JAMA Network Open

Original Investigation | Public Health

Neighborhood Exposure to Firearm Violence and Measures of Psychosocial Distress

James Macinko, PhD; Tanvi Shinkre, PhD; Falco J. Bargagli-Stoffi, PhD; Jack Kappelman, MPA; Diana Silver, PhD

Abstract

IMPORTANCE Exposure to firearm violence is believed to have substantial indirect health effects among those who experience and witness it.

OBJECTIVE To assess whether neighborhood firearm violence is associated with psychological and behavioral outcomes.

DESIGN, SETTING, AND PARTICIPANTS This cross-sectional study links geocoded, individual-level data from adults participating in the 2021 and 2022 California Health Interview Surveys, a state-representative survey conducted annually by the UCLA Center for Health Policy Research linked to shooting events near interviewees' home from the Gun Violence Archive. Data analysis was performed from August to October 2025.

EXPOSURE Any shooting event occurring within 500 m of interviewees' households within the past 12 months (January 1, 2020, and December 31, 2022). Sensitivity analyses included any fatal shooting, any shooting within the past 2 months, and more than 1 shooting event.

MAIN OUTCOME AND MEASURES Primary outcomes were self-reported worry about experiencing firearm violence, feeling unsafe in one's neighborhood, heavy substance use, and psychological distress. Survey-adjusted multivariable Poisson regression models assessed the association between the exposure and each outcome.

RESULTS Among the 45 916 adults interviewed (mean [SD] age, 48.2 [18.7] years; 26 077 [51.8%] female), 6289 (17.2%, weighted) had a shooting occur near their home; there were no missing data. Polysubstance use was positively associated with most exposures, with the highest incident rate ratios (IRRs) among those experiencing a recent shooting in their neighborhood within the past 2 months (IRR, 1.41; 95% CI, 1.18-1.68) and those experiencing more than 1 shooting (IRR, 1.33; 95% CI, 1.14-1.55). The highest magnitude associations for each exposure were observed with the outcome of feeling unsafe in one's neighborhood among those experiencing a recent shooting event (IRR, 1.73; 95% CI, 1.52-1.97) or more than 1 shooting (IRR, 2.36; 95% CI, 2.17-2.56). All exposures had a positive association with worry about experiencing firearm violence, with IRRs of 1.14 (95% CI, 1.04-1.24) for those experiencing any shooting to 1.28 (95% CI, 1.13-1.43) for those experiencing more than 1 shooting in the past 12 months.

CONCLUSIONS AND RELEVANCE In this cross-sectional study of the association between firearm violence and self-reported psychosocial distress, exposure to neighborhood firearm violence was associated with a range of outcomes that may affect people's perceptions of their safety and could potentially contribute to negative coping behaviors, such as substance use.

Key Points

Question Is neighborhood exposure to firearm violence associated with psychosocial distress, perceptions of safety, and substance use among adults in California?

Findings In this cross-sectional study of 45 916 adults, 17.2% experienced a shooting within 500 m of their home. Shooting exposure was associated with worry about experiencing firearm violence, feeling unsafe in one's neighborhood, and substance use but not psychological distress overall.

Meaning Neighborhood firearm violence may affect residents beyond direct physical injury by influencing perceived safety and negative coping behaviors, but longitudinal research is needed to establish causality.

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

JAMA Network Open. 2026;9(11):e2644237. doi:10.1001/jamanetworkopen.2026.44237

Open Access. This is an open access article distributed under the terms of the CC-BY-NC-ND License, which does not permit alteration or commercial use, including those for text and data mining, AI training, and similar technologies.

jamanetwork/2026/jno/11_16_2026/zoi261187 PAGE: 1 SESS: 49 OUTPUT: Oct 27 13:29 2026

Introduction

Firearm violence is ubiquitous in the US.[1] Despite recent decreases in some locations, it continues to be a leading cause of death and disability, contributing to more than 47 000 deaths in 2023 and generating societal costs estimated at $500 billion.[2] Beyond the direct physical impacts of firearm violence, there are additional emotional, psychological, and behavioral effects, including posttraumatic stress disorder.[3] Whether due to direct experience or through vicarious exposure, nearly one-third of adults and one-quarter of adolescents have reported being very anxious or very worried about firearm violence.[4,5]

Concern or worry about firearm violence can translate into behaviors such as acquiring a firearm to feel safer[6] or health outcomes such as depression,[7] suicidal ideation,[8] and violence.[9] Violent crime involving a firearm may result in greater emotional and physical repercussions than violent crimes involving other types of weapons.[10] Moreover, exposure to firearm violence is more often experienced by racial and ethnic minoritized populations, suggesting a concentration of multiple risk factors for experiencing gun violence either directly or indirectly.[8]

This exploratory study assesses the association between psychosocial factors and exposure to firearm-related violence in several ways. First, this study links geospatial data on specific firearm violence incidents (not self-reported) to high-quality, individual-level survey data to assess factors associated with exposure to a shooting event that occurred near one's home address. Second, it tests how different ways of operationalizing exposure to local firearm violence may affect these associations. Third, it assesses several interrelated measures of psychosocial distress that could plausibly be influenced by firearm violence exposure, including substance use behaviors. This is of particular concern given the association between prior or habitual alcohol use and firearm-related homicide and suicide[11] and evidence of significant increases in alcohol sales after a mass shooting event.[12]

Methods

Data and Measures

This cross-sectional study uses individual-level data from all 45 916 adults in the combined 2021 and 2022 California Health Interview Survey (CHIS), a state-representative survey conducted annually by the UCLA Center for Health Policy Research. The CHIS team uses several imputation techniques to produce datasets with no missing data, as detailed elsewhere.[18] Implied consent is obtained once a respondent hears an introductory script and voluntarily chooses to proceed. The CHIS is approved under the University of California, Los Angeles Institutional Review Board. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline for cross-sectional studies.

Using the CHIS secure data access center, we linked each survey respondent's residential mailing address (where they received the invitation to participate in the study) to geocoded data from the Gun Violence Archive (GVA) to obtain a precise measure of each individual's exposure to shooting events from January 1, 2020, to December 31, 2022. An individual was considered exposed if a shooting event occurred in the 500-m buffer around the individual's home any time in the 12 months before their interview date (eMethods in Supplement 1). A 500-m range represents the average distance a person could walk in 5 to 6 minutes.[13] Previous work[14] also suggests that the closer the proximity to a shooting event, the higher the risk of negative health outcomes. We constructed additional measures, which can be considered to be of increasing potential salience: the occurrence of any fatal shooting, any recent shooting (within the past 2 months), and more than 1 shooting in the specified area in the 12 months before interview.

Our main dependent variable is the response to the following question: "How worried are you about being the victim of gun violence? Are you…very worried, somewhat worried, not too worried, or not at all worried?" We combine responses for very and somewhat worried vs not too and not at

jamanetwork/2026/jno/11_16_2026/zoi261187 PAGE: 2 SESS: 49 OUTPUT: Oct 27 13:29 2026

all worried to construct our binary outcome measure. We also assess whether the respondent feels safe in their neighborhood some or none of the time (vs all or most of the time). To explore potential downstream results of exposure to firearm violence, we examine moderate or severe psychological distress in the past 30 days (a score of 9 of 24 or greater from the Kessler Psychological Distress Scale[15]), whether respondents report any heavy substance use (binge or heavy alcohol consumption, ≥10 days of marijuana use, any illicit drug use, or any tobacco use), or polysubstance use (>1 of the previous items) all in the past 30 days.

Self-reported control variables include age groups, birth sex (male or female), race and ethnicity (African American, Asian, Latino or Hispanic, White, and other groups, including American Indian, Asian or Pacific Islander, and multiple races), income tertiles (<$60 000, $60 000-$119 000, ≥$120 000), educational attainment (college vs less), poor or fair self-rated health, and report of any exposure to violence before the age of 18 years. We included an index of perceived neighborhood social capital derived from the sum of responses to the following binary questions: people in my neighborhood are (1) not willing to help each other, (2) do not get along, and (3) cannot be trusted to control for neighborhood social disorganization, a proxy for crime.[16]

Firearm access (operationalized as having at least 1 gun in the house) is both a risk factor for shooting events as well as a possible reaction to experienced or perceived risk of violence.[17] For this reason, we hypothesized that gun access may moderate the association of a shooting exposure with outcomes and therefore stratify secondary analyses by gun access.

Statistical Analysis

All CHIS analyses use the provided replicate weights to account for sample selection probabilities, undercoverage, and nonresponse bias, making results representative of the noninstitutionalized adult population of California. We additionally incorporated variance estimation adjustments to correct for the survey's complex sampling design.[19]

We estimated the association between each exposure and each outcome using multiple regression analyses that adjust for relevant covariates. Because the prevalence of each outcome is greater than 10%,[20] regression analyses used a survey-adjusted Poisson specification with exponentiated regression coefficients to obtain incident rate ratios (IRRs).[21] To assess absolute differences in outcomes between those exposed and unexposed to gun violence, we transformed fully adjusted IRRs into predicted probabilities using marginal standardization and calculated differences between exposed and unexposed groups.[22] Predicted probabilities for each outcome are presented by household gun access status along with a Wald *z* test for interactions between gun access and each exposure.[23] For all results, a 2-sided $P < .05$ was used to identify statistical significance. Data were analyzed from August to October 2025 using the statistical program R, version 4.5.1 (R Foundation for Statistical Computing).

Results

Figure 1 maps the Gun Violence Archive (GVA) data to display the locations of all recorded shooting events that took place during the study period. Figure 1 shows that every county had at least 1 shooting recorded during the study period. Most shootings were clustered primarily in large metropolitan areas in the Northern (Alameda, San Bernadino, and Sacramento), Central (Fresno), and Southern (Los Angeles and San Diego) regions of the state. This clustering was relatively consistent during the study period. Shooting events in California increased slightly from 2020 to 2021 and then decreased slightly in 2022 (eFigure in Supplement 1). Approximately half of all shootings during this period resulted in at least 1 death. In total, from 2020 to 2022, there were 12 546 people (including perpetrators) killed or injured due to gunfire.

A total of 45 916 adults (mean [SD] age, 48.2 [18.7] years; 26 077 [51.8%] female; 7240 [13.8%] Asian, 2197 [5.6%] Black, 6827 [23.4%] Latino or Hispanic, 23 215 [42.0%] White, and 6437 [15.2%] other races or ethnicities) were interviewed in California between 2021 and 2022. A total of 20 550

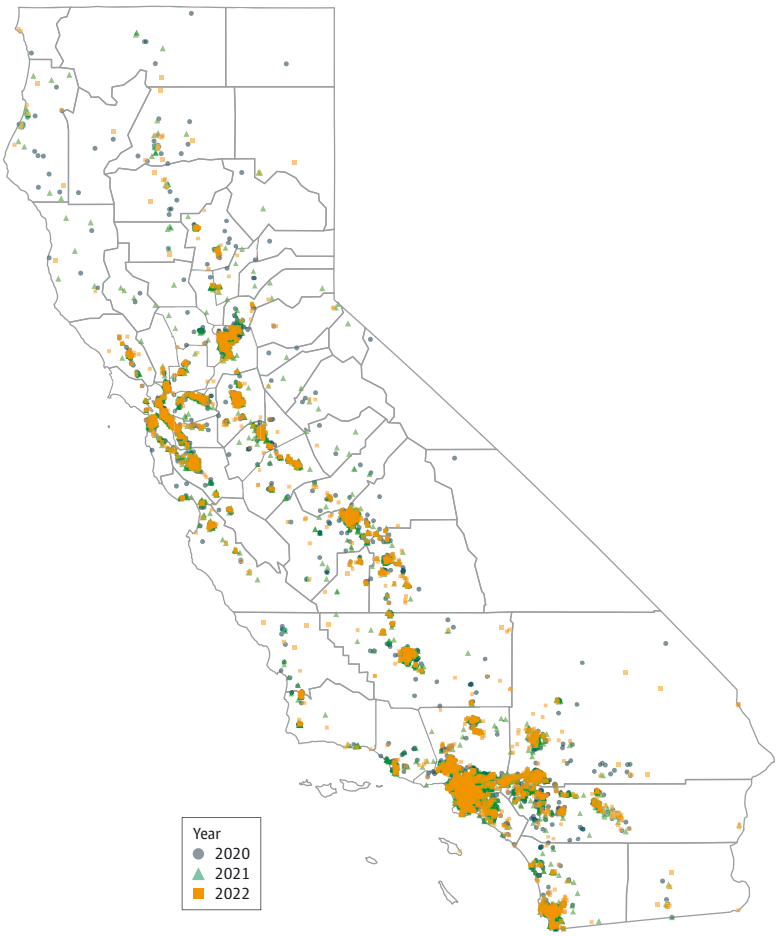
jamanetwork/2026/jno/11_16_2026/zoi261187 PAGE: 3 SESS: 49 OUTPUT: Oct 27 13:29 2026

(56.8%) had a college education or higher, and 17 316 (41.0%) had household incomes below $60 000. A total of 32 050 (63.9%) reported living in an area with high social capital, 9533 (17.8%) had a firearm in the household, and 9925 (22.9%) reported experiencing violence before the age of 18 years. Weighted and survey-adjusted characteristics of respondents are given in the **Table**.

A total of 6289 respondents (unweighted percentage, 18.9%; weighted percentage, 17.2%) had 1 and 2114 (unweighted percentage, 4.8%; weighted percentage, 5.9%) had 2 or more shootings occur within 500 m of their home address in the 12 months before their interview. A total of 3906 (unweighted percentage, 9.3%; weighted percentage, 11.0%) experienced a fatal shooting and 1437 (unweighted percentage, 3.2%; weighted percentage, 4.2%) a recent shooting within 500 m of their home address. A total of 5330 (14.6%) reported being "very worried" about experiencing gun violence, and 4564 (13.1%) reported feeling unsafe in their neighborhood. A total of 13 236 (29.2%) of the sample used any substance in the past 30 days, and 3303 (9.1%) experienced mental distress.

Descriptive characteristics of those exposed and unexposed to firearm violence are presented in eTable 1 in Supplement 1. Exposed respondents were more likely to be aged 18 to 29 years (25.2% vs 21.1%; $P < .001$), male (48.4% vs 43.5%; $P < .001$), Latino or Hispanic (34.7% vs 21.5%; $P < .001$), or Black (11.1% vs 4.5%; $P < .001$), have household incomes below $60 000 (54.5% vs 38.1%; $P < .001$), have a college degree or higher (68.1% vs 54.9%; $P < .001$), have experienced violence before the age of 18 years (28.5% vs 22.2%; $P < .001$), and use any substance in the past 30 days (31.3% vs 29.2%; $P = .048$).

Figure 1. Map of Shooting Events in California, 2020 to 2022



Lines in map designate county borders. Data are from the Gun Violence Archive.[52]

jamanetwork/2026/jno/11_16_2026/zoi261187 PAGE: 4 SESS: 49 OUTPUT: Oct 27 13:29 2026

Table. Descriptive Characteristics of the Study Sample[a]

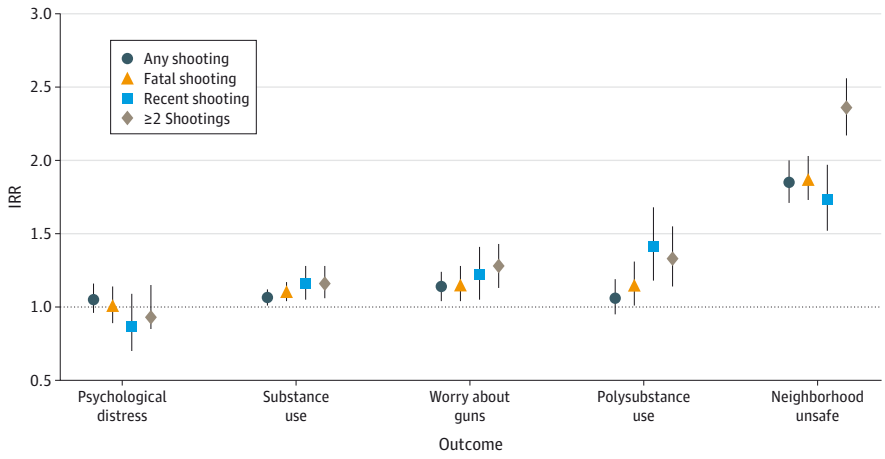
Characteristic	No. (%) [95% CI] (N = 45 916)[b]
Age, mean (SD), y	48.2 (18.7)
Sex	
Male	19 816 (48.2) [48.0-58.5]
Female	26 077 (51.8) [51.5-52.0]
Race and ethnicity	
African American or Black	2197 (5.6) [5.5-5.8]
Asian	7240 (13.8) [13.7-14.0]
Latino or Hispanic	6827 (23.4) [23.0-23.8]
White	23 215 (42.0) [41.8-42.2]
All other races and ethnicities[c]	6437 (15.2) [14.8-15.8]
Educational attainment	
Less than college education	25 366 (43.2) [42.8-43.6]
College or more	20 550 (56.8) [56.4-57.2]
Annual income, $	
<60 000	17 316 (41.0) [40.4-41.6]
60 000-119 000	13 513 (28.1) [27.5-28.7]
≥120 000	15 087 (30.9) [30.4-31.4]
Neighborhood social capital	
1 (Good)	32 050 (63.9) [63.3-64.4]
2 (Medium)	7372 (18.7) [18.2-19.2]
3 (Poor)	6471 (17.2) [16.9-18.0]
Gun in household	9533 (17.8) [17.3-18.3]
Experienced violence before 18 years of age	9925 (22.8) [22.2-23.4]
Outcomes	
Very worried about gun violence	5330 (14.6) [14.1-15.1]
Feels unsafe in neighborhood	4564 (13.1) [12.6-13.5]
Any substance use in past 30 days	13 236 (29.2) [28.5-29.8]
>1 Substance use in past 30 days	4131 (8.9) [8.5-9.3]
Mental distress in past 30 days	3303 (9.1) [8.7-9.5]

[a] Data are from the California Interview Survey 2021-2022 and the Gun Violence Archive.

[b] Numbers are unweighted.

[c] Other includes American Indian, Asian or Pacific Islander, and multiple races.

Figure 2. Dot Plot of Adjusted Incident Rate Ratios (IRRs) and 95% CIs for Each Exposure and Outcome Combination



Data are adjusted from survey-weighted Poisson regression analyses controlling for all covariates listed in the Table. Errors bars indicated 95% CIs.

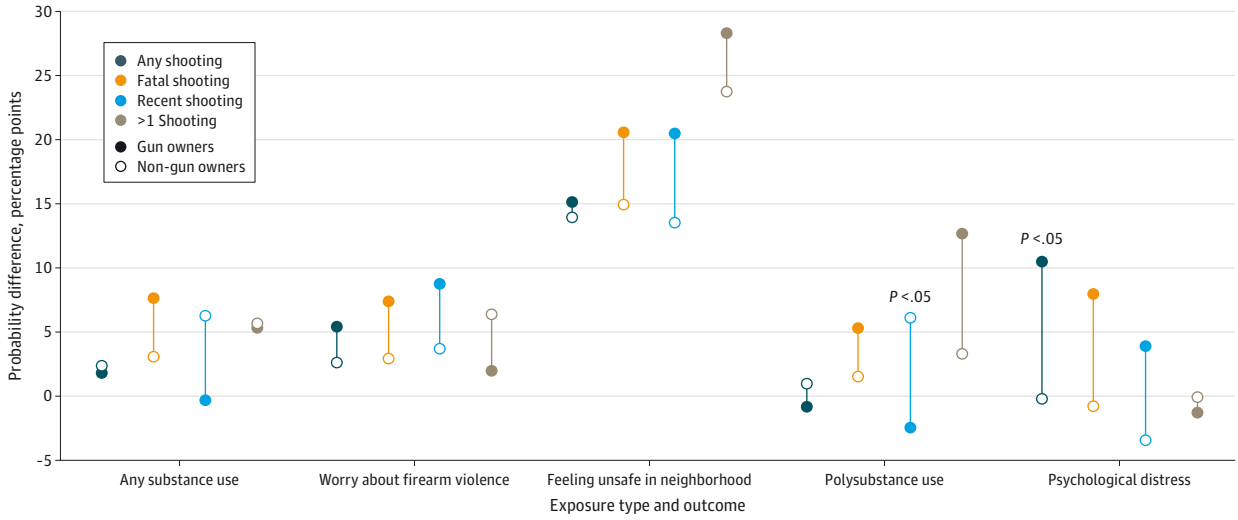
Figure 2 compares regression coefficients for each exposure and outcome. Each exposure measure was positively associated with any substance use, although the magnitude of these associations was small. There was no significant association between any exposure measure and reports of psychological distress. Polysubstance use was positively associated with most exposures, with the highest IRRs among those experiencing a recent shooting in their neighborhood within the past 2 months (IRR, 1.41; 95% CI, 1.18-1.68) and those experiencing more than 1 shooting (IRR, 1.33; 95% CI 1.14-1.55). The highest magnitude associations for each exposure were observed with the outcome of feeling unsafe in one's neighborhood among those experiencing a recent shooting event (IRR, 1.73; 95% CI, 1.52-1.97) to or more than 1 shooting (IRR, 2.36; 95% CI, 2.17-2.56). All exposures had a positive association with worry about experiencing firearm violence, with IRRs ranging from 1.14 (95% CI, 1.04-1.24) for those experiencing any shooting to 1.28 (95% CI, 1.13-1.43) for those experiencing more than 1 shooting in the past 12 months. Full results are presented in eTables 2 to 6 in Supplement 1).

Figure 3 presents differences in predicted probabilities (exposed minus unexposed) for each outcome and exposure combination, stratified by gun access. Those with gun access and exposed to a shooting within 500 m of their residence had a 10.7–percentage point larger increase in predicted probability of psychological distress than those without (P = .004). Those with gun access and exposed to a recent shooting showed a smaller increase in polysubstance use than those without (−8.6 percentage points; P = .048). The remaining exposure-outcome combinations showed no evidence of statistical interaction by gun ownership. See eTables 7 and 8 in Supplement 1 for details.

Discussion

As in many parts of the country, firearm violence increased in California during and immediately after the COVID-19 pandemic such that there were approximately 11 shooting events each day between 2020 and 2022.[24] Our results suggest that the frequency and severity of shootings are associated with additional effects among exposed populations. Exposure to firearm violence near one's home was not uncommon, with approximately 17% of California residents having a shooting event occur in

Figure 3. Dot Plot of Differences in Predicted Probabilities Between Exposed and Unexposed Individuals by Exposure Type, Outcome, and Household Gun Access



Data are from multivariable survey-weighted Poisson regression analyses (eTable 7 in Supplement 1). Statistical significance was determined with the Wald test comparing the exposed minus unexposed difference in predicted probability between gun owner and non–gun owner strata (eTable 8 in Supplement 1). Gun owner is defined as having at least 1 firearm in the house. Exposures were any shooting, fatal shooting, or more than 1 shooting all within 500 m in the past 12 months before interview. Recent shooting was any shooting in the past 2 months before interview. Outcomes were any substance use in the past 12 months, worry about personally experiencing gun violence, feeling one's neighborhood is unsafe, polysubstance use, and moderate to severe mental distress on the Kessler Psychological Distress Scale.

jamanetwork/2026/jno/11_16_2026/zoi261187 PAGE: 6 SESS: 49 OUTPUT: Oct 27 13:29 2026

their immediate neighborhood—within a 5- to 6-minute walk from their home—in the 12 months before their interview. Results also show that individuals with at least 1 firearm violence episode nearby were more likely than those living more than 500 m away from such events to report worry about experiencing firearm violence themselves, feeling that their neighborhood was unsafe, and using 1 or more substances in the 30 days before the interview.

Several individual-level factors were consistently associated with each outcome measure. Women and minoritized racial and ethnic groups were more likely to report worry about firearm violence and to feel their neighborhood was unsafe compared with their respective reference groups. These findings are largely in line with the literature[25-27] and point to populations that may be most affected by shooting events and other indicators of neighborhood insecurity.

The association between exposure to shooting events and any substance use was mostly consistent, although the type of substance (binge drinking in the case of worry and heavy marijuana use in the case of neighborhood safety and psychological distress) differed by outcome. The literature suggests several possible explanations. First, shootings are more likely to occur in places where there is greater supply of alcohol or drugs, and proximity to such outlets may be driving higher use in these locations.[28,29] Second, alcohol and substance use are both risk factors for both perpetrating and experiencing gun violence, so in locations where more gun-related violence occurs, substance use may co-occur.[30,31] Third, alcohol and drugs may be used as a reaction to exposure to different types of traumatic events, such as firearm and intimate partner violence.[32,33] Although the cross-sectional nature of the study makes it impossible to disentangle which mechanism (or combination thereof) may be driving the observed association, the intersection between firearm violence and substance remains an active area of research and intervention.[34]

No shooting exposures were associated with moderate to severe psychological distress in the full sample. This finding is somewhat unexpected given previous literature documenting an association between exposure to firearm violence and a range of mental health outcomes,[35,36] including posttraumatic stress disorder [7] and stress-related emergency department visits.[37] One explanation is that previous studies focused either on self-reported exposure to firearm violence or mass shooting events, whereas our measure of exposure was based on physical proximity to any type of shooting.

Firearm access presented several important results. Although those with gun access overall reported lower baseline worry—consistent with motivational theories of defensive ownership[38]—this pattern reversed when exposed to some forms of firearm violence. Gun access significantly modified the association between any shooting and psychological distress, with gun owners showing a larger increase in predicted probability than nonowners while modifying (reducing) the association between a recent shooting and polysubstance use. We did not find evidence that gun access modified the association between shooting exposure and perceived neighborhood safety or worry about experiencing gun violence, despite larger point estimates among gun owners for several of these outcomes. Previous reports suggest that one motivation for purchasing a firearm is to enhance feelings of individual safety[17] or that of one's family.[39] Having a firearm in own's home may signal a set of risk perceptions,[40] expectations of safety,[41] or coping styles that, when confronted with proximate violence, are associated with greater psychosocial impact.[42]

Our results also point to a consistent association between different types of shooting events and concern about firearm violence in one's neighborhood. Although prior research[43] suggests that neighborhood violence may result in only ephemeral effects on attitudes and behaviors around firearm policy, our findings show that attitudes less directly tied to support for firearm regulations (such as worry about experiencing gun violence) appear to be more durably associated with exposure to localized firearm violence. Moreover, because nearby shootings were associated with negative assessment of the safety of one's neighborhood, there are potential implications for health behaviors,[44] such as walking,[45] quality of life,[46] and aspects of social capital, which could, in turn, affect community mobilization[47] and participation.[48,49] However, longitudinal data would be needed to test these hypotheses.

jamanetwork/2026/jno/11_16_2026/zoi261187 PAGE: 7 SESS: 49 OUTPUT: Oct 27 13:29 2026

Limitations

This study has some limitations. All individual-level responses are based on self-report, which is influenced by multiple factors, including recall bias. The period immediately after the COVID-19 pandemic was generally a period of increased worry for many US residents,[50] and there is no way to isolate the effects of such an event from other factors contributing to worry or feelings of unsafety.

The cross-sectional nature of the individual-level data means that we do not know whether the outcomes reported were in response to or may have been present prior to the shooting event. Although our analyses ensured that the date of the shooting event (from the GVA) always happened before the individual's interview date (from the CHIS dataset), the only measure of previous experience of violence available in the dataset captured self-reported violence (it does not specify type) that took place before the individual turned 18 years of age. Selection bias was also a possibility as people sort into different neighborhoods and self-select whether to purchase a firearm. Future work using longitudinal data with more robust causal inference methods is needed to assess these associations.

The use of a 500-m buffer is a crude measure of the neighborhood and is particularly limited when applied to less densely populated regions. However, most shooting events in California took place in larger metropolitan areas. We were also unable to assess whether an individual we classify as exposed was actually aware of the shooting in their immediate neighborhood, leading to potential misclassification bias.

Lastly, the GVA database has known limitations. The GVA team primarily compiles data from news reports, police reports, press releases, and official statements, which means that incidents receiving media coverage are overrepresented, and shootings in areas without such coverage may be underreported. Our measure of fatal shooting events is particularly important in terms of robustness because fatalities are less likely to be underreported than nonfatal shootings due to the presence of a police report. Suicides are largely excluded from the real-time geocoded GVA data. This is unlikely to bias our estimates, however, because the theoretical mechanism of interest centers on exposure to neighborhood-level violent events that may shape fear and perceived risk of experiencing gun violence. Nonfatal injuries and defensive gun uses are also likely underreported. Despite its limitations, the GVA data have been found to be well suited for geospatial clustering analyses, which is the use case in the context of this study.[51]

Conclusions

This study found that firearm violence was highly prevalent in California from 2020 to 2022 and was associated with a range of outcomes related to people's perceptions of their safety and negative coping behaviors, such as substance use. However, before these observations can inform policies or programs, future work is needed to assess whether they are truly causal in nature.

ARTICLE INFORMATION

Accepted for Publication: September 11, 2026.

Published: November 16, 2026. doi:10.1001/jamanetworkopen.2026.44237

Open Access: This is an open access article distributed under the terms of the CC-BY-NC-ND License, which does not permit alteration or commercial use, including those for text and data mining, AI training, and similar technologies. © 2026 Macinko J et al. *JAMA Network Open*.

Corresponding Author: James Macinko, PhD, Fielding School of Public Health, UCLA, 650 Charles E Young Dr S, Los Angeles, CA 90095 (jmacinko@ucla.edu).

Author Affiliations: Department of Health Policy and Management, Fielding School of Public Health, UCLA, Los Angeles, California (Macinko); Department of Statistics, UCLA, Los Angeles, California (Shinkre); Department of Biostatistics, Fielding School of Public Health, UCLA, Los Angeles, California (Bargagli-Stoffi); Department of Political Science, UCLA, Los Angeles, California (Kappelman); Department of Public Health Policy and

Management, NYU School of Global Public Health, New York, New York (Silver).

Author Contributions: Drs Macinko and Shinkre had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: Macinko, Bargagli-Stoffi, Kappelman, Silver.

Acquisition, analysis, or interpretation of data: Macinko, Shinkre, Kappelman.

Drafting of the manuscript: Macinko, Bargagli-Stoffi, Kappelman, Silver.

Critical review of the manuscript for important intellectual content: Macinko, Shinkre.

Statistical analysis: Shinkre, Kappelman, Silver.

Obtained funding: Macinko.

Administrative, technical, or material support: Macinko, Silver.

Supervision: Macinko, Bargagli-Stoffi.

Conflict of Interest Disclosures: None reported.

Funding/Support: This work was supported by grant 1R01CE003617-01-00 from the Centers for Disease Control and Prevention (CDC).

Role of the Funder/Sponsor: The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Disclaimer: The analyses, results, and conclusions presented here are those of the authors and do not necessarily reflect those of the CDC.

Data Sharing Statement: See Supplement 2.

REFERENCES

1. Rees CA, Monuteaux MC, Steidley I, et al. Trends and disparities in firearm fatalities in the United States, 1990-2021. *JAMA Netw Open*. 2022;5(11):e2244221. doi:10.1001/jamanetworkopen.2022.44221

2. Kegler SR, Simon TR, Zwald ML, et al. Vital signs: changes in firearm homicide and suicide rates - United States, 2019-2020. *MMWR Morb Mortal Wkly Rep*. 2022;71(19):656-663. doi:10.15585/mmwr.mm7119e1

3. Hemenway D, Nelson E. The scope of the problem: gun violence in the USA. *Curr Trauma Rep*. 2020;6 (1):29-35. doi:10.1007/s40719-020-00182-x

4. Kottke TE, Palmer BA, Hooker SA, Pronk NP, Arena R, Woodard C. Gun violence as a source of anxiety and stress in the US population. *Am J Health Promot*. 2025;39(7):1010-1015. doi:10.1177/08901171251333563

5. Kagawa RM, Pear VA, Rudolph KE, Keyes KM, Cerdá M, Wintemute GJ. Distress level and daily functioning problems attributed to firearm victimization: sociodemographic-specific responses. *Ann Epidemiol*. 2020;41:35-42.e3.

6. Anestis MD, Bryan CJ. Threat perceptions and the intention to acquire firearms. *J Psychiatr Res*. 2021;133: 113-118. doi:10.1016/j.jpsychires.2020.12.033

7. Semenza DC, Bond AE, Ziminski D, Anestis MD. Frequency, recency, and variety of gun violence exposure: implications for mental health and suicide among US adults. *Soc Sci Med*. 2025;366:117672. doi:10.1016/j.socscimed.2025.117672

8. Smith ME, Sharpe TL, Richardson J, Pahwa R, Smith D, DeVylder J. The impact of exposure to gun violence fatality on mental health outcomes in four urban U.S. settings. *Soc Sci Med*. 2020;246:112587. doi:10.1016/j.socscimed.2019.112587

9. Garbarino J. The war-zone mentality—mental health effects of gun violence in US children and adolescents. *N Engl J Med*. 2022;387(13):1149-1151. doi:10.1056/NEJMp2209422

10. Rossin-Slater M, Schnell M, Schwandt H, Trejo S, Uniat L. Local exposure to school shootings and youth antidepressant use. *Proc Natl Acad Sci U S A*. 2020;117(38):23484-23489. doi:10.1073/pnas.2000804117

11. Matthay EC, Gobaud AN, Branas CC, Keyes KM, Roy B, Cerdá M. Assessing links between alcohol exposure and firearm violence: a scoping review update. *Alcohol Res*. 2025;45(1):01. doi:10.35946/arcr.v45.1.01

12. Buttrick N, Yang S, Okada S. Mass shootings durably increase the sale of alcohol in American communities. *Proc Natl Acad Sci U S A Nexus*. 2025;4(1):pgae570. doi:10.1093/pnasnexus/pgae570

13. Gard AM, Brooks-Gunn J, McLanahan SS, Mitchell C, Monk CS, Hyde LW. Deadly gun violence, neighborhood collective efficacy, and adolescent neurobehavioral outcomes. *Proc Natl Acad Sci U S A Nexus*. 2022;1(3):pgac061. doi:10.1093/pnasnexus/pgac061

14. Montgomerie JZ, Lawrence AE, LaMotte AD, Taft CT. The link between posttraumatic stress disorder and firearm violence: a review. *Aggress Violent Behav*. 2015;21:39-44. doi:10.1016/j.avb.2015.01.009

15. Kessler RC, Andrews G, Colpe LJ, et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychol Med*. 2002;32(6):959-976. doi:10.1017/S0033291702006074

16. Sampson RJ, Groves WB. Community structure and crime: testing social-disorganization theory. *Am J Sociol*. 1989;94(4):774-802. doi:10.1086/229068

17. Buttrick N. Protective gun ownership as a coping mechanism. *Perspect Psychol Sci*. 2020;15(4):835-855. doi:10.1177/1745691619898847

18. California Health Interview Survey. *CHIS 2023-2024 Methodology Series: Report 3 - Data Processing Procedures*. UCLA Center for Health Policy Research; 2025. Accessed December 10, 2025. https://healthpolicy.ucla.edu/sites/default/files/2025-09/CHIS_2023_2024_MethodologyReport3_Confidential_082625_CLEAN.pdf

19. UCLA Center for Health Policy Research, California Health Interview Survey. CHIS 2019-2020 redesign: rationale, empirical evaluation, and trends. September 24, 2025. Updated September 2021. Accessed December 10, 2025. https://healthpolicy.ucla.edu/sites/default/files/2023-05/chis2019-2020-redesign-workingpaper-09142021.pdf

20. Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. *BMC Med Res Methodol*. 2003;3:21. doi:10.1186/1471-2288-3-21

21. Efron B. Double exponential families and their use in generalized linear regression. *J Am Stat Assoc*. 1986;81(395):709-721. doi:10.1080/01621459.1986.10478327

22. Muller CJ, MacLehose RF. Estimating predicted probabilities from logistic regression: different methods correspond to different target populations. *Int J Epidemiol*. 2014;43(3):962-970. doi:10.1093/ije/dyu029

23. Altman DG, Bland JM. Interaction revisited: the difference between two estimates. *BMJ*. 2003;326(7382):219. doi:10.1136/bmj.326.7382.219

24. Donnelly BM, Kuza MC, Sargent BB, et al. Firearm violence surrounding the COVID-19 pandemic: a reopening phenomenon. *J Surg Res*. 2023;285:168-175.

25. Fontanarosa PB, Bibbins-Domingo K. The unrelenting epidemic of firearm violence. *JAMA*. 2022;328(12):1201-1203. doi:10.1001/jama.2022.17293

26. Buggs SA, Kravitz-Wirtz ND, Lund JJ. Social and structural determinants of community firearm violence and community trauma. *Ann Am Acad Pol Soc Sci*. 2022;704(1):224-241. doi:10.1177/00027162231173324

27. Schumacher S, Kirzinger A, Presiado M, Valdes I, Brodie M. *Americans' Experiences With Gun-Related Violence, Injuries, and Deaths*. Kaiser Family Foundation; 2023.

28. McGinty EE, Webster DW. The roles of alcohol and drugs in firearm violence. *JAMA Intern Med*. 2017;177(3):324-325. doi:10.1001/jamainternmed.2016.8192

29. Branas CC, Richmond TS, Ten Have TR, Wiebe DJ. Acute alcohol consumption, alcohol outlets, and gun suicide. *Subst Use Misuse*. 2011;46(13):1592-1603. doi:10.3109/10826084.2011.604371

30. Branas CC, Elliott MR, Richmond TS, Culhane DP, Wiebe DJ. Alcohol consumption, alcohol outlets, and the risk of being assaulted with a gun. *Alcohol Clin Exp Res*. 2009;33(5):906-915. doi:10.1111/j.1530-0277.2009.00912.x

31. Sanchez C, Jaguan D, Shaikh S, McKenney M, Elkbuli A. A systematic review of the causes and prevention strategies in reducing gun violence in the United States. *Am J Emerg Med*. 2020;38(10):2169-2178. doi:10.1016/j.ajem.2020.06.062

32. Gezinski LB, Gonzalez-Pons KM, Rogers MM. Substance use as a coping mechanism for survivors of intimate partner violence: implications for safety and service accessibility. *Violence Against Women*. 2021;27(2):108-123. doi:10.1177/1077801219882496

33. Keyes KM, Hatzenbuehler ML, Hasin DS. Stressful life experiences, alcohol consumption, and alcohol use disorders: the epidemiologic evidence for four main types of stressors. *Psychopharmacology (Berl)*. 2011;218(1):1-17. doi:10.1007/s00213-011-2236-1

34. Cerdá M, Hamilton AD, Tracy M, Branas C, Fink D, Keyes KM. Would restricting firearm purchases due to alcohol- and drug-related misdemeanor offenses reduce firearm homicide and suicide? an agent-based simulation. *Inj Epidemiol*. 2022;9(1):17. doi:10.1186/s40621-022-00381-x

35. Peterson JK, Densley JA, Pyrooz DC. Mental health consequences of exposure to mass and non-mass shootings in a national sample of US adults. *Nat Ment Health*. 2025;3(5):530-537. doi:10.1038/s44220-025-00413-7

36. Magee LA, Aalsma MC, Fortenberry JD, Gharbi S, Wiehe SE. Mental health outcomes from direct and indirect exposure to firearm violence: a cohort study of nonfatal shooting survivors and family members. *J Crim Justice*. 2022;83:101961. doi:10.1016/j.jcrimjus.2022.101961

37. Gujral K, Ellyson AM, Rowhani-Rahbar A, Rivara F. The community impact of school-shootings on stress-related emergency department visits. *Contemp Econ Policy*. 2023;41(3):455-470. doi:10.1111/coep.12603

38. Bélanger JJ, Leander NP, Agostini M, Kreienkamp J, Stroebe W. Passion for guns and beliefs in a dangerous world: an examination of defensive gun ownership. *Aggress Behav*. 2024;50(3):e22146. doi:10.1002/ab.22146

39. Ye GF, Thatipamala P, Siegel M. Assessment of reasons for ownership and attitudes about policies among firearm owners with and without children. *JAMA Netw Open*. 2022;5(1):e2142995. doi:10.1001/jamanetworkopen.2021.42995

40. Bryan CJ, Daruwala SE, Tabares JV, Butner JE, Coccaro EF, Gorka SM. Heightened threat perceptions and reduced stability in anxiety and fear among U.S. adults who carry handguns. *J Anxiety Disord*. 2023;99:102764. doi:10.1016/j.janxdis.2023.102764

41. Warner TD, Steidley T. Some fear, more loathing? threats and anxieties shaping protective gun ownership and gun carry in the U.S. *J Crime Justice*. 2022;45(4):484-505. doi:10.1080/0735648X.2021.1997787

42. Giraldi DM, Swingler S, Kirk DS, et al. Understanding the broader impacts of non-fatal firearm violence trauma in the United States: a scoping review. *Lancet Reg Health Am*. 2025;46:101091. doi:10.1016/j.lana.2025.101091

43. Sharkey P, Shen Y. The effect of mass shootings on daily emotions is limited by time, geographic proximity, and political affiliation. *Proc Natl Acad Sci U S A*. 2021;118(23):e2100846118. doi:10.1073/pnas.2100846118

44. Hines AL, Albert MA, Blair JP, et al. Neighborhood factors, individual stressors, and cardiovascular health among black and white adults in the us: the Reasons for Geographic and Racial Differences in Stroke (REGARDS) study. *JAMA Netw Open*. 2023;6(9):e2336207. doi:10.1001/jamanetworkopen.2023.36207

45. Schober DJ, Lewis T, Forbes C, Keller A, Bruce D. The effects of neighborhood violence on physical activity following the COVID-19 stay-at-home order: a multilevel analysis. *J Racial Ethn Health Disparities*. 2026;13(4):3088-3097.

46. Paruk J, Semenza D. Gun violence exposure and quality of life in nine US states. *J Urban Health*. 2024;101(5):942-950. doi:10.1007/s11524-024-00891-7

47. Parsons A, Harvey TD, Andrade SD, et al. "We know what's going on in our community": a qualitative analysis identifying community assets that deter gun violence. *SSM Qual Res Health*. 2023;3:100258. doi:10.1016/j.ssmqr.2023.100258

48. Ohmer ML, Teixeira S, Booth J, Zuberi A, Kolke D. Preventing violence in disadvantaged communities: strategies for building collective efficacy and improving community health. *J Hum Behav Soc Environ*. 2016;26(7-8):608-621. doi:10.1080/10911359.2016.1238804

49. Thomas SA, Harris CT, Drawve G. Exploring the influence of elements of the social and physical environment on neighborhood gun crime. *Am J Crim Justice*. 2022;47(3):370-398. doi:10.1007/s12103-020-09599-1

50. Shah AD, Laternser C, Tatachar P, Duong P. The COVID-19 pandemic and its effects on mental health:a before, during, and after comparison using the U.S. Census Bureau's Household Pulse Survey. *Int J Environ Res Public Health*. 2024;21(10):1306. doi:10.3390/ijerph21101306

51. Gobaud AN, Mehranbod CA, Kaufman E, et al. Assessing the gun violence archive as an epidemiologic data source for community firearm violence in 4 US cities. *JAMA Netw Open*. 2023;6(6):e2316545. doi:10.1001/jamanetworkopen.2023.16545

52. Gun Violence Archive. General methodology and data collection. Accessed January 15, 2025. https://www.gunviolencearchive.org/methodology

SUPPLEMENT 1.

eMethods. Supplementary methods
eTable 1. Descriptive statistics by exposure status: any shooting within 500 meters of home address
eFigure. Bar chart of California shooting events, deaths, injuries, and fatality rate by year, 2020-2022
eTable 2. Moderate/severe psychological distress: Poisson regression results, by exposure
eTable 3. Any substance use: Poisson regression results, by exposure
eTable 4. Polysubstance use: Poisson regression results, by exposure
eTable 5. Worry about gun violence: Poisson regression results, by exposure (N=45,916)
eTable 6. Neighborhood considered unsafe: Poisson regression results, by exposure
eTable 7. Predicted probabilities by outcome, exposure, and household gun access
eTable 8. Formal test of gun-access and exposure interaction on the predicted-probability (risk-difference) scale

SUPPLEMENT 2.
Data Sharing Statement

jamanetwork/2026/jno/11_16_2026/zoi261187 PAGE: 12 SESS: 49 OUTPUT: Oct 27 13:29 2026