the majority of the students (63.4%), only few students (14.8%) indicated that neither of their parents had a high education level. As

can be seen in Table 3, the burden of mental disorders in the sample was quite high. Approximately, one-third of all students experienced at least one 12-month disorder (35.2%), and 28.6% reported exactly one, 5.3% exactly two, and 1.3% three or more 12-month mental disorders. Approximately, half of the sample (52.5%) reported at least one traumatic experience before the age of 17; with 28.4% experiencing parental psychopathology as the most reported type of traumatic experience, followed by bully victimization (25.4%). Every second student also reported at least one 12-month stressful life event (52.5%, Table 2).

## 4.2 | Twelve-month incidence of MDD during college freshman year

Twelve-month prevalence of MDD at baseline was 11.0% (95%CI: 10.0–12.0%, n = 277/2,519). Among the remaining cases without 12-month MDD (n = 2,242), lifetime prevalence of MDD was only 3.5% (95%CI: 2.9–4.2%; n = 79). All analyses were restricted to the 2,242 students who had no history of MDD during the 12 months prior to the baseline survey. The incidence of depressive disorder in the first year after college matriculation was estimated at 6.9% (95%CI: 5.3–8.4%; n = 154/2,242). Most of these cases were first-onset incidence cases (94.15%; n = 145/154).

## 4.3 | Individual- and population-level predictors of 12-month MDD incidence

Models adjusting for lifetime MDD at baseline (Tables 1–3) revealed the following key findings. First, socio-demographic variables did not significantly predict the onset of MDD in students in their first year of college. Second, the most important predictors of MDD onset at the individual level were 12-month suicide plans and/or attempts (OR = 9.55), sexual abuse prior to the age of 17 (OR = 8.01), three or more 12-month mental disorders other than MDD (OR = 6.27), three or more 12-month stressful events (OR = 4.29), and 12-month generalized anxiety disorder (OR = 4.11). However, the impact of these predictors at population level were all small (PARP < 12%) due to the low prevalence of these predictors.

Third, large proportions of MDD onset were attributable to any 12-month mental disorder at baseline (other than MDD, PARP = 25.6%), any childhood–adolescent trauma (PARP = 31.5%), and any stressful experience in the past year (PARP = 34.5%). Specific associations regarding stressful experiences included: break-up with a romantic partner, romantic partner cheated, serious betrayal by someone else than partner, and serious ongoing arguments or break-up with a friend or family member (median OR = 2.7; median PARP = 13.5%). In relation to any childhood–adolescent trauma, specifically parental psychopathology, emotional abuse, sexual abuse, and dating violence (median OR = 2.7; median PARP = 12.5%) were significantly associated with MD. With regard to being at risk for comorbid mental health issues, specific associations included generalized anxiety disorder, nonsuicidal self-injury, suicidal ideation, and suicide plans and/or attempts (median OR = 3.9; median PARP = 6.7%).

**TABLE 1** Socio-demographic Variables as Baseline Predictors for Depression Onset during Follow-up

| | Prevalence | | | Bivariate Model[a] | | |
| | | | | Subsample no. 12-m MDD | | |
| | n (w) | % (w) | (SE) | OR | 95%CI | PARP (%) |
|---|---|---|---|---|---|---|
| *I. Socio-demographic variables* | | | | | | |
| Being male | 1,021 | 45.5 | 0.9 | 0.68 | (0.41–1.12) | −14.4 |
| Age > 18 years | 495 | 22.1 | 0.8 | 1.40 | (0.83–2.37) | 7.0 |
| Non-Belgian nationality | 134 | 6.0 | 0.4 | 1.48 | (0.63–3.45) | 3.2 |
| Parents' financial situation difficult | 344 | 15.3 | 0.7 | 1.05 | (0.53–2.07) | 1.0 |
| Parental education[b] | | | | | | |
| Both parents high | 1,422 | 63.4 | 1.0 | (ref) | – | – |
| Only one parent high | 487 | 21.7 | 0.8 | 0.95 | (0.54–1.68) | −0.8 |
| None of parents high | 333 | 14.8 | 0.7 | 1.03 | (0.51–2.10) | 0.7 |
| Nonintact familial composition[c] | 472 | 21.0 | 0.8 | 1.23 | (0.68–2.20) | 4.3 |
| *College-related socio-demographics* | | | | | | |
| University Group membership | | | | | | |
| Human Sciences | 1,171 | 52.2 | 0.9 | (ref) | – | – |
| Science & Technology | 623 | 27.8 | 0.8 | 0.61 | (0.35–1.07) | −12.7 |
| Biomedical Sciences | 448 | 20.0 | 0.7 | 0.61 | (0.31–1.17) | −9.3 |
| Non-GSE pre-educational level | 131 | 5.8 | 0.4 | 1.33 | (0.49–3.57) | 1.9 |

*Note.* Significant odds ratios/PARPs are shown in bold ($\alpha = 0.05$); OR = odds ratio; PARP = population attributable risk proportion; GSE = general secondary education.
[a]The bivariate associations are based on a separate model for each row, with the variable in the row as the only predictor in the model, adjusted for lifetime MDD at baseline.
[b]High degree of parental education defined as holding a college bachelor degree or more.
[c]Nonintact familial composition defined as parents being divorced or separated.

Fourth, a positive dose–response relationship was found within each domain, with MDD risk among students who had three or more risk indicators substantially elevated both at the individual level (ORs between 3.4 and 6.3) and at the population level (PARPs between 4.0 and 16.2%). Finally, when considering both individual- and population-level effects, the most important risk indicators (i.e., OR $\geq$ 2 and PARP $\geq$ 15%) were any traumatic experience prior to the age of 17, break-up with a romantic partner in the past year, serious ongoing arguments or break-up with a friend or family member in the past year and three or more stressful life events in the last 12 months.

## 4.4 | Multivariate model for MDD onset during freshman year

The total effect size (Nagelkerke pseudo-R2) of risk indicators was 0.23. The prediction model had a reasonable performance with a cross-validated AUC of 0.73 (SE = 0.04). The 10% of students at highest predicted risk for subsequent onset of MDD within the first 12 months after college matriculation included 36.1% (SE = 6.1) of all observed MDD cases (Table 4). The probability of MDD onset in this 10% of respondents was 24.7% (SE = 4.9). The only significant predictors in the final model, when adjusted for all other risk domains, were suicidal ideation (OR = 2.88; 95%CI = 1.10–7.56; PARP = 4.4%) and suicide plans and/or attempts (OR = 6.77; 95%CI = 1.55–29.62; PARP = 3.9%). A full overview of the multivariate estimates can be found in the supplementary materials.

## 5 | DISCUSSION

### 5.1 | Main findings

This prospective study examined the onset of MDD in a large representative sample of college students. In the first year of college, the incidence of MDD was estimated at 6.9%. Among the 10% of students with the highest predicted risk of MDD onset based on our model, approximately one out of four developed MDD. Suicidal plans and/or attempts were most strongly associated with MDD onset at the individual level. The largest population-level effects, however, were found for any 12-month mental disorder at baseline (PARP = 25.6%), a history of any childhood–adolescent trauma (PARP = 31.5%), and stressful experiences in the past 12 months (PARP = 34.5%).

### 5.2 | Limitations

Several limitations are noteworthy. First, response rates were moderate (61.0% at baseline; 57.5% at follow-up). However, these response rates compare favourably to those achieved in other large-scale prospective college student surveys (39–44%) (Eisenberg et al., 2013; Paul, Tsypes, Eidlitz, Ernhout, & Whitlock, 2015). In addition, state-of-the-art missing data techniques were applied to increase the representativeness of the findings. Nonetheless it is possible that systematic nonresponse might have biased results. Second, baseline risk for mental disorders was not assessed by diagnostic interviews

**TABLE 2** Childhood–Adolescent Traumatic Experiences and 12-Month Stressful Experiences as Baseline Predictors for Depression Onset during Follow-up

| | Prevalence | | | Bivariate Model[a] | | |
| | | | | Subsample no. 12-m MDD | | |
| | n (w) | % (w) | (SE) | OR | 95%CI | PARP (%) |
|---|---|---|---|---|---|---|
| *II. Twelve-month stressful experiences* | | | | | | |
| Life-threatening illness or injury of a friend or family member | 481 | 21.5 | 1.1 | 1.18 | (0.60–2.34) | 3.9 |
| Death of a friend or family member | 437 | 19.5 | 1.0 | 1.07 | (0.52–2.20) | 1.7 |
| Break-up with a romantic partner | 394 | 17.7 | 1.0 | **2.63** | **(1.37–5.09)** | **20.3** |
| Romantic partner cheated | 87 | 3.9 | 0.5 | **3.81** | **(1.11–13.07)** | **8.5** |
| Serious betrayal someone else than partner | 210 | 9.4 | 0.7 | **2.35** | **(1.07–5.17)** | **10.4** |
| Serious ongoing arguments or break-up with friend or family member | 284 | 12.7 | 0.8 | **2.78** | **(1.46–5.31)** | **16.7** |
| Life-threatening accident | 22 | 1.0 | 0.3 | 2.60 | (0.21–32.11) | 1.9 |
| Seriously physically assaulted | 65 | 2.9 | 0.4 | 1.22 | (0.18–8.09) | 1.2 |
| Sexually assaulted or raped | 8 | 0.4 | 0.1 | 2.26 | (0.13–38.25) | 0.6 |
| Any serious legal problem | 44 | 1.9 | 0.3 | 2.20 | (0.31–15.73) | 2.6 |
| **Any stressful event** | 1,177 | 52.5 | 1.2 | **2.12** | **(1.20–3.75)** | **34.5** |
| **Number of stressful experiences** | | | | | | |
| 0 | 1,065 | 47.5 | 1.2 | (ref) | – | – |
| 1 | 620 | 27.6 | 1.1 | 1.53 | (0.83–2.82) | 8.8 |
| 2 | 355 | 15.9 | 0.9 | **2.04** | **(1.01–4.13)** | **9.8** |
| 3+ | 202 | 9.0 | 0.7 | **4.29** | **(1.85–9.96)** | 16.2 |
| *F*-test (*p*-value)[b] | | | | F = 2.69 (0.046) | | |
| *III. Traumatic experiences (≤ age 17)* | | | | | | |
| Parental psychopathology | 637 | 28.4 | 1.1 | **1.96** | **(1.13–3.39)** | **19.7** |
| Physical abuse | 96 | 4.3 | 0.5 | 2.01 | (0.74–5.45) | 4.0 |
| Emotional abuse | 329 | 14.7 | 0.8 | **2.51** | **(1.34–4.71)** | **16.4** |
| Sexual abuse | 18 | 0.8 | 0.2 | **8.01** | **(1.64–39.06)** | **3.6** |
| Neglect | 116 | 5.2 | 0.5 | 1.44 | (0.51–4.05) | 2.4 |
| Bully victimization | 570 | 25.4 | 1.1 | 1.19 | (0.68–2.09) | 4.5 |
| Dating violence | 115 | 5.1 | 0.5 | **2.94** | **(1.03–8.40)** | **8.5** |
| **Any traumatic experience** | 1,141 | 50.9 | 1.2 | **2.00** | **(1.17–3.43)** | **31.5** |
| **Number of traumatic experiences** | | | | | | |
| 0 | 1,099 | 49.1 | 1.2 | (ref) | – | – |
| 1 | 688 | 30.7 | 1.1 | 1.46 | (0.80–2.66) | 9.0 |
| 2 | 272 | 12.1 | 0.8 | **2.57** | **(1.28–5.15)** | **11.4** |
| 3+ | 181 | 8.1 | 0.7 | **3.43** | **(1.52–7.74)** | **11.7** |
| *F*-test (*p*-value)[b] | | | | F = 3.04 (0.029) | | |

*Note.* Significant odds ratios/PARPs are shown in bold ($\alpha = 0.05$); OR = odds ratio; PARP = population attributable risk proportion.

[a]The bivariate associations are based on a separate model for each row, with the variable in the row as the only predictor in the model, adjusted for lifetime MDD at baseline.

[b]Cochran–Armitage trend test. The *F*-test evaluates significance ($\alpha = 0.05$) of 200 pooled Cochran–Armitage $\chi^2$ (3) linear trend tests.

**TABLE 3** Twelve-Month Mental Disorders as Baseline Predictors for Depression Onset during Follow-up

| | Prevalence | | | Bivariate Model[a] | | |
| | | | | Subsample no. 12-m MDD | | |
| | n (w) | % (w) | (SE) | OR | 95%CI | PARP (%) |
|---|---|---|---|---|---|---|
| IV. *Twelve-month mental disorders* | | | | | | |
| Generalized anxiety disorder | 70 | 3.1 | 0.3 | **4.11** | (1.75–9.70) | **7.5** |
| Panic disorder | 23 | 1.0 | 0.2 | 0.94 | (0.07–12.05) | 0.2 |
| Broad mania | 22 | 1.0 | 0.2 | 2.75 | (0.58–12.98) | 1.6 |
| Low risk for alcohol use disorder | 1,660 | 74.0 | 0.8 | (ref) | – | – |
| Risky or hazardous drinking | 505 | 22.5 | 0.8 | 1.17 | (0.69–1.96) | 3.3 |
| Risk for alcohol dependence | 77 | 3.4 | 0.4 | 1.34 | (0.39–4.63) | 1.2 |
| Drug abuse/dependence | 25 | 1.1 | 0.2 | 1.93 | (0.39–9.41) | 1.0 |
| Nonsuicidal self-injury | 161 | 7.2 | 0.5 | **2.53** | (1.28–5.02) | **8.7** |
| No STB | 2,154 | 96.1 | 0.4 | (ref) | – | – |
| Suicidal ideation | 64 | 2.9 | 0.3 | **3.76** | (1.65–8.57) | **5.9** |
| Suicide plans and/or attempts | 24 | 1.1 | 0.2 | **9.55** | (2.96–30.78) | **5.0** |
| **Any mental disorder** | 790 | 35.2 | 0.9 | **2.12** | (1.34–3.36) | **25.6** |
| **Number of mental disorder** | | | | | | |
| 0 | 1,452 | 64.8 | 0.9 | (ref) | – | – |
| 1 | 641 | 28.6 | 0.9 | **1.76** | (1.09–2.86) | **14.3** |
| 2 | 119 | 5.3 | 0.4 | **3.34** | (1.55–7.19) | **7.8** |
| 3+ | 30 | 1.3 | 0.2 | **6.27** | (1.85–21.33) | **4.0** |
| F-test (p-value)[c] | | | | F = 4.16 (0.006) | | |

*Note.* Significant odds ratios/PARPs are shown in bold ($\alpha = 0.05$); STB = suicidal thoughts and behaviors; OR = odds ratio; PARP = population attributable risk proportion.

[a]The bivariate associations are based on a separate model for each row, with the variable in the row as the only predictor in the model, adjusted for lifetime MDD at baseline.

[b]Cochran–Armitage trend test. The F-test evaluates significance ($\alpha = 0.05$) of 200 pooled Cochran–Armitage $\chi^2$ (3) linear trend tests.

but with self-report measures and a categorical cut-off scoring system. The latter measures were well-validated screening scales used in prior general population surveys that have shown high concordance with with blinded clinical diagnoses in clinical reappraisal studies (Kessler et al., 2010). However, it remains unknown whether screening scale performance is different among college students. Although we plan to carry out clinical reappraisal studies to address this limitation in future iterations of the WMH college surveys, this has not yet been done and caution is consequently needed in interpreting results regarding prevalence estimates. Third, the survey was conducted among freshmen in one Belgian college. The findings might not generalize to college students from other universities in different countries or cultures. Finally, although we included a large set of known risk indicators for MDD onset, some important risk indicators were not assessed, such as subsyndromal depression, chronic somatic conditions, personality traits/disorders, psychotic experiences/disorders, poor self-perceived health, low emotion regulation skills, low self-esteem, low resilience, and neuroticism (Berking, Wirtz, Svaldi, & Hofmann, 2014; Cole & Dendukuri, 2003; Ebert, Hopfinger, & Berking, 2017; Korten, Comijs, Lamers, & Penninx, 2012; Pelkonen, Marttunen, Kaprio, Huurre, & Aro, 2008; Wild et al., 2016). As a result, the strength of the composite risk index found here should be considered a lower bound estimate compared to the estimate that might be obtained in future research

that includes additional predictors. A related limitation is that we used conventional research analysis methods to develop the risk model. It is likely that we will be able to improve on this performance in planned cross-national analyses using machine learning methods (Kessler et al., 2016, 2017). Finally, we did not assess serious life events during follow-up. Therefore, we do not know which MDD incidence cases are due to baseline vulnerability and which due to exposure to random traumas that could not be predicted at baseline (e.g., sexual assault, death of a parent). Such information would not only be important to inform about strategies to improve prediction accuracy of the algorithm, but also relevant for the development of appropriate prevention strategies. This should be explored in future studies.

## 5.3 | Implications for clinical practice and future research

Our study has relevant implications for clinical practice and future research. First, to the best of our knowledge, this study is among the first that prospectively estimated the 1-year incidence proportion of MDD in students during their first year of college. The reported incidence proportion is somewhat higher than the estimated incidence of MDD among college students based on the World Health Organization

**TABLE 4** Concentration of Risk of Depression Cases in Different Proportions of Incoming Freshmen at Highest Predicted Risk based on a Multivariate Model[a] Including all Risk Factors

| % at Highest Predicted Risk | Depression Onset | |
| --- | --- | --- |
| | Sensitivity (%[SE])[b] | PPV (%[SE])[c] |
| 100 | 100.0 (0.0) | 6.9 (0.8) |
| 90 | 96.0 (2.4) | 7.3 (0.9) |
| 80 | 91.8 (3.4) | 7.9 (1.0) |
| 70 | 87.4 (4.1) | 8.6 (1.2) |
| 60 | 82.7 (4.8) | 9.5 (1.3) |
| 50 | 77.2 (5.2) | 10.6 (1.5) |
| 40 | 71.0 (5.9) | 12.2 (1.8) |
| 30 | 63.1 (6.3) | 14.4 (2.3) |
| 20 | 52.4 (6.5) | 17.9 (3.0) |
| 10 | 36.1 (6.1) | 24.7 (4.9) |

[a]See the model in the supplementary materials covering multivariate model construction (Supplementary Tables 1 and 2). Model-based AUC values were 0.78 [SE = 0.03] for depression onset. Cross-validated AUC values were 0.73 [SE = 0.04].
[b]Sensitivity = proportion of depression cases found among the row % of respondents at highest predicted risk, based on cross-validated predicted probabilities.
[c]Positive predictive value (PPV) = probability of effectively developing a depression when being among the row % at highest predicted risk, based on cross-validated predicted probabilities.

(WHO) World Mental Health Surveys (Auerbach et al., 2016). Differences may be explained by geographical or methodological differences (i.e., adjustment for college attriters or the use of retrospective designs in the WHO surveys). Our data suggest that the first year in college constitutes a risk period for the onset of MDD. In fact, the vast majority of observed MDD cases were incidence cases (94.8%), thus this period in life seems to be an opportune point in time to intervene preventively.

Second, our study further adds to the cumulating evidence that the development of risk-prediction for psychiatric disorders is feasible (Bernardini et al., 2017) and provides evidence that a multivariate prediction model can be a useful tool to accurately predict the onset of MDD during college. Prediction accuracy (AUC = 0.73) was comparable to the few prediction algorithms that have been evaluated for depression within a general population (AUC = 0.71) (Nigatu, Liu, & Wang, 2016) and primary care samples (AUC = 0.82) (Bellon et al., 2011) and are also comparable to other fields of medicine (Karnes et al., 2017; ten Haaf et al., 2017). However, to achieve optimal performance, recalibration of models is needed prior to applying the models to a new population. As predictors included in the model contribute to a model's calibration capacity, it is important to develop target group-specific prediction algorithms because predictors for the risk of MDD onset and their predicted values may differ among different population segments (i.e., college students). The risk prediction algorithm could be used to predict future MDD among incoming freshmen. More research on the validation of such specific risk prediction models is warranted; nevertheless, it is a promising methodology and enables interesting opportunities for the development of individualized approaches for MDD in emerging adults. Data on self-reported risk factors could easily be collected by means of regular student surveys.

The assigned predicted probabilities could then be used as a way to delineate those at highest risk for onset of MDD in the following year. However, although risk-prediction algorithms might be of high value for detecting students at risk, for developing mental health problems, it should be noted that relying only on procedures based on students self-reports might be not sufficient to detect students at risk, and other measures such as staff training and awareness campaigns should not be neglected. Students considered to be at high risk could be offered preventive interventions, for example delivered through the internet (Buntrock et al., 2016, 2017; Ebert et al., 2018; Harrer et al., 2018). Based on our model, over one third of MDD cases will occur in the 10% of students at highest predicted risk. However, this does not imply that students at lower risk do not warrant preventive interventions. More research is needed to obtain information on the needs of students who are associated with different risk levels and which interventions work best at varying levels. Due to high comorbidity rates between emotional disorders (Beekman et al., 2000) and overlapping risk factors (de Graaf, Bijl, Smit, Vollebergh, & Spijker, 2002), such studies should also explore relative advantages of disorder versus trans-diagnostic and individual tailored preventive interventions (Weisel et al., 2018). In addition, clinical outcome and cost-effectiveness research based on varying risk thresholds should be conducted so that intervention decisions derived from the prediction model are evidence-based.

Third, the population-level estimates offered relevant insights into the design of future interventions. Based on individual-level effect sizes, one could argue preventive interventions should focus on students who have been either sexually abused or who had suicide plans or attempts (OR > 8). However, the impact of these factors on a population level overall was very low (PARP < 5%) due to low prevalence. In contrast, targeting students who experience any childhood–adolescent trauma, such as emotional abuse, could have a beneficiary effect for about one third of subsequent depression onsets. Also, the incidence of depression among these students designated to be at high risk (24.7%) is sufficiently high that the cost-effectiveness of a preventive intervention has a reasonable chance of being within an actionable range. Likewise, targeting students whose parents have a mental disorder could potentially reduce one fifth of depression cases (19.7%). Targeting students at college entry who broke recently up with a romantic partner, could have preventive effects for one fifth of subsequent MDD cases. In general, offering such specific interventions, subsequent to a screening at college student entrance, might result in a more developmental approach to the prevention of depression during adolescence and emerging adulthood which may ultimately help decrease the large burden associated with this disorder in young people.

Finally, prevalence estimates of STBs were, potentially due to the exclusion of MDD baseline cases in the present study, somewhat lower than recent estimates of STB cross-national prevalence rates (Mortier et al., 2018). These low prevalence rates lead, as stated above, to a comparable low proportion of MDD cases in the population attributable to STBs. However, due to the disabling nature of STBs and their adverse consequences, there nevertheless is a clear need for interventions that are specifically designed to reach this underreached population (Mortier et al., 2018) and help affected students to cope effectively.

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## DECLARATION OF INTEREST

None.

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## REFERENCES

Alonso, J., Mortier, P., Auerbach, R. P., Bruffaerts, R., Vilagut, G., Cuijpers, P., … Kessler, R. C. (2018). Severe role impairment associated with mental disorders: Results of the WHO World Mental Health Surveys International College Student Project. *Depression and Anxiety*, 35, 802–814. https://doi.org/10.1002/da.22778

Arria, A. M., Caldeira, K. M., Vincent, K. B., Winick, E. R., Baron, R. A., & O'Grady, K. E. (2013). Discontinuous college enrollment: Associations with substance use and mental health. *Psychiatric Services*, 64, 165–172. https://doi.org/10.1176/appi.ps.201200106

Auerbach, R. P., Alonso, J., Axinn, W. G., Cuijpers, P., Ebert, D. D., Green, J. G., … Bruffaerts, R. (2016). Mental disorders among college students in the World Health Organization World Mental Health Surveys. *Psychological Medicine*, 46, 2955–2970. https://doi.org/10.1017/S0033291716001665

Auerbach, R. P., Mortier, P., Bruffaerts, R., Alonso, J., Benjet, C., Cuijpers, P., … & Murray, E. (2018). WHO World Mental Health Surveys International College Student Project: Prevalence and predictors of mental disorders. *Journal of Abnormal Psychology*, 127(7), 623–638.

Babor, T., Higgins-Biddle, J. C., Saunders, J. B., & Monteiro, M. G. (2001). The alcohol use disorders identification test: Guidelines for use in primary care. Geneva, Switzerland: World Health Organization.

Beekman, A. T., de Beurs, E., van Balkom, A. J., Deeg, D. J., van Dyck, R., & van Tilburg, W. (2000). Anxiety and depression in later life: Co-occurrence and communality of risk factors. *The American Journal of Psychiatry*, 157, 89–95. https://doi.org/10.1176/ajp.157.1.89

Bellón, J. A., de Dios Luna, J., King, M., Moreno-Kustner, B., Nazareth, I., Monton-Franco, C., … Torres-Gonzalez, F. (2011). Predicting the onset of major depression in primary care: International validation of a risk prediction algorithm from Spain. *Psychological Medicine*, 41, 2075–2088. https://doi.org/10.1017/s0033291711000468

Berking, M., Wirtz, C. M., Svaldi, J., & Hofmann, S. G. (2014). Emotion regulation predicts symptoms of depression over five years. *Behaviour Research and Therapy*, 57, 13–20. https://doi.org/10.1016/j.brat.2014.03.003

Bernardini, F., Attademo, L., Cleary, S. D., Luther, C., Shim, R. S., Quartesan, R., & Compton, M. T. (2017). Risk prediction models in psychiatry. *The Journal of Clinical Psychiatry*, 78, 572–583. https://doi.org/10.4088/JCP.15r10003

Brandy, J. M., Penckofer, S., Solari-Twadell, P. A., & Velsor-Friedrich, B. (2015). Factors predictive of depression in first-year college students. *Journal of Psychosocial Nursing and Mental Health Services*, 53, 38–44. https://doi.org/10.3928/02793695-20150126-03

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. https://doi.org/10.1111/j.1360-0443.2007.01841.x

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. https://doi.org/10.1111/j.1600-0447.1990.tb01360.x

Buntrock, C., Berking, M., Smit, F., Lehr, D., Nobis, S., Riper, H., … Ebert, D. (2017). Preventing depression in adults with subthreshold depression: Health-economic evaluation alongside a pragmatic randomized controlled trial of a web-based intervention. *Journal of Medical Internet Research*, 19, e5. https://doi.org/10.2196/jmir.6587

Buntrock, C., Ebert, D. D., Lehr, D., Smit, F., Riper, H., Berking, M., & Cuijpers, P. (2016). Effect of a web-based guided self-help intervention for prevention of major depression in adults with subthreshold depression a randomized clinical trial. *JAMA - Journal of the American Medical Association*, 315, 1854–1863. https://doi.org/10.1001/jama.2016.4326

Cole, M. G., & Dendukuri, N. (2003). Risk factors for depression among elderly community subjects: A systematic review and meta-analysis. *American Journal of Psychiatry*, 160, 1147–1156. https://doi.org/10.1176/appi.ajp.160.6.1147

Cranford, J. A., Eisenberg, D., & Serras, A. M. (2009). Substance use behaviors, mental health problems, and use of mental health services in a probability sample of college students. *Addictive Behaviors*, 34, 134–145. https://doi.org/10.1016/j.addbeh.2008.09.004

de Graaf, R., Bijl, R. V., Smit, F., Vollebergh, W. A. M., & Spijker, J. (2002). Risk factors for 12-month comorbidity of mood, anxiety, and substance use disorders: Findings from the Netherlands Mental Health Survey and Incidence Study. *American Journal of Psychiatry*, 159, 620–629. https://doi.org/10.1176/appi.ajp.159.4.620

DeMartini, K. S., & Carey, K. B. (2012). Optimizing the use of the AUDIT for alcohol screening in college students. *Psychological Assessment*, 24, 954–963. https://doi.org/10.1037/a0028519

Ebert, D. D., Hopfinger, L., & Berking, M. (2017). Emotion regulation protects against recurrence of depressive symptoms following inpatient care for major depressive disorder. *Behavior Therapy*, 48, 739–749. https://doi.org/10.1016/j.beth.2017.03.003

Ebert, D. D., Van Daele, T., Nordgreen, T., Karekla, M., Compare, A., Zarbo, C., … Baumeister, H. (2018). Internet- and mobile-based psychological

interventions: Applications, efficacy, and potential for improving mental health–A report of the EFPA E-Health Taskforce. *European Psychologist, 23*, 167–187. https://doi.org/10.1027/1016-9040/a000318

Efron, B., & Gong, G. (1983). A leisurely look at the bootstrap, the jackknife, and cross-validation. *The American Statistician, 37*, 36–48. https://doi.org/10.2307/2685844

Eisenberg, D., Hunt, J., & Speer, N. (2013). Mental health in American colleges and universities: Variation across student subgroups and across campuses. *The Journal of Nervous and Mental Disease, 201*, 60–67. https://doi.org/10.1097/NMD.0b013e31827ab077

Farabaugh, A., Bitran, S., Nyer, M., Holt, D. J., Pedrelli, P., Shyu, I., … Fava, M. (2012). Depression and suicidal ideation in college students. *Psychopathology, 45*, 228–234. https://doi.org/10.1159/000331598

Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., … Marks, J. S. (1998). Household dysfunction to many of the leading causes of death in adults the adverse childhood experiences (ACE) study. *American Journal of Preventive Medicine, 14*, 245–258. https://doi.org/10.1016/s0749-3797(98)00017-8

Firth, D. (1993). Bias reduction of maximum likelihood estimates. *Biometrika, 80*(1), 27–38.

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. https://doi.org/10.2196/jmir.9293

Hysenbegasi, A., Hass, S. L., & Rowland, C. R. (2005). The impact of depression on the academic productivity of university students. *The Journal of Mental Health Policy and Economics, 8*, 145–151.

Karnes, R. J., Choeurng, V., Ross, A. E., Schaeffer, E. M., Klein, E. A., Freedland, S. J., … Trock, B. J. (2017). Validation of a genomic risk classifier to predict prostate cancer-specific mortality in men with adverse pathologic features. *European Urology, 73*, 168–175. https://doi.org/10.1016/j.eururo.2017.03.036

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 in Psychiatric Research, 22*, 303–321. https://doi.org/10.1002/mpr.1398

Kessler, R. C., & Üstün, 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 in Psychiatric Research, 13*, 93–118.

Kessler, R. C., van Loo, H. M., Wardenaar, K. J., Bossarte, R. M., Brenner, L. A., Cai, T., … Zaslavsky, A. M. (2016). Testing a machine-learning algorithm to predict the persistence and severity of major depressive disorder from baseline self-reports. *Molecular Psychiatry, 21*, 1366–1371. https://doi.org/10.1038/mp.2015.198

Kessler, R. C., van Loo, H. M., Wardenaar, K. J., Bossarte, R. M., Brenner, L. A., Ebert, D. D., … Zaslavsky, A. M. (2017). Using patient self-reports to study heterogeneity of treatment effects in major depressive disorder. *Epidemiology and Psychiatric Sciences, 26*, 22–36. https://doi.org/10.1017/S2045796016000020

Kessler, R., Farley, P., Gruber, M., Harshaw, Q., Jewell, M., Sampson, N., & Shillington, A. (2010). Concordance of computerized self-report measures of Dsm-Iv-Tr mood and anxiety disorders compared to gold standard clinical assessments in primary care. International Society *for* Pharmacoeconomics and Outcomes Research 15th Annual International Meeting, Atlanta, Georgia.

Korten, N. C. M., Comijs, H. C., Lamers, F., & Penninx, B. W. J. H. (2012). Early and late onset depression in young and middle aged adults:

Differential symptomatology, characteristics and risk factors? *Journal of Affective Disorders, 138*, 259–267. https://doi.org/10.1016/j.jad.2012.01.042

Krysinska, K., & Martin, G. (2009). The struggle to prevent and evaluate: Application of population attributable risk and preventive fraction to suicide prevention research. *Suicide & Life-Threatening Behavior, 39*, 548–557. https://doi.org/10.1521/suli.2009.39.5.548

Leino, E. V., & Kisch, J. (2005). Correlates and predictors of depression in college students: Results from the spring 2000 national college health assessment. *American Journal of Health Education, 36*, 66–74. https://doi.org/10.1080/19325037.2005.10608162

Mahmoud, J. S. R., "Topsy" Staten, R., Hall, L. A., & Lennie, T. A. (2012). The relationship among young adult college students' depression, anxiety, stress, demographics, life satisfaction, and coping styles. *Issues in Mental Health Nursing, 33*, 149–156. https://doi.org/10.3109/01612840.2011.632708

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*, 279–288. https://doi.org/10.1007/s00127-018-1481-6

Mortier, P., Auerbach, R. P., Alonso, J., Bantjes, J., Benjet, C., Cuijpers, P., … Vives, M. (2018). Suicidal thoughts and behaviors among first-year college students: Results from the WMH-ICS Project. *Journal of the American Academy of Child and Adolescent Psychiatry, 57*, 263–273. https://doi.org/10.1016/j.jaac.2018.01.018

Mortier, P., Demyttenaere, K., Auerbach, R. P., Cuijpers, P., Green, J. G., Kiekens, G., … Bruffaerts, R. (2017). First onset of suicidal thoughts and behaviours in college. *Journal of Affective Disorders, 207*, 291–299. https://doi.org/10.1016/j.jad.2016.09.033

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. https://doi.org/10.1001/jama.285.16.2094

Nigatu, Y. T., Liu, Y., & Wang, J. (2016). External validation of the international risk prediction algorithm for major depressive episode in the US general population: The PredictD-US study. *BMC Psychiatry, 16*, 1–8. https://doi.org/10.1186/s12888-016-0971-x

Nock, M. K., Borges, G., & Ono, Y. (2012). *Suicide: Global perspectives from the WHO World Mental Health Surveys*. Cambridge: Cambridge University Press.

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*, 309–317. https://doi.org/10.1037/1040-3590.19.3.309

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*, 276–282. https://doi.org/10.1016/j.psychres.2014.12.026

Pelkonen, M., Marttunen, M., Kaprio, J., Huurre, T., & Aro, H. (2008). Adolescent risk factors for episodic and persistent depression in adulthood. A 16-year prospective follow-up study of adolescents. *Journal of Affective Disorders, 106*, 123–131. https://doi.org/10.1016/j.jad.2007.06.001

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*, 1266–1277. https://doi.org/10.1176/appi.ajp.2011.10111704

Rawson, H. E., Bloomer, K., & Kendall, A. (1994). Stress, anxiety, depression, and physical illness in college students. *Journal of Genetic Psychology*, *155*, 321–330. https://doi.org/10.1080/00221325.1994.9914782

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies of causal effects. *Biometrika*, *70*, 41–55. https://doi.org/10.1093/biomet/70.1.41

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): World Health Organisations Collaborative Project on early detection of persons with harmful alcohol consumption - II. *Addiction*, *88*, 791–804. https://doi.org/10.1111/j.1360-0443.1993.tb02093.x

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 Addictive Behaviors*, *24*, 119–128. https://doi.org/10.1037/a0017210

Smith, G. C., Seaman, S. R., Wood, A. M., Royston, P., & White, I. R. (2014). Correcting for optimistic prediction in small data sets. *American Journal of Epidemiology*, *180*, 318–324. https://doi.org/10.1093/aje/kwu140

Swearer, S. M., & Cary, P. T. (2003). Perceptions and attitudes toward bullying in middle school youth: A developmental examination across the bully/victim continuum. *Journal of Applied School Psychology*, *19*(2), 63–79. https://doi.org/10.1300/j008v19n02_05

ten Haaf, K., Jeon, J., Tammemägi, M. C., Han, S. S., Kong, C. Y., Plevritis, S. K., … Meza, R. (2017). Risk prediction models for selection of lung cancer screening candidates: A retrospective validation study. *PLOS Medicine*, *14*, e1002277. https://doi.org/10.1371/journal.pmed.1002277

van Buuren, S. (2007). Multiple imputation of discrete and continuous data by fully conditional specification. *Statistical Methods in Medical Research*, *16*, 219–242. https://doi.org/10.1177/0962280206074463

van Zoonen, K., Buntrock, C., Ebert, D. D., Smit, F., Reynolds, C. F., Beekman, A. T., & Cuijpers, P. (2014). Preventing the onset of major depressive disorder: A meta-analytic review of psychological interventions. *International Journal of Epidemiology*, *43*, 318–329. https://doi.org/10.1093/ije/dyt175

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 Operation Iraqi Freedom veterans. *Assessment*, *15*, 391–403. https://doi.org/10.1177/1073191108316030

Vos, T., Flaxman, A. D., Naghavi, M., Lozano, R., Michaud, C., Ezzati, M., … Memish, Z. A. (2012). Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet*, *380*, 2163–2196. https://doi.org/10.1016/s0140-6736(12)61729-2

Weisel, K. K., Zarski, A.-C., Berger, T., Krieger, T., Schaub, M. P., Moser, C. T., … Ebert, D. D. (2018). Efficacy and cost-effectiveness of guided and unguided internet- and mobile-based indicated transdiagnostic prevention of depression and anxiety (ICare Prevent): A three-armed randomized controlled trial in four European countries. *Internet Interventions*, https://doi.org/10.1016/j.invent.2018.04.002

Wild, J., Smith, K. V, Thompson, E., Béar, F., Lommen, M. J. J., & Ehlers, A. (2016). A prospective study of pre-trauma risk factors for post-traumatic stress disorder and depression. *Psychological Medicine*, *46*, 2571–2582. https://doi.org/10.1017/S0033291716000532

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*, 180–185. https://doi.org/10.1016/j.jad.2009.01.001

## SUPPORTING INFORMATION

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