SPECIAL ARTICLE

Mental Health Outcomes in Children after Parental Firearm Injury

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ABSTRACT

BACKGROUND

Every year, approximately 20,000 youths lose a parent to firearm injury in the United States. Many more youths have parents who sustain nonfatal firearm injuries. The effect of parents' firearm injuries on their children's health and health care is poorly understood.

METHODS

Using U.S. commercial health insurance claims data from the 2007–2022 period, we identified youths, 1 to 19 years of age, whose parents had received treatment for firearm injury (exposure). Each youth with exposure was matched with up to five control youths on the basis of year, month, youth sex, metropolitan statistical area, state, insurance plan type, and prescription drug coverage; mean values of age and a risk score predicting future health care use (to provide a proxy for health status) were balanced. The primary outcome was a diagnosis of psychiatric disorder among youths, assessed as a rate, which was defined as the number of youths with at least one related insurance claim in a given month, divided by the total number of youths. Secondary outcomes included substance use disorder diagnosis, health care use, and medical spending. After matching, we estimated the difference in differences in outcomes between the exposure group and the control group 12 months before the parental injury through 12 months after the injury, using a least-squares regression model with adjustment for age and risk score.

RESULTS

We examined 3790 youths with exposure and 18,535 matched controls. The mean age of the youths was 10.7 years, and 51.5% were male. Parental firearm injury was associated with 8.4 additional psychiatric diagnoses (95% confidence interval [CI], 4.8 to 12.0) per 1000 youths and 23.1 additional mental health visits (95% CI, 8.2 to 38.1) per 1000 youths as compared with control, averaged over the year. This associated increase in the exposure group was largest for diagnoses of trauma-related disorders, including post-traumatic stress disorder, with an additional 8.5 diagnoses (95% CI, 6.0 to 10.9) per 1000 youths as compared with control, averaged over the year. No apparent changes relative to control were observed in rates of other diagnoses, medical encounters, procedures, and services or in medical spending.

CONCLUSIONS

Parents' firearm injuries were associated with increases in rates of psychiatric disorders and mental health visits among their children. (Funded by the National Institute for Health Care Management and the National Institute of Mental Health.)

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Firearm injuries are the leading cause of death among children and adolescents (1 to 19 years of age) in the United States, with 4470 youths killed in 2023 alone.[1,2] Direct injury, however, is only one way that firearm violence affects individual persons, families, and communities. A recent study[3] estimated that between 1999 and 2020, approximately 434,000 children (<18 years of age) lost a parent to firearm injury in the United States — an average of nearly 20,000 children annually and 13 times the number of children who were killed by firearm injuries in the United States during this period.[2] Because nonfatal firearm injuries are thought to be two to three times as frequent as deaths, these deaths capture only a fraction of the harm caused by firearm violence.[4]

Youth survivors of firearm injury face increased risks of psychiatric, substance use, and pain-related disorders, with accompanying increases in health care use and spending.[5-10] Firearm injury is also followed by increases in psychiatric diagnoses and mental health care use among other family members,[11,12] especially among parents of children with firearm injury.[9] Two recent single-city studies showed an increased prevalence of mental health diagnoses — stress, anxiety, and mood disorders, in particular — among family members of persons with fatal[13] or nonfatal[14] firearm injury, with the greatest increases among children of injured adults. Other studies have investigated the relationship between psychiatric symptoms and exposure to family and friend homicide but have often been limited by cross-sectional study designs, narrow geographic coverage, or relatively small sample sizes, and most have tended to focus on fatal injuries.[15-19]

Studies that have been based on methods that enhance a causal understanding of the effects of parents' firearm injury on their children have been limited.[9,11,12] We conducted a matched-cohort analysis involving children and parents with commercial health insurance in the United States and used a difference-in-differences design to estimate associations between parents' firearm injuries and the health, health care use, and medical spending of their children.

METHODS

STUDY DATA

We analyzed the Merative MarketScan commercial insurance claims databases from the 2007–2022 period. These databases comprise a nationwide convenience sample of enrollees in the United States with employer-sponsored insurance, with more than 40 million persons covered annually.[20]

STUDY POPULATION AND DESIGN

This study included youths, 1 to 19 years of age, who were the children of persons who had received treatment for incident firearm injury that had occurred between January 2008 and January 2022, as well as comparable youths without such exposure. We excluded youths who had received treatment for firearm injury themselves. We identified firearm injuries using codes from the *International Classification of Diseases, 9th Revision* and *10th Revision* (ICD-9 and ICD-10, respectively) (Methods S1, S2, and S3 in the Supplementary Appendix, available with the full text of this article at NEJM.org). We identified children as the nonspouse dependents within the same insurance plan, defined by a plan identification number. For each youth, we required a minimum enrollment of 12 months before and after the parental firearm injury, with enrollment defined as active health insurance coverage by an employer-sponsored plan reporting data to MarketScan. We also required a minimum of 300 days of youth enrollment in the calendar year preceding the parental injury in order to calculate the Diagnostic Cost Related Group (DxCG) risk score, which served as a proxy for youth baseline health status. The DxCG score reflects expected future health care spending according to calendar year on the basis of current age, sex, and diagnoses.[21]

We did not require a minimum enrollment duration for parents; therefore, they may have disenrolled after the injury. Because it is not possible to ascertain death as the cause of disenrollment, this cohort may include exposure to fatal and nonfatal parental firearm injuries. We calculated the percentage of parents with firearm injury who remained enrolled for at least 3 months after the firearm injury, which suggests that they survived the initial injury. Parents who disenrolled earlier may have done so for reasons other than a fatal injury, including loss of health insurance, changes in insurance plans, separation from a spouse providing them with insurance, or incarceration. The Harvard Medical School institutional review board approved this research.

MATCHING

We matched each youth in the exposure group with up to five control youths without exposure. We used risk-set matching without replacement, with exact matching for year, month, youth sex, metropolitan statistical area, state, insurance plan type, and prescription drug coverage.[22] We balanced the means of two continuous variables, youth age and risk score, using a mathematical optimization approach to maximize the number of matches and reduce the covariate distance between matched pairs.[23-25] Data for matching variables were drawn from the month immediately before parental firearm injury. Control youths received matching weights of $1 \div N$, where N was the number of control youths matched to a youth with exposure (e.g., if five controls were matched to a specific youth with exposure, each control received a weight of one fifth). To assess match quality, we calculated the absolute standardized mean differences between the exposure group and the control group before and after matching.

OUTCOMES

The primary outcome was a diagnosis of psychiatric disorder, assessed as a rate per 1000 youths according to month and averaged over the year. We examined these data in aggregate and according to subcategory (anxiety disorder; mood disorder; neuropsychiatric disorder; psychotic disorder; trauma-related disorder, including post-traumatic stress disorder [PTSD]; and other).[12] We examined diagnoses related to attention deficit–hyperactivity disorder (ADHD) separately, given the high baseline prevalence of ADHD. We examined rates of substance use disorder diagnoses in aggregate and according to substance-specific subcategories. Other secondary outcomes included rates of mental health visits, general medical (office) visits, emergency department visits, hospitalizations, imaging tests, laboratory tests, and other health care use (other tests, home health services, or transportation services); medical spending; and prescription drug use. We analyzed the rate of chronic pain diagnoses as a negative control (i.e., an outcome that we would not expect to change after exposure).[26]

Diagnoses were identified with the use of ICD-9 and ICD-10 codes (Methods S4). Diagnosis rates were calculated as the number of youths with at least one related diagnosis on a claim in a given month, divided by total youths, and are reported per 1000 youths. If, in a single month, a youth had claims related to diagnoses in multiple subcategories (e.g., PTSD and anxiety disorder), these were counted as one at the aggregate category level (psychiatric disorders) but were counted individually in the subcategories. Therefore, the sum of the component rates could exceed the aggregate rate.

We used procedure code fields to classify outpatient visits as mental health or general office visits and to identify emergency department visits, hospitalizations, tests, and other services. The methods for calculating medical spending and prescription drug use are discussed in the Supplementary Appendix.

STATISTICAL ANALYSIS

We examined psychiatric diagnoses in youths during the 12 months before the parental firearm injury and the 12 months after the injury. We calculated the unadjusted rate of psychiatric diagnosis for each month before and after injury. We then calculated the change in the psychiatric diagnosis rate as the difference between the means before and after injury (i.e., the difference between the mean of monthly rates in the 12 months before exposure and the mean of monthly rates 12 months after exposure) within the exposure and control groups. To calculate the unadjusted differential change associated with parental firearm injury, we subtracted the difference in means for the control group from the difference in means for the exposure group. We used least-squares regression to adjust the differential change for residual differences in age and risk score, which were not exactly matched (Methods S5). The same method was used to estimate the change in other diagnostic categories, health care use, prescription drug use, and medical spending.

We also calculated the differential change in the proportion of youths who had at least one claim with a psychiatric diagnosis at any point in the 12 months before and the 12 months after parental firearm injury, again adjusting for age and risk score. The same method was used to estimate the change in proportions in other diagnostic categories.

Total missingness of any matching variable was approximately 5%. We conducted a complete-case analysis with the assumption that the miss-

Table 1. Characteristics of Youths with Exposure to Parental Firearm Injury and Matched Controls.*

Characteristic	Exposure Group (N=3790)	Matched Control Group (N=18,535)
Age (yr)	10.9±5.2	10.6±5.4
Male sex (%)	51.5	51.5
DxCG risk score†	0.35±1.95	0.32±1.30
Prescription drug coverage (%)	86.7	86.7
Plan type (%)		
PPO	58.8	58.8
CDHP or HDHP	17.2	17.2
HMO	14.7	14.7
Point of service	5.4	5.4
Basic–major medical or comprehensive	3.1	3.1
EPO	0.8	0.8

* Plus–minus values are means ±SD. CDHP denotes consumer-directed health plan, EPO exclusive provider organization, HDHP high-deductible health plan, HMO health maintenance organization, and PPO preferred provider organization.

† The Diagnostic Cost Related Group (DxCG) risk score is a measure of expected spending, driven largely by clinical diagnoses, with higher scores indicating a larger disease burden and greater expected spending. The risk scores are centered around 1.0, and a risk score of 1.0 means that the person's risk burden is equal to the mean in the DxCG development sample. Risk scores cannot be negative.

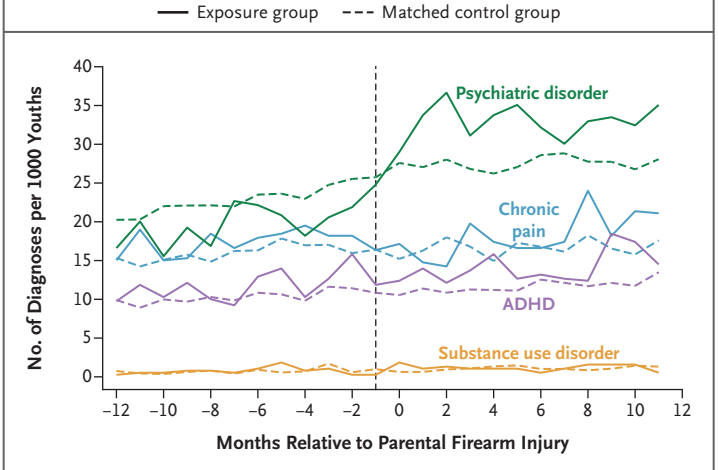

Figure 1. Diagnoses in Youths before and after Parental Firearm Injury.

Shown are unadjusted rates of diagnoses of psychiatric disorder, substance use disorder, attention deficit–hyperactivity disorder (ADHD), and chronic pain according to month among youths with exposure to parental firearm injury, as compared with their matched controls. The rate of chronic pain diagnosis was included as a negative control. The dashed vertical line indicates the month immediately before the parental firearm injury.

ingness of data was not associated with the outcome variables after controlling for the observed variables (see Methods S6 for additional details on missing data).[27] The low rate of missingness attenuates potential biases if this assumption does not hold.

We conducted subgroup analyses with stratification according to injury severity, defined as the parent receiving care in the intensive care unit (ICU) during the index hospitalization after the injury, given that greater injury severity is associated with worse health outcomes and higher spending.[9,11] We also conducted subgroup analyses with stratification according to youth sex (given sex differences in behavioral responses to stress, frequency of pediatric psychiatric conditions, and likelihood of diagnosis[28,29]).

We repeated our analyses using nonparametric permutation t-tests to assess the sensitivity of our estimates to the parametric assumptions of linear regression. We also used Rosenbaum bounds to assess sensitivity to unmeasured confounding (Methods S7).[30]

Confidence intervals for the primary and secondary outcomes were not adjusted for multiple comparisons and should not be used in place of hypothesis testing. Analyses were conducted with the use of R software, version 4.4.0, and Stata software, version 18.0 (StataCorp).

RESULTS

COHORT CHARACTERISTICS

A total of 4053 youths met the inclusion criteria, of whom 202 (5.0%) were excluded owing to missing data for one or more matching variables and 61 (1.5%) owing to an inability to find at least one match (Fig. S1). After matching, the cohort included 3790 youths with exposure and 18,535 control youths (Table 1). The mean age of the youths was 10.7 years, and 51.5% were male. Characteristics were closely balanced between the exposure group and the control group (Table S1). The mean age of the parents with firearm injury was 40.6 years, 84.1% were male, and 96.7% had been enrolled in their insurance plan for at least 3 months after the injury, which suggests that they survived the initial injury.

DIAGNOSES AND PRESCRIPTIONS

Unadjusted analysis showed similar rates of diagnoses before parental firearm injury, with trends

that did not clearly deviate between the exposure group and the control group. After parental firearm injury, a sharp and persistent increase in the rate of psychiatric diagnoses was seen in the exposure group (Fig. 1), which was most pronounced in the subcategory of trauma-related disorders, including PTSD (Fig. 2).

In an adjusted analysis, parental firearm injury was associated with 8.4 additional psychiatric diagnoses (95% confidence interval [CI], 4.8 to 12.0) per 1000 youths as compared with control, averaged over the year (Table 2). Over the year, differential increases in the exposure group as compared with the control group were also seen in the rates of trauma-related disorders, including PTSD (8.5 diagnoses per 1000 youths; 95% CI, 6.0 to 10.9), and of mood disorder (2.2 diagnoses per 1000 youths; 95% CI, 0.5 to 3.9). No differential changes in rates of ADHD-related diagnoses, other psychiatric diagnosis subcategories, substance use diagnoses, or drug prescriptions were apparent. No apparent difference was seen in the rate of chronic pain diagnoses (the negative control).

Adjusted analysis of the change in the proportion of youths with at least one psychiatric diagnosis claim at any time in the 12 months before the parental firearm injury, as compared with any time in the 12 months after, showed differential increases in the rates of psychiatric disorder (13.5 diagnoses per 1000 youths; 95% CI, 0.1 to 26.9) and of trauma-related disorders, including PTSD (23.1 diagnoses per 1000 youths; 95% CI, 15.4 to 30.9). Details are provided in Table S6.

HEALTH CARE USE AND SPENDING

Parental firearm injury was associated with a differential increase of 23.1 mental health visits (95% CI, 8.2 to 38.1) per 1000 youths as compared with control, averaged over the year (Table 2). No differential changes were apparent in medical spending (Table 2) or in other types of medical encounters or other procedures or services (Table S3).

SUBGROUP ANALYSES

A total of 380 youths had exposure to severe parental firearm injury (defined as ICU care after injury). Severe injury was associated with larger differences in outcomes than less-severe injury over the year, with differential increases per 1000 youths of 28.2 (95% CI, 9.8 to 46.7) in aggregate psychiatric diagnoses; 23.1 (95% CI, 9.8 to 36.3) in diagnoses of trauma-related disorders, including PTSD; and 80.1 (95% CI, 25.3 to 134.8) in mental health visits (Table 3 and Figs. S2 and S3).

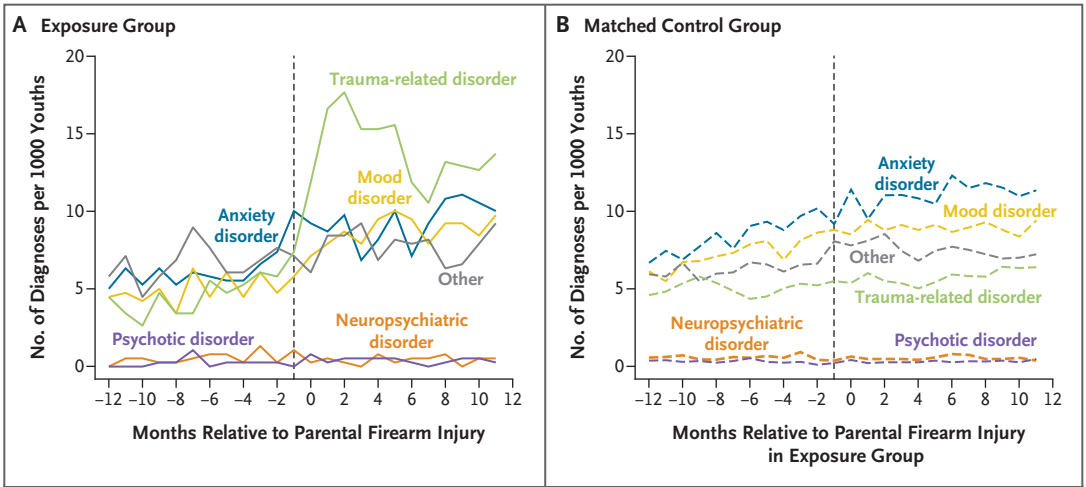

Figure 2. Psychiatric Diagnoses in Youths According to Clinical Category before and after Parental Firearm Injury.

Shown are unadjusted rates of psychiatric diagnoses (anxiety disorder; mood disorder; neuropsychiatric disorder; psychotic disorder; trauma-related disorder, including post-traumatic stress disorder; or other) according to month among youths with exposure to parental firearm injury (Panel A), as compared with their matched controls (Panel B). In each panel, the dashed vertical line indicates the month immediately before the parental firearm injury in the exposure group.

Table 2. Changes in Rates of Diagnoses, Health Care Use, and Prescriptions and in Medical Spending among Youths with Exposure to Parental Firearm Injury.*

Outcome	Exposure Group (N=3790)		Matched Control Group (N=18,535)		Differential Change between Groups	
	12 Mo before Injury	12 Mo after Injury	12 Mo before Injury	12 Mo after Injury	Adjusted Change (95% CI)	Percentage Change (95% CI)
No. of diagnoses per 1000 youths						
Psychiatric disorder	20.0	33.0	22.9	27.6	8.4 (4.8 to 12.0)	42.0 (23.8 to 60.1)
Anxiety disorder	6.3	9.3	8.4	11.1	0.3 (–1.3 to 2.0)	5.1 (–21.4 to 31.5)
Mood disorder	5.0	8.8	7.3	8.9	2.2 (0.5 to 3.9)	43.5 (9.2 to 77.8)
Neuropsychiatric disorder	0.5	0.4	0.6	0.5	–0.1 (–0.5 to 0.3)	–17.9 (–96.2 to 60.3)
Psychotic disorder	0.2	0.4	0.3	0.3	0.2 (–0.1 to 0.5)	84.0 (–57.1 to 225.1)
Trauma-related disorder, including PTSD	4.7	13.9	5.1	5.8	8.5 (6.0 to 10.9)	178.3 (126.4 to 230.3)
Other	6.7	7.8	6.4	7.5	0.0 (–1.7 to 1.7)	–0.4 (–25.9 to 25.1)
ADHD	11.7	14.1	10.3	11.7	1.0 (–1.2 to 3.2)	8.7 (–9.8 to 27.2)
Substance use disorder	0.7	1.2	0.7	1.1	0.1 (–0.4 to 0.7)	18.3 (–59.8 to 96.5)
Chronic pain	17.3	18.2	16.0	16.6	0.2 (–1.9 to 2.4)	1.4 (–11.1 to 13.9)
Psychiatric drug prescriptions per youth						
No. of prescriptions	0.1	0.1	0.1	0.1	0.0 (0.0 to 0.0)	4.6 (–3.9 to 13.0)
No. of days covered	1.6	2.0	1.8	2.1	0.0 (–0.1 to 0.2)	2.6 (–6.5 to 11.8)
Health care use (no. per 1000 youths)						
Mental health visits	38.3	69.7	56.1	64.3	23.1 (8.2 to 38.1)	60.4 (21.4 to 99.3)
General office visits	244.9	241.8	253.6	243.7	6.7 (–7.2 to 20.5)	2.7 (–2.9 to 8.4)
Emergency department visits	28.7	29.7	18.1	18.1	1.1 (–2.7 to 4.8)	3.7 (–9.4 to 16.9)
Hospitalizations	1.4	1.9	1.6	1.4	0.7 (0.0 to 1.3)	47.4 (2.6 to 92.2)
Medical spending per youth (U.S. $)						
Total	170	206	177	192	20 (–27 to 67)	11.9 (–16.0 to 40.0)
Out of pocket	30	2	28	31	–3 (–6 to 0)	–10.7 (–20.0 to –1.0)

* The unadjusted differential change was calculated as the difference between the mean values before and after injury in the exposure group (youths with exposure to parental firearm injury) minus the difference between the mean values before and after injury in the control group (youths with no exposure to parental firearm injury). Means were calculated by averaging monthly rates over the 12 months before and after the parental firearm injury. The differential change was then adjusted for youth age and risk score, which were not exactly matched. Confidence intervals for the primary and secondary outcomes were not adjusted for multiple comparisons and should not be used in place of hypothesis testing. If, in a single month, a youth received diagnoses in multiple diagnostic subcategories (e.g., post-traumatic stress disorder [PTSD] and anxiety disorder), these counted as one at the aggregate category level (psychiatric disorders) but were counted individually in their subcategories. Therefore, the sum of the component rates may exceed the aggregate rate. ADHD denotes attention deficit–hyperactivity disorder.

We found larger associated differences among female youths than among male youths (Tables S4 and S5 and Fig. S4). Over the year, the differential increase in the rate of psychiatric diagnoses as compared with control was 13.1 (95% CI, 6.9 to 19.4) per 1000 female youths and 3.9 (95% CI. –1.0 to 8.8) per 1000 male youths. Subgroup analyses of the differential changes in the proportions of youths, according to the severity of the parental firearm injury and youth sex, who had at least one diagnosis before and after the parental firearm injury are shown in Tables S7, S8, and S9.

SENSITIVITY ANALYSES

Nonparametric estimation with permutation t-tests produced results similar to those of the main and subgroup analyses using least-squares regression (Table S10). Sensitivity analysis with Rosenbaum bounds showed that after matching, an unmeasured confounder — differing across both exposure and time — would need to increase the odds of exposure to parental firearm injury in the main analysis by 1.27 for aggregate psychiatric diagnoses and by 2.19 for diagnoses of trauma-related disorders, including PTSD, in order for the confidence interval of these estimates to include a null effect (i.e., a differential increase in diagnosis rates of 0). This finding is consistent with results that are insensitive to small-to-moderate unmeasured biases but sensitive to larger biases.

DISCUSSION

Parents' firearm injuries were associated with increases in psychiatric disorders and mental health visits in their children, as compared with closely matched youths without exposure to parental firearm injury. These changes were larger among children whose parents sustained more-severe injuries and among female youths.

Severe parental firearm injury was associated with greater increases in mental health diagnoses among youths. Given that ICU care for the parent is an observable marker of injury severity, it can help identify these particularly vulnerable children for assistance. Severe injuries are associated with longer hospital stays and provide the opportunity for more extensive interactions with clinical and social service providers, including hospital-based violence intervention programs, both during hospitalization and after discharge.[31] Mental health consequences, however, are not limited to the children of severely injured parents. Children of less severely injured parents may receive fewer support services because they are less readily identified and engaged.

The amplified association of parental firearm injury with mental health outcomes in female children is also of note. In general, girls' and women's experience with firearm violence is underappreciated because boys and men make up more than 85% of firearm deaths annually.[2] Yet, the reverberations of parental firearm injury are at least as likely to affect female children as male children, as shown by the even sex distribution in our study, and caregiving responsibilities after firearm injury fall disproportionately on the female relatives of male survivors.[32] The sex differences that we observed should, however, be interpreted in light of reported sex differences in the underlying prevalence of mental health conditions, behavioral responses to stress, care seeking, clinician diagnostic biases and tendencies, and the distribution of specific psychiatric diagnoses that may lead to underdiagnosis among male children.[28,29]

Although we did not observe apparent changes in rates of substance use disorder diagnoses among youths in the year after parental firearm injury, previous research has shown associations between substance use and both personal and indirect exposure to firearm violence.[9,11,12,33] The absence of such a finding may be related to the young age in our cohort, given that substance use disorders are less common in younger children than in adolescents and may develop more slowly and take longer to come to medical attention, if they do at all, than our observation period allowed us to detect.

Among youths with severely injured parents, the increase in the rate of psychiatric disorders that we found (an additional 28.2 diagnoses per 1000 youths, as compared with control) exceeded earlier estimates — from data that used identical outcome definitions and similar methods — of the effect of children's firearm injuries on their own mental health (18.8 diagnoses per 1000 children), although it was below the increase in the rate observed after severe firearm injury to children themselves (99.4 diagnoses per 1000 children).[9] Although cross-cohort comparisons should

Table 3. Changes in Rates of Diagnoses, Health Care Use, and Prescriptions and in Medical Spending among Youths with Exposure to Severe Parental Firearm Injury.*

Outcome	Exposure Group (N=380)		Matched Control Group (N=1850)		Differential Change between Groups	
	12 Mo before Injury	12 Mo after Injury	12 Mo before Injury	12 Mo after Injury	Adjusted Change (95% CI)	Percentage Change (95% CI)
No. of diagnoses per 1000 youths						
Psychiatric disorder	24.1	55.7	29.5	32.9	28.2 (9.8 to 46.7)	117 (40.6 to 193.4)
Anxiety disorder	10.3	17.3	9.6	14.6	2.0 (–7.1 to 11.1)	19.3 (–69.0 to 107.6)
Mood disorder	7.2	11.8	11.2	10.5	5.4 (–0.4 to 11.1)	74.1 (–5.7 to 154.0)
Neuropsychiatric disorder	0.4	0.7	0.3	0.3	0.3 (–0.4 to 1.0)	66.7 (–89.0 to 222.3)
Psychotic disorder	0.2	0.7	0.3	0.3	0.4 (–0.4 to 1.2)	180 (–169.6 to 529.6)
Trauma-related disorder, including PTSD	4.8	28.5	7.7	8.3	23.1 (9.8 to 36.3)	478.2 (202.9 to 753.4)
Other	6.8	8.3	10.1	11.0	0.6 (–5.5 to 6.6)	8.2 (–81.4 to 97.7)
ADHD	13.4	19.1	12.6	12.6	5.7 (–1.4 to 12.9)	43 (–10.5 to 96.4)
Substance use disorder	0.2	1.5	0.5	1.0	0.9 (–1.9 to 3.7)	400 (–869.0 to 1669.0)
Chronic pain	18.6	17.5	15.7	14.2	0.4 (–5.9 to 6.7)	2.4 (–31.4 to 36.2)
Psychiatric drug prescriptions per youth						
No. of prescriptions	0.1	0.1	0.1	0.1	0.0 (0.0 to 0.0)	13.1 (–4.3 to 30.5)
No. of days covered	3.4	4.1	2.2	2.5	0.5 (–0.2 to 1.2)	14.2 (–6.6 to 35.0)
Health care use (no. per 1000 youths)						
Mental health visits	32.2	115.6	67.2	70.5	80.1 (25.3 to 134.8)	248.4 (78.5 to 418.2)
General office visits	251.5	251.8	258.1	237.0	21.3 (–9.5 to 52.2)	8.5 (–3.8 to 20.7)
Emergency department visits	34.9	31.8	16.4	15.1	–1.8 (–11.8 to 8.2)	–5.1 (–33.8 to 23.6)
Hospitalizations	2.2	2.4	1.8	1.8	0.2 (–1.8 to 2.3)	10 (–83.3 to 103.3)
Medical spending per youth (U.S. $)						
Total	162	221	163	162	61 (–53 to 175)	37.8 (–33.0 to 108.0)
Out of pocket	30	30	29	29	0 (–8 to 7)	–0.8 (–26.0 to 25.0)

* The unadjusted differential change was calculated as the difference between the mean values before and after injury in the exposure group minus the difference between the mean values before and after injury in the control group. Means were calculated by averaging monthly rates over the 12 months before and after the parental firearm injury. The differential change was then adjusted for differences according to youth age and risk score, which were not exactly matched. Confidence intervals were not adjusted for multiple comparisons and should not be used in place of hypothesis testing. If, in a single month, a youth received diagnoses in multiple diagnostic subcategories (e.g., PTSD and anxiety disorder), these counted as one at the aggregate category level (psychiatric disorders) but were counted individually in their subcategories. Therefore, the sum of the component rates may exceed the aggregate rate.

be made with caution, this finding is consistent with results of a previous study showing that the prevalence of PTSD among children after parental trauma surpassed the prevalence after injury to children themselves.[34]

Taken together, our findings emphasize the substantial within-family spillover effects of firearm injury. Our findings extend research that has linked negative outcomes to a variety of youth exposures to firearm violence, including direct injury and community-level exposures.[5-10,35] Recognition of the many ways that firearm violence can affect youths has motivated calls to formally classify firearm and community violence as a specific adverse childhood experience.[36,37] Such experiences — especially when severe, cooccurring, and persistent — have strong associations with changes in brain development and long-term effects on physical and mental health that persist into adulthood.[33,38-41]

Our findings highlight the importance of robust supportive care for children after parental firearm injury and deliberate care coordination between teams taking care of adults with firearm injury and teams caring for their children. Previous research on parental death from homicide has linked worsening mental health in their children not only to the intense grief accompanying the loss of a parent but also to a loss of confidence in society, a sudden sense of vulnerability and insecurity, fear of additional violence to other family members or to themselves, worsening mental health in the surviving parent, and strained family dynamics.[17] Studies involving both survivors of firearm injury and their affected relatives, however, suggest that mental health services are difficult to access and underused.[42-45]

Informing the survivors of firearm injury about the possible mental health consequences for their children and about the benefit of intervention may facilitate broader recognition of such challenges and could potentially facilitate earlier access to care. Clinicians can also seek parental permission to coordinate with pediatricians to monitor for emerging mental health needs in their children. Hospital-based violence-intervention programs can assist in coordinating care for injured adults and their affected children.[46] To leverage existing resources, teams caring for adult survivors can refer their children to supportive programs designed to serve youth survivors of firearm injury. They can also refer children to community-based programs that support survivors and their families.

Our study has limitations. First, despite careful matching with closely balanced exposure and control groups, there may be less-balanced unobserved variables, including socioeconomic status. The balanced trends in preexposure outcomes across the exposure and control groups and the sharp increase in the rates after injury in the exposure group alone, however, support our interpretation.

Second, we analyzed families with employer-sponsored health insurance from large employers, which may not generalize to other populations, particularly to recipients of Medicaid, which is the other major source of insurance for children and is more commonly represented among persons injured by firearms.[47] Third, we were not able to definitively identify fatal parental firearm injury, which could be associated with larger effects on the mental health of children. The fact that more than 95% of the injured parents were still enrolled 3 months after the injury suggests that most parents in our study survived their initial injury. Our findings, therefore, probably underestimate the effects on children of parents with fatal firearm injuries.

Fourth, our study excluded youths who had not been continuously enrolled in an insurance plan for 12 months after the parental firearm injury. Firearm injury is associated with insurance disruption in survivors and their dependents, with greater effects seen after severe firearm injury.[48] The exclusion of persons who experienced such a disruption may have also biased our estimates toward the null. Fifth, we did not analyze effects according to the firearm-injury intent (i.e., unintentional, assault, or personal self-harm) because ICD codes lack precision in distinguishing among these.[49]

Sixth, our primary outcome was dependent on recorded diagnoses on insurance claims and was therefore susceptible to factors related to care-seeking behavior, screening, and diagnosis. Medical diagnoses may underestimate the full mental health effects of parents' firearm injuries on their children. This situation may be especially true in contexts where mental health care is especially difficult to access, such as in rural and inner-city areas, or when such care is not billable to insurance, as occurs with care pro-

vided by school counselors. On the other hand, it is possible that increased screening because of familial or clinician concern after parental firearm injury could have led to increased ascertainment of psychiatric disorders and related mental health visits, which would have elevated the apparent effects. Finally, confidence intervals were not adjusted for multiple comparisons and should not be used in place of hypothesis testing.

Parents' firearm injuries were associated with increases in rates of psychiatric diagnoses and mental health visits among their children, a finding driven by diagnoses of trauma-related disorders, including PTSD. Severe injuries in parents were associated with larger mental health effects in children, and the effects were larger in female children than in male children.

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