**Title:**

Intersectional inequities in suicide ideation by race, sexual orientation, and gender among U.S. high school students pre and post 2020: An application of random effects intersectional MAIHDA

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## Abstract

Quantifying intersectional health inequities and examining changes over time are foundational to social epidemiology. I-MAIHDA (intersectional multilevel analysis of individual heterogeneity and discriminatory accuracy) is a recent innovation that simplifies quantitative intersectional analyses while providing methodological improvements over conventional approaches. We illustrate the use of logistic I-MAIHDA with random effects to estimate intersectional inequities in suicidal ideation among U.S. high school students before and after 2020 by race, sexual orientation, and gender, using 2017-2021 data from the Youth Risk Behavior Surveillance System. The U.S. faces a youth mental health crisis made worse by the many disruptions of 2020, including the beginning of the COVID-19 pandemic. Before 2020, we found substantial inequities in ideation, ranging from 9.8-12.7% among heterosexual boys to over 50% among bisexual Multi-race/Other and White girls. We also found notable changes pre/post 2020. Strata at the lowest (heterosexual boys) and highest risk (bisexual girls) showed little change, while middle risk-ranked strata (Black Other/Questioning and lesbian girls, White Other/Questioning boys and girls, and Multi-race/Other gay boys) reported large increases in ideation. Our findings suggest worsening teen mental health in the 2017-2021 period, particularly among racial and sexual orientation minorities. We illustrate the value of I-MAIHDA for understanding changes in intersectional health inequities.

## Introduction

Numerous lines of research warn of a growing youth mental health crisis in the United States (U.S.), especially among teen girls, sexual minorities, and certain racial and ethnic groups (1–3). High school students have increasingly reported persistent feelings of sadness over the past decade, but the multi-faceted disruptions of 2020 appear to have exacerbated this trend and widened inequities in adverse mental health outcomes (4). In particular, the rising prevalence of suicidal *ideation* (i.e., seriously considering suicide) and suicide *attempts* have made suicide one of the leading causes of death for U.S. teens (5–7). Youth who are girls, Black, and/or identify as lesbian, gay, bisexual, transgender, queer or questioning, intersex, asexual, and more (LGBTQIA+) have been disproportionately impacted (4,8). Suicidal ideation is linked to psychosocial stressors and is associated with increased odds of subsequent suicide attempts (9–11), making it an important outcome for understanding the circumstances contributing to mental health inequities that can inform interventions. Myriad factors may have

contributed to the alarming increase in teen suicidal ideation in recent years, including the social and financial disruptions of the COVID-19 pandemic (12), high profile cases of police brutality against Black Americans (13,14) racist/xenophobic rhetoric directed at Asian Americans during the COVID-19 pandemic (15,16), and the proliferation of state-level policies targeting LGBTQIA+ youth (17). These factors are thought to have differentially impacted youth with minoritized identities, but few studies have investigated changes in suicidal ideation at the *intersections* of race, sexual orientation, and gender.

A growing body of research recognizes the value of investigating youth mental health inequities using an intersectional framework (18,19). Intersectionality emerged from Black feminist scholarship and focuses attention on interlocking systems of power and oppression (e.g., racism and sexism) underlying the unique experiences of individuals with multiple marginalized identities (e.g., Black women) that cannot adequately be explained by their additive impact (20–22). Systems of oppression such as racism, sexism, and homophobia are central drivers of health inequities that impact risk as well as resources and opportunities. Various aspects of daily life are impacted, including access to housing, employment, education, exposure to air and environmental contaminants, and quality health care (CITE). Intersectionality has gained traction as a broader framework for examining how the disadvantages *and* privileges afforded at intersecting social positions can vary across time and place to shape the exposures, risks, and resources that relate to health outcomes (22,23). For example, gender and sexual minority youth are at higher risk for numerous negative mental health outcomes, but teens who also have minoritized racial identities are even more likely to self-report depressive symptoms and suicidal ideation (24–26), despite being less likely to experience bullying and cyberbullying (25,27). Moreover, although depressive symptoms have increased among all demographics of high school students in recent years, Black girls and sexual minorities in particular experienced significant increases in self-reported sadness and suicide-related behaviors (8,28,29) and had the largest increase in emergency room visits for suspected suicide attempts at the beginning of the COVID-19 pandemic (30,31). These findings demonstrate the utility of intersectional research for disentangling the exposures and outcomes associated with mental health outcomes for different marginalized groups but leave open questions about overarching teen mental health inequities before and after 2020. To address these gaps, we focus on vulnerable groups identified in prior work, but provide a more stratified investigation of suicidal ideation at intersections of race, sexual orientation, and gender.

Intersectional investigations of youth mental health are important for understanding socio-contextual factors impacting different populations, but there are several limitations in the extant literature. Most studies have examined a small set of intersecting identities by focusing on just two identity dimensions (e.g., race and gender (26)), dichotomizing minority and majority group status (e.g., heterosexual versus sexual minorities (24)) or examining a subset of racial categories (e.g., Black, Hispanic, and White students (25,27)). A more comprehensive, intersectional, multi-dimensional evaluation of teen mental health is needed. Moreover, few studies have examined changes in intersectional mental health disparities before and after 2020, a period characterized by notable disruptions in many aspects of life (12). Thus, the experiences of groups who faced unique challenges, like Asian Americans, have remained under-explored. These limitations are due, in part, to methodological considerations of the statistical power needed to examine fully disaggregated social strata (29,32). Nonetheless, they limit our understanding of the true range of youth mental health inequalities and the relative risk experienced in different intersectional groups. Intersectional multilevel analysis of individual heterogeneity and discriminatory accuracy (I-MAIHDA) is a recent methodological innovation with comparative advantages over conventional approaches, such as single-level regression models, particularly when sample sizes are small and the number of interaction effects is large (33–37). By leveraging the inherent properties of multilevel models, I-MAIHDA provides a robust, theory-informed descriptive modeling approach for obtaining interpretable, precision-

weighted intersectional effect estimates. This is particularly important for examining multiply minoritized populations that often have smaller sample sizes even in large datasets.

The overarching goals of the present study are to: 1) quantify the extent of intersectional inequity in self-reported suicidal ideation among U.S. high school students by race, gender, and sexual orientation, 2) examine changes in suicidal ideation from pre-2020 (in 2017 and 2019) to post-2020 (in 2021) for all groups, and 3) evaluate shifting inequity patterns in suicidal ideation pre- and post-2020. We used data from the Youth Risk Behavior Surveillance System (YRBSS) conducted by the Centers for Disease Control and Prevention (38) and fit a series of logistic models following the I-MAIHDA approach (34,39,40). We examined the probability of self-reported suicidal ideation across 40 social strata of U.S. youth at the intersections of 4 sexual orientation-, 5 racial-, and 2 gender-identities. In addition to these substantive contributions, we demonstrate the use of random effects I-MAIHDA to examine inequality changes over time in repeated cross-sectional surveys, an approach with broad potential in epidemiology and beyond.

## Methods

### *Data*

The YRBSS surveys are conducted by the CDC every two years in coordination with health and education departments of participating U.S. states (38). YRBSS includes self-reported measures of mental health outcomes and behaviors from representative state-level samples of high school students that has good test-retest reliability (cite). In 2017, more states began collecting self-reported sexual orientation and gender identity information. Thus, we focused on the cross-sectional YRBSS data collected in 2017, 2019, and 2021, which includes responses from large samples of high school students across 44 states, yielding an original sample of N=520,129 observations. Figure 1 summarizes the data exclusion process. Briefly, we excluded 142,767 observations that were missing the necessary demographic or dependent variables, which yielded a final analytic sample of N=377,362 respondents across 36 states (Figure 2). Supplemental Table 1 provides the sample sizes for each intersectional stratum, overall and by year. Supplemental Table 2 provides details for the states included in the primary and supplementary analyses, including the total and usable observations per state (overall and by year), and the reasons why observations were excluded. This table reveals that of the 14 states that were excluded for missing data, six states had not collected any survey measures, seven states did not ask about sexual orientation, and one state did not ask about suicidal ideation. Thus, our estimates are not nationally representative given the exclusion of 14 states.

**Figure 1.** Data exclusions and summary of analytic sample

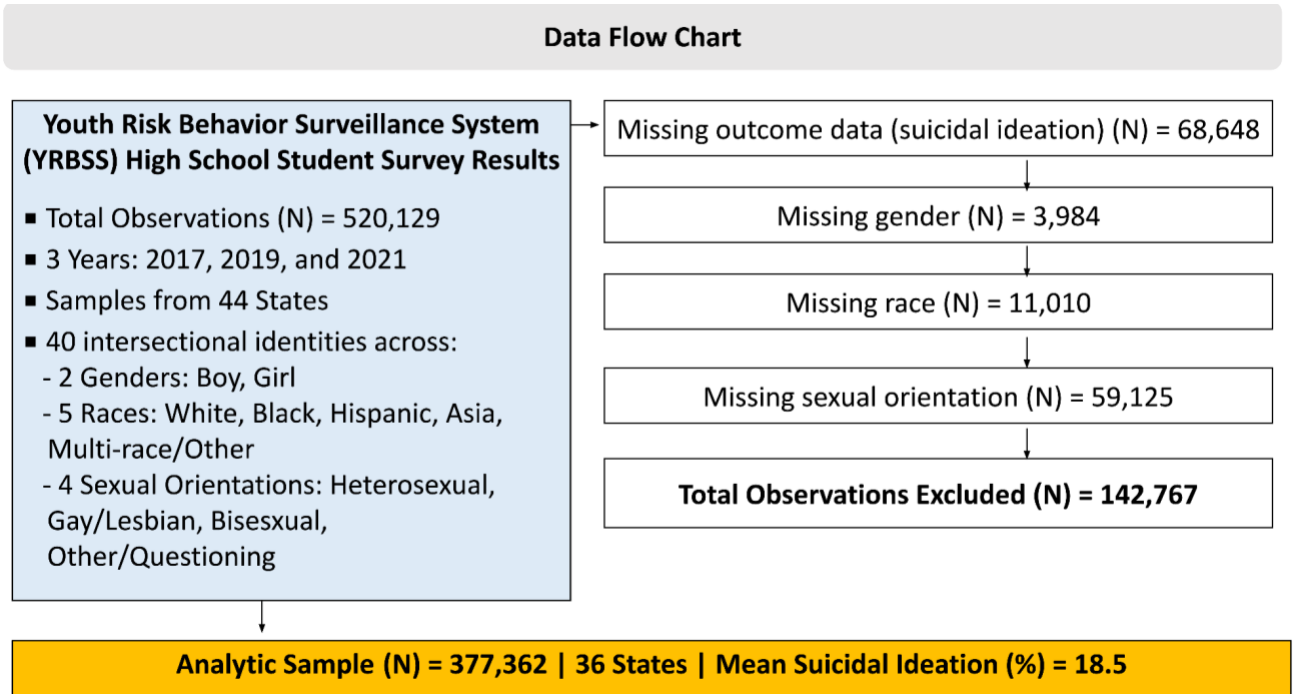


**Figure 2.** States included in main and supplemental analyses, color-coded by the number of years for which we have data

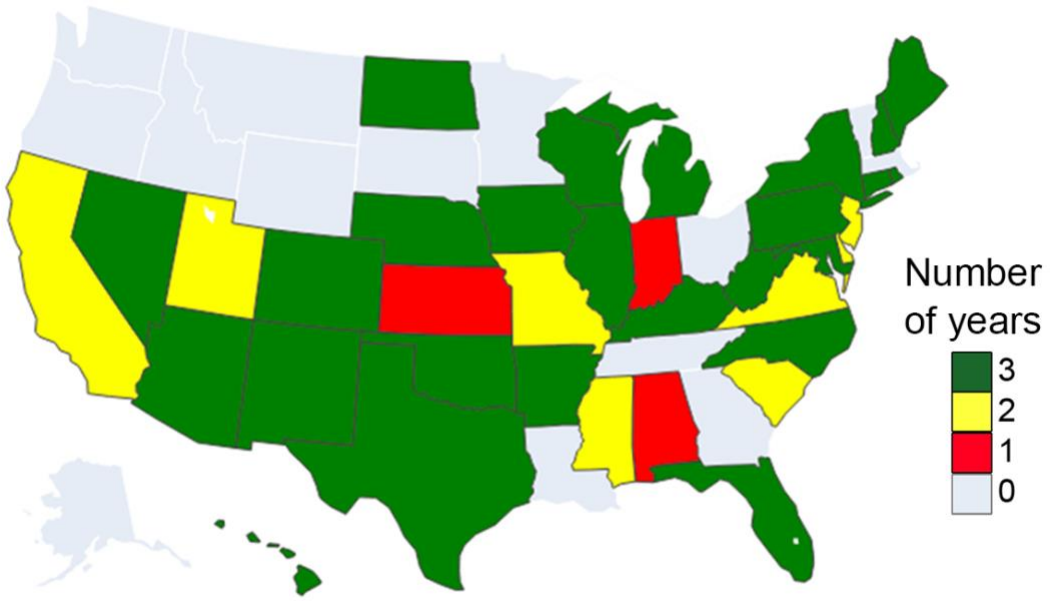


**Table 1.** Characteristics of high school students in YRBSS sample used in our analysis of suicidal ideation by year

| | **Total** | **2017** N = 134,611 | **2019** N = 135,558 | **2021** N = 107,193 |
|---|---|---|---|---|
| **Gender** | | | | |
| **Age: Mean (SD) [min-max]** | 15.7 (1.2) [12-18] | 15.8 (1.2) [12-18] | 15.8 (1.2) [12-18] | 15.6 (1.2) [12-18] |
| **Gender** | | | | |
| Girl | 192,777 (51.1%) | 69,181 (51.4%) | 69,364 (51.2%) | 54,232 (50.6%) |
| Boy | 184,585 (48.9%) | 65,430 (48.6%) | 66,194 (48.8%) | 52,961 (49.4%) |
| **Race** | | | | |
| Asian | 20,028 (5.3%) | 7,600 (5.6%) | 7,075 (5.2%) | 5,353 (5.0%) |
| Black | 52,334 (13.9%) | 19,012 (14.1%) | 18,138 (13.4%) | 15,184 (14.2%) |
| Hispanic | 78,844 (20.9%) | 27,692 (20.6%) | 29,107 (21.5%) | 22,045 (20.6%) |
| Multi-race/Other | 35,297 (9.4%) | 12,977 (9.6%) | 12,477 (9.2%) | 9,843 (9.2%) |
| White | 190,859 (50.6%) | 67,330 (50.0%) | 68,761 (50.7%) | 54,768 (51.1%) |
| **Sexual Orientation** | | | | |
| Bisexual | 35,598 (9.4%) | 10,919 (8.1%) | 12,162 (9.0%) | 12,517 (12%) |
| Heterosexual | 308,007 (81.6%) | 113,194 (84.1%) | 113,550 (83.8%) | 81,263 (75.8%) |
| Gay/Lesbian | 11,482 (3.0%) | 3,891 (2.9%) | 3,787 (2.8%) | 3,804 (3.5%) |
| Other/Questioning | 22,275 (5.9%) | 6,607 (4.9%) | 6,059 (4.5%) | 9,609 (9.0%) |
| **Suicidal Ideation (yes)** | 69,916 (18.5%) | 22,772 (16.9%) | 24,747 (18.3%) | 22,397 (20.9%) |

### *Intersectional Strata*

Most states collected YRBSS survey questions with seven race/ethnicity categories and 5 sexual orientation categories, but far fewer collected questions about minority gender identities (e.g., transgender), which was more recently added. Therefore, we used self-reported sex (assigned at birth) as the closest available proxy for gender identity and used the terms

"girls" and "boys" when referencing our sample to reflect the binary response options that respondents answered. Because our investigation focuses on the social determinants of health based on the socialization of gender, we follow the convention in epidemiology research and refer to this as our binary gender variable (36). Moreover, because some of the race, ethnicity, and sexual orientation categories had relatively small samples, we combined multi-race, other race, Hawaii/Pacific Islander, and Alaska/Native American into the "Multi-race/Other" race group, and combined "other", "not sure", and "don't know" responses of the sexual orientation question into "Other/Questioning" category. Although I-MAIHDA is a robust approach for estimating effects for small sample-sized groups, there are still practical considerations related to small samples (34,36,37). For this study, we balanced pragmatic considerations of allowing large enough strata sizes to study cross-sectionally over the years, and the theoretical motivation for investigating groups identified in prior research, but future research can build on this foundation to further investigate subgroup inequities. This yielded 40 identity strata at the intersection of 2 genders (boys and girls), 5 racial identities (White, Black, Hispanic, Asian, and Multi-race/Other), and 4 sexual orientations (heterosexual, gay or lesbian, bisexual, and other) categories. Table 1 provides descriptive statistics for our final analytical sample, and additional details can be found in Supplemental Table 1.

***Year***

Year was included as a dummy variable in some models coded as 1 for observations from the YRBSS 2021 data collection wave, and 0 for observations from the 2017 and 2019 survey waves. It is important to note that the suicidal ideation outcome we focused on asks about thoughts of suicide in the past 12 months (see below). Thus, we use the term "post-2020" to reference the YRBSS collection wave, even though participants' self-reported suicidal ideation includes thinking back to 2020.

***Dependent Variable: Passive Suicidal Ideation***

For our primary analyses, we focused on the "passive" suicidal ideation question that asks, "During the past 12 months, did you ever seriously consider attempting suicide?" (Yes/No response options). We chose this question rather than the "active" suicide plan question (i.e., "During the past 12 months, did you make a plan about how you would attempt suicide?") because research suggests a progression from passive ideation to active planning in suicidal behavior, thereby making passive suicidal ideation an important, early indicator for targeted interventions (cite).

***Analyses***

We implemented the logistic specification of the I-MAIHDA approach (34) to examine intersectional inequities in self-reported suicidal ideation by race, sexual orientation, and gender from pre- to post-2019. All analyses were conducted in Stata version 18.0 (41) and R version 4.2.2 (42) using the glmmTMB package (43). Code for running these analyses can be found at: https://github.com/JunaidMerchant/MAIHDA_YRBSS. Following the approach outlined by Evans et al. (39) for conducting I-MAIHDA with random effects, we include pre/post-2020 binary variable as a random coefficient to examine inequity patterns across strata within and between time periods. I-MAIHDA is a recent methodological innovation with advantages over conventional, single-level modeling approaches with fixed interaction terms (33,35–37,44,45). Results from single-level models become increasingly complex and less interpretable as more

intersecting social dimensions are considered because the number of interaction terms increases geometrically. Moreover, some strata may have small sample sizes, which can result in unstable estimates (33,36,37). I-MAIHDA models are two-level multilevel random effects models where individual observations (level 1) are nested in intersectional strata (level 2), and the number of strata is defined by the combinations of sociodemographic variables analyzed. The sociodemographic identity variables are theorized as proxies for positionalities within interlocking systems of oppression (e.g., racism, sexism, homophobia/biphobia), not individual level "risk factors." By leveraging the inherent properties of multilevel models, such as relative parsimony and precision-weighted effect estimates, I-MAIHDA addresses many of the limitations of the conventional approach (35,44,45).

For methodological illustration purposes, we provide details of all the steps of our model-building process and how to interpret key estimates so researchers can replicate our procedure in other studies. We hypothesized that we would find: 1) meaningful inequities in suicidal ideation across intersectional strata, both pre- and post-2020; 2) a general increase in suicidal ideation from pre- to post-2020 due to the significant social disruptions of this period; and 3) that different strata would experience different increases in ideation over this period.

*Model 1 (null)*

The null or "empty" I-MAIHDA Model 1 is fit for baseline comparison purposes, with individuals (level 1) nested in the 40 intersectional strata (level 2), but it includes no fixed effects beyond the intercept. It is specified as:

$$\begin{gathered} y_{ij} \sim Bernoulli(\pi_{ij}) \\ logit(\pi_{ij}) = log\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \beta_0 + \mu_{0j} \\ \mu_{0j} \sim N(0, \sigma^2_{u0}) \end{gathered}$$

Where $y_{ij}$ is a binary measure for suicidal ideation (1=yes, 0=no) for individual $i$ in stratum $j$, which follows a Bernoulli distribution with probability of $y_{ij} = 1$ given by $\pi_{ij}$. $logit(\pi_{ij})$ denotes the logit link function, which maps these probabilities onto the logit or log-odds scale. The right-hand side of the equation contains only the overall intercept $\beta_0$ and the stratum-level residual for stratum $j$ (given by $\mu_{0j}$). $\mu_{0j}$ is assumed to be normally distributed with a mean of 0 and between-stratum variance $\sigma^2_{u0}$. In logistic I-MAIHDA (and other multilevel logistic models) there is no individual-level residual estimated because the outcome is expressed in terms of logit probabilities. After fitting the model on the logit scale (here and in later models), stratum-specific estimates can be calculated and then converted back to the probability scale. In this model, the total degree of inequity in predicted probabilities of suicidal ideation between strata is captured by $\sigma^2_{u0}$, though this estimate does not adjust for compositional effects (e.g., strata may be differentially composed of observations from different survey years).

Another measure of between-stratum inequity/variance is given by the Variance Partition Coefficient (VPC), calculated as the between-stratum variance divided by the total variance. Since we do not estimate level 1 variance in logistic models, we use the latent response approach to approximate level 1 variance (46), which involves setting this equal to $\frac{\pi^2}{3} \approx 3.29$ where here $\pi$ denotes the mathematical constant 3.142. As such:

$$VPC = \frac{Level\ 2\ Variance}{Total\ Variance} = \frac{Level\ 2\ Variance}{(Level\ 2\ Variance + Level\ 1\ Variance)} = \frac{\sigma^2_{u0}}{(\sigma^2_{u0} + 3.29)} \times 100\%$$

*Model 2 (Fixed Year Effect)*

Survey year ($post2020$) is added to the model as a dummy fixed effect, with all else specified as before:

$$logit(\pi_{ij}) = \beta_0 + \beta_1(post2020) + \mu_{0j}$$

This adjusts for the compositional differences between strata by observation year and allows for estimating the overall difference in suicidal ideation between pre- and post-2020 periods for all strata (given by $\beta_1$), but this difference across periods is assumed to be the same in all strata.

*Model 3 (Random Year Effect)*

Year ($post2020$) is treated as a random coefficient:

$$logit(\pi_{ij}) = \beta_0 + \beta_1(post2020) + \mu_{0j} + \mu_{1j}(post2020)$$
$$\begin{bmatrix}\mu_{0j}\\ \mu_{1j}\end{bmatrix} \sim N\left(0, \begin{bmatrix}\sigma^2_{u0} & \\ \sigma_{uou1} & \sigma^2_{u1}\end{bmatrix}\right)$$

In this model, $\beta_1$ is the overall (across all strata) difference in ideation between pre- and post-2020 periods, while $\mu_{1j}$ modifies this pre/post difference in stratum $j$, allowing us to calculate how suicidal ideation is different for each stratum ($\beta_{1j} = \beta_1 + \mu_{1j}$). In this model (and later in Model 5) the unexplained between-stratum variance pre-2020 is given by $Var(\mu_{0j}) = \sigma^2_{u0}$. The unexplained between-stratum variance post-2020 is calculated as: $Var(\mu_{0j} + \mu_{1j}) = \sigma^2_{u0} + 2\sigma_{uou1} + \sigma^2_{u1}$, where $\sigma^2_{u1}$ is the residual variance in pre/post differences and $\sigma_{uou1}$ is the covariance between $\mu_{0j}$ and $\mu_{1j}$.

The VPC also depends on pre/post-2020 status, with VPC pre-2020 calculated as above, and VPC post-2020 calculated as:

$$VPC_{post2020} = \frac{(\sigma^2_{u0} + 2\sigma_{uou1} + \sigma^2_{u1})}{(\sigma^2_{u0} + 2\sigma_{uou1} + \sigma^2_{u1}) + 3.29} \times 100\%$$

*Model 4 (Fixed Year Effect + Fixed Main Effects)*

Model 4 treats year ($post2020$) as a fixed effect and adds a vector of level 2 additive fixed (or "main") effects for race, sexual orientation and gender given by $\gamma_j$ with associated parameter values $\beta_\alpha$. Importantly, the model includes no fixed interaction effects between these variables, allowing stratum-level deviations from additive predictions to be captured by the stratum-level residual ($\mu_{0j}$), which is now interpreted as a unique "interaction effect" for each stratum.

$$logit(\pi_{ij}) = \beta_0 + \beta_1(post2020) + \beta_\alpha\gamma_j + \mu_{0j}$$

*Model 5 (Random Year Effect + Fixed Main Effects)*

The final, fully specified model includes all fixed main effects (as in Model 4) and treats year ($post2020$) as a random effect (as in Model 3). In contrast to Model 4, this model allows a

unique “interaction effect” to be estimated separately for all combinations of strata and pre/post-2020 status.

$$logit(\pi_{ij}) = \beta_0 + \beta_1(post2020) + \beta_\alpha \gamma_j + \mu_{0j} + \mu_{1j}(post2020)$$
$$\begin{bmatrix}\mu_{0j}\\ \mu_{1j}\end{bmatrix} \sim N\left(0, \begin{bmatrix}\sigma^2_{u0} & \\ \sigma_{uou1} & \sigma^2_{u1}\end{bmatrix}\right)$$

Following recommended practice (29,34,42), this model has two primary uses. First, it is used to generate final estimates of suicidal ideation in each stratum in each period (pre/post-2020) by combining all relevant fixed and residual effects for each stratum/period and converting them back to the predicted probability scale. Second, it can be used to evaluate the extent to which inequalities between strata follow ‘consistent patterns’ (e.g., follow fixed main effects) or whether there are ‘unique’ outcomes for some strata that break with the overall fixed effects patterns (either by having unexpectedly high or low predicted values, necessitating interaction effects to characterize them). A commonly used statistic to characterize this additive-versus-interaction effect magnitude in I-MAIHDA is the Proportional Change in Variance (PCV), which quantifies the amount of between-stratum variance that is accounted for by including fixed main effects in the model.

Generally, the PCV is calculated through a comparison of between-stratum variance in two models—one inclusive of fixed main effects (as in Models 5) and one without (as in Model 3, the direct comparator of Model 5 because it also treats time as a random effect). However, because between-stratum variance differs in pre- and post-2020 periods ($Var(\mu_{0j})$ in pre-2020 and $Var(\mu_{0j} + \mu_{1j})$ in post-2020), we calculate PCV separately for each period:

$$PCV_{pre2020} = \left[\frac{\sigma^2_{u0,Model3} - \sigma^2_{u0,Model5}}{\sigma^2_{u0,Model3}}\right] \times 100\%$$

$$PCV_{post2020} = \left[\frac{\left(\sigma^2_{u0,Model3} + 2\sigma_{uou1,Model3} + \sigma^2_{u1,Model3}\right) - \left(\sigma^2_{u0,Model5} + 2\sigma_{uou1,Model5} + \sigma^2_{u1,Model5}\right)}{\left(\sigma^2_{u0,Model3} + 2\sigma_{uou1,Model3} + \sigma^2_{u1,Model3}\right)}\right] \times 100\%$$

### *Supplemental Analyses*

The focus of the current study is to characterize changes in overall intersectional inequity patterns of suicidal ideation among U.S. high school students. However, 11 states did not have data for all three years. The variation in state-level samples used across the years may bias our results, especially when considering that research indicates that there are state-level variations in mental health outcomes. Although adjusting for state-level effects is beyond the scope of the current work, we adjust for state-level samples across periods by calculating a set of supplemental I-MAIHDA models that are the same as the primary models but using only the 25 states with data for all three years. This ensured that the observed changes in suicidal ideation we quantified from our random coefficient models cannot be attributed to differences in the state-level samples (Supplemental Table 3-4; Supplemental Figures 2). Additional model specifications were fit to adjust for state-level clustering using fixed dummy variables. However, given that state-level policies or social/environmental effects may be part of the social production of observed inequality patterns, it is not obvious if controlling for state effects is a desirable approach, as it might have distorted or partially eliminated the inequalities of interest. In this case, results were generally robust to model specification, but this methodological issue

should be investigated in future research. Side-by-side comparisons of results from the primary and supplemental models are provided (Supplemental Table 5; Supplemental Figures 3).

**Results**

The analytic sample includes 377,362 respondents across 36 states, aged 12-18 years with a mean of 15.7 years (SD=1.2) (Table 1), with 51% girls and race/ethnicity breakdown of 5% Asian, 14% Black, 21% Hispanic, 50% White, and 9% Multi-race/Other. Eighty-two percent identified as heterosexual, 9% as bisexual, 3% as gay or lesbian, and 6% responded other (Table 1). Across the 2017-2021 period, a concerning 18.5% of students reported suicidal ideation. There were observed increases over time with 16.9% of respondents reporting suicide ideation in 2017 to 20.9% in 2021 (Table 1). The odds ratio for the fixed-year effect across all models indicates that the post-2020 years were associated with increased odds of suicidal ideation in the overall sample (Table 2). The VPC for both Model 1 (null model) and Model 2 (adjusted for fixed-year effects) was 11%, indicating meaningful between-strata inequities and considerable within-strata variability regardless of the adjustment for year. Model 3 included post-2020 as a random coefficient, enabling us to evaluate between-stratum inequities separately by period. Interestingly, between-stratum variance was slightly larger post-2020 ($Var(\mu_{0j} + \mu_{1j})$=0.438, VPC=11.7%) than pre-2020 ($Var(\mu_{0j})$=0.414, VPC=11.2%), suggesting stable-to-modest increases in intersectional inequities during this period (i.e., a relative increase of 5.8% in between-stratum variance). Supplemental analyses of the 25 states with data for all three years yielded very similar VPC estimates, suggesting that the increases are not due to differences in state samples available pre- and post-2020 (Supplemental Table 3).

Odds ratios (OR) for fixed main effects were similar between Models 4 and 5, so we focus on results for Model 5. In terms of general, consistent inequity patterns, the odds of reporting suicidal ideation were lower for Black (OR=0.85; 95% CI: 0.77, 0.95) and Asian (OR=0.80; 95% CI: 0.72, 0.89) respondents and higher for other/multiracial (OR=1.10; 95% CI: 1.00, 1.20) compared with White respondents. Girls had higher odds of suicidal ideation than boys overall (OR=1.60; 95% CI: 1.49, 1.72) and all sexual minorities had substantially higher odds of suicidal ideation than heterosexuals, with ORs ranging from 3.3 (95% CI: 2.72, 4.00) for other-sexual to 4.45 (95% CI:4.09, 4.85) for bisexual individuals. While these fixed effects align with findings from past research, they are not sufficient to characterize the intersectional patterns. The PCV was 94.9 % pre-2020, suggesting meaningful interaction effects, but the PCV was larger post-2020 (98.9%), indicating that most of the post-2020 between stratum variance on the log-odds scale is explained by the fixed main effects.

Figure 3 visualizes predicted probabilities of suicidal ideation for each stratum across periods, ranked from high to low based on pre-2020 ideation (from Model 5), while Table 3 provides the specific point estimates and rankings for the strata. This illustrates the substantial intersectional inequities in suicidal ideation across strata, ranging from less than 10% of heterosexual Black boys to over 50% for bisexual Multi-race/Other girls. In general, heterosexual boys of all races reported the lowest levels of ideation, followed by heterosexual girls of all races. Conversely, Bisexual girls of all races, White and Multi-race/Other lesbian girls, and White and Multi-race/Other bisexual boys were among the highest-ranked strata for suicidal ideation. Although the highest and lowest ranked strata typically did not change much from pre- to post-2020, the middle-ranked strata, particularly those including sexual and racial minorities, exhibited substantial increases in suicidal ideation, with Black lesbian girls showing the largest increase in ideation, from 32.5% pre-2020 to 43.2% post-2020 (difference=10.7% point increase; Supplemental Table 2).

Supplemental analyses of the 25 states with data for all three years yielded comparable ORs as the primary analyses for the fixed main effects of race, gender, sexual orientation, and year. Predicted probabilities of ideation calculated from supplemental Model 5 were also similar and generally retained the rankings of the highest and lowest strata, but there were some differences in the ranking of strata based on pre- to post-2020 increases. For example, White Other/Questioning girls went from being the 4th to the 7th ranked strata in terms of pre- to post-2020 increases in suicidal ideation, despite having nearly identical predicted probability estimates as the primary analyses.

**Table 2.** Logistic MAIHDA model results for suicidal ideation among U.S. high school students pre- and post-2020 at the intersection of gender, race, and sexual orientation

| | Model 1: Null | | | Model 2: Fixed Year Effect (pre/post-2020) | | | Model 3: Random Year Effect | | | Model 4: Fixed YearEffect + FixedMain Effects | | | Model 5: Random Year Effect + Fixed Main Effects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fixed Effects** | **Coefficient (SE) [95% CI]** | **exp(Coef.) (SE) [95% CI]** | **z** | **Coefficient (SE) [95% CI]** | **exp(Coef.) (SE) [95% CI]** | **z** | **Coefficient (SE) [95% CI]** | **exp(Coef.) (SE) [95% CI]** | **z** | **Coefficient (SE) [95% CI]** | **exp(Coef.) (SE) [95% CI]** | **z** | **Coefficient (SE) [95% CI]** | **exp(Coef.) (SE) [95% CI]** | **z** |
| Intercept | -0.9 (0.1) [-1.11, -0.7] | 0.41 (0.04) [0.33, 0.5] | -8.77 | -0.94 (0.1) [-1.14, -0.74] | 0.39 (0.04) [0.32, 0.48] | -9.14 | -0.96 (0.1) [-1.16, -0.76] | 0.38 (0.04) [0.31, 0.47] | -9.42 | -2.02 (0.04) [-2.1, -1.94] | 0.13 (0.01) [0.12, 0.14] | -48.9 | -2.08 (0.05) [-2.18, -1.98] | 0.13 (0.01) [0.11, 0.14] | -40.0 |
| | **Log-Odds** | **Odds Ratio** | | **Log-Odds** | **Odds Ratio** | | **Log-Odds** | **Odds Ratio** | | **Log-Odds** | **Odds Ratio** | | **Log-Odds** | **Odds Ratio** | |
| **Year (base: pre-2020)** | | | | | | | | | | | | | | | |
| post-2020 | | | | 0.1 (0.01) [0.08, 0.12] | 1.1 (0.01) [1.08, 1.12] | 10.3 | 0.17 (0.04) [0.1, 0.24] | 1.18 (0.04) [1.1, 1.27] | 4.65 | 0.1 (0.01) [0.08, 0.12] | 1.1 (0.01) [1.08, 1.12] | 10.3 | 0.17 (0.04) [0.09, 0.24] | 1.18 (0.04) [1.1, 1.27] | 4.5 |
| **Race (base: White)** | | | | | | | | | | | | | | | |
| Black | | | | | | | | | | -0.22 (0.05) [-0.31, -0.13] | 0.8 (0.04) [0.73, 0.88] | -4.83 | -0.2 (0.05) [-0.29, -0.11] | 0.82 (0.04) [0.75, 0.9] | -4.29 |
| Hispanic | | | | | | | | | | -0.03 (0.04) [-0.12, 0.06] | 0.97 (0.04) [0.89, 1.06] | -0.69 | -0.05 (0.04) [-0.14, 0.04] | 0.95 (0.04) [0.87, 1.04] | -1.05 |
| Asian | | | | | | | | | | -0.25 (0.05) [-0.35, -0.15] | 0.78 (0.04) [0.7, 0.86] | -4.95 | -0.24 (0.05) [-0.34, -0.14] | 0.79 (0.04) [0.71, 0.87] | -4.84 |
| Multi-race/Other | | | | | | | | | | 0.11 (0.05) [0.02, 0.2] | 1.11 (0.05) [1.02, 1.22] | 2.33 | 0.1 (0.05) [0.01, 0.19] | 1.11 (0.05) [1.01, 1.21] | 2.21 |
| **Gender (base: Boy)** | | | | | | | | | | | | | | | |
| Girl | | | | | | | | | | 0.45 (0.03) [0.39, 0.51] | 1.58 (0.05) [1.48, 1.67] | 14.88 | 0.45 (0.03) [0.39, 0.51] | 1.57 (0.05) [1.48, 1.67] | 14.68 |
| **Sexual Orientation (base: Heterosexual** | | | | | | | | | | | | | | | |
| Gay/Lesbian | | | | | | | | | | 1.26 (0.04) [1.17, 1.34] | 3.51 (0.15) [3.22, 3.82] | 28.5 | 1.31 (0.06) [1.2, 1.42] | 3.7 (0.21) [3.31, 4.13] | 23.34 |
| Bisexual | | | | | | | | | | 1.53 (0.04) [1.45, 1.61] | 4.61 (0.19) [4.26, 4.99] | 37.67 | 1.52 (0.04) [1.44, 1.6] | 4.58 (0.18) [4.23, 4.95] | 37.97 |
| Other/Questioning | | | | | | | | | | 0.97 (0.04) [0.89, 1.05] | 2.64 (0.11) [2.43, 2.86] | 23.42 | 1.04 (0.07) [0.9, 1.19] | 2.84 (0.21) [2.45, 3.29] | 13.97 |
| **Random Effects** | **SD** | **Variance** | | **SD** | **Variance** | | **SD** | **Variance** | | **SD** | **Variance** | | **SD** | **Variance** | |
| Intercept (Strata) | 0.649 | 0.421 | | 0.645 | 0.416 | | 0.643 | 0.414 | | 0.081 | 0.007 | | 0.144 | 0.021 | |
| Year (Post-2020) | | | | | | | 0.195 | 0.038 | | | | | 0.204 | 0.041 | |
| Correlation \| Covariance | | | | | | | -0.054 | -0.007 | | | | | -0.852 | -0.025 | |
| **Summary Statistics** | | | | | | | | | | | | | | | |
| Between Stratum Variance | 0.421 | | | 0.416 | | | 0.414 | | | 0.007 | | | 0.021 | | |
| Betwn Strat Var (Post-2020) | | | | | | | 0.438 | | | | | | 0.012 | | |
| VPC (%) | 11.34 | | | 11.219 | | | 11.166 | | | 0.201 | | | 0.63 | | |
| VPC: Post-2020 (%) | | | | | | | 11.748 | | | | | | 0.369 | | |
| PCV (%) | | | | M 1 - M2: 1.188 | | | | | | M 1 - M4: 98.337 | | | M3 - M5: 94.928 | | |
| PCV: Post-2020 (%) | | | | | | | | | | | | | 97.260 | | |
| Hausman Test | | | | chi2 (1) = 1272, p-value < 2.2e-16 | | | | | | chi2 (9) = 13.60, p-value = 0.14 | | | | | |

**Figure 3.** Strata rank-ordered by pre-2020 predicted probabilities for suicidal ideation (square markers) with post-2020 suicidal ideation (circles) obtained from Model 5. The point estimates include 95% confidence interval bars based on the standard error of the mean. Sexual orientation by Gender categories is color-coded, and the y-axis contains the full description of each stratum, including race category.

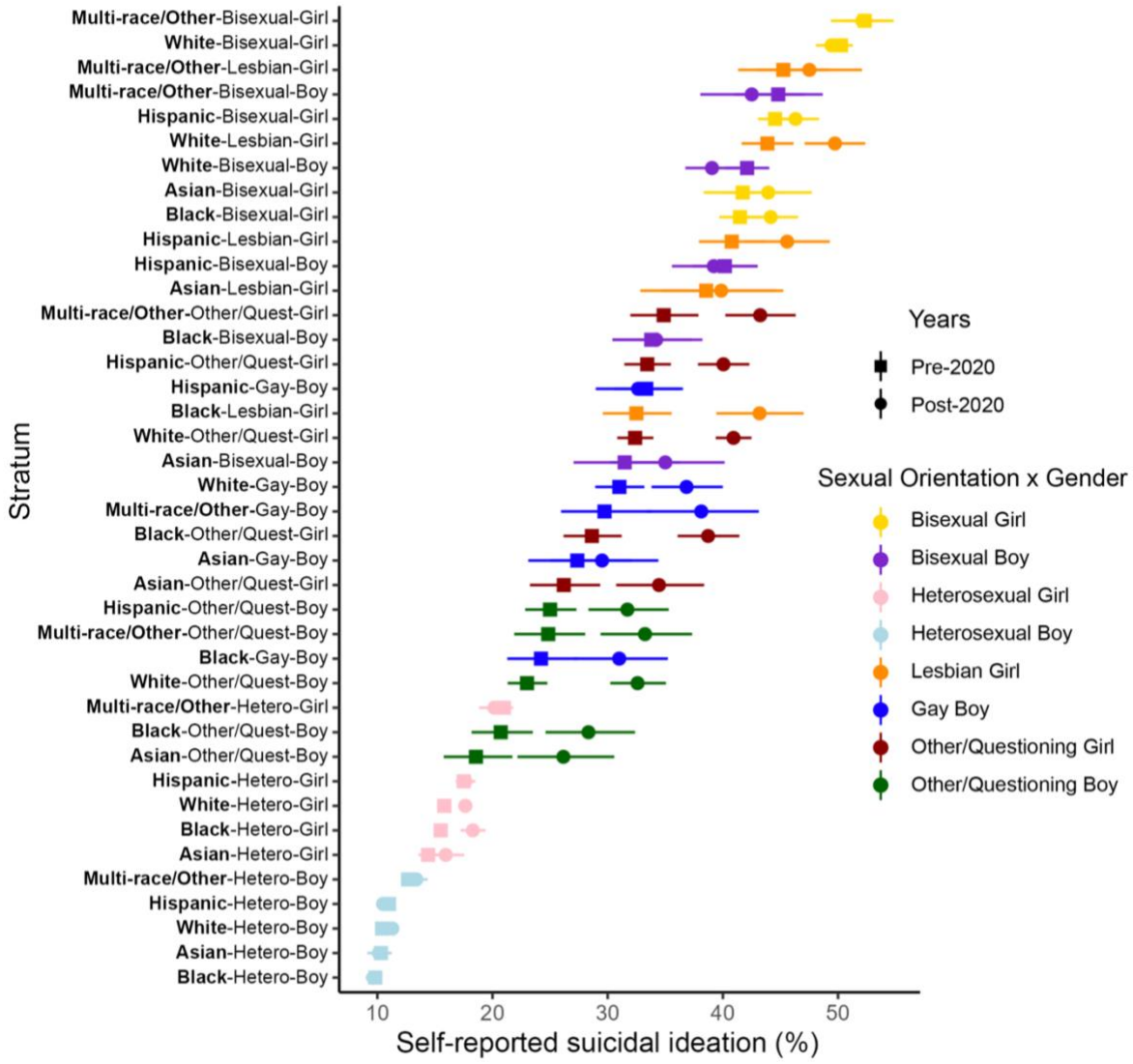



**Table 3.** Predicted probabilities of suicidal ideation (Model 5)

| Intersectional Strata | | | Pre-2020 | | Post-2020 | | Changes in Suicidal Ideation (SI) | | |
|---|---|---|---|---|---|---|---|---|---|
| Race | Sexual Orientation | Gender | Suicidal Ideation (%) (95% CI) | Rank | Suicidal Ideation (%) (95% CI) | Rank | SI Increase (post- minus pre-2020) | Rank of Increase | Rank Change (pre- minus post-2020) |
| Multi/Other | Bisexual | Girl | 52.3 (50, 54) | 1 | 52.1 (49, 55) | 1 | -0.2 | 33 | 0 |
| White | Bisexual | Girl | 50.3 (49, 51) | 2 | 49.4 (48, 51) | 3 | -0.8 | 37 | -1 |
| Multi/Other | Lesbian | Girl | 45.2 (41, 49) | 3 | 47.5 (43, 52) | 4 | 2.3 | 20 | -1 |
| Multi/Other | Bisexual | Boy | 44.8 (41, 49) | 4 | 42.5 (38, 47) | 11 | -2.3 | 39 | -7 |
| Hispanic | Bisexual | Girl | 44.5 (43, 46) | 5 | 46.3 (44, 48) | 5 | 1.8 | 24 | 0 |
| White | Lesbian | Girl | 43.9 (42, 46) | 6 | 49.7 (47, 52) | 2 | 5.9 | 14 | 4 |
| White | Bisexual | Boy | 42.1 (40, 44) | 7 | 39.1 (37, 41) | 16 | -3.1 | 40 | -9 |
| Asian | Bisexual | Girl | 41.7 (38, 45) | 8 | 43.9 (40, 48) | 8 | 2.2 | 21 | 0 |
| Black | Bisexual | Girl | 41.5 (40, 43) | 9 | 44.2 (42, 47) | 7 | 2.7 | 19 | 2 |
| Hispanic | Lesbian | Girl | 40.8 (38, 44) | 10 | 45.6 (42, 49) | 6 | 4.8 | 16 | 4 |
| Hispanic | Bisexual | Boy | 40.2 (37, 43) | 11 | 39.2 (36, 43) | 15 | -1 | 38 | -4 |
| Asian | Lesbian | Girl | 38.5 (33, 45) | 12 | 39.9 (35, 45) | 14 | 1.3 | 26 | -2 |
| Multi/Other | Other/Quest | Girl | 34.9 (32, 38) | 13 | 43.2 (40, 46) | 9 | 8.4 | 7 | 4 |
| Black | Bisexual | Boy | 33.8 (30, 37) | 14 | 34.2 (30, 38) | 22 | 0.4 | 29 | -8 |
| Hispanic | Other/Quest | Girl | 33.4 (31, 35) | 15 | 40.0 (38, 42) | 13 | 6.6 | 13 | 2 |
| Hispanic | Gay | Boy | 33.3 (31, 36) | 16 | 32.6 (29, 37) | 24 | -0.7 | 35 | -8 |
| Black | Lesbian | Girl | 32.5 (30, 36) | 17 | 43.2 (39, 47) | 10 | 10.7 | 1 | 7 |
| White | Other/Quest | Girl | 32.4 (31, 34) | 18 | 40.9 (39, 42) | 12 | 8.5 | 4 | 6 |
| Asian | Bisexual | Boy | 31.5 (27, 36) | 19 | 35.0 (30, 40) | 20 | 3.5 | 17 | -1 |
| White | Gay | Boy | 31.0 (29, 33) | 20 | 36.8 (34, 40) | 19 | 5.8 | 15 | 1 |
| Multi/Other | Gay | Boy | 29.7 (26, 34) | 21 | 38.1 (33, 43) | 18 | 8.4 | 5 | 3 |
| Black | Other/Quest | Girl | 28.6 (26, 31) | 22 | 38.7 (36, 41) | 17 | 10.1 | 2 | 5 |
| Asian | Gay | Boy | 27.4 (23, 32) | 23 | 29.5 (25, 34) | 28 | 2.1 | 22 | -5 |
| Asian | Other/Quest | Girl | 26.2 (23, 29) | 24 | 34.5 (31, 38) | 21 | 8.3 | 8 | 3 |
| Hispanic | Other/Quest | Boy | 25.0 (23, 27) | 25 | 31.7 (28, 35) | 26 | 6.7 | 12 | -1 |
| Multi/Other | Other/Quest | Boy | 24.8 (22, 28) | 26 | 33.2 (29, 37) | 23 | 8.4 | 6 | 3 |
| Black | Gay | Boy | 24.2 (21, 27) | 27 | 31.0 (27, 35) | 27 | 6.8 | 11 | 0 |
| White | Other/Quest | Boy | 23.0 (21, 25) | 28 | 32.6 (30, 35) | 25 | 9.6 | 3 | 3 |
| Multi/Other | Hetero | Girl | 21.0 (20, 22) | 29 | 20.2 (19, 22) | 31 | -0.8 | 36 | -2 |
| Black | Other/Quest | Boy | 20.7 (18, 24) | 30 | 28.3 (25, 32) | 29 | 7.6 | 9 | 1 |
| Asian | Other/Quest | Boy | 18.6 (16, 22) | 31 | 26.2 (22, 31) | 30 | 7.6 | 10 | 1 |
| Hispanic | Hetero | Girl | 17.5 (17, 18) | 32 | 17.6 (17, 19) | 34 | 0.1 | 30 | -2 |
| White | Hetero | Girl | 15.8 (16, 16) | 33 | 17.6 (17, 18) | 33 | 1.8 | 23 | 0 |
| Black | Hetero | Girl | 15.5 (15, 16) | 34 | 18.3 (17, 19) | 32 | 2.8 | 18 | 2 |
| Asian | Hetero | Girl | 14.4 (14, 15) | 35 | 15.9 (14, 18) | 35 | 1.5 | 25 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Multi/Other | Hetero | Boy | 12.7 (12, 13) | 36 | 13.4 (12, 14) | 36 | 0.7 | 28 | 0 |
| Hispanic | Hetero | Boy | 11.0 (11, 11) | 37 | 10.5 (10, 11) | 38 | -0.5 | 34 | -1 |
| White | Hetero | Boy | 10.4 (10, 11) | 38 | 11.3 (11, 12) | 37 | 0.9 | 27 | 1 |
| Asian | Hetero | Boy | 10.3 (10, 11) | 39 | 10.1 (9, 11) | 39 | -0.2 | 31 | 0 |
| Black | Hetero | Boy | 9.8 (9, 10) | 40 | 9.6 (9, 10) | 40 | -0.2 | 32 | 0 |

## Discussion

The present study builds on recent developments extending MAIHDA into longitudinal analysis (47) by showcasing a simplified random coefficient example of how surveys with repeated cross-sectional sampling can be used to construct longitudinal trends at the stratum-group level, which can be expanded in future studies. Using logistic intersectional I-MAIHDA with random effects, we investigated inequities in suicidal ideation among U.S. high school students at intersections of racial, sexual orientation-, and gender-identities during the highly turbulent years before and after 2020. We found that a substantial and growing percentage of youth reported past-year suicidal ideation, such that over 1 in 5 respondents experienced this adverse mental health outcome in 2021. However, these summary statistics obscure important intersectional inequities in suicidal ideation between groups. For instance, while boys overall tended to report lower levels of suicidal ideation than girls, multi/other racial bisexual boys were among the highest ranked in suicidal ideation (44.8% in 2017-2019). In both the pre- and post-2019 periods there were substantial inequities across strata, such that heterosexual boys of all races reported the lowest levels of suicidal ideation (9.6-13.4%), with Black heterosexual boys ranked lowest at both time points, while bisexual individuals, primarily girls reporting the highest levels (42.5-52.3%), with multi/other-racial bisexual girls ranked highest for both pre- and post-2020.

The VPC in both periods (11.2% pre-2020, 11.7% post-2020) confirms the notable degree of inequity between strata and suggests a stable-to-small-increase in intersectional inequities over this period. Comparing the post-2019 and 2017-2019 periods, we see the most substantial increases in self-reported suicidal ideation among strata previously ranked in the middle—with particularly large increases among strata of sexual and racial minorities. The five strata showing the biggest changes were Black other-sexual and lesbian girls, White other-sexual boys and girls, and Multi-race/Other gay boys with increases ranging from 8.4 to 10.7 percentage points (Table 3). However, even among the highest- and lowest-ranked strata which generally exhibited small changes from pre- and post-2020, there were meaningful increases that may be cause for concern. For instance, although Black heterosexual girls ranked low in suicidal ideation and had relatively small increases from pre- to post-2020, non-overlapping confidence intervals indicate they may be an increasingly vulnerable group (Figure 3).

Explanations for why we see such meaningful increases, particularly among multiply minoritized strata, are varied. Along with the social isolation imposed by COVID-19 lockdowns, 2020 was characterized by economic, political, and social upheavals, which likely impacted mental health differently depending on social identity and positionality (12,31). For instance, the COVID-19 pandemic led to a surge in xenophobia and hate crimes against Asian Americans, which has been linked to worsening mental health among certain Asian American communities (15,16). Our results add nuance to this work by demonstrating that Asian sexual minorities were the most impacted. Moreover, other studies have shown that engagement with the Black Lives Matter protests, both online and in-person, was associated with worsening mental health for

Black compared to White adolescents, but qualitative reports suggest that they are less likely to bring this up in therapy (48–50). During this period, numerous states also proposed anti-LGBTQ+ policies that had negative effects on the mental health of gender and sexual minority youth (51,52) which aligns with our findings showing that sexual minorities, particularly bisexual individuals, of all races and genders reporting suicidal ideation at high rates. Together, our findings suggest that among U.S. high school students, sexual minorities and girls are among the most impacted by the growing youth mental health crisis and provide clues about the circumstances that exacerbate mental health inequities by race that can be further investigated.

[**It is critical to note that health inequities have long existed before the pandemic and are created and perpetuated by systems of oppression. Expand…]**

This study adds to the growing body of research on youth mental health by uncovering fine-grain patterns of intersectional inequities in teen suicidal ideation. Our results align with prior work showing that sexual minorities, particularly bisexual individuals, experience high levels of discrimination and depressive symptoms (27,32). Importantly, by utilizing the I-MAIHDA approach that overcomes some of the limitations of single-level model approaches used in prior research, we were able to estimate more reliable predicted probabilities across a larger number of intersectional strata and reveal less intuitive findings. For instance, from pre- to post-2020, we found small but meaningful increases in suicidal ideation (i.e., non-overlapping confidence intervals) for Black and White heterosexual girls who had lower rank in overall inequities, but who may be groups that are sensitive to the social disruptions like those experienced during 2020. Together, the current work provides a theoretical and methodological framework for investigating the U.S. youth mental health crisis.

Suicide is a growing public health concern across the lifespan, particularly for U.S. teens, for whom suicide became the third leading cause of death in 2021 (5,8). Prior work indicates that suicidal ideation can serve as an important indicator for later suicide attempts (10,11). Thus, the current work provides important insights about the groups that are most impacted by suicidal ideation, which can be used to target mental health services and policies for sexual and racial minority youth. Moreover, our results demonstrated inequities in the increasing prevalence of suicidal ideation across intersectional strata that can provide clues about the factors leading to strata-specific changes. For instance, prior studies have demonstrated that state-level racial sentiment is associated with racial inequities in adverse birth outcomes (53,54) and that news exposure to anti-transgender policies is linked to worsening mental health among LGBTQ+ youth (17). It is important to note that the risk of suicidal ideation was alarmingly common (~10%) even among the lowest-risk strata, indicating that the youth mental health crisis is simultaneously disproportionately experienced and universally an issue of concern. Future research should build on our findings to explore how state-level factors and policy changes may contribute to youth suicidal ideation.

The current work is not without limitations. Our analytic sample was limited to individuals with no missing data for race, sexual orientation, gender, and suicidal ideation which yielded samples from 36 states that are not fully representative of the country as a whole. More specifically, of the 8 states that collected YRBSS data but were excluded from the primary analyses for missing necessary variables, 7 (Alaska, Georgia, Idaho, Louisiana, Montana, South Dakota, and Tennessee) were more conservative states that were excluded for missing questions about sexual orientation, which suggests that we are likely under-estimating the range of intersectional inequities and the magnitude of risk faced by LGBTQIA+ youth**.** Sexual orientation in the data did not include other sexual orientation categories, like pansexual, who may broadly identify as queer and/or experience varying sexual attraction. Moreover, suicidal ideation and sexual orientation is self-reported and may be influenced by an array of individual-level and cultural-level factors, like social stigmatization, that impact reporting in a

public health survey. Furthermore, as we noted in the methods section, we used self-reported sex to define our binary gender variable due to limited data on self-identified gender within the sample. The data did not include expansive gender categories such as non-binary, two-spirit, and transgender. Because sexual orientation and gender identity are fluid and can change with development, encourage future collections of the YRBSS and other large-scale surveys to include questions about self-identified gender to better enable investigations of health inequities by self-identified gender. The “Other/Questioning” and “Multi-racial/Other” labels were heterogeneous groupings for analytic convenience. That is, we combined Pacific Islander, Native Hawaiian, multi-race, and other race participants into a race category due to small sample sizes. It would be valuable for future research with an adequate sample size to investigate these outcomes using disaggregated groups. YRBSS is a cross-sectional survey, so we were not able to investigate changes in self-identification of race, gender, and sexual orientation. It would be meaningful to examine longitudinal patterns of changes in identities with changes in suicidal ideation. While the focus of this paper was examining inequities by race, sexual orientation, and gender, it would be valuable to examine other identity dimensions in future research.

This study finds stark inequities in suicidal ideation among U.S. teens, and that mental health is worsening particularly for youth who have multiple minoritized identities. There is an urgent need to investigate and act to counter the drivers of these inequities. In line with the critical intersectional framework that guided this study, we hope to spur the transformation of the systemic drivers and social and political determinants of these inequities.

## Supplemental Methods

***Supplemental Table 1.*** *Observations by intersecting identity categories*

| Race | Bisexual | Heterosexual | Gay/Lesbian | Other | Total |
|---|---|---|---|---|---|
| **ALL YEARS** | | | | | |
| | **Girls** | | | | |
| **Asian** | 1,049 | 7,671 | 198 | 1,021 | 9,939 |
| **Black** | 4,181 | 19,582 | 1,218 | 2,074 | 27,055 |
| **Hispanic** | 6,351 | 29,678 | 1,379 | 3,484 | 40,892 |
| **MultiOther** | 3,170 | 12,777 | 674 | 1,589 | 18,210 |
| **White** | 13,554 | 73,318 | 2,974 | 6,835 | 96,681 |
| **Total** | 28,305 | 143,026 | 6,443 | 15,003 | 192,777 |
| | **Boys** | | | | |
| **Asian** | 300 | 8,987 | 257 | 545 | 10,089 |
| **Black** | 816 | 22,771 | 804 | 888 | 25,279 |
| **Hispanic** | 1,507 | 33,530 | 1,179 | 1,736 | 37,952 |
| **MultiOther** | 785 | 14,958 | 525 | 819 | 17,087 |
| **White** | 3,885 | 84,735 | 2,274 | 3,284 | 94,178 |
| **Total** | 7,293 | 164,981 | 5,039 | 7,272 | 184,585 |
| **2017** | | | | | |
| | **Girls** | | | | |
| **Asian** | 297 | 3,079 | 52 | 364 | 3,792 |
| **Black** | 1,352 | 7,523 | 427 | 583 | 9,885 |
| **Hispanic** | 1,966 | 11,057 | 464 | 1,002 | 14,489 |
| **MultiOther** | 1,064 | 5,020 | 224 | 441 | 6,749 |
| **White** | 4,009 | 27,851 | 843 | 1,563 | 34,266 |
| **Total** | 8,688 | 54,530 | 2,010 | 3,953 | 69,181 |
| | **Boys** | | | | |
| **Asian** | 105 | 3,379 | 94 | 230 | 3,808 |
| **Black** | 274 | 8,159 | 323 | 371 | 9,127 |
| **Hispanic** | 455 | 11,606 | 439 | 703 | 13,203 |

| | | | | | |
|---|---|---|---|---|---|
| **MultiOther** | 288 | 5,441 | 226 | 273 | 6,228 |
| **White** | 1,109 | 30,079 | 799 | 1,077 | 33,064 |
| **Total** | 2,231 | 58,664 | 1,881 | 2,654 | 65,430 |
| **2019** | | | | | |
| | **Girl** | | | | |
| **Asian** | 337 | 2,847 | 66 | 261 | 3,511 |
| **Black** | 1,352 | 7,218 | 372 | 472 | 9,414 |
| **Hispanic** | 2,272 | 11,551 | 478 | 912 | 15,213 |
| **MultiOther** | 1,083 | 4,802 | 219 | 381 | 6,485 |
| **White** | 4,610 | 27,543 | 914 | 1,674 | 34,741 |
| **Total** | 9,654 | 53,961 | 2,049 | 3,700 | 69,364 |
| | **Boy** | | | | |
| **Asian** | 94 | 3,187 | 87 | 196 | 3,564 |
| **Black** | 270 | 7,904 | 250 | 300 | 8,724 |
| **Hispanic** | 559 | 12,348 | 421 | 566 | 13,894 |
| **MultiOther** | 244 | 5,294 | 169 | 285 | 5,992 |
| **White** | 1,341 | 30,856 | 811 | 1,012 | 34,020 |
| **Total** | 2,508 | 59,589 | 1,738 | 2,359 | 66,194 |
| **2021** | | | | | |
| | **Girl** | | | | |
| **Asian** | 415 | 1,745 | 80 | 396 | 2,636 |
| **Black** | 1,477 | 4,841 | 419 | 1,019 | 7,756 |
| **Hispanic** | 2,113 | 7,070 | 437 | 1,570 | 11,190 |
| **MultiOther** | 1,023 | 2,955 | 231 | 767 | 4,976 |
| **White** | 4,935 | 17,924 | 1,217 | 3,598 | 27,674 |
| **Total** | 9,963 | 34,535 | 2,384 | 7,350 | 54,232 |
| | **Boy** | | | | |
| **Asian** | 101 | 2,421 | 76 | 119 | 2,717 |
| **Black** | 272 | 6,708 | 231 | 217 | 7,428 |
| **Hispanic** | 493 | 9,576 | 319 | 467 | 10,855 |
| **MultiOther** | 253 | 4,223 | 130 | 261 | 4,867 |

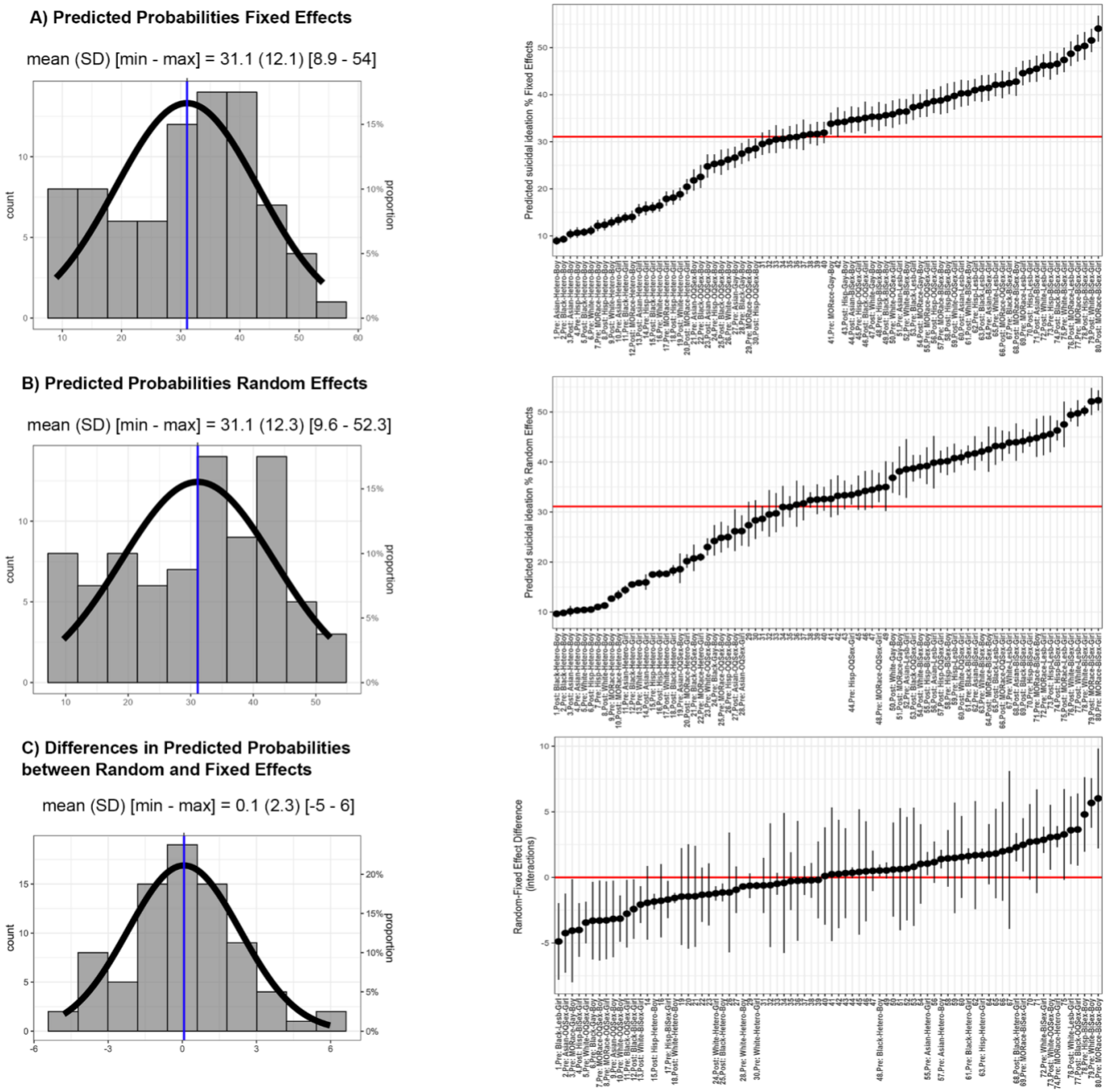
| | | | | | |
|---|---|---|---|---|---|
| **White** | 1,435 | 23,800 | 664 | 1,195 | 27,094 |
| **Total** | 2,554 | 46,728 | 1,420 | 2,259 | 52,961 |

***Supplemental Table 2.*** *Number of usable and total observations for each state by year, and with reasons for excluded observations. Unbolded states did not provide any data (n=6). States with a single asterisk (n=8) were removed before primary analyses because they did not provide complete observations needed for the analyses. States with two asterisks (n=11) were excluded from supplementary analyses because they did not have data for all three years.*

| | | **Observations By Year** | | | **Reason For Exclusion** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **State** | **All Observations Usable (=377,362) / Total (=520,129)** | **2017 Usable (=134,611) / Total (=189,723)** | **2019 Usable (=135,558) / Total (=182,491)** | **2021 Usable (=107,193) / Total (=147,903)** | **Complete Data N = 377,362** | **Missing Outcome N = 68,636** | **Missing Gender N = 3,984** | **Missing Race N = 11,010** | **Missing Sexual Orientation N = 59,125** |
| **AK*** | 0 / 3,219 | 0 / 1,344 | 0 / 1,875 | 0 / 0 | 0 | 34 | 26 | 72 | 3,087 |
| **AL**** | 1,895 / 2,459 | 0 / 0 | 1,895 / 2,040 | 0 / 419 | 1,895 | 42 | 16 | 49 | 457 |
| **AR** | 4,755 / 5,258 | 1,491 / 1,682 | 1,869 / 2,024 | 1,395 / 1,552 | 4,755 | 142 | 35 | 123 | 203 |
| **AZ** | 4,801 / 5,246 | 1,990 / 2,139 | 1,712 / 1,926 | 1,099 / 1,181 | 4,801 | 164 | 34 | 96 | 151 |
| **CA**** | 2,983 / 3,112 | 1,693 / 1,778 | 1,290 / 1,334 | 0 / 0 | 2,983 | 32 | 19 | 61 | 17 |
| **CO** | 3,242 / 3,877 | 1,239 / 1,493 | 1,276 / 1,348 | 727 / 1,036 | 3,242 | 56 | 45 | 92 | 442 |
| **CT** | 5,706 / 6,200 | 2,218 / 2,425 | 1,891 / 2,015 | 1,597 / 1,760 | 5,706 | 118 | 24 | 78 | 274 |
| **DE**** | 3,920 / 4,484 | 2,550 / 2,906 | 0 / 0 | 1,370 / 1,578 | 3,920 | 136 | 61 | 63 | 304 |
| **FL** | 15,287 / 16,546 | 5,720 / 6,171 | 5,281 / 5,703 | 4,286 / 4,672 | 15,287 | 235 | 160 | 221 | 643 |
| **GA*** | 0 / 5,168 | 0 / 0 | 0 / 4,564 | 0 / 604 | 0 | 136 | 42 | 123 | 4,867 |
| **HI** | 16,057 / 17,547 | 5,445 / 6,031 | 5,421 / 5,879 | 5,191 / 5,637 | 16,057 | 439 | 154 | 436 | 461 |
| **IA** | 4,247 / 4,671 | 1,482 / 1,691 | 1,469 / 1,593 | 1,296 / 1,387 | 4,247 | 47 | 23 | 83 | 271 |
| **ID*** | 0 / 4,018 | 0 / 1,818 | 0 / 1,210 | 0 / 990 | 0 | 43 | 23 | 78 | 3,874 |
| **IL** | 9,984 / 11,110 | 4,475 / 5,010 | 2,843 / 3,125 | 2,666 / 2,975 | 9,984 | 239 | 91 | 290 | 506 |
| **IN**** | 957 / 1,029 | 0 / 0 | 0 / 0 | 957 / 1,029 | 957 | 9 | 10 | 25 | 28 |
| **KS**** | 1,288 / 5,347 | 0 / 2,413 | 0 / 1,417 | 1,288 / 1,517 | 1,288 | 76 | 29 | 138 | 3,816 |
| **KY** | 5,783 / 6,171 | 1,896 / 1,997 | 1,875 / 1,996 | 2,012 / 2,178 | 5,783 | 95 | 42 | 122 | 129 |
| **LA*** | 0 / 3,217 | 0 / 1,273 | 0 / 1,305 | 0 / 639 | 0 | 131 | 26 | 94 | 2,966 |
| MA | - | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **MD** | 116,788 / 127,783 | 45,788 / 51,087 | 38,419 / 41,091 | 32,581 / 35,605 | 116,788 | 2,628 | 1,209 | 3,442 | 3,716 |
| **ME** | 22,792 / 24,405 | 8,924 / 9,501 | 7,919 / 8,378 | 5,949 / 6,526 | 22,792 | 443 | 242 | 702 | 226 |
| **MI** | 9,099 / 9,942 | 1,550 / 1,626 | 4,201 / 4,565 | 3,348 / 3,751 | 9,099 | 166 | 66 | 247 | 364 |
| MN | - | | | | | | | | |
| **MO**** | 1,960 / 3,972 | 0 / 1,864 | 1,140 / 1,216 | 820 / 892 | 1,960 | 61 | 15 | 91 | 1,845 |
| **MS**** | 3,173 / 3,514 | 0 / 0 | 1,640 / 1,767 | 1,533 / 1,747 | 3,173 | 71 | 32 | 110 | 128 |
| **MT*** | 0 / 13,027 | 0 / 4,741 | 0 / 3,819 | 0 / 4,467 | 0 | 73 | 76 | 241 | 12,637 |
| **NC** | 7,395 / 7,927 | 2,939 / 3,151 | 2,842 / 3,056 | 1,614 / 1,720 | 7,395 | 147 | 60 | 159 | 166 |
| **ND** | 5,793 / 6,196 | 2,027 / 2,142 | 1,851 / 2,045 | 1,915 / 2,009 | 5,793 | 33 | 25 | 117 | 228 |
| **NE** | 3,232 / 3,431 | 1,342 / 1,427 | 1,265 / 1,328 | 625 / 676 | 3,232 | 31 | 17 | 60 | 91 |
| **NH** | 34,862 / 39,517 | 10,754 / 12,050 | 12,210 / 13,710 | 11,898 / 13,757 | 34,862 | 2,382 | 623 | 861 | 789 |
| **NJ**** | 2,006 / 2,088 | 0 / 0 | 1,348 / 1,393 | 658 / 695 | 2,006 | 10 | 12 | 28 | 32 |
| **NM** | 16,748 / 17,938 | 5,445 / 5,781 | 7,238 / 7,603 | 4,065 / 4,554 | 16,748 | 119 | 77 | 242 | 752 |
| **NV** | 4,350 / 4,791 | 1,568 / 1,667 | 1,319 / 1,409 | 1,463 / 1,715 | 4,350 | 88 | 40 | 129 | 184 |
| **NY** | 24,037 / 26,903 | 10,296 / 11,411 | 9,818 / 10,858 | 3,923 / 4,634 | 24,037 | 928 | 248 | 1,147 | 543 |
| OH | - | | | | | | | | |
| **OK** | 5,018 / 5,347 | 1,561 / 1,649 | 1,917 / 2,008 | 1,540 / 1,690 | 5,018 | 59 | 36 | 125 | 109 |
| OR | - | | | | | | | | |
| **PA** | 7,125 / 7,738 | 3,442 / 3,761 | 2,208 / 2,338 | 1,475 / 1,639 | 7,125 | 102 | 51 | 205 | 255 |
| **RI** | 5,544 / 5,987 | 2,092 / 2,221 | 1,496 / 1,613 | 1,956 / 2,153 | 5,544 | 111 | 49 | 94 | 189 |
| **SC**** | 2,281 / 4,324 | 1,269 / 1,501 | 1,012 / 1,221 | 0 / 1,602 | 2,281 | 1,871 | 23 | 68 | 81 |
| **SD*** | 0 / 2,401 | 0 / 0 | 0 / 1,457 | 0 / 944 | 0 | 40 | 13 | 45 | 2,303 |
| **TN*** | 0 / 6,245 | 0 / 2,043 | 0 / 2,228 | 0 / 1,974 | 0 | 91 | 48 | 134 | 5,972 |
| **TX** | 5,426 / 5,827 | 1,985 / 2,113 | 1,894 / 2,032 | 1,547 / 1,682 | 5,426 | 72 | 27 | 117 | 185 |
| **UT**** | 2,903 / 4,886 | 0 / 1,848 | 1,480 / 1,537 | 1,423 / 1,501 | 2,903 | 29 | 27 | 124 | 1,803 |
| **VA**** | 7,231 / 11,400 | 0 / 3,697 | 4,429 / 4,620 | 2,802 / 3,083 | 7,231 | 127 | 49 | 127 | 3,866 |
| **VT*** | 0 / 56,678 | 0 / 20,653 | 0 / 18,613 | 0 / 17,412 | 0 | 56,678 | 0 | 0 | 0 |
| WA | - | | | | | | | | |
| **WI** | 5,450 / 5,734 | 1,953 / 2,067 | 1,773 / 1,829 | 1,724 / 1,838 | 5,450 | 57 | 31 | 76 | 120 |
| **WV** | 3,244 / 3,449 | 1,477 / 1,563 | 1,317 / 1,403 | 450 / 483 | 3,244 | 45 | 28 | 75 | 57 |
| WY | - | | | | | | | | |

***Supplemental Figure 1.*** *Predicted probabilities estimated from the fixed and random effects parameters of Model 5 and the difference to demonstrate. The histograms on the left demonstrate the shrinkage of I-MAIHDA models from fixed (A) to random (B) effects. The caterpillar plots on the right are rank-order the starta by predicted probabilities, and labels are included for the estimates that do not include the mean (in red A and B) or zero (in C). Differences between random and fixed effects that do not include zero are indicative of the interaction effects such that they deviate from what would be expected for the main effects for these strata. In total, differences for 33 strata x year (pre/post-2020) deviate from zero, with 23 coming from pre-2020 and 10 from post-2020, supporting that more of the between stratum variance can be explained by main effects after 2020.*




## Sensitivity Analyses

The focus of the current study is to characterize overall intersectional inequity patterns of U.S. high school students, but research indicates that there are state-level differences in teen

mental health outcomes. The current sample was not adequately powered to examine differences in inequity patterns by adding state as an additional, intersectional dimension, and a deeper investigation of state-level effects using cross-classified models or more sophisticated state-specific adjustments is beyond the scope of the current work. However, because 11 states did have data for all three years, we ran a set of supplementary I-MAIHDA models as described in the primary manuscript, but using only the 25 states that had usable data for all three years to ensure that the observed changes in suicidal ideation we quantified from our random coefficient models cannot be attributed to differences in the state-level samples (Supplemental Table 4). This excluded 30,597 observations, 19,746 from pre-2020 and 10,851 from post-2020. Supplemental Table 2 (above) provides details for the states included in the primary and supplementary analyses, including the total and usable observations per state, overall and by year, and the reasons why observations were excluded. We further adjust for state by fitting a supplemental sensitivity Model 6 that is the same as Model 5 but includes fixed state effects (Supplemental Table 4) with Maryland as the reference state because it had the largest samples provided. This model provides estimates for state-level effects and allows the calculation of PCV that is attributable to additive main effects and state effects.

Supplemental analyses supported our primary findings and yielded similar odds ratios for the main effects of race, gender, sexual orientation, and year, but provided different estimates for the variance associated with intersectional inequities. Supplemental analyses using only the 25 states with usable data for all three years revealed different PCVs of 43% (pre-2020) and 47% (post-2020; Model 5, Supplemental Table 4). Adjusting for fixed effects of state, both sets of supplementary analyses yielded PCVs of 95% for pre-2020 and 97% for post-2020 (Model 6; Supplemental Tables 4). However, state sample sizes had a wide range (Indiana n=957, Maryland n=116,788) and were not proportional to the state populations (e.g., Maryland has 7x more data than Florida), so these findings should be interpreted with caution. Together, these findings suggest that additive main effects accounted for a larger portion of between stratum variance post-2020, although the exact amount is unclear, and that state-level effects play an important role in shaping teen mental health that requires further investigation.

***Supplemental Table 3.*** *Logistic I-MAIHDA model parameters for the primary sample from 36 states (left) and for the sensitivity analysis of 25 states with full data for all three years (right) for side-by-side comparison. The table includes parameters from supplementary Model 6, which includes fixed state effects.*

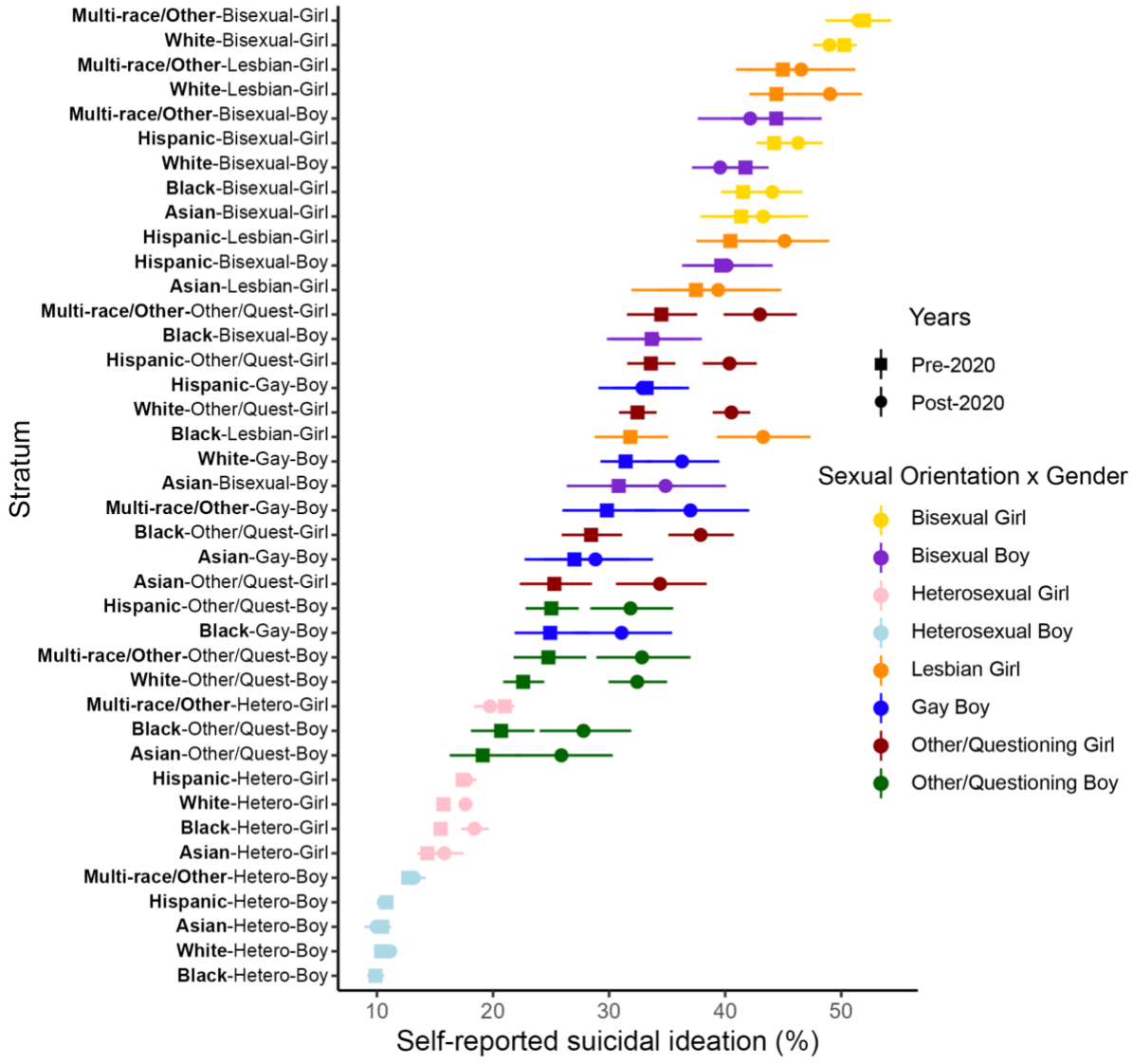
| Models with 36 States | | | | | | |
|---|---|---|---|---|---|---|
| | **Model 1: Null model** | **Model 2: Fixed Year Effect (pre/post-2020)** | **Model 3: Random Year Effect** | **Model 4: Fixed YearEffect + FixedMain Effects** | **Model 5: Random Year Effect + Fixed Main Effects** | **Model 6: Random Year Effect + Fixed Main Effects + State** |
| **Intercept** | 0.41 (0.33, 0.50) | 0.39 (0.32, 0.48) | 0.38 (0.31, 0.47) | 0.13 (0.12, 0.14) | 0.12 (0.10, 0.14) | 0.15 (0.13,0.18) |
| | **Odds Ratio (95% Confidence interval)** | | | | | |
| **Year (pre-2020)** | | 1 (base) | 1 (base) | 1 (base) | 1 (base) | |
| post-2020 | | 1.10 (1.08, 1.12) | 1.18 (1.10, 1.27) | 1.10 (1.08, 1.12) | 1.19 (1.05, 1.35) | 1.17 (1.09,1.25) |
| **Race** | | | | | | |
| White | | | | 1 (base) | 1 (base) | 1 (base) |
| Black | | | | 0.80 (0.73, 0.88) | 0.85 (0.77, 0.95) | 0.83 (0.76,0.91) |
| Hispanic | | | | 0.97 (0.89, 1.06) | 0.93 (0.85, 1.01) | 1.01 (0.92,1.11) |
| Asian | | | | 0.78 (0.70, 0.86) | 0.80 (0.72, 0.89) | 0.84 (0.76,0.93) |
| Other/Multi | | | | 1.11 (1.02, 1.22) | 1.10 (1.00, 1.20) | 1.15 (1.05,1.26) |
| **Gender** | | | | | | |
| Boy | | | | 1 (base) | 1 (base) | 1 (base) |
| Girl | | | | 1.58 (1.48, 1.67) | 1.60 (1.49, 1.72) | 1.58 (1.48,1.68) |
| **Sexual Orientation** | | | | | | |
| Heterosexual | | | | 1 (base) | 1 (base) | 1 (base) |
| Bisexual | | | | 4.61 (4.26, 4.99) | 4.45 (4.09, 4.85) | 4.61 (4.26,4.99) |
| Gay/Lesbian | | | | 3.51 (3.22, 3.82) | 4.03 (3.50, 4.64) | 3.70 (3.31,4.14) |
| Other | | | | 2.64 (2.43, 2.86) | 3.30 (2.72, 4.00) | 2.87 (2.48,3.32) |
| **State** | | | | | | |
| MD | | | | | | 1 (base) |
| AL | | | | | | 1.19 (1.06,1.34) |

| Models with 25 States | | | | | | |
|---|---|---|---|---|---|---|
| **Model 1: Null model** | **Model 2: Fixed Year Effect (pre/post-2020)** | **Model 3: Random Year Effect** | **Model 4: Fixed YearEffect + FixedMain Effects** | **Model 5: Random Year Effect + Fixed Main Effects** | **Model 6: Random Year Effect + Fixed Main Effects + State** |
| 0.40 (0.33, 0.49) | 0.39 (0.32, 0.47) | 0.38 (0.31, 0.46) | 0.13 (0.12, 0.14) | 0.12 (0.10, 0.14) | 0.16 (0.14,0.18) |
| **Odds Ratio (95% Confidence interval)** | | | | | |
| | 1 (base) | 1 (base) | 1 (base) | 1 (base) | |
| | 1.10 (1.08, 1.12) | 1.18 (1.10, 1.26) | 1.10 (1.08, 1.12) | 1.19 (1.02, 1.39) | 1.16 (1.08,1.24) |
| | | | | | |
| | | | 1 (base) | 1 (base) | 1 (base) |
| | | | 0.80 (0.73, 0.88) | 0.87 (0.78, 0.97) | 0.83 (0.76,0.92) |
| | | | 0.97 (0.89, 1.06) | 0.94 (0.86, 1.03) | 1.02 (0.93,1.12) |
| | | | 0.77 (0.70, 0.85) | 0.80 (0.71, 0.89) | 0.84 (0.75,0.93) |
| | | | 1.11 (1.01, 1.22) | 1.08 (0.98, 1.19) | 1.14 (1.03,1.25) |
| | | | | | |
| | | | 1 (base) | 1 (base) | 1 (base) |
| | | | 1.56 (1.47, 1.66) | 1.59 (1.48, 1.72) | 1.56 (1.47,1.67) |
| | | | | | |
| | | | 1 (base) | 1 (base) | 1 (base) |
| | | | 4.58 (4.22, 4.97) | 4.43 (4.06, 4.83) | 4.58 (4.22,4.96) |
| | | | 3.49 (3.19, 3.81) | 4.02 (3.48, 4.63) | 3.67 (3.29,4.09) |
| | | | 2.62 (2.41, 2.85) | 3.36 (2.75, 4.11) | 2.85 (2.47,3.30) |
| | | | | | |
| | | | | | 1 (base) |
| | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AR | | | | | | 1.22 (1.14,1.32) | | | | | | 1.22 (1.14,1.32) |
| AZ | | | | | | 1.06 (0.98,1.15) | | | | | | 1.06 (0.98,1.15) |
| CA | | | | | | 1.2 (1.09,1.32) | | | | | | |
| CO | | | | | | 0.99 (0.9,1.09) | | | | | | 0.99 (0.91,1.09) |
| CT | | | | | | 0.63 (0.58,0.69) | | | | | | 0.63 (0.58,0.69) |
| DE | | | | | | 0.84 (0.77,0.92) | | | | | | |
| FL | | | | | | 0.77 (0.73,0.81) | | | | | | 0.77 (0.73,0.81) |
| HI | | | | | | 0.82 (0.79,0.86) | | | | | | 0.83 (0.79,0.87) |
| IA | | | | | | 1.17 (1.09,1.27) | | | | | | 1.18 (1.09,1.27) |
| IL | | | | | | 0.94 (0.89,0.99) | | | | | | 0.94 (0.89,0.99) |
| IN | | | | | | 1.46 (1.26,1.71) | | | | | | |
| KS | | | | | | 0.93 (0.8,1.08) | | | | | | |
| KY | | | | | | 0.91 (0.85,0.98) | | | | | | 0.91 (0.85,0.98) |
| ME | | | | | | 0.81 (0.78,0.85) | | | | | | 0.81 (0.78,0.85) |
| MI | | | | | | 1.07 (1.01,1.13) | | | | | | 1.07 (1.01,1.13) |
| MO | | | | | | 0.96 (0.85,1.08) | | | | | | |
| MS | | | | | | 1.09 (0.99,1.19) | | | | | | |
| NC | | | | | | 1.02 (0.96,1.09) | | | | | | 1.02 (0.96,1.09) |
| ND | | | | | | 1.02 (0.95,1.1) | | | | | | 1.02 (0.95,1.1) |
| NE | | | | | | 1.07 (0.98,1.18) | | | | | | 1.07 (0.98,1.18) |
| NH | | | | | | 1.07 (1.03,1.1) | | | | | | 1.07 (1.04,1.11) |
| NJ | | | | | | 0.81 (0.72,0.92) | | | | | | |
| NM | | | | | | 0.89 (0.85,0.93) | | | | | | 0.89 (0.85,0.93) |
| NV | | | | | | 0.92 (0.85,1) | | | | | | 0.92 (0.85,1) |
| NY | | | | | | 0.76 (0.73,0.79) | | | | | | 0.76 (0.73,0.79) |
| OK | | | | | | 1.21 (1.12,1.3) | | | | | | 1.21 (1.12,1.3) |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PA | | | | | | 0.91 (0.85,0.97) | | | | | | 0.91 (0.85,0.97) |
| RI | | | | | | 0.74 (0.68,0.8) | | | | | | 0.74 (0.68,0.8) |
| SC | | | | | | 1.04 (0.93,1.16) | | | | | | |
| TX | | | | | | 1 (0.93,1.08) | | | | | | 1 (0.93,1.08) |
| UT | | | | | | 1.36 (1.24,1.49) | | | | | | |
| VA | | | | | | 0.86 (0.8,0.92) | | | | | | |
| WI | | | | | | 0.87 (0.81,0.94) | | | | | | 0.87 (0.81,0.94) |
| WV | | | | | | 1.19 (1.09,1.31) | | | | | | 1.2 (1.09,1.31) |
| | | | | | | | | | | | | |
| **Random effects** | | | | | | | | | | | | |
| Variance: Strata | 0.421 | 0.416 | 0.414 | 0.007 | 0.021 | 0.020 | 0.414 | 0.409 | 0.407 | 0.007 | 0.021 | 0.020 |
| Variance: Year: Post-2020 | | | 0.038 | | 0.041 | 0.038 | | | 0.038 | | 0.04 | 0.037 |
| Covariance | | | -0.007 | | -0.025 | -0.023 | | | -0.007 | | -0.024 | -0.022 |
| **Summary Statistics** | | | | | | | | | | | | |
| Between Stratum Variance | 0.421 | 0.416 | 0.414 | 0.007 | 0.021 | 0.020 | 0.414 | 0.409 | 0.407 | 0.007 | 0.021 | 0.020 |
| Between Stratum Variance, Post-2020 | | | 0.438 | | 0.012 | 0.012 | | | 0.431 | | 0.012 | 0.012 |
| VPC (%) | 11.339 | 11.219 | 11.166 | 0.201 | 0.63 | 0.600 | 11.178 | 11.061 | 11.020 | 0.209 | 0.622 | 0.594 |
| VPC (%) Post-2020 | | | 11.748 | | 0.369 | 0.364 | | | 11.595 | | 0.374 | 0.359 |
| PCV (%) | | M 1 - M2: 1.188 | | M 1 - M4: 98.337 | M3 - M5: 94.928 | | | M 1 - M2: 1.208 | | M 1 - M4: 98.309 | M3 - M5: 94.840 | |
| PCV (%) Post-2020 | | | | | 97.260 | | | | | | 97.216 | |
| **Hausman Test** | | chi2 (1) = 1272 p-value < 2.2e-161 | | $chi^2$ (9) = 13.60 p-value = 0.14 | | | | chi2 (1) = 1168.7 p-value < 2.2e-16 | | chi2 (9) = 15.25 p-value = 0.08 | | |

***Supplemental Figure 2.*** *Strata rank-ordered by pre-2020 predicted probabilities for suicidal ideation (square markers) with post-2020 suicidal ideation (circles) obtained from Model 5 after removing 11 states that did not have data for all three years. The point estimates include 95% confidence interval bars based on the standard error of the mean. Sexual orientation by Gender categories are color-coded, and the y-axis contains the full description of each stratum, including race category. A comparison between predicted probabilities from the primary and supplementary Model 5 can be found below this figure.*



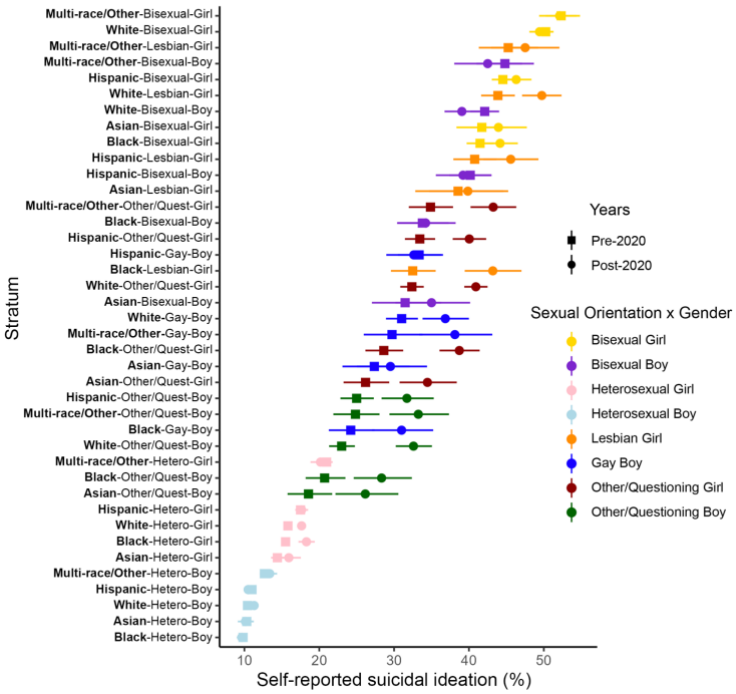

***Supplemental Table 4.*** *Predicted probabilities of suicidal ideation (Model 5) after removing 11 states that did not have data for all three years. A comparison between predicted probabilities from the primary and supplementary Model 5 can be found below this table.*

| Intersectional Strata | | | Pre-2020 | | Post-2020 | | Changes in Suicidal Ideation (SI) | | |
|---|---|---|---|---|---|---|---|---|---|
| Race | Sexual Orientation | Gender | Suicidal Ideation (%) (95% CI) | Rank | Suicidal Ideation (%) (95% CI) | Rank | SI Increase (post- minus pre-2020) | Rank of Increase | Rank Change (pre- minus post-2020) |
| Multi/Other | Bisexual | Girl | 51.9 (50,54) | 1 | 51.5 (49,54) | 1 | -0.5 | 36 | 0 |
| White | Bisexual | Girl | 50.3 (49,51) | 2 | 49 (48,50) | 2 | -1.3 | 38 | 0 |
| Multi/Other | Lesbian | Girl | 45 (41,49) | 3 | 46.6 (42,51) | 4 | 1.6 | 25 | -1 |
| White | Lesbian | Girl | 44.4 (42,47) | 4 | 49 (46,52) | 3 | 4.6 | 16 | 1 |
| Multi/Other | Bisexual | Boy | 44.4 (41,48) | 5 | 42.2 (38,47) | 11 | -2.2 | 40 | -6 |
| Hispanic | Bisexual | Girl | 44.2 (43,46) | 6 | 46.3 (44,48) | 5 | 2.1 | 20 | 1 |
| White | Bisexual | Boy | 41.7 (40,44) | 7 | 39.6 (37,42) | 15 | -2.2 | 39 | -8 |
| Black | Bisexual | Girl | 41.5 (40,43) | 8 | 44.1 (42,47) | 7 | 2.5 | 19 | 1 |
| Asian | Bisexual | Girl | 41.4 (38,45) | 9 | 43.3 (39,47) | 8 | 1.9 | 21 | 1 |
| Hispanic | Lesbian | Girl | 40.4 (38,43) | 10 | 45.1 (41,49) | 6 | 4.7 | 15 | 4 |
| Hispanic | Bisexual | Boy | 39.7 (37,43) | 11 | 40.1 (36,44) | 14 | 0.5 | 28 | -3 |
| Asian | Lesbian | Girl | 37.5 (32,43) | 12 | 39.4 (34,45) | 16 | 1.9 | 22 | -4 |
| Multi/Other | Other/Quest | Girl | 34.5 (32,38) | 13 | 43 (40,46) | 10 | 8.5 | 5 | 3 |
| Black | Bisexual | Boy | 33.7 (30,37) | 14 | 33.8 (30,38) | 22 | 0.1 | 31 | -8 |
| Hispanic | Other/Quest | Girl | 33.6 (32,36) | 15 | 40.4 (38,43) | 13 | 6.8 | 11 | 2 |
| Hispanic | Gay | Boy | 33.2 (30,36) | 16 | 32.9 (29,37) | 23 | -0.4 | 34 | -7 |
| White | Other/Quest | Girl | 32.4 (31,34) | 17 | 40.5 (39,42) | 12 | 8.1 | 7 | 5 |
| Black | Lesbian | Girl | 31.8 (29,35) | 18 | 43.3 (39,47) | 9 | 11.4 | 1 | 9 |
| White | Gay | Boy | 31.4 (29,34) | 19 | 36.3 (33,40) | 19 | 4.9 | 14 | 0 |
| Asian | Bisexual | Boy | 30.8 (26,36) | 20 | 34.9 (30,40) | 20 | 4 | 17 | 0 |
| Multi/Other | Gay | Boy | 29.8 (26,34) | 21 | 37 (32,42) | 18 | 7.2 | 8 | 3 |
| Black | Other/Quest | Girl | 28.5 (26,31) | 22 | 37.9 (35,41) | 17 | 9.4 | 3 | 5 |
| Asian | Gay | Boy | 27 (23,32) | 23 | 28.8 (24,34) | 28 | 1.8 | 24 | -5 |
| Asian | Other/Quest | Girl | 25.3 (22,29) | 24 | 34.4 (31,38) | 21 | 9.1 | 4 | 3 |
| Hispanic | Other/Quest | Boy | 25 (23,27) | 25 | 31.8 (28,36) | 26 | 6.8 | 12 | -1 |
| Black | Gay | Boy | 24.9 (22,28) | 26 | 31.1 (27,35) | 27 | 6.1 | 13 | -1 |
| Multi/Other | Other/Quest | Boy | 24.8 (22,28) | 27 | 32.8 (29,37) | 24 | 8.1 | 6 | 3 |
| White | Other/Quest | Boy | 22.6 (21,24) | 28 | 32.4 (30,35) | 25 | 9.8 | 2 | 3 |

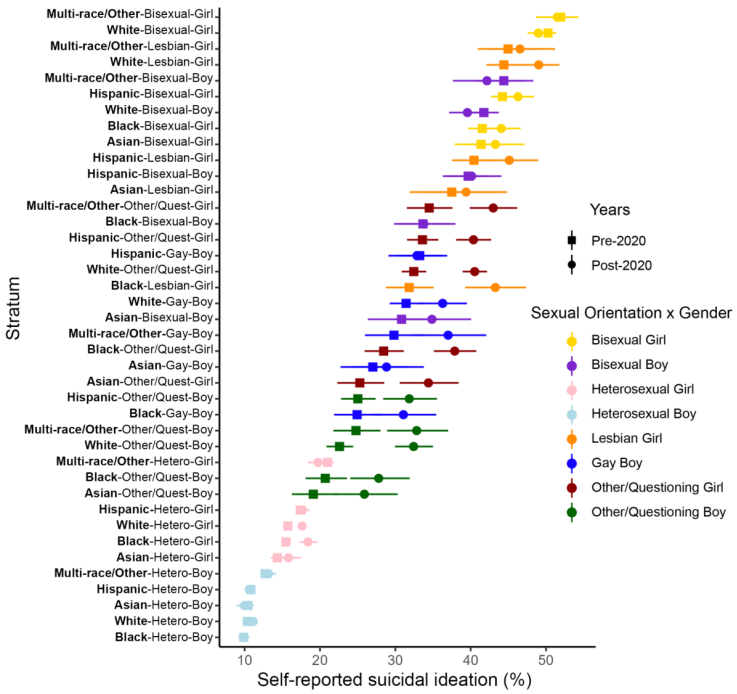
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Multi/Other | Hetero | Girl | 21 (20,22) | 29 | 19.7 (18,21) | 31 | -1.3 | 37 | -2 |
| Black | Other/Quest | Boy | 20.7 (18,24) | 30 | 27.8 (24,32) | 29 | 7.1 | 9 | 1 |
| Asian | Other/Quest | Boy | 19.1 (16,22) | 31 | 25.9 (22,30) | 30 | 6.8 | 10 | 1 |
| Hispanic | Hetero | Girl | 17.4 (17,18) | 32 | 17.7 (17,19) | 33 | 0.3 | 30 | -1 |
| White | Hetero | Girl | 15.7 (15,16) | 33 | 17.6 (17,18) | 34 | 1.9 | 23 | -1 |
| Black | Hetero | Girl | 15.5 (15,16) | 34 | 18.4 (17,20) | 32 | 2.9 | 18 | 2 |
| Asian | Hetero | Girl | 14.3 (13,15) | 35 | 15.8 (14,17) | 35 | 1.5 | 26 | 0 |
| Multi/Other | Hetero | Boy | 12.7 (12,13) | 36 | 13.2 (12,14) | 36 | 0.5 | 29 | 0 |
| Hispanic | Hetero | Boy | 10.8 (10,11) | 37 | 10.6 (10,11) | 38 | -0.2 | 33 | -1 |
| Asian | Hetero | Boy | 10.4 (10,11) | 38 | 10 (9,11) | 39 | -0.5 | 35 | -1 |
| White | Hetero | Boy | 10.4 (10,11) | 39 | 11.1 (11,12) | 37 | 0.8 | 27 | 2 |
| Black | Hetero | Boy | 9.9 (9,10) | 40 | 9.9 (9,11) | 40 | 0 | 32 | 0 |

***Supplemental Figure 2.*** *A comparison of figures visualizing predicted probabilities from the primary and supplementary Model 5.*

A) PREDICTIONS FROM PRIMARY MODELS WITH 36 STATES




B) PREDICTIONS FROM SUPPLEMENTAL MODELS WITH 25 STATES



***Supplemental Table 5.*** *A comparison between predicted probabilities from the primary and supplementary Model 5.*

| | | | PREDICTIONS FROM PRIMARY MODELS WITH 36 STATES | | | | | | | PREDICTIONS FROM SUPPLEMENTAL MODELS WITH 25 STATES | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Intersectional Strata** | | | **Pre-2020** | | **Post-2020** | | **Changes in Suicidal Ideation (SI)** | | | **Pre-2020** | | **Post-2020** | | **Changes in Suicidal Ideation (SI)** | | |
| ***Race*** | ***Sexual Orientation*** | ***Gender*** | Suicidal Ideation (%) (95% CI) | Rank | Suicidal Ideation (%) (95% CI) | Rank | SI Increase post- minus pre-2020 | Rank of Increase | Rank Change (pre- minus post-2020) | Suicidal Ideation (%) (95% CI) | Rank | Suicidal Ideation (%) (95% CI) | Rank | SI Increase post- minus pre-2020 | Rank of Increase | Rank Change (pre- minus post-2020) |
| Multi/Other | Bisexual | Girl | 52.3 (50, 54) | 1 | 52.1 (49, 55) | 1 | -0.2 | 33 | 0 | 51.9 (50,54) | 1 | 51.5 (49,54) | 1 | -0.5 | 36 | 0 |
| White | Bisexual | Girl | 50.3 (49, 51) | 2 | 49.4 (48, 51) | 3 | -0.8 | 37 | -1 | 50.3 (49,51) | 2 | 49 (48,50) | 2 | -1.3 | 38 | 0 |
| Multi/Other | Lesbian | Girl | 45.2 (41, 49) | 3 | 47.5 (43, 52) | 4 | 2.3 | 20 | -1 | 45 (41,49) | 3 | 46.6 (42,51) | 4 | 1.6 | 25 | -1 |
| White | Lesbian | Girl | 43.9 (42, 46) | 6 | 49.7 (47, 52) | 2 | 5.9 | 14 | 4 | 44.4 (42,47) | 4 | 49 (46,52) | 3 | 4.6 | 16 | 1 |
| Multi/Other | Bisexual | Boy | 44.8 (41, 49) | 4 | 42.5 (38, 47) | 11 | -2.3 | 39 | -7 | 44.4 (41,48) | 5 | 42.2 (38,47) | 11 | -2.2 | 40 | -6 |
| Hispanic | Bisexual | Girl | 44.5 (43, 46) | 5 | 46.3 (44, 48) | 5 | 1.8 | 24 | 0 | 44.2 (43,46) | 6 | 46.3 (44,48) | 5 | 2.1 | 20 | 1 |
| White | Bisexual | Boy | 42.1 (40, 44) | 7 | 39.1 (37, 41) | 16 | -3.1 | 40 | -9 | 41.7 (40,44) | 7 | 39.6 (37,42) | 15 | -2.2 | 39 | -8 |
| Black | Bisexual | Girl | 41.5 (40, 43) | 9 | 44.2 (42, 47) | 7 | 2.7 | 19 | 2 | 41.5 (40,43) | 8 | 44.1 (42,47) | 7 | 2.5 | 19 | 1 |
| Asian | Bisexual | Girl | 41.7 (38, 45) | 8 | 43.9 (40, 48) | 8 | 2.2 | 21 | 0 | 41.4 (38,45) | 9 | 43.3 (39,47) | 8 | 1.9 | 21 | 1 |
| Hispanic | Lesbian | Girl | 40.8 (38, 44) | 10 | 45.6 (42, 49) | 6 | 4.8 | 16 | 4 | 40.4 (38,43) | 10 | 45.1 (41,49) | 6 | 4.7 | 15 | 4 |
| Hispanic | Bisexual | Boy | 40.2 (37, 43) | 11 | 39.2 (36, 43) | 15 | -1 | 38 | -4 | 39.7 (37,43) | 11 | 40.1 (36,44) | 14 | 0.5 | 28 | -3 |
| Asian | Lesbian | Girl | 38.5 (33, 45) | 12 | 39.9 (35, 45) | 14 | 1.3 | 26 | -2 | 37.5 (32,43) | 12 | 39.4 (34,45) | 16 | 1.9 | 22 | -4 |
| Multi/Other | Other/Quest | Girl | 34.9 (32, 38) | 13 | 43.2 (40, 46) | 9 | 8.4 | 7 | 4 | 34.5 (32,38) | 13 | 43 (40,46) | 10 | 8.5 | 5 | 3 |
| Black | Bisexual | Boy | 33.8 (30, 37) | 14 | 34.2 (30, 38) | 22 | 0.4 | 29 | -8 | 33.7 (30,37) | 14 | 33.8 (30,38) | 22 | 0.1 | 31 | -8 |
| Hispanic | Other/Quest | Girl | 33.4 (31, 35) | 15 | 40.0 (38, 42) | 13 | 6.6 | 13 | 2 | 33.6 (32,36) | 15 | 40.4 (38,43) | 13 | 6.8 | 11 | 2 |
| Hispanic | Gay | Boy | 33.3 (31, 36) | 16 | 32.6 (29, 37) | 24 | -0.7 | 35 | -8 | 33.2 (30,36) | 16 | 32.9 (29,37) | 23 | -0.4 | 34 | -7 |
| White | Other/Quest | Girl | 32.4 (31, 34) | 18 | 40.9 (39, 42) | 12 | 8.5 | 4 | 6 | 32.4 (31,34) | 17 | 40.5 (39,42) | 12 | 8.1 | 7 | 5 |
| Black | Lesbian | Girl | 32.5 (30, 36) | 17 | 43.2 (39, 47) | 10 | 10.7 | 1 | 7 | 31.8 (29,35) | 18 | 43.3 (39,47) | 9 | 11.4 | 1 | 9 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| White | Gay | Boy | 31.0 (29, 33) | 20 | 36.8 (34, 40) | 19 | 5.8 | 15 | 1 | | 31.4 (29,34) | 19 | 36.3 (33,40) | 19 | 4.9 | 14 | 0 |
| Asian | Bisexual | Boy | 31.5 (27, 36) | 19 | 35.0 (30, 40) | 20 | 3.5 | 17 | -1 | | 30.8 (26,36) | 20 | 34.9 (30,40) | 20 | 4 | 17 | 0 |
| Multi/Other | Gay | Boy | 29.7 (26, 34) | 21 | 38.1 (33, 43) | 18 | 8.4 | 5 | 3 | | 29.8 (26,34) | 21 | 37 (32,42) | 18 | 7.2 | 8 | 3 |
| Black | Other/Quest | Girl | 28.6 (26, 31) | 22 | 38.7 (36, 41) | 17 | 10.1 | 2 | 5 | | 28.5 (26,31) | 22 | 37.9 (35,41) | 17 | 9.4 | 3 | 5 |
| Asian | Gay | Boy | 27.4 (23, 32) | 23 | 29.5 (25, 34) | 28 | 2.1 | 22 | -5 | | 27 (23,32) | 23 | 28.8 (24,34) | 28 | 1.8 | 24 | -5 |
| Asian | Other/Quest | Girl | 26.2 (23, 29) | 24 | 34.5 (31, 38) | 21 | 8.3 | 8 | 3 | | 25.3 (22,29) | 24 | 34.4 (31,38) | 21 | 9.1 | 4 | 3 |
| Hispanic | Other/Quest | Boy | 25.0 (23, 27) | 25 | 31.7 (28, 35) | 26 | 6.7 | 12 | -1 | | 25 (23,27) | 25 | 31.8 (28,36) | 26 | 6.8 | 12 | -1 |
| Black | Gay | Boy | 24.2 (21, 27) | 27 | 31.0 (27, 35) | 27 | 6.8 | 11 | 0 | | 24.9 (22,28) | 26 | 31.1 (27,35) | 27 | 6.1 | 13 | -1 |
| Multi/Other | Other/Quest | Boy | 24.8 (22, 28) | 26 | 33.2 (29, 37) | 23 | 8.4 | 6 | 3 | | 24.8 (22,28) | 27 | 32.8 (29,37) | 24 | 8.1 | 6 | 3 |
| White | Other/Quest | Boy | 23.0 (21, 25) | 28 | 32.6 (30, 35) | 25 | 9.6 | 3 | 3 | | 22.6 (21,24) | 28 | 32.4 (30,35) | 25 | 9.8 | 2 | 3 |
| Multi/Other | Hetero | Girl | 21.0 (20, 22) | 29 | 20.2 (19, 22) | 31 | -0.8 | 36 | -2 | | 21 (20,22) | 29 | 19.7 (18,21) | 31 | -1.3 | 37 | -2 |
| Black | Other/Quest | Boy | 20.7 (18, 24) | 30 | 28.3 (25, 32) | 29 | 7.6 | 9 | 1 | | 20.7 (18,24) | 30 | 27.8 (24,32) | 29 | 7.1 | 9 | 1 |
| Asian | Other/Quest | Boy | 18.6 (16, 22) | 31 | 26.2 (22, 31) | 30 | 7.6 | 10 | 1 | | 19.1 (16,22) | 31 | 25.9 (22,30) | 30 | 6.8 | 10 | 1 |
| Hispanic | Hetero | Girl | 17.5 (17, 18) | 32 | 17.6 (17, 19) | 34 | 0.1 | 30 | -2 | | 17.4 (17,18) | 32 | 17.7 (17,19) | 33 | 0.3 | 30 | -1 |
| White | Hetero | Girl | 15.8 (16, 16) | 33 | 17.6 (17, 18) | 33 | 1.8 | 23 | 0 | | 15.7 (15,16) | 33 | 17.6 (17,18) | 34 | 1.9 | 23 | -1 |
| Black | Hetero | Girl | 15.5 (15, 16) | 34 | 18.3 (17, 19) | 32 | 2.8 | 18 | 2 | | 15.5 (15,16) | 34 | 18.4 (17,20) | 32 | 2.9 | 18 | 2 |
| Asian | Hetero | Girl | 14.4 (14, 15) | 35 | 15.9 (14, 18) | 35 | 1.5 | 25 | 0 | | 14.3 (13,15) | 35 | 15.8 (14,17) | 35 | 1.5 | 26 | 0 |
| Multi/Other | Hetero | Boy | 12.7 (12, 13) | 36 | 13.4 (12, 14) | 36 | 0.7 | 28 | 0 | | 12.7 (12,13) | 36 | 13.2 (12,14) | 36 | 0.5 | 29 | 0 |
| Hispanic | Hetero | Boy | 11.0 (11, 11) | 37 | 10.5 (10, 11) | 38 | -0.5 | 34 | -1 | | 10.8 (10,11) | 37 | 10.6 (10,11) | 38 | -0.2 | 33 | -1 |
| Asian | Hetero | Boy | 10.3 (10, 11) | 39 | 10.1 (9, 11) | 39 | -0.2 | 31 | 0 | | 10.4 (10,11) | 38 | 10 (9,11) | 39 | -0.5 | 35 | -1 |
| White | Hetero | Boy | 10.4 (10, 11) | 38 | 11.3 (11, 12) | 37 | 0.9 | 27 | 1 | | 10.4 (10,11) | 39 | 11.1 (11,12) | 37 | 0.8 | 27 | 2 |
| Black | Hetero | Boy | 9.8 (9, 10) | 40 | 9.6 (9, 10) | 40 | -0.2 | 32 | 0 | | 9.9 (9,10) | 40 | 9.9 (9,11) | 40 | 0 | 32 | 0 |

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