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Mental health outcomes from direct and indirect exposure to firearm violence: A cohort study of nonfatal shooting survivors and family members

Lauren A. Magee, PhD[1], Matthew C. Aalsma, PhD[2], J. Dennis Fortenberry, MD, MS[3,] Sami Gharbi, MS[4], and Sarah E. Wiehe, MD,MPH[4]

Affiliations:

[1] O'Neill School of Public and Environmental Affairs, Indiana University Purdue University – Indianapolis, 801 W. Michigan Street, Indianapolis, Indiana, 46204

[2] Adolescent Behavioral Health Research Program, Department of Pediatrics, Indiana University School of Medicine, 410 W. 10th Street, Indianapolis, IN, 46204

[3] Department of Adolescent Medicine, Indiana University School of Medicine, 410 W. 10th Street, Indianapolis, IN, 46204

[4] Children's Health Services Research, Department of Pediatrics, Indiana University School of Medicine, 410 W. 10th Street, Indianapolis, IN, 46204

Corresponding author: Lauren A. Magee, PhD, O'Neill School of Public and Environmental Affairs, Indiana University Purdue University – Indianapolis, 801 W. Michigan Street, BS4058, Indianapolis, Indiana, 46204, Office: 317-278-8624, Fax: 1-317-274-5153, Email: lamagee@iu.edu

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Abstract

Background: Firearm violence is a public health crisis in the US. Beyond the survivor, firearm violence also impacts family members and communities of firearm violence survivors. Despite the known health inequities that exist among nonfatal shooting survivors, little research has focused on the mental health needs of family members of nonfatal shootings survivors.

Methods: Police and Medicaid claims data linked at the individual level between January 1, 2007 – December 31, 2016 in Indianapolis, Indiana. The Medicaid case number was used to identify nonfatal shooting survivors and family members. Differences in mental health prevalence and clinical care utilization were examined in the 12-months preceding and following an index nonfatal shooting for both survivors and family members. Results were stratified by age.

Results: Mental health prevalence rates increased by three percent for family members of nonfatal shooting survivors in the 12-months following a nonfatal shooting, compared to the preinjury period. Among youth with a new mental health diagnosis over half were family members and no differences were observed in mental health conditions between survivors and family members.

Conclusions: Findings indicate a need for improved trauma informed services and connection to mental health care for both youth survivors and family members of nonfatal shootings.

KEYWORDS: nonfatal shootings, mental health outcomes, secondary survivors

1. Introduction

Firearm violence is a leading public health crisis in the United States. Firearm violence has significantly increased since the onset of the COVID-19 pandemic and hit historical highs in 2021(Rosenfeld, 2021). Compared to firearm homicides which killed an estimated 19,000 people in 2020, nonfatal shootings are typically four times more prevalent, with estimates of at least 85,000 nonfatal shootings occurring annually in the US (Hipple & Magee, 2017; Kaufman et al., 2020). Despite the known underlying drivers (e.g., gang involvement, poverty, structural disadvantage) of firearm violence at both the individual and neighborhood level (Barrett et al., 2022; Garbarino et al., 2002; Magee, 2020; Papachristos et al., 2015), much less is known about the outcomes associated with firearm violence.

Nonfatal shootings leave a survivor to cope with the physical and emotional consequences of their injury and overall health care and mental health related healthcare costs increase by three to twenty times in the six months following a nonfatal firearm injury (Ranney et al., 2020). Beyond the victim, firearm violence also impacts family members and communities of firearm violence survivors. Chronic exposure to the direct and indirect trauma of firearm violence increases the risk of adverse health outcomes and unhealed trauma often leads to involvement in future violence (Kar, 2019; Semenza & Stansfield, 2021a, 2021b; Turner et al., 2019). Despite the known health inequities that exist among nonfatal shooting survivors, little research has focused on the mental health needs of family members of nonfatal shootings survivors.

1.1 Individual and Community Exposure to Firearm Violence

Nonfatal shootings are well established sources of health inequities at both the individual and community level. Survivors of gunshot injury are often left with physical disabilities and bullets retained in their bodies that cause pain, stress, and anxiety (Lee, 2012). In addition to the physical trauma, survivors of firearm violence often experience increased mental health needs following their gunshot. For instance, survivors of gunshot injuries reported worse physical and mental health outcomes compared to non-firearm survivors and nearly half of survivors had posttraumatic stress disorder and increased substance use in the years following their injury (Vella et al., 2020). Another study examined mental health diagnosis among youth nonfatal shooting survivors using health claims data. Results indicate 38.8 percent of survivors had a mental health diagnosis prior to their firearm injury and 25.7 percent of youth nonfatal shooting survivors received a new mental health diagnosis in the 12 months following their injury. The most prevalent new diagnoses were for stress-related, substance-related, and conduct-related disorders (Oddo et al., 2021).

Beyond nonfatal shooting survivors, a growing body of research suggests community exposure to firearm violence increases adverse mental health outcomes due to the trauma exposure; however, much of the current research has focused on exposure to firearm homicides. In a sample across four cities, respondents who reported knowing someone who died due to firearm violence reported higher rates of depression, psychological distress, suicidal ideation, and psychosis-like experiences (Smith et al., 2020). In a similar study of adolescents, anxiety and depression were strongest - particularly among girls - when a firearm homicide occurred within a half mile of the youth's home or school (Leibbrand et al., 2020).

In the context of broader health outcomes, higher rates of community nonfatal shootings are associated with higher levels of obesity, smoking, lack of sleep, physical inactivity, and higher levels of disability at the community level, compared to fatal firearm injuries when controlling for potential confounders, speaking to the unique dynamics of nonfatal shootings (Semenza & Stansfield, 2021a, 2021b). At a community level, higher rates of nonfatal shootings are positively associated with poor mental health outcomes. For instance, a study in Philadelphia, Pennsylvania examined emergency department encounters for mental health among adolescents in the 60 days following a shooting. Results suggest children living within two to three blocks of a shooting presented for more mental health needs compared to children living outside the proximity of a shooting (Vasan et al., 2021), suggesting the negative impact on the children's mental health. In a community sample of mothers, low-income mothers who witnessed a shooting had higher odds of experiencing symptoms of depression by as much as 58%. Findings also suggest witnessing a shooting had both direct and indirect associations with parental aggression and maternal depression (Leibbrand et al., 2021). These findings speak to the potential indirect spillover effects of firearm violence on family members.

1.2 Outcomes of Family Members' Exposure to Firearm Violence

The impact of nonfatal firearm violence on survivors' family members' (also known as "secondary survivors") mental health outcomes are particularly understudied. Several theories provide a framework for understanding why family members experience the indirect trauma of a loved ones shooting event including the psychosocial theory and the trauma-informed theory of individual health behavior (TTB). Psychosocial theory posits that acute and chronic stress of a social environment can act as a disease and trauma-informed theory of individual health behavior posits that trauma-replicating environments can expose individuals (i.e., family members) to

acute experiences of trauma (Krieger, 2001; Marks et al., 2022). Family members often provide the most support in physical healing and emotional support for nonfatal shooting survivors in the post injury period and survivors note the emotional impact their shooting has on their children and partners (Hink et al., 2021; Patton et al., 2019). For example, one recent study of nonfatal shooting survivors, highlighted the emotional impact on their children and loved ones because of uncertainty about a parent's survival (Patton et al., 2019). TTB also posits that resilience factors such as one's safety and trust are related to one's capacity to respond to the stressors of a loved one's shooting (Marks et al., 2022). One mother noted a lack of safety after the shooting of her son, stating her son being shot was synonymous with her being shot, as she constantly worried the offender would shoot her next (Perfetti et al., 2022). Exposure to such a traumatic event can increase the risk of developing PTSD and other trauma related symptoms (Bottiani et al., 2021; Turner et al., 2019).

Although the research literature on secondary survivors of gunshot survivors is limited, research on secondary survivors of homicide survivors is more robust. Research suggests homicide secondary survivors are likely to experience psychological and physical effects of losing a family member. In a national sample of adolescents, 1 in 10 adolescents identified as a family member of a homicide victim and were at greater risk for depression, substance use, and alcohol abuse when adjusting for other violence exposures compared to non-survivors. Black Americans and Hispanics were disproportionately represented among family members of homicide survivors (Rheingold et al., 2012). Among a community sample of family members of homicide survivors, thirty-four percent of participants met the criteria for post-traumatic stress disorder and nearly half reported major depressive disorder two years following the homicide. Survivors with PTSD and depressive disorder reported less perceived social support following

their loss compared to survivors who did not meet the criteria of PTSD or depression (Rheingold & Williams, 2015). These studies rely on survey data that do not indicate official diagnosis or if the individual obtained mental health care and focuses primarily on homicide survivors, which may be different from nonfatal shooting survivors. Despite these limitations, these studies do provide preliminary evidence of the shockwave of trauma among family members who experience firearm violence. Further investigations are necessary to identify mental health outcomes of family members of nonfatal firearm violence survivors. Such data could inform changes in trauma-informed programs intended to support families as well as survivors of firearm violence.

1.3 The current study

The International Associations of Chief of Police recently proposed that police agencies adopt a public health-informed policing (PHIP) model, which identifies a need for more comprehensive approaches to firearm violence and addressing the associated trauma and harm in order to improve the health of communities. To address this recent proposal, we must first understand the mental health prevalence and needs of survivors and family members of nonfatal firearm violence. We leveraged a unique dataset of police and Medicaid claims data linked at the individual and family level to define nonfatal shooting survivors and their family members (e.g., children, siblings, and/or parents), and mental health outcomes of both. The dataset represents Indianapolis (Marion County), Indiana which is the 11th most violent city in the United States (Rosenfeld, 2021). This study fills a gap in the literature by examining mental health outcomes of nonfatal firearm violence survivors and their family members to provide evidence and direction for future trauma-informed violence interventions.

2. Methods

2.1 Data and study procedures

This study utilized police records on nonfatal shootings between January 1, 2008 and December 31, 2015 (identifying reference 1) and Medicaid claims data between January 1, 2007 and December 31, 2016. Medicaid claims data were included for a wider date range so we could obtain mental health history of individuals during the 12-months before an index nonfatal shooting and during the 12-months following an index nonfatal shooting.

Data were obtained through ongoing partnerships with the Indianapolis Metropolitan Police Department (IMPD) and the Indiana Family and Social Services Administration (FSSA) that have been developed and maintained through personal and working relationships between research team members and the agency over multiple years (Wiehe et al., 2018). Our research team maintains active data sharing agreements and memorandums of understanding with both IMPD and FSSA, which grants us access to individual level identifiable information. Through these partnerships our research team receives both real time data access to IMPD files and batch data pulls from FSSA every few years. All data are securely maintained and analyzed on a password-protected and encrypted server behind the university firewall. Only core research team members have access to personal identifiers, which are used for linkage purposes only and replaced with an individual unique identifier following the linkage process.

As part of a larger study that examines health inequities among a justice involved population over two decades, individuals from the police data were linked to Medicaid claims data at an individual level with personal identifiers (first, middle, and last name; sex; month, day, and year of birth; social security number; ZIP code; and address number). The linkage process

uses deterministic and probabilistic matching algorithms to identify records of the same individual across both data sources (Grannis et al., 2003; Grannis et al., 2002). The matching process included multiple steps to ensure true matches. We used a combination of 24 deterministic match algorithms and 24 probabilistic algorithms. First, multiple deterministic algorithms with different combinations of identifiers identified 'conservative' matches, considered by the independent review of at least three research team members to yield 100% true matches. This process effectively reduced the volume of matched pairs requiring hand validation during the probabilistic matching review process. Next, multiple probabilistic algorithms were employed. Each probabilistic algorithm defined the probability that a specific pair of records is a true match (Grannis et al., 2003; Grannis et al., 2002). Multiple targeted strategies are used to refine the record linkage: for example, phonetic transformations using "Soundex" and "NYSIIS" methods were created to help link misspelled names; nicknames were matched against first names; and stratified analyses were performed by sex with different emphasis on last name. Lastly, three research team members reviewed the probabilistic matching algorithms independently and assigned a score threshold respectively, and the most conservative score threshold for each output list (by algorithm) was used to define the true match pairs (identifying reference 1, identifying reference 2). The combination of using both deterministic and probabilistic matching algorithm ensures a better performing record linkage process across the multiple data sources.

2.2 Cohort definition

A nonfatal shooting victim was defined from police records and is defined as a criminal assault in which a projectile weapon with a powder discharge caused a penetrating, nonfatal injury (Beaman et al., 2000; Magee, Ranney, et al., 2021). Family members of nonfatal shooting

survivors were defined from Medicaid data. Family members were connected through a common case number, which was used to define family members of nonfatal shooting survivors (Angier et al., 2014). A family member was defined as parent, sibling, or guardian included on the same Medicaid health plan. An "index" nonfatal shooting victimization was defined as the first shooting injury during the study time window and used to define our nonfatal shooting survivors. Mental health outcomes were defined in the preceding 12-months and in the 12-months following of the index nonfatal shooting date for both survivors and family members based on Medicaid claims data.

2.3 Measures

Nonfatal shooting survivor race (Black, White, other), sex, and age were defined from police records. Family members race (Black, White, other), sex, and age were defined from Medicaid claims data. Age was defined for survivors and family members based on the date of the nonfatal shooting event provided from police records. Age categories were defined as; 5-9, 10-14, and 15-19, 20 – 24 years, 25 – 29 years, 30 – 34 years, and 35 years and older. Clinical care utilization was defined as the number of Medicaid claims in the 12- months prior and 12-months following the index nonfatal shooting. In order to compare mental health prevalence rates of nonfatal shooting youth survivors and family members to that of the general Medicaid covered population in Marion County, the total number of Medicaid claims by race, sex, age groups, and mental health diagnoses were calculated based on Medicaid claims data. As in previous work on youth population comparisons, victim and family members were removed from the total Medicaid covered youth and adult populations (Aalsma et al., 2016). We used January 1, 2014 to define individual age and prevalence rates in the preceding 12-months and

following 12-months to establish Medicaid covered youth and adult population rates, as this period is prior to Medicaid expansion (Freedman et al., 2018).

2.4 Mental health diagnoses

Mental health diagnoses were defined from the Medicaid claims data using the primary diagnosis and secondary diagnosis codes based on International Classifications of Diseases (ICD). We defined three mental health categories: (1) stress and anxiety disorders, (2) depression and mood disorders, and (3) disruptive behavior disorders based on Diagnostic and Statistical Manual (DSM) subgroups (Lau et al., 2018; Neff et al., 2013) based on prior research (Oddo et al., 2021; Vella et al., 2020). We also defined any mental health condition as having any DSM mental health diagnosis and substance use disorder (SUD) using ICD diagnoses codes at time of Medicaid claim (Magee, Fortenberry, et al., 2021). The number of mental health claims were defined as the total number of claims with a primary or secondary diagnosis code in the 12-months preceding and following the index nonfatal shooting. Our main outcome was a new mental health diagnosis in the 12-months following the index nonfatal shooting. We defined this as any diagnosis that was present in the 12-months following the nonfatal shooting that was not present in the preceding 12-months. All measures were defined for both survivors and family members. A binary measure indicating victim or family member was also defined.

2.5 Statistical analysis

Descriptive statistics were calculated for nonfatal shooting survivors, and family members. Prevalence rates for mental health diagnoses, new mental health diagnosis, clinical care utilization and mental health care utilization were calculated for the 12-months preceding and 12-month following the index nonfatal shooting for both survivors and family members. We

stratified these findings by age group, youth (19 years and under) and adult (20 years and over) populations due to differences in mental health treatment, risk of involvement in violence, and Medicaid coverage (Parreco et al., 2018; Ranney et al., 2019). We also defined mental health and substance use disorder prevalence rates for the Medicaid covered population in Marion County and stratified these rates by youth and adult populations. These population level prevalence rates allowed us to compare mental health prevalence rates of nonfatal shooting survivors and family members to those of the Medicaid population. Differences in mental health prevalence and clinical care utilization and mental health care utilization in the 12-months preceding and 12-month following the index nonfatal shooting were evaluated with pared t-tests for continuous measures and chi-square for categorical measures at a significance level of $p < 0.05$. All analyses were conducted in Stata version 16 and this study was approved by the Institutional Review Board.

3. Results

There were 2,838 individuals affected by nonfatal shootings including, 1,311 survivors and 1,527 family members (e.g., children, siblings, or parent) of shooting survivors. Survivors were predominantly Black (76.5.0%), male (74.0%), and between 15 and 19 years of age (32.9%). Family members were also predominantly Black (78.2%), but family members were majority female (64.0%) and over 35 years of age (29.8%). The next most predominate age group for family members was youth between 10 and 14 years of age (Table1), noting differences in the age distribution between youth survivors and youth family members.

The number of overall Medicaid claims 12 months before and 12 months after the index shooting injury increased for both survivors (Mean (SD): pre-shooting 5.89 (19.9) vs. post-shooting 13.6 (36.6); $p <0.05$) and family members (Mean (SD): pre-shooting 6.01 (16.5) vs.

post-shooting 7.86 (22.5); p <0.05). Survivors, however, had a higher increase in the total number of clinical claims than family members. The overall number of claims for mental health services significantly increased for family members (Mean (SD): pre-shooting 1.08 (7.09) vs. post-shooting 1.78 (10.6); p <0.05) in the 12-months following the index nonfatal shooting compared to the preceding 12-month period, whereas survivors (Mean (SD): pre-shooting 1.22 (7.04) vs. post-shooting 1.41 (7.06); p > 0.05) had a smaller increase in the number of mental health claims in the 12-months following the index NFS. Survivors and family members had lower clinical care claims and mental health claims compared to the general Medicaid population (Table 1).

3.1 Mental Health Outcomes

Table 2 indicates the mental health claims prevalence rates for youth survivors, youth family members, and Medicaid covered youth. For survivors, the prevalence of any mental health diagnosis slightly decreased to 13.7 percent in 12-months after their injury, compared to 15.3 percent in the preceding 12-months ($p < 0.05$) and were overall higher rates compared to Medicaid covered youth. Diagnoses for disruptive behavior disorders (pre-shooting 6.84 vs. post-shooting 7.04, $p < 0.05$) were the only mental health conditions that increased for survivors in the 12-months after the NFS, compared to the preceding 12-months. Among survivors, prevalence rates for depression and mood disorders (pre: 3.42 vs. post: 2.82, $p < 0.05$), and substance use disorders (pre: 4.63 vs. post: 3.62, $p < 0.05$), decreased in the 12-months following the index NFS, compared to the preceding 12-months. Diagnoses for stress and anxiety disorders (pre: 1.81 vs. post:3.32, $p > 0.05$) increased in the post 12-months, however it did not reach the level of statistical significance.

For youth family members, the prevalence rate for any mental health diagnosis increased by 2.69 percent in the 12-months following the index nonfatal shooting injury compared to the preceding 12-months (pre: 8.51 vs. post: 11.2, $p < 0.05$), and is the highest increase compared to survivors or Medicaid covered youth. Diagnoses increased for disruptive behavior disorders (pre: 2.92 vs. post: 3.56, $p < 0.05$), stress and anxiety disorders (pre: 0.89 vs. post: 2.80, $p < 0.05$), depression and mood disorders (pre: 1.78 vs. post: 2.54, $p < 0.05$), and substance use disorders (Pre: 0.64 vs. Post: 0.76, $p < 0.05$) in the 12-months following a family member's nonfatal shooting, compared to the preceding 12-months.

Table 3 indicates the mental health claims prevalence rates for adult survivors, adult family members, and the Medicaid covered adult population. For adult survivors, the prevalence of any mental health diagnosis increased by 5.7 percent in 12-months after their injury and post injury mental health rates (pre: 7.00 vs. post. 12.7; $p <0.05$) were higher compared to Medicaid covered adults (10.4%). Diagnoses for substance use disorder, (pre-shooting 1.47 vs. post-shooting 3.44, $p < 0.05$), stress and anxiety disorders (pre: 2.21 vs. post: 4.42, $p < 0.05$), and depression and mood disorders (pre: 1.72 vs. post: 4.42, $p < 0.05$) all increased for in the 12-months after the NFS, compared to the preceding 12-months. Mental health prevalence rates for adult survivors were higher compared to the adult Medicaid population.

For adult family members, the overall mental health prevalence rate was consistent in the 12-months preceding and following an index NFS (pre: 6.49 vs. post: 6.49, $p < 0.05$). Stress and anxiety disorders were the only diagnoses that increased in the 12-months following the NFS for adult family members (pre: 1.89 vs. post: 2.84, $p < 0.05$). All prevalence rates for adult family members were lower than the adult Medicaid population.

3.2 New Mental Health Diagnoses

During the 12-months following the index nonfatal shooting, 6.2 percent (n = 175) of survivors and family members received a new mental health diagnosis (Table 4), compared to only 4.3 percent of the Medicaid covered population. For youth, the most common new mental health diagnoses were for disruptive behavior disorders and stress and anxiety disorders: 46.3 percent of survivors and 27.3 percent of family members received a disruptive behavior diagnosis, compared to 14.0 percent of Medicaid covered youth. In the 12-months following the index nonfatal shooting, 26.8 percent of survivors and 27.3 percent of family members received a stress and anxiety related diagnosis, compared to 16.3 percent of the Medicaid covered youth. No statistically significant differences were observed across new mental health diagnoses for survivors and family members in the 12-months following the index nonfatal shooting. Among those with new mental health diagnoses, differences between survivors and family members were observed on sex and age. There were a larger proportion of female family members compared to female survivors (60.6% vs. 23.1%, $p < 0.05$) and 20.0% of family members were between 10 and 14 years old, compared to 32.9% of survivors who received a new mental health diagnosis were between 15 and 17 years of age ($p < 0.05$).

Among adult survivors and adult family members, the most prevalent new mental health diagnoses were for stress and anxiety disorders: 42.9 percent for survivors and 44.4 percent for family members, compared to 31.5 percent for the Medicaid population.

4. Discussion

Our study used police and Medicaid claims data linked at the individual and family level to examine direct and indirect exposure of nonfatal shootings on mental health conditions for survivors and family members of nonfatal shootings. Major findings include a nearly three

percent increase in mental health prevalence rates for youth family members of nonfatal shooting survivors in the 12-months post injury but no observed increase in adult family members. Additionally, among individuals with a new mental health diagnosis in the post injury period, four percent were family members, and no differences were observed in mental health condition between survivors and family members. These findings suggest that mental health sequelae are as important for youth family members as for shooting survivors in the year following a nonfatal shooting.

Our findings also demonstrate a significant increase in the number of mental health claims for family members, compared to a decrease in mental health prevalence and mental health claims among survivors in the 12-month post injury period. The most prevalent conditions for both survivors and family members in the post injury period, and among those with new mental health diagnoses, were for disruptive behavior disorders, stress and anxiety disorders, and depression and mood disorders, which align with prior research findings (Oddo et al., 2021; Vella et al., 2020). Differences were also observed across survivors and family members by age. For instance, adult survivors and youth family members experienced the most significant increase in mental health prevalence in the post injury period, compared to an observed decrease in youth survivors and adult family members. These findings indicate age disparities that may speak to access and need of mental health services (Magee et al., 2022; Neufeld et al., 2021).

Our results confirm prior work demonstrating connections between nonfatal shootings and subsequent psychological conditions for the survivors and extend these findings to siblings and children of shooting survivors, confirming the known shockwave effect of firearm violence (Leibbrand et al., 2020; Song et al., 2022; Vasan et al., 2021). Our findings also indicate youth family members less than 19 years of age were the most likely to receive a new mental health

diagnosis in the period following a nonfatal shooting, compared to adult family members. These findings are particularly important given this developmental period is associated with significant growth and understanding in regulating emotions (Scherf et al., 2013). Trauma and stress negatively impact amygdala development, which is concerning as adolescents are primed to develop emotional regulation skills during this time period (Nooner et al., 2013). Moreover, multiple exposures to violence and unaddressed trauma increases future involvement in the criminal justice system (Kar, 2019; Turner et al., 2019). For instance, research indicates among a sample of youth, losing a family member or peer due to violence increased the odds of firearm injury by three times (Bernardin et al., 2021). Adult family members only experienced a slight increase in stress and anxiety disorders in the post injury period, this finding may be because adult family members have experienced more cumulative trauma and respond differently to a nonfatal shooting incident compared to youth family members (Atwoli et al., 2016).

Although most prior research has not examined the direct mental health impact of nonfatal shootings on siblings or children our findings do align with work that examined the mental health outcomes of youth exposed to higher rates of community firearm violence and adolescent homicide survivors (Leibbrand et al., 2020; Rheingold & Williams, 2015; Rheingold et al., 2012; Vasan et al., 2021). Findings from two studies of nonfatal shooting survivors highlight the need to improve access to mental health counselors for family or "secondary survivors," as survivors expressed the emotional impact their shooting had on their children and partners. Survivors also expressed that family members provided the most support in physical healing and emotional support in the post injury period (Hink et al., 2021; Patton et al., 2019). These findings suggest the need for trauma-informed services for both nonfatal shooting survivors and family members. Primary care offices and schools might provide accessible

platforms for these types of services for young family members although the efficacy for prevention of adverse mental health outcomes is not well-documented (Berger, 2019; Flynn et al., 2015).

Our findings also demonstrate a decrease in overall prevalence of mental health and a smaller proportion of mental health claims compared to overall health care visits in the post injury period which aligns with prior research (Ranney et al., 2020). For instance, one study using healthcare claims data also noted an increase in overall healthcare use, but a smaller proportion of mental health claims increased in the period following a nonfatal shooting (Ranney et al., 2020). Our findings indicate survivors and family members are accessing the healthcare system but are not able to access or not willing to access mental health services. Disparities and sigma around accessing mental health services well-described within Black communities (Wong et al., 2017), and Black nonfatal shooting survivors and family members are overrepresented in our cohort. Several qualitative studies have demonstrated the challenges and barriers to care survivors of nonfatal shootings experience in the post injury period. For instance, nonfatal shooting survivors' report lack of transportation, financial barriers to transportation and medical care, fear of revictimization in public spaces and receiving adequate physical care but a lack of education and access to mental health services (Hink et al., 2021; Patton et al., 2019; Richardson et al., 2021).

Where trauma-informed services for nonfatal shooting survivors do exist, however, services are often not extended to family members of nonfatal shooting survivors, particularly siblings and children who may be the most at risk for involvement in future firearm violence. The most common model, Hospital Based Violence Intervention Programs (HVIPs) are within the health care setting and attempt to optimize the time immediately post shooting to offer and

connect survivors with needed social and mental health services (Bell et al., 2018). Evidence suggests such programs reduce violent injury recidivism; however, further post-discharge follow-up services have demonstrated more success in connecting youth survivors with mental health services and increasing mental health care utilization (Neufeld et al., 2021). Limitations to healthcare focused models is that they are typically located within one specific trauma center, do not extend resources to family members of shooting survivors, and do not treat all nonfatal shooting survivors within a city, leaving gaps in access to such resources for a large proportion of survivors and families. For example, Indianapolis has five level one trauma hospitals and one level one pediatric trauma hospital all of which nonfatal shooting survivors may be treated in, and all are located within one police jurisdiction.

An avenue to close this gap in connection with services is to utilize Victim's Assistance Units which are housed within police departments. Due to mandatory reporting laws, all firearm injuries are reported to law enforcement and therefore investigated and captured within police data irrelevant of which hospital system the victim was treated in (Magee, Ranney, et al., 2021). Victim's Assistance Units within police departments aid survivors and families of violence with needed social services, such as financial assistance, housing, food insecurity, and accessing the Victim's Compensation Fund. The Victim's Compensation fund is managed by The Office for Survivors of Crime with the Department of Justice and provides state funds for survivors or beneficiaries to access for needed services (Newmark, 2004). Such units, however, have largely been overlooked by survivors and families of nonfatal shootings and many survivors of violence underutilize such services or are unaware they even exist (Roman et al., 2022). For instance, in a study of survivors of violent crimes only 16 percent of participants accessed one of four available victim services and only 4 percent of survivors accessed the state victim's

compensation fund. Survivors were more likely to receive mental health treatment though when they did receive services from the Victim's Assistance Unit (Roman et al., 2022), indicating a potential avenue to reach nonfatal shooting survivors and family members.

Distrust and lack of cooperation between nonfatal shooting survivors and the police are well established challenges in engaging survivors and families through law enforcement resources (Cook et al., 2019; Hipple et al., 2019). Cooperation with the investigation and victim's services are often synonymous with each other. Survivors often note that officers are more concerned about the suspect than helping survivors with their injuries (Jacoby et al., 2020; Patton et al., 2019), however police – survivor contacts during the investigative period are potential missed opportunities for connection to services.

A promising avenue to improve both cooperation in nonfatal shooting investigations and connection to mental health services for nonfatal survivors and family members is to extend the homicide working group model to survivors of nonfatal shootings, and their families. The homicide working group, aligns with the public health-informed policing model, and is a collaboration between homicide detectives, Victim's Assistance advocates, other key stakeholders, and family members of homicide survivors. During monthly meetings detectives update families on the criminal investigation and victim advocates help families with needed resources and services (e.g., burial assistance, medical services, counseling). Such programs have demonstrated increases in case clearance rates, witness cooperation with investigations, and improved community-police trust (Carleton & Monroe, 2020; Richardson et al., 2020). A nonfatal shooting working group has the potential to increase cooperation, improve community-police trust, and connect survivors and family members to needed mental and social services in the months following a nonfatal shooting.

Despite the strengths of this study, there are a number of limitations. First, this is a descriptive analysis and therefore these results cannot imply causation. Second, nonfatal shooting survivors are disproportionately represented in Medicaid data and our findings demonstrate official mental health diagnoses and utilization; however, our data only represent Medicaid claims and are missing mental health services received through community counseling or private insurance. Our findings do, however, align with prior work using Medicare and private insurance data (Song et al., 2022). Although our study only includes one city, a strength is the ability to identify family members of shooting survivors using Medicaid claims data; however, as with all secondary data analysis the quality of the available data may be missing or may have missed potential family links. We attempted to match all individuals through multiple probabilistic matching algorithms, however, family links not connected by Medicaid case number are unable to be accounted for. Future research should expand the definition of family connections using other data sources, such as police records, to better capture all family links. Nonfatal shooting incidents not reported to police may be missed, however, police records are known to be more complete than clinical records due to mandatory reporting laws (Gupta, 2007; Kaufman et al., 2019; Magee, Ranney, et al., 2021). Lastly, the index nonfatal shooting may not be the first nonfatal shooting if the prior shooting preceded our study period or due to other community exposure, though our data do cover eight years. Future research should examine longitudinal follow-up beyond one year, examine violent injury recidivism among survivors, mental health outcomes, severity of injury, location of injury, and subsequent firearm victimization and offending among family members following a nonfatal shooting incident. This type of longitudinal study is feasible with clinical data and criminal justice data linked at the individual level over multiple years and should be a clear direction for future research.

5. Conclusion

Overall, this study finds that siblings and children of nonfatal shooting survivors experience the same if not worse mental health outcomes in the 12-months following the shooting compared to shooting survivors. There is a decrease in mental health care utilization among survivors in the 12-months following the shooting despite having higher mental health prevalence rates compared to the Medicaid covered youth population. These findings indicate a need for improved trauma- informed services and connection to mental health care for both youth survivors, siblings, children of nonfatal shootings survivors, and other family members. Addressing the mental health needs of youth survivors, siblings and children of nonfatal shootings is critical to reducing future involvement in firearm violence, improving overall health outcomes, and potentially breaking the cycle of violence by addressing the trauma associated with firearm violence.

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CONFLICTS OF INTEREST

The authors report that they have no conflicts of interest.

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Table 1. Descriptive statistics for nonfatal shooting survivors compared to family members and Marion County Medicaid Population for all ages

Measures	Survivors		Family Members		Medicaid Covered Population	
N=1,466	n = 1,311		n = 1,527		n = 350,777	
	%		%		%	
Race						
Black	76.5		78.2		40.3	
Non-Black	23.5		21.7		59.7	
Unknown	0.00		0.13			
Sex						
Male	**74.0**		**35.6**		37.2	
Female	**26.0**		**64.0**		62.2	
Unknown	**0.00**		**0.07**			
Age Category						
5 – 9 years	**1.14**		**14.4**		20.1	
10 – 14 years	**3.89**		**19.9**		14.7	
15 – 19 years	**32.9**		**17.2**		11.6	
20 – 24 years	**23.9**		**9.89**		8.75	
25 – 29 years	**9.38**		**4.72**		8.52	
30 – 34 years	**8.16**		**4.06**		6.56	
>= 35 years	**20.7**		**29.8**		29.8	
Clinical care utilization (Mean, SD)	**Prior**	**Post**	**Prior**	**Post**	**Prior**	**Post**
# Of clinical encounters	**5.89 (19.9)**	**13.6 (36.6)**	**6.01 (16.5)**	**7.86 (22.5)**	**105.9 (300.7)**	**104.7 (295.8)**
# Of mental health encounters	1.22 (7.04)	1.41 (7.06)	**1.08 (7.09)**	**1.78 (10.6)**	3.52 (24.9)	3.53 (25.0)

*Bolded values indicate $p < 0.05$, demographic differences between survivors and family members, other differences between prior and post clinical care utilization within person category. SD= Standard deviation

Table 2. Mental Health Prevalence Rates in the 12-months preceding and following an index nonfatal shooting for youth survivors, family members, and the Marion County Medicaid Youth population

	Survivors		Family Members		Medicaid Covered Youth	
	n = 497	n=497	n = 787	n = 787	n = 162,554	n = 162,554
Mental Health Outcomes	Prior Year	Post Year	Prior Year	Post Year	Prior Year	Post Year
	%	%	%	%	%	%
Any mental health diagnosis	**15.3**	**13.7**	**8.51**	**11.2**	**10.4**	**10.7**
Substance use disorder	**4.63**	**3.62**	**0.64**	**0.76**	**0.55**	**0.55**
Stress/Anxiety disorders	1.81	3.22	**0.89**	**2.80**	**1.51**	**1.61**
Depression/Mood disorders	**3.42**	**2.82**	**1.78**	**2.54**	**2.55**	**2.66**
Disruptive behavior disorders	**6.84**	**7.04**	**2.92**	**3.56**	**1.69**	**1.62**

*Bolded values indicate $p < 0.05$ when comparing prior year with post year within survivors, family members, and Medicaid covered population

Table 3. Mental Health Prevalence Rates in the 12-months preceding and following an index nonfatal shooting for adult survivors, family members, and the Marion County Medicaid population

	Survivors		Family Members		Medicaid Covered Adults	
	n = 814	n=814	n = 740	n = 740	n = 188,223	n = 188,223
Mental Health Outcomes	Prior Year	Post Year	Prior Year	Post Year	Prior Year	Post Year
	%	%	%	%	%	%
Any mental health diagnosis	**7.00**	**12.7**	**6.49**	**6.49**	**10.2**	**10.4**
Substance use disorder	**1.47**	**3.44**	0.68	0.81	**1.23**	**1.18**
Stress/Anxiety disorders	**2.21**	**4.42**	**1.89**	**2.84**	**2.96**	**2.96**
Depression/Mood disorders	**1.72**	**4.42**	**3.78**	**3.24**	**4.19**	**4.15**

*Bolded values indicate $p < 0.05$ when comparing prior year with post year within survivors, family members, and Medicaid covered population

Table 4. New Mental Health Prevalence Rates in the 12-months following an index nonfatal shooting for survivors, family members, and Marion County Medicaid Population, stratified by age group

Youth Survivors and Family Members			
Mental Health Outcomes	Survivors	Family Members	Medicaid Covered Youth
	n=41	n=44	n=7,250
Substance use disorder	12.2	4.55	2.15
Stress/Anxiety disorders	26.8	27.3	16.3
Depression/Mood disorders	19.5	18.2	21.6
Disruptive behavior disorders	46.3	27.3	14.0
Adult Survivors and Family Members			
	Survivors	Family Members	Medicaid Covered Adults
	n=63	n=27	n=7,904
Substance use disorder	14.3	3.70	6.28
Stress/Anxiety disorders	42.9	44.4	31.5
Depression/Mood disorders	36.5	44.4	35.5