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Effects of Mass Shootings on Mental Illness Stigma in the United States

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Abstract

Although the vast majority of people with mental illness (PWMI) are not violent, Americans tend to think they are more dangerous than the general population. Because negative media portrayals may contribute to stigma, we used time-series analyses to examine changes in the public's perceived dangerousness of PWMI around six mass shootings whose perpetrators were reported to have a mental illness. From 2011 to 2019, 38,094 U.S. participants completed an online study assessing implicit and explicit perceived dangerousness of PWMI. There were large, upward spikes in perceived dangerousness the week of the Sandy Hook mass shooting that were relatively short-lived. However, there was not a consistent pattern of effects for other events analyzed, and any other spikes observed were smaller. Effects tended to be larger for explicit versus implicit perceived dangerousness. Sandy Hook seemed to temporarily worsen perceived dangerousness of PWMI, but this pattern was not observed for other mass shootings.

Keywords
perceived dangerousness, stigma, violence, implicit cognition

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Despite the prevalence of mental illness (affecting one in four Americans each year, and nearly half in their lifetime; Kessler, Berglund, et al., 2005; Kessler, Chiu, et al., 2005), it remains stigmatized, including high levels of desired social distance, internalized stereotypes and hopelessness, and structural barriers to success (Angermeyer & Matschinger, 1996; Hatzenbuehler et al., 2013; Hipes et al., 2016; Livingston & Boyd, 2010). Here, we focus on one aspect of stigma: perceived dangerousness, or the widespread belief that persons with mental illness (PWMI) are more dangerous than people with physical illness or healthy people (Jorm et al., 2012; Link et al., 1999). A national public opinion survey found that 46% of Americans believed that people with serious mental illness were "far more dangerous than the general population" (Barry et al., 2013). To better understand what drives this form of stigma, the present study assesses the degree to which public beliefs about the dangerousness of PWMI change in the wake of highly publicized mass shootings connected to mental illness.

Violence Risk Associated With Mental Illness

Although results of epidemiological studies are somewhat mixed due to varied samples, assessments of mental illness, and analytic approaches (Elbogen & Johnson, 2009; Fazel et al., 2010; Steadman et al., 1998; Van Dorn et al., 2012), converging evidence suggests that there is a small, significant relation between mental illness and violence risk, and that substance abuse (which is more prevalent among PWMI) further increases violence risk. (Here, we refer to violence only toward another person, not oneself.) Despite having a slightly elevated risk of violence, though, the vast majority of PWMI are not violent (Swanson et al., 2015). In a large epidemiological study in the United States, the past-year violence rate of people with serious mental illness was 2.9% compared with 0.8% among the general population (Van Dorn et al., 2012). In fact, PWMI are a vulnerable population: adults with mental illnesses are more likely to be victims than perpetrators of violence (Desmarais et al., 2014), and people with serious mental illness are 11 times likelier to be victims of violent crime than the general population (Teplin et al., 2005). In addition, the vast majority of gun violence, like other forms of violence, is perpetrated by people without a diagnosed mental illness; fewer than 5% of the 120,000 gun-related killings (excluding suicides) between

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2001 and 2010 were committed by people with a diagnosed mental illness (Metzl & MacLeish, 2015).

Mass Shootings

Despite accounting for a small proportion of gun violence, mass shootings garner significant media attention, and public and political discourse following mass shootings differs from the response to other types of gun violence. For example, mass shootings accounted for only about 0.13% of all gun deaths and 0.34% of gun murders between 1989 and 2014, but the per-death impact on firearm bills introduced in state legislatures is about 125 times greater for mass shootings compared with non-mass shooting gun homicides (Luca et al., 2020). Many people are quick to blame PWMI for mass shootings (Metzl & MacLeish, 2015). Following the infamous Sandy Hook elementary school shooting in Newtown, Connecticut, a 2013 national poll found that policies aimed at restricting gun possession among PWMI were among those with the most public support, and 60.6% of respondents favored increasing government spending on mental health screening and treatment in order to reduce gun violence (Barry et al., 2013).

However, similar to other forms of violence, the majority of mass shootings cannot be attributed to mental illness. Out of the 235 instances of mass murder committed between 1913 and 2015, only 22% of the mass murderers are believed to be mentally ill at the time of the event (Stone, 2015). Furthermore, only 14.8% of the 88 recorded mass shootings since 1966 in which four or more people were killed were committed by people diagnosed with a psychotic disorder (Fox & Fridel, 2016). Taken together, these findings show that the presence of mental illness does not indicate that someone is likely to be violent, nor is it a prerequisite for committing a mass shooting.

The Role of Media

Many factors contribute to the public overestimation of the dangerousness of PWMI, including skewed media portrayals, which often emphasize dangerousness, criminality, and unpredictability (Coverdale et al., 2002; Sieff, 2003; Stuart, 2006). Reading a brief narrative linking serious mental illness to violence increases perceived dangerousness beliefs (McGinty et al., 2018), and more time spent watching TV is associated with less knowledge about serious mental illnesses (Kimmerle & Cress, 2013). Media coverage of mass shootings committed by PWMI may be particularly stigmatizing: People who read a story about a mass shooting committed by a PWMI were less willing to work with or live near PWMI (vs. no mental illness), and they were more likely to believe that PWMI were "by far" more dangerous than the general population (McGinty et al., 2013). Even when these stories are true—when the mass shooter has a mental illness—the salience of these negative representations and dearth of positive ones may perpetuate stigma. Furthermore, media coverage of mass shootings by PWMI in the United States interest readers in other countries and may worsen perceptions of dangerousness worldwide (Jorm & Reavley, 2014).

Implicit and Explicit Stigma

Individuals can hold beliefs, including stigmatizing ones, on both implicit and explicit levels. People have conscious control and awareness of their explicit beliefs, whereas their implicit beliefs are relatively more involuntary and difficult to consciously control (Greenwald et al., 2003; Teachman et al., 2012). As such, explicit beliefs can be measured with self-report, whereas implicit beliefs are measured with tasks that rely instead on indirect metrics like response time to measure the speed of automatic associations (e.g., the Implicit Association Test). While implicit and explicit beliefs typically show a small to medium relation (Hofmann et al., 2005; Nosek, 2007), implicit and explicit beliefs about PWMI can diverge (Peris et al., 2008; Teachman et al., 2006), and salient events can affect implicit and explicit beliefs in different ways (Inbar et al., 2016).

Once formed, implicit beliefs tend to be less durably malleable than explicit beliefs (Gregg et al., 2006). Although interventions aimed at reducing biases can produce change in implicit beliefs measured immediately post-intervention, this change tends not to persist a few hours or days later (Lai et al., 2016). Educational interventions aimed at reducing mental illness stigma tend to decrease explicit, but not implicit, stereotypes (Lincoln et al., 2008). Although more research is needed, individual-level implicit beliefs appear to be less susceptible to sustained change in the face of new information than explicit beliefs.

Macro-Level Approaches

Individual-level measures of implicit bias have been noted to have low stability over time (Gawronski et al., 2017), but aggregating measures of implicit bias within a region can provide more stable estimates of macro-level implicit biases, or what some researchers refer to as the "bias of crowds" (Payne et al., 2017). These macro-level implicit biases may reflect the automatic biases that exist within communities, and which may be slower to change given the history and policies within a community that affect the beliefs of its members (Payne et al., 2017). In fact, macro-level implicit biases have been found to correlate with structural biases (defined as "societal-level conditions, cultural norms, and institutional policies that constrain the opportunities, resources, and well-being of the stigmatized"; Hatzenbuehler, 2016): for example, one study found that implicit racial bias on college campuses related to an index of their structural inequality (Vuletich & Payne, 2019). In order to understand effects of mass shootings on mental illness stigma at the macro-level, the present study aggregates individually reported beliefs from respondents across the United States, which here is viewed as a large geographic region.

Prior research outside the mental illness stigma literature has found that highly publicized events can change population-level explicit attitudes toward homosexuality, war, HIV, and race (Carnagey & Anderson, 2007; Casey et al., 2003; Nier et al., 2000; Westgate et al., 2015). *Implicit* biases, however, may be more resistant to change after some events; for example, implicit racial biases barely changed over the course of Barack Obama's presidential campaign and early presidency (Schmidt & Nosek, 2010). However, recent studies have found evidence of implicit biases changing in response to major social movements (Darling-Hammond et al., 2020; Ofosu et al., 2019; Sawyer & Gampa, 2018). Perhaps most relevant to the current study because of its defined event-related design, Ravary and colleagues (2019) found that high-notoriety celebrity fat-shaming events were followed by spikes in implicit, but not explicit, body-weight bias, which then returned to baseline. These spikes in implicit bias may be explained by the bias of crowds model described above, which posits that implicit biases may reflect temporarily accessible associations in the environment (e.g., fat-shameful associations after a celebrity fat-shaming event), in contrast to explicit biases reflecting more stable, individual values.

Within the mental illness stigma literature, explicit stigma toward PWMI has been shown to increase immediately following violent attacks perpetrated by people with mental illness, and then decrease in the following months. Explicit perceived dangerousness of PWMI increased shortly after the Hungerford Massacre, a mass shooting in the United Kingdom committed by a man believed to have schizophrenia, and then decreased back to baseline 6 months later (Appleby & Wessely, 1988). Explicit perceived dangerousness also increased immediately after two assassination attempts in Germany by people with schizophrenia and did not return to baseline until about a year later (Angermeyer & Matschinger, 1996). A month after a German plane crash attributed to a co-pilot with severe depression, Munich residents reported higher perceived dangerousness of PWMI than the year before (Von Dem Knesebeck et al., 2015). All of these studies were conducted in Europe, and so may not apply to an American sample, and did not include implicit belief measures. Given the evidence reviewed in the preceding section that implicit measures tend to be less malleable in terms of showing durable change than explicit ones, including implicit stigma about mental illness (Gregg et al., 2006; Lincoln et al., 2008), implicit (vs. explicit) perceived dangerousness may change less after violent events (although the bias of crowds model might argue that implicit perceived dangerousness would change more than explicit, given implicit bias's relation to situationally accessible associations[1]). However, there is little empirical work to speak to this question.

Overview and Hypotheses

The present study uses data collected over 8 years across the United States to examine changes in explicit and implicit mental illness stigma following highly publicized mass shootings committed by people who reportedly had a mental illness. Data on implicit and explicit dangerousness beliefs were collected via the public website Project Implicit Health. Although some participants may not have been aware of some mass shooting events, data on implicit and explicit dangerousness beliefs were aggregated across the country and should be viewed as snapshots of macro-level beliefs across the United States. Related past studies have taken a similar macro-level approach to examine effects of violent events on stigma about PWMI across a geographic region, though only using explicit measures, and with at most six measurement occasions over 2 years (Angermeyer & Matschinger, 1996; Appleby & Wessely, 1988; Barry et al., 2013; Von Dem Knesebeck et al., 2015). The present study builds upon this prior work by including both implicit and explicit measures of stigma about PWMI and employing a time-series analytic approach to incorporate data collected daily over a period of 8 years.

Based on prior results from research on the lasting effects of highly publicized events on stigma, we hypothesize that the public's perceived dangerousness of PWMI will increase immediately following mass shootings perpetrated by people the media describes as having a history of mental illness. We hypothesize that this stigma will decrease in the months following its initial increase, but will not return to baseline, reflecting a durable change in perceived dangerousness. Finally, based on prior research that implicit attitudes are more resistant to change than explicit attitudes, we hypothesize that implicit stigma will not change as much as explicit stigma following these mass shootings.

Method

This study, including hypotheses and analytic plan, was preregistered, and de-identified data and analysis scripts are publicly available (https://osf.io/g62vy/).[2] After preregistration, we added media coverage of each mass shooting into our models and repeated our analyses with gender-career attitude data replacing perceived dangerousness of PWMI to understand the specificity of effects.

Participants

A total of 38,094 residents of the United States aged 18 and older completed an online study on Project Implicit Health (a public website where volunteers complete tasks assessing their implicit and explicit associations about a variety of mental health topics; https://implicit.harvard.edu/implicit/user/pih/pih/index.jsp) between September 4, 2011, and November 1, 2019 (see Table 1 for self-reported demographic characteristics

Table 1. Self-Reported Demographics of the Sample.

Variable	Value
N	38,094
Sex	
Females (%)	74%
Males (%)	26%
M_{age} in years (SD_{age})	28.23 (11.61)
Ethnicity	
Latinx/Hispanic (%)	11%
Not Latinx/Hispanic (%)	84%
Unknown (%)	5%
Race	
White (%)	73%
Asian (%)	4%
African American/Black (%)	9%
Native Hawaiian/Pacific Islander (%)	1%
Multiracial (%)	6%
Other/Unknown (%)	7%
Highest level of educational attainment	
Did not graduate high school	4%
High school graduate	9%
Some college	34%
Associate's degree	10%
Bachelor's degree	17%
At least some graduate school	26%

Note. No data are available about non-binary gender identities.

and supplemental materials for a secondary analysis covarying for changing demographics each week). Although the sample of participants is not nationally representative or randomly assigned (participants visited the PIH website voluntarily and elected which implicit bias tasks they completed), the large size and diversity of the sample, and the measurement over several years, provide a unique opportunity to examine macro-level changes in implicit and explicit perceived dangerousness of PWMI for a longer period of time both before and after mass shootings.

Measures

Danger Implicit Association Test. The Implicit Association Test (IAT; Greenwald et al., 1998) is a computerized task in which participants categorize words into four possible categories that are grouped into two pairs. For half of the critical blocks, participants press one button if the target word relates to either mentally ill people (the target words to be classified are included in each category's parentheses: schizophrenia, bipolar disorder, depression, obsessive–compulsive disorder) or dangerous (violent, aggressive, dangerous, and unsafe). They press another button if the word relates to either physically ill people (diabetes, appendicitis, cerebral palsy, and multiple sclerosis) or harmless (peaceful, gentle, harmless, and safe). In the other critical blocks, the pairings are reversed: mentally ill people or harmless, and physically ill people or dangerous. Reaction times are compared for each pair of categories, resulting in a *D* score (analogous to Cohen's *d* effect size) reflecting the relative strength of that participant's automatic associations between paired categories. More positive scores indicate stronger associations between mentally (vs. physically) ill people and dangerousness, and more negative scores indicate stronger associations between physically (vs. mentally) ill people and dangerousness. This particular IAT has been used in previous studies about mental illness stigma and has been found to relate to clinical care decisions (e.g., Peris et al., 2008; Stull et al., 2013), and similar IATs have been used to measure self-stigma in PWMI (Rüsch et al., 2010; Teachman et al., 2006). To ensure data quality, the scoring algorithm described in Greenwald et al. (2003) was used, resulting in the exclusion of data from 9.8% of participants. While there have been controversies surrounding what the IAT measures (e.g., individual differences vs. situational associations), there is considerable evidence for its good psychometric properties, particularly when aggregated across groups (for a fuller discussion of critiques of the IAT and the evidence for its use and interpretation, see Greenwald et al., in press).

Perceived Dangerousness Scale. Explicit stigma was measured with the Perceived Dangerousness Scale (PDS; Link et al., 1987), an eight-item self-report scale about perceived dangerousness of persons with mental illness (in general, not specifying what type of mental illness). Items (e.g., "If a group of former mental patients lived nearby, I would not allow my children to go to the movie theater alone.") are rated on a 6-point Likert-type scale (1 = *strongly agree* to 6 = *strongly disagree*), and item scores are averaged for a mean scale score. Scores were scaled to range from −2.5 to 2.5, with more positive scores reflecting the belief that individuals with mental illness are more dangerous.[3]

Gender-career bias. Data collected through Project Implicit measuring implicit and explicit gender-career bias were used for robustness checks (Xu et al., 2021). We used the IAT *D* score as a measure of implicit gender-career bias. The measure of explicit gender-career bias was the difference between responses on the question: "How strongly do you associate career and family with males and females?," with "Career" and "Family" each rated separately on a 7-point Likert-type scale (1 = *Strongly female* to 7 = *Strongly male*). This measure ranged from −6 (*reflecting strong female-career, male-family associations*) to 6 (*reflecting strong male-career, female-family associations*). To make this analysis as closely comparable with our PWMI-perceived dangerousness analysis as possible, we subsetted the data to responses from the same timeframe, from participants residing in the United States, and used as close to the same data reduction algorithm as possible. We were unable to exclude participants with fast responses on >25% of any critical block, as data are not available on fast responses for each block, but

Table 2. Mass Shooting Events and Associated Media Cloud Explorer Search Terms.

Date	Name	Fatalities	Search term
June 20, 2012	Aurora	12	Aurora
December 14, 2012	Sandy Hook	27	("Sandy Hook" OR Newtown)
September 16, 2013	Navy Yard	12	("D.C. Navy Yard" OR "DC Navy Yard" OR "Washington Navy Yard")
November 5, 2017	Sutherland Springs	27	"Sutherland Springs"
February 14, 2018	Parkland	17	(Parkland OR "Stoneman Douglas")
November 7, 2018	Thousand Oaks	12	"Thousand Oaks"

Note. All search queries also included: AND shooting AND (mental* or psych* or depress* or schizo* or bipolar or anxiety or ptsd or adhd or "attention-deficit/hyperactivity disorder" or "attention deficit disorder" or "post-traumatic stress disorder" or suicide or mania or autism or asperger or "obsessive–compulsive disorder" or OCD or delusion).

completed all other data preparation and cleaning steps to match the data about perceived dangerousness of PWMI. This resulted in a dataset of N = 878,293 implicit and N = 937,645 explicit responses.

Media coverage. We used Media Cloud Explorer, a website that tracks digital news media, to search for articles that included a search term related to each event, the word "shooting," and several terms related to mental illness (adapted from McGinty et al., 2016; see Table 2). We downloaded data on the number of articles per day in U.S. National media outlets matching these criteria for each event, as well as the total number of articles per day included in the database from these outlets. To create a time series of daily media coverage for each event, we computed the proportion of articles per day that matched our search criteria (see Supplementary Figure 2).

Procedure

Participants selected the mental illness study from a list of mental health domains available on the Project Implicit Mental Health website and then completed an informed consent form with information about the upcoming tasks. Participants were not compensated, given this was a volunteer online study. The IAT, PDS, and demographic questionnaires were then administered in random order. The application was pre-downloaded onto participants' computers before starting that IAT (i.e., it was not streaming) so connectivity issues did not interfere with measurement of reaction times. Afterward, participants were fully debriefed and given the option of viewing their IAT score and feedback. At both consent and debriefing, mental health resources (e.g., numbers for national hotlines and links for referrals) were provided.

Event selection. Six mass shootings (defined as those with three or more shooting victims, excluding the shooter, that are not identifiably related to gangs, drugs, or organized crime[4]) over the period of data collection were selected for analysis based on public discussion in the media about the mental health of the perpetrator as reported in the Mother Jones Mass Shootings Database (Follman et al., 2020; see Table 2). These events were selected because they were included in both the Mother Jones Mass Shootings Database (Follman et al., 2020) and the Stanford Mass Shootings in America database (Stanford Mass Shootings in America, courtesy of the Stanford Geospatial Center and Stanford Libraries, n.d.). Furthermore, these shooting events had the highest number of fatalities during the time of data collection of mass shootings perpetrated by a person indicated to have a history of mental illness. In addition, because the Stanford database stopped being managed after October 2017, two events that occurred after this time that were included in the Mother Jones database, which had high fatalities, and which were perpetrated by persons indicated to have a history of mental illness were also included. Based on these criteria, the events selected were those that occurred at a movie theater in Aurora, Colorado (July 20, 2012); Sandy Hook Elementary School in Newtown, Connecticut (December 14, 2012); the Navy Yard in Washington, D.C. (September 16, 2013); the First Baptist Church in Sutherland Springs, Texas (November 5, 2017); the Marjory Stoneman Douglas High School in Parkland, Florida (February 14, 2018); and a country-western bar in Thousand Oaks, California (November 7, 2018).[5]

Primary Analyses

Time-series intervention analysis. Time-series intervention analysis is a modeling technique used for studying how a singular event may influence the behavior of a system (Box & Tiao, 1975). Specifically, time-series intervention analysis simultaneously models both immediate increases/decreases in a system caused by an event or change, and the duration of deviation from baseline of that system after the event before it returns to equilibrium. Prior research has established time-series intervention analysis as a reputable model from which conclusions can be drawn about the duration and impact of specific events (Catalano et al., 2005; Fink et al., 2018). The benefits of time series based analysis over simpler pre-event to post-event comparisons (e.g., Angermeyer & Matschinger,

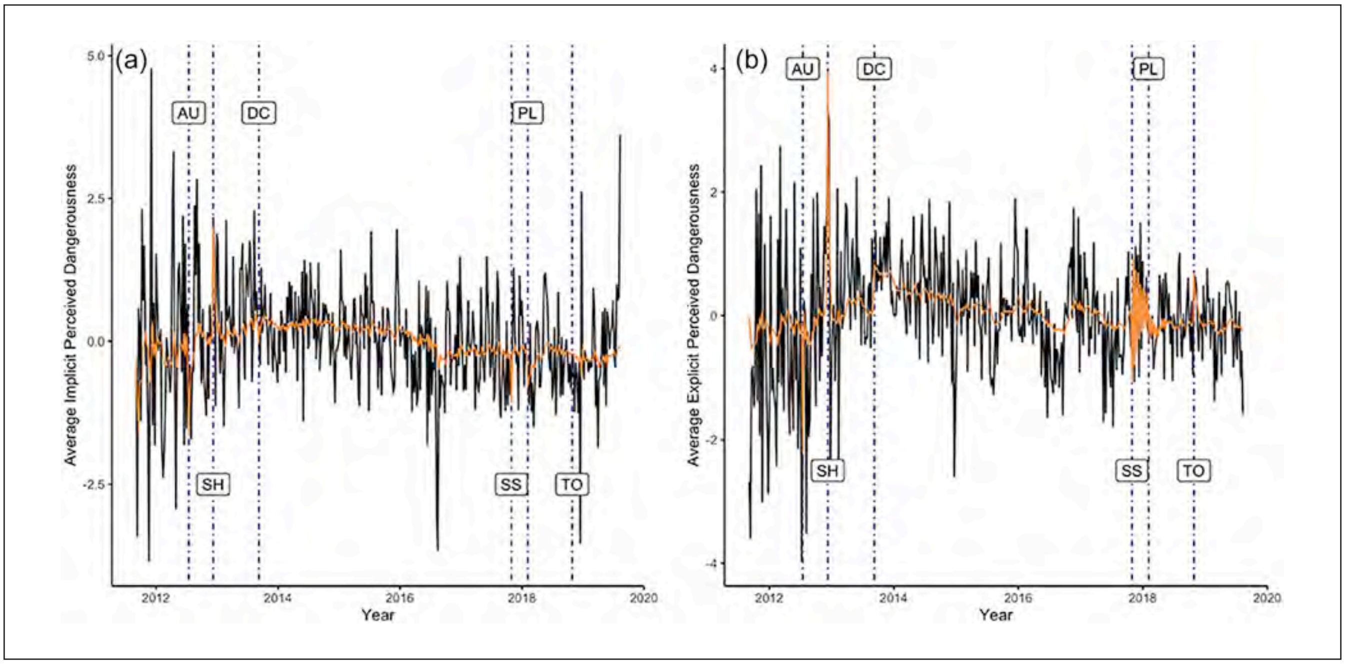

Figure 1. (A) Average weekly implicit perceived dangerousness values from September 2011 until November 2019 (with black line for time series, red line for model, and dashed vertical blue lines for each event); (B) Average weekly explicit perceived dangerousness values from September 2011 until October 2019 (with black line for time series, red line for model, and dashed vertical blue lines for each event).

Note. AU = Aurora, Colorado; SH = Sandy Hook Elementary; DC = D.C. Navy Yard; SS = Sutherland Springs; PL = Parkland; TO = Thousand Oaks.

1996; Barry et al., 2013; Von Dem Knesebeck et al., 2015) include the use of all relevant data points to make claims (not just pre/post averages), the ability to model more complex patterns of change than mean level shifts, and the ability to account for autocorrelation within the data. Notably, time-series analysis has recently been applied to implicit and explicit attitude data to understand change over time (Charlesworth & Banaji, 2019).

Prior to time-series analysis, participant responses were aggregated by week and standardized to *Z*-scores to create a time series of average implicit and a time series of average explicit beliefs about the dangerousness of PWMI (see Figures 1 and 2). Data were aggregated by week rather than day to obtain more reliable estimates of national implicit and explicit beliefs. The mean responses in a week were 89.83.

Time-series intervention models are an extension of autoregressive integrated moving average (ARIMA) models for modeling the effects of events (e.g., mass shootings) on a time series. ARIMA models are characterized by three components: an autoregressive component (AR) relating a time series at time t to the value of that series at time $t - 1$, an integration (or difference) component (I) used to make the time series behave more like a stationary process, and a moving average component (MA) which is the average of the last n time points. ARIMA models are typically described as ARIMA (X, Y, Z) where X is the number of time lags to include in the autoregressive component of the model, Y is the number of differences made on a time series to make the time series behave more like a stationary process, and Z is the number of previous time points to include when calculating the moving average.

Time-series intervention models take the form:

$$y_t = u + \frac{\theta_x^B}{1-\Phi_x^B} x_t + \frac{\theta_w^B}{1-\Phi_w^B} w_t,$$

where y_t is the value of a time series at time t, u is the grand mean of x_t, x_t is the value of a transfer function (valued as 1 if an event of interest occurred and 0 otherwise), θ^B are moving average (MA) parameters up to lag B, Φ^B are autoregressive (AR) parameters up to lag B, and w_t is noise or error at time t. In the current study, for each mass shooting event, y_t represents either implicit or explicit perceived dangerousness values aggregated across the United States by week, and x_t represents a transfer function, which takes the value of 1 during weeks with the identified mass shootings and 0 otherwise. All analyses were conducted with the TSA package in R version 3.5.1 (Cryer & Chan, 2008; R Core Team, 2017).

For short time series, statistical power may be a concern for detecting intervention effects. McLeod and Vingilis (2005) developed a power analysis method and sample size recommendations for intervention analyses. Statistical power for intervention analysis is a function of the length of a time

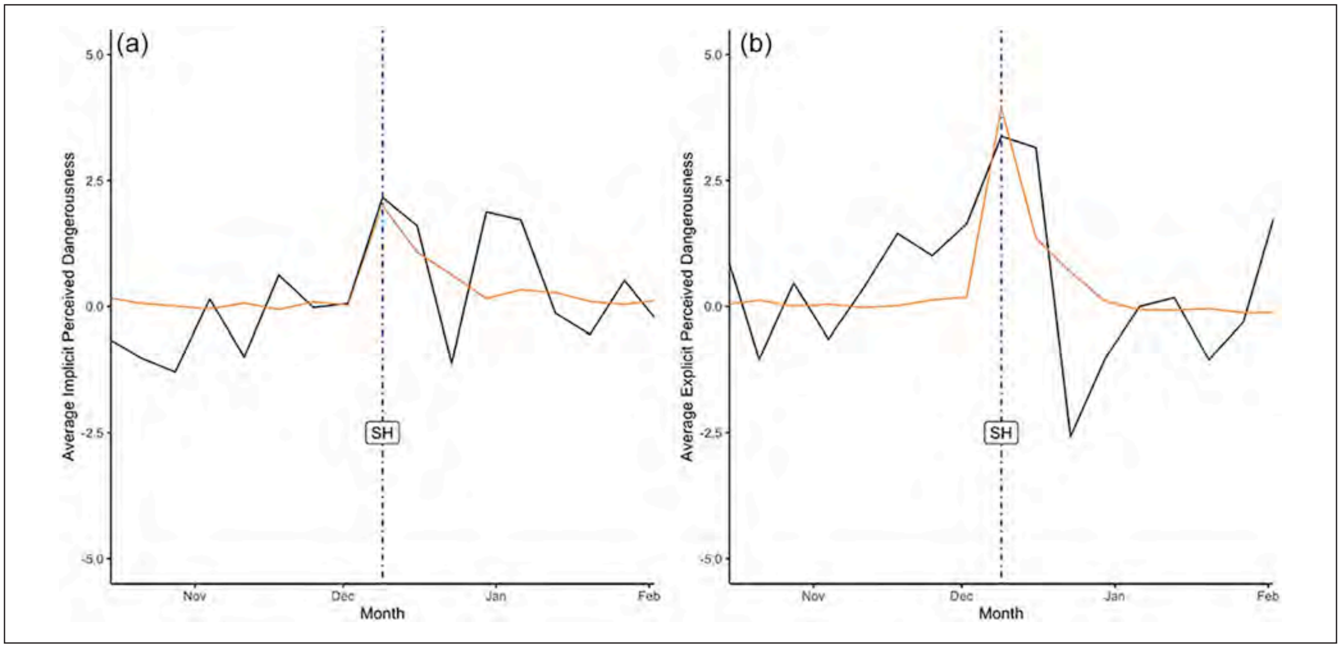

Figure 2. (A) Average weekly implicit perceived dangerousness values around Sandy Hook (with black line for time series, red line for model, and dashed vertical blue lines for each event); (B) Average weekly explicit perceived dangerousness values around Sandy Hook (with black line for time series, red line for model, and dashed vertical blue lines for each event).
Note. SH = Sandy Hook.

series and the number of time points available after an event occurs. McLeod and Vingilis (2005) found that adequate power (>80%) for small to moderate effect sizes was achieved with a time series of length 198 observations and 50 post-event samples. In the current study, time-series lengths are greater than 400 observations with an average of 309 post-event samples per mass shooting event (range = 41–369).

Comparison of changes to implicit and explicit perceived dangerousness. To test our hypothesis that mass shooting events will be associated with more extreme changes in explicit (vs. implicit) perceived dangerousness, we compared the z-scores of implicit and explicit perceived dangerousness during the week of each event as a measurement of the deviation from baseline. Because the difference of two z-scores is also a z-score, we can compare the difference between implicit and explicit stigma z-scores, with respect to the pooled standard error of each time series, at the time of a mass shooting event with a significance test yielding a p-value.

Secondary Analyses

Specificity of effects to implicit and explicit perceived dangerousness. To confirm that implicit and explicit perceived dangerousness were specifically related to the mass shooting events specified, rather than the events resulting in changes in implicit and explicit biases more generally or some other history or sampling effect, we performed the same time-series intervention analysis on a control dataset assessing gender-career bias (similar to Riddle & Sinclair, 2019).

Relations between perceived dangerousness and media coverage of events. To explore the relations between perceived dangerousness of PWMI (both implicit and explicit) and media coverage of the mass shooting events analyzed in this study, we modeled the cross-correlation relationships between perceived dangerousness and media coverage for each mass shooting event individually, with multiple time lags considered (see Table 5). Up to four lags were considered for each cross-correlation analysis, equivalent to 4 weeks (approximately 1 month) time, to consider that there might be delayed relations between media coverage and perceived dangerousness.

Results

Primary Analyses

A time-series intervention analysis was conducted to test the effects of six mass shooting events on implicit and explicit beliefs about the dangerousness of PWMI between September 2011 and November 2019. A separate ARIMA model was fit to each time series (implicit or explicit perceived dangerousness) to determine whether there were components of the time series that could be modeled and distinguished reliably from random noise. Through model selection based on comparison of AIC and BIC values using the “auto.arima()” function, we found that an ARIMA (0, 1, 2) model (where the

0, 1, and 2 represent the autoregressive component of the model, the number of differences used to achieve a stationary time series, and the moving average component of the model, respectively) was the best fit for the implicit time series and an ARIMA (1, 1, 1) model was the best fit for the explicit time series. Intervention effects were modeled as MA(0) parameters, indicating that a mass shooting event and changes in perceived dangerousness were modeled to occur simultaneously.[6]

Next, we added to each model a separate ARMA (1, 0) transfer function for each mass shooting event. The MA(0) component represents the increase/decrease in implicit/explicit perceived dangerousness during the week of a mass shooting event, in *SD* units. Significant MA(0) values indicate a change in perceived dangerousness greater than expected by chance. The AR(1) component represents the time it takes for implicit/explicit perceived dangerousness to return to equilibrium after a mass shooting event. It is a decay parameter bounded between −1 and 1, with higher absolute values indicating a slower return to baseline after an event. Significant positive AR(1) values indicate that after a mass shooting, perceived dangerousness returned to baseline asymptotically, whereas significant negative values indicate that perceived dangerousness oscillated below and above the baseline before reaching an equilibrium. Nonsignificant AR(1) values indicate that we cannot determine whether the shooting's effects lasted beyond the week of the event. Because significant AR(1) values in the presence of nonsignificant MA(0) components are difficult to interpret in a meaningful way (as they would suggest there is no immediate increase or decrease in perceived dangerousness greater than chance, but then perceived dangerousness deviates from its baseline for some time after a mass shooting), we interpret them as no change in perceived dangerousness here. Table 3 represents the immediate increases/decreases in the time series as intervention effects and durations of deviation from baseline as half-lives in weeks. To ensure that we were not missing delayed effects, all time-series models were visually inspected to confirm that increases/decreases in implicit/explicit perceived dangerousness aligned with each mass shooting event.

Mass shooting events

Results overview. Both implicit and explicit perceived dangerousness significantly increased the week of Sandy Hook and then quickly returned to baseline. Implicit perceived dangerousness did not deviate from its baseline the week of any other mass shooting events. Explicit perceived dangerousness decreased following two events (Aurora and Sutherland Springs), increased following one (D.C. Navy Yard), and did not deviate from baseline for two others (Parkland and Thousand Oaks). For three of the four events that were followed by a significant intervention effect, the intervention effect was larger for explicit than for implicit perceived dangerousness. In inspecting the autoregressive components of these intervention effects, significant intervention effects had half-lives of approximately 1 week, quickly returning to baseline values. Results for specific mass shooting events are presented below.

Aurora. We found no evidence for an immediate change in implicit perceived dangerousness beyond that expected by chance during the week of this mass shooting event, MA(0) $= -1.63$, $p = .065$. However, average values of implicit perceived dangerousness remained lower than expected by chance in the weeks after the event, AR(1) $= 0.54$, $p = .012$. Parameter estimates were in the same direction for explicit perceived dangerousness, but showed a different pattern of significance. There was a significant immediate decrease in explicit perceived dangerousness greater than expected by chance during the week of this mass shooting event, MA(0) $= -1.81$, $p = .049$. However, this decrease did not persist longer than expected by chance after the week of the event, AR(1) $= 0.22$, $p = .357$.

During the week of this mass shooting event, the Z-score of the explicit time series (–2.27) was significantly lower than the Z-score of the implicit time series (–1.38), $p < .001$. Consistent with hypotheses, this indicates that during the week of this mass shooting event, explicit perceived dangerousness deviated from its baseline more than implicit perceived dangerousness did (see Table 4).

Sandy Hook. We found a significant immediate increase in implicit perceived dangerousness greater than expected by chance during the week of this mass shooting event, MA(0) $= 1.96$, $p = .042$. However, this increase did not persist longer than expected by chance in the weeks after the event, AR(1) $= 0.52$, $p = .161$. Parameter estimates were in the same direction for explicit perceived dangerousness. We found a significant immediate increase in explicit perceived dangerousness greater than expected by chance during the week of this mass shooting event, MA(0) $= 3.67$, $p < .001$. This increase, though, did persist longer than expected by chance after the week of the event, AR(1) $= 0.32$, $p = .015$.

During the week of this mass shooting event, the Z-score of the explicit time series (3.38) was significantly higher than the Z-score of the implicit time series (2.16), $p < .001$, indicating that explicit perceived dangerousness deviated from its baseline more than implicit perceived dangerousness did, consistent with hypotheses (see Table 4).

DC Navy Yard. We found no evidence for an immediate change in implicit perceived dangerousness greater than expected by chance during the week of this mass shooting event, MA(0) $= -0.37$, $p = .743$, nor evidence that average values of implicit perceived dangerousness remained higher or lower than expected by chance in the weeks after the event, AR(1) $= 0.31$, $p = .743$. However, we did find a significant immediate increase in explicit perceived dangerousness greater than expected by chance during the week of

Table 3. Intervention Effects and Half-Lives of Mass Shootings on Perceived Dangerousness of People With Mental Illness.

Shooting	Perceived dangerousness type	Intervention effect (95% CI)	z	p	Half-life in weeks (95% CI)	z	p	Qualitative description
AU	Implicit	−1.64 [−3.38, 0.1]	−1.85	.065	0.90 [0.28, 55.41]	2.52	.012*	No change in implicit stigma
	Explicit	−1.81 [−3.6, −0.01]	−1.97	.049*	3.44 [0.20, 12.45]	−0.92	.357	Immediate decrease in explicit stigma that did not persist beyond the week of AU
SH	Implicit	1.96 [0.07, 3.85]	2.03	.042*	0.94 [0.24, 17.20]	1.40	.161	Immediate increase in implicit stigma that did not persist beyond the week of SH
	Explicit	3.67 [1.89, 5.45]	4.04	<.001*	1.79 [0.29, 20.92]	2.42	.015*	Immediate increase in explicit stigma, then quick decrease in baseline
DCNY	Implicit	−0.37 [−2.23, 1.5]	−0.38	.701	1.87 [0.25, 6.46]	0.33	.743	No change in implicit stigma
	Explicit	0.67 [0.05, 1.3]	2.11	.035*	0.18 [0.32, 49.66]	123.02	<.001*	Immediate increase in explicit stigma, then quick decrease in baseline
SS	Implicit	−0.77 [−2.64, 1.1]	−0.81	.419	8.00 [0.23, 86.30]	−0.15	.877	No change in implicit stigma
	Explicit	−1.04 [−2.03, −0.05]	−2.07	.039*	1.09 [0.27, 36.36]	−12.86	<.001*	Immediate decrease in explicit stigma, then systematic increases and decreases around baseline (oscillation) as explicit stigma returned to baseline
PL	Implicit	−0.63 [−1.96, 0.69]	−0.94	.349	0.41 [0.35, 20.07]	4.11	<.001*	No change in implicit stigma
	Explicit	−0.22 [−0.78, 0.35]	−0.75	.454	0.11 [0.43, 6.31]	31.58	<.001*	No change in explicit stigma
TO	Implicit	0.04 [−1.85, 1.92]	0.04	.971	49.17 [0.38, 16.33]	0.00	.997	No change in implicit stigma
	Explicit	0.9 [−0.91, 2.71]	0.97	0.33	0.54 [0.39, 8.62]	1.51	.131	No change in explicit stigma

Note. Intervention effects reflect the immediate increase or decrease in a perceived dangerousness time series (either implicit or explicit) during the week of a mass shooting event, and significant intervention effects reflect an immediate increase or decrease greater than expected by chance. Half-lives reflect the number of weeks it took for the magnitude of the immediate increase or decrease in the perceived dangerousness time series to reduce by half, and so represents the duration of the time-series deviation from its baseline, with longer half-lives suggesting a slower return to baseline after a mass shooting event. AU = Aurora, Colorado; SH = Sandy Hook Elementary; DCNY = D.C. Navy Yard; SS = Sutherland Springs; PL = Parkland; TO = Thousand Oaks.
*$p < .05$.

Table 4. *Z*-tests Comparing Explicit Versus Implicit Perceived Dangerousness *Z*-Scores.

	Z-score			
Event	Implicit	Explicit	Abs. Diff.	*p*
AU	−1.38	–2.27	0.93	<.001*
SH	2.16	3.38	1.21	<.001*
DCNY	–0.02	0.40	0.42	<.001*
SS	–0.97	–0.55	0.42	<.001
PL	–0.44	–0.36	0.08	.139
TO	–0.22	0.40	0.62	<.001*

Note. AU = Aurora, Colorado; SH = Sandy Hook Elementary; DCNY = D.C. Navy Yard; SS = Sutherland Springs; PL = Parkland; TO = Thousand Oaks.
*$p < .05$.

this mass shooting event, MA(0) = 0.67, p = .035, which persisted longer than expected by chance after the week of the event, AR(1) = 0.98, $p < .001$.

During the week of this mass shooting event, the *Z*-score of the explicit time series (0.40) was significantly higher than the *Z*-score of the implicit time series (–0.02), $p < .001$, exhibiting a greater deviation from its baseline (see Table 4). As with Sandy Hook and Aurora, this pattern was consistent with hypotheses.

Sutherland Springs. We found no evidence for an immediate change in implicit perceived dangerousness greater than expected by chance during the week of this mass shooting event, MA(0) = −0.77, p = .419, nor evidence that average values of implicit perceived dangerousness remained higher or lower than expected by chance in the weeks after the event, AR(1) = −0.09, p = .877. However, we did find a significant immediate decrease in explicit perceived dangerousness greater than expected by chance during the week of this mass shooting event, MA(0) = −1.04, p = .039. This was immediately followed by a fluctuating pattern of increasing and decreasing explicit perceived dangerousness in the weeks after the event, AR(1) = −0.89, $p < .001$.

During the week of this mass shooting event, the *Z*-score of the implicit time series (–0.97) was significantly lower than the *Z*-score of the explicit time series (–0.55), $p < .001$, contrary to hypotheses (see Table 4).

Parkland. We found no evidence for an immediate change in implicit perceived dangerousness greater than expected by chance during the week of this mass shooting event, MA(0) = −0.63, p = .349. However, average values of implicit perceived dangerousness remained lower than expected by chance in the weeks after the event, AR(1) = 0.82, $p < .001$. Similarly, we found no evidence for an immediate change in explicit perceived dangerousness greater than expected by chance during the week of the event, MA(0) = −0.22, p = .454, but average values of explicit perceived dangerousness remained lower than expected by chance in the weeks after, AR(1) = 0.99, $p < .001$.

In addition, we found no evidence that the *Z*-score of the explicit time series (–0.36) was different than the *Z*-score of the implicit time series (–0.44) during the week of this mass shooting event, p = .139 (see Table 4).

Thousand Oaks. We found no evidence for an immediate change in implicit perceived dangerousness greater than expected by chance during the week of this mass shooting event, MA(0) = 0.04, p = .971, nor evidence that average values of implicit perceived dangerousness remained higher or lower than expected by chance in the weeks after, AR(1) = −0.01, p = .997. Similarly, we found no evidence for an immediate change in explicit perceived dangerousness greater than expected by chance during the week of this mass shooting event, MA(0) = 0.90, p = .330, nor evidence that average values of explicit perceived dangerousness remained higher or lower than expected by chance in the weeks after, AR(1) = 0.72, p = .131.

In addition, during the week of this mass shooting event the *Z*-score of the explicit time series (0.40) was significantly higher than the *Z*-score of the implicit time series (−0.22), $p < .001$ (see Table 4). This result is consistent with three other events, and our hypothesis that explicit perceived dangerousness would change more than implicit perceived dangerousness in response to mass shooting events.

Secondary Analyses

Specificity of effects to perceived dangerousness. In all of our analyses of gender-career bias effects, there was only one immediate change greater than chance that occurred after a mass shooting event: Explicit gender-career bias increased after Aurora, and then fluctuated above and below its baseline in the weeks after the event. There were no other significant immediate effects on either implicit or explicit gender-career bias after any of the other mass shooting events. (For more detail, see Supplementary Materials.)

Relations between perceived dangerousness and media coverage of events

Sandy Hook. We found significant positive cross-correlation values of Sandy Hook media coverage predicting perceived dangerousness for both implicit (with lags of 1 and 2 weeks) and explicit perceived dangerousness (with lags of 1, 2, 3, and 4 weeks; see Table 5). This indicates that increases in media coverage of Sandy Hook predicted future increases in both implicit and explicit perceived dangerousness.

Other shooting events. We found no significant cross-correlation values for media coverage of any of the other mass shooting events predicting perceived dangerousness (see Supplementary Table 3). We also tested the relations in the reverse direction, considering whether increases in implicit

Table 5. Cross-Correlation Analysis of Media Coverage of Each Mass Shooting Event With Perceived Dangerousness Time Series.

Preceding time series	Following time series	Lag (weeks)	Cross-correlation (95% CI)	*p*
Media Coverage of Aurora	Implicit Perceived Dangerousness	0	–0.01 [–0.10, 0.09]	.875
		1	0.07 [–0.03, 0.17]	.150
		2	0.08 [–0.02, 0.17]	.113
		3	0.01 [–0.08, 0.11]	.806
		4	0.07 [–0.03, 0.16]	.188
	Explicit Perceived Dangerousness	0	–0.03 [–0.13, 0.06]	.517
		1	0.06 [–0.03, 0.16]	.195
		2	–0.06 [–0.15, 0.04]	.232
		3	–0.06 [–0.15, 0.04]	.253
		4	0.05 [–0.04, 0.15]	.272
Media Coverage of DCNY	Implicit Perceived Dangerousness	0	0.06 [–0.03, 0.16]	.194
		1	0.00 [–0.10, 0.10]	.980
		2	0.01 [–0.09, 0.11]	.831
		3	0.02 [–0.08, 0.12]	.687
		4	0.06 [–0.03, 0.16]	.202
	Explicit Perceived Dangerousness	0	0.04 [–0.05, 0.14]	.365
		1	0.09 [–0.01, 0.18]	.071
		2	0.05 [–0.04, 0.15]	.290
		3	0.06 [–0.03, 0.16]	.206
		4	0.08 [–0.01, 0.18]	.094
Media Coverage of Parkland	Implicit Perceived Dangerousness	0	–0.05 [–0.15, 0.05]	.304
		1	–0.08 [–0.17, 0.02]	.120
		2	–0.09 [–0.18, 0.01]	.068
		3	–0.07 [–0.17, 0.03]	.153
		4	–0.07 [–0.17, 0.03]	.155
	Explicit Perceived Dangerousness	0	–0.05 [–0.15, 0.04]	.280
		1	–0.04 [–0.14, 0.05]	.365
		2	–0.06 [–0.15, 0.04]	.244
		3	–0.05 [–0.14, 0.05]	.349
		4	–0.02 [–0.12, 0.08]	.692
Media Coverage of Sandy Hook	Implicit Perceived Dangerousness	0	0.02 [–0.07, 0.12]	.624
		1	0.11 [0.02, 0.21]	.020*
		2	0.12 [0.03, 0.22]	.013*
		3	0.06 [–0.04, 0.15]	.233
		4	0.06 [–0.03, 0.16]	.198
	Explicit Perceived Dangerousness	0	–0.03 [–0.13, 0.06]	.496
		1	0.18 [0.09, 0.27]	<.001*
		2	0.19 [0.10, 0.28]	<.001*
		3	0.13 [0.03, 0.22]	.009*
		4	0.15 [0.05, 0.24]	.003*
Media Coverage of Sutherland Springs	Implicit Perceived Dangerousness	0	0.08 [–0.02, 0.17]	.120
		1	0.01 [–0.09, 0.11]	.839
		2	–0.06 [–0.15, 0.04]	.241
		3	–0.06 [–0.16, 0.03]	.204
		4	–0.04 [–0.14, 0.06]	.404
	Explicit Perceived Dangerousness	0	–0.05 [–0.15, 0.04]	.286
		1	0.03 [–0.07, 0.12]	.577
		2	–0.04 [–0.13, 0.06]	.472
		3	–0.03 [–0.13, 0.06]	.511
		4	0.00 [–0.10, 0.10]	.984
Media Coverage of Thousand Oaks	Implicit Perceived Dangerousness	0	0.06 [–0.03, 0.16]	.194
		1	0.00 [–0.10, 0.10]	.980

(continued)

Table 5. (continued)

Preceding time series	Following time series	Lag (weeks)	Cross-correlation (95% CI)	*p*
		2	0.01 [–0.09, 0.11]	.831
		3	0.02 [–0.08, 0.12]	.687
		4	0.06 [–0.03, 0.16]	.202
	Explicit Perceived Dangerousness	0	0.04 [–0.05, 0.14]	.365
		1	0.09 [–0.01, 0.18]	.071
		2	0.05 [–0.04, 0.15]	.290
		3	0.06 [–0.03, 0.16]	.206
		4	0.08 [–0.01, 0.18]	.094

Note. This table shows the correlations of the time series of implicit and explicit perceived dangerousness with the time series of media coverage for each mass shooting event, at lags ranging from 0 to 4 weeks. Implicit perceived dangerousness was significantly positively correlated with media coverage of Sandy Hook with a 1- and 2-week delay, and explicit perceived dangerousness was significantly correlated with media coverage of Sandy Hook with 1-, 2-, 3-, and 4-week delays.
*$p < .05$.

or explicit perceived dangerousness may predict increases in media coverage of each event that references mental illness. Significant cross-correlation values were found only for Aurora. A significant positive cross-correlation value was found between implicit perceived dangerousness and media coverage at a lag of 3 weeks (ccf = .14 [0.04, 0.23], $p = .005$). A significant negative cross-correlation value was found between explicit stigma and media coverage at a lag of 1 week (ccf = –.14 [–0.23, 0.04], $p = .005$).

Discussion

The present study examined changes in macro-level implicit and explicit beliefs about the dangerousness of PWMI across the United States after six mass shootings perpetrated by PWMI. Results partially supported hypotheses: In line with hypotheses, both implicit and explicit perceived dangerousness increased in the week after the Sandy Hook shooting. The spikes in implicit and explicit dangerousness after Sandy Hook were much larger than any of the other effects observed. Furthermore, there appeared not to be one prototypical pattern of effects on macro-level perceived dangerousness, as various patterns of smaller effects were found after other mass shootings.

A similar pattern was found in secondary analyses of media coverage. We found no significant relations between overall media coverage of these six mass shootings and perceived dangerousness of PWMI. However, coverage of Sandy Hook specifically was followed by increases in implicit and explicit perceived dangerousness. Media coverage of other mass shootings tended not to significantly relate to perceived dangerousness.

In our control dataset assessing gender-career bias, we found only one statistically significant immediate effect on gender-career bias after mass shootings (out of 12 possible immediate effects), as compared with the five (out of 12) statistically significant immediate effects on perceived dangerousness of PWMI. This pattern suggests that these mass shooting events were more specifically connected to changes in the perceived dangerousness of PWMI than to changes in other implicit or explicit beliefs, like gender-career bias. We feel more confident interpreting the spikes in implicit and explicit perceived dangerousness after Sandy Hook than the effects of other events on perceived dangerousness or the one significant effect on gender-career bias because of the larger effect sizes for Sandy Hook and clear patterns of return to baseline (instead of oscillation after the spike, which is unclear how to interpret).

Notably, mass shooting events had larger effects on explicit versus implicit perceived dangerousness for most events analyzed, in line with hypotheses. Furthermore, effects of mass shooting events on implicit and explicit perceived dangerousness tended to be in the same direction (and were in the same direction for cases where both were significant). The present study is the first to our knowledge to assess implicit perceived dangerousness of PWMI after violent events, so this result broadens our understanding of effects of violent events: They may have larger effects on explicit stigma beliefs and smaller effects in the same direction on implicit stigma beliefs. Although this effect runs counter to what might be predicted by the bias of crowds model, which would predict that macro-level implicit beliefs would change more than explicit beliefs in response to high-notoriety events (e.g., Ravary et al., 2019), this result is consistent with prior research finding greater change in explicit than implicit beliefs after certain events (Carnagey & Anderson, 2007; Casey et al., 2003; Nier et al., 2000; Westgate et al., 2015), and with research finding greater change in explicit than implicit stereotypes about PWMI after an anti-stigma intervention (Lincoln et al., 2008).

Consistent with studies of change in explicit perceived dangerousness after violent attacks by PWMI in Europe, the present study found a spike in explicit perceived dangerousness after Sandy Hook, and a spike in implicit perceived dangerousness, which was not assessed in these prior studies (Angermeyer & Matschinger, 1996; Appleby & Wessely, 1988; Von Dem Knesebeck et al., 2015). The effects found in the present study, however, were shorter-lived, and similar patterns of changes in beliefs were not found for the other mass shootings analyzed. Media coverage of the events analyzed in this study may have differed in tone or content from each other and from the events in Europe analyzed in the aforementioned studies. More recent increases in the speed of the news cycle in the United States as well as cultural differences in beliefs about PWMI and about mass shootings may also account for differences in effects from the prior studies. Notably, the only event analyzed here for which increases in media coverage were followed by increases in stigma was Sandy Hook. These effects were in the same direction for both implicit and explicit perceived dangerousness, and the effects were for several consecutive weeks, showing a clear pattern. However, when testing for cross-correlations in the opposite direction (changes in stigma followed by changes in media coverage), only two significant effects were found. Both were related to coverage of Aurora, though they were at different lags and in opposite directions for implicit versus explicit stigma, and each only occurred at one lag. It is difficult to speculate as to what if anything these effects might mean.

Although we did not specify a hypothesized duration of effects after a mass shooting, the relatively short half-life of effects observed across events is notable. This indicates that, at least on the macro level, perceived dangerousness of PWMI returned to baseline levels a few days to weeks after a mass shooting by a PWMI. As such, the immediate aftermath of a mass shooting may be a critical moment for journalists and others shaping the public conversation about mental illness to educate the public about the true, low risk of violence by most PWMI. Our secondary finding that media coverage of Sandy Hook was directly correlated with perceived dangerousness of PWMI weeks after that media coverage underscores the importance of this media coverage, and suggests that even later media coverage of Sandy Hook continued to relate to stigma. It is worth noting, however, that the media coverage of other events tended not to relate to perceived dangerousness, suggesting that media coverage may have differed for those events versus Sandy Hook, or that media coverage of some events might be less influential than others.

Variability in Effects on Stigma

While all the events studied here were mass shootings by PWMI that had many fatalities and received wide media coverage, they clearly demonstrated variability in their effects on stigma about PWMI. It may be a mistake to view mass shootings by PWMI as monolithic; different circumstances and media coverage may relate to different effects on macro-level stigma. Sandy Hook, though, stood out from the other events in having the largest effects on stigma. This might relate to some unique aspects of Sandy Hook. Although Parkland was also a school shooting (occurring at Marjory Stoneman Douglas High School), the fact that the Sandy Hook Elementary School shooting victims were so young—elementary school—could have contributed to the public shock that followed. Notably, of the eight items in the measure of explicit perceived dangerousness used in the present study, three related to dangerousness of PWMI around children. As such, this measure may be particularly sensitive to changes in perceived dangerousness toward children, as might be observed after a school shooting. Furthermore, although Sandy Hook and Sutherland Springs each had 27 fatalities, the maximum of the events studied here, Sandy Hook received more media coverage.

Given the larger effects of Sandy Hook (vs. other events) on perceived dangerousness, and the stronger relations among its media coverage and perceived dangerousness, future studies may wish to qualitatively compare the type of media coverage after mass shootings: Did fewer articles about Sutherland Springs refer to the mental illness of the shooter as causal? Did more note that most PWMI are nonviolent? Did the gun violence prevention activism of Marjory Stoneman Douglas High School students help to steer the public conversation away from attributing violence to mental illness? In the 5 years between Sandy Hook and Parkland, there were numerous calls for changes in the way journalists report on mass shootings so as to avoid romanticizing shooters, stigmatizing mental illness, and leading to copycat shootings. Investigating the extent to which these recommendations have been followed may help explain the differential effects of events studied here on public stigma of PWMI and why mental health-related media coverage only related to perceived dangerousness for Sandy Hook and not for other events. Between 1997 and 2012 (so, before any of the events analyzed here), less than 20% of U.S. news stories about serious mental illness and gun violence noted that the majority of PWMI are not violent (McGinty et al., 2014). A similar investigation of news stories since 2012 might provide insight into changing effects of mass shooting events over time. Another sobering possibility is that with the alarming frequency of mass shootings in the United States, each one is increasingly less shocking to the public, leading to smaller effects on perceived dangerousness.

Limitations and Conclusions

The present study has several limitations. First, this study is about macro-level beliefs, and it is important not to draw conclusions about individual-level patterns from macro-level data (i.e., the ecological fallacy). In other words, this study shows that across the United States, both macro-level implicit and explicit perceived dangerousness of PWMI were higher after Sandy Hook and media coverage of Sandy Hook, but we cannot say that exposure to news articles about Sandy Hook caused an increase in an individual's perceived dangerousness beliefs. In fact, some participants in this sample may have been unaware of some events analyzed. While this would be problematic for individual-level conclusions, this likely reflects true variance in macro-level awareness of these events, so does not interfere with macro-level inferences.

Another limitation is that our sample differed demographically from the population of the United States (our sample is more female, White, educated, and liberal), and the number of responses varied from week to week, such that weeks with more responses are likely more reliable estimates of macro-level beliefs than weeks with fewer responses (see Supplement for more information on responses per week). Furthermore, participants self-selected to voluntarily participate in an online study about PWMI, which may reflect a greater than usual interest in issues related to PWMI. It is possible that some participants contributed multiple responses over the course of the study; each session, rather than participant, was assigned a unique identifier, so we are unfortunately unable to track this. This study also only assessed perceived dangerousness of PWMI; it is possible that mass shootings also affect other facets of stigma, such as social distancing and structural discrimination, but those are outside the scope of this study.

The present study was the first to examine discontinuities in the pattern of perceived dangerousness of PWMI as a result of mass shootings, using both implicit and explicit measurements. Given differences in effects observed on implicit versus explicit measures, future studies of stigma should make efforts to include both. Although the expected, large increases in perceived dangerousness were found following Sandy Hook, variability in effects for the other events analyzed suggest that future research should examine differences between school versus non-school shootings, as well as changes in media coverage of mass shootings by PWMI since 2012. Furthermore, it would be interesting to assess whether similar effects on perceived dangerousness of PWMI are seen following mass shootings perpetrated by people without a history of mental illness, as the public may make assumptions or generalize. The way we talk about PWMI and violence may have significant effects on the lives of a large portion of the population; accurately depicting the low violence risk of the vast majority of PWMI is particularly important in the wake of mass shootings.

Declaration of Conflicting Interests

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Supplemental Material

Supplemental material is available online with this article.

Notes

1. We thank an anonymous reviewer for suggesting this alternative hypothesis.
2. Researchers interested in accessing the raw data may contact author B.A.T.
3. These measures are part of a larger study that also included measures not analyzed here related to participants' mental health history and demographics. Full details available from the first author.
4. There is no commonly agreed-upon definition of mass murder. This definition of mass shooting is used by the Stanford Mass Shootings in America database, although all events selected also match other commonly used definitions of mass murder specifying four or more shooting victims in one place and time (Douglas et al., 2013; U.S. Federal Bureau of Investigation, 2008).
5. A similar analysis was performed for a mass shooting at Umpqua Community College in Roseburg, Oregon (October 1, 2015). Because the shooter was coded as having a history of mental illness in the Stanford database but not the Mother Jones database, these results are included in Supplementary Online Material.
6. The "0" in the MA(0) parameter means that 0 time points prior to the week of the event were used in the calculation of intervention effects. An MA(1) intervention effect would indicate that both the intervention effect at the week of the mass shooting event (MA[0]) and the week prior to the mass shooting event (MA[1]) would be modeled. We considered only MA(0) effects because we have no reason to suspect weeks prior to the mass shooting event would affect perceived dangerousness on the week of and following a mass shooting event.

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