# **Research article**



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# Assault mortality in United States women of childbearing age

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### Abstract

In the United States (US), homicide the leading cause of death among young Black men, Data on women of childbearing age, are sparse. We report trends in assault mortality in US women of childbearing age overall as well as by race, and weapon type from 1999 to 2018. We used death certificate data from the US Centres for Disease Control and Prevention and joinpoint regression analyses to test for trends. After years of decline, there were statistically significant increases from 2015-2018, particularly among non-Hispanic Black (NHB) women by firearms. Preventive medicine and community health efforts are necessary to curb this epidemic.

# Introduction

In the United States (US), homicide is far and away the leading cause of death among young Black men [1] The magnitude and urgency of this "new American tragedy" are so profound, that the well described racial inequalities in overall mortality [2] would improve more by eliminating homicide than any other causes except cardiovascular disease or cancer [3]. In contrast, data in assault mortality in United States women, in particular, those of childbearing age, are sparse although recent data show increasing overall assault mortality among US women [4]. The knowledge gap filled by this investigation includes recent alarming trends in assault mortality in US women of childbearing age overall as well as by race, level of urbanization and type of weapon.

# Methods

We utilized publicly available data from the US Centers for Disease Control (CDC) and Prevention's public Multiple Cause of Death files as presented on the Wide-ranging ONline Data for Epidemiologic Research (WONDER) internet site in order to avoid underestimates which may occur by sole reliance on underlying cause of death. We explored homicide (ICD-10 codes X85-Y09 and Y87.1 as underlying or contributory cause of death) by race (Non-Hispanic Black (NHB) or Non-Hispanic White (NHW)), and type of weapon. Level of urbanization by the National Center for Health Statistics (NCHS) definitions include Large Central and Large Fringe with populations of 1,000,000 or more; Medium (250,000-999,999) and Small (<250,000) and Non-metropolitan areas (Micropolitan (10,000-49,999) and noncore (or rural non-metropolitan). We obtained annual percent change (APC) as well as relative risks and 95% confidence intervals (CDC WONDER) [5]. We adhered to NCHS cautions against using either American Indian and Alaska Native data or pre-1999 Hispanic data as well as race-specific Hispanic data [6]. In addition, we used reliable rates (>20 deaths) (CDC WONDER) as well as joinpoint regression analyses to test for significance of trends [7]. Childbearing age was defined as 15 to 54 years based on US natality data showing that 99.9%



Segment (Years)	Annual Percent Change (95% Confidence Interval)	Р
2015-	+5.5 (2.6, 8.6)	< 0.05
2018		
1999-	-2.2 (-2.6, -1.8)	< 0.05
2014		

Figure 1. Joinpoint regression analysis of homicide assault mortality among women ages 15 to 54 years. United States of America (US). 1999-2018.

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Each Segment Includes Data for 1999-2018

Figure 2. Assault Mortality Among Women Ages 15-24, 25-34, 35-44, and 45-54. United States of America. 1999-2018.

of all US births occur to women ages 15 to 50+ years of age (United States Department of Health and Human Services, n.d.). The Baylor College of Medicine Institutional Review Board classified this research as exempt.

#### Results

Figure 1 shows trends in overall homicide rates in all US women ages 15 to 54 from 1999 to 2018. From 2015 to 2018 there were significant increases in the APC of +5.5%. In contrast, between 1999 to 2014 there were significant decreases in the APC of -2.2% (p<0.05). Further, for NHB the corresponding APCs were +7.1(p<0.05) between 2015 and 2018 and -3.4(p<0.05) between 1999 and 2014. For NHW, the corresponding APCs were +4.7(p<0.05) and -1.4(p<0.05), during these same time periods. Age-sex-specific rates during this period (ten-year age groups, from 15-24 to 45-54) are shown in Figure 2 and indicate that the predominant impact of increased assault mortality was from 15-44 years of age.

Table 1 shows results of joinpoint regression analyses of assault mortality among women ages 15 to 54 years according to race and ethnicity. Non-Hispanic Blacks and non-Hispanic Whites are most prominently affected. There is no increase detected for non-Hispanic Asian and Pacific Islanders. Among Hispanic women, there is a statistically significant decline ending in the year 2013, but the increase from 2013 to 2018 is not statistically significant.

Table 2 shows the results of joinpoint regression analyses according to US Census Region. Statistically significant increases are found only in the Midwest (beginning in 2011) and the South (beginning in 2014). Table 3 amplifies the geographic variation, showing results by US state within each Census Region for all states with reliable yearly mortality rates from 1999 to 2018. Onset of the upsurge in assault mortality is variable, as are the time periods encompassed by 95% Confidence Intervals for each joinpoint. In the Midwest, only Illinois shows a statistically significant increase (2012-2018), while in the South, significant increases are seen for Alabama, Tennessee, and Texas (Data not shown).

Using six levels of urbanization (Table 4), NHB women experienced significant increases which followed significant declines in Large Central, Medium, and Small Metropolitan areas, while NHW women experienced the same pattern in Large Fringe Metropolitan areas. NHB women in Small metropolitan areas suffered the largest increase in APC of +18.3% (p<0.05).

Firearms accounted for 71.9% of the 4,022 homicides in NHB woman and 57.0% of the 4,784 in NHW. NHB women accounted for 45.7% of the homicides and 19.6% of the study population. Homicide rates were 8.1 per 100,000 (95% Confidence Interval 7.8, 8.3) in NHB women and 3.6 (3.5, 3.6) in NHW women, a 2.25-fold higher risk. Homicide by firearms were 5.8 (5.6, 6.0) among NHB women and 1.4 (1.3-1.4) among NHW women, a 4.2-fold higher risk. Table 5 shows that there were statistically significant increases in mortality from firearms among NHB women and NHW women but not for non-firearm related homicides from 2015 to 2018.

#### Discussion

These descriptive data indicate overall increases in assault mortality in US women of childbearing age which occurred between 2015 to 2018. These alarming observations followed a 15-year decline in these rates between 1999 and 2014. Significant increases were found in the Midwestern and Southern US and were particularly notable among NHB women in small metropolitan areas and related to firearms. The

Table 1. Joinpoint Regression Analyses of Trends in Assault Mortality Among Women of Child-bearing Age According to Race and Ethnicity. 1999-2018.

	Race and Ethnicity	Joinpoint(s)	Years (95% Confidence Intervals)	APC (95% Confidence Interval(s))	Р
	Non-Hispanic Asian & Pacific Islander	none	1999-2018	-4.5 (-5.3, -3.7)	<0.05
	Non-Hispanic	2014 (2012, 2015)	1999-2014	-3.0 (-3.6, -2.4)	< 0.05
Black		2014-2018	7.1 (2.4, 12.1)	< 0.05	
	Non-Hispanic	2014 (2011, 2015)	1999-2014	-1.4 (-1.9, -0.9)	< 0.05
White		2014-2018	4.7 (0.4, 9.1)	<0.05	
Hispanic	Hispanic	2013 (2011, 2015)	1999-2013	-3.8 (-4.5, -3.0)	< 0.05
		2013-2018	3.4 (-0.2, 7.2)	0.1	

Table 2. Joinpoint Regression Analyses of Trends in Assault Mortality Among Women of Child-bearing Age According to US Census Regions.\* 1999-2018.

Census Region	Joinpoints and Segments	Years (95% Confidence Intervals)	APC and (95% Confidence Intervals) for Segments	Р
Census Region 1 (Northeast)	No Joinpoint	1999-2018	-1.7 (-2.3, -1.2)	< 0.05
Census Region 2 (Midwest)	2011 (2009, 2015)	1999-2011	-2.7 (-3.9, -1.5)	< 0.05
		2011-2018	4.3 (1.5, 7.2)	< 0.05
Census Region 3 (South)	2014 (2012, 2015)	1999-2014	-2.2 (-2.5, -1.8)	< 0.05
		2014-2018	4.6 (1.6, 7.7)	< 0.05
Census Region 4	2014 (2010, 2016)	1999-2014	-2.7 (-3.6, -1.7)	< 0.05
(West)		2014-2018	5.3 (-2.7, 13.9)	0.2

\*Northeast: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont.

Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin.

South: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia.

West: Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah.

Census Region and State Joinpoint(s)		Segment(s)	APC and (95% Confidence Intervals) for Segments	Р	
Census Region 1 (Northeast)					
New Jersey	None	1999-2018	-1.8 (-3.0, -0.6)	<0.05	
New York	None	1999-2018	-3.4 (-4.3, -2.4)	< 0.05	
Pennsylvania	2015 (2013, 2016)	1999-2015	-1.9 (-2.7, -1.0)	<0.05	
Census Region 2 (Midwest)		2015-2018	13.0 (-0.2, 27.9)	0.1	
THE STATE	2012 (2010, 2015)	1999-2012	-5.0 (-6.1, -4.0)	<0.05	
IIInois		2012-2018	7.1 (3.2, 11.1)	< 0.05	
Indiana	2011 (2007, 2016)	1999-2011	-3.3 (-5.6, -1.0)	< 0.05	
		2011-2018	4.9 (-0.5, 10.6)	0.1	
Michigan	None	1999-2018	-1.7 (-2.6, -0.8)	<0.05	
Missouri	2013 (2001, 2016)	1999-2013	-1.2 (-3.6, 1.3)	0.3	
		2013-2018	11.3 (-0.5, 24.5)	0.1	
Wisconsin	None	1999-2018	-0.1 (-1.9, 1.8)	0.9	
Census Region 3 (South)					
Alabama	2012 (2009, 2015)	1999-2012	-3.5 (-5.3, -1.6)	<0.05	
		2012-2018	7.4 (0.7, 14.4)	< 0.05	
Arkansas	none	1999-2018	0.6 (-0.3, 1.6)	0.2	
Florida	none	1999-2018	-1.3 (-2.0, -1.6)	<0.05	
Georgia	none	1999-2018	-2.2 (-3.0, -1.5)	< 0.05	
Kentucky	none	1999-2018	-0.3 (-1.7, 1.3)	0.7	
Louisiana	none	1999-2018	-0.5 (-1.5, 0.4)	0.3	
Mississinni	2014 (2003, 2016)	1999-2014	-2.6 (-4.3, -0.9)	< 0.05	
		2014-2018	11.9 (-2.0, 27.7)	0.1	
North Carolina	none	1999-2018	-2.7 (-3.6, -1.8)	<0.05	
South Carolina	none	1999-2018	-2.6 (-4.3, -0.9)	<0.05	
Tennessee	2014 (2008, 2015)	1999-2014	-2.1 (-3.0, -1.3)	<0.05	
Tellifessee		2014-2018	7.8 (1.2, 14.9)	<0.05	
	2009 (2001, 2010)	1999-2009	-1.1 (-2.2, 0.1)	0.1	
Texas	2012 (2010, 2014)	2009-2012	-7.2 (-20.2, 7.9)	0.3	
		2012-2018	3.9 (1.4, 6.5)	<0.05	
Census Region 4 (West)					
California	2014 (2011, 2016)	1999-2014	-3.3 (-4.4, -2.3)	<0.05	
		2014-2018	3.6 (-5.3, 13.3)	0.4	
Colorado	none	1999-2018	-1.2 (-2.3, 0.0)	< 0.05	
Washington	none	1999-2018	-0.4 (-1.3, 0.5)	0.3	

Table 3. Joinpoint Regression Analyses of Trends in Assault Mortality Among Women of Child-bearing Age According to US States with Reliable Yearly Data (at least 20 deaths per year). 1999-2018.

considerable geographic variation in occurrence and the timing of significant increases in assault mortality in these data generates many hypotheses. It seems most plausible that the causes of the observed increases are complex and appear to vary by geographic location. Further research concerning these patterns may offer an opportunity to identify areas of greatest need and target interventions for the greatest reduction in rates.

These data in women of childbearing age are consistent with overall trends in homicide in the US. For example, in data from the Federal Bureau of Investigation (FBI) there were significant increases in overall homicide rates in 2015 and 2016 which followed many years of significant declines [8,9] as well as analyses of firearm mortality based on death certificate data [4].

While not focusing on childbearing age, one study revealed a marked national increase in firearm-related deaths from 2015-2017, which included a 90% increase among women for all states with reliable rates [4]. This increases in firearm-related mortality mirrored national trends in only 21 US states. Thus, while they considered the increases to

reflect a broad-based epidemic, they also noted wide variations within US demographic and geographic areas.

Several hypotheses have been offered, including structural disadvantages facing minorities [10], the emerging opioid epidemic [11], the increasing lethality of violence [12], and state laws relating to gun permits [13]. Structural disadvantages associated with homicide have been defined by household income, percentages of youthful populations, families in poverty, individuals receiving public assistance, unemployed residents, single parent households, divorced residents, rented households, residents with a tenure below five years, and those without a high school diploma [10]. The emerging epidemic of opioid mortality is notable, in part, for its occurrence in three waves, two of which correspond to overall trends for assault mortality among women of childbearing age. Specifically, the second wave began in 2010, one year before the turning point observed in these data for the US Midwest and was associated with overdose deaths from heroin. The third wave began in 2013, one year before the observed turning point in these data for the US South and was particularly related to illicitly manufactured fentanyl [11]. The increasing lethality of violent incidents may also

have played a role [12], and finally, in view of the predominant role of firearms in the current epidemic, state laws prohibiting gun possession by people with violent misdemeanour convictions are associated with lower firearm homicide rates in suburban and rural areas, but not large cities, and those mandating permit requirements have been associated with lower homicide rates in both large cities and suburban and rural areas [13].

Pregnant and postpartum women are at a particular risk for violence, with a 1.84-fold greater risk of dying from homicide than non-pregnant or non-postpartum women [14]. Homicide was found to be the second leading cause of death in all pregnancy-associated injury deaths in the US between 1991 and 1999 [15], and in 2017, over 2,200 US women of childbearing age were victims of homicide [16], with racial/ethnic minority women being disproportionately affected [17].

The Bureau of Justice Statistics found that 15% of all violent crime victimizations between 2003 and 2012 were related to intimate partner violence, with 82% of reported victims of intimate partner violence being female [18]. In the US, the proportion of female homicide victims killed by a current or former intimate partner ranges up to 58% [19,20]. Of note, a multisite case-controlled study found when intimate

partner abusers have access to a firearm, the risk for femicide increases five-fold [21]. Therefore, the role of intimate partner violence must be explored further when analyzing assault mortality among women of childbearing age.

Studies of assault mortality among women of childbearing age may be of particular importance, in part, because emerging literature links stresses from neighborhood crime, including homicide, with adverse infant outcomes [22-29]. Thus, the victims of crime may extend beyond those who are immediately affected. In pregnant women, a possible pathophysiological pathway has been proposed, linking exposure to crime with increased chronic stress which is, in turn, associated with hormonal and neuroendocrine changes which may induce preterm birth and/or restricted fetal growth [25,29]. Moreover, pregnant women who experience stress due to neighborhood crime may be prone to increase unhealthy behaviors such as smoking and alcohol consumption while reducing healthy behaviors such as physical exercise [22]. By documenting increasing mortality among women of childbearing age, the present study supports continued investigation of possible extension of adverse effects among women of childbearing age to general infant health in affected communities.

Table 4. Joinpoint Regression Analyses (BIC). Assault Mortality Among Women Ages 15 to 54 Years According to Race (Non-Hispanic Black (NHB) and Non-Hispanic White (NHW)) and Urbanization. USA. 1999-2018.

Urbanization	Race and Ethnicity	Joinpoint (95% Confidence Interval)	Segments	APC (95% Confidence Interval)	Р
	NHB	2014 (2012, 2016)	1999-2014	-3.1 (-3.8,-2.4)	<0.05
Large Central Metro			2014-2018	6.6 (0.7,12.9)	<0.05
	NHB	2014 (2009, 2016)	1999-2014	-2.8 (-4.0, -1.6)	<0.05
Large Fringe Metro			2014-2018	5.0 (-4.0, 14.9),	0.2
Madiana Mataz	NHB	2014 (2009, 2106)	1999-2014	-2.2 (-3.3, -1.1)	<0.05
Medium Metro			2014-2018	8.5 (0.3, 17.3)	<0.05
Sarall Mater	NHB	2015 (2013, 2016)	1999-2015	-3.4 (-4.6, -2.1)	<0.05
Small Metro			2015-2018	18.3 (0.9, 38.7)	<0.05
Micropolitan	NHB	2015 (2012, 2016)	1999-2015	-2.7 (-4.1, -1.2)	<0.05
			2015-2018	14.6 (-5.7, 39.3)	0.2
	NHB	2015 (2012, 2016)	1999-2015	-2.7 (-4.1, -1.2)	<0.05
Non-Core, Non-Metro			2011-2018	14.6 (-5.7, 39.3)	0.2
	NHW	2013 (2008, 2016)	1999-2013	-2.8 (-4.1,-1.4)	<0.05
Large Central Metro			2013-2018	3.3 (-4.2, , 11.4)	0.4
	NHW	2014 (2012, 2016)	1999-2014	-1.3 (-1.9, -0.7)	<0.05
Large Fringe Metro			2014-2018	6.7 (1.6, 11.9)	<0.05
	NHW	2013 (2001, 2016)	1999-2013	-1.2 (-2.2, -0.2)	<0.05
Medium Metro			2013-2018	2.3 (-3.0, 7.8)	0.4
	NHW	2015 (2001, 2016)	1999-2015	-0.4 (-1.3, 0.5)	0.3
Small Metro			2015-2018	5.5 (-6.2, 18.6)	0.3
Micropolitan	NHW	2015 (2012, 2016)	1999-2015	-2.7 (-4.1, -1.2)	<0.05
			2015-2018	14.6 (-5.7, 39.3)	0.2
Non-Core, Non-Metro	NHW	2006 (2001, 2016)	1999-2006	-3.3 (-7.9, 1.5)	0.2
			2006-2018	1.2 (-1.0, 3.6)	0.3
	HISPANIC	2014 (2011, 2016)	1999-2014	-3.8 (-4.8, -2.7)	<0.05
Large Central Metro			2014-2018	6.2 (-1.7, 14.7)	0.10
Large Fringe Metro	HISPANIC	none	1999-2018	-2.6 (-3.8, -1.4)	<0.05
Medium Metro	HISPANIC	none	1999-2018	-1.7 (-3.0,-0.4)	<0.05

Weapon	Time Period	APC (95% Confidence Interval)	р
Non-Hispanic Black			
Pine and	1999- 2014	-1.3 (-2.2, -0.5)	<0.05
Firearm	2014-2018	10.1 (3.8, 16.9)	<0.05
New Electron	1999-2015	-6.2 (-6.9, -5.5)	<0.05
Non-Firearm	2015-2018	5.8 (-5.9, 18.8)	0.3
Non-Hispanic White			
Pine ma	1999-2014	-0.3 (-0.9, 0.4)	0.1
Firearm	2014-2018	5.6 (1.2, 10.2)	<0.05
Non Eineemu	1999-2013	-3.6 (-4.4, 2.7)	<0.05
Non-Firearm	2013-2018	3.8 (-0.8, 8.6)	0.3

Table 5. Joinpoint Regression Analyses of Trends in Firearm-related and Non-firearm-related Homicides Among NHB and NHW Women of Childbearing Age. USA. 1999-2018.

While these descriptive data are subject to the usual reliance on death certificates [30], it is also true that death certificates provide a nearly complete set of national data about legal US residents and in that they are considered a reliable source of information about homicides other than those considered to be legal residents by virtue of police activity [31]. Another limitation, however, relates to the wide confidence intervals accompanying most joinpoints identified in these trend analyses. This, as well as the variations evident in sub-set analyses, point to the need for analytic epidemiologic studies designed a priori to test the many hypotheses which are generated by these descriptive data [32]. In the meanwhile, increased clinical and public health efforts are necessary to reduce the large numbers of avoidable premature deaths and the enormous costs to society from assault mortality in US women of childbearing age. While further research is necessary, at present we believe that combatting the epidemic of assault mortality due to firearms without addressing firearms is analogous to combatting the epidemic of lung cancer due to cigarette smoking without addressing cigarettes [1].

## Conclusion

We observed alarming increases in assault mortality in US women of childbearing age, particularly among NHB women as well as in the Midwestern and Southern regions. NHB women suffered particularly large increases in assault mortality in small metropolitan areas. Increasing trends were primarily related to firearms. These descriptive data are useful to formulate many hypotheses which are directly testable in analytic studies designed a priori to do so. In the meanwhile, increased clinical and public health efforts are necessary to reduce the large numbers of firearm-related deaths in US women of childbearing age, particularly NHB women.

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