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HISTORICAL PERSPECTIVE

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Trends in workplace homicides in the U.S., 1994–2021: An end to years of decline

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Abstract

Workplace and non-workplace homicides in the United States (U.S.) have declined for over 30 years until recently. This study was conducted to address the change in trends for both workplace and non-workplace homicides and to evaluate the homogeneity of the change in workplace homicides by specified categories. Joinpoint and autoregressive models were used to assess trends of U.S. workplace and non-workplace homicides utilizing surveillance data collected by the Bureau of Labor Statistics and the Federal Bureau of Investigation from 1994 through 2021. Both workplace and non-workplace homicides decreased significantly from 1994 through 2014. Workplace homicides showed no significant trend from 2014 through 2021 ($p = 0.79$), while non-workplace homicides showed a significant average annual increase of 4.1% from 2014 through 2020 ($p = 0.0013$). The large decreases in the trend of workplace homicides occurring during a criminal act, such as robbery, leveled off and started to increase by the end of the study period ($p < 0.0001$). Declines in workplace homicides due to shootings also leveled off and started to increase by the end of the study period ($p < 0.0001$). U.S. workplace and non-workplace homicide rates declined from the 1990s until around 2014. Trends in workplace homicides varied by the types of the homicide committed and by the type of employee that was the victim. Criminal-intent-related events, such as robbery, appear to be the largest contributor to changes in workplace homicides. Researchers and industry leaders could develop and evaluate interventions that further address criminal-intent-related workplace homicides.

KEYWORDS

CFOI, homicide, Joinpoint, trends, workplace

1 | INTRODUCTION

Workplace homicides have consistently been one of the leading causes of occupational fatalities in the United States (U.S.) recorded by the Bureau of Labor Statistics' (BLS) Census of Fatal Occupational Injuries (CFOI), since its inception in 1992.[1–3] While workplace homicides had a slight decrease during the 1980s into the early 1990s,[4] a more significant drop was seen from 1994 to 2019 when workplace homicides dropped by over 50%.[5] From 1994 through 2002, the decline in workplace homicides was particularly steep. This steep drop was mainly driven by large declines in criminal-intent-related workplace homicides, such as robbery, while other workplace homicides such as worker on worker homicide,

All work was performed at the National Institute for Occupational Safety and Health.

intimate partner related homicide, and client on worker related homicide remained steady or experienced slight increases.[6]

While workplace homicides have generally declined over the past 30 years,[5] there are some indications that this decline may be coming to an end and that workplace homicides may be starting to increase. Workplace homicides increased by 11% between 2014 and 2019.[5] In 2021, there were 481 workplace homicides in the U.S., the highest number recorded since 2016.[2] Additionally, overall U.S. homicide rates due to firearms have shown increases recently after falling over the previous 25 years.[7–11] Comparing workplace homicides to overall U.S. homicides trends can provide important insights into how workplace and non-workplace homicides may differ and how that may affect violence prevention efforts.

In 2001, a typology was developed to categorize types of workplace violence based on the intent and relationship of the perpetrator to the victim.[12] This categorization is useful when developing workplace prevention efforts. Type I is defined as criminal-intent incidents in which the perpetrator has no legitimate business relationship to the business and is usually committing a crime in conjunction with the violence, such as robbery. Type II is defined as customer/client incidents in which the perpetrator has a legitimate business relationship with the business and becomes violent while being served by the business. Type III is defined as worker-on-worker incidents in which the perpetrator is an employee or past employee of the business and attacks or threatens another employee. Type IV is defined as personal relationship incidents in which the perpetrator does not have a relationship with the workplace but has a personal relationship with the intended victim and includes intimate partner violence occurring in the workplace.

It is important to understand the trends by the four types of workplace violence in conjunction with understanding homicide trends by industry, occupation, demographics, and other relevant variables. This allows researchers and business leaders to develop and evaluate effective intervention strategies aimed at reducing workplace homicides for specific businesses, types of violence, and types of impacted workers. Additionally, if changes in trends can be identified early, specific interventions can be proposed to mitigate workplace homicides. This manuscript will evaluate trends by these variables to detect recent fluctuations in trend direction, compare workplace homicide to non-workplace homicide trends, and provide an update to a previously published manuscript that examined a decade of trends in workplace homicides from 1993 to 2002.[6]

2 | METHODS AND MATERIALS

2.1 | Workplace homicide data sources

Workplace homicide fatality numbers for the years 1994–2021, inclusively, were obtained from the Census of Fatal Occupational Injuries (CFOI). CFOI is operated under the Bureau of Labor Statistics' (BLS) Injuries, Illnesses, and Fatalities program. CFOI collects occupational fatality data from all 50 states and the District of Columbia and includes all employment types, including private industry and the self-employed. CFOI data are collected from multiple, cross-referenced sources, including death certificates, workers' compensation records, medical examiner reports, police reports, news media, and follow-up questionnaires. A fatal injury is captured in CFOI if the decedent was employed at the time of the incident, engaged in a legal work activity, and at the incident site as a job requirement. For accuracy, work-relatedness of the fatality must be substantiated by two or more independent sources.[13]

Workplace homicides were identified using BLS's Occupational Injury and Illness Classification System (OIICS).[14] The classification of an occupational fatality due to homicide included events coded as homicide (for years 1994 to 2010 codes 61XX to 619X; for years 2011 to 2021 codes 11XX to 1119). The 123 victims of the Oklahoma City bombing in 1995 were excluded from the data and not included in these analyses. Additionally, fatalities associated with the September 11, 2001 terrorist attacks are not available with these data.

The total number of workplace homicides per year were obtained through the public query system operated by BLS.[15] After 2017, due to changes in BLS's public reporting policies, the number of workplace homicides broken down by additional variables in the public query system is incomplete.[15] Access to these additional data were obtained through a Memorandum of Understanding between BLS and the National Institute for Occupational Safety and Health (NIOSH) which allowed restricted access to CFOI within BLS's Virtual Data Enclave. The number of homicides per year by the type of weapon used, location of the incident, and victim's demographics, such as gender, age, race, occupation, industry, and worker activity were compiled by the NIOSH researchers. Only variables which had sufficient numbers per year to meet BLS's reporting requirements were included. Each of these variables were coded by BLS and further details on the coding can be obtained from BLS's Handbook of Methods.[13] Types I–IV workplace violence coding for homicides were based on the primary source codes from OIICS.[12,13] Since industry and occupation coding underwent a significant change after 2002, trends by industry and occupation are only presented from 2003 to 2021 based on the North American Industrial Classification System (NAICS) and the Standard Occupational Classification (SOC), respectively.[13]

Full-time equivalent (FTE) employment estimates from the Current Population Survey (CPS) were used as the denominators for the calculation of workplace homicide rates overall and by worker characteristics.[16] One FTE is equal to 40 h of work per week for 50 weeks per year. The CPS, collected by the U.S. Census Bureau for BLS, is the primary source of labor force statistics in the U.S. and surveys approximately 60,000 households with about 110,000 individuals interviewed each month.[17] The households are selected on a rotating basis to be a representative sample of the U.S. civilian noninstitutional population aged 16 and older.

2.2 | Non-workplace homicide data sources

U.S. homicide data were obtained from the Uniform Crime Report (UCR) public query system.[18] The Federal Bureau of Investigation (FBI) collects UCR data from approximately 18,000 U.S. law enforcement agencies.

Due to issues with the transition from UCR to the National Incident-Based Reporting System (NIBRS) in 2021, the FBI determined the 2021 data are unreliable for trend analyses and are not included in this analysis.[19] The number of workplace homicides obtained from CFOI was subtracted from the number of overall U.S. homicides obtained from the FBI in all models. U.S. population estimates, which were used as denominators for yearly homicide rates, were obtained from the UCR data. These population estimates are U.S. Census Bureau provisional estimates as of July 1 for each year except 2000, 2010, and 2020 which are decennial census counts.

2.3 | Statistical methods

Annual workplace homicide rates were calculated by dividing the number of homicides by the total number of FTEs employed in the U.S. per year and expressed per 100,000 FTE. Annual workplace homicides rates (per 100,000 FTE) were also calculated for gender, age, race, occupation, and industry by dividing the number of workplace homicides by the corresponding FTE employment estimates per year. Annual non-workplace U.S. homicide rates (per 100,000 population) were calculated by dividing all U.S. homicides, minus the workplace homicides, per year by the average total U.S. population per year.

Trends over 28 years are very often nonlinear and can be very complex. Additionally, time series data such as these, often exhibit significant serial correlation which need to be addressed to ensure proper precision estimates such as the standard errors of model parameters. Two different statistical modeling techniques, which can control for serial correlation, were employed. For all the variables we considered, as well as all workplace and non-workplace homicides, a quadratic fit using an autoregressive model to the trends was used to assess if a linear fit would be adequate for a specific series. When a linear fit was found to not be adequate, the quadratic fit was also used to estimate when a change in trend occurred. To determine if there were any other significant trend changes in overall workplace and non-workplace homicides and to estimate where these changes occurred, Joinpoint analysis was used.

2.3.1 | Autoregressive models

For annual workplace and non-workplace homicide rates, as well as specific categories of workplace homicide rates, nonlinearity of trends during the study years was first assessed with a quadratic, autogressive, with one lag, (AR(1)) model with the equation:

$$\begin{aligned} \text{Rate}_t &= \beta_0 + \beta_1 \text{Year}_t + \beta_2 \text{Year}_t^2 + v_t \\ v_t &= -\varphi v_{t-1} + \varepsilon_t \end{aligned} \quad (1)$$

where ε_t is the residual error term at time t. If the p-value for φ, the AR (1) parameter, was greater than 0.05, the AR(1) parameter was dropped from any future possible models and a regular linear regression with quadratic structure was fit. If the p-value for the parameter β_2 was less than 0.01, it was concluded that the trend was nonlinear, and Equation (1) was used as the final model. For interpretability of this final quadratic model, a point of inflection of the quadratic curve was calculated as:

$$\text{Inflection Point} = -\beta_1/(2\beta_2) \quad (2)$$

The standard error for the date of inflection was estimated through a Taylor series approximation employing the values of the variances and covariances of β_1 and β_2 estimated from the model.[20]

If the p-value for the parameter β_2 was greater than 0.01, then it was assumed that a linear trend would provide a better fit to the specific series and the following model was used for the series' final model:

$$\begin{aligned} \text{Rate}_t &= \beta_0 + \beta_1 \text{Year}_t + v_t \\ v_t &= -\varphi v_{t-1} + \varepsilon_t \end{aligned} \quad (3)$$

For final models that only included a linear term, the average annual change in homicide rates (or homicides), and its corresponding standard error, were estimated by the parameter β_1 from Equation (3). The final model for each series was used to predict an estimated rate for the last year of the study period.

For location and activity of the workplace homicide, the same process was used, with the number of homicides replacing rates as the dependent variable. The final models were then used to estimate the percentage of workplace homicides for each category of location and activity. All models were calculated employing PROC AUTOREG in SAS version 9.4.[21]

2.3.2 | Joinpoint modeling

To assess whether the overall rates of workplace homicide and non-workplace homicide could be described beyond a quadratic relationship, piecewise linear regression employing Joinpoint analysis was conducted.[22] This analysis also allowed us to compare if changes in workplace and non-workplace homicide trends occurred at similar times. Joinpoint analysis allows for the determination of trend changes, as well as where the change in trend occurred, for each data series. An autocorrelation error structure was used to model each series. An annual average percent change in rates was calculated for each segment of the piecewise regression by calculating the slope divided by the average predicted value of the specified segment times 100. All models were estimated using the software Joinpoint.[23]

3 | RESULTS

3.1 | Workplace and non-workplace homicide rates

Over the period 1994–2021, 16,497 U.S. workers were intentionally killed while at work. The highest workplace homicide rate

was 0.88 homicides per 100,000 FTE in 1994 and the lowest workplace homicide rate was 0.27 per 100,000 FTE in 2020, followed closely by 0.28 in years 2013, 2014, and 2015 (Figure 1B). During the period 1994–2020, 456,494 non-workplace homicides occurred in the U.S. The highest non-workplace homicide rate was 8.96 per 100,000 persons in 1994 and the lowest was 4.44 in 2014 (Figure 1A).

The predicted rate of workplace homicides in 2021 for males (0.47 per 100,000) was over three times higher than the predicted rate of females (0.13 per 100,000). The predicted rates of workplace homicides in 2021 was very similar across all age groups. By race, blacks had the highest predicted rate of workplace homicides (0.74 per 100,000), followed by Hispanics (0.32 per 100,000) and whites (0.18 per 100,000) during 2021. The occupations with the highest predicted rates of workplace homicides in 2021 were protective services (2.74 per 100,000), followed by taxi and chauffeurs (2.21 per 100,000), and retail sales (1.06 per 100,000). Gasoline stations had the highest rate of workplace homicides in 2021 (5.55 per 100,000) compared to any other industries (Table 2). Almost half of all workplace homicides occurred in public buildings during 2021. Tending retail accounted for 29% of all workplace homicides that occurred during 2021 when looking at the activity of the employee, followed by 19% who were performing protective services when the homicide occurred (Table 3).

3.2 | Overall trends in rates

Two significant trend changes in workplace homicide rates were detected between 1994 and 2021 using the Joinpoint analysis. A significant change occurred in 1999 ($p < 0.0001$), and another occurred in 2014 ($p = 0.0029$) (Figure 1B). For non-workplace homicide rates, the Joinpoint analysis detected three significant trend changes between 1994 and 2020. The trend changes occurred in 1999 ($p < 0.0001$), 2006 ($p < 0.0505$), and 2013 ($p = 0.0003$). The point of inflection for the quadratic fit of non-workplace homicide rates was 2010.2 (95% CI: 2008.6–2011.9) and was significantly lower than the inflection point of the quadratic fit for workplace homicides rates of 2015.2 (95% CI: 2012.2–2018.1) (Figure 1A).

From 1994 to 1999, U.S. workplace and non-workplace homicide rates experienced a similar large decline in rates, with an average annual decline of 10.6% (95% CI: 8.8%–12.4%) and 9.1% (95% CI: 6.6%–11.6%) per year, respectively (Table 1). While workplace homicides showed an average annual decline of 3.3% (95% CI: 2.8%–3.9%) per year from 1999 to 2014, the non-workplace homicide rate demonstrated no significant change from 1999 to 2006, followed by an average annual decline of 3.7% (95% CI: 1.0%–6.3%) per year from 2006 to 2013 (Table 1). The end of the study period showed different trends between U.S. workplace and non-workplace homicides. Workplace homicides showed no significant changes in trends from 2014 to 2021, while the non-workplace homicide rate had a significant average annual increase of 4.1% (95% CI: 2.0%–6.2%) per year. (Table 1)

3.3 | Workplace homicide trends by selected variables

Workplace homicide trends by socio-demographics (gender, age, and race) were similar and generally corresponded to the overall workplace homicide trends found during the study period (Table 2). When looking at workplace homicide trends by the perpetrator of the event, Type III (worker-on-worker) and Type IV (personal acquaintance) both showed a nonsignificant decrease, while Type II (customer/client) had a small, but slightly significant increase

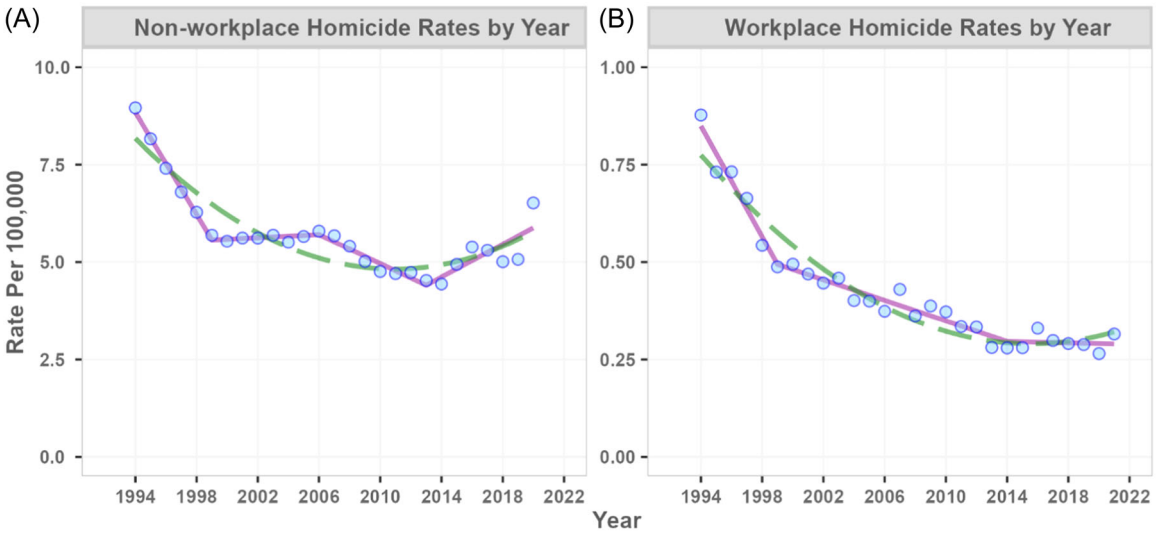

FIGURE 1 US Homicide Rates (per 100,000) with Estimated Piecewise Regression (Solid Line) and Quadratic Regression (Dashed Curve).

TABLE 1 Piecewise linear regressions for workplace and non-workplace homicides in the U.S., 1994–2021.

	Segment	Parameter	Parameter Estimate	Standard Error	p-value	Average Annual Change (95% CI)
Workplace	1994–1999	Intercept 1	142.5963	12.1946	<0.0001	
Homicides		Slope 1	−0.0711	0.0061	<0.0001	−10.6% (−12.4%, −8.8%)
	1999–2014	Intercept 2	26.8606	2.2348	<0.0001	
		Slope 2	−0.0132	0.0011	<0.0001	−3.3% (−3.9%, −2.8%)
	2014–2021	Intercept 3	2.1324	6.9413	0.7619	
		Slope 3	−0.0009	0.0034	0.7937	−0.3% (−2.6%, 2.0%)
Non-workplace	1994–1999	Intercept 1	1315.7997	181.2924	<0.0001	
Homicides		Slope 1	−0.6554	0.0908	<0.0001	−9.1% (−11.6%, −6.6%)
	1999–2006	Intercept 2	−33.9749	137.6193	0.8081	
		Slope 2	0.0198	0.0687	0.7772	0.4% (−2.0%, 2.7%)
	2006–2013	Intercept 3	378.2321	138.1004	0.0146	
		Slope 3	−0.1857	0.0687	0.0157	−3.7% (−6.3%, −1.0%)
	2013–2020	Intercept 4	−419.6249	109.6620	0.0015	
		Slope 4	0.2106	0.0544	0.0013	4.1% (2.0%, 6.2%)

($p = 0.0277$). Type I (criminal intent) workplace homicides demonstrated a similar trend to all workplace homicides, having a large decrease at the beginning of the study period. However, starting around 2015, Type I homicides experienced a slight, but significant increase ($p < 0.001$) (Table 2).

Workplace homicides caused by physical force including hitting, kicking, and beating, declined significantly for the entire study period (Table 2). Workplace homicides due to stabbings and shootings decreased early during the time period, however, these decreases terminated by the end of the study period ($p = 0.0016$ and $p < 0.0001$, respectively).

Protective service and construction occupations had no significant change in workplace homicides during the study period ($p = 0.3073$ and $p = 0.2296$) (Table 2). The occupations of management, office and administration, transportation, and taxi and chauffeurs all had significant linear decreases in workplace homicide rates throughout the study period. Those working in food prep and serving, sales (non-retail), retail sales, and production experienced a similar trend to all workplace homicides with initial decreases early in the study period that ended during the later part of the study period (Table 2).

By industry, workplace homicides in construction, educational and health services, and government and public administration showed minimal change during the study period. Transportation and warehousing, and accommodation and food services industry sectors had significant linear decreases during the study period. The retail trade industry had a significant nonlinear trend during the study period ($p = 0.0074$), with an inflection date of 2021.7 that was outside the study period. However, the retail trades subsector of gasoline stations demonstrated no significant trend while the retail trades subsector of grocery stores had a highly significant linear average annual decrease of 0.09 per 100,000 FTE per year ($p < 0.0001$) (Table 2).

Workplace homicides occurring at an industrial place or office building significantly declined throughout the study period ($p = 0.0014$ and $p = 0.0001$, respectively) (Table 3). When analyzing workplace homicide trends by worker activity, performing protective services slightly decreased by 0.8 homicides per year ($p = 0.0426$), while office work had a highly significant linear decrease of 1.5 fewer homicides per year ($p < 0.0001$). Performing healthcare and social services tasks had no significant change in workplace homicides during the study period ($p = 0.8576$) (Table 3).

4 | DISCUSSION

This manuscript compared the most recent workplace homicide trends with non-workplace homicide trends using state-of-the art statistical methods that can detect multiple changes in trends over a 28-year time span. For both workplace and non-workplace homicides, the sharp rate decreases beginning in 1994 appear to have leveled off. Beginning around 2013, non-workplace homicides trends increased by an average of 4.1% annually, while workplace homicide rates have remained steady. Additionally, workplace homicide trends differed by the type of violence that workers are exposed to in their jobs.

A previous trend analysis of workplace and non-workplace homicide rates found that between 1993 and 2002 the decline in workplace homicide rates was statistically greater than the decline in non-workplace rates,[6] and the decline in workplace homicides was

TABLE 2 Autoregressive models for the trend in the rate of workplace homicides for socio-demographic and occupational subgroups.

			Quadratic Trend Model[a]			Linear Trend Model[b]	
	Study Years	Predicted 2021 Rate[c]	Quadratic Parameter	p-value	Inflection Date (95%CI)[d]	Linear Parameter[e]	p-value
U.S. Non-workplace Homicides	1994–2020	5.61[f]	0.01430	<0.0001	2010.2 (2008.6, 2011.9)		
U.S. Workplace Homicides	1994–2021	0.32	0.00118	<0.0001	2015.2 (2012.2, 2018.1)		
Perpetrator							
Type I – Criminal Intent	1994–2021	0.20	0.00122	<0.0001	2015.3 (2012.5, 2018.1)		
Type II – Customer/Client	1994–2021	0.04	−0.00002	0.5908		0.00046	0.0277
Type III – Co/ex worker	1994–2021	0.05	0.00006	0.0359		−0.00028	0.2168
Type IV – Personal Acquaintances	1994–2021	0.03	−0.00001	0.4813		−0.00022	0.0615
Weapon Type							
Hit/Kick/Beat	1994–2021	0.01	0.00003	0.0406		−0.00090	<0.0001
Shooting	1994–2021	0.25	0.00114	<0.0001	2014.4 (2011.6, 2017.2)		
Stabbing	1994–2021	0.03	0.00007	0.0016	2016.6 (2011.2, 2022.0)		
Gender							
Female	1994–2021	0.13	0.00047	<0.0001	2016.9 (2014.1, 2019.7)		
Male	1994–2021	0.47	0.00163	<0.0001	2014.9 (2011.7, 2018.1)		
Age							
16-24	1994–2021	0.34	0.00128	<0.0001	2013.1 (2010.3, 2015.8)		
25-34	1994–2021	0.34	0.00109	<0.0001	2015.0 (2013.0, 2017.1)		
35-44	1994–2021	0.30	0.00077	0.0002	2016.9 (2012.5, 2021.4)		
45-54	1994–2021	0.34	0.00105	<0.0001	2015.0 (2012.5, 2017.5)		
55+	1994–2021	0.32	0.00190	0.0004	2016.8 (2012.0, 2021.6)		
Race							
White	1994–2021	0.18	0.00052	<0.0001	2017.3 (2013.6, 2020.9)		
Black	1994–2021	0.74	0.00278	0.0003	2013.0 (2010.4, 2015.6)		
Hispanic	1994–2021	0.32	0.00190	<0.0001	2016.4 (2012.7, 2020.2)		
Occupation							
Management	2003–2021	0.13	−0.00075	0.084		−0.01260	<0.0001
Protective Service	2003–2021	2.74	0.00640	0.1038		−0.02010	0.3073
Food Prep and Serving	2003–2021	0.50	0.00285	0.0096	2014.9 (2012.8, 2016.9)		
Sales	2003–2021	0.57	0.00137	0.0087	2023.9 (2016.0, 2031.8)		
Retail Sales	2003–2021	1.06	0.00555	0.0019	2014.2 (2012.6, 2015.7)		
Office and Administration	2003–2021	0.08	0.00047	0.1115		−0.00414	0.0097
Construction	2003–2021	0.23	0.00078	0.123		0.00303	0.2296
Production	2003–2021	0.21	0.00123	0.0073	2012.3 (2010.8, 2013.9)		
Transportation	2003–2021	0.62	0.00027	0.8044		−0.01800	0.0022
Taxi and Chauffeurs	2003–2021	2.21	0.00908	0.5776		−0.60470	<0.0001
Industry							
Construction	2003–2021	0.20	0.00102	0.0145		0.00221	0.3154
Manufacturing	2003–2021	0.11	0.00058	0.0019	2012.3 (2011.1, 2013.6)		

(Continues)

TABLE 2 (Continued)

	Study Years	Predicted 2021 Rate[c]	Quadratic Trend Model[a]			Linear Trend Model[b]	
			Quadratic Parameter	p-value	Inflection Date (95%CI)[d]	Linear Parameter[e]	p-value
Retail Trade	2003–2021	0.55	0.00164	0.0074	2021.7 (2014.9, 2028.5)		
Grocery Stores	2003–2021	0.75	0.00394	0.2321		−0.09370	<0.0001
Gasoline Stations	2003–2021	5.55	0.00779	0.5615		−0.08130	0.2128
Transportation and Warehousing	2003–2021	0.59	0.00108	0.3635		−0.01850	0.0043
Educational and Health Services	2003–2021	0.09	−0.00014	0.4963		−0.00112	0.2553
Health Services	2003–2021	0.12	0.00008	0.8077		−0.00023	0.8731
Accommodation and Food Services	2003–2021	0.58	0.00192	0.0908		−0.03640	<0.0001
Government/Public Administration	2003–2021	0.85	−0.00021	0.8631		−0.00780	0.1912

[a]Final model when quadratic parameter <0.01.
[b]Final model when quadratic parameter ≥0.01.
[c]Rate predicted from the final autoregressive model per 100,000 FTE.
[d]Estimated troughs from the autoregressive quadratic model. This was only calculated when the quadratic model was the final model.
[e]Estimate of the average yearly decline in the rate of homicides per 100,000 employees.
[f]Estimated 2020 rate per 100,000.

primarily driven by reductions in Type I violence (events occurring during the course of a crime, such as robbery).[6] The current trend analysis found that between 1994 and 2021, Type 1 workplace homicide rates leveled off and started to increase. Previous research has emphasized the importance of non-robbery homicides in the overall workplace violence picture. One study found that 50% of workplace homicides occurred during a non-robbery crime and suggested that increases in workplace homicides were being driven by non-robbery crimes.[24] However, our study found that trends in non-robbery related homicides changed very little over our study period.

There are several possible reasons for these findings. First, the combination of workplace violence prevention programs, policies, legislation, and trainings have largely been successful in mitigating workplace violence, even in the face of overall rising U.S. homicide rates. Second, during the COVID-19 pandemic, many workers were unable to work at their usual workplace for long periods of time, thereby providing an element of protection from workplace violence during a time of increasing overall homicide rates. Third, homicides related to firearms have increased in recent years, and the increased firearm violence in the U.S. is leading to increased firearm violence in the workplace.

For decades, occupational safety and health researchers, industry leaders, policy makers, and law enforcement have collaborated to develop, refine, and evaluate strategies and programs to mitigate workplace violence.[25] Workplace violence interventions can be organized in three main categories: crime prevention through environmental design (CPTED), policy & legislation, and employee training & education.[26] CPTED has provided a blueprint for making environmental and design changes to a business with the goal of decreasing any rewards to perpetrators of criminal acts, and increasing the risks of apprehension to the perpetrator when a criminal act occurs. A 2009 literature review on the effectiveness of workplace violence interventions found nearly 100 intervention evaluations published since 1992; over 50% were from the healthcare industry, 11% from the retail industry, and 35% addressed the workplace in general.[26] The 2009 review found that CPTED-based interventions were the most effective in preventing workplace violence occurring in the commission of criminal acts in retail settings. More recently, in an effort to update the 2009 literature review, a meta-analysis of the effects of workplace violence programs was performed. Results suggested that workplace violence prevention programs are associated with small-to-moderate reductions in workplace violence.[25]

Two types of businesses that have consistently had high rates of workplace homicides, convenience stores and taxi-cab services, have adopted CPTED principles that have been proven to reduce criminal activities in the workplace.[27,28] Workplace homicides trends in convenience stores, after years of significant decline, began to show an increase towards the end of our study period. However, taxi-cab homicides decreased over the entire study period. Additionally, taxi-cab workplace homicides demonstrated the largest reduction since 1994 in our study, deceasing by an average of 0.6 per 100,000 workplace homicides per year. The continued decline in taxi-cab

TABLE 3 Autoregressive models for trend in number of workplace homicides by location and activity of the homicide.

			Quadratic Trend Model[a]			Linear Trend Model[b]	
	Study Years	Predicted Percentage of 2021 Homicides[c]	Quadratic Parameter	p-value	Inflection Date (95%CI)[d]	Linear parameter[e]	p-value
Location							
Street or Highway	1994–2021	15%	0.2054	<0.0001	2013.0 (2010.4, 2015.5)		
Industrial Place	1994–2021	7%	0.0639	0.0457		−0.834	0.0014
Public Building	1994–2021	42%	0.7224	<0.0001	2017.4 (2014.2, 2020.5)		
Convenience Store	1994–2021	12%	0.3058	<0.0001	2014.2 (2011.3, 2017.2)		
Office Building	1994–2021	3%	0.0533	0.0335		−0.841	0.0001
Restaurant Café	1994–2021	8%	0.0970	0.0046	2018.5 (2011.2, 2025.9)		
Commercial Store	1994–2021	11%	0.1380	0.0035	2023.5 (2013.5, 2033.4)		
Activity							
Vehicular/Transportation	1994–2021	12%	0.1400	0.001	2012.6 (2009.3, 2015.9)		
Protective Services	1994–2021	19%	0.0922	0.0584		−0.753	0.0426
Tending Retail	1994–2021	29%	0.5728	<0.0001	2017.2 (2014.0, 2020.4)		
Office Work	1994–2021	5%	−0.0380	0.1621		−1.530	<0.0001
Healthcare/Social Services	1994–2021	2%	0.0051	0.7236		0.018	0.8576

[a]Final model when quadratic parameter <0.01.

[b]Final model when quadratic parameter ≥0.01.

[c]Percentage predicted from final autoregressive model.

[d]Estimated troughs from the autoregressive quadratic model. This was only calculated when the quadratic model was the final model.

[e]Estimate of the average yearly decline in the number of homicides.

workplace homicides could be due, in part, to increased customer use of smart phone apps in this industry, along with the use of electronic payment in place of cash transactions. The results of these changes have reduced the reward of robbery related taxi-cab homicide, with less cash on hand to be stolen, and an increased risk of capture for the perpetrator. While these changes in the taxi-cab industry are more cultural and technological in nature and are being driven by the consumer as well as the employer, their effect in reducing workplace homicide is very similar to the principles of CPTED.

Several states have recently instituted legislation to protect healthcare workers from violence. It should be noted that while healthcare has the largest number of nonfatal violence incidents each year, it also has one of the lowest rates of workplace homicides.[29] Nine states have laws requiring healthcare facilities to have a workplace violence prevention program.[30] The states include Oregon, Illinois, California, Washington, New York, Maine, Maryland, New Jersey, and Connecticut and requirements differ across the states.[30] Future research could evaluate the effectiveness of state-level laws. Further the most effective tools at preventing workplace homicides in healthcare could be identified, leading to further implementation of the effective strategies more thoroughly across the U.S.

The COVID-19 pandemic has been associated with increasing violence, particularly firearm-related homicides. During the COVID-19 pandemic, in 2020, the U.S. firearm homicide rate increased 35%, reaching its highest level since 1994.[11] Reasons for this increase are not well-understood, but could include economic stressors, disruption in health and emergency services, strains on law enforcement, and the exacerbation of existing social stressors.[11] There is also emerging evidence as to how COVID-19 restrictions impacted gun violence. A 2023 analysis of firearm hospitalizations found that after stay-at-home orders were implemented, gunshot wound hospitalization rates increased substantially and declined after restrictions were lifted.[31] One possible reason for this is that in many industries, workers were unable to physically be in a workplace, reducing the number of people who could possibly be killed while at work. Another possible reason is that workplace violence became less severe during the COVID-19

pandemic. While data is limited to support this hypothesis, research has shown that new forms of workplace violence that do not necessarily lead to homicide, such as coughing and spitting on individuals, became prevalent during the COVID-19 pandemic.[32]

While previous studies in this area have mainly concentrated on evaluating trends in firearm related homicides and violence,[9–11,24,33,34] this study included all workplace and non-workplace homicides. Our results mirror those in previously published research focusing only on firearm related homicide or violence as an outcome. Further, based on the earlier inflection point and highly significant p-value for shooting events, our results indicate that firearm-related workplace homicides are more likely to be increasing in comparison with non-firearm-related workplace homicides. Therefore, a reduction in overall firearm related violence could result in reductions in workplace homicides.

There are limitations to these data. First, caution needs to be taken in interpreting the point of inflection dates calculated from the quadratic models. Due to the inclusion of a parabolic fit to the data, the estimation of the inflection date may be skewed to earlier dates compared to the Joinpoint models. Second, workplace and non-workplace homicide numbers originated from two different databases. Although we removed workplace homicide counts from the UCR to avoid double-counting, it was not possible to verify the accuracy of this approach. Third, since this analysis is limited to decedents, it did not include the full spectrum of workplace violence including nonfatal events such as threats, bullying, and discrimination, and nonfatal assaults. Finally, the methodology of collection and coding of surveillance data can change over time. For our analysis, this limited the trends analysis by occupation and industry to data after 2003 and caused the exclusion of 2021 non-workplace homicides in the analysis. Additionally, reporting to the FBI of crime statistics by police jurisdictions is voluntary which can introduce selection bias in estimates of UCR data. Future analyses conducted in this area could benefit from using other surveillance systems which capture homicides in the U.S. such as the National Vital Statistics System.

5 | CONCLUSIONS

From 1994 to 2021, workplace homicides have declined more than non-workplace homicides. However, decreases in workplace homicide were not consistent across types of homicides and occupations. This analysis also suggests that after two decades of decreasing workplace homicides, these trends are changing. From 2014 to 2021, workplace homicides rates have stabilized. Additionally, workplace homicides occurring during a criminal act and those that involved a shooting began to increase by the end of the study period. As additional years of new data become available, future analyses can be conducted to assess whether workplace homicides continue to stabilize or start to increase throughout the 2020s following the trend of U.S. non-workplace homicides. In addition to developing new violence prevention strategies, researchers and industry leaders can use these finding to assess previous workplace violence interventions with proven effectiveness in the reduction of workplace homicides. Furthermore, these effective strategies, which have often been industry specific, could result in widespread violence mitigation if they were adopted more broadly and thoroughly across all industries in the U.S.

AUTHOR CONTRIBUTIONS

All of the authors participated in a) conception or design of the work; b) the acquisition, analysis, or interpretation of data for the work; c) drafting the work or revising it critically for important intellectual content; d) final approval of the version to be published; and e) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

John Meyer declares that he has no conflict of interest in the review and publication decision regarding this article.

DATA AVAILABILITY STATEMENT

The data used from CFOI for these analyses was obtained and processed by the authors through special permission by the BLS on a secured server within the BLS. While BLS makes some summary statistics from CFOI publicly available, the data used here are not generally available to the public. All other data used in this analysis were obtained through publicly available websites and referenced accordingly in the manuscript.

ETHICS APPROVAL AND INFORMED CONSENT

This work was performed at the National Institute for Occupational Safety and Health. This study did not use human subjects and synthesized already-collected data available from sources outside of NIOSH. This research was reviewed by the Centers for Disease Control and Prevention and was conducted consistent with applicable federal law and CDC policy.

DISCLAIMERS

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. The views expressed here do not necessarily reflect the views of the BLS.

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