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Age, Period, and Cohort Trends in Mood Disorder Indicators and Suicide-Related Outcomes in a Nationally Representative Dataset, 2005–2017

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Drawing from the National Survey on Drug Use and Health (NSDUH; N = 611,880), a nationally representative survey of U.S. adolescents and adults, we assess age, period, and cohort trends in mood disorders and suicide-related outcomes since the mid-2000s. Rates of major depressive episode in the last year increased 52% 2005–2017 (from 8.7% to 13.2%) among adolescents aged 12 to 17 and 63% 2009–2017 (from 8.1% to 13.2%) among young adults 18–25. Serious psychological distress in the last month and suicide-related outcomes (suicidal ideation, plans, attempts, and deaths by suicide) in the last year also increased among young adults 18–25 from 2008–2017 (with a 71% increase in serious psychological distress), with less consistent and weaker increases among adults ages 26 and over. Hierarchical linear modeling analyses separating the effects of age, period, and birth cohort suggest the trends among adults are primarily due to cohort, with a steady rise in mood disorder and suicide-related outcomes between cohorts born from the early 1980s (Millennials) to the late 1990s (iGen). Cultural trends contributing to an increase in mood disorders and suicidal thoughts and behaviors since the mid-2000s, including the rise of electronic communication and digital media and declines in sleep duration, may have had a larger impact on younger people, creating a cohort effect.

General Scientific Summary
More U.S. adolescents and young adults in the late 2010s (vs. the mid-2000s) experienced serious psychological distress, major depression, and suicidal thoughts, and more attempted suicide and took their own lives. These trends are weak or nonexistent among adults 26 years old and over, suggesting a generational shift in mood disorders and suicide-related outcomes rather than an overall increase across all ages.

Keywords: mood disorders, depression, suicide, birth cohort

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The public health burden of mood disorders is substantial, with negative effects including functional impairment, reduced quality of life, disability, low work productivity, premature mortality, and increased health care utilization (Cassano & Fava, 2002; Mrazek, Hornberger, Altar, & Degtiar, 2014; Simon, 2003). The economic costs of depression are estimated to be in the range of $106–118 billion per year in the United States (Mrazek et al., 2014). In addition to being costly in many domains, depression is widespread; an estimated one in six individuals will experience major depressive disorder at some point in their lives (Davidson &

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The analyses and results of the current project have not been previously presented, although descriptive statistics by broad age groups are publicly available in the yearly National Survey on Drug Use and Health (NSDUH) detailed tables posted online. Institutional review board approval for the NSDUH was obtained by the survey administrator, RTI International, on behalf of the U.S. Department of Health and Human Services; the study does not include data collected by any of the authors. During the completion of this project, Mary E. Duffy was supported by the National Science Foundation Graduate Research Fellowship Program under Grant NSF 1449440. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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Meltzer-Brody, 1999), and depression has a 12-month prevalence rate of 7% (American Psychiatric Association [APA], 2013). Mood disorders are also associated with suicidal thoughts and behaviors. Longitudinal work indicates that major depressive episodes (MDEs) and suicidal ideation each independently predict future MDEs and suicidal ideation (Mitsui et al., 2018). As many as 17% of people with treatment-resistant depression attempt suicide (Mrazek et al., 2014). Importantly, suicidal thoughts and behaviors are some of the most consistent predictors of future suicide attempts and death by suicide (Bostwick, Pabbati, Geske, & McKean, 2016; Ribeiro et al., 2016). With over 45,000 lives lost to suicide in the United States in 2016, the toll is far too high (Centers for Disease Control [CDC], 2018).

Although several studies have documented increases in mood disorders and suicide-related outcomes among adolescents since 2010 (Mojtabai, Olfson, & Han, 2016; Plemmons et al., 2018; Twenge, Joiner, Rogers, & Martin, 2018) and established recent prevalence estimates among college-aged individuals (Auerbach et al., 2016, 2018; Mortier et al., 2018), little research has examined trends in these indicators in recent years across age groups by including adolescents, young adults, and older adults from the same sample. Thus, it is unclear if the recent rise in mood disorder indicators among adolescents is isolated to that age group or extends more broadly to those of all ages. A previous study found no change in serious psychological distress among adults 18 years and older up to 2012 (Mojtabai & Jorm, 2015), but trends since 2013 are unknown. MDE appears to have increased among some adult age groups in recent years in descriptive analyses (Weinberger et al., 2018). Some evidence suggests that suicide attempts rose between 2004 and 2013 among adults ages 21 and over (Olfson et al., 2017), but trends since that time and among younger adults are unclear, as are trends in suicidal ideation and suicide planning. Rates of death by suicide have been rising across the United States in the past decade (CDC, 2018), but it is less certain whether these increases are being driven by particular age groups.

In addition, it is unknown whether trends in mood disorder indicators and suicide-related outcomes are due to age, time period, or birth cohort, three different processes that can cause change over time (Campbell, Campbell, Siedor, & Twenge, 2015; Schaie, 1986; Yang & Land, 2008). First, change can be due to age or development; for example, the incidence of mood disorders generally lessens with age, with likelihood of onset increasing at puberty and peaking in the mid-20s (APA, 2013). Second, change can be due to time period, or a cultural change that affects people of all ages. Perhaps more (or fewer) Americans of all ages are experiencing mood disorders and their related symptoms in recent years. Third, changes in mood disorder indicators could be due to cohort (also known as *generation*), a cultural change that affects people differently depending on their age or generation. Perhaps more young Americans in recent cohorts are experiencing mood disorders even if previous (older) cohorts are not. Such a finding would suggest a cohort or generational effect, with cultural changes having a larger effect on younger age groups than older age groups. If trends were instead due to time period, that would suggest cultural changes were impacting people of all ages equally.

Given that the first incidence of major depressive episode (MDE) strongly predicts the risk of another episode in the future (Wang et al., 2013), a cohort effect among younger people may predict a greater need for mental health services for these cohorts as they mature. Research indicates that earlier onset of depression predicts chronicity, recurrence, and severity of episodes throughout life (APA, 2013; Garcia-Toro et al., 2013; Weissman et al., 1999). When followed into adulthood, those with adolescent-onset depression (compared to those without) are twice as likely to have MDE, five times more likely to attempt suicide, and are at increased risk for death by suicide (Weissman et al., 1999). A cohort effect among younger people would indicate a need for increased attention to, and specialized interventions for, this group over time, as the cost of mood disorders and suicide is high. It also seems important to examine whether trends over time vary based on gender, race/ethnicity, or income level, to determine which groups are most affected.

In this article, we seek to explore trends in psychological distress, past-year MDEs, and suicide-related outcomes (suicidal ideation, plans, attempts, and deaths by suicide) from 2005 to 2017 in the National Survey on Drug Use and Health (NSDUH), a large (N = 611,880), nationally representative sample of Americans ages 12 and older. We take a two-pronged approach to examining these trends. First, we compare mood disorder indicators and suicide-related outcomes within age groups over the years with comparable data (since 2008 for serious psychological distress and suicide-related outcomes, since 2005 for MDE among adolescents, and since 2009 for MDE among adults). Second, we perform age-period-cohort (APC) analysis on both adolescents (12 to 17) and adults (ages 18 and over). This relatively new statistical technique uses hierarchical linear modeling to separate the effects of age, time period, and cohort/generation (Yang & Land, 2008, 2013). Thus, APC can show whether trends over time are due to time period or cohort as well as documenting age differences. We hypothesized that there would be an increase in the prevalence of psychological distress, past-year MDEs, and suicide-related outcomes in recent years, and that this increase would be driven by cohort effects (with greater incidence in younger cohorts), rather than by age or time period effects. In additional exploratory analyses, we examined gender, race/ethnicity, and income to discern whether any trends in mood disorder indicators and suicide-related outcomes were more pronounced among some groups compared to others. We made no a priori hypotheses about these potential moderating variables.

Method

Sample

Administered by the U.S. Substance Abuse and Mental Health Services Administration, the NSDUH is an annual survey of the U.S. population, including individuals 12 years of age and older; it oversamples adolescents and young adults. The annual mean weighted response rate of the NSDUH was 65.2% for the years included in the current study (Center for Behavioral Health Statistics & Quality, 2017). Respondents included 212,913 adolescents ages 12 to 17 from 2005 to 2017 and 398,967 adults ages 18 and over from 2008 to 2017 (N = 611,880). As recommended by the survey administrators, analyses were weighted to make the sample nationally representative of the U.S. population. From age 12 to age 21, age is coded in the dataset as individual ages. Above age 22, age is coded within categories, so we recoded age ranges to means, rounding up when necessary: 22–23 = 23; 24–25 = 25;

26–29 = 28; 30–34 = 32; 35–49 = 42; 50–64 = 57; 65 and over = 70. Demographic variables included sex (male, female), race/ethnicity (Black, White, Asian, Hispanic), and total family income level in four categories (less than $20,000, $20,000–49,999, $50,000–74,999, and $75,000 or more).

The adolescent sample (51% female) was 58% non-Hispanic White, 14% non-Hispanic Black, 19% Hispanic, 4% Asian or Pacific Islander, and 5% multiracial. Total family income was 17% less than $20,000, 29% $20,000–49,999, 27% $50,000–74,999, and 27% $75,000 or more. The adult sample (52% female) was 60% non-Hispanic White, 13% non-Hispanic Black, 17% Hispanic, 4% Asian, and 4% multiracial. Total family income was 22% less than $20,000, 33% $20,000–49,999, 16% $50,000–74,999, and 29% $75,000 or more.

Procedures

The NSDUH data collection protocol was approved by the institutional review board at RTI International (Research Triangle Park, NC). NSDUH interviews employ computer-assisted interviewing so respondents can answer questions more privately. The NSDUH codebook includes full details on sample section and survey administration procedures (Center for Behavioral Health Statistics & Quality, 2017).

Measures

Serious psychological distress. Beginning in 2008, adult respondents (18 years of age and older) completed the Kessler-6 Distress Scale, a valid and reliable scale (Kessler et al., 2002) that asks adult respondents how frequently they experienced symptoms of psychological distress during the past 30 days. The six symptoms were: feeling nervous, feeling hopeless, feeling restless or fidgety, feeling so sad or depressed that nothing could cheer you up, feeling that everything was an effort, and feeling down on yourself, no good, or worthless. Response choices were coded as 4 (*all of the time*), 3 (*most of the time*), 2 (*some of the time*), 1 (*little of the time*), and 0 (*none of the time*). Cronbach's alpha in this sample was .93. The possible range of scores was 0 to 24. Scores of 13 and over were coded by the survey administrators as indicative of serious psychological distress; as the other outcomes were dichotomous, we relied on this dichotomous variable in our analyses.

MDE in the last year. MDE was assessed using a structured interview with questions adapted from the depression section of the NCS-Replication. A respondent was classified as having a MDE in the past year if they reported experiencing at least five out of the nine criteria for MDE in the standard nomenclature (e.g., *DSM–5*; APA, 2013), where at least one of the criteria is a depressed mood or loss of interest or pleasure in daily activities.

The measurement of MDE is comparable across years in the adolescent samples since 2005 and is comparable across years in the adult samples since 2009. MDE was assessed using different items on role impairment among adolescents (ages 12 to 17) and adults (18 and over; e.g., "school or work" for adolescents and "ability to work" for adults); thus, we did not directly compare the two age groups or combine the data across them.

Suicide-related outcomes: Thoughts (ideation), plans, attempts. Beginning in 2008, three questions assessed suicide-related outcomes among adults (18 and over). These include thoughts ("The next few questions are about thoughts of suicide. At any time in the past 12 months, that is, from [the date 12 months prior] up to and including today, did you seriously think about trying to kill yourself?"), plans ("During the past 12 months, did you make any plans to kill yourself?"), and attempts ("During the past 12 months, did you try to kill yourself?") Response options for each question were "yes" and "no."

Deaths by suicide. Suicide deaths per 100,000 individuals for the adult age groups and years corresponding to the NSDUH were calculated from the online version of the CDC Fatal Injury Reports, which has data available from 1999 to 2017 (CDC, 2018). We focused on adults, as trends in suicide rates for adolescents were recently examined in Twenge, Joiner, et al. (2018), and because only adults in the NSDUH answered the questions on suicide-related outcomes.

Data Analysis Plan

We first calculated descriptive statistics to determine rates of each outcome (serious psychological distress, past-year MDE, and suicide-related outcomes including suicidal thoughts, making a suicide plan, and suicide attempts, or having at least one of the three). We then calculated percent difference (PD; relative percentage change) from the first year of available data to the last, capturing the percentage increase or decrease in the number of respondents fitting criteria for each of the outcome variables (e.g., a rise from 10% to 15% represents a 50% percent difference: 15 − 10 = 5; 5/10 = 50%; a 50% PD is the same as a relative risk of 1.50). We analyzed data by individual years, though we will sometimes refer to generations such as Boomers (born 1946–1964), Generation X (1965–1979), Millennials (1980–1994), and iGen (1995–2012; Twenge, 2017). Given the large sample sizes, we focus primarily on effect sizes rather than statistical significance.

Next, to better separate the effects of age, time period, and cohort, we performed APC analyses. Psychological distress, past-year MDE, and each of the suicide-related outcomes were the outcome variables. Following the recommendations of Yang and Land (2013), we estimated mixed effects models allowing intercepts to vary across time periods (years) and cohorts. Thus, effectively, an intercept (mean) score was calculated (using empirical Bayes) for each cohort and each survey year. In addition, a fixed intercept (grand mean) is estimated along with fixed effects for age. For all variables, we estimated a model each for linear, quadratic, and cubic effects of age and chose the best fitting model in terms of incremental explanatory power and parsimony. Table 1 displays the results of the chi-square model comparison tests. The final model for each variable has three variance components: One for variability in intercepts due to cohorts ($\tau u0$), one for variability in intercepts due to period ($\tau v0$), and a residual term containing unmodeled variance within cohorts and periods. Variance in the intercepts across time periods and cohorts indicates period and cohort differences, respectively. Effectively, this allows us to estimate the percentage of respondents reporting each of the out-

Table 1
Chi-Square Tests for Model Fit, Age-Period-Cohort Analyses

Model	*df*	AIC	χ^2	*p*
Serious psychological distress				
Null	3	196,835		
Linear	4	196,730	107.13	<.001
Quadratic	5	196,728	3.924	.048
Cubic	6	196,727	2.143	.143
Adolescent MDE				
Null	3	133,739		
Linear	4	133,625	116.49	<.001
Quadratic	5	133,272	355.06	<.001
Cubic	6	133,274	.025	.875
Adult MDE				
Null	3	202,582		
Linear	4	202,530	53.453	<.001
Quadratic	5	202,478	54.214	<.001
Cubic	6	202,477	2.943	.086
Suicidal thoughts				
Null	3	166,536		
Linear	4	166,420	118.21	<.001
Quadratic	5	166,419	3.233	.072
Cubic	6	166,387	33.742	<.001
Suicide plan				
Null	3	67,211		
Linear	4	67,116	96.738	<.001
Quadratic	5	67,113	4.588	.032
Cubic	6	67,079	36.197	<.001
Suicide attempt				
Null	3	39,031		
Linear	4	38,935	98.297	<.001
Quadratic	5	38,907	30.148	<.001
Cubic	6	38,881	28.017	<.001

Note. MDE = major depressive episodes; AIC = Akaike information criterion. Each model within each variable was tested against the model above it. The gray-highlighted row within each variable represents the model that was chosen for later analyses.

come variables for each year and cohort, with year and cohort independent of each other and of age. All APC analyses were conducted using the lme4 package (Bates, Maechler, Bolker, & Walker, 2014) in R (R Core Team, 2014).

We used generalized mixed effects models because all outcome variables were dichotomous. Weighting could not be used for the mixed-effects analyses because proper probability weighting for variance component estimation requires consideration of pairwise selection probabilities, which is not possible with current statistical software. We also examined moderators of the trends in the APC analyses, focusing on gender, race/ethnicity, and income level. To better illustrate the differences, *y*-axes of figures differ in their range, and this should be kept in mind when interpreting the figures.

Results

Serious Psychological Distress in the Last Month

The percentage of adults meeting the criterion for serious psychological distress in the last month rose between 2008 and 2017 among most age groups, with a larger rise among younger adults and a slight decline among adults ages 65 and older (see Table 2 and Figure 1). The largest increase was among 20- to 21-year-olds, where 78% more in 2017 (vs. 2008) experienced serious psychological distress in the last month; among 18- to 25-year-olds overall, 71% more in 2017 (vs. 2008; 7.7% vs. 13.1%) experienced serious psychological distress.

APC analysis suggested that the trend was due to both time period (year) and cohort, but primarily to cohort (see Table 3, which displays the best-fitting models). The percentage experiencing serious psychological distress was highest in the cohorts born in the 1950s (Boomers) and the 1990s (iGen), with a consistent decline across the 1970s birth cohorts and a consistent increase from the early 1980s birth cohorts (Millennials) to the late 1990s cohorts (iGen; see Figure 2). In cohorts born since 1980, distress was lowest in the 1985 cohort (5.5%) and highest in the 1999 cohort (8.2%); thus, the 1999 cohort was 49% more likely than the 1985 cohort to have reported serious psychological distress in the past month with age and time period controlled. Time period effects were weaker, with serious distress increasing from 6.3% in 2014 to 8.1% in 2017, a 29% increase. Psychological distress generally declined with age (see Figure 2).

MDE in the Last 12 Months

MDE in the last 12 months increased among adolescents ages 12 to 17 and among young adults ages 18 to 25 but was either unchanged or declined slightly among those ages 26 and older (see Table 4 and Figure 3).

MDE among adolescents 12 to 17 increased from 8.7% in 2005 to 13.2% in 2017, a 52% increase. MDE among girls increased from 13.1% in 2005 to 19.9% (one out of five) in 2017. APC analysis showed that the trend among adolescents

Table 2
Incidence of Serious Psychological Distress in Last Month, Percent of Adults by Age Category

Age (years)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	PD
18–19	8.97	8.47	8.92	9.23	9.4	9.55	10.99	12.33	13.05	14.97	+67%
20–21	8.09	8.45	9.04	7.07	8.57	8.68	9.77	10.68	12.62	14.37	+78%
22–23	6.96	7.56	7.20	7.07	7.48	7.94	8.27	9.09	9.77	11.99	+72%
24–25	6.38	7.08	6.36	7.24	7.58	6.19	8.05	9.53	8.48	11.08	+74%
26–29	6.17	5.31	5.67	7.01	6.07	7.33	5.12	7.24	7.16	9.19	+49%
30–34	4.96	6.06	5.37	4.87	6.04	5.96	5.36	5.38	6.17	6.58	+33%
35–49	5.31	5.11	4.75	5.16	5.01	5.06	4.66	5.00	5.56	5.44	+2%
50–64	3.21	3.63	4.41	4.10	4.37	4.14	4.41	4.15	4.62	3.83	+19%
65+	2.91	1.90	2.15	1.52	3.24	2.81	2.6	1.97	2.00	1.87	−36%

Note. Positive percent differences (PDs) indicate an increase in prevalence, and negative PDs indicate a decrease in prevalence.

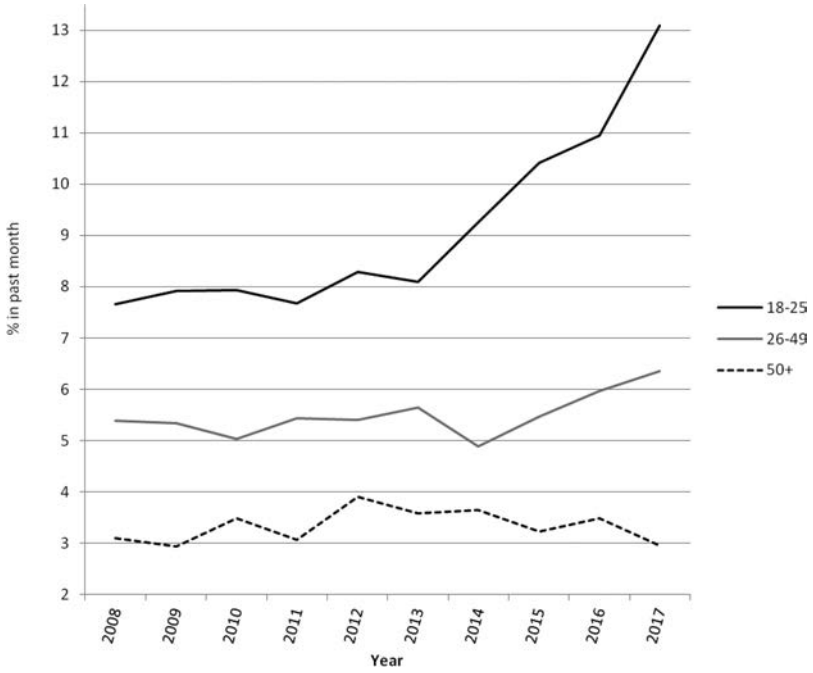

Figure 1. Percent with serious psychological distress in the last month by age group, 2008–2017.

was primarily due to time period, with MDE increasing from a low of 8.8% in 2006 to a high of 14.8% in 2017, a 68% increase. Nearly all of the increase occurred after 2010; from 2010 (9.1%) to 2017 (14.8%), MDE among adolescents increased 63% (see Supplemental Figure S1 in the online supplemental material).

Among adults, however, the trend was primarily due to cohort, with 7.3% of the 1982 cohort (Millennials) experiencing MDE in

Table 3
GLMMs Fixed and Random Effects Estimates, Age-Period-Cohort Analyses

	Fixed effects estimates			Random effects *SD* (logit)		*N* observations
Model	Odds ratio	Probability	*p*	Birthyear	Year	Total; birth year; year
Serious psychological distress				.170	.105	398,967; 54; 10
Intercept	.070	.066	<.001			
Age	.973	.493	<.001			
Adolescent MDE				.034	.209	212,913; 18; 13
Intercept	.122	.108	<.001			
Age	1.260	.558	<.001			
Age^2	.940	.485	<.001			
Adult MDE				.182	.063	357,875; 50; 9
Intercept	.106	.096	<.001			
Age	.992	.498	<.001			
Age^2	.999	.500	<.001			
Suicidal thoughts				.205	.048	396,984; 54; 10
Intercept	.055	.052	<.001			
Age	.971	.493	<.001			
Suicide plan				.284	.036	396,953; 54; 10
Intercept	.016	.016	<.001			
Age	.967	.492	<.001			
Suicide attempt				.134	.073	396,949; 54; 10
Intercept	.006	.005	<.001			
Age	.968	.492	<.001			
Age^2	1.002	.501	<.001			
Age^3	1.000	.500	<.001			

Note. MDE = major depressive episodes. Generalized linear mixed models (GLMMs) produce coefficients in the forms of log odds. For greater ease of interpretation of coefficients, log odds were converted to odds ratios and then probabilities.

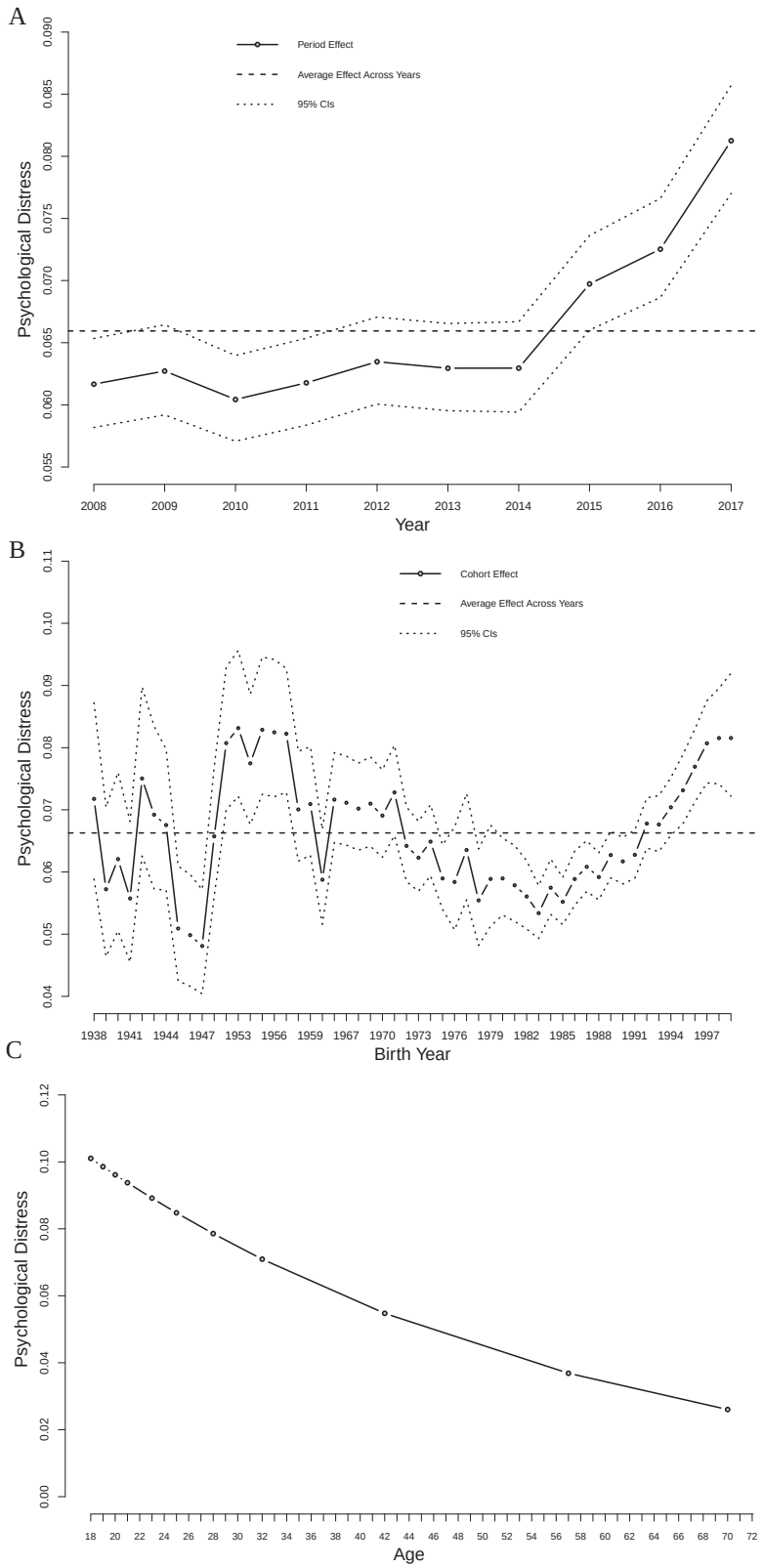

Figure 2. Percent of adults with serious psychological distress 2008–2017 in age-period-cohort analyses: Effects for (A) year, (B) cohort, and (C) age.

Table 4
Incidence of Major Depressive Episode (MDE) in Last 12 Months: Percent of Adolescents and Adults by Age Category, 2005–2017

Age (years)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	PD
12–13	5.59	5.27	4.29	5.18	4.57	4.20	4.16	5.58	5.90	7.17	8.20	7.22	6.73	+47% (+20%)
14–15	9.19	7.82	8.60	8.62	8.72	9.11	8.71	10.05	12.14	11.76	13.77	13.32	14.28	+64% (+55%)
16–17	11.18	10.59	11.55	11.14	10.55	10.68	11.69	11.93	13.38	14.68	15.52	17.60	17.81	+69% (+59%)
18–19	—	—	—	—	8.50	8.74	8.68	9.64	9.17	10.62	11.34	11.23	12.42	+46%
20–21	—	—	—	—	6.80	8.47	8.36	9.19	9.06	8.94	11.68	12.48	15.12	+122%
22–23	—	—	—	—	8.01	8.86	7.32	8.93	8.53	9.5	9.41	9.97	12.77	+59%
24–25	—	—	—	—	8.90	7.59	8.56	8.18	8.98	9.19	8.8	9.98	12.37	+39%
26–29	—	—	—	—	7.53	6.76	8.34	7.88	8.34	7.56	8.16	7.98	9.55	+27%
30–34	—	—	—	—	8.29	7.41	7.43	7.49	8.02	6.76	6.96	7.94	7.98	−4%
35–49	—	—	—	—	7.47	7.59	8.19	7.56	7.35	7.25	7.67	7.05	7.21	−3%
50–64	—	—	—	—	7.22	7.94	6.98	7.16	7.16	6.96	6.04	6.29	6.23	−14%
65+	—	—	—	—	2.44	2.27	1.78	3.37	2.68	3.00	3.19	2.64	3.17	+30%

Note. Adolescent and adult major depressive episode (MDE) are measured using different criteria; thus, we do not directly compare them. Percent differences (PDs) in parentheses for adolescents are 2005–2017. All other PDs are 2009–2017. Positive PDs indicate an increase in prevalence, and negative PDs indicate a decrease in prevalence.

the last year, compared to 12.8% of the 1997 (iGen) cohort (a 75% increase) and 11.8% of the 1999 cohort (a 62% increase). Time period effects in the APC analyses were weaker, with MDE incidence among adults at 9.3% in 2009 and 10.1% in 2017 (a 9% increase; see Figure 4).

Suicide-Related Outcomes: Thoughts (Ideation), Plans, Attempts

Suicide-related outcomes also increased more among younger adults than among older adults (see Table 5 and Figure 5), although the low base rate (particularly for suicide attempts) suggests these results should be interpreted with caution.

APC analyses showed that the increase was primarily due to cohort (see Figure 6). For example, nearly twice as many in the iGen 1999 cohort (7.8%) compared to the Millennial 1982 cohort (3.8%) reported thinking about suicide (suicidal ideation). Nearly three times as many in the 1999 cohort (2.9%) as compared to the 1982 cohort (1.0%) reported making a suicide plan. Cohort differences in suicide attempts were weaker, with .66% in the 1998 cohort reporting an attempt, compared to .46% of the 1982 cohort. Time period effects were smaller across all of the suicide-related outcomes, with increases from 5.0% in 2014 to 5.6% in 2017 in suicidal ideation, from 1.5% in 2014 to 1.6% in 2017 in making a suicide plan, and from .52% in 2014 to .61% in 2017 in suicide attempts.

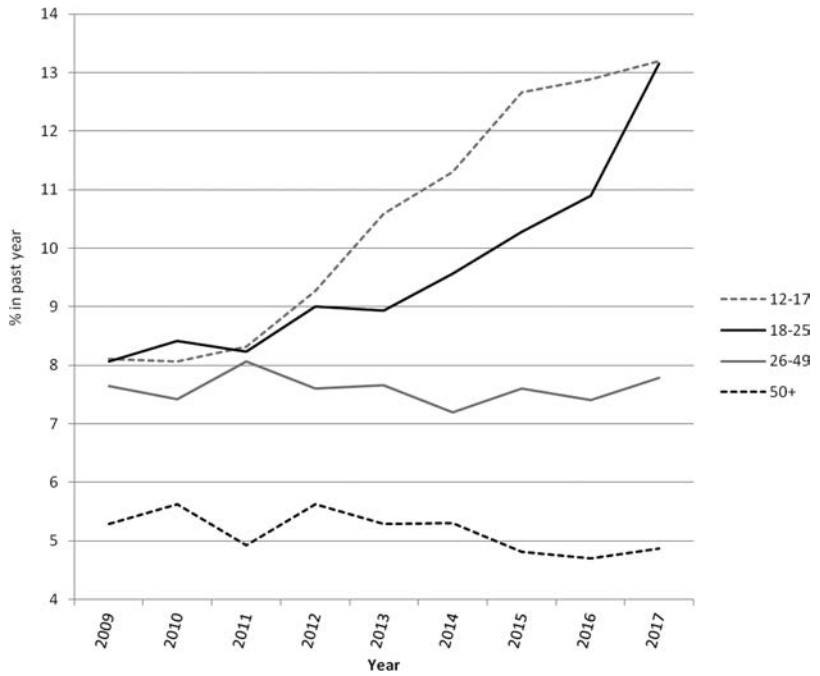

Figure 3. Percent with major depressive episode in the past 12 months, by age group, 2009–2017.

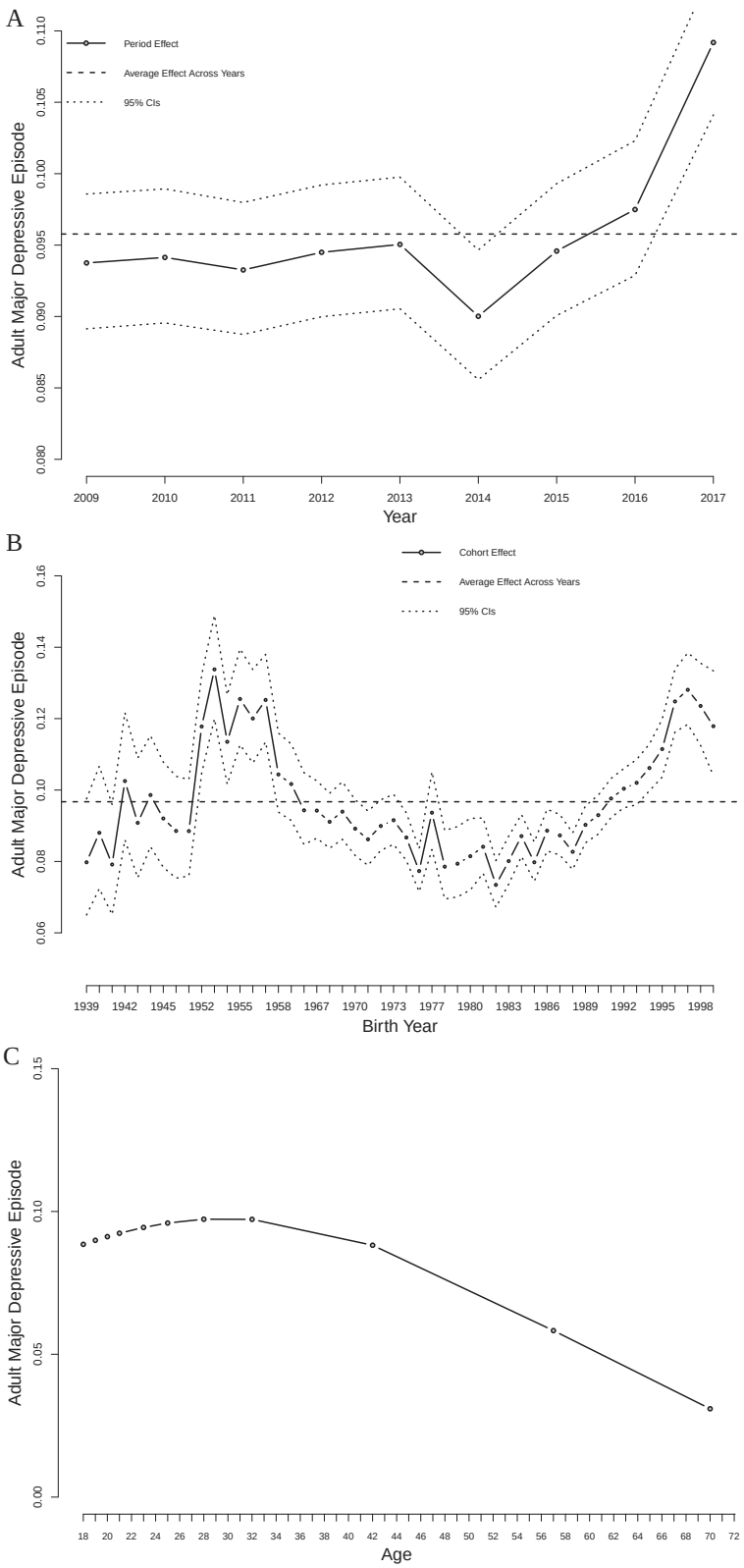

Figure 4. Percent of adults with major depressive episode in the last 12 months in age-period-cohort analyses: Effects for (A) year, (B) cohort, and (C) age.

Table 5
Incidence of Suicidal Thoughts, Plans, and Attempts in Last 12 Months: Percentage of Adults by Age Category

Age (years)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	PD
Thoughts											
18–19	8.51	7.44	8.59	8.86	9.43	9.63	9.82	11.16	10.35	12.40	+46%
20–21	7.17	6.52	7.32	6.89	7.58	8.46	7.91	8.60	10.10	12.03	+68%
22–23	5.72	5.33	6.13	5.94	6.15	6.67	6.46	7.88	7.66	8.86	+55%
24–25	6.20	5.07	5.41	5.27	5.45	5.25	5.87	5.93	6.60	7.98	+29%
26–29	4.35	4.15	4.43	4.42	4.20	4.41	4.37	6.07	5.70	6.30	+45%
30–34	3.71	4.38	4.00	2.59	4.19	4.44	4.17	4.36	5.11	4.46	+20%
35–49	3.90	4.30	4.09	3.89	4.13	3.86	3.75	3.54	3.74	3.58	−8%
50–64	2.95	3.04	3.06	3.35	2.84	3.73	3.75	3.01	2.89	3.07	+4%
65+	1.62	1.30	1.61	1.67	2.07	1.54	1.58	1.78	1.63	2.28	+41%
Plans											
18–19	2.94	2.61	2.67	2.56	3.58	3.31	3.09	4.15	3.52	5.17	+76%
20–21	2.16	1.89	2.11	1.68	2.39	3.02	2.57	2.76	3.46	4.59	+113%
22–23	1.21	1.23	1.90	1.43	1.62	2.20	1.69	2.59	2.41	2.63	+117%
24–25	1.67	1.62	1.56	1.79	1.62	1.21	1.68	1.24	2.02	2.24	+34%
26–29	1.14	.78	1.00	1.70	1.11	1.54	1.27	1.17	1.55	1.58	+39%
30–34	1.13	.89	1.19	.52	.93	1.42	.96	1.15	1.40	1.10	−3%
35–49	1.03	1.15	1.09	1.17	1.49	1.25	1.12	.92	1.12	1.07	+4%
50–64	1.02	.91	1.04	.95	.66	.70	.93	.86	.63	.83	−19%
65+	.26	.20	.61	.33	.51	.21	.52	.41	.22	.49	+88%
Attempts											
18–19	2.46	1.46	1.68	1.87	2.07	1.77	1.66	2.42	2.36	2.99	+22%
20–21	1.07	.90	1.10	1.26	1.60	1.40	1.38	1.63	2.31	2.00	+87%
22–23	.65	.73	1.13	.74	1.08	.91	.96	1.48	1.17	1.35	+108%
24–25	.89	1.11	.78	.88	.87	.54	.89	1.04	.97	1.10	+24%
26–29	.66	.34	.23	.73	.49	.62	.53	.65	.79	.96	+45%
30–34	.66	.43	.54	.40	.43	.76	.38	.63	.41	.37	−44%
35–49	.36	.43	.43	.41	.48	.59	.57	.39	.47	.40	+11%
50–64	.51	.27	.30	.50	.26	.32	.26	.42	.23	.33	−35%
65+	.07	.13	.23	.07	.32	.14	.16	.18	.15	.22	+214%
Thoughts but no attempt											
18–19	6.04	5.96	6.91	6.98	7.36	7.86	8.16	8.74	7.93	9.38	+55%
20–21	6.08	5.62	6.21	5.63	5.81	7.01	6.52	6.97	7.78	10.04	+65%
22–23	5.07	4.60	5.00	5.20	5.07	5.73	5.50	6.39	6.49	7.51	+48%
24–25	5.31	3.96	4.63	4.39	4.58	4.70	4.98	4.88	5.64	6.89	+30%
26–29	3.67	3.81	4.21	3.69	3.71	3.79	3.81	5.42	4.91	5.60	+53%
30–34	3.06	3.95	3.46	2.19	3.75	3.67	3.79	3.73	4.70	4.08	+33%
35–49	3.54	3.87	3.64	3.47	3.65	3.27	3.17	3.14	3.27	3.18	−10%
50–64	2.44	2.77	2.76	2.85	2.47	3.42	3.49	2.59	2.65	2.74	+12%
65+	1.55	1.17	1.38	1.60	1.71	1.39	1.42	1.61	1.48	2.06	+33%

Note. Positive percent differences (PDs) indicate an increase in prevalence, and negative PDs indicate a decrease in prevalence.

Deaths by Suicide

Rates of suicide deaths also increased between 2008 and 2017, with the increase again larger among younger age groups (see Table 6). Unlike the other outcomes, in which consistent increases only occurred for those ages 25 and under, the suicide rate also increased among those in their late 20s and early 30s at about the same rate as for those ages 20 to 25.

Moderators

We examined sex, race/ethnicity, and income level as moderators of the cohort effects in the APC analyses for adults, and as moderators of the time period effects for adolescents (see Supplemental Figures S2–S13 in the online supplemental material). In the analyses in the text for the adult samples, we focused primarily on comparing the 1982 and 1999 cohorts, as these cohorts demonstrated the largest and most consistent increases in outcome variables in the primary analyses; the supplemental figures show trends across all cohorts.

The cohort increase in serious psychological distress was larger among women (6.3% in the 1982 cohort vs. 11.0% in the 1999 cohort; PD = 75%) than among men (5.0% vs. 5.5%; PD = 10%; see Supplemental Figure 2). The time period increase in adolescent MDE was larger for girls (14.3% in 2010 vs. 22.8% in 2017; PD = 59%) than for boys (4.4% vs. 6.3%; PD = 43%; see Supplemental Figure S3 in the online supplemental material). The cohort increase in adult MDE was larger for women (8.9% vs. 15.3%; PD = 72%) than for men (5.5% vs. 7.1%; PD = 29%; see Supplemental Figure S4). The cohort increases in suicide-related outcomes were larger among women: suicidal thoughts (3.9% vs. 9.7%; PD = 149% among women, and 3.8% vs. 5.5%; PD = 45% among men; see Supplemental Figure S5), suicide plans (1.1% vs. 3.9%; PD = 255% among women, and 1.1% vs. 1.6%; PD = 45% among men), and suicide attempts (.50% vs. .69%; PD = 38% among women,

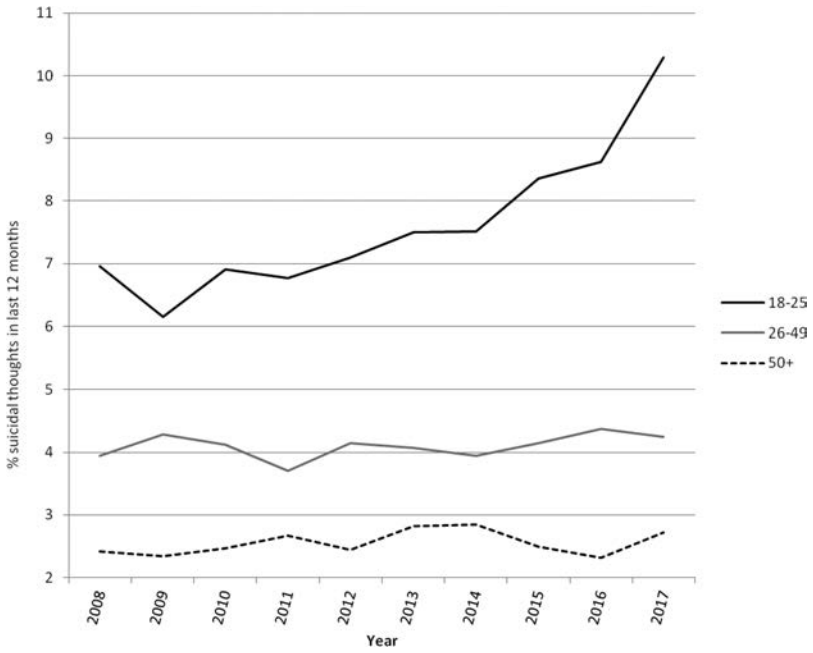

Figure 5. Percent of adults with at least one suicide-related outcome (thoughts, plans, or attempts) in the last year, by age group, 2008–2017.

and .44% vs. .53%; PD = 20% among men). Thus, the increases in mood disorder indicators and suicide-related outcomes were consistently larger among women.

The cohort increase in psychological distress was largest among Hispanic Americans (5.6% vs. 10.8%; PD = 93%) and smallest among Black Americans (6.9% vs. 7.7%; PD = 12%; see Supplemental Figure S6 in the online supplemental material). The time period increase in adolescent MDE was largest among White Americans (9.5 vs. 15.2% PD = 60%) and Hispanic Americans (9.6% vs. 15.3% PD = 59%) and smallest among Black Americans (8.3% vs. 8.7%; PD = 5%; see Supplemental Figure S7). The cohort increase in adult MDE was largest among White Americans (8.5% vs. 13.2%; PD = 55%) and did not appear among Asian Americans (see Supplemental Figure S8). The increase in suicidal ideation was largest among White Americans (4.2% vs. 7.8%; PD = 86%) and smallest among Black Americans (4.1% vs. 4.5%; PD = 10%; see Supplemental Figure S9). The increase in making a suicide plan was largest among White Americans (1.0% vs. 3.2%; PD = 220%) and smallest among Asian Americans (.82% vs. .88%; PD = 7%). The cohort increase in suicide attempts was largest among White Americans (.49% vs. .63%; PD = 29%) and did not appear among Hispanic Americans or Asian Americans. Thus, with the exception of psychological distress, the increases were larger among White Americans compared to other races and ethnicities.

The cohort increase in psychological distress was largest in the highest income group (3.0% vs. 4.8%; PD = 60%); distress actually declined slightly in the lowest income group between the 1982 and 1999 cohorts (11.1% vs. 10.8%; PD = −3%; see Supplemental Figure S10 in the online supplemental material). The time period increase in adolescent MDE was largest in the highest-income group (7.9% in 2010 vs. 14.1% in 2017; PD = 79%) and smallest in the lowest-income group (9.9% vs. 15.3%; PD = 55%; see Supplemental Figure S11). The cohort increase in adult MDE was largest in the lowest income group (10.5% vs. 17.0%; PD = 62%; see Supplemental Figure S12). The cohort increase in suicidal ideation was largest in the highest income group (2.6% vs. 7.0%; PD = 169%) and smallest in the lowest income group (6.1% vs. 8.5%; PD = 39%; see Supplemental Figure S13). The increase in making a suicide plan was largest in the highest income group (.37% vs. 2.3%; PD = 522%) and smallest in the lowest-income group (2.2% vs. 2.8%; PD = 27%). The increase in suicide attempts was largest in the second-lowest income group (.55% vs. .63%; PD = 15%) and did not appear in the highest-income group. Thus, with the exception of adult MDE and suicide attempts, the cohort increases were the largest and most consistent among those with the highest income.

Discussion

Indicators of mood disorders, suicide-related outcomes, and rates of deaths by suicide rose between the mid-2000s and 2017, primarily driven by increases among adolescents and adults ages 18 to 25. The effects were primarily due to cohort, with the Boomer cohorts of the 1950s and the iGen cohorts of the late 1990s the most likely to experience serious psychological distress, MDE in the last year, and suicide-related outcomes. The results suggest that cultural trends in the last 10 years may have had a larger effect on mood disorders and suicide-related outcomes among younger people compared to older people.

Mood disorder indicators increased among both men and women, but the increases were larger among women. Thus, the more pronounced increase in depression since 2011 among adolescent girls (vs. boys) found in previous research (Mojtabai et al.,

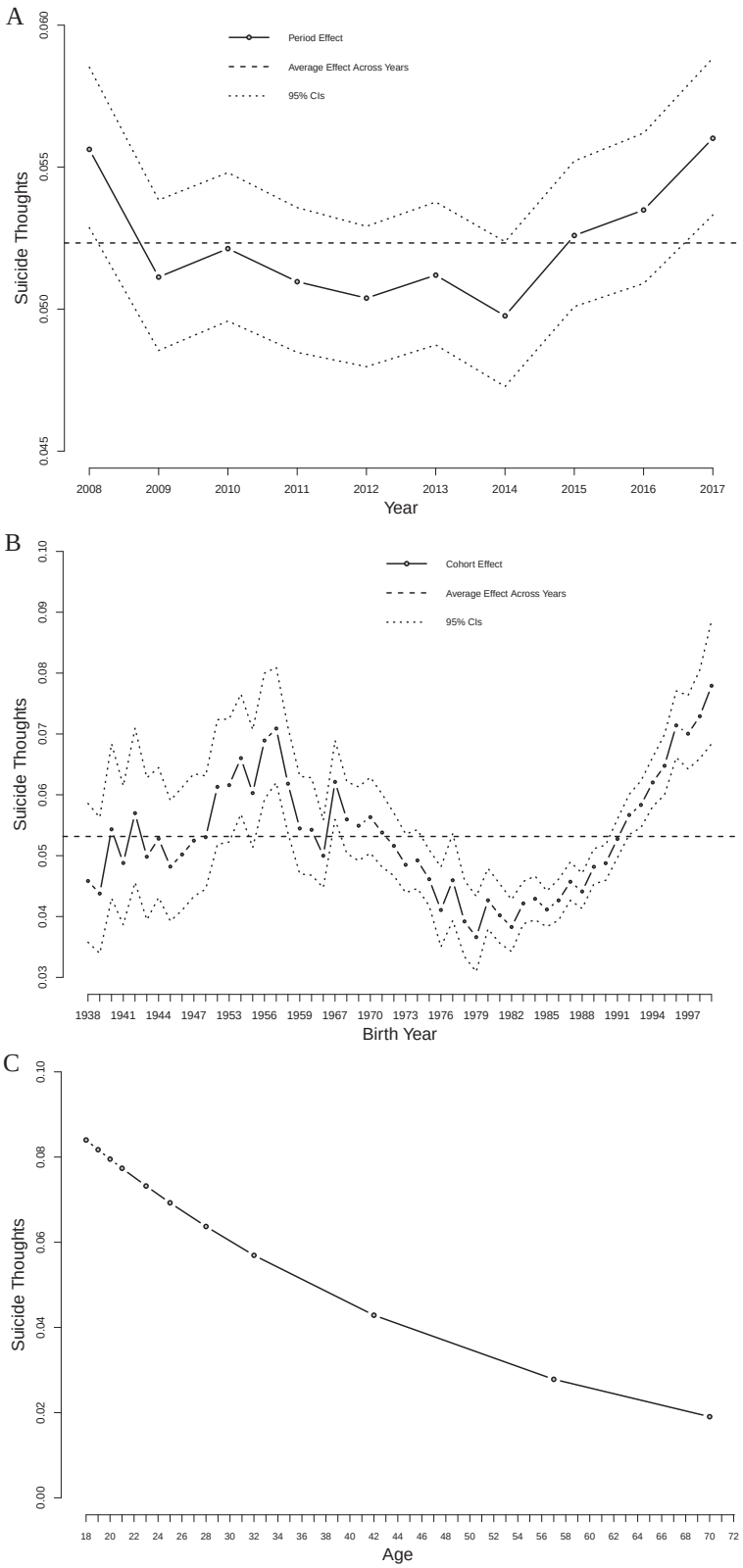

Figure 6. Percent of adults having suicidal thoughts in the last year, in age-period-cohort analyses: Effects for (A) year, (B) cohort, and (C) age.

Table 6
Completed Suicides, Rate Out of 100,000, by Age Group

Age (years)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	PD
18–19	9.33	9.58	10.17	10.76	10.50	10.30	10.78	12.70	12.11	14.53	56%
20–21	12.15	11.94	12.26	12.76	12.99	12.81	13.20	14.79	15.75	16.45	35%
22–23	13.13	13.18	14.65	14.55	14.16	14.46	14.84	15.28	16.58	17.38	32%
24–25	13.35	12.94	14.19	14.01	14.44	13.97	14.54	15.63	16.14	17.70	33%
26–29	12.82	12.78	14.28	14.54	14.91	15.43	15.16	15.20	16.60	17.24	34%
30–34	13.39	13.34	13.70	14.66	14.50	14.49	15.30	16.24	16.41	17.65	32%
35–49	16.87	16.92	17.16	17.32	17.57	17.11	17.67	17.87	17.74	18.70	11%
50–64	17.00	17.76	18.39	18.30	18.98	18.98	19.49	19.78	19.47	19.42	14%
65+	14.84	14.78	14.89	15.28	15.40	16.15	16.67	16.58	16.66	16.85	14%

Note. Positive percent differences (PDs) indicate an increase in prevalence, and negative PD's indicate a decrease in prevalence.

2016; Twenge, Joiner, et al., 2018) extends to young adults and to indicators of psychological distress and suicide-related outcomes. The increases appeared across most racial and ethnic groups for most indicators, with the increases generally larger among White Americans. With the exception of MDE and suicide attempts, increases in mood disorder indicators were largest among Americans with the highest total family income. This suggests the largest increases in mood disorder outcomes occurred among higher socioeconomic status White women and girls. This demographic profile is consistent with previous research finding an even higher prevalence of past-year MDE (18.5%; Auerbach et al., 2018) and suicidal ideation in college populations (17.2%; Mortier et al., 2018) than the overall rates for 18- to 25-year-olds found here.

One consistent cohort effect was a rise in mood disorder indicators and suicide-related outcomes from those born in the early 1980s to those born in the late 1990s. Thus, those born in the 1990s (late Millennials and early iGen) appear to be experiencing these outcomes and at a higher rate than those born in the 1980s, even when time period and age are taken into account. As past MDE is a strong predictor of increased risk of MDE recurrence (Wang et al., 2013), this generation may be more likely to experience mood disorders throughout their lives. Given that earlier onset of mood disorders predicts increased odds of chronicity, recurrent episodes, psychiatric and medical hospitalization, impaired functioning, suicide attempts, and death by suicide (APA, 2013; Garcia-Toro et al., 2013; Weissman et al., 1999), these findings are concerning.

The cause of the reported cohort trends is unknown. However, some potential explanations seem less plausible. The increase in mood disorder indicators occurred during a period of economic expansion in the U.S. economy after 2011, which was accompanied by falling unemployment. This suggests the trends are not due to cyclical economic factors. In addition, research indicates drug and alcohol use among adolescent and young adult populations is unchanged or decreasing (Mojtabai et al., 2016; Twenge & Park, 2017), making substance abuse issues an unlikely cause of the increase.

Perhaps recent cohorts are more willing to admit to mental health issues on self-report measures. However, this would not explain the curvilinear effect of cohort in the data; if a general movement toward admitting to problems had occurred, one would expect the trends to be linear. Willingness to admit to issues also does not explain why suicide (a behavior not dependent on self-report) also increased over the same time period (though it is possible that this was influenced, in part, by more accurate reporting of suicide deaths by coroners and medical examiners). Other studies suggest that nonsuicidal self-injury documented by emergency department admissions, another non-self-report behavior related to mood disorders, also increased over this time period, with the largest increases among the youngest populations and among females (Mercado, Holland, Leemis, Stone, & Wang, 2017), a pattern similar to that found in the current study. In addition, hospitalizations for suicidal ideation and suicide attempts among adolescents also increased since 2008 (Plemmons et al., 2018). Nevertheless, as the measures employed here rely largely on self-report, we cannot entirely rule out increased likelihood to self-disclose among more recent cohorts as an explanation.

Opioid use increased during this time period among adults; however, the opioid epidemic was considerably more pronounced among certain groups than others. First, opioid overdoses increased more among those over age 25 (Hedegaard, Warner, & Minino, 2017), yet the increases in mood disorder indicators was more pronounced among those ages 25 and younger in our analyses. Opioid overdoses were significantly more common among Whites (Seth, Scholl, & Rudd, 2018), and although the cohort increases in mood disorder indicators were also larger among Whites in most cases in the current study, they appeared across all racial and ethnic groups. Overdoses in this period were more common among lower-income individuals (NIDA, 2017), yet the increases in mood disorder indicators in the current study were usually largest among those with the highest incomes. Nevertheless, with opioid addiction increasing over the same time period as mood disorder indicators, it cannot be ruled out as a possible cause or effect of the trend.

Another possibility is that the increased use of electronic communication and digital media during this time period may have changed modes of social interaction enough to affect mood disorders and suicide-related outcomes. For example, individuals who spend more time on social media and less time with others face-to-face report lower well-being and are more likely to be depressed (Lin et al., 2016; Shakya & Christakis, 2017). Likewise, both general Internet use and involvement in cyber-bullying (as victim or perpetrator) have been associated with depression, self-harm, and suicidal thoughts and behaviors (Daine et al., 2013; John et al., 2018). The increase in adolescent MDE began after 2011, concurrent with the increased ownership of smartphones (mobile digital

devices) and a concomitant increase in digital media time in this age group (Twenge, Joiner, et al., 2018). The later rise in MDE among adults, with the time period effect after 2014, could be due to later adoption of smartphones among older individuals (Anderson & Perrin, 2017). The stronger cohort effect may have occurred because the trend toward digital media had a different impact on individuals depending on their age and developmental stage. For example, the time adolescents spent with their friends face-to-face declined between 2008 and 2017 (Twenge, Spitzberg, & Campbell, in press), whereas shifts in the frequency of face-to-face social interaction among adults appear to be less pronounced (Patulny & Seaman, 2017). In addition, social media and the Internet can be used for suicide-related purposes (e.g., searching for information about suicide methods, exposure to images of suicide and self-injury), and that this practice is common among young adults, particularly those experiencing suicidal thoughts and behaviors (Daine et al., 2013; Marchant et al., 2017; Mars et al., 2015). The rise of electronic communication and digital media would be expected to have a greater impact on young people, and thus could be a plausible driver of the study findings.

Sleep may also play a role in the trends. Sleep duration among U.S. adolescents appears to be declining (Twenge, Krizan, & Hisler, 2017), and some studies (Ford, Cunningham, & Croft, 2015; cf. Youngstedt et al., 2016) find declines in sleep duration among adults as well. A recent review of studies since the year 2000 found a weighted mean prevalence for insomnia of 18.5% among university students, whereas prevalence in the general population is estimated at 7.4% (Jiang et al., 2015). Compromised sleep is a major risk factor in the onset, recurrence, chronicity, and severity of MDEs (Chan et al., 2014; Franzen & Buysse, 2008). Several reviews also indicate that sleep disturbances are associated with suicidal ideation, suicide attempts, and death by suicide (Bernert & Joiner, 2008; Pigeon, Pinquart, & Conner, 2012). If younger Americans are now sleeping less, that might account for why mood disorder indicators have increased in more recent cohorts (alternatively, the increase in mood disorder indicators could be why sleep duration has declined, as sleep disturbance is one of the criteria for MDE). Time spent on portable electronic devices, especially in the evening, is associated with both shortened sleep duration and poorer sleep quality (Carter, Rees, Hale, Bhattacharjee, & Paradkar, 2016; Chang, Aeschbach, Duffy, & Czeisler, 2015; Twenge, Hisler, & Krizan, 2018). Several recent studies have found that problematic Internet and social media use and sleep disturbance among youth are linked, and that these associations contribute to depressive symptoms in this group (Bhandari et al., 2017; Li et al., 2017). If adolescents and young adults are more likely than older adults to allow devices to interfere with sleep, that could play a role in the cohort increase in mood disorder indicators.

The findings point to several directions for future work. First, prospective studies that consider variables such as sleep and technology use are needed to determine directionality, temporality, and likelihood that these explanations underlie the rise of mood disorder and suicide-related outcomes in recent cohorts. The current study was strengthened by use of a large, nationally representative dataset but was cross-sectional in nature and did not assess many potential explanatory variables. In addition, the dataset included only single-item assessments of suicide-related outcomes, and standardized definitions for these outcomes were not included, so it is possible that these outcomes were over- or underendorsed in the study sample (Millner, Lee, & Nock, 2015). It is also important to note that suicide-related outcomes were not assessed in adolescents, so it is unclear whether patterns described for these outcomes extend to the youngest individuals in the sample. The assessment of adolescents also did not include irritability as a criterion for MDE, potentially resulting in an underestimate of the true prevalence of past-year MDEs among adolescents. As findings were largely driven by more recent cohorts, this suggests increasing trends of MDEs may be even more pronounced than reported here. Results should be replicated in studies including comprehensive assessment of depressive symptoms and suicidal thoughts and behaviors across all studied age groups.

Relatedly, future studies should assess the onset and prevalence of mood disorder indicators and suicide-related outcomes in those born after 2006 to determine whether the trends reported here continue into more recent and future cohorts. The youngest participants in the current study were born in the early 2000s, and the proposed explanations (e.g., technology use, sleep disturbance) continue to affect youth today. Also, the increases in mood disorder indicators and suicide-related outcomes in the younger cohorts suggest a need for interventions that will reach this group. Though the overuse of technology can be problematic, many individuals also report using the Internet or social media to seek formal and informal support, learn coping strategies, and reduce feelings of isolation (Daine et al., 2013; Marchant et al., 2017; Mars et al., 2015). It would be beneficial to examine how technology can best be leveraged to increase the likelihood it will be used by vulnerable individuals for constructive rather than destructive purposes. In addition, some of the moderator effects may warrant more elaboration in future research; for instance, as women showed greater increases in suicide-related outcomes than men, it would be interesting to know more about whether suicidal thoughts and behaviors in females are more malleable than in males (McNulty, Olson, & Joiner, 2018; Twenge, Joiner, et al., 2018). Finally, an important implication of the current study is that studies assessing incidence of depression and suicide-related variables in adolescents and young adults may wish to consider cohort effects in addition to age or life stage.

Conclusion

In conclusion, this investigation of a large, nationally representative dataset found that rates of recent serious psychological distress, past-year MDE, and past-year suicide-related outcomes (suicidal ideation, plans, attempts, and deaths by suicide) increased among adolescents aged 12 to 17 and young adults ages 18 to 25 between the mid-2000s and 2017, with smaller and less consistent increases among adults ages 26 and over. APC analyses suggest these trends were largely attributable to birth cohort, with a steady rise in all outcomes among those born from 1982 to 1999. The results suggest a need for more research to understand the role of factors such as technology and digital media use and sleep disturbance may play in mood disorder and suicide-related outcomes, and to develop specialized interventions for younger cohorts. This work is necessary given the high cost of mood disorders and suicide.

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