Behavioral Responses to Mass Shootings: Physical Activity, Mental Health and Labor Outcomes

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Abstract

The odds of experiencing a public mass shooting in first person are low. Approximately 411 people have died in such tragic events during the past decade in the United States. However, the high saliency of mass shooting events might induce changes in behavior that may pose an external cost on society. In this paper, I estimate the impact of indirect exposure to high profile acts of violence on behavior by using information on 45 mass shootings from 2003 to 2016. Using individual-level data, I find that being within 250 miles shortly after a mass shooting, individuals overall activity levels decrease by 1.7 percent. This decline is equivalent to a daily 16 minute walk. For an average weight person, this decline would mean 50 less calories burned per day. The decline in activity is mainly explained by a 10 percent decrease in minutes of moderate to vigorous activities and is driven mostly by individuals under 30. In addition to a decrease in activity levels, I find an increase in the probability of having more days where perceived mental health is poor. And interestingly, I find an increase in the probability of binge drinking. Finally, I also find a statistically significant decrease of 10.6 minutes worked per week shortly after a mass shooting has occurred. These results show that aside from direct victims, mass shootings also impact the short-term behavior of a broader portion of the population.

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1 Introduction

High profile acts of violence induce fear. Among these acts, mass shootings have been a contemporary issue in the United States. During the past decade, approximately 411 people have died in such tragic events[1]. Mass shootings are events in which there is an active shooter in a public place, and there are at least four fatalities not including the perpetrator. Although the odds of experiencing a public mass shooting in first person are low, the high saliency of a mass shooting is likely to induce changes in behavior that may pose a cost on society.

People tend to significantly overestimate the frequency of rare causes of death (Lichtenstein *et al.*, 1978). Tversky and Kahneman (1975) state that individuals judge the probability of an event by how easy it is to recall instances of the event. Similarly, according to Barberis (2013), because extreme events receive disproportionate media coverage, individuals tend to overestimate the likelihood of such events. Hence, indirect exposure to a negative event can potentially change the perceived probability of a similar event happening to oneself.

Exposure to high-profile acts of violence can shape people's perceptions and behaviors. Moreover, these events can inflict harm by creating fear and inducing changes in behavior and individual choices (Becker *et al.*, 2004). Consequently, we may see distortions in behavior that may be costly for individuals and society. In this paper, I address mostly unmeasured external costs of high-profile acts of violence: changes in activity levels and other behaviors due to indirect exposure to mass shootings. I measure changes in these outcomes shortly after a mass shooting has occurred while taking into account temporal and geographical distance to mass shooting incidents in the continental United States. The focus is on a scenario in which mass shootings provide an exogenous shock where individuals' assessment of risk can potentially lead to costly outcomes.

Literature on the subject has focused mostly on the impact of violent crimes and fear of crime on mental health outcomes[2]. Where in most studies (Littleton *et al.* (2011), Cornaglia *et al.* (2014), Metcalfe *et al.* (2011), Dustmann and Fasani (2013)) exposure to violent crimes leads to adverse outcomes in both survivors and members of affected communities such as post-traumatic stress disorder (PTSD), general distress, depression, and anxiety. Related to these results, Rossin-Slater *et al.* (2020) find that local exposure to school shootings increased youth antidepressant use. Particularly, mass shootings lead to a short-term increase in fear and a decline in perceived safety (Lowe and Galea, 2017). For instance, Bor *et al.* (2018) find that police shootings of unarmed Black Americans led to

[1] Follman *et al.* (2017), number of fatalities comes from events in public places from 2013 to 2016 where there were 4 or more people dead not including the perpetrator. For a more thorough explanation of what a mass shooting encompasses check section 2.1 of the present analysis.

[2] For an extensive review on the effect of mass shootings on mental health outcomes see Lowe and Galea (2017). Likewise, Lorenc *et al.* (2012) survey crime, fear or crime and its impact in wellbeing.

an increase in poor mental health days using a difference in differences approach. As for the effects of violent crime on other health outcomes, Janke *et al.* (2016) study the effect of recorded violent crime on walking. Their results show a significant decrease in walking for non-victims due to local area violent crimes in the United Kingdom.

Furthermore, high-profile acts of violence have an impact on education outcomes. Ang (2020) finds that after a police shooting, students who live close to shootings experienced a significant decline in grade point averages, an increase in clinical diagnoses of emotional disturbance and lower rates of high school completion and college enrollment. Also, Clark *et al.* (2020) find that shortly after the Boston marathon bombings, individuals increased their time accessing media and there was an average 30-minute decline in hours worked. Also, in the context of labor outcomes, Hamermesh (1999) finds that higher homicide rates lead to a lower propensity to work evenings and nights in large metropolitan areas, costing the economy between $4 and $10 billion. As for other behavioral responses, Rubin *et al.* (2005), look at the impact of the London bombings for people in the city and find an increase on stress levels and a decrease in travel using public transport (where the bombings happened). Similar to that result, Becker *et al.* (2004) find that after terror incidents occurred in Israel during the "al-Aqsa" Intifada, the usage of goods and services related to these attacks was affected.

The purpose of this paper is to add a novel perspective to the existing literature on how high-profile acts of violence can impact the behavior of a broader set of individuals. I focus on measuring the impact of mass shootings on physical activity levels, self-reported mental health, hours worked and other outcomes. I measure this impact for individuals who were not necessarily direct victims, but had increased exposure to these events. To measure this effect, I use exogenous variation in time and geographical location coming from public mass shootings. Distance to a mass shooting as measure of exposure is consistent with a dose-response relationship where, according to the American Psychiatric Association, the severity, duration, and proximity of an individual's exposure to the traumatic event, are the most important factors affecting the likelihood of developing post traumatic stress symptoms. Additionally, mass shootings are events that can be difficult to predict. They are not directly related to local crime rates. Not to mention, mass shootings have happened in almost every state of the United States during the past two decades.

In order to identify the prevalence of mass shootings in the United States, the ideal scenario would be to have administrative data of every single event[3]. However, in absence of such data I have to rely on two other main sources of information: first, media reports on mass shootings and second, searching

[3]There are no official statistics on mass shootings in the United States, a few media outlets (Follman *et al.* (2017), USA-Today (2013)) and initiatives such as Stanford MSA (Stanford Geospatial Center, 2016) and Gun Violence Archive (G.V.A, 2018) who also have reports based on media coverage of these events. The FBI has published a study on active shooter incidents between 2000 and 2013 (Blair and Schweit, 2014)

behavior for mass shootings on the Internet.

I use media reports data compiled by Mother Jones from 2003 to 2016 on mass shootings which identifies every major event where there were at least 4 fatalities minus the perpetrator. The advantages of using this data is that it is an open-source database with information on the dates and coordinates for every event. This helps identify with more precision the proximity and exposure to a mass shooting. Indeed, anoter advantage of using this data is that it excludes shootings stemming from more conventional crimes such as armed robbery or gang violence, which would be more related to local crime patterns[4].

Before measuring any type of impact on behavior, it is critical to know the degree to which these events are salient to individuals. For this reason, I use Google Trends to measure whether people utilize the web to search more for information about mass shootings after an event has happened. Then, I study whether search behavior is different as a function of time and geographical proximity. I find that search interest for the phrase "mass shooting" has a statistically significant increase shortly after an event has occurred and is higher for places that are closer to incidents. More specifically, the increase in searches is concentrated on individuals who live in communities that are within 250 miles of a mass shooting. This result shows that mass shootings are disproportionately more salient shortly after an event has occurred nearby compared to periods when there are no such events. This saliency measured in Internet search behavior fades with time and geographical distance to the event.

Consequentially, coping with increased fear of crime can lead individuals to change their normal activities and plausibly affect other outcomes too. Overall activity levels can be seen as revealed preferences and manifest changes in individual behavior. By the same token, activity levels are one of the main ways in which individuals can invest in their health. People choose their daily activities constrained by the number of hours in a day, their current health and other resources. Previous research has found that adequate levels of physical activity decrease the risk of cardiovascular diseases, diabetes, colon and breast cancer, and depression (WHO (2017)). In the United States, inadequate levels of physical activity are already an issue. Approximately 21% of adults meet the recommended levels of physical activity (Johnson *et al.*, 2014). From 1965 to 2009 there has been a 32.2 percent decrease in physical activity measured in terms of metabolic equivalents of task-hours per week among adults (Ng and Popkin, 2012).

To measure the impact of mass shootings on activity levels, I use time-diary information from the American Time Use Survey (ATUS) from 2003 to 2016. ATUS is a nationally representative survey that asks individuals about every activity partaken in a day, who they did those activities with, where they did them and allows classification of activities by their level of strenuousness. There are two main

[4]For more information on the data source http://www.motherjones.com/politics/2012/07/mass-shootings-map/

advantages of utilizing ATUS to measure physical activity. First, I am able to take into consideration all activities an individual does in a day. Second, I can also consider the level of strenuousness of these activities. I can measure this by using metabolic equivalents of task (MET). METs measure the ratio of a person's working metabolic rate relative to their basal metabolic rate (Sallis *et al.*, 1985) among adults (Ng and Popkin, 2012). For instance, one MET would be the equivalent in energy that is required to sit quietly which is approximately 70 calories.[5].

Using ATUS data under a difference in differences estimation approach, I find that living within 250 miles of a mass shooting and in the last two weeks leads to a reduction in overall activity of 1.7 percent.[6] In terms of METs, this decline is equivalent to a daily 16-minute walk or spending 6.5 minutes less running. For a person who weights 160 pounds, this decline is equivalent to burning 50 less calories per day. To validate these results, I run event studies that prove there is no measurable change on activity levels in the weeks preceding a mass shooting. The event studies also show that most of the change in behavior happens in the first week after a mass shooting has happened. This decline in phyisical activity levels is mainly explained by a statistically significant 10 percent decline in minutes of moderate and vigorous activities. Besides this, I study whether there is a differential impact by population groups. The main changes in activity are driven mostly by individuals under 30. And the observed changes in behavior are not only inherent to physical activity.

The nature of the activities an individual engages in a day, the deviation from normal activities, and the incurrence in coping mechanism behaviors can also tell us about the effect of fear and exposure to mass shootings. I find no statistically significant evidence that individuals spend less time in public places or more time at home, although the result is statistically significant for younger individuals.

Previous literature has found a decline in hours worked after terrorist attacks and mass shootings (Clark *et al.*, 2020). I use Current Population Survey (CPS) data from 2003 to 2016 to further study this relationship using more than one event. I find a statistically significant decrease in hours worked of 0.5 percent or 10 minutes a week, the decrease is highest for men, Hispanics, workers with some college, those aged between 45 to 64 and for hours worked at the main job.

Aside from the observed impact on overall activity, it is imperative to address whether mass shootings might also induce changes in other health behaviors. Using the Behavioral Risk Factor Surveillance System (BRFSS) from 2004 to 2016, I measure whether mass shootings have an impact on self-perceived mental health and whether exposure to these events leads to risky health behaviors. I find that shortly after a mass shooting the number of days when mental health was not good in the past month increases in the intensive margin equivalent to a 3.2 percent increase. Most of the effect seems to come from

[5]Physical activity guidelines for Americans, US Department of Health and Human Services (of Health *et al.*, 2008)
[6]Results for other distances are shown in the Appendix Table A2.

individuals that already had lower self-perceived mental health. The probability of having 14 or more days as a measure of frequent mental distress shows no significant effect. Exposure to mass shootings may also lead individuals to engage in risky health behaviors. I find that although positive, there is no statistically significant reltionship with the number of drinks per month and a statistically significant increase in the probability of binge drinking of 5 percent on average.

This paper contributes to the existing literature by exploring a plausibly causal link between the exposure to high profile acts of violence and overall physical activity among other behaviors. To the best of my knowledge, this is the first study to look at the effects of fear of crime stemming from mass shootings on overall activity levels using individual time diaries. Furthermore, I am able to explore different mechanisms individuals enact to cope with experiences of insecurity. Also, I am able to measure exposure to high-profile acts of violence by looking at changes in search interest using Google Trends. Additionally, by using MET as an outcome variable, I can measure physical activity in a more comprehensive way which allows me to measure the effects in terms of calories burned per day and whether individuals engage in more sedentary behaviors. Another advantage of this analysis is the use of 45 different events from 2003 to 2016.[7] The match between these events and detailed temporal data, allows a more precise estimation of the short term externalities stemming from high-profile acts of violence. Finally, the results show that aside from direct victims, mass shootings also have an impact on the behavior of a broader portion of the population.

The current paper proceeds as follows. Section 2 provides details on the data used to measure search interest, time use and other outcomes. Then, Section 3 provides the identification strategy and econometric methods. And before offering a conclusion, Section 4 presents the main results for time use, labor and mental health outcomes.

2 Data

Data for this paper comes from five major sources: mass shootings data, search interest data, time use data, mental health data and labor outcomes data.

2.1 Mass Shootings Data

To measure the effect of indirect exposure to mass shootings on individual behavior, the ideal data to use are administrative records of mass shootings in the United States. Since this information does not currently exist, I use several unofficial sources of information. A particular issue with mass shootings is

[7] For example Littleton *et al.* (2011) uses the Virginia Tech mass shooting, Metcalfe *et al.* (2011) 9/11 terrorist attacks in United States, Rubin *et al.* (2005) the London Bombings and Becker *et al.* (2004), the "al-Aqsa" Intifada in Israel.

that, since there is no official consensus and administative data on incidents, there are endless sources of unoficial data. Depending on the source, the number of mass shootings can vary extensively[8]. For this reason, I use the data that fits the definition of what a mass shooting entails more accurately and compare results using different sources to validate.

I use mass shootings incidents in this analysis to be able to distinguish the plausible effect on behavior that is induced by events that are salient and not related to local crime trends, gangs or drug associated crimes which may be endogenous to some individual characteristics. The sources that best differentiate between mass shootings and shootings that are correlated to other local events come from the "Mother Jones Investigation on Mass Shootings" and Stanford's "Mass Shootings of America (MSA)"[9].

Data on mass shooting events comes from the Mother Jones investigation on Mass Shootings[10], which is an open-source database that documents indiscriminate rampages in public places that result in 4 or more people killed excluding the perpetrator. As can be seen in Figure 1, from 2003 to 2016 there were 45 mass shootings in the continental United States[11]. Mass shooting events happen in almost every state of the country. There is a higher incidence on states that are highly populated such as California, states in the East Coast, Illinois, Michigan, Texas, Florida, with isolated events in other states as well.

With this data I am looking into 45 mass shootings with a median of 6 fatalities and 3 people injured. In total, they add up to 411 fatalities and 356 people injured; the event with the highest number of fatalities in the study is the Orlando nightclub massacre from 2016, where 49 people died. There is information on events with three or more fatalities starting 2013, but, to keep information comparable across time I only use events where four or more people died excluding the perpetrator.

FIGURE 1

2.2 Search Interest Data

Web search data comes from Google Trends data at the Designated Market Areas (DMA) level from 2011 to 2015. I use Google Trends to identify whether people were searching and getting more information on the Internet after a mass shooting happened. To test this, I analyze whether people

[8] Depending on the source, the number of mass shootings can vary in frequency from 4 events a year, to a weekly occurrence.

[9] Even tough this paper uses the data from Mother Jones media reports primarily, in the Appendix I show results using the MSA data. This source of data was discontinued in 2016.

[10] For more information on the data source: http://www.motherjones.com/politics/2012/07/mass-shootings-map/

[11] Table A1 in the Appendix lists the events that are part of the present analysis.

search on the web for the term "mass shooting" taking into account variation in weeks after an event has occurred and the geographical location of each event. Google Trends data is a random sample of all queries done at a specific time and geographical area. Since the search interest is a sample of all searches, I use 100 draws of the search term and average them out to gain more precision. Google Trends provides an index of the volume of times users search for a given term, for a specific time span and geographic area. This index is based on query share: the total query volume for the search term in question within a particular geographic region divided by the total number of queries in that region during the time period being examined. The maximum query share in the time period specified is normalized to be 100 and the query share at the initial date being examined is normalized to be zero (Choi and Varian, 2012).

There is strong evidence that Google searches suffer significantly less from social desirability bias than other data sources (Stephens-Davidowitz, 2014) which makes them a good source to link mass shootings with individuals' behavior. Regardless of the formal definition of what a mass shooting encompasses, it gives information on how salient the event was on individuals for events that are happening at the local and national level.

The time frame from 2011 to 2015 was chosen for two main reasons. The first, to have the data at the week level of observation since queries for more than 4 years only have data at the month level of observation. Second, in January 2011 Google implemented an improvement in their geographical assignment. This allows for a more adequate geographical disaggregation into DMA's.

2.3 Time Use Data

Time use data comes from the American Time Use Survey (ATUS) from the Bureau of Labor Statistics from 2003 to 2016. ATUS measures the amount of time people spend in different activities from 4 AM of the previous day to 4 AM of the interview day. It is a nationally representative survey done via telephone interviews to a selected sample of Current Population Survey (CPS) respondents. Since ATUS respondents were interviewed in CPS before, I can identify individuals county of residence, sociodemographic and labor characteristic with more accuracy.

The main advantage of using ATUS for this analysis is the high level of disaggregation in the activities an individual can engage in, who they do these activities with and where they were done. Based on the work done by Tudor-Locke *et al.* (2009), the data has metabolic equivalents of task (MET) for every activity. With this variable I can measure more precisely the level of activity an individual does in a certain amount of time and categorize activities by their level of strenuousness.

In addition to using the values of MET, I categorize activities into three main categories: sedentary activities (MET$\in [0, 1.5)$) which encompasses activities such as watching TV, relaxing, waiting, read-

ing, riding in a car, sleeping; light activities (MET$\in [1.5, 3)$) such as eating and drinking, socializing, attending sports events, computer use, shopping, walking at a slow pace, grocery shopping, attending movies or museums, and moderate or vigorous activities (MET≥ 3) like dancing, doing sports, hiking or playing with household children.

I use repeated cross-sections of the ATUS from 2003 to 2016. The data includes 180,425 observations from the continental United States. To arrive at the estimation sample, I drop individuals for with there is no county-level temperature information match (329 observations deleted) and individuals for which there is no information on county of residence (101,458 observations). The final sample consists of 78,638 individuals who reside mainly in metropolitan areas (97 percent of the sample).[12] Additionally, it is worth mentioning that ATUS collects data for every day of the year but oversamples data for weekend days. From 2013 to 2016, approximately half of the sample was surveyed on Saturday or Sunday), to address this I control for day of the week for all my model specifications. Within the final sample, I am able to identify individuals at the county/week/year level.

Finally, having information on day of interview and county, I estimated the geographic distance to every mass shooting in the data. Since I have no coordinates for individuals in the ATUS sample, I estimate the distance from the centroid coordinates of each individual's residence county to the coordinates of each mass shooting. This allows me to identify which individuals had a higher exposure to said events. For example, 2.5 percent of the sample lived within a 250 mile radius of a place where mass shooting occurred.

2.4 Current Population Survey

Data on hours worked per week comes from the Current Population Survey (CPS) conducted for Bureau of Labor Statistics (BLS) by the U.S. Census Bureau (Sarah Flood and Warren, 2018). It is a monthly survey of households that includes statistics on the employment status of the civilian non-institutional population.

Even tough CPS data does not include day of interview, by using the survey reference week for each month, I can measure the distance in weeks to mass shootings at the county level. The estimation sample consists of 4,176,782 observations at the county/week/year level.

[12]Since I am deleting observations that do not have information on county of residence, the composition of the final sample is more urban. This means that when using ATUS, I am measuring effects in behavior of people who live in more densely populated areas and not of total population.

2.5 Mental Health and Drinking Behaviors Data

Data on health outcomes comes from the Behavioral Risk Factor Surveillance System (BRFSS) from 2004 to 2012 by the Centers for Disease Control and Prevention (CDC). The BRFSS is a telephone survey that collects state data from United States residents and has information on their health-related risk behaviors, chronic health conditions and use of preventive services (CDC, 2001).

I use BRFSS to assess whether there is an impact of indirect exposure to mass shootings on health outcomes such as self-perceived mental health and drinking. The estimation sample consists of 5,147,060 observations. To get to this number of observations, I drop observations that are not part of continental United States, with missing values in sociodemographic characteristics such as age, gender, race and education. I also exclude observations with missing values on mental health and drinking behavior responses and observations for which there is no residence county temperature or precipitation data. Within the final sample, I am able to identify individuals at the state/week/year level.

2.6 Other Data Sources

The other data sources used for the present analysis are weather data from the Daily Global Historical Climatology Network (GHCN-DAILY) and local crime data from the Uniform Crime Reporting Statistics (UCR).

The weather data from GHCN (Menne *et al.* (2012b), Menne *et al.* (2012a)) is weighted at the state level using information from weather stations across the continental United States from 2003 to 2016. The main indicators are average temperature in Fahrenheit degrees and precipitation measured in tenths of millimeters. Controlling for weather in the main model estimations allows me to account for the impact weather might have on daily activities. In addition to this data, I also include hours of sunlight using Shrader (2017) algorithm of NOAA's implementation of Meeus' sunset time calculation. I include this indicator to control for potential changes in activity due to hours of sunlight.

The local crime data comes from the UCR data statistics on violent crimes (FBI, 2017). I use violent criminalization rates per 100,000 people from the year before to control for local crime at the state level. This reinforces the analysis making sure what is being measured is the impact of mass shootings solely and not reactions to preexisting local crime rates.

3 Empirical Strategy

3.1 Exposure to Mass Shootings

To identify the extent to which mass shootings may induce changes in behavior, it is paramount to know the degree to which people are exposed to such events and how salient they might be to individuals. To validate that the data on mass shooting events does accurately capture accurately the events and their saliency, I look at individuals search behavior on the Internet. If people do search more for information on shootings after an event, it helps to validate the media reports data used in the present analysis and establish the level of saliency each mass shooting had.

With this in mind, I use Google Trends to measure whether people utilize the Internet to search more for the term "mass shooting" after an event has happened according to media reports data. I use data on searches from 2011 to 2015 to model how does search interest for mass shootings vary by geographical proximity and in the subsequent weeks to an event.[13]

To identify the impact of mass shootings on search interest levels, I use exogenous variation in time and geographical location of these events using the following equation:

$$y_{ct} = \sum_{T \neq -1} \beta_T MSI_{t,T} + \gamma_t + \alpha_c + \epsilon_{ct} \tag{1}$$

Where y_{ct} represents search interest of individuals in each Designated Market Area (DMA) c at time t. MSI_t is a dummy variable that takes the value of one if a mass shooting has happened in t within a certain amount of miles from the DMA, γ_t are time fixed effects and α_c are DMA fixed effects. I cluster at the DMA level allowing for correlation of errors within the 208 DMA's.

Figure 2, Panel A graph shows equation (1) results on search interest for the term "mass shooting" when an event has occurred within 250 miles. It shows that the largest spike in search interest happens in the subsequent two weeks after the event happened, a decline after 2 weeks and then no significant change in search interest. Additionally, in previous periods there is no increase in search interest which serves as a falsification test. Panel B shows the same results using a distance from the event of 500 miles. Results are very similar to those of Panel A in terms of direction, but with lower coefficient magnitudes. This result shows that people are in fact disproportionately searching more for mass shootings in the Internet shortly after an event has happened compared to periods when there are no such events and that this spike in search interest fades with time.

Since most of the effect on individuals searching behavior for mass shootings happens in the first

[13] I use these years and not more because Google Trends only gives weekly data on search interest if the query is limited to 5 or less years. By identifying the changes in Google searches at the weekly level, the precision of the estimates is enhanced.

two weeks after the event has occurred, Panels C and D of Figure 2 show the effect by distance of the event where the omitted category is being more than 1000 miles away from the event. Results show that most of the increase in online searches comes from individuals in DMA's that are located within 250 miles of the incidents. The observed increase in search interest after a mass shooting has occurred helps validate the use of media reports data on mass shootings (Follman *et al.*, 2017) for the present analysis and highlights the short-term increase in exposure to information on mass shooting incidents.

FIGURE 2

3.2 Identification Strategy

Results from Internet searches give evidence that people are disproportionately more interested in mass shootings right after one has occurred and when individuals are closer geographically to one. The action of searching the Internet for the term "mass shooting" can help explain why there could be a potential change in behavior. To measure the effect of high-profile acts of violence on individual behavior, I compare the conditional trends in selected outcomes within a specific geographical distance from a mass shooting and a number of weeks to the rest of periods and geographical units where there are no events. For my main model, I identify individuals as treated when they reside in counties that are within 250 miles and that were surveyed in the week after an incident happened.[14]

Since public versions of ATUS, BRFSS and CPS do not include exact coordinates of the residence of respondents, I use the centroid coordinates of the county in which an individual resides and compare them with the coordinates of each mass shooting in the time span of the analysis. This way every individual in a county that is within a 250 mile radius of a mass shooting and that was surveyed in the week after the event is treated. I expect that the change in behavior of individuals who live closer to where an event occurred to be higher on average compared to that of those who live further away.

To identify the impact of mass shootings on daily activity levels, mental health and hours of work, I use the exogenous variation in time and geographical location of mass shootings using a difference in differences approach. The main estimating equation is:

$$y_{ict} = \beta_0 + \beta_1 MSI_{ct} + \beta_2 M250_{ct} + \beta_3 W1_t + \delta_{ict} X_{ict} + \gamma_{yt} + \alpha_c + \eta_{sm} + \phi_t + \epsilon_{ict} \tag{2}$$

Where y_{ist} can be logarithm of metabolic equivalents of task (MET), minutes of sedentary activities, minutes of moderate and vigorous activities, hours of work, for example. MSI_{ct} is a dummy variable

[14] Appendix Figure 6 shows a graphical description of the identification strategy used. Other geographical distances and week estimates are shown in the Appendix as a robustness check.

that takes the value of one if a mass shooting has happened within 2 weeks and 250 miles or zero otherwise, $\beta_2 M250_{ct}$ is a dummy variable that has a value of one if the individual is within 250 miles of a mass shooting and $\beta_3 W1_t$ takes the value of one if an individual was surveyed in the week after a mass shooting. To improve the precision of estimates, $\delta_{ict} X_{ist}$ are observable characteristics of individuals such as age, gender, race, and educational attainment.

I also control for average daily temperature at the state level, the number of hours of sunlight and each state's violent crime rates from the year before the event takes place. This allows me to single out first, the impact that temperature and hours of sunlight potentially have on daily activities which could bias the results and second, the impact past local crime may have on individuals behavior.

I use year-week γ_{yt} fixed effects to control for time variation at the weekly level, day of the week ϕ_t effects to control for changes in activity depending on the day of the week, county α_c fixed effects to control for county-specific effects with no time variation and state-month η_{sm} fixed effects to control for differences across states by month of the year. Finally, I cluster standard errors at the county of residence level.

The key identifying assumption is that activity levels at the county level at time t would be the same in an area that is within 250 miles of a mass shooting compared to an area that was not within this radius in the absence of a mass shooting. In other words, being within 250 miles of a mass shooting at a specific time, introduces a deviation from each affected area's conditional time trends in the outcome variables used in this analysis. The parameter of interest is then β_1.

4 Results

In the following section, I analyze the impact mass shootings have on activity levels shortly after a mass shooting has occurred using ATUS. Similarly, I analyze whether mass shootings have an impact on the hours worked in a week using CPS. Finally, I run the preferred model specification to see whether there is an observable impact on mental health and drinking behaviors using BRFSS.

4.1 Activity Outcomes

Table 1 presents summary statistics of the main outcome and control variables using the ATUS from 2003 to 2016. Column 1 shows the averages for the total population sample, column 2 shows the averages for individuals who were surveyed more than a two weeks after a mass shooting occurred or whose county of residence is more than 250 miles from any mass shooting incident. Column 3 shows the average for individuals with a higher exposure to mass shootings (i.e. surveyed withing two weeks and who reside within 250 miles of the event). Finally, column 4 presents the p-value on the means

equality test between values depicted in columns 2 and 3.

Results show that the amount of metabolic equivalents of task were lower for individuals who lived within 250 miles shortly after a mass shooting occurred compared to the total population. These results are similar for minutes of sedentary activities, moderate and vigorous activities, minutes spent at home and minutes of recreational activities. When looking at individuals observable characteristics, I see no statistical differences by race-ethnicity, age group, and having children under 18 years. Most of family income bracket categories show no differences except for individuals whoose family income is between 15 and 20k. In terms of education, the highly exposed sample show no statistically significant differences except for the proportion of individuals who have less than highschool. The highly exposed sample seems to be exposed to lower temperatures and lower violent crime rates. Looking at observable characteristics of individuals, the mean values are fairly similar across comparison groups showing that there is no group that is disproportionately represented as part of the treated population.

Table 1

Table 2 shows coefficient estimates and robust standard errors from estimation of equation 2 using metabolic equivalents of task as main outcome. It shows the effect on physical activity derived from indirect exposure to mass shootings. Panel A shows that for individuals who live within 250 miles of an incident, activity levels decrease by 1.7 percent on average which is statistically significant at the 99 percent confidence level. These results are consistent between the estimates that only include fixed effects (column 1) and those who include a larger variety of control variables (columns 2 and 3). In other words, controlling for sociodemographic characteristics (column 2), local temperature, hours of sunlight and state violent crime rates (column 3) does not change the direction, magnitude or precision of the results. Panel B shows a lower magnitude and a statistically significant relationship when individuals live within 500 miles of the incident. This result highlights the fact that people who live closer to these incidents are the ones who change their behaviors the most.

To put in perspective, the 1.7 percent decrease in daily activities is equivalent to a daily 16 minute decrease in walking or a daily decline of 6.5 minutes running at a pace of 4 miles per hour. For an individual who weighs 160 pounds, a 1.7 percent decrease in metabolic equivalents of task is equiparable to burning 50 less calories per day.

Table 2

To be able to further affirm that the observed effects on physical activity are in fact a product of changes in behavior due to high-profile acts of violence there should be no measurable effects in physical

activity before a mass shooting. In addition to this test, it is important to examine whether the effect shown in Table 2 persists over time. Figure 3 Panel A shows the results of event studies estimation using physical activity as main outcome of interest. Results for metabolic equivalents of task show that there is no effect on activity before an event occurred which also serves as a falsification test. Additionally, results show that the changes in activity are mostly concentrated in the first week after a mass shooting. After the first week results are not statistically significant exccept for an increase after 3 weeks. A possible explanation for this increase is that individuals are compensating the decrease in activity with a slight increase in physical activity. After that increase in activity, individuals return to their original levels of physical activity. These results show that even though there is an effect of indirect exposure to mass shootings on physical activities, it is a short-term lived one.

In order to identify whether there is a differential impact on physical activity by geographical distance, Panel B of Figure 3 shows the effect of being exposed to a mass shooting broken down by miles from an event shortly after it occcurred. Results show that there is a statistically significant decline shortly after a mass shooting for people who are within 250 miles of the incident compared to those who live more than a thousand miles away. Results are not statistically significant for larger distances and show that the closer an individual is to a mass shooting, decline in physical activity is higher in magnitude.

FIGURE 3

To further explain where the observed decrease in overall activity comes from, Table 3 shows results for minutes engaging in different activities depending on their level of strenuousness. Panel A shows that although positive, there was no significant change in the number of minutes of sleep. Additionally, Panel B shows a non-statistically significant decline in minutes of sedentary activities (MET$\in [0, 1.5)$) not including minutes of sleep. Conversely, Panel C shows a non-statistically significant increase in minutes of light activities (MET$\in [1.5, 3)$). Contrary to these results, Panel D shows a statistically significant decline in minutes of moderate or vigorous activities (MET≥ 3) of 9 minutes per day. This result is equivalent to a 10 percent decline in daily moderate and vigorous activities. These results highlight that the observed decline in overall activity (or METs) is mainly explained by a decrease in the amount of time individuals engage in more strenouss activities after a mass shooting has occurred.

TABLE 3

Compensating behaviors to cope with increased fear of crime may not only be mantled by the level of strenuousness of activities but also by the location where activities take place. To shed some

light on this, I estimate the preferred model on minutes spent at home and in public places as shown in Table 4. These indicators are relevant because mass shootings happen mainly in public places so they could inhibit people spending more time in similar locations. Panel A shows that even though there is an increase in the number of minutes people spend at home, this increase is not statistically significant. On the other hand, Panel B shows that individuals spend approximately 14 minutes less per day at public places although the result is not statistically significant. Panel C presents results for hours at work for employed population and shows a statistically significant decrease shortly after a mass shooting has occurred. This decline represents a 10.8 percent decrease. Finally, even though workers spend less time at work, results in Panel D show that even though it is negative, the number of minutes working is not statistically different from zero. This result helps to put in context the results stemming from the analysis done using the Current Population Survey (CPS) in which I look at the effect of indirect exposure to mass shootings on hours worked.

TABLE 4

Finally, to study whether there are differences in activity levels by observable characteristics, Table 5 presents estimates on METs, light, moderate and vigorous activities, minutes spent in public and at home by individuals' observable characteristics. Column 1 shows results for overall activity levels where men seem to be driving the decline in overall activity with a statistically significant dectease of 2.3 percent. When looking at race and ethnicity, point estimates are higher for Hispanic population with a decline quivalent to 3.2 percent. Educational attainment shows statistically significant results for individuals with some college and no effect for more educated individuals. Results by age show an interesting story, they show a U curve relationship where in terms of point estimates, the decline in overall activity levels are higher for the youngest (ages 15 to 29) and the oldest (more than 64 years). Results are statistically significant and seem to be driven by individuals under 45.

Column 2 shows that there are no statistically significant effects of indirect exposure to mass shooting incidents on minutes of sleep except for Hispanic population. Conversely, minutes of moderate and vidgorous activities decline in most groups. When looking at the differences by gender, I find that men spend less minutes doing these activities compared to women and when considering race and ethnicity, the group with the most sizable decline are Whites although the effect is not different to zero. Similar to the results in overall activity, the largest decline by educational attainment is for individuals with some college. Results by age are non-statistically different from zero but higher for younger individuals which is consistent with the overall decline in activity for individuals under 45.

Average results for minutes spent in public places and minutes at home were in the expected direction although not statistically significant using the full sample. When looking at observable characteristics, another picture emerges. Younger individuals are the ones who as a result of indirect exposure to mass shootings spend less time in public spaces (approximately 64 minutes) and more time at home (50 minutes) but not statistically different from zero.

Table 5

4.2 Hours Worked

Increased fear of crime may also take a toll on workers' productivity levels and other labor outcomes. Previous literature has found a relationship between hours worked and exposure to high profile acts of violence. For example, Clark *et al.* (2020) found that shortly after the Boston Marathon bombings, individuals decreased their hours worked by approximately 30 minutes. In line with that result, Hamermesh (1999) finds that higher homicide rates causes lower propensity to work evenings and nights in large metropolitan areas. There is also evidence that developing mental health problems can lead to an increase in the probability to transitioning to non-employment with no consistent results on hours worked as reported in Mitra and Jones (2017). To test whether exposure to high profile acts of violence has an impact on hours worked, I use the Current Population Survey (CPS) from 2003 to 2016.

Table 6 presents results on hours worked during the last week using CPS. Panel A shows that shortly after a mass shooting, employed individuals decreased the number of weekly hours worked by 0.5 percent or 10.6 minutes on average, this decline is statistically significant at the 95 percent level of confidence. In terms of forgone wages, this decrease in hours worked would translate into a $7.00 decrease per week in 2016 U.S. dollars. Panels B and C show that the decline is mostly explained by a decrease in the hours worked in the main job and not other jobs workers might have.

Table 6

I find that shortly after a mass shooting has occured, workers who live closer to where the event happened work 10.6 minutes less on average. This finding makes relevant the need to gain context on whether this effect is short-lived or not and to understand whether this effect varies by proximity to high profile acts of violence. Figure 4 presents event study results for total hours worked by weeks

before and after an event and results disaggregated by geographical proximity. Panel A shows that there was no significant effect of mass shootings on hours worked before these events happened which serves as a falsification test. Additionally, results show that the effect on hours worked is mainly concentrated on the first week after the mass shooting. This finding is consistent with the result depicted in Figure 2 on physical activity levels.

Figure 4, Panel B shows that compared to individuals who resided in counties 1000 miles or more away from mass shootings, there is a decrease in hours worked that is only statistically significant for people who live within a 250 mile radius of the incident. This result mirrors the effect by geographical distance found on physical activity levels.

Finally, Table 7 presents results for total hours worked by individual observable characteristics. Results show that there was a slightly higher decline for men, non-Hispanic whites, Hispanic population, individuals with some college and those aged between 45 to 64 and older than 64 although results for this last group are not statistically significant.

TABLE 7

4.3 Mental Health and Drinking Behaviors

Previous literature has found an increase in a number of mental health issues for both direct and indirect victims stemming from mass shootings (Lowe and Galea, 2017). Being able to measure mental health on a nationally representative sample is challenging. Most pathologies need exhaustive detail to be diagnosed so the best scenario for this analysis is to use self-perceived mental health. With this in mind, I use BRFSS to measure whether individuals' perceived mental health has been reduced shortly after a mass shooting. This outcome is subject to measurement error; if this error is not related to the covariates of the analysis, the resulting coefficients will not be biased.

Respondents in BRFSS are asked for how many days during the past 30 days was their mental health not good, Table 8 presents these results along with results on whether individuals engaged in risky health behaviors. Panel A shows that on average individuals feel their mental health is not good 3.69 days a month, being exposed to a mass shooting has no statistically significant although the coefficient is positive as expected. I find no effect on the probability of having any day where self-perceived mental health is not good as shown in Panel B. However, there is a statistically significant increase in days where mental health was not good on the intensive margin as shown in Panel C. The increase size is equivalent to a 3.2 percent increase and is statistically significant. Bor *et al.* (2018) use having 14 or more days when mental health is not good to quantify the population prevalence

of frequent mental distress. Panel D results show that indirect exposure to mass shooting had no statistically significant effect on the prevalence of frequent mental distress.

Exposure to mass shootings has an effect on days where mental health was not good. Exposure to such events may also lead individuals to engage in risky health behaviors. To explore this, Panels E and F show the effect on drinks per month and the probability of being a binge drinker. Results show that although positive, there is no statistically significant reltionship with the number of drinks per month and a statistically significant increase in the probability of binge drinking of 5 percent.

TABLE 8

To further the analysis of these effects, I explore to what extent the observed changes in behavior after a mass shooting had differential effects across individuals depending on their observable characteristics. Table 9 presents results on mental health outcomes and drinking behaviors for different population groups.

Table 9 breaks down the effects on mental health due to short-term exposure to high profile acts of violence. Results in column 1 show that the increase in days when mental health was not good was higher (although not statistically significant) for men compared to women, higher for Hispanics, and not significantly different by educational attainment. Results by age group are not statistically different but they show a negative relationship between age and days of decreased mental health quality, younger individuals have the highest point estimates and this effect decreases by age. Column 2 shows that there are no statistically significant effects for frequent mental distress. Although not statistically significant it is noteworthy to mention that the highest impact is for the youngest population.

Columns 3 and 4 of Table 9 show the effects on drinks per month and the probability of binge drinking for selected populations. Results show that the increase in drinks comes mostly from men who drink on average 1 drink more which is statistically significant at the 90 percent level, the coefficient for women is zero. Black population show an increase in 1.4 drinks per month that is statistically significant. When looking at the effect by educational attainment, although not statistically significant, there is a negative relationship between attainment and number of drinks where the most educated drink less after a mass shooting and individuals with highschool or less have present the highest point estimates. This inverse relationship happens by age too. I find a statistically significant increase in drinks per month for individuals under 45.

Finally, men present a higher probability to binge drink after a mass shooting compared to women, similar to White people compared to other ethnicities and races. In terms of educational attainment, I find that the point estimates are higher for the least educated. Results by age are not statistically

significant but point estimates show that the probability of binge drinking due to indirect exposure to high profile acts of violence decreases with age.

TABLE 9

5 Concluding Remarks

In this paper, I measure the effect of indirect exposure to mass shootings on activity levels, hours worked and other health behaviors in the United States. Results indicate that there is a statistically significant decline in activity levels within 250 miles shortly after a mass shooting has occurred. This result is mostly explained by a decline in moderate and vigorous activities. This decrease in activity does not represent a permanent change in behavior, but mostly a short term change. Using an event study for metabolic equivalents of task, the decrease in activity is mainly explained by the changes in behavior that occur 1 week after a mass shooting. I find no evidence for the full sample that individuals spend less time in public places or more time at home except for individuals under 30.

In terms of mental health, I find an increase in the intensive margin of days when mental health is not good which is highest for Hispanics, more educated and younger infividuals. Binge drinking and drinks per month increase the most for men, younger individuals and those with less educational attainment.

As has been noted, the effect of exposure to high profile acts of violence is not only in activity levels, but also for self-perceived mental health, hours worked and drinking behaviors. Moreover, the effects seem to be larger across for the youngest individuals.

Results in this paper provide a novel analysis on what is the effect of indirect exposure to high-profile acts of violence on behavior which has relevant policy implications. First, although mass shootings are events that are extremely hard to predict, policy that addresses the motivating factors that lead to mass shootings is important. Second, given the fact that indirect exposure to these events leads to adverse mental health, activity and risky health behaviors there is a need to have policies that reach affected community members that were not necessarily directly exposed to these events. Third, although this analysis focuses on high profile acts of violence and given the complexity of measuring the effects of violent crime on behavior, this paper can guide the mechanisms that individuals may use to cope with fear of crime.

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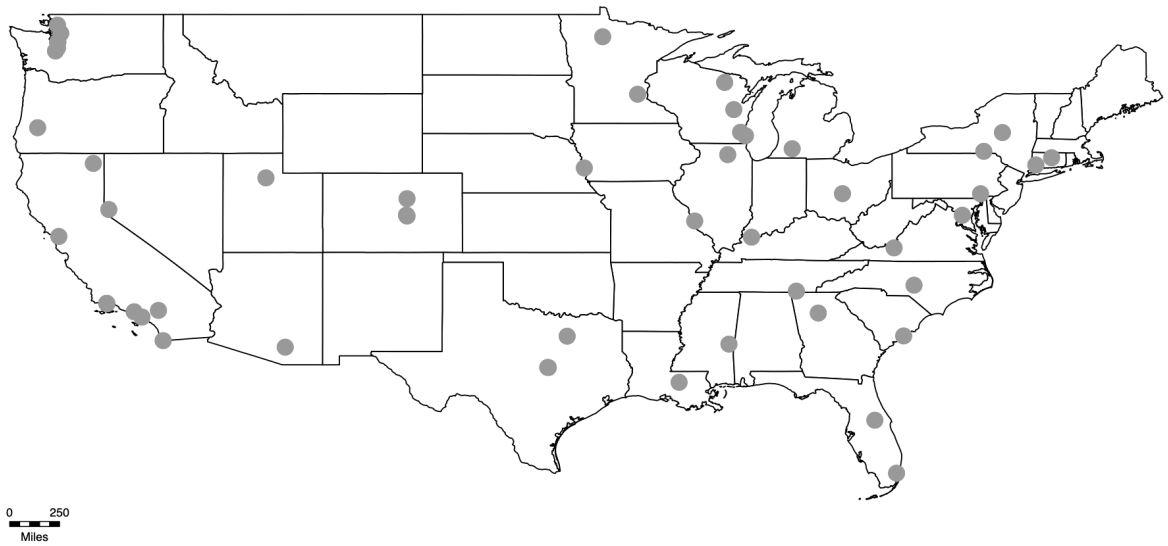
6 Figures and Tables

6.1 Figures

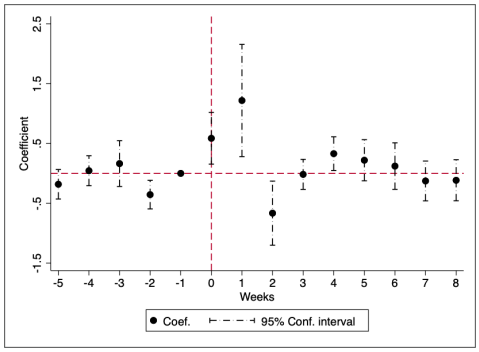
Figure 1: Mass Shootings in the United States 2003-2016



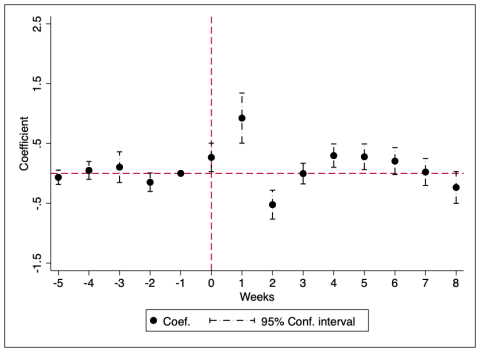
Source: Media reports compiled by Mother Jones U.S. Mass Shootings from 2003 to 2016.

Figure 2: Search Interest for "Mass Shootings" by Distance in Miles and Weeks from a Mass Shooting Incident (MSI) in the United States 2011-2015

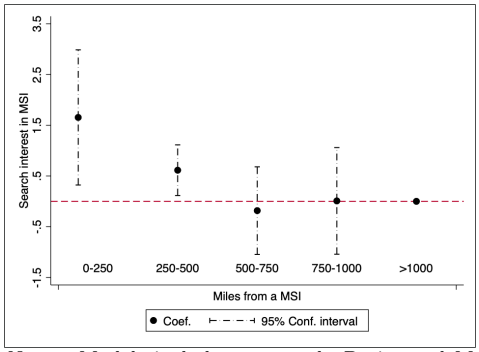
Panel A. Search Interest by Distance in Weeks (250 Miles from MSI)



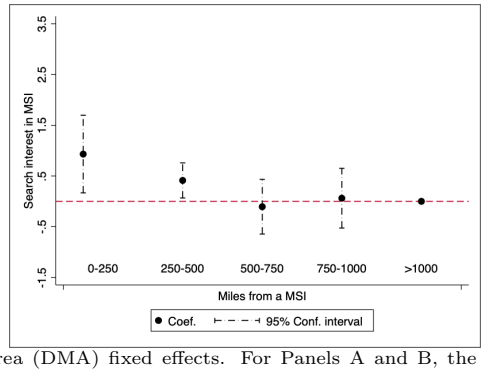
Panel B. Search Interest by Distance in Weeks (500 Miles from MSI)



Panel C. Search Interest by Distance in Miles (1 Week after MSI)



Panel D. Search Interest by Distance in Miles (2 Weeks after MSI)

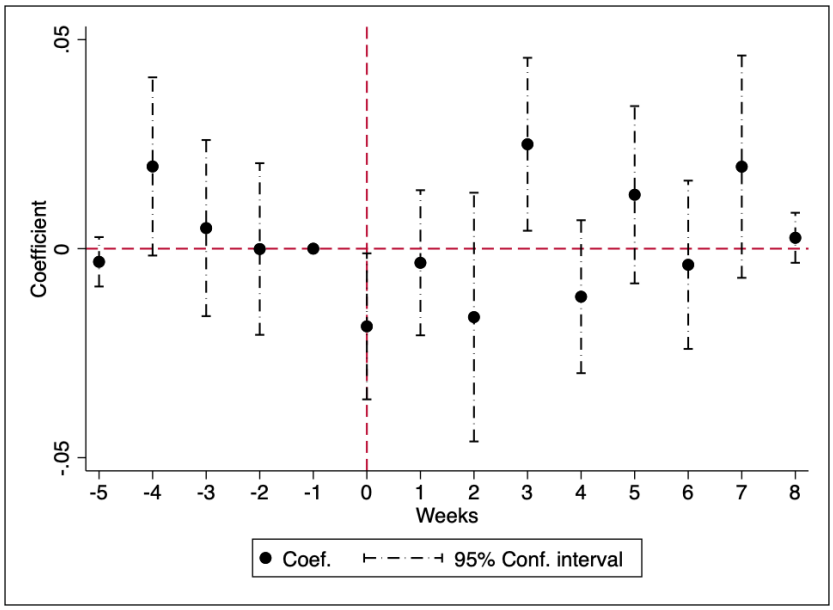


Notes: Models include year, week, Designated Market Area (DMA) fixed effects. For Panels A and B, the omitted category is $t-1$ and for Panels C and D, the omitted category are individuals who live 1000 or more miles away from an event. Dots in the graphs denote the estimated equation coefficients and spikes show the 95% confidence intervals which utilize robust standard errors clustered at the DMA level.

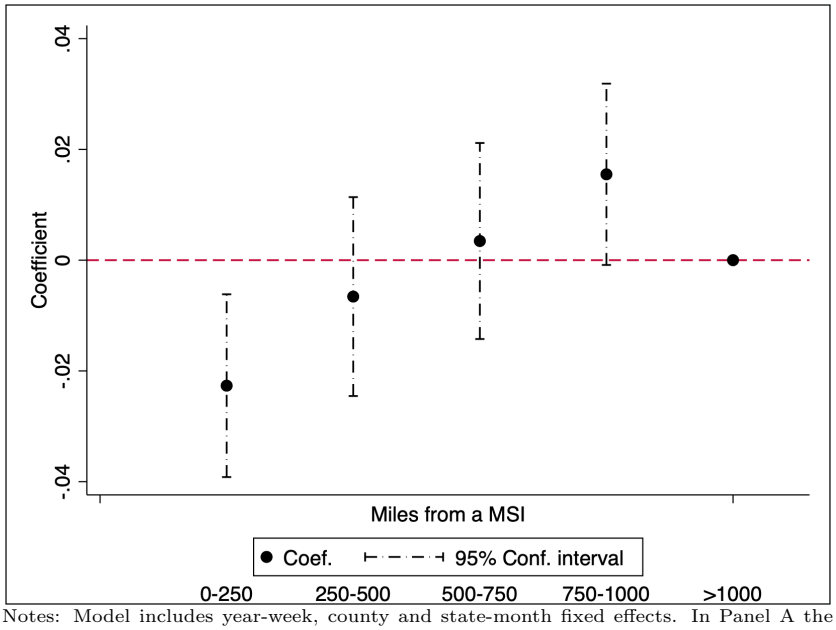
Search interest values come from averaging 100 sample draws from Google Trends. Source: Author estimations using media reports compiled by Mother Jones U.S. Mass Shootings data and Google Trends (www.google.com/trends) from 2011 to 2015.

Figure 3: Event Study using Logarithm of Metabolic Equivalents of Task as Outcome by Distance in Weeks and Miles to a Mass Shooting Incident (MSI)

Panel A. Activity Levels by Weeks to MSI



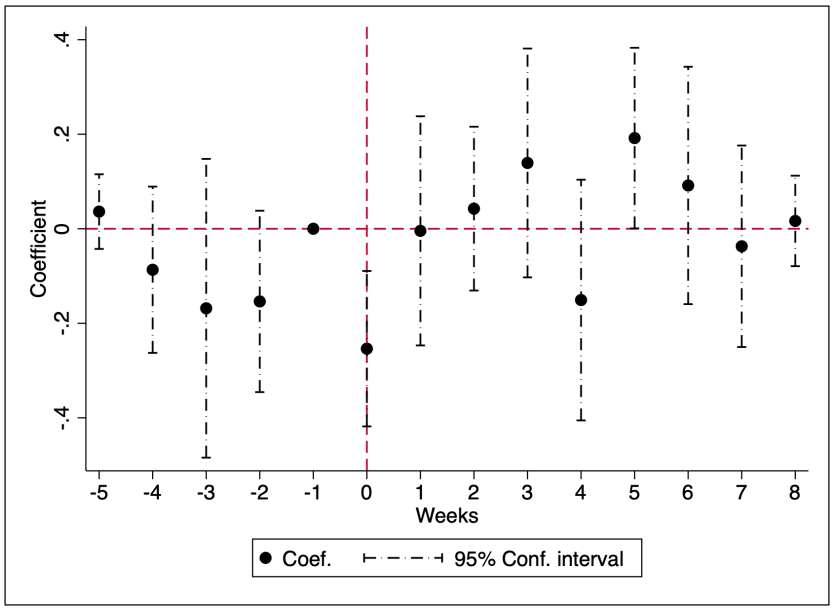
Panel B. Activity Levels by Miles from MSI



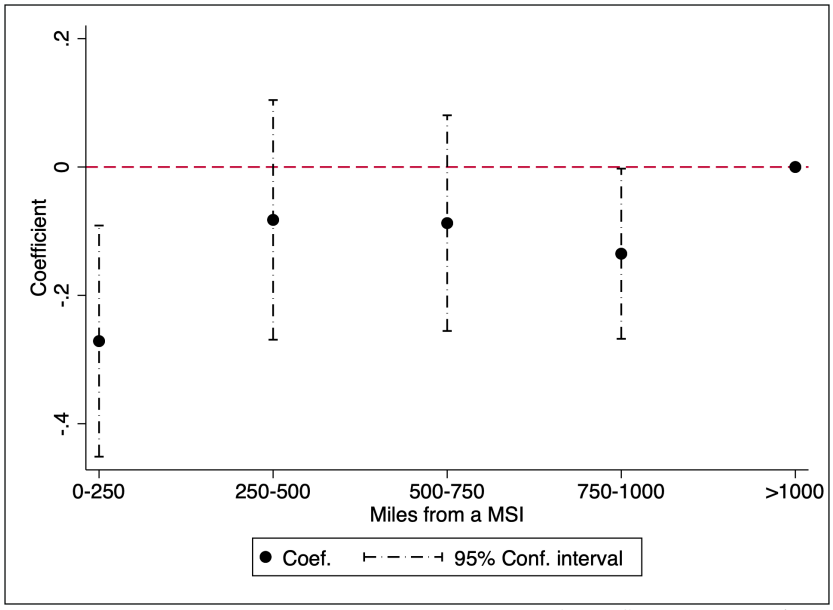
Notes: Model includes year-week, county and state-month fixed effects. In Panel A the omitted category is one week before a MSI. For Panel B the omitted category are individuals who live 1000 or more miles away from an event. Dots in the graphs denote the estimated equation coefficients and spikes show the 95% confidence intervals which utilize robust standard errors clustered at the county level. Author estimations using ATUS data from 2003 to 2016.

Figure 4: Event Study using Hours Worked Last Week as Outcome by Distance in Weeks and Miles to a Mass Shooting Incident (MSI)

Panel A. Total Hours Worked by Weeks to MSI



Panel B. Total Hours Worked by Miles from MSI



Notes: Models include year-week,county and state-month fixed effects. In Panel A the omitted category is one week before a MSI. For Panel B the omitted category are individuals who live 1000 or more miles away from an event. Dots in the graphs denote the estimated equation coefficients and spikes show the 95% confidence intervals which utilize robust standard errors clustered at the county level. Author estimations using CPS data from 2003 to 2016.

6.2 Tables

Table 1: Time Use, Activity Levels and Sociodemographic Characteristics Descriptive Statistics

	(1)	(2)	(3)	(4)
Variable	Total	>2 week or 250 miles from MSI	<2 week and 250 miles from MSI	(2)-(3) P-value
Metabolic Val.	37.86	37.87	36.93	0.00
Sedentary Activities (mins)	877.50	877.52	875.79	0.89
Light Activities (mins)	459.20	459.01	474.65	0.24
Moderate and Vigorous Activities (mins)	91.04	91.22	75.39	0.01
Minutes at Home	443.05	443.09	439.41	0.79
Minutes in Public Places	389.39	389.48	381.82	0.58
Recreational Activities (mins)	18.71	18.76	14.53	0.03
African-American	0.12	0.12	0.15	0.16
Hispanic	0.20	0.20	0.20	0.75
White	0.61	0.61	0.62	0.83
Ed. < High School	0.18	0.18	0.14	0.02
Ed. High School	0.30	0.30	0.31	0.45
Ed. Some College	0.21	0.21	0.20	0.81
Ed. College or More	0.32	0.32	0.34	0.23
Age [15,24]	0.18	0.18	0.18	0.73
Age [25,34]	0.18	0.18	0.19	0.49
Age [35,44]	0.18	0.18	0.16	0.18
Age [45,54]	0.17	0.17	0.17	0.96
Age [55,64]	0.14	0.14	0.13	0.51
Age 65 or More	0.16	0.16	0.16	0.64
Income $<10k$	0.06	0.06	0.04	0.16
Income $[10,15k)$	0.05	0.05	0.05	0.37
Income $[15,20k)$	0.04	0.04	0.03	0.07
Income $[20,25k)$	0.05	0.05	0.07	0.24
Income $[25,35k)$	0.12	0.12	0.12	0.87
Income $[35,50k)$	0.14	0.14	0.14	0.84
Income $[50,75k)$	0.19	0.19	0.20	0.60
Income $>75k$	0.35	0.35	0.36	0.83
Married	0.51	0.51	0.44	0.01
Single	0.32	0.32	0.37	0.05
Children<18	0.29	0.29	0.29	0.76
Average Temp. (F)	59.29	59.33	56.35	0.00
Hours of Sunlight	12.18	12.18	12.02	0.06
Last year's State Violent Crime Rate	448.77	449.11	420.12	0.00

Notes: n=78,638. Author estimations using ATUS data from 2003 to 2016.

Table 2: Estimation Results for Metabolic Equivalents of Task after a Mass Shooting

	(1)	(2)	(3)
Panel A: Metabolic Equivalents of Task Logarithm, mean: 3.618 , S.D.: 0.176			
Mass Shooting within 250 miles	-0.018***	-0.017***	-0.017***
	(0.007)	(0.007)	(0.006)
Mass Shooting within 500 miles	-0.013**	-0.013**	-0.013**
	(0.006)	(0.006)	(0.006)
Year-Week Fixed Effects	Yes	Yes	Yes
State-Month Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
Day of the Week and Holiday Fixed Effects	Yes	Yes	Yes
Sociodem. Charact.	No	Yes	Yes
Temperature and Hours of Sunlight	No	No	Yes
Last Year Violent Crime Rate	No	No	Yes
Observations	78,638	78,638	78,638

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors clustered at the county level.
Author estimations using ATUS from 2003 to 2016.

Table 3: Estimation Results for Activity Outcomes by Level of Strenuousness After a Mass Shooting

	(1)	(2)	(3)
Panel A: Minutes of Sleep, mean: 522.054			
Mass Shooting within 250 miles	10.409	10.028	9.986
	(6.441)	(6.343)	(6.333)
Panel B: Minutes of Sedentary Activities, mean: 355.443			
Mass Shooting within 250 miles	-5.066	-3.549	-3.512
	(10.891)	(10.777)	(10.772)
Panel C: Minutes of Light Activities, mean: 459.195			
Mass Shooting within 250 miles	4.232	1.272	1.217
	(13.164)	(12.793)	(12.802)
Panel D: Minutes of Moderate and Vigorous Activities, mean: 91.038			
Mass Shooting within 250 miles	-10.944*	-9.093*	-9.029*
	(5.661)	(5.346)	(5.345)
Year-Week Fixed Effects	Yes	Yes	Yes
State-Month Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
Day of the Week and Holiday Fixed Effects	Yes	Yes	Yes
Sociodem. Charact.	No	Yes	Yes
Weather and State Violent Crime Rates	No	No	Yes
Observations	78,638	78,638	78,638

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors clustered at the county level. Author estimations using ATUS data from 2003 to 2016.

Table 4: Estimation Results for Location of Activity Outcomes After a Mass Shooting

	(1)	(2)	(3)
Panel A: Minutes at Home, mean: 443.051			
Mass Shooting within 250 miles	2.467	5.212	5.214
	(13.224)	(12.803)	(12.790)
Panel B: Minutes in Public Places, mean: 389.394			
Mass Shooting within 250 miles	-13.110	-14.426	-14.409
	(14.150)	(13.878)	(13.863)
Observations	78,638	78,638	78,638
Panel C: Minutes at Work, mean: 290.539			
Mass Shooting within 250 miles	-31.498**	-31.906**	-31.427**
	(14.630)	(14.539)	(14.577)
Observations	48,784	48,784	48,784
Panel D: Minutes Working, mean: 312.576			
Mass Shooting within 250 miles	-15.260	-15.265	-14.754
	(14.581)	(13.852)	(13.878)
Observations	48,784	48,784	48,784
Year-Week Fixed Effects	Yes	Yes	Yes
State-Month Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
Day of the Week and Holiday Fixed Effects	Yes	Yes	Yes
Sociodem. Charact.	No	Yes	Yes
Weather and State Violent Crime Rates	No	No	Yes

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors clustered at the county level.
Author estimations using ATUS data from 2003 to 2016.

Table 5: Heterogeneous Effects for Main Activity Outcomes After a Mass Shooting

	Ln. Met Act.	Mins. Sleep	Mod. and Vig. Act.	Mins. Public.	Mins. Home
Full Sample	-0.017***	9.986	-9.029*	-14.409	5.214
	(0.006)	(6.333)	(5.345)	(13.863)	(12.790)
Gender					
Women	-0.010	3.485	1.084	11.003	-12.202
	(0.007)	(7.727)	(5.607)	(15.811)	(14.010)
Men	-0.023**	15.226	-19.542*	-39.403*	19.281
	(0.011)	(10.222)	(10.636)	(20.522)	(19.968)
Race-ethnicity					
White	-0.011	9.122	-9.430	-20.970	10.676
	(0.009)	(8.925)	(7.554)	(19.736)	(17.230)
Black	-0.024	-3.004	-7.112	-34.498	36.127
	(0.018)	(15.654)	(10.743)	(34.312)	(33.967)
Hispanic	-0.032**	27.123**	-4.934	13.766	-35.693
	(0.015)	(12.322)	(16.966)	(35.599)	(34.754)
Educational attainment					
Highschool or less	-0.012	3.790	0.222	1.501	1.857
	(0.013)	(9.407)	(11.256)	(18.243)	(18.924)
Some College	-0.038**	16.520	-31.952***	-42.677	10.033
	(0.017)	(12.275)	(10.343)	(29.963)	(24.246)
College or more	0.005	8.368	0.991	1.247	-7.991
	(0.010)	(8.991)	(7.910)	(19.403)	(18.953)
Age					
15 to 29	-0.032**	6.442	-18.722	-63.585*	50.563
	(0.014)	(16.096)	(12.370)	(35.019)	(34.112)
30 to 44	-0.025*	13.674	-17.795	11.307	-16.202
	(0.014)	(9.683)	(11.784)	(21.145)	(17.757)
45 to 64	-0.002	7.098	-1.035	2.262	-14.234
	(0.012)	(9.107)	(10.599)	(22.689)	(20.134)
More than 64	-0.023	2.950	-11.117	-13.419	8.169
	(0.016)	(13.765)	(14.313)	(22.429)	(24.695)

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors clustered at the County level. Estimations use, Year-week, State-month, County and day of the week Fixed Effects. The models include as covariates Sociodemographic Characteristics, if the survey day was a holiday, Weather and State Violent Crime Rates Author estimations using ATUS data from 2003 to 2016.

Table 6: Estimation Results for Hours Worked After a Mass Shooting

	(1)	(2)
Panel A: Hours Worked Last Week, mean: 38.500		
Mass Shooting within 250 miles	-0.184**	-0.177**
	(0.073)	(0.070)
Panel B: Hours Worked Last Week (Main Job), mean: 37.877		
Mass Shooting within 250 miles	-0.132*	-0.126*
	(0.070)	(0.068)
Panel C: Hours Worked Last Week (Other Jobs) mean: 0.665		
Mass Shooting within 250 miles	-0.048**	-0.046**
	(0.020)	(0.020)
Year-Month Fixed Effects	Yes	Yes
County Fixed Effects	Yes	Yes
Sociodem. Charact.	No	Yes
Observations	4,176,782	4,176,782

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors clustered at the county level. Author estimations using CPS data from 2003 to 2016.

Table 7: Heterogeneous Effects for Total Hours Worked

	250 miles
Full Sample	-0.177**
	(0.070)
Gender	
Women	-0.149
	(0.096)
Men	-0.211**
	(0.094)
Race-ethnicity	
White	-0.143*
	(0.083)
Black	-0.025
	(0.219)
Hispanic	-0.304*
	(0.167)
Educational attainment	
Less than Highschool	-0.294
	(0.218)
Highschool	-0.028
	(0.123)
Some College	-0.437***
	(0.165)
College or more	-0.126
	(0.101)
Age	
18 to 29	0.002
	(0.176)
30 to 44	-0.138
	(0.133)
45 to 64	-0.295***
	(0.106)
>64	-0.335
	(0.329)

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors clustered at the County level. Estimations use, Year-month, and County Fixed Effects. The models include as covariates Sociodemographic Characteristics.
Author estimations using CPS data from 2003 to 2016.

Table 8: Estimation Results for Main Health Outcomes a Month After a Mass Shooting Has Occurred in the Last 30 days

	(1)	(2)
Panel A: Days mental health was not good in the past month, mean: 3.698		
Mass Shooting within 250 miles in the last 30 days	0.064	0.063
	(0.086)	(0.079)
Panel B: Having any day mental health was not good, mean: 0.345		
Mass Shooting within 250 miles in the last 30 days	-0.004	-0.004
	(0.005)	(0.004)
Panel C: Days mental health was not good given there was at least one not good day, mean: 10.733		
Mass Shooting within 250 miles in the last 30 days	0.320*	0.348**
	(0.180)	(0.173)
Panel D: Having 14 or more days mental health was not good, mean: 0.114		
Mass Shooting within 250 miles in the last 30 days	0.004	0.004
	(0.003)	(0.003)
Panel E: Drinks per month, mean: 12.260		
Mass Shooting within 250 miles in the last 30 days	0.414	0.445
	(0.394)	(0.348)
Panel F: Binge Drinker, mean: 0.160		
Mass Shooting within 250 miles in the last 30 days	0.008*	0.008**
	(0.004)	(0.003)
Year-Week Fixed Effects	Yes	Yes
State-Month Fixed Effects	Yes	Yes
State Fixed Effects	Yes	Yes
Sociodem. Charact.	No	Yes
Weather and State Violent Crime Rates	No	Yes
Observations	5,147,060	5,147,060

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors clustered at the state level. Author estimations using BRFSS data from 2004 to 2016.

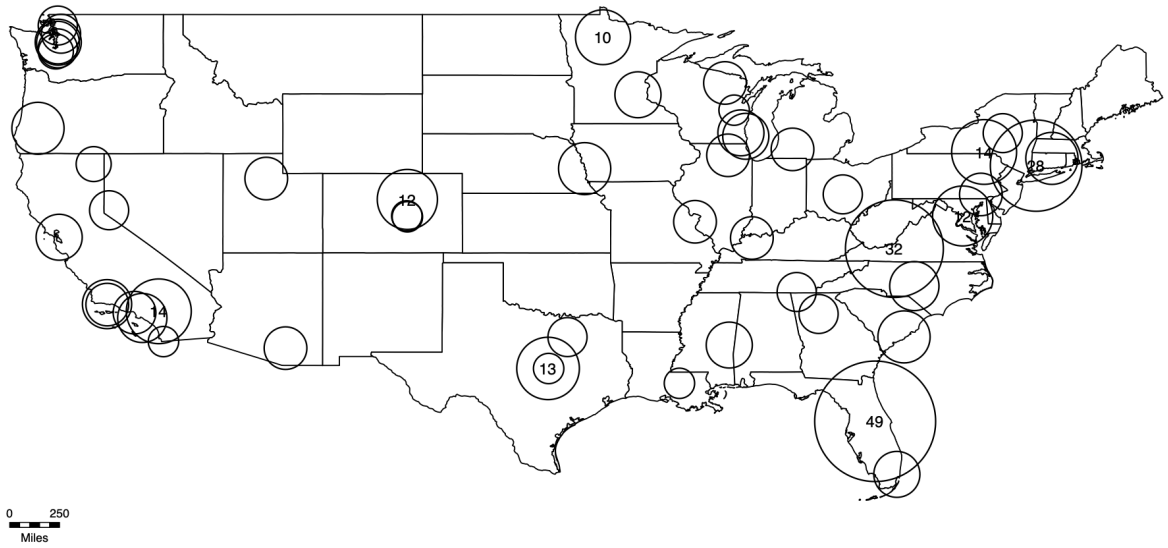
Table 9: Heterogeneous effects for days when mental health was not good (MHDays) within 2 weeks and 250 miles of a mass shooting

	MHDays≥ 1	MHDays≥ 14	Drinks/month	Binge Drinker
Full Sample	0.348**	0.004	0.445	0.008**
	(0.173)	(0.003)	(0.348)	(0.003)
Gender				
Women	0.221*	0.002	0.001	0.005
	(0.121)	(0.003)	(0.292)	(0.003)
Men	0.529	0.005	0.948*	0.010**
	(0.347)	(0.005)	(0.560)	(0.005)
Race-ethnicity				
White	0.268	0.003	0.456	0.010***
	(0.184)	(0.003)	(0.345)	(0.004)
Black	0.202	0.007	1.399**	0.009
	(0.376)	(0.007)	(0.690)	(0.011)
Hispanic	1.130**	0.014	0.519	-0.007
	(0.511)	(0.011)	(0.839)	(0.005)
Educational attainment				
Highschool or less	0.195	0.000	0.670	0.012*
	(0.232)	(0.003)	(0.753)	(0.006)
Some College	0.363	0.006	0.382	0.006
	(0.241)	(0.005)	(0.517)	(0.005)
College or more	0.212*	0.002	-0.244	0.001
	(0.114)	(0.002)	(0.364)	(0.004)
Age				
15 to 29	0.509	0.014	1.846*	0.013
	(0.381)	(0.009)	(1.046)	(0.011)
30 to 44	0.343*	0.003	1.037**	0.008
	(0.191)	(0.005)	(0.499)	(0.006)
45 to 64	0.329	0.002	-0.408	0.006
	(0.226)	(0.004)	(0.482)	(0.004)
More than 64	0.178	-0.001	-0.356	0.002
	(0.255)	(0.005)	(0.439)	(0.002)

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors clustered at the County level. Estimations use, Year-week, State-month, County and day of the week Fixed Effects. The models include as covariates Sociodemographic Characteristics, if the survey day was a holiday, Weather and State Violent Crime Rates.
Author estimations using ATUS data from 2003 to 2016.

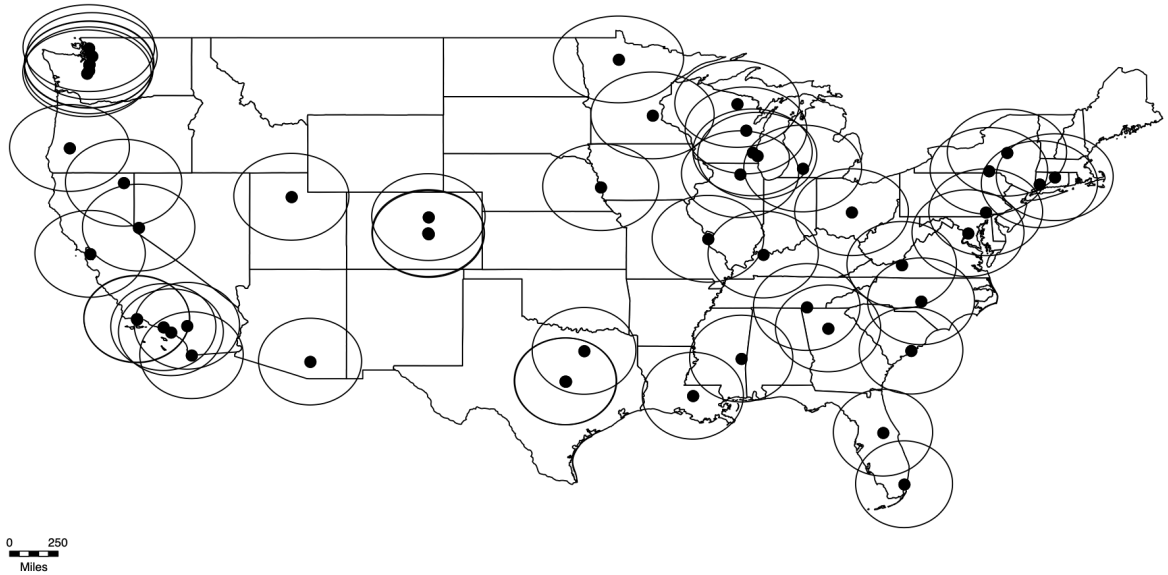
7 Appendix

Figure 5: Mass Shootings in the United States 2003-2016



Note: Circles are proportional to the number of fatalities in each event. Only events above 9 fatalities have a number in the figure for presentation purposes. Source: Media reports compiled by Mother Jones U.S. Mass Shootings from 2003 to 2016.

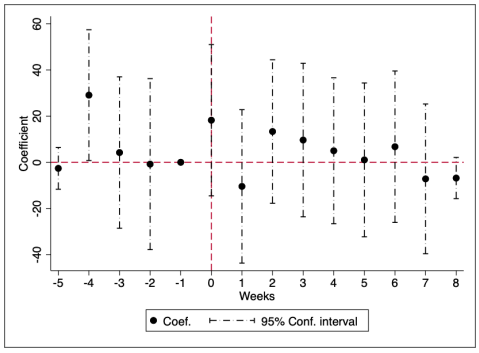
Figure 6: Identification Strategy: Mass Shootings within a 250 miles radius in the United States 2003-2016



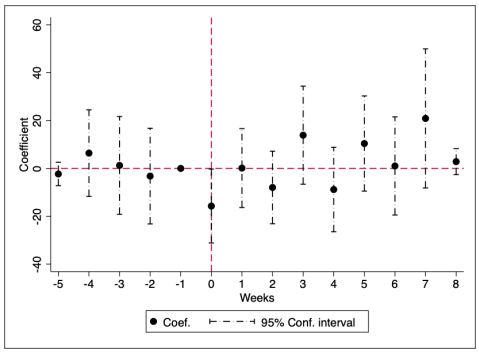
Note: Radius is shown only for events with more than 9 fatalities for presentation purposes. Source: Media reports compiled by Mother Jones U.S. Mass Shootings from 2003 to 2016.

Figure 7: Activity levels by distance in weeks

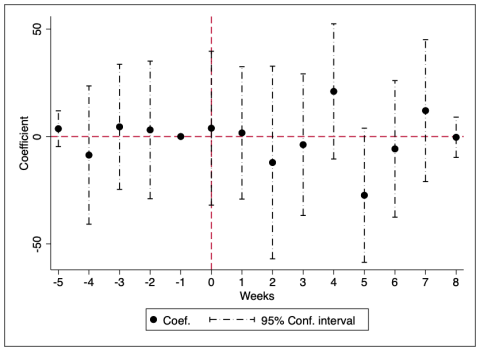
Panel A. Minutes of Light Activities



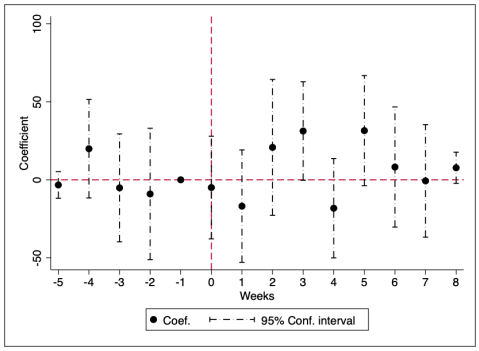
Panel B. Minutes of Moderate to Vigorous Activities



Panel C. Minutes at Home



Panel D. Minutes in Public Places



Notes: Model includes year-week,county and state-month fixed effects. Author estimations using ATUS data from 2003 to 2016.

Table A1: Mass Shootings included in the analysis, 2003 to 2016

Case	Location	Date	Fatalities	Injured
Lockheed Martin shooting	Meridian, Mississippi	07/08/03	7	8
Damageplan show shooting	Columbus, Ohio	12/08/04	5	7
Living Church of God shooting	Brookfield, Wisconsin	03/12/05	7	4
Red Lake massacre	Red Lake, Minnesota	03/21/05	10	5
Goleta postal shootings	Goleta, California	01/30/06	8	0
Capitol Hill massacre	Seattle, Washington	03/25/06	7	2
Amish school shooting	Lancaster County, Pennsylvania	10/02/06	6	5
Trolley Square shooting	Salt Lake City, Utah	02/12/07	6	4
Virginia Tech massacre	Blacksburg, Virginia	04/16/07	32	23
Crandon shooting	Crandon, Wisconsin	10/07/07	6	1
Westroads Mall shooting	Omaha, Nebraska	12/05/07	9	4
Kirkwood City Council shooting	Kirkwood, Missouri	02/07/08	6	2
Northern Illinois University shooting	DeKalb, Illinois	02/14/08	6	21
Atlantis Plastics shooting	Henderson, Kentucky	06/25/08	6	1
Carthage nursing home shooting	Carthage, North Carolina	03/29/09	8	3
Binghamton shootings	Binghamton, New York	04/03/09	14	4
Fort Hood massacre	Fort Hood, Texas	11/05/09	13	30
Coffee shop police killings	Parkland, Washington	11/29/09	4	1
Hartford Beer Distributor shooting	Manchester, Connecticut	08/03/10	9	2
Tucson shooting	Tucson, Arizona	01/08/11	6	13
IHOP shooting	Carson City, Nevada	09/06/11	5	7
Seal Beach shooting	Seal Beach, California	10/14/11	8	1
Su Jung Health Sauna shooting	Norcross, Georgia	02/22/12	5	0
Oikos University killings	Oakland, California	04/02/12	7	3
Seattle cafe shooting	Seattle, Washington	05/20/12	6	1
Aurora theater shooting	Aurora, Colorado	07/20/12	12	70
Sikh temple shooting	Oak Creek, Wisconsin	08/05/12	7	3
Accent Signage Systems shooting	Minneapolis, Minnesota	09/27/12	7	1
Newtown school shooting	Newtown, Connecticut	12/14/12	28	2
Mohawk Valley shootings	Herkimer County, New York	03/13/13	5	2
Pinewood Village Apartment shooting	Federal Way, Washington	04/21/13	5	0
Santa Monica rampage	Santa Monica, California	06/07/13	6	3
Hialeah apartment shooting	Hialeah, Florida	07/26/13	7	0
Washington Navy Yard shooting	Washington, D.C.	09/16/13	12	8
Alturas tribal shooting	Alturas, California	02/20/14	4	2
Isla Vista mass murder	Santa Barbara, California	05/23/14	6	13
Marysville-Pilchuck High School shooting	Marysville, Washington	10/24/14	5	1
Charleston Church Shooting	Charleston, South Carolina	06/17/15	9	1
Chattanooga military recruitment center	Chattanooga, Tennessee	07/16/15	5	2
Umpqua Community College shooting	Roseburg, Oregon	10/01/15	9	9
San Bernardino mass shooting	San Bernardino, California	12/02/15	14	21
Kalamazoo shooting spree	Kalamazoo County, Michigan	2/20/16	6	2
Orlando nightclub massacre	Orlando, Florida	6/12/16	49	53
Dallas police shooting	Dallas, Texas	7/7/16	5	11
Cascade Mall shooting	Burlington, Washington	9/23/16	5	0

Source: Media reports compiled by Mother Jones Mass Shootings data from 2003 to 2016.

Table A2: Estimation results for Metabolic Equivalents of Activity Using Different Sources for Mass Shootings

	(1)	(2)	(3)
Panel A: Mother Jones Mass Shootings Media Reports Data			
Mass Shooting within 250 miles	-0.018***	-0.017***	-0.017***
	(0.007)	(0.007)	(0.006)
Mass Shooting within 500 miles	-0.013**	-0.013**	-0.013**
	(0.006)	(0.006)	(0.006)
Panel B: Stanford Mass Shootings of America (MSA) Data Project			
Mass Shooting within 250 miles	-0.014*	-0.013*	-0.013*
	(0.008)	(0.008)	(0.008)
Mass Shooting within 500 miles	-0.009	-0.010*	-0.010*
	(0.006)	(0.006)	(0.006)
Year-Week Fixed Effects	Yes	Yes	Yes
State-Month Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
Day of the Week and Holiday Fixed Effects	Yes	Yes	Yes
Sociodem. Charact.	No	Yes	Yes
Weather and hours of sunlight	No	No	Yes
Observations	78,638	78,638	78,638

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors clustered at the county level.
Author estimations using ATUS data from 2003 to 2016.

Table A3: Estimation Results for Activity Outcomes After a Mass Shooting

	(1)	(2)	(3)
Panel A: Minutes of Watching TV, mean: 160.776			
Mass Shooting within 250 miles	-2.411	-0.578	-0.434
	(8.245)	(7.883)	(7.885)
Panel B: Minutes of Using Computer, mean: 10.979			
Mass Shooting within 250 miles	0.930	0.855	0.872
	(1.703)	(1.767)	(1.771)
Panel C: Minutes of Listening to the Radio, mean: 1.265			
Mass Shooting within 250 miles	-0.566	-0.519	-0.515
	(0.451)	(0.449)	(0.448)
Panel D: Minutes of Following Media, mean: 173.019			
Mass Shooting within 250 miles	-2.047	-0.242	-0.077
	(8.625)	(8.319)	(8.323)
Year-Week Fixed Effects	Yes	Yes	Yes
State-Month Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
Day of the Week and Holiday Fixed Effects	Yes	Yes	Yes
Sociodem. Charact.	No	Yes	Yes
Weather and State Violent Crime Rates	No	No	Yes
Observations	78,638	78,638	78,638

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors clustered at the county level.
Author estimations using ATUS data from 2003 to 2016.

Table A4: Estimation Results for Who Individuals did Activities With After a Mass Shooting

	(1)	(2)	(3)
Panel A: Minutes Alone, mean: 313.496			
Mass Shooting within 250 miles	-4.254	-2.198	-2.344
	(12.019)	(10.659)	(10.674)
Observations	78,638	78,638	78,638
Panel B: Minutes with Partner, mean: 301.176			
Mass Shooting within 250 miles	-12.819	-12.148	-12.450
	(15.724)	(15.484)	(15.474)
Observations	40,753	40,753	40,753
Panel C: Minutes with Children, mean: 241.800			
Mass Shooting within 250 miles	20.198	15.917	16.059
	(17.493)	(15.629)	(15.663)
Observations	35,639	35,639	35,639
Panel D: Minutes with Family, mean: 118.418			
Mass Shooting within 250 miles	16.338	13.180	13.076
	(15.404)	(13.912)	(13.907)
Observations	78,638	78,638	78,638
Panel E: Minutes with Friends, mean: 60.300			
Mass Shooting within 250 miles	-4.760	-6.242	-6.320
	(7.112)	(6.387)	(6.420)
Observations	78,638	78,638	78,638
Panel F: Minutes with Other People, mean: 56.683			
Mass Shooting within 250 miles	12.812*	11.893*	11.890*
	(7.538)	(7.193)	(7.195)
Observations	78,638	78,638	78,638
Panel G: Minutes with Co-workers, mean: 281.051			
Mass Shooting within 250 miles	-29.250	-31.662	-31.463
	(29.538)	(30.008)	(30.019)
Observations	31,087	31,087	31,087
Year-Week Fixed Effects	Yes	Yes	Yes
State-Month Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
Day of the Week and Holiday Fixed Effects	Yes	Yes	Yes
Sociodem. Charact.	No	Yes	Yes
Weather and State Violent Crime Rates	No	No	Yes
Observations	78,638	78,638	78,638

Notes: * .10 ** .05 *** .01 sig. levels. Robust standard errors clustered at the county level. Author estimations using ATUS data from 2003 to 2016.