

# Trends in depressive symptoms among high school students with and without health-risk behaviors in the United States: A population-based study



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## Summary

**Background** Despite the recent rise in depressive symptoms among adolescents, trends in at-risk groups remain poorly understood. This study estimated national trends in depressive symptoms among high school students with and without health-risk behaviors.

**Methods** Data were analyzed from the 2007 to 2021 Youth Risk Behavior Survey (YRBS), a biennial cross-sectional survey of US high school students ( $n = 119,654$ ). Depressive symptoms were defined as past-year feelings of sadness/hopelessness almost every day for  $\geq 2$  weeks impacting usual activities. 24 health-risk behaviors across five categories (violence, substance use, sexual, physical/sedentary, and weight-related) were considered. Multivariable-adjusted logistic regression identified health-risk behaviors independently associated with depressive symptoms. National trends in depressive symptoms among students with and without these health-risk behaviors were estimated. National trends in health-risk behaviors were also estimated among those with depressive symptoms.

**Findings** Among 119,654 students (mean age, 16.0 [SD = 1.2] years; 50.1% females; and 45.3% non-Hispanic White), depressive symptoms increased from 28.4% (2007) to 42.3% (2021) (biennial average percent change (BAPC), 3.0% [95% confidence interval (CI), 2.6–3.4%]). The largest increases occurred among females (BAPC, 3.3% [2.9–3.8%]) and non-Hispanic White students (BAPC, 3.6% [3.0–4.1%]). Depressive symptoms increased more among students engaging in  $\leq 1$  risk category (BAPC = 4.6% [3.6–5.7%]) than students engaging in 4–5 risk categories (BAPC = 2.9% [2.4–3.3%]) (interaction,  $p = 0.037$ ) and there was a general trend toward decreasing engagement in risk behaviors among students with depressive symptoms. In subgroup analyses, there was a disproportionately large increase in depressive symptoms among students reporting cannabis use, high-risk screen time, shorter sleep hours, and unhealthy weight perception.

**Interpretation** Depressive symptoms increased faster among high school students without than with multiple behavioral risk factors. A broadening of the depression risk profile underscores the potential value of universal depression screening to identify students who may otherwise go undetected by targeted screening.

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**Keywords:** Adolescent; Depression; Youth; Mental health; Substance use

## Introduction

In the past decade, national survey data have revealed a concerning rise in depression and depressive symptoms

among adolescents, especially among females.<sup>1–4</sup> Recent studies have found that the percent of adolescent females meeting criteria for major depression doubled

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### Research in context

#### Evidence before this study

We searched PubMed and Google Scholar for studies examining trends in depression or depressive symptoms among adolescents. We used the following search terms: ("depression" OR "major depressive disorder" OR "depressive symptoms") AND ("adolescents" OR "high school students" OR "middle school students" OR "teenagers") AND ("trend" OR "prevalence" OR "incidence" or "rate"). This search was supplemented with searching of references in identified papers. Our search was limited to studies examining trends after 2007 in the United States. Studies published after February 2024 were not included. This search found that previous studies have focused on trends in depressive symptoms stratified by sex and race and ethnicity, showing that females and White and Hispanic adolescents have demonstrated a recent disproportionate increase in depressive symptoms, but there has been little investigation of trends in

other risk groups, including adolescents engaging in risk behaviors associated with depressive symptoms.

#### Added value of this study

This nationally-representative study of over 119,000 high school students extends prior studies by demonstrating that the recent rise in depressive symptoms among adolescents has not been confined to students with established behavioral risks, but has actually increased more among students with few or no behavioral risks.

#### Implications of all the available evidence

A broadening of the depression risk profile underscores the potential value of universal depression screening to identify students who may otherwise go undetected by targeted screening.

from 11.4% to 23.4% between 2009 and 2019,<sup>4</sup> and the percent reporting depressive symptoms increased 33.9%–46.6% over this period.<sup>5</sup> These trends are a concerning departure from the four decades prior which saw stable or decreasing rates of adolescent depression.<sup>6,7</sup> While depressive symptoms are more common than clinical depression,<sup>8</sup> they are associated with functional impairment<sup>9</sup> and increased risk of developing clinical depression and other psychiatric conditions in adulthood.<sup>10,11</sup> Thus, adolescent depressive symptoms are an important mental health vulnerability to monitor.

Despite the rise in adolescent depressive symptoms, identification of at-risk groups and risk factors associated with this rise remain poorly understood. While previous studies have focused on trends in depressive symptoms stratified by sex and race and ethnicity, showing that females and White and Hispanic adolescents have demonstrated the largest increase,<sup>4,5</sup> there has been little investigation of trends in other risk groups, including adolescents engaging in risk behaviors associated with depressive symptoms.

Adolescence is a period of increasing engagement in risk-taking behaviors and emergence of psychopathology. Several health-risk behaviors have been shown to be associated with depressive symptoms bidirectionally, including substance use,<sup>12,13</sup> victimization,<sup>14–17</sup> sedentary activity,<sup>18–20</sup> body dissatisfaction and unhealthy weight control behaviors,<sup>21,22</sup> obesity,<sup>23,24</sup> inadequate sleep,<sup>25</sup> and high-risk screen time.<sup>26–29</sup> These behaviors increase risk of developing depressive symptoms through biological, psychological, and social mechanisms. Similarly, depressive symptoms predispose adolescents to greater engagement in risk behaviors through similar processes.<sup>30–32</sup> It is not known whether depressive symptoms have been increasing disproportionately

among adolescents impacted by one or more of these risk behaviors or whether certain risk behaviors are associated with the rise in depressive symptoms.

There are two primary ways of assessing the relationship between risk behaviors and depressive symptoms among adolescents. The first is to examine trends in depressive symptoms among adolescents with and without risk behaviors, allowing for the identification of emerging at-risk groups where depressive symptoms are rising faster than others. The second is to examine trends in risk behaviors among adolescents reporting depressive symptoms, which allows for identification of risk behaviors that co-occur with depressive symptoms to a greater or lesser degree over time.

Examining trends in health-risk behaviors and depressive symptoms may inform screening and intervention strategies at the clinical and population levels. For example, if depressive symptoms are rising disproportionately among groups with known behavioral risks, it may favor targeted depression screening toward these groups. However, if symptoms are extending to those without established risk factors, it may support universal screening.<sup>33</sup> Furthermore, if certain behavioral risks are increasing among adolescents with depressive symptoms, clinical or population-based strategies may be warranted to prevent or intervene upon these risk behaviors.

This study uses data from the 2007 to 2021 Youth Risk Behavior Survey (YRBS), a cross-sectional survey of US high school students that monitors health-risk behaviors contributing to the leading causes of death and disability among adolescents, including violence, substance use, sexual, physical/sedentary, and weight-related risk behaviors.<sup>6,34–37</sup> The aim of this study was to examine trends in depressive symptoms from 2007 to

2021 among high school students with and without health-risk behaviors. We hypothesized a disproportionate increase in depressive symptoms among students with established behavioral risk factors.

## Methods

### Data source and study sample

YRBS has been conducted biennially by the Centers for Disease Control and Prevention (CDC) since 1991. The survey uses a 3-stage cluster sampling design to produce a nationally-representative sample of high school students in grades 9–12 among public and private schools.<sup>34</sup> A weighting factor in the complex survey design based on student sex, race and ethnicity, and grade was applied to each record to adjust for non-response and oversampling of Black and Hispanic students.<sup>38</sup> The survey is administered during class time by trained data collectors. No compensation is provided and students complete the questionnaire anonymously and voluntarily. Informed consent is obtained from the legal guardian of each student. The CDC Institutional Review Board approved the YRBS protocol.<sup>34</sup> Our study used data that were publicly available and did not include human participant research. As per 45 CFR §46.102(f) of the United States Department of Health & Human Services Regulations, this study was not submitted for institutional review board approval and did not require informed consent procedures. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline for cross-sectional studies ([Supplementary Table S6](#)).<sup>39</sup>

This study included data from the 2007 to 2021 YRBS. We selected 2007 as the baseline year as this was the period in which depressive symptoms began to rise.<sup>6</sup> School response rates ranged from 73% (2021) to 81% (2009); student response rates ranged from 79% (2021) to 88% (2009), and overall response rates ranged from 58% (2021) to 71% (2009).<sup>40</sup> The analytic sample included 119,654 high school students who answered questions about depressive symptoms from 2007 to 2021. Additional details regarding the methodology and design of the YRBS are reported elsewhere.<sup>38,40,41</sup>

### Measures

*Demographic variables* included self-reported biological sex (female vs. male), grade, sexual identity, and race and ethnicity. YRBS asks two questions about race and Hispanic heritage, resulting in four categories: non-Hispanic White, non-Hispanic Black, Hispanic, and non-Hispanic other races. Sexual identity questions were introduced in 2015 and asked respondents to identify which identity best described them (heterosexual, gay/lesbian, bisexual, and not sure).

*Depressive symptoms* were assessed with a dichotomous variable (yes/no) that asked respondents “During

the past 12 months, did you ever feel so sad or hopeless almost every day for two weeks or more in a row that you stopped doing some usual activities?” This item has been extensively used to assess depressive symptoms<sup>5,29,42</sup> with a reliability kappa of 0.427–0.564.<sup>43,44</sup>

*Health-risk behaviors* included 24 risk behaviors that have been associated with depressive symptoms and were included in each biennial survey from 2007 to 2021. Three exceptions were made for behaviors more recently introduced in YRBS, including school bullying (2009–2021), electronic bullying (2011–2021), and sexual identity (2015–2021). While this limits the ability to assess trends in these risk behaviors over the entire study period, we chose to include them because they have been highly associated with depressive symptoms.<sup>45–47</sup> The 24 health-risk behaviors were then grouped into five *categories*: violence, substance use, sexual activity, weight-related, and physical/sedentary activity, consistent with previous studies.<sup>48</sup> The definition and analytic coding for each health-risk behavior is listed in [Supplementary Table S1](#).

*Risk groups* were created based on the number of risk categories in which students endorsed behaviors. Students were classified as *low-risk* if they endorsed  $\geq 1$  health-risk behavior in 0 or 1 category, *medium-risk* if they endorsed  $\geq 1$  behavior in 2 or 3 categories, and *high-risk* if they endorsed  $\geq 1$  behavior in 4 or 5 categories. For example, if a student endorsed being bullied in the last month (violence risk category) and was getting an average of 5 h of sleep per night (physical/sedentary risk category), they were considered “medium-risk” since they endorsed a risk behavior in 2 categories.

### Data analysis

First, to identify demographic and health-risk behaviors associated with depressive symptoms in the entire sample and by sex, we performed multivariable-adjusted logistic regression analysis, which included all aforementioned covariates except some of variables due to multi-collinearity issues (i.e., age, forced to have sexual intercourse, perception of weight, and any lifetime IV drug use) ([Table 1](#)). The multivariable-adjusted logistic regression analysis was appropriate as the outcome of interest (i.e., depressive symptoms) had binary responses (i.e., yes or no), and the multi-collinearity issues were tested using a variance inflation factor (VIF) (with a cut-point of 10 or greater having multi-collinearity issues). Second, we estimated national trends of depressive symptoms among high school students from 2007 to 2021. We report biennial average percent changes (BAPCs) with 95% confidence intervals (CIs),<sup>49</sup> using a modified Poisson model. Modified Poisson regression models were deemed appropriate after testing for multiple goodness-of-fit tests (e.g., modified Hosmer–Lemeshow test with empirical variance and normalized residual sum of squares test)<sup>50</sup> and they were adjusted for age, sex, and race and ethnicity<sup>51</sup> ([Table 2](#)).

| <i>Reference group in a parenthesis.</i>                     | <b>Overall<br/>Odds ratio (95% CI; p)</b> | <b>Among males<br/>Odds ratio (95% CI; p)</b> | <b>Among females<br/>Odds ratio (95% CI; p)</b> |
|--|---|---|---|
| Period   | 1.08 (1.05–1.17; <0.0001)                 | 1.10 (1.05–1.15; <0.0001)                     | 1.06 (1.02–1.11; 0.005)                         |
| <b>Socio-demographic factor</b>                              |   |   |   |
| Grade (freshman)   |   |   |   |
| Sophomore  | 1.08 (0.96–1.21; 0.19)                    | 1.19 (0.99–1.42; 0.06)                        | 1.00 (0.87–1.15; 0.97)                          |
| Junior   | 1.11 (0.99–1.25; 0.07)                    | 1.31 (1.11–1.55; 0.002)                       | 0.96 (0.82–1.12; 0.59)                          |
| Senior   | 1.03 (0.91–1.17; 0.59)                    | 1.43 (1.16–1.76; 0.001)                       | 0.79 (0.68–0.92; 0.002)                         |
| Sex (female)   |   |   |   |
| Male   | 0.46 (0.41–0.51; <0.0001)                 |   |   |
| Sexual orientation (straight)                                |   |   |   |
| Gay or lesbian   | 2.96 (2.21–3.98; <0.0001)                 | 2.55 (1.62–4.04; <0.0001)                     | 3.32 (2.29–4.82; <0.0001)                       |
| Bisexual   | 2.91 (2.51–3.37; <0.0001)                 | 2.73 (1.88–3.94; <0.0001)                     | 2.89 (2.45–3.41; <0.0001)                       |
| Other  | 1.89 (1.50–2.39; <0.0001)                 | 2.02 (1.39–2.94; <0.0001)                     | 1.83 (1.37–2.43; <0.0001)                       |
| Race and ethnicity (non-Hispanic White)                      |   |   |   |
| Black, non-Hispanic  | 0.76 (0.65–0.90; 0.001)                   | 0.64 (0.49–0.83; 0.001)                       | 0.88 (0.71–1.09; 0.24)                          |
| Hispanic   | 1.30 (1.16–1.45; <0.0001)                 | 2.73 (1.88–3.97; <0.0001)                     | 1.42 (1.23–1.64; <0.0001)                       |
| Other, non-Hispanic  | 1.19 (1.04–1.36; 0.010)                   | 2.02 (1.39–2.94; <0.0001)                     | 1.16 (0.97–1.40; 0.11)                          |
| <b>Violence-related risk behavior</b>                        |   |   |   |
| Carrying a weapon in the past month (never)                  |   |   |   |
| 1–3 days   | 0.82 (0.53–1.29; 0.40)                    | 0.89 (0.55–1.45; 0.64)                        | 0.70 (0.22–2.27; 0.55)                          |
| ≥4 days  | 0.90 (0.64–1.28; 0.51)                    | 0.85 (0.55–1.29; 0.43)                        | 1.20 (0.67–2.15; 0.54)                          |
| Threatened with a weapon in the past year (never)            |   |   |   |
| 1–3 times  | 1.36 (1.06–1.76; 0.02)                    | 1.56 (1.14–2.13; 0.006)                       | 1.19 (0.85–1.66; 0.32)                          |
| ≥4 times   | 0.95 (0.61–1.47; 0.82)                    | 0.98 (0.57–1.68; 0.95)                        | 1.09 (0.53–2.23; 0.81)                          |
| Physical fight in the past year (never)                      |   |   |   |
| 1–3 times  | 1.58 (1.35–1.86; <0.0001)                 | 1.64 (1.35–1.98; <0.0001)                     | 1.48 (1.20–1.82; <0.0001)                       |
| ≥4 times   | 1.38 (1.11–1.71; 0.004)                   | 1.41 (1.04–1.92; 0.027)                       | 1.62 (1.06–2.47; 0.024)                         |
| Missed school due to safety issues in the past month (never) |   |   |   |
| 1–3 times  | 2.10 (1.67–2.63; <0.0001)                 | 1.92 (1.28–2.87; 0.002)                       | 2.31 (1.79–2.98; <0.0001)                       |
| ≥4 times   | 2.29 (1.38–3.82; 0.001)                   | 1.27 (0.61–2.67; 0.52)                        | 4.72 (1.68–13.25; 0.003)                        |
| Bullied on a school property in the past year (no)           |   |   |   |
| Yes  | 1.98 (1.76–2.22; <0.0001)                 | 1.98 (1.67–2.34; <0.0001)                     | 1.99 (1.72–2.31; <0.0001)                       |
| Bullied electronically in the past year (no)                 |   |   |   |
| Yes  | 2.06 (1.83–2.32; <0.0001)                 | 2.16 (1.75–2.68; <0.0001)                     | 1.96 (1.70–2.26; <0.0001)                       |
| <b>Physical/sedentary-related risk behavior</b>              |   |   |   |
| Watching TV on a daily basis (not at all)                    |   |   |   |
| 1 h per day or less  | 0.82 (0.73–0.92; 0.001)                   | 0.83 (0.70–0.98; 0.029)                       | 0.85 (0.74–0.97; 0.015)                         |
| 2 or 3 h per day   | 0.82 (0.73–0.92; 0.001)                   | 0.78 (0.66–0.91; 0.001)                       | 0.88 (0.76–1.01; 0.08)                          |
| 4 or more h per day  | 0.85 (0.72–1.01; 0.07)                    | 0.76 (0.60–0.96; 0.020)                       | 0.97 (0.80–1.19; 0.79)                          |
| Physical activity on a weekly basis (≥5 days)                |   |   |   |
| Not at all   | 1.35 (1.20–1.52; <0.0001)                 | 1.41 (1.13–1.76; 0.002)                       | 1.29 (1.09–1.54; 0.004)                         |
| 1 or 2 days  | 1.24 (1.12–1.39; <0.0001)                 | 1.34 (1.10–1.63; 0.003)                       | 1.19 (1.01–1.39; 0.033)                         |
| 3 or 4 days  | 1.19 (1.07–1.32; 0.001)                   | 1.08 (0.92–1.27; 0.36)                        | 1.27 (1.09–1.47; 0.002)                         |
| Hours of sleep on average school night (≥8 h)                |   |   |   |
| ≤5 h   | 2.51 (2.24–2.82; <0.0001)                 | 2.43 (1.92–3.06; <0.0001)                     | 2.61 (2.18–3.12; <0.0001)                       |
| 6–7 h  | 1.38 (1.23–1.56; <0.0001)                 | 1.37 (1.17–1.60; <0.0001)                     | 1.40 (1.16–1.69; 0.001)                         |
| Screen time on a daily basis (not at all)                    |   |   |   |
| 1 h per day or less  | 1.03 (0.87–1.21; 0.71)                    | 0.89 (0.72–1.11; 0.31)                        | 1.11 (0.91–1.34; 0.30)                          |
| 2 or 3 h per day   | 1.19 (1.04–1.35; 0.009)                   | 1.05 (0.85–1.30; 0.67)                        | 1.27 (1.09–1.47; 0.002)                         |
| 4 or more h per day  | 1.54 (1.34–1.76; <0.0001)                 | 1.32 (1.06–1.63; 0.011)                       | 1.63 (1.38–1.94; <0.0001)                       |
| <b>Weighted-related risk factor</b>                          |   |   |   |
| Body mass index (underweight or normal)                      |   |   |   |
| Overweight   | 1.14 (1.03–1.27; 0.014)                   | 1.09 (0.92–1.28; 0.32)                        | 1.16 (1.02–1.33; 0.022)                         |
| Obese  | 1.15 (1.00–1.31; 0.043)                   | 1.11 (0.92–1.35; 0.28)                        | 1.21 (1.01–1.45; 0.041)                         |

(Table 1 continues on next page)

| Reference group in a parenthesis.  | Overall<br>Odds ratio (95% CI; p) | Among males<br>Odds ratio (95% CI; p) | Among females<br>Odds ratio (95% CI; p) |
|--|-----------------------------------|---------------------------------------|---|
| (Continued from previous page)   |                                   |                                       |   |
| <b>Substance use-related risk behavior</b>   |                                   |                                       |   |
| Alcohol use in the past month (never)  |                                   |                                       |   |
| <10 days   | 1.17 (1.02-1.33; 0.025)           | 1.11 (0.91-1.35; 0.30)                | 1.19 (1.03-1.38; 0.016)                 |
| ≥10 days   | 1.00 (0.76-1.31; 1.00)            | 0.91 (0.60-1.37; 0.64)                | 1.11 (0.73-1.68; 0.62)                  |
| Cigarette use in the past month (never)  |                                   |                                       |   |
| <10 days   | 1.17 (0.97-1.42; 0.10)            | 1.14 (0.89-1.45; 0.30)                | 1.25 (0.87-1.81; 0.23)                  |
| ≥10 days   | 1.30 (0.99-1.70; 0.05)            | 1.24 (0.84-1.85; 0.28)                | 1.29 (0.87-1.92; 0.21)                  |
| Cannabis use in the past month (never)   |                                   |                                       |   |
| <10 times  | 1.38 (1.17-1.62; <0.0001)         | 1.34 (1.06-1.68; 0.013)               | 1.36 (1.12-1.66; 0.002)                 |
| ≥10 times  | 1.35 (1.14-1.61; 0.001)           | 1.28 (1.01-1.63; 0.04)                | 1.47 (1.15-1.90; 0.003)                 |
| Lifetime cocaine use (no)  |                                   |                                       |   |
| Yes  | 1.18 (0.91-1.54; 0.20)            | 1.09 (0.76-1.56; 0.62)                | 1.36 (0.90-2.06; 0.14)                  |
| Lifetime inhalant use (no)   |                                   |                                       |   |
| Yes  | 1.71 (1.32-2.20; <0.0001)         | 2.08 (1.48-2.93; <0.0001)             | 1.47 (1.09-1.98; 0.011)                 |
| Lifetime heroin use (no)   |                                   |                                       |   |
| Yes  | 1.84 (0.94-3.61; 0.08)            | 2.76 (1.13-6.77; 0.027)               | 1.38 (0.45-4.19; 0.57)                  |
| Lifetime methamphetamine use (no)  |                                   |                                       |   |
| Yes  | 0.85 (0.61-1.20; 0.36)            | 0.72 (0.42-1.23; 0.23)                | 1.01 (0.57-1.77; 0.98)                  |
| Lifetime ecstasy use (no)  |                                   |                                       |   |
| Yes  | 0.97 (0.74-1.26; 0.81)            | 0.90 (0.62-1.31; 0.58)                | 1.11 (0.71-1.75; 0.64)                  |
| Lifetime hallucinogenic use (no)   |                                   |                                       |   |
| Yes  | 1.16 (0.96-1.39; 0.12)            | 1.05 (0.78-1.43; 0.74)                | 1.31 (0.92-1.86; 0.14)                  |
| <b>Sexual risk behavior</b>  |                                   |                                       |   |
| Sexual activity in the past 3 months (never)   |                                   |                                       |   |
| Yes, but not in the past 3 months  | 1.31 (1.16-1.49; <0.0001)         | 1.17 (0.93-1.46; 0.18)                | 1.54 (1.29-1.85; <0.0001)               |
| Yes, and with 1 person only  | 1.34 (1.22-1.48; <0.0001)         | 1.18 (0.99-1.40; 0.06)                | 1.51 (1.30-1.74; <0.0001)               |
| Yes, and with ≥2 persons   | 1.23 (1.00-1.52; 0.047)           | 1.06 (0.81-1.39; 0.65)                | 1.60 (1.23-2.09; 0.001)                 |
| <b>Note:</b> Data are from Youth Risk Behavior Survey (YRBS), and analyses were adjusted for complex survey designs. CI, confidence interval. <i>p</i> denotes <i>p</i> -values. Some of variables were not included due to multi-collinearity (e.g., age, forced to have sexual intercourse, perception of weight, and any lifetime IV drug use). |                                   |                                       |   |
| <b>Table 1: Multivariable-adjusted logistic regression models of sociodemographic factors and health-risk behaviors associated with depressive symptoms among high school students, 2007–2021.</b>   |                                   |                                       |   |

Third, we estimated national trends of depressive symptoms by individual demographic and health-risk behaviors and reported BAPCs with 95% CIs. We conducted interaction analyses (using logistic regression models) of each factor and time on depressive symptoms, controlling for age, sex, and race and ethnicity (Table 2). A similar analysis was repeated among students who endorsed depressive symptoms (Table 3).

Fourth, we estimated national trends of depressive symptoms by risk group and reported BAPCs with 95% CIs (Fig. 1). We also estimated trends in risk groups over time among students with depressive symptoms (Fig. 2). Lastly, we performed subgroup analyses by COVID-19 pandemic (Supplementary Tables S2 and S3) and by sex (Supplementary Tables S4 and S5).

We used the statistical software, Stata version 16.1 MP/4-Core, for all analyses. We accounted for YRBS complex survey design using *svy* commands to account for multi-stage, complex survey sampling techniques (i.e., unequal probability of selection, clustering, and

stratification) used in the data collection. Taylor-linearized variance estimation was used. Missing data in covariates (<1.8% of the entire sample) were controlled for using a listwise deletion method in the final multivariable-adjusted models.<sup>52</sup> The depressive symptoms had a missing proportion of 1.3% across the years. Similar random missing patterns were found in all other key socio-demographic variables (e.g., grade and sex), except the year, which had complete data. Because this study is exploratory in nature, multiplicity was not tested and therefore *p*-values and confidence intervals should be interpreted with caution. We set *p*-value <0.05 (two-tailed) as the test of statistical significance.

#### Role of the funding source

The funders were not involved in the study design, data collection, analysis, interpretation of data, writing of the report, or the decision to submit the manuscript for publication.

| Unweighted sample (weighted row %)                   | Unweighted sample size | 2007            | 2009            | 2011            | 2013            | 2015           | 2017           | 2019           | 2021           | Biennial APC (95% CI; p-value) | Interaction <sup>a</sup> (95% CI; p-value) |
|--|------------------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|----------------|----------------|--------------------------------|--|
|  | 119,654                | 13,950 (11.6%)  | 16,295 (13.6%)  | 15,295 (12.8%)  | 13,462 (11.3%)  | 15,498 (13.0%) | 14,603 (12.2%) | 13,518 (11.3%) | 17,033 (14.2%) |                                |  |
| All  | 118,197                | 28.4%           | 26.1%           | 28.4%           | 30.0%           | 29.9%          | 31.4%          | 36.7%          | 42.3%          | 3.0% (2.6–3.4%; <0.0001)       |  |
| Grade  |                        |                 |                 |                 |                 |                |                |                |                |                                |  |
| Freshman   | 30,468                 | 28.2%           | 26.5%           | 27.6%           | 29.4%           | 28.3%          | 29.7%          | 33.1%          | 38.5%          | 2.3% (1.6–3.0%; <0.0001)       | Reference                                  |
| Sophomore  | 29,628                 | 29.0%           | 26.1%           | 28.6%           | 29.5%           | 29.8%          | 32.5%          | 37.0%          | 41.3%          | 3.0% (2.4–3.7%; <0.0001)       | 1.01 (1.00–1.02; 0.050)                    |
| Junior   | 29,457                 | 27.0%           | 27.3%           | 28.7%           | 31.7%           | 31.5%          | 32.5%          | 37.9%          | 45.9%          | 3.5% (3.0–4.1%; <0.0001)       | 1.02 (1.01–1.04; <0.0001)                  |
| Senior   | 28,213                 | 29.3%           | 24.2%           | 28.8%           | 29.1%           | 30.0%          | 30.9%          | 39.0%          | 43.7%          | 3.5% (2.9–4.1%; <0.0001)       | 1.02 (1.01–1.03; <0.0001)                  |
| Sex  |                        |                 |                 |                 |                 |                |                |                |                |                                |  |
| Female   | 59,011                 | 35.8%           | 33.9%           | 35.8%           | 39.1%           | 39.8%          | 41.0%          | 46.6%          | 56.5%          | 3.3% (2.9–3.8%; <0.0001)       | 1.03 (1.02–1.04; <0.0001)                  |
| Male   | 58,782                 | 21.1%           | 19.0%           | 21.4%           | 20.7%           | 20.3%          | 21.3%          | 26.7%          | 28.6%          | 2.4% (1.8–3.0%; <0.0001)       | Reference                                  |
| Sexual orientation                                   |                        |                 |                 |                 |                 |                |                |                |                |                                |  |
| Straight   | 47,319                 | – <sup>a)</sup> | – <sup>a)</sup> | – <sup>a)</sup> | – <sup>a)</sup> | 26.4%          | 27.5%          | 32.2%          | 34.7%          | 5.7% (4.3–7.1%; <0.0001)       | Reference                                  |
| Gay or lesbian                                       | 1492                   | – <sup>a)</sup> | – <sup>a)</sup> | – <sup>a)</sup> | – <sup>a)</sup> | 46.5%          | 54.1%          | 60.4%          | 62.6%          | 3.6% (0.4–6.8%; 0.027)         | 1.02 (0.94–1.10; 0.67)                     |
| Bisexual   | 4925                   | – <sup>a)</sup> | – <sup>a)</sup> | – <sup>a)</sup> | – <sup>a)</sup> | 65.0%          | 66.0%          | 68.3%          | 72.2%          | 1.6% (0.2–3.0%; 0.025)         | 0.98 (0.93–1.02; 0.29)                     |
| Not sure   | 3365                   | – <sup>a)</sup> | – <sup>a)</sup> | – <sup>a)</sup> | – <sup>a)</sup> | 46.4%          | 45.7%          | 47.1%          | 58.5%          | 4.3% (2.0–6.7%; <0.0001)       | 1.01 (0.96–1.05; 0.79)                     |
| Race and ethnicity                                   |                        |                 |                 |                 |                 |                |                |                |                |                                |  |
| Non-Hispanic White                                   | 52,639                 | 26.2%           | 23.7%           | 27.2%           | 27.3%           | 28.6%          | 30.2%          | 36.0%          | 41.1%          | 3.6% (3.0–4.1%; <0.0001)       | Reference                                  |
| Black, non-Hispanic                                  | 19,919                 | 29.2%           | 27.7%           | 24.7%           | 27.6%           | 25.2%          | 29.3%          | 31.6%          | 39.4%          | 2.1% (1.4–3.0%; <0.0001)       | 0.98 (0.97–0.99; 0.003)                    |
| Hispanic   | 31,083                 | 36.1%           | 31.5%           | 32.5%           | 36.9%           | 35.2%          | 33.3%          | 39.8%          | 46.4%          | 2.1% (1.6–2.7%; <0.0001)       | 0.98 (0.97–0.99; 0.002)                    |
| Other, non-Hispanic                                  | 12,469                 | 27.2%           | 28.2%           | 32.1%           | 34.2%           | 32.3%          | 35.5%          | 38.5%          | 42.3%          | 3.1% (2.1–4.0%; <0.0001)       | 0.99 (0.98–1.01; 0.52)                     |
| High-risk behavior                                   |                        |                 |                 |                 |                 |                |                |                |                |                                |  |
| Violence-related risk behavior                       |                        |                 |                 |                 |                 |                |                |                |                |                                |  |
| Carrying a weapon in the past month                  |                        |                 |                 |                 |                 |                |                |                |                |                                |  |
| Never  | 106,852                | 27.2%           | 25.2%           | 27.5%           | 29.2%           | 29.2%          | 30.9%          | 36.5%          | 42.2%          | 3.3% (2.9–3.7%; <0.0001)       | Reference                                  |
| 1–3 days   | 2408                   | 49.1%           | 35.8%           | 46.6%           | 38.5%           | 40.6%          | 45.1%          | 47.0%          | 59.5%          | 1.4% (0.0–2.8%; 0.038)         | 0.97 (0.95–0.99; 0.012)                    |
| ≥4 days  | 2590                   | 41.4%           | 42.2%           | 39.4%           | 42.3%           | 46.7%          | 37.9%          | 38.4%          | 65.2%          | 1.5% (0.0–2.9%; 0.045)         | 0.97 (0.95–0.99; 0.040)                    |
| Threatened with a weapon in the past year            |                        |                 |                 |                 |                 |                |                |                |                |                                |  |
| Never  | 108,626                | 26.6%           | 24.1%           | 26.3%           | 28.3%           | 28.7%          | 29.9%          | 35.0%          | 40.5%          | 3.3% (2.9–3.7%; <0.0001)       | Reference                                  |
| 1–3 times  | 5817                   | 45.3%           | 48.5%           | 50.9%           | 49.9%           | 48.7%          | 51.9%          | 58.0%          | 66.9%          | 2.3% (1.6–3.0%; <0.0001)       | 0.99 (0.98–1.01; 0.50)                     |
| ≥4 times   | 2412                   | 58.1%           | 53.1%           | 62.6%           | 56.9%           | 51.3%          | 62.6%          | 57.0%          | 65.6%          | 0.5% (–0.4 to 1.5%; 0.27)      | 0.96 (0.94–0.98; <0.0001)                  |
| Physical fight in the past year                      |                        |                 |                 |                 |                 |                |                |                |                |                                |  |
| Never  | 74,724                 | 24.0%           | 22.1%           | 23.6%           | 25.7%           | 26.5%          | 28.3%          | 34.3%          | 40.0%          | 4.1% (3.6–4.6%; <0.0001)       | Reference                                  |
| 1–3 times  | 21,680                 | 33.7%           | 32.8%           | 35.3%           | 40.9%           | 41.2%          | 40.4%          | 47.9%          | 52.5%          | 3.2% (2.6–3.7%; <0.0001)       | 1.00 (0.98–1.01; 0.35)                     |
| ≥4 times   | 6713                   | 44.1%           | 39.9%           | 43.7%           | 46.8%           | 41.0%          | 46.0%          | 44.5%          | 61.9%          | 1.8% (0.9–2.7%; <0.0001)       | 0.97 (0.96–0.99; 0.002)                    |
| Missed school due to safety issues in the past month |                        |                 |                 |                 |                 |                |                |                |                |                                |  |
| Never  | 107,398                | 26.7%           | 24.5%           | 26.6%           | 27.6%           | 28.2%          | 29.6%          | 34.6%          | 39.8%          | 3.1% (2.7–3.5%; <0.0001)       | Reference                                  |
| 1–3 times  | 6323                   | 58.9%           | 55.4%           | 55.8%           | 60.4%           | 60.6%          | 54.7%          | 61.0%          | 70.6%          | 1.2% (0.6–1.8%; <0.0001)       | 0.98 (0.97–1.00; 0.041)                    |
| ≥4 times   | 1753                   | 61.6%           | 62.7%           | 60.8%           | 61.3%           | 56.9%          | 68.6%          | 53.2%          | 68.6%          | 0.3% (–0.8 to 1.4%; 0.60)      | 0.95 (0.92–0.98; 0.001)                    |
| Bullied on a school property in the past year        |                        |                 |                 |                 |                 |                |                |                |                |                                |  |
| No   | 83,737                 | – <sup>a)</sup> | 21.8%           | 23.6%           | 24.5%           | 24.3%          | 25.2%          | 30.6%          | 37.2%          | 4.2% (3.7–4.7%; <0.0001)       | Reference                                  |
| Yes  | 18,742                 | – <sup>a)</sup> | 43.4%           | 47.6%           | 52.4%           | 51.7%          | 57.4%          | 61.8%          | 70.6%          | 3.5% (3.0–4.0%; <0.0001)       | 1.02 (1.01–1.03; <0.0001)                  |
| Bullied electronically in the past year              |                        |                 |                 |                 |                 |                |                |                |                |                                |  |
| No   | 73,750                 | – <sup>a)</sup> | – <sup>a)</sup> | 23.1%           | 25.1%           | 24.4%          | 26.1%          | 31.5%          | 36.8%          | 4.7% (4.0–5.4%; <0.0001)       | Reference                                  |
| Yes  | 12,915                 | – <sup>a)</sup> | – <sup>a)</sup> | 55.8%           | 57.6%           | 59.7%          | 61.9%          | 65.0%          | 71.4%          | 2.6% (2.0–3.2%; <0.0001)       | 1.00 (0.99–1.02; 0.63)                     |

(Table 2 continues on next page)

| Unweighted sample<br>(weighted row %)      | Unweighted<br>sample size | 2007              | 2009              | 2011              | 2013              | 2015              | 2017              | 2019              | 2021              | Biennial APC (95% CI;<br>p-value) | Interaction <sup>a</sup> (95% CI;<br>p-value) |
|--|---------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-----------------------------------|---|
|  | 119,654                   | 13,950<br>(11.6%) | 16,295<br>(13.6%) | 15,295<br>(12.8%) | 13,462<br>(11.3%) | 15,498<br>(13.0%) | 14,603<br>(12.2%) | 13,518<br>(11.3%) | 17,033<br>(14.2%) |                                   |   |
| (Continued from previous page)             |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Lifetime forced to have sexual intercourse |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| No   | 102,443                   | 25.7%             | 23.7%             | 25.7%             | 27.3%             | 27.5%             | 28.7%             | 34.1%             | 38.4%             | 3.1% (2.6–3.5%; <0.0001)          | Reference                                     |
| Yes  | 8742                      | 59.4%             | 55.1%             | 58.9%             | 62.8%             | 62.3%             | 70.9%             | 71.8%             | 83.9%             | 2.4% (2.0–2.9%; <0.0001)          | 1.03 (1.02–1.05; <0.0001)                     |
| Physical/sedentary-related risk behavior   |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Watching TV on a daily basis               |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Not at all                                 | 16,010                    | 30.3%             | 27.6%             | 32.1%             | 32.3%             | 31.8%             | 32.7%             | 39.0%             | <sup>b)</sup>     | 2.5% (1.4–3.6%; <0.0001)          | Reference                                     |
| 1 h per day or less                        | 31,653                    | 27.8%             | 25.6%             | 27.6%             | 28.3%             | 29.0%             | 29.6%             | 33.4%             | <sup>b)</sup>     | 1.4% (0.7–2.1%; <0.0001)          | 0.98 (0.97–1.00; 0.045)                       |
| 2 or 3 h per day                           | 33,960                    | 26.6%             | 24.1%             | 26.3%             | 28.6%             | 27.9%             | 30.2%             | 37.1%             | <sup>b)</sup>     | 2.2% (1.4–3.0%; <0.0001)          | 0.99 (0.98–1.01; 0.55)                        |
| 4 or more h per day                        | 16,468                    | 31.9%             | 30.2%             | 32.1%             | 33.7%             | 35.1%             | 36.7%             | 41.7%             | <sup>b)</sup>     | 1.7% (0.9–2.5%; <0.0001)          | 0.99 (0.97–1.01; 0.39)                        |
| Screen time on a daily basis               |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Not at all                                 | 18,537                    | 30.8%             | 26.8%             | 27.5%             | 27.8%             | 27.0%             | 30.6%             | 33.7%             | 29.5%             | 0.9% (0.0–1.8%; 0.037)            | Reference                                     |
| 1 h per day or less                        | 32,328                    | 24.3%             | 22.7%             | 25.8%             | 24.5%             | 23.8%             | 25.1%             | 30.7%             | 33.5%             | 2.3% (1.7–3.0%; <0.0001)          | 1.02 (1.01–1.03; 0.006)                       |
| 2 or 3 h per day                           | 34,096                    | 27.7%             | 26.5%             | 28.3%             | 28.4%             | 26.8%             | 29.7%             | 33.6%             | 39.0%             | 2.3% (1.7–2.9%; <0.0001)          | 1.02 (1.01–1.03; 0.007)                       |
| 4 or more h per day                        | 29,608                    | 37.5%             | 34.0%             | 34.5%             | 38.0%             | 40.0%             | 37.9%             | 46.2%             | 51.9%             | 2.4% (1.9–2.9%; <0.0001)          | 1.03 (1.01–1.04; <0.0001)                     |
| Physical activity on a weekly basis        |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Not at all                                 | 21,225                    | 32.7%             | 30.2%             | 35.5%             | 35.6%             | 37.7%             | 35.5%             | 42.2%             | 48.0%             | 2.8% (2.2–3.4%; <0.0001)          | 1.00 (0.99–1.01; 0.91)                        |
| 1 or 2 days                                | 21,060                    | 31.5%             | 30.0%             | 35.7%             | 34.4%             | 36.4%             | 35.5%             | 45.0%             | 50.7%             | 3.2% (2.5–3.9%; <0.0001)          | 1.00 (0.99–1.02; 0.30)                        |
| 3 or 4 days                                | 23,844                    | 27.5%             | 26.6%             | 29.4%             | 32.7%             | 31.9%             | 34.8%             | 40.0%             | 46.1%             | 3.6% (2.9–4.3%; <0.0001)          | 1.01 (1.00–1.02; 0.10)                        |
| 5 or more days                             | 49,190                    | 23.7%             | 20.9%             | 23.5%             | 25.4%             | 24.6%             | 27.1%             | 30.1%             | 35.9%             | 3.2% (2.6–3.8%; <0.0001)          | Reference                                     |
| Hours of sleep on average school night     |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| 5 h or less                                | 20,805                    | 44.1%             | 41.6%             | 46.9%             | 47.4%             | 47.2%             | 47.8%             | 53.3%             | 59.3%             | 2.1% (1.7–2.6%; <0.0001)          | 1.01 (1.00–1.03; 0.039)                       |
| 6–7 h                                      | 53,298                    | 27.1%             | 25.4%             | 27.0%             | 29.1%             | 27.5%             | 29.8%             | 34.7%             | 39.8%             | 2.7% (2.2–3.2%; <0.0001)          | 1.01 (1.00–1.02; 0.047)                       |
| 8 h or more                                | 28,700                    | 21.5%             | 19.0%             | 20.3%             | 21.3%             | 22.0%             | 21.4%             | 23.9%             | 30.8%             | 2.2% (1.4–3.0%; <0.0001)          | Reference                                     |
| Weight-related risk factor                 |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Body mass index                            |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Underweight or normal                      | 74,672                    | 27.8%             | 25.0%             | 27.9%             | 29.3%             | 28.9%             | 29.5%             | 34.9%             | 39.8%             | 2.8% (2.3–3.3%; <0.0001)          | Reference                                     |
| Overweight                                 | 17,514                    | 28.9%             | 27.8%             | 28.3%             | 32.0%             | 33.7%             | 35.7%             | 39.4%             | 46.9%             | 3.4% (2.6–4.1%; <0.0001)          | 1.01 (1.00–1.02; 0.08)                        |
| Obese                                      | 16,080                    | 31.0%             | 27.6%             | 29.8%             | 31.0%             | 30.6%             | 34.4%             | 40.0%             | 44.8%             | 2.9% (2.1–3.7%; <0.0001)          | 1.00 (0.99–1.02; 0.59)                        |
| Perception of weight                       |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Underweight                                | 16,781                    | 31.3%             | 27.1%             | 31.6%             | 32.7%             | 31.8%             | 33.5%             | 38.7%             | 46.4%             | 3.1% (2.3–3.8%; <0.0001)          | 1.01 (1.00–1.02; 0.037)                       |
| About right                                | 59,184                    | 24.2%             | 22.9%             | 24.4%             | 25.9%             | 25.5%             | 25.5%             | 31.5%             | 35.1%             | 2.5% (2.0–3.0%; <0.0001)          | Reference                                     |
| Overweight/obese                           | 33,848                    | 34.8%             | 32.2%             | 34.6%             | 36.0%             | 36.5%             | 40.3%             | 44.5%             | 52.1%             | 3.1% (2.6–3.7%; <0.0001)          | 1.02 (1.01–1.03; <0.0001)                     |
| Substance use-related risk behavior        |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Lifetime IV use for any illegal drugs      |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| No   | 106,478                   | 27.6%             | 25.5%             | 27.5%             | 29.6%             | 29.5%             | 31.1%             | 36.8%             | 42.8%             | 3.2% (2.8–3.7%; <0.0001)          | Reference                                     |
| Yes  | 1986                      | 69.3%             | 58.6%             | 57.8%             | 54.4%             | 53.5%             | 69.9%             | 58.1%             | 66.2%             | –0.1% (–1.2 to 1.1%; 0.90)        | 0.95 (0.92–0.98; 0.001)                       |
| Alcohol use in the past month              |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Never                                      | 70,998                    | 22.1%             | 20.2%             | 21.8%             | 24.1%             | 24.4%             | 25.4%             | 31.6%             | 35.7%             | 4.1% (3.6–4.6%; <0.0001)          | Reference                                     |
| <10 day                                    | 32,692                    | 34.1%             | 32.3%             | 35.9%             | 38.6%             | 38.7%             | 41.3%             | 38.5%             | 62.1%             | 3.6% (3.2–4.1%; <0.0001)          | 1.01 (1.00–1.02; 0.040)                       |
| ≥10 days                                   | 4169                      | 42.6%             | 36.9%             | 46.1%             | 47.0%             | 44.7%             | 49.6%             | 51.3%             | 62.1%             | 2.3% (1.4–3.2%; <0.0001)          | 0.99 (0.97–1.01; 0.32)                        |
| Cigarette use in the past month            |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Never                                      | 99,660                    | 24.5%             | 22.5%             | 24.7%             | 26.8%             | 27.0%             | 29.2%             | 35.4%             | 41.1%             | 4.2% (3.7–4.6%; <0.0001)          | Reference                                     |
| <10 days                                   | 7961                      | 38.4%             | 38.6%             | 40.9%             | 42.5%             | 47.0%             | 51.1%             | 53.9%             | 68.9%             | 3.9% (3.2–4.7%; <0.0001)          | 1.02 (1.00–1.03; 0.06)                        |

(Table 2 continues on next page)



| Unweighted sample<br>(weighted row %)   | Unweighted<br>sample size | 2007              | 2009              | 2011              | 2013              | 2015              | 2017              | 2019              | 2021              | Biennial APC (95% CI;<br>p-value) | Interaction <sup>a</sup> (95% CI;<br>p-value) |
|---|---------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-----------------------------------|---|
|   | 119,654                   | 13,950<br>(11.6%) | 16,295<br>(13.6%) | 15,295<br>(12.8%) | 13,462<br>(11.3%) | 15,498<br>(13.0%) | 14,603<br>(12.2%) | 13,518<br>(11.3%) | 17,033<br>(14.2%) |                                   |   |
| (Continued from previous page)          |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| ≥10 days                                | 5864                      | 43.1%             | 40.8%             | 46.4%             | 48.8%             | 55.8%             | 52.6%             | 65.9%             | 73.3%             | 3.5% (2.5–4.5%; <0.0001)          | 1.01 (0.99–1.04; 0.20)                        |
| Cannabis use in the past<br>month       |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Never                                   | 91,530                    | 25.5%             | 23.5%             | 25.3%             | 26.4%             | 26.2%             | 27.2%             | 32.8%             | 37.5%             | 3.0% (2.5–3.4%; <0.0001)          | Reference                                     |
| <10 times                               | 13,950                    | 39.7%             | 34.1%             | 37.0%             | 40.9%             | 42.7%             | 46.4%             | 48.6%             | 68.7%             | 3.5% (2.8–4.2%; <0.0001)          | 1.02 (1.01–1.04; 0.001)                       |
| ≥10 times                               | 10,308                    | 39.3%             | 36.7%             | 39.8%             | 41.7%             | 42.2%             | 51.0%             | 52.9%             | 69.3%             | 3.6% (2.9–4.2%; <0.0001)          | 1.03 (1.01–1.04; <0.0001)                     |
| Lifetime cocaine use                    |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| No                                      | 105,408                   | 26.5%             | 24.5%             | 27.0%             | 28.7%             | 28.7%             | 30.2%             | 36.2%             | 42.5%             | 3.5% (3.1–3.9%; <0.0001)          | Reference                                     |
| Yes                                     | 6156                      | 53.4%             | 46.9%             | 47.2%             | 51.2%             | 51.7%             | 55.8%             | 57.9%             | 70.3%             | 1.9% (1.2–2.7%; <0.0001)          | 0.99 (0.97–1.01; 0.20)                        |
| Lifetime inhalant use                   |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| No                                      | 94,179                    | 25.0%             | 23.0%             | 25.3%             | 27.6%             | 28.2%             | 30.1%             | 35.1%             | 40.7%             | 3.7% (3.3–4.1%; <0.0001)          | Reference                                     |
| Yes                                     | 9630                      | 50.2%             | 49.5%             | 51.7%             | 54.6%             | 53.8%             | 56.0%             | 65.6%             | 72.4%             | 2.5% (2.0–3.0%; <0.0001)          | 1.00 (0.99–1.02; 0.48)                        |
| Lifetime heroin use                     |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| No                                      | 111,726                   | 27.6%             | 25.4%             | 27.6%             | 29.5%             | 29.3%             | 31.2%             | 36.7%             | 42.2%             | 3.2% (2.8–3.6%; <0.0001)          | Reference                                     |
| Yes                                     | 2324                      | 64.0%             | 52.1%             | 55.7%             | 52.9%             | 56.2%             | 65.0%             | 58.2%             | 65.8%             | 0.7% (–0.4%–1.9%; 0.23)           | 0.97 (0.94–1.00; 0.029)                       |
| Lifetime<br>methamphetamine use         |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| No                                      | 111,537                   | 27.1%             | 25.0%             | 27.4%             | 29.1%             | 29.1%             | 31.0%             | 36.6%             | 42.0%             | 3.4% (2.9–3.8%; <0.0001)          | Reference                                     |
| Yes                                     | 3440                      | 56.0%             | 53.4%             | 53.7%             | 57.2%             | 54.3%             | 59.7%             | 56.2%             | 67.8%             | 1.2% (0.3–2.0%; 0.011)            | 0.98 (0.95–1.00; 0.029)                       |
| Lifetime ecstasy use                    |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| No                                      | 104,230                   | 26.9%             | 24.6%             | 26.5%             | 28.7%             | 28.7%             | 30.6%             | 36.4%             | 42.4%             | 3.4% (3.0–3.9%; <0.0001)          | Reference                                     |
| Yes                                     | 6072                      | 52.0%             | 45.8%             | 48.6%             | 47.8%             | 51.6%             | 57.8%             | 55.3%             | 72.9%             | 2.2% (1.4–3.0%; <0.0001)          | 1.00 (0.98–1.02; 0.74)                        |
| Lifetime hallucinogenic use             |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| No                                      | 84,367                    | 26.6%             | 24.5%             | 26.4%             | 28.7%             | 28.6%             | 30.0%             | 35.8%             | 41.5%             | 3.3% (2.8–3.7%; <0.0001)          | Reference                                     |
| Yes                                     | 6307                      | 45.0%             | 44.1%             | 48.9%             | 49.4%             | 48.5%             | 54.8%             | 58.9%             | 69.4%             | 2.6% (1.9–3.3%; <0.0001)          | 1.01 (0.99–1.03; 0.31)                        |
| Sexual risk behavior                    |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Sexual activity in the past 3<br>months |                           |                   |                   |                   |                   |                   |                   |                   |                   |                                   |   |
| Never                                   | 60,521                    | 21.4%             | 20.4%             | 22.4%             | 23.9%             | 24.8%             | 27.4%             | 31.7%             | 36.5%             | 4.1% (3.6–4.7%; <0.0001)          | Reference                                     |
| Yes, but not in the past<br>3 months    | 12,919                    | 33.6%             | 30.1%             | 32.0%             | 38.0%             | 36.1%             | 39.7%             | 43.0%             | 58.7%             | 3.7% (3.0–4.4%; <0.0001)          | 1.01 (0.99–1.02; 0.35)                        |
| Yes, and with 1 person<br>only          | 25,269                    | 35.3%             | 32.2%             | 34.9%             | 34.8%             | 38.1%             | 39.0%             | 45.1%             | 56.3%             | 3.2% (2.7–3.8%; <0.0001)          | 1.00 (0.99–1.01; 0.73)                        |
| Yes, and with ≥2<br>persons             | 9315                      | 40.4%             | 36.7%             | 39.0%             | 41.9%             | 36.6%             | 42.5%             | 48.6%             | 65.5%             | 2.2% (1.4–3.0%; <0.0001)          | 0.98 (0.97–1.00; 0.046)                       |

**Note:** Data are from Youth Risk Behavior Survey (YRBS), and analyses were adjusted for complex survey designs. a) denotes that survey questionnaires were not asked during the survey years. b) this questionnaire was merged to "social media and video game use on a daily basis" in 2021. APC denotes average percentage change. <sup>a</sup>Interaction estimates are from the logistic regression analyses (i.e., interaction term of each variable by survey year on depressive symptoms). Both biennial APC and interaction analyses were accounted for age, sex, and race/ethnicity.

Table 2: Trends in depressive symptoms among high school students by sociodemographic factors and health-risk behaviors, 2007–2021.

## Results

### Study sample

The overall sample was 50.1% female and distributed across grades 9–12. Individuals most commonly identified as non-Hispanic White (unweighted sample,  $n = 52,639$ ; weighted percentage, 45.3%), Hispanic ( $n = 31,083$ ; 26.8%), and non-Hispanic Black ( $n = 19,919$ ; 17.2%).

### Multivariable analysis of risk behaviors associated with depressive symptoms

Table 1 shows a multivariable analysis of demographic factors and health-risk behaviors associated with

depressive symptoms in the sample. Males were half as likely as females to report depressive symptoms (adjusted odds ratio [aOR], 0.46 [95% CI, 0.41–0.51]). Compared to non-Hispanic White students, Hispanic students were significantly more likely (aOR, 1.30 [1.16–1.45]) while non-Hispanic Black students were less likely to report depressive symptoms (aOR, 0.76 [0.65–0.90]). Students identifying as gay/lesbian or bisexual were approximately three times more likely to report depressive symptoms than straight students (aORs, 2.96 [2.21–3.98] and 2.91 [2.51–3.37], respectively).



| Unweighted sample<br>(weighted row %)                | Unweighted<br>sample size | 2007            | 2009            | 2011            | 2013            | 2015            | 2017            | 2019            | 2021            | Biennial APC (95% CI; p-value) |
|--|---------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|--------------------------------|
|  |                           | 4115<br>(10.8%) | 4481<br>(11.8%) | 4495<br>(11.8%) | 4055<br>(10.7%) | 4744<br>(12.5%) | 4566<br>(12.0%) | 4865<br>(12.8%) | 6674<br>(17.6%) |                                |
| Grade  |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                |
| Freshman   | 9520                      | 28.8%           | 28.3%           | 26.8%           | 26.8%           | 25.8%           | 25.7%           | 24.0%           | 24.0%           | -3.1% (-3.7 to -2.4%; <0.0001) |
| Sophomore  | 9684                      | 26.8%           | 26.5%           | 25.9%           | 25.5%           | 25.6%           | 26.7%           | 25.8%           | 25.0%           | -0.8% (-1.3 to -0.2%; 0.009)   |
| Junior   | 9626                      | 22.4%           | 24.7%           | 24.3%           | 25.3%           | 25.2%           | 24.9%           | 25.1%           | 26.7%           | 1.4% (0.8-1.9%; <0.0001)       |
| Senior   | 9008                      | 22.1%           | 20.6%           | 23.1%           | 22.5%           | 23.3%           | 22.8%           | 25.1%           | 24.4%           | 2.9% (2.0-3.9%; <0.0001)       |
| Sex  |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                |
| Female   | 24,361                    | 62.4%           | 62.0%           | 61.2%           | 65.5%           | 65.2%           | 66.6%           | 63.1%           | 64.9%           | 0.3% (0.00-0.6%; 0.035)        |
| Male   | 13,410                    | 37.6%           | 38.0%           | 38.8%           | 34.5%           | 34.9%           | 33.4%           | 36.9%           | 35.1%           | 0.0% (-1.1 to 0.6%; 0.034)     |
| Sexual orientation                                   |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                |
| Straight   | 14,020                    | ^a)             | ^a)             | ^a)             | ^a)             | 79.0%           | 73.7%           | 74.3%           | 60.7%           | -3.8% (-4.5 to -3.1%; <0.0001) |
| Gay or lesbian                                       | 849                       | ^a)             | ^a)             | ^a)             | ^a)             | 3.1%            | 3.9%            | 4.1%            | 4.6%            | 6.1% (1.3-11.2%; 0.012)        |
| Bisexual   | 3351                      | ^a)             | ^a)             | ^a)             | ^a)             | 13.1%           | 16.5%           | 16.0%           | 20.1%           | 6.5% (4.1-9.0%; <0.0001)       |
| Not sure   | 1745                      | ^a)             | ^a)             | ^a)             | ^a)             | 4.8%            | 5.9%            | 5.6%            | 14.6%           | 21.9% (17.5-26.5%; <0.0001)    |
| Race and ethnicity                                   |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                |
| Non-Hispanic White                                   | 16,124                    | 56.2%           | 53.3%           | 54.6%           | 50.9%           | 52.2%           | 51.8%           | 50.5%           | 49.5%           | -0.7% (-2.0 to 0.5%; 0.24)     |
| Black, non-Hispanic                                  | 5824                      | 15.3%           | 15.3%           | 12.4%           | 13.2%           | 11.4%           | 12.4%           | 10.4%           | 11.2%           | -2.4% (-4.8 to 0.1%; 0.05)     |
| Hispanic   | 11,043                    | 21.2%           | 22.4%           | 22.8%           | 25.9%           | 26.1%           | 24.2%           | 28.1%           | 27.6%           | 1.7% (-0.3 to 3.8%; 0.10)      |
| Other, non-Hispanic                                  | 4329                      | 7.4%            | 9.0%            | 10.2%           | 10.0%           | 10.3%           | 11.6%           | 11.1%           | 11.7%           | 2.6% (0.5-4.7%; 0.015)         |
| Violence-related risk behavior                       |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                |
| Carrying a weapon in the past month                  |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                |
| Never  | 33,557                    | 90.8%           | 91.7%           | 92.0%           | 93.1%           | 94.2%           | 95.4%           | 97.2%           | 95.7%           | 4.3% (3.4-5.2%; <0.0001)       |
| 1-3 days   | 1069                      | 4.4%            | 3.9%            | 4.3%            | 2.9%            | 2.5%            | 2.1%            | 1.2%            | 2.1%            | -6.9% (-8.7 to -5.1%; <0.0001) |
| ≥4 days  | 1164                      | 4.8%            | 4.5%            | 3.7%            | 4.0%            | 3.3%            | 2.4%            | 1.6%            | 2.2%            | -6.2% (-7.9 to -4.4%; <0.0001) |
| Threatened with a weapon in the past year            |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                |
| Never  | 33,008                    | 86.7%           | 85.6%           | 86.0%           | 88.3%           | 90.5%           | 90.0%           | 88.9%           | 89.8%           | 3.5% (2.2-4.7%; <0.0001)       |
| 1-3 times  | 3078                      | 8.6%            | 9.4%            | 9.0%            | 7.7%            | 6.8%            | 6.9%            | 8.7%            | 7.8%            | -1.2% (-2.3 to -0.1%; 0.03)    |
| ≥4 times   | 1403                      | 4.7%            | 5.0%            | 5.0%            | 4.0%            | 2.8%            | 3.1%            | 2.4%            | 2.5%            | -5.6% (-6.9 to -4.2%; <0.0001) |
| Physical fight in the past year                      |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                |
| Never  | 21,287                    | 54.8%           | 58.3%           | 56.5%           | 65.3%           | 69.0%           | 69.0%           | 72.5%           | 76.6%           | 2.5% (2.2-2.7%; <0.0001)       |
| 1-3 times  | 8622                      | 32.4%           | 30.2%           | 30.5%           | 25.9%           | 24.2%           | 23.4%           | 22.2%           | 17.2%           | -4.0% (-4.6 to -3.4%; <0.0001) |
| ≥4 times   | 3032                      | 12.9%           | 11.4%           | 13.0%           | 8.8%            | 6.8%            | 7.7%            | 5.4%            | 6.2%            | -6.0% (-7.0 to -5.0%; <0.0001) |
| Missed school due to safety issues in the past month |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                |
| Never  | 32,290                    | 88.8%           | 89.3%           | 88.3%           | 86.0%           | 89.2%           | 88.3%           | 86.4%           | 86.1%           | -0.2% (-0.3 to -0.1%; 0.006)   |
| 1-3 times  | 3765                      | 8.7%            | 7.5%            | 8.2%            | 11.2%           | 8.7%            | 9.7%            | 11.5%           | 11.3%           | 2.4% (1.2-3.6%; <0.0001)       |
| ≥4 times   | 1069                      | 2.5%            | 3.2%            | 3.5%            | 2.7%            | 2.1%            | 2.1%            | 2.1%            | 2.6%            | -1.9% (-3.7 to 0.0%; 0.05)     |
| Bullied on a school property in the past year        |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                |
| No   | 22,818                    | ^a)             | 67.0%           | 66.4%           | 65.7%           | 64.9%           | 65.2%           | 67.4%           | 75.0%           | 1.0% (0.7-1.3%; <0.0001)       |
| Yes  | 10,360                    | ^a)             | 33.0%           | 33.6%           | 34.3%           | 35.1%           | 34.8%           | 32.6%           | 25.0%           | -2.1% (-2.7 to -1.4%; <0.0001) |
| Bullied electronically in the past year              |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                |
| No   | 20,790                    | ^a)             | ^a)             | 68.1%           | 71.6%           | 69.1%           | 70.8%           | 72.6%           | 73.4%           | 0.7% (0.4-1.0%; <0.0001)       |
| Yes  | 8076                      | ^a)             | ^a)             | 31.9%           | 28.4%           | 30.9%           | 29.2%           | 27.4%           | 26.7%           | -1.8% (-2.5 to -1.0%; <0.0001) |
| Lifetime forced to have sexual intercourse           |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                |
| No   | 29,775                    | 83.7%           | 84.5%           | 83.6%           | 84.9%           | 86.1%           | 83.9%           | 86.0%           | 83.3%           | 0.0% (-0.1 to 0.2%; 0.90)      |
| Yes  | 5624                      | 16.3%           | 15.5%           | 16.4%           | 15.1%           | 13.9%           | 16.1%           | 14.0%           | 16.7%           | 0.0% (-0.9 to 0.8%; 0.92)      |

(Table 3 continues on next page)

| Unweighted sample<br>(weighted row %)    | Unweighted<br>sample size | 2007            | 2009            | 2011            | 2013            | 2015            | 2017            | 2019            | 2021            | Biennial APC (95% CI; p-value)    |
|--|---------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------------------------|
|  |                           | 4115<br>(10.8%) | 4481<br>(11.8%) | 4495<br>(11.8%) | 4055<br>(10.7%) | 4744<br>(12.5%) | 4566<br>(12.0%) | 4865<br>(12.8%) | 6674<br>(17.6%) |                                   |
| (Continued from previous page)           |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| Physical/sedentary-related risk behavior |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| Watching TV on a daily basis             |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| Not at all                               | 5501                      | 9.3%            | 10.4%           | 13.0%           | 15.5%           | 20.2%           | 27.3%           | 29.8%           | <sup>b)</sup>   | 11.2% (10.1–12.3%; <0.0001)       |
| 1 h per day or less                      | 9421                      | 32.8%           | 33.8%           | 32.2%           | 30.4%           | 35.2%           | 32.8%           | 32.0%           | <sup>b)</sup>   | –0.1% (–0.7 to 0.6%; 0.76)        |
| 2 or 3 h per day                         | 9833                      | 36.6%           | 35.4%           | 35.6%           | 34.8%           | 30.4%           | 28.0%           | 26.7%           | <sup>b)</sup>   | –2.7% (–3.3 to –2.2%; <0.0001)    |
| 4 or more h per day                      | 5488                      | 21.3%           | 20.4%           | 19.2%           | 19.3%           | 14.2%           | 11.9%           | 11.5%           | <sup>b)</sup>   | –5.4% (–6.5 to –4.3%; <0.0001)    |
| Screen time on a daily basis             |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| Not at all                               | 5660                      | 20.1%           | 17.5%           | 12.3%           | 13.7%           | 16.3%           | 19.1%           | 15.9%           | 4.1%            | –4.7% (–6.0 to –3.4%; <0.0001)    |
| 1 h per day or less                      | 8574                      | 34.2%           | 36.3%           | 34.4%           | 23.3%           | 19.5%           | 17.9%           | 17.1%           | 14.1%           | –6.9% (–7.4 to –6.3%; <0.0001)    |
| 2 or 3 h per day                         | 10,388                    | 27.6%           | 28.0%           | 31.1%           | 27.2%           | 26.2%           | 26.6%           | 28.5%           | 34.0%           | 0.9% (0.3–1.6%; 0.005)            |
| 4 or more h per day                      | 12,172                    | 18.2%           | 18.2%           | 22.3%           | 35.8%           | 38.0%           | 36.4%           | 38.6%           | 47.8%           | 6.8% (6.2–7.4%; <0.0001)          |
| Physical activity on a weekly basis      |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| Not at all                               | 7811                      | 28.5%           | 26.9%           | 17.2%           | 17.9%           | 18.0%           | 17.1%           | 19.3%           | 17.7%           | –3.0% (–3.8 to –2.3%; <0.0001)    |
| 1 or 2 days                              | 7784                      | 23.3%           | 24.4%           | 20.5%           | 19.0%           | 18.7%           | 18.9%           | 20.3%           | 19.7%           | –1.4% (–2.1 to –0.6%; <0.0001)    |
| 3 or 4 days                              | 8207                      | 19.1%           | 19.0%           | 21.3%           | 23.0%           | 23.2%           | 23.5%           | 24.2%           | 24.2%           | 1.7% (1.0–2.4%; <0.0001)          |
| 5 or more days                           | 13,239                    | 29.3%           | 29.7%           | 41.0%           | 40.1%           | 40.2%           | 40.4%           | 36.2%           | 38.5%           | 1.4% (0.9–1.9%; <0.0001)          |
| Hours of sleep on average school night   |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| 5 h or less                              | 10,065                    | 24.9%           | 25.0%           | 28.7%           | 29.4%           | 31.6%           | 32.1%           | 35.7%           | 35.2%           | 2.8% (2.2–3.4%; <0.0001)          |
| 6–7 h                                    | 16,252                    | 51.3%           | 52.4%           | 48.8%           | 48.1%           | 48.4%           | 50.6%           | 50.0%           | 48.4%           | –0.3% (–0.6 to 0.1%; 0.11)        |
| 8 h or more                              | 6615                      | 23.8%           | 22.6%           | 22.6%           | 22.5%           | 20.0%           | 17.4%           | 14.3%           | 16.4%           | –3.5% (–4.2 to –2.8%; <0.0001)    |
| Weight-related risk factor               |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| Body mass index                          |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| Underweight or normal                    | 23,075                    | 68.8%           | 69.3%           | 70.8%           | 68.2%           | 67.8%           | 66.0%           | 65.7%           | 64.4%           | –0.6% (–0.9 to –0.3%; <0.0001)    |
| Overweight                               | 5935                      | 16.0%           | 16.8%           | 15.4%           | 17.8%           | 18.0%           | 17.8%           | 17.4%           | 18.0%           | 0.7% (0.0–1.5%; 0.047)            |
| Obese                                    | 5491                      | 15.2%           | 13.9%           | 13.8%           | 14.1%           | 14.3%           | 16.2%           | 16.9%           | 17.7%           | 1.8% (0.8–2.8%; <0.0001)          |
| Perception of weight                     |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| Underweight                              | 5909                      | 15.0%           | 14.3%           | 16.4%           | 15.0%           | 15.4%           | 16.6%           | 18.2%           | 20.8%           | 2.5% (1.7–3.4%; <0.0001)          |
| About right                              | 16,089                    | 48.9%           | 51.4%           | 48.1%           | 47.7%           | 46.0%           | 42.9%           | 42.8%           | 39.8%           | –1.6% (–2.0 to –1.2%; <0.0001)    |
| Overweight/obese                         | 13,192                    | 36.2%           | 34.2%           | 35.5%           | 37.3%           | 38.6%           | 40.4%           | 39.1%           | 39.5%           | 0.9% (0.4–1.4%; <0.0001)          |
| Substance use-related risk behavior      |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| Lifetime IV use for any illegal drugs    |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| No                                       | 33,680                    | 95.6%           | 95.6%           | 95.5%           | 97.1%           | 97.1%           | 97.2%           | 97.9%           | 98.0%           | 0.2% (0.1–0.3%; <0.0001)          |
| Yes                                      | 1130                      | 4.4%            | 4.5%            | 4.5%            | 2.9%            | 2.9%            | 2.8%            | 2.1%            | 2.0%            | –6.3% (–8.5 to –4.2%; <0.0001)    |
| Alcohol use in the past month            |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| Never                                    | 19,008                    | 43.8%           | 46.1%           | 48.2%           | 53.2%           | 56.1%           | 58.8%           | 61.3%           | 66.1%           | 2.8% (2.5–3.2%; <0.0001)          |
| <10 days                                 | 13,258                    | 47.3%           | 46.7%           | 43.5%           | 40.5%           | 39.6%           | 36.2%           | 35.4%           | 30.5%           | –2.9% (–3.3 to –2.5%; <0.0001)    |
| ≥10 days                                 | 1890                      | 8.9%            | 7.2%            | 8.3%            | 6.3%            | 4.4%            | 5.0%            | 3.3%            | 3.4%            | –6.8% (–8.0 to –5.5%; <0.0001)    |
| Cigarette use in the past month          |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| Never                                    | 29,821                    | 70.6%           | 70.3%           | 72.1%           | 76.3%           | 81.8%           | 85.7%           | 91.0%           | 93.7%           | 2.3% (2.0–2.5%; <0.0001)          |
| <10 days                                 | 3576                      | 13.4%           | 14.7%           | 14.3%           | 12.1%           | 10.1%           | 8.6%            | 6.0%            | 4.3%            | –7.6% (–8.6 to –6.6%; <0.0001)    |
| ≥10 days                                 | 2734                      | 16.0%           | 15.1%           | 13.6%           | 11.7%           | 8.1%            | 5.8%            | 3.0%            | 2.1%            | –12.1% (–13.5 to –10.6%; <0.0001) |
| Cannabis use in the past month           |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| Never                                    | 26,372                    | 72.5%           | 72.0%           | 68.9%           | 67.8%           | 69.2%           | 69.8%           | 70.3%           | 74.5%           | 0.1% (–0.2 to 0.3%; 0.69)         |
| <10 times                                | 6103                      | 16.3%           | 16.2%           | 16.4%           | 17.4%           | 17.9%           | 17.4%           | 16.8%           | 13.5%           | –0.6% (–1.4 to 0.2%; 0.11)        |
| ≥10 times                                | 4633                      | 11.2%           | 11.8%           | 14.7%           | 14.8%           | 12.9%           | 12.9%           | 12.9%           | 12.0%           | 0.5% (–0.5 to 1.5%; 0.35)         |
| Lifetime cocaine use                     |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                   |
| No                                       | 32,699                    | 86.8%           | 88.7%           | 88.8%           | 90.8%           | 91.4%           | 92.0%           | 94.5%           | 96.2%           | 0.7% (0.6–0.8%; <0.0001)          |
| Yes                                      | 3126                      | 13.2%           | 11.3%           | 11.2%           | 9.3%            | 8.6%            | 8.0%            | 5.6%            | 3.8%            | –7.5% (–8.7 to –6.3%; <0.0001)    |

(Table 3 continues on next page)

| Unweighted sample<br>(weighted row %) | Unweighted<br>sample size | 2007            | 2009            | 2011            | 2013            | 2015            | 2017            | 2019            | 2021            | Biennial APC (95% CI; p-value)  |
|---------------------------------------|---------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|---------------------------------|
|                                       |                           | 4115<br>(10.8%) | 4481<br>(11.8%) | 4495<br>(11.8%) | 4055<br>(10.7%) | 4744<br>(12.5%) | 4566<br>(12.0%) | 4865<br>(12.8%) | 6674<br>(17.6%) |                                 |
| (Continued from previous page)        |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                 |
| Lifetime inhalant use                 |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                 |
| No                                    | 27,895                    | 76.7%           | 78.0%           | 79.4%           | 83.9%           | 87.8%           | 89.4%           | 89.1%           | 86.4%           | 1.1% (0.9–1.3%; <0.0001)        |
| Yes                                   | 5250                      | 23.4%           | 22.0%           | 20.6%           | 16.1%           | 12.2%           | 10.6%           | 10.9%           | 13.6%           | –5.6% (–6.6 to –4.7%; <0.0001)  |
| Lifetime heroin use                   |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                 |
| No                                    | 35,481                    | 95.3%           | 95.2%           | 94.7%           | 96.4%           | 96.5%           | 97.0%           | 97.9%           | 98.1%           | 0.3% (0.2–0.3%; <0.0001)        |
| Yes                                   | 1259                      | 4.7%            | 4.8%            | 5.3%            | 3.6%            | 3.5%            | 3.0%            | 2.1%            | 1.9%            | –7.2% (–8.9 to –5.5%; <0.0001)  |
| Lifetime methamphetamine use          |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                 |
| No                                    | 35,120                    | 91.7%           | 92.0%           | 93.1%           | 94.2%           | 94.7%           | 95.9%           | 97.3%           | 97.4%           | 0.5% (0.4–0.6%; <0.0001)        |
| Yes                                   | 1859                      | 8.3%            | 8.0%            | 6.9%            | 5.8%            | 5.1%            | 4.1%            | 2.7%            | 2.6%            | –8.9% (–10.2 to –7.5%; <0.0001) |
| Lifetime ecstasy use                  |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                 |
| No                                    | 32,433                    | 89.7%           | 88.7%           | 86.1%           | 89.7%           | 91.7%           | 93.2%           | 95.3%           | 95.2%           | 0.6% (0.5–0.7%; <0.0001)        |
| Yes                                   | 3030                      | 10.3%           | 11.4%           | 13.9%           | 10.3%           | 8.3%            | 6.8%            | 4.7%            | 4.8%            | –6.6% (–7.8 to –5.5%; <0.0001)  |
| Lifetime hallucinogenic use           |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                 |
| No                                    | 25,903                    | 87.6%           | 86.8%           | 85.2%           | 88.6%           | 89.7%           | 88.8%           | 89.5%           | 89.5%           | 0.2% (0.00–0.03%; 0.006)        |
| Yes                                   | 3208                      | 12.4%           | 13.2%           | 14.8%           | 11.4%           | 10.3%           | 11.2%           | 10.5%           | 10.5%           | –1.7% (–2.8 to –0.5%; 0.004)    |
| Sexual risk behavior                  |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                 |
| Sexual activity in the past 3 months  |                           |                 |                 |                 |                 |                 |                 |                 |                 |                                 |
| Never                                 | 16,462                    | 39.5%           | 42.7%           | 41.6%           | 42.5%           | 49.0%           | 51.4%           | 53.2%           | 59.6%           | 2.6% (2.1–3.2%; <0.0001)        |
| Yes, but not in the past 3 months     | 4868                      | 15.3%           | 13.6%           | 15.4%           | 16.1%           | 13.3%           | 13.3%           | 11.2%           | 12.3%           | –1.7% (–2.4 to –0.9%; <0.0001)  |
| Yes, and with 1 person only           | 9729                      | 31.5%           | 30.1%           | 29.5%           | 29.1%           | 29.4%           | 27.5%           | 22.8%           | 22.4%           | –2.1% (–2.8 to –1.5%; <0.0001)  |
| Yes, and with ≥2 persons              | 3768                      | 13.7%           | 13.6%           | 13.5%           | 12.3%           | 8.3%            | 7.8%            | 12.8%           | 5.7%            | –4.3% (–5.5 to –3.2%; <0.0001)  |

**Note:** Data are from Youth Risk Behavior Survey (YRBS), and analyses were adjusted for complex survey designs. a) denotes that survey questionnaires were not asked during the survey years. b) this questionnaire was merged to “social media and video game use on a daily basis” in 2021. APC denotes average percentage change.

**Table 3: Trends in health-risk behaviors among high school students who endorsed depressive symptoms, 2007–2021.**

Nearly all health-risk behaviors were independently associated with depressive symptoms, except for carrying a weapon, past-month cigarette use, and lifetime cocaine, methamphetamine, ecstasy, and hallucinogen use. The risk behaviors that were especially associated with depressive symptoms included sleeping ≤5 h per night (aOR, 2.51 [2.24–2.82]), missing school due to feeling unsafe (aOR, 2.29 [1.38–3.82]), being the victim of electronic or school bullying (aORs, 2.06 [1.83–2.32] and 1.98 [1.76–2.22], respectively), high-risk screen time (aOR, 1.54 [1.34–1.76]), and past-month cannabis use (aOR, 1.35 [1.14–1.61]).

### Trends in depressive symptoms, by demographic subgroups

As shown in [Table 2](#), in the entire sample from 2007 to 2021, the percentage of students who reported depressive symptoms increased significantly from 28.4% to 42.3% (BAPC, 3.0% [95% CI, 2.6–3.4%]), with most of this increase occurring from 2017 to 2021. The increase of depressive symptoms was disproportionately greater in females than males (interaction, aOR, 1.03 [1.02–1.04],  $p < 0.0001$ ), and in non-Hispanic White students compared to non-Hispanic Black and Hispanic students ( $p = 0.003$  and  $p = 0.002$  for interaction terms,

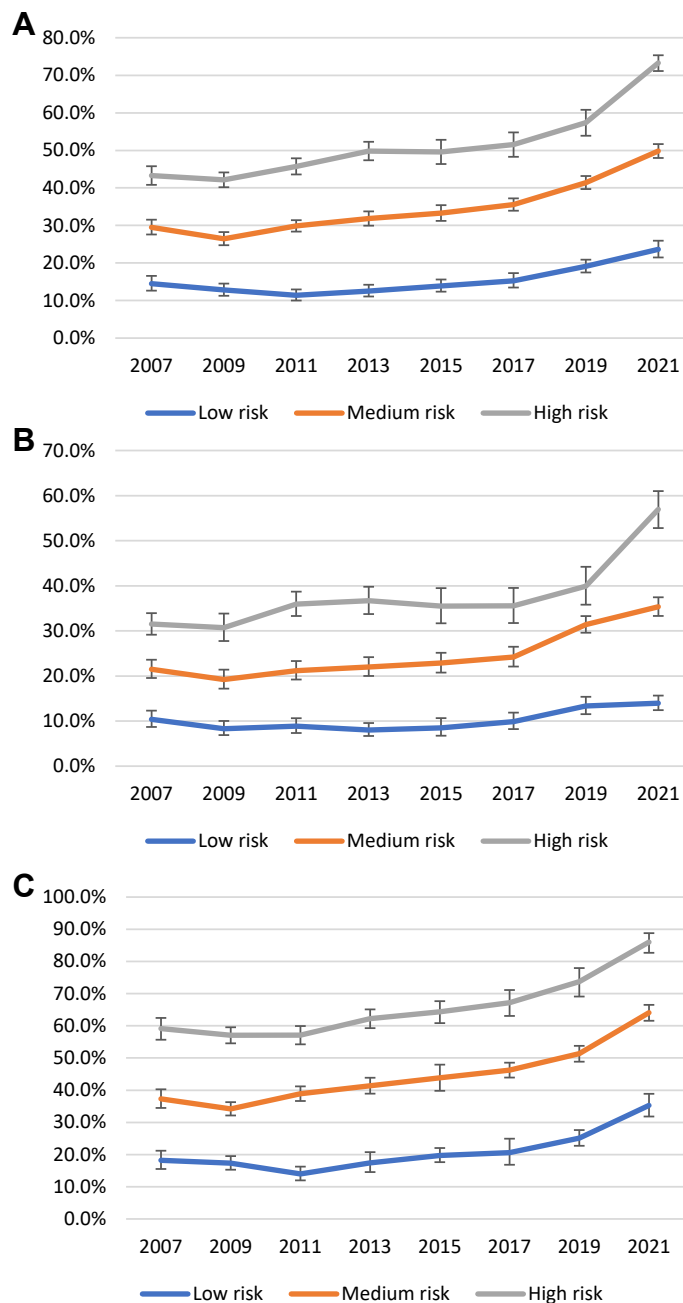
respectively). Regarding sexual orientation, approximately two-thirds of students identifying as bisexual or gay/lesbian reported depressive symptoms in 2021; although the rate of increase across the study period was larger among students identifying as straight when compared to those identifying as bisexual or gay/lesbian.

### Trends in depressive symptoms during the COVID-19 pandemic

As shown in [Supplementary Table S2](#), from 2019 to 2021, the first full year of the COVID-19 pandemic, all socio-demographic groups reported a significant increase in depressive symptoms, with the exception of males, students identifying as gay/lesbian or bisexual, and students of the non-Hispanic other racial group. Among high school students who endorsed depressive symptoms ([Supplementary Table S3](#)), the socio-demographic distributions were not significantly different before and during the COVID-19 pandemic, except sexual orientation ( $p < 0.0001$ ).

### Trends in depressive symptoms, by students with and without health-risk behaviors

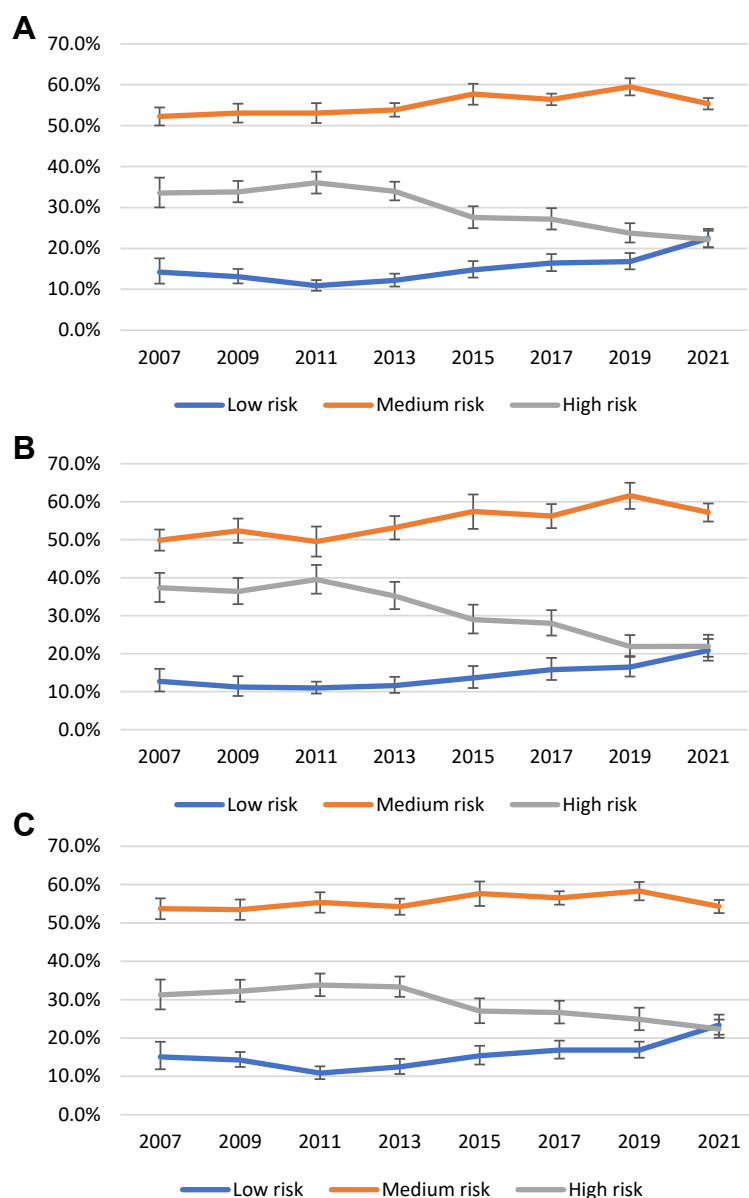
Across the entire sample, a general trend emerged in which depressive symptoms were most common among



**Fig. 1:** Trends in depressive symptoms (%) among high school students by risk group and sex, 2007–2021. **Panel 1A.** Overall trends in depressive symptoms among high school students by risk group, 2007–2021. **Panel 1B.** Trends in depressive symptoms among male high school students by risk group, 2007–2021. **Panel 1C.** Trends in depressive symptoms among female high school students by risk group, 2007–2021. **Note for Fig. 1:** Data are from Youth Risk Behavior Survey (YRBS), and analyses were adjusted for complex survey designs. Y-axis represents percentage (%) and x-axis represents survey year. Bars represent 95% confidence intervals. Students were classified as *low-risk* if they endorsed at least 1 health-risk behavior in 0 or 1 risk category, *medium-risk* if they endorsed at least 1 behavior in 2 or 3 categories, and *high-risk* if they endorsed at least 1 behavior in 4 or 5 categories. Categories included violence, substance use, sexual, physical/sedentary, and weight-related behaviors.

students engaging in the highest frequency of risk behaviors, but symptoms rose as much or more from 2007 to 2021 among students engaging in few or no risk

behaviors as students who were (Table 2). This trend was true for both females and males (Supplementary Tables S4 and S5). There were six notable exceptions



**Fig. 2:** Prevalence of risk groups among high school students who endorsed depressive symptoms, 2007–2021. **Panel 2A.** Overall trends in prevalence of risk groups among high school students who endorsed depressive symptoms, 2007–2021. **Panel 2B.** Trends in prevalence of risk groups among male high school students who endorsed depressive symptoms, 2007–2021. **Panel 2C.** Trends in prevalence of risk groups among female high school students who endorsed depressive symptoms, 2007–2021. **Note for Fig. 2:** Data are from Youth Risk Behavior Survey (YRBS), and analyses were adjusted for complex survey designs. Y-axis represents percentage (%) and x-axis represents survey year. Bars represent 95% confidence intervals. Students were classified as *low-risk* if they endorsed at least 1 health-risk behavior in 0 or 1 risk category, *medium-risk* if they endorsed at least 1 behavior in 2 or 3 categories, and *high-risk* if they endorsed at least 1 behavior in 4 or 5 categories. Categories included violence, substance use, sexual, physical/sedentary, and weight-related behaviors.

where depressive symptoms increased significantly more among students engaging in risk behaviors than students who were not, including being the victim of school bullying (interaction, aOR, 1.02 [1.01–1.03],  $p < 0.0001$ ) or forced sexual intercourse (interaction, aOR, 1.03 [1.02–1.05],  $p < 0.0001$ ), high-risk screen time

(interaction, aOR, 1.03 [1.01–1.04],  $p < 0.0001$ ), unhealthy weight perception (interaction, aOR, 1.02 [1.01–1.03],  $p < 0.0001$ ), sleeping  $\leq 7$  h per night (interaction, aOR, 1.01 [1.00–1.02],  $p = 0.047$ ), and past-month cannabis use (interaction, aOR, 1.03 [1.01–1.04],  $p < 0.0001$ ).

Fig. 1 demonstrates trends in depressive symptoms by risk groups. While depressive symptoms were more common with each escalating risk group, from 2007 to 2021, depressive symptoms increased more among the low-risk group (BAPC, 4.6% [3.6–5.7%]) than the high-risk group (BAPC, 2.9% [2.4–3.3%]) (interaction,  $p = 0.037$ ).

#### Trends in health-risk behaviors, among students reporting depressive symptoms

Table 3 shows trends in health-risk behaviors among students reporting depressive symptoms. Across risk behaviors, there was a general trend toward decreasing engagement in health-risk behaviors. For example, there was a significant decline in students reporting violence-related risk behaviors substance use, sedentary activity, and sexual activity. However, there were several health-risk behaviors that increased among students with depressive symptoms over the study period, including missing 1–3 days of school in the past month due to safety issues (BAPC, 2.4% [1.2–3.6%]), high-risk screen time (BAPC, 6.8% [6.2–7.4%]), sleeping  $\leq 5$  h per night (BAPC, 2.8% [2.2–3.4%]), being overweight or obese (BAPC, 1.8% [0.8–2.8%]), and unhealthy weight perception (BAPC = 2.5% [1.7–3.4] for underweight and BAPC, 0.9% [0.4–1.4%] for overweight/obese).

Consistent with these trends, there was a significant decrease in the percentage of students with depressive symptoms who met criteria for the high-risk group (BAPC, –2.9% [–3.6% to –2.2%]) and an increase in students meeting criteria for the low (BAPC, 3.4% [2.2–4.6%]) and medium-risk groups (BAPC, 0.5% [0.2–0.7%]) (Fig. 2).

#### Discussion

In this nationally-representative sample of over 119,000 high school students, there was a significant increase from 2007 to 2021 in the percentage of students reporting depressive symptoms. By 2021, approximately 42% of US high school students reported depressive symptoms including 56% of female students. The rise in depressive symptoms has been widespread, increasing more among students without than with established behavioral risks. The rise in depressive symptoms has coincided with a general decline in health-risk behaviors, including reductions in violence, substance use, sexual, and physical/sedentary risk behaviors. However, depressive symptoms are disproportionately increasing among a few at-risk groups and these risk behaviors are affecting a greater share of students with depressive symptoms, including students engaging in high-risk screen time, unhealthy weight perception, and inadequate sleep hours.

This study provides updated estimates of depressive symptoms among adolescents, and is consistent with prior studies demonstrating that the recent rise in

depressive symptoms has been most pronounced among females<sup>6,35,36</sup> and White individuals.<sup>4,5</sup> We extend these studies by presenting the first national estimates of trends during the first year of the COVID-19 pandemic, showing a substantial rise in symptoms from 2019 to 2021, although rates had been rising considerably even before the pandemic.

This study also extends prior studies by demonstrating that the increase in depressive symptoms has not been confined to students with established behavioral risks. Relative to students with multiple behavioral risks, depressive symptoms increased more among those with few or no behavioral risks. Whereas previous studies have focused on broad trends in depressive symptoms among sociodemographic groups,<sup>1–5</sup> our study examines trends among adolescents with varying levels of behavioral risks, revealing a broadening of the adolescent depression risk profile.

This finding underscores the potential importance of universal depression screening. The US Preventative Services Task Force recommends universal depression screening in primary care beginning at age 12.<sup>33,53</sup> Unfortunately, adolescent depression screening remains an uncommon practice, occurring in less than 2% of adolescents seen in primary care,<sup>54,55</sup> and recent data suggest screening declined during COVID-19, despite increases in positive depression screens.<sup>56</sup> Currently, screening most commonly occurs in adolescents with known social and behavioral risks. However, our results suggest these targeted screening practices are likely to miss many adolescents experiencing depressive symptoms.

In addition to universal screening in primary care, the results underscore the potential value of universal depression screening in school settings. While universal screening has been most established in primary care, many adolescents do not receive annual primary care services.<sup>57,58</sup> This has led to calls for universal depression screening in schools. Schools commonly use targeted screening, where students are referred for depression screening after concerning classroom behaviors. However, recent studies demonstrate the effectiveness of universal screening strategies. In one randomized controlled trial, high school students who received universal screening were nearly six times more likely to be identified with major depression and two times more likely to initiate treatment for depression than students exposed to targeted screening.<sup>59</sup> Combined with results of our study, these findings suggest that universal depression screening may be an effective way to promote linkages to depression care for adolescents who might otherwise go undetected.

While depressive symptoms appear to be rising more among students without established behavioral risks, we did find several at-risk groups with disproportionately increasing rates of symptoms. In separate analysis, students with these risk behaviors accounted for an

increasing share of individuals with depressive symptoms. These risk groups include students with high-risk screen time, unhealthy weight perception, and inadequate sleep hours. Our time series cross-sectional study cannot establish whether these behaviors are contributing to the observed increases in depressive symptoms or whether they are related indicators of underlying factors. Moreover, this study was not able to assess the impact of changes in broader social factors on adolescent depressive symptoms, including changes in media, social interaction, or mental health stigma. Longitudinal cohort studies are needed to better understand the causality and directionality between depressive symptoms and the risk behaviors in this study. Nonetheless, the risk behaviors identified may be important targets to curb rising rates of depressive symptoms in adolescents and clinicians can educate adolescents and their families on the importance of healthy media practices and adequate sleep.<sup>60</sup>

Finally, our findings reaffirm several groups with persistently elevated rates of depressive symptoms, including Hispanic students, sexual minorities, students impacted by violence, especially bullying and forced sexual intercourse, and students using substances. Year after year, students in these groups reported exceptionally high rates of depressive symptoms. Clinical and population-based strategies to reduce adolescent depression are incomplete without prevention and intervention efforts targeted at these high-risk groups.

This study has several limitations. First, as described in the introduction, this study sought to assess depressive symptoms and does not ascertain clinical diagnoses of depression, which require multiple symptoms of depression over a specific period. Additionally, the study is limited by use of a single dichotomous item to assess depressive symptoms, which may reduce reliability. Second, findings may not be representative of students who are not enrolled in school or students who do not speak English. Furthermore, despite the robust sampling design, residual bias may remain if the clusters (i.e., schools) are not representative of the overall population. Third, given this study is cross-sectional, causality and directionality of associations cannot be determined and the incidence-prevalence bias cannot be ruled out. In addition, data were collected biennially, so our analyses may have over-simplified the fluctuations of trends in depressive symptoms. Fourth, results of YRBS are subject to self-reporting bias and the extent of overreporting or underreporting of depressive symptoms or health-risk behaviors cannot be determined. However, YRBS survey questions have been shown to demonstrate good test-retest reliability.<sup>43,44</sup> Fifth, whereas YRBS has historically been administered in the spring, in 2021, it was administered during the fall, which could impact comparisons with previous years. Similarly, COVID-19 precautions reduced student and

school participation in 2021 and as a result, CDC sampled more schools than prior cycles to obtain sufficient numbers of students.<sup>41</sup> It is possible that variability in school response rates, particularly during years with lower response rates, such as 2021, could introduce non-response bias. Additionally, YRBS aggregates data for race and ethnicity into broad categories of Black, Hispanic, White, and other, precluding analysis of racial and ethnic subgroups. The surveys also did not seek to accommodate varying cultural concepts of depressive symptoms across groups.<sup>61</sup> Finally, some unmeasured confounding factors, such as academic stress, family financial strain, access to healthcare, and family history of mental illness, could influence depressive symptoms but could not be assessed with the measures available in YRBS. Thus, there are likely other unexamined factors contributing to recent trends in adolescent depressive symptoms.

## Conclusions

Nonetheless, this study provides valuable information on a growing public health problem in adolescents. We demonstrate how rising rates of depressive symptoms among high school students have not been confined to students with established behavioral risk factors and have increased more among students with few or no behavioral risks. These findings underscore the potential value of universal depression screening to identify adolescents who might otherwise go undetected by targeted screening practices.

## Contributors

Study concept and design: TJB, MO, & TGR; Data acquisition and statistical analyses: TGR; Interpretation of data: TJB, MO, & TGR; Drafting of manuscript: TJB & TGR; Critical revision of manuscript for important intellectual content: TJB, MO, & TGR; Supervision: MO & TGR. TGR had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

## Data sharing statement

Data are publicly available using the following web link: <https://www.cdc.gov/yrbbs/index.html>.

## Declaration of interests

Each author completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and had none directly related to this manuscript.

- 1) **Bommersbach** reported none.
- 2) **Olfson** reported none.
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# Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.j.lana.2025.101000>.

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