The Association Between Same-Sex Marriage Legalization and Youth Deaths by Suicide: A Multimethod Counterfactual Analysis

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A B S T R A C T

Purpose: To estimate the association between same-sex marriage legalization and deaths by suicide among youth.

Methods: The study used country-level suicide data sourced from the Global Burden of Disease Study for all 36 Organisation for Economic Co-operation and Development countries for the period 1991–2017. We analyzed the suicide rates of all youth, male youth, and female youth aged 10–24 years using multiple policy-evaluation methods—difference-in-differences, matrix completion, and generalized synthetic control via expectation-maximization—to estimate the impact of same-sex marriage legalization at the country level. Secondary analysis considered several covariate specifications, evaluated the immediacy and persistence of the estimated associations, and assessed whether any observed association was limited to early adopters of same-sex marriage.

Results: The state-of-the-art matrix completion analysis indicated that same-sex marriage legalization was associated with a decline in the youth suicide rate of 1.191 deaths per 100,000 individuals (95% CI = −1.66, −0.64; p < .001), corresponding to a reduction of 17.90% compared to the youth suicide rate at the time of legalization. This decline was most pronounced in males for whom the suicide rate fell by 1.993 (CI = −2.76, −1.12; p < .001) compared to a decrease of 0.348 for female youth (CI = −0.60, −0.06; p = .02), corresponding to decreases of 19.98% and 10.90%, respectively. These associations persisted after legalization, but to differing degrees depending on model specification.

Conclusions: Developed countries that are yet to legalize same-sex marriage have an opportunity to put downward pressure on youth suicide.
stresses, over and above the stressors faced by heterosexual individuals. These include institutionalized discrimination and interactions with prejudice, expectations of future victimization or rejection, concealment of their sexual identity, and internalization of negative social attitudes. This excess stress derived from stigma, it is argued, contributes to the higher rates of suicide observed in LGB youth [10,11].

Among the causes of stigma, the denial of same-sex marriage is a structural stressor because it labels sexual minorities as inherently different, legitimizes discrimination and animosity, and disenfranchises same-sex couples of the legal, financial, health, and other benefits associated with marriage [12–14]. Hatzenbuehler et al. [15], for instance, found that the prevalence of alcohol abuse, mood disorders, and generalized anxiety disorder for sexual minorities increased after the banning of same-sex marriage through state-level constitutional amendment in the United States (US). In contrast, the legalization of same-sex marriage has been well documented as liberalizing the social environment toward sexual minorities [16,17]. Increased social acceptance toward sexual minorities, in turn, decreases the likelihood of bias-based bullying and family and friend rejection, both of which are positively associated with the suicidality of sexual minority youth [7,9,18–25].

In a seminal contribution, Raifman et al. [12] found that the legalization of same-sex marriage in the US was associated with a 7% reduction in youth suicide attempts. In particular, this decline was concentrated among self-identified LGB students for whom suicide attempts decreased by 14%. Outside of this, however, quantification of the association between legalization of same-sex marriage and suicide rates has been relatively unexplored and there has been no research analyzing the onset and persistence of any impact.

In this study, we estimated the association between same-sex marriage legalization and deaths by suicide for youth aged 10–24 years using data for all Organisation for Economic Co-operation and Development (OECD) countries from 1991 to 2017. This contributes to the growing literature on sexual orientation-related policies and mental health outcomes in several respects. First, we make a methodological contribution by applying state-of-the-art policy-evaluation methods to estimate the impact of same-sex marriage legalization, including analyzing the immediacy and persistence of any observed associations. Second, we used panel data for all OECD countries, rather than data solely from the US. Third, rather than using self-reported individual-level measures of suicidality (suicide attempts, plans, and/or ideation), our analysis examined country-level aggregate data on suicide deaths.

We hypothesized that the legalization of same-sex marriage would be associated with decreases in the youth suicide rate. Although we believe any association would likely be localized to sexual minorities, data limitations meant we were unable to test this hypothesis directly.

**Methods**

**Data and sample**

We used annual population-level data from all 36 OECD member countries over the period 1991–2017. During this timespan, 18 OECD countries (the treatment group) passed same-sex marriage legislation, leaving the remaining 18 countries to form the pool of pure control countries. Figure A1, in the online Supplement, summarizes the sample of countries and their treatment status. We included only OECD countries in the sample because they share fundamental democratic institutions and relatively similar socioeconomic outcomes, thereby avoiding major differences between treated and control countries. The study period utilized the latest suicide data and was the maximum time period for which there were no missing data for any of the variables for any country. This study was deemed exempt by the University of Otago’s Institutional Ethics Committee because it used publicly available data.

**Exposure and outcome**

All suicide rate data were obtained from the Global Burden of Disease Study [28–30], mapped to ICD10 codes X60–64.9, X66–X84.9, Y87.0. These data measure the number of deaths per 100,000 individuals aged 10–24 years that were attributed to self-harm. Figures B1–B3 in the online Supplement illustrate the differences in country trends in these rates. The treatment dummy variable for same-sex marriage legalization was constructed based on the year that legislation came into effect at the national level.

**Statistical analysis**

We applied two quasi-experimental estimation methods in our primary analysis of the association between same-sex marriage legalization and youth suicide. In different ways, both methods impute counterfactuals for the treatment group, estimating the suicide rate in the absence of same-sex marriage legalization for the years when same-sex marriage was legal. This panel data setting, further, differs from conventional analysis as the key variable on which we “match” treated and control units is the observed suicide rate in the time period prior to same-sex marriage legalization rather than qualitatively different characteristics such as income [26]. In this sense, the role of covariates is to facilitate the prediction of what the suicide rate would have been in the absence of same-sex marriage legalization.

As a natural starting point in policy evaluation, we applied the difference-in-differences estimator with time-varying parameters, denoted DID-TVP. The DID-TVP method identifies the impact of same-sex marriage legalization by comparing the differences in suicide rates between the treatment group and the control group over time [26,27]. Double differencing removes bias resulting from permanent differences between the treatment and control groups or from comparisons over time in the presence of common time trends unrelated to same-sex marriage legalization. A significant drawback of DID-TVP, however, is that it estimates counterfactuals by taking a simple average of the suicide rates of the control group, commonly referred to as imposing the parallel trends assumption whereby unobserved confounders that vary across countries must be time invariant and time-varying confounders must be invariant across countries [26,27]. To counteract these potential sources of bias, we also adopted the matrix completion estimator, denoted MC-NNM, as the preferred estimation method in this study. Recently proposed by Athey et al. [28,29], MC-NNM treats the counterfactual outcomes as missing observations in a matrix of data arranged by country (rows) and year (columns). MC-NNM then predicts the missing entries using a matrix version of regularized regression, which minimizes the squared difference between the counterfactual
and observed suicide rates for the periods prior to same-sex marriage legalization, subject to a penalty term. For a semitechnical explanation, see the Supplement. This machine learning approach has three main advantages. First, MC-NNM exploits more complex patterns in the data across both countries and time, allowing for richer patterns of unobserved heterogeneity than DID or factor models. Second, MC-NNM helps alleviate concerns that treatment status is nonrandom—a consideration often overlooked when applying DID—by being able to model the unobserved evolution of social attitudes over time. Third, MC-NNM nests all existing classes of panel treatment effect estimators, enabling data-driven and flexible estimation of counterfactuals by side-stepping the restrictions imposed by an ex ante choice of estimation method. Owing to this generalized structure, the matrix completion method is arguably the most reliable quasi-experimental method for estimating treatment effects presently available [28,29].

Model specification

For each of the specifications, we used the binary indicator for same-sex marriage legalization to estimate the time-varying impact of same-sex marriage legalization. Because different countries adopted same-sex marriage legislation in different years, we standardized time for this indicator around the year that legislation was adopted ("year 0"); the time index for the treatment indicator therefore took negative values for pretreatment years and positive values posttreatment.

For our main specification, we included the fertility rate, homicide rate, and cohort unemployment rate (youth, male, female; aged 15–24) as covariates. We also incorporated country fixed effects to account for differences in the suicide rate related to country-specific time-invariant characteristics such as culture. The fertility rate was included based on the notion that the presence of children fosters social integration and family cohesion, which are protective influences against suicidality [30]. The sex-based unemployment rate was included as a covariate to capture the effect of economic fluctuations on deaths by suicide [31]. The homicide rate was included to control for the influence of unobserved cultural and societal forces generating frustration, whether directed inwards (suicide) or outwards (homicide) [32]. The data for the covariates were taken from a variety of sources and are described in greater detail in the Supplement. We did not include variables that could mediate the relationship between same-sex marriage legalization and youth suicide—such as drug abuse or social attitudes—as this could bias our estimates.

We constructed p-values and confidence intervals for the estimated treatment effects using a nonparametric bootstrap with 10,000 repetitions to account for potential serial correlation. This initial analysis was performed on the suicide rate of total youth and then separately repeated for male youth and female youth. All analyses were conducted in R (version 3.5.1) using the gsynth package.

We performed four robustness checks and secondary analyses for each of the sex-based cohorts. First, we utilized a variant of the generalized synthetic control estimator, denoted GSCM-EM, as an alternative, albeit less efficient, estimator that uses a machine learning expectation-maximization algorithm to exploit richer patterns in the data compared to traditional estimators [33,34]. Second, we tested the sensitivity of our findings to the choice of covariates by using the female labor force participation rate, the adolescent fertility rate, the percentage of the population living in rural areas, and an education index as an alternative set of covariates. For justification of the alternative covariates and explanation of GSCM-EM, see the Supplement. Third, to check that our findings were not the result of patterns in the covariates, we estimated the association of same-sex marriage legalization without including covariates in the model. Finally, we re-ran all of our specifications using only treated countries with at least (1) 15 pretreatment years of data; and (2) 20 pretreatment years of data, which limits these samples to later adopters and reduces bias by having more pretreatment periods to match on.

Results

Figures 1–3 display the counterfactuals, estimated using each of the three methods, and the observed suicide rates for treated countries for total youth, male youth, and female youth, respectively, using our main covariate specification. After the legalization of same-sex marriage (represented by the vertical line at time 0), the difference between the observed suicide rate (averaged across all treated countries) and a given counterfactual represents the estimated change in the suicide rate in that year associated with same-sex marriage legalization. The average estimated treatment effect over all posttreatment years, the corresponding percentage change, and the individual years in which a statistically significant association was observed using MC-NNM for all specifications are reported in Table 1. Figures and the estimated treatment effects for each of the methods and specifications are available in the Supplement.

Based on visual inspection of Figures 1–3, the DID-TVP counterfactuals were poor matches to the observed pretreatment data, indicating that the DID-TVP estimates were almost certainly biased. In addition, given that DID-TVP yields statistically significant associations in the pretreatment period for years too distant from same-sex marriage legalization to be attributed to policy anticipation, it was also likely that the parallel trends assumption required for DID-TVP was violated. For these reasons, we disregarded the DID-TVP results in favor of the MC-NNM results.

The MC-NNM estimated that same-sex marriage legalization was associated with a statistically significant decrease in youth suicide of 1.919 deaths per 100,000 individuals (95% CI = 1.66, −64; p < .001). Compared to the youth suicide rate at the time of legalization, this decrease corresponds to a reduction of 17.90%. With respect to the immediacy and persistence of the estimated association, we found that same-sex marriage legalization exhibited a statistically significant association from the second year after legalization to the end of our posttreatment period of 17 years.

Decomposing by sex, we observed that same-sex marriage legalization was associated with a statistically significant decline in the suicide rate of male youth of 1.993 deaths per 100,000 youth (CI = −2.76, −1.12; p < .001). In comparison, the suicide rate of female youth was associated with a statistically significant decrease of .348 deaths per 100,000 youth (CI = −.60, −.06; p = .02). Based on these results, the legalization of same-sex marriage was estimated to have a greater proportionate impact on young males. The suicide rate for male youth was estimated to decrease by 19.98%, markedly higher than the reduction for female youth of 10.90%. Likewise, there was also a discernible disparity between the sexes in regard to the persistence of the estimated association. The MC-NNM results implied an almost immediate and persistent impact...
on the suicide rate of young males, being statistically significant from legalization onward. In contrast, the suicide rate of female youth experienced a statistically significant decrease only between the third and sixth years after legalization.

The results for all sensitivity analyses are reported in the Supplement. Using the GSCM-EM estimator, we corroborated our initial findings using the main covariate specification for total youth (coefficient = -1.161; CI = -1.69, -0.69; p < .001), male
of pretreatment data, we validated our initial findings of a negative and statistically significant association between same-sex marriage legalization and the suicide rate for each of the specifications. The exception was the results using the alternative covariate specification where we now observed a statistically significant negative association in the fourth year after legalization (−1.382; CI = −2.25, −0.01; p = .049). For female youth, we found no evidence of a statistically significant association at the 5% significance level.

Finally, limiting the number of treated countries to those with (1) at least 15 years of pretreatment data; and (2) at least 20 years of pretreatment data, we validated our initial findings of a negative and statistically significant association between same-sex marriage legalization and the suicide rate for each of the specifications. The exception was the results using the alternative covariate specification where we now observed a statistically significant negative association between same-sex marriage legalization and the suicide rates of total youth, male youth, and particularly female youth for which we previously found no statistically significant association. This slight difference across the alternative covariate specification when we limit treated countries is likely due to reduced bias from having more pretreatment years to match on and fewer posttreatment years to average over, or some combination thereof.

Discussion

This study found that same-sex marriage legalization in OECD countries was associated with a subsequent statistically significant decrease in the rate of deaths by suicide for youth. Following the legalization of same-sex marriage, the youth suicide rate declined by 1.191 deaths per 100,000 youths, corresponding to a reduction of 17.90% compared to the youth suicide rate at the time of legalization. This decline in youth suicide, further, was not limited just to early adopters of same-sex marriage, but was also observed when we limited our sample of treated countries to later adopters. Decomposing by sex, we observed that same-sex marriage legalization was associated with a statistically significant decline in the suicide rate of male youth of 1.993 deaths per 100,000. In comparison, the suicide rate of female youth was associated with a statistically significant decrease of .348 deaths per 100,000. Based on these point estimates, the legalization of same-sex marriage was estimated to have a greater proportionate impact on young males. The suicide rate for male youth was estimated to decrease by 19.98%, markedly higher than the reduction for female youth of 10.90%.

In terms of the persistence of the observed association, we found mixed results. Both the main covariate specification and no covariate specification indicated that same-sex marriage legalization had a statistically significant association with the suicide rates of total youth and male youth from just after legalization onward, and that the decline in suicide deaths for female youth was a more delayed and temporary association. Our
alternative specification of covariates, however, suggested a more temporary association between same-sex marriage legalization and the suicide rates of total youth and male youth. Given this slight difference in the results, we believe that additional research using a different research design is warranted to clarify whether same-sex marriage legalization shaped the underlying social environment in a way that persistently dampened youth suicide or whether it was just a temporary shock to youth suicide.

Albeit outside the empirical scope of this study, previous research suggests that the mechanism underlying the negative association is that same-sex marriage legalization alleviates some of the structural stigma exerted on sexual minorities by delegitimizing discrimination and animosity towards sexual minorities, validating sexual minority status, and enfranchising sexual minorities with the same legal, financial, health, and other benefits associated with marriage as heterosexual couples [7–25]. To this extent, our results are consistent with the conclusion of Raifman et al. [12] that same-sex marriage legalization has a negative and statistically significant association with youth suicide attempts, although our point estimates for suicide deaths were notably larger than their finding of a 7% decrease in attempted suicide. This difference may be due to the DID approach utilized by Raifman et al., statistical uncertainty, or because death by suicide is further along the suicidal process than attempted suicide. Further, our finding that male youth were more responsive to same-sex marriage legalization supports other empirical literature documenting that male youth are generally more impacted by homophobic stigma than female youth [35,36]. One potential explanation for this is that male youth are not subject to the additional forces of misogyny and gender-based violence faced by female youth; hence, the alleviation of sexuality-based stressors has a greater observed proportional impact on the suicidality of young males.

A key strength of this study was the use of international panel data and the MC-NNM estimation method. This approach not only addressed recent calls for unconventional and innovative research methods to overcome the ethical constraints hindering suicide research, but it allowed us to extend the literature outside the usual setting of the US, making our findings more immediately relevant to policymakers in other developed countries [37,38]. Further, by abstracting away from self-reported measures, this study broadens analysis of the relationship between discriminatory policy settings and mental health outcomes among LGB youth to the context of death by suicide, an area that to date has been relatively unexplored by the literature.

Our findings, however, should be considered alongside the study’s limitations. First, our results are reliant on the validity of suicide data which historically are prone to underestimation due to misclassification and underreporting. The suicide data from the Global Burden of Disease, however, provide the latest and most accurate country-level information currently available, with any inaccuracy in these data likely causing the association involving deaths per 100,000 individuals to be underestimated.
Second, our empirical analysis does not identify the mechanisms through which the decline in deaths by suicide manifested. Finally, the country-level data used in our analysis are not decomposable by sexual orientation meaning that we were neither able to isolate individual-level factors influencing youth suicidality nor ascertain whether the decline in youth suicide associated with same-sex marriage legalization was specific to sexual minorities. If more detailed data were available, future research could address the latter two limitations in order to better understand the relationship between stigma, minority health, and government policy.

Our findings also have important policy implications. In a global climate where same-sex marriage is contentious and discriminatory policies are resurgent, we demonstrate that same-sex marriage legalization is associated with population health improvements for youth. To this extent, same-sex marriage legalization can be considered a policy tool to reduce youth suicide in countries where same-sex marriage is currently prohibited. Within these policy debates, physicians have an evidence-based duty of care to advocate for these changes as health measures, as well as support other policies targeted toward reducing stigma related to sexual identity. Further, we conjecture that this advocacy is generalizable to other communities, such as transgender communities, that exhibit disproportionate rates of suicidality and that are also stigmatized by structural institutions [6,9]. Although structural changes to government policy often take time, one place to start would be to progress clinical practice to be more inclusive of LGBTQ+ communities and challenge clinic cultures that condone discrimination, especially given the existing stigma surrounding seeking support for mental health [39,40].

Supplementary Data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jadohealth.2021.101.033.

References