Available online at http://www.journalijdr.com

IJDR

ISSN: 2230-9926

International Journal of Development Research
Vol. 11, Issue, 05, pp. 46972-46977, May, 2021
https://doi.org/10.37118/ijdr.21803.05.2021

RESEARCH ARTICLE OPEN ACCESS

FIREARM DEATH RATES IN CEARÁ, BRAZIL: DIFFERENCES BETWEEN SEXES

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ARTICLE INFO

Article History:
Received 06th February, 2021
Received in revised form
09th March, 2021
Accepted 27th April, 2021
Published online 22th May, 2021

Key Words:
Firearm death rate; data scraping technique; Poisson's regression; formulation and execution of public security measures; State of Ceará, Brazil.

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ABSTRACT

This article describes firearm death rates and estimates the factors associated with this phenomenon between 2014 and 2019, according to sex, in the State of Ceará, Brazil. This is a population, ecological and cross-sectional study. During the period in focus, a high firearm death rate was found in this state (83.8%), with a high incidence among men (92.6%), and an even greater intensity in the years 2017 and 2018. Regardless of sex, fewer cases occurred in 2016 and 2019. When considering women, positive associations were observed for the factors: a) living in a region with a high population density; b) living in a metropolitan region; and c) being a teenager. In turn, for men, positive associations were observed for these factors: a) living in a region with a high human development index (HDI); b) living in a metropolitan region; c) being a teenager; and d) the years 2017 and 2018.

Citation: ***Erivando de Sena Ramos, Carlos Mendes Tavares, John Hebert da Silva Felix, Francisco Horácio da Silva Frota et al. 2021.*** "firearm death rates in Ceará, Brazil: differences between sexes", *International Journal of Development Research*, 11, (05), 46972-46977.

INTRODUCTION

Murder consists in the violent event with the most serious human and social repercussions (Silva et al. 2011) and it signals the edge of the human aggressive and destructive potential (Lolis 2008). It is estimated that around 64,357 people were victims of murder in Brazil in 2012, leading the country to stand 11th in the world ranking of lethal violence among 133 countries analyzed (WHO 2014). Regarding data from South America, Brazil ranks 3rd, behind only Venezuela and Colombia (UNODC 2011). The high homicide rate in Brazil (22.7/100,000 inhabitants), 3 times higher than the world average (6.9/100,000 inhabitants), signals the importance of research studies on this serious situation that affects the lives of Brazilians at various levels (UNODC 2011). Murders have been a matter of concern not only due to the lives lost on a daily basis, but also because of those closely related to victims, who are deeply impacted by a traumatic loss (Redmond 1989). Unlike direct victims of homicide, who are easily identified and counted in statistics, their relatives and friends remain unknown, with little or no support for their needs, fading into obscurity in many contexts (Hertz et al. 2005). Death by murder encompasses, in most cases, some specific aspects: a) the violence with which it is perpetrated; b) the sudden and abrupt loss of life (Costa et al. 2017); and, in the case of firearm death, c) the prematurity of death. This tragic combination of factors particularly influences a family's responses to loss, and it may even have a negative impact on family members' health (Asaro 2001). Violence, which includes murders and firearm deaths, is a social issue that has become a public health issue, since it is necessary to deal with the adverse results of violent events in this area (Minayo 2005). Although murder is not the only form of violence, it is emblematic because it takes humanity to the edge of its aggressive potential. The debate on homicidal violence, particularly by firearms, is unthinkable outside the institutional and historical context where it currently takes place, which permeates the recognition of international organized crime and its rationale of profit at all costs (Lolis 2008). This idea suggests that knowing each region and the states is a strategy for those who structure drug trade and weapons smuggling. Furthermore, it is also key to emphasize there is no criminal organization today that does not have an interface with legal means and the social universe of businesses and officials within the Executive, Legislative, and Judiciary branches of government (Lolis 2008). Brazilian and international studies reveal that the risk of murder is related to a set of factors that includes sex, skin color/ethnicity, educational level, marital status, social inequality, age group, temporal exposure, and psychological state (Ganiyu 2018; Geberth 2010; IPEA 2019; McPhedran and Baker 2011). This article describes firearm death rates and estimates factors associated with this phenomenon in the State of Ceará, Brazil, according to sex.

METHODOLOGICAL PROCEDURES

This population, ecological, and cross-sectional study (Zangirolami-Raimundo et al. 2018) was conducted in Ceará, a Brazilian state with 148,894,757 km^2 of area and an estimated population of 8,448,055 inhabitants – which is equivalent to 4.4% of the Brazilian population (IBGE 2010). The information was obtained through the data scraping technique applied to criminal indicators available on the web portal of the SSPDS Ceará (2014), which registers lethal and intentional violent crimes (LIVCs) that occurred in this state. Data scraping is a computational technique in which a software extracts data from social media networks, RSS feeds, blogs, wiki systems, news websites, etc. or from public databases, through an application programming interface (API) in human-readable output, provided by an online service or application (Batrinca and Treleaven 2014). Resorting to the statistical software *R* (Equipe RStudio 2018; Lavor 2019; R Core Team 2019), the data scraping process was divided into 5 parts: a) collection; b) cleaning; c) treatment; d) analysis; and e) data visualization. Information taken from the web portal of the SSPDS Ceará (2014) was in a closed format (portable document format [PDF]), something which makes it hard for the general population to analyze it. All CVLI records related to the State of Ceará within the period from 2014 to 2019 (SSPDS Ceará 2014) were considered eligible for this research.

In this study, there were a total of 1,647 missing data among 24,017 individuals under analysis (6.9%). Despite this low rate of missing data, it was decided to obtain a balanced data set instead of discarding the units with incomplete observations. In large epidemiological surveys, just as in the case of this study, data collection is almost inevitable due to the lack of data, for example, because of the item's lack of response. An approach to deal with missing data in these contexts is multiple imputation (Rubin 1987). However, multiple imputations are used herein by means of chained equations with sequential regression trees as conditional models, since this is pointed by the literature as the most plausible imputation method and, therefore, the one that produces more reliable inferences, in complex contexts, in comparison with the naive application of standard sequential regression imputation techniques (Burgette and Reiter 2010), a nonparametric approach to implement multiple imputations.
This study had firearm death rates as a dependent variable. Such dichotomous variable refers to the occurrence of death (taking value 1 for firearm death and 0 for death due to other types of weapon). The independent variables taken into account were: a) temporal exposure (from 2014 to 2019); social inequality (regional housing conditions and municipal human development index [HDI]); c) population density; and d) age group. The analyses of this research were performed by using the statistical software *R* (Equipe RStudio 2018; Lavor 2019; R Core Team 2019).

Descriptive analysis was presented by using proportions, mean values, and standard deviation. Differences in proportions between groups of firearm use and use of other weapons were firstly compared for each factor on an individual basis by using Pearson's chi-square tests. Subsequently, these groups were compared in relation to the various associated factors. The associated factors with p <15% in univariate analysis were included in the multiple Poisson's regression model adjusted by robust variance estimate. In this analysis, data were analyzed hierarchically: the variables of temporal exposure at the proximal level, the variables related to social inequality at the intermediate level, and the variables of population density and age group at the distal level. The blocks were analyzed in this order and within each block there was an increasing selection (from the lowest to the highest p value). The display variables with p <5%, or those that adjusted the incidence ratio (IR) values by at least 10% were kept in multiple models. Thus, the display variable was considered as associated with the outcome when it remained in the final multiple model with a 5% significance using Wald's test.

Distal level: Population density (larger/denser areas have higher rates) and age group (young people commit more crimes).

Intermediate level: Social inequality: regional housing conditions (capital city or metropolitan region × countryside) and municipal HDI.

Proximal level: Temporal exposure: from 2014 to 2019.

RESULTS AND DISCUSSION

Out of the 24,017 individuals who died during the study period, 83.8% (20,120) died by firearms and 92.6% (22,234) were men. These differences in the percentage of firearm deaths between sexes were statistically significant (p <0.001 using Pearson's chi-square test). There were also average age differences between sexes of firearm murder victims. Men died on average at 28.3 years (SD = ±11.7) and women at 29.2 years (SD = ±12.8). These differences were statistically significant (p = 0.015 using the Student's *t*-test). Men died earlier than women. Table 1 shows the distribution of characteristics: a) social inequality; b) population density; c) age group; d) temporal exposure to firearm death rates; and e) sex. Most individuals, regardless of sex, who were firearm death victims: a) lived in regions with more than 200,000 inhabitants; b) lived in a capital city or a metropolitan region; c) lived in an area with a high HDI; and d) were over 19 years of age (Table 1). Table 2 shows the results of the distribution of individuals according to firearm death rates, the possible associated variables, and sex. Regardless of sex, the highest firearm death rates were observed among individuals living in regions with more than 200,000 inhabitants, in a capital city or a metropolitan region, with a high HDI, teenagers aged from 15 to 19 years, in 2017 and 2018. On the other hand, there was a decrease in this rate in both sexes in 2019. Data in Table 2 were similar to those of the Poisson's regression model estimates adjusted by robust variance estimate (Table 3). Table 4 shows Poisson's multiple regression model estimates, adjusted by robust variance estimate, for firearm death rates, according to sex, for the complete and final models.

In the final models, the associated factors were: a) being a teenager; b) living in a capital city or a metropolitan region; c) living in a region with a high HDI; and d) the years 2016 and 2019. For women, positive associations were observed for the factors: a) living in a region with a high population density (at a 10% significance level); b) living in a capital city or a metropolitan region; and c) being a teenager. For men, positive associations were observed for the factors: a) region with a high HDI; b) living in a capital city or a metropolitan region; c) being a teenager; and d) the years 2017 and 2018. On the other hand, in both sexes, firearm death rates were negatively associated with the years 2016 and 2019 (Table 4). The increase in gunshot deaths follows the trend in total number of murders. In this study, it was observed that out of the 24,017 individuals who died within these 6 years (from 2014 to 2019), in the State of Ceará, 83.8% (20,120) died by firearms. Similar results point out that, in 2017, 65,602 people were killed in Brazil, with 47,510 (72.4%) dying from gunshots, the highest rate within 10 years (IPEA 2019). Almost 1 million Brazilians lost their lives due to gunshots, between 1980 and 2017 and this number could have been even greater if the Brazilian Disarmament Statute failed to pass, in 2003, which

Table 1. Distribution of characteristics: social inequality, population density, age group, and temporal exposure, according to firearm death rates for both sexes. State of Ceará, Brazil (2014-2019)

Dependent variable: § Use of firearm	Sex									
	Female					Male				
Independent variables:	Use of firearm					Use of firearm				
∞ Population density	Yes (n)	%	No (n)	%	*P*	Yes (n)	%	No (n)	%	*P*
High	747	57.0	177	37.4	0.000*	10061	53.5	1223	35.7	0.000*
Low	563	43.0	296	62.6		8749	46.5	2201	64.3	
Total	1310	100	473	100		18810	100	3424	100	
Average age		29.1 (SD† = 12.8)						28.3 (SD† = 11.7)		0.015ɤ
Age group										
Teenager	261	19.9	62	13.1	0.000*	3907	20.8	383	11.2	0.000*
Others	1049	80.1	411	86.9		14903	79.2	3041	88.8	
Total	1310	100	473	100		18810	100	3424	100	
Regional housing conditions										
Capital city/Metropolitan region	892	68.1	219	46.3	0.000*	12224	65.0	1580	46.1	0.000*
Countryside	418	31.9	254	53.7		6586	35.0	1844	53.9	
Total	1310	100	473	100		18810	100	3424	100	
ɤ Municipal HDI										
High	834	63.7	214	45.2	0.000*	11468	61.0	1507	44.0	0.000*
Low	476	36.3	259	54.8		7342	39.0	1917	56.0	
Total	1310	100	473	100		18810	100	3424	100	
§ Year 2016										
Yes	132	10.1	78	16.5	0.000*	2634	14.0	615	18.0	0.000*
No	1178	89.9	395	83.5		16176	86.0	2809	82.0	
Total	1310	100	473	100		18810	100	3424	100	
§ Year 2017										
Yes	281	21.5	86	18.2	0.1317921	4198	22.3	611	17.8	0.000*
No	1029	78.5	387	81.8		14612	77.7	2813	82.2	
Total	1310	100	473	100		18810	100	3424	100	
§ Year 2018										
Yes	373	28.5	89	18.8	0.000*	3577	19.0	529	15.4	0.000*
No	937	71.5	384	81.2		15233	81.0	2895	84.6	
Total	1310	100	473	100		18810	100	3424	100	
§ Year 2019										
Yes	155	11.8	75	15.9	0.025	1624	08.6	405	11.8	0.000*
No	1155	88.2	398	84.1		17186	91.4	3019	88.2	
Total	1310	100	473	100		18810	100	3424	100	

* p <0.005 using Pearson's chi-square test, to study the association between firearm death rates and social inequality, population density, age group, and temporal exposures; ɤ p <0.005 using Student's *t*-test, to compare the average age of firearm death rates between sexes. † SD = standard deviation. § Yes, it includes only firearm death rates, within the reference period, and does not include deaths due to other types of weapons, within periods other than the reference period. ‖ Yes, the category includes only firearm death rates, and it does not include deaths due to other types of weapons.

Table 2. Distribution of individuals according to firearm death rates, possible associated variables, and sex. State of Ceará, Brazil (2014-2019)

Dependent variable: § Use of firearm	Sex									
	Female					Male				
Independent variables:	Use of firearm					Use of firearm				
∞ Population density	Yes (n)	%	No (n)	%	*P*	Yes (n)	%	No (n)	%	*P*
High	747	80.8	177	19.2	0.000*	10061	89.2	1223	10.8	0.000*
Low	563	65.5	296	34.5		8749	79.9	2201	20.1	
Total	1310	73.5	473	26.5		18810	84.6	3424	15.4	
Age group										
Teenager	261	80.8	62	19.2	0.000*	3907	91.1	383	08.9	0.000*
Others	1049	71.8	411	28.2		14903	83.1	3041	16.9	
Total	1310	73.5	473	26.5		18810	84.6	3424	15.4	
Regional housing conditions										
Capital city/Metropolitan region	892	80.3	219	37.8	0.000*	12224	88.6	1580	11.4	0.000*
Countryside	418	62.2	254	19.7		6586	78.1	1844	21.9	
Total	1310	73.5	473	26.5		18810	84.6	3424	15.4	
ɤ Municipal HDI										
High	834	79.6	214	20.4	0.000*	11468	88.4	1507	11.6	0.000*
Low	476	64.8	259	35.2		7342	79.3	1917	20.7	
Total	1310	73.5	473	26.5		18810	84.6	3424	15.4	
§ Year 2016										
Yes	132	62.9	78	37.1	0.000*	2634	81.1	615	18.9	0.000*
No	1178	74.9	395	25.1		16176	85.2	2809	14.8	
Total	1310	73.5	473	26.5		18810	84.6	3424	15.4	
§ Year 2017										
Yes	281	76.6	86	23.4	0.1317921	4198	87.3	611	12.7	0.000*
No	1029	72.7	387	27.3		14612	83.9	2813	16.1	
Total	1310	73.5	473	26.5		18810	84.6	3424	15.4	
§ Year 2018										
Yes	373	80.7	89	19.3	0.000*	3577	87.1	529	12.9	0.000*
No	937	70.9	384	29.1		15233	84.0	2895	16.0	
Total	1310	73.5	473	26.5		18810	84.6	3424	15.4	
§ Year 2019										
Yes	155	67.4	75	32.6	0.025	1624	80.0	405	20.0	0.000*
No	1155	74.4	398	25.6		17186	85.1	3019	14.9	
Total	1310	73.5	473	26.5		18810	84.6	3424	15.4	

* p <0.005 using Pearson's chi-square test, to study the association between firearm death rates and social inequality, population density, age group, and temporal exposures; ɤ p <0.005 using Student's *t*-test, to compare the average age of firearm death rates between sexes. † SD = standard deviation. § Yes, it includes only firearm death rates, within the reference period, and does not include deaths due to other types of weapons, within periods other than the reference period. ‖ Yes, the category includes only firearm death rates, and it does not include deaths due to other types of weapons. ɤ High municipal HDI, for values greater than or equal to its median value (0.68), and low municipal HDI, for values less than the median value of municipal HDI. ∞ High population density, people who live in regions with more than 200,000 inhabitants, and low population density, people who live in regions with 200,000 inhabitants or less. Note: The covariables that showed p > 15% in univariate analysis were not shown in the table (year 2014 and year 2015).

Table 3. Poisson's univariate regression model estimates, adjusted by robust variance estimate, for firearm death rates, according to sex. State of Ceará, Brazil (2014-2019)

Dependent variable: § Use of firearm	Sex			
Independent variables:	Female Use of firearm OR* (95% CI†)	*P*	Male Use of firearm OR (95% CI)	*P*
∞ *Population density*				
High	1.06 (1.05; 1.08)	0.000‡	1.04 (1.03; 1.04)	0.000‡
Low (reference)				
Age group				
Teenager	1.04 (1.01; 1.06)	0.000‡	1.03 (1.03; 1.03)	0.000‡
Others (reference)				
Regional housing conditions				
Capital city/Metropolitan region	1.08 (1.06; 1.10)	0.000‡	1.04 (1.04; 1.04)	0.000‡
Countryside (reference)				
¥ *Municipal HDI*				
High	1.06 (1.04; 1.08)	0.000‡	1.03 (1.03; 1.04)	0.000‡
Low (reference)				
Year 2016				
Yes	0.95 (0.92; 0.98)	0.000‡	0.98 (0.98; 0.99)	0.000‡
No (reference)				
‖ *Year 2017*				
Yes	1.01 (0.99; 1.04)	0.132‡	1.01 (1.01; 1.02)	0.000‡
No (reference)				
‖ *Year 2018*				
Yes	1.04 (1.02; 1.06)	0.000‡	1.01 (1.01; 1.02)	0.000‡
No (reference)				
‖ *Year 2019*				
Yes	0.97 (0.95; 1.00)	0.0253‡	0.98 (0.97; 0.99)	0.000‡
No (reference)				

* OR = odds ratio. † CI = confidence interval. ‡ p <0.005 by Poisson's regression, univariate, adjusted by robust variance estimate, to verify the association between firearm death rates and social inequality, population density, age group, and temporal exposure. § Yes, it includes only firearm death rates, within the reference period, and does not include deaths due to other types of weapons, within periods other than the reference period. ‖ Yes, the category includes only firearm death rates, and it does not include deaths due to other types of weapons. ¥ High municipal HDI, for values greater than or equal to its median value (0.68), and low municipal HDI, for values less than the median value of municipal HDI. ∞ High population density, people who live in regions with more than 200,000 inhabitants, and low population density, people who live in regions with 200,000 inhabitants or less. **Note:** The covariables that showed p > 15% in univariate analysis were not shown in the table (year 2014 and year 2015)

Table 4. Multiple Poisson's regression model estimates, adjusted by robust variance estimate for firearm death rates, according to sex for the complete and final models. State of Ceará, Brazil (2014-2019)

	* Complete model				‡ Final model			
Dependent variable: § *Use of firearm*	Sex Female		Male		Sex Female		Male	
Independent variables:	OR§ (95% CI‖)	*P*	OR§ (95% CI‖)	*P*	OR§ (95% CI‖)	*P*	OR§ (95% CI‖)	*P*
∞ *Population density*								
High	1.02 (1.00; 1.05)	0.057	1.00 (1.00; 1.01)	0.222	1.02 (1.00; 0.04)	0.059	- -	-
Low (reference)								
Age group								
Teenager	1.02 (1.00; 1.05)	0.023	1.03 (1.02; 1.03)	0.000	1.02 (1.00; 0.04)	0.022	1.03 (1.02; 1.03)	0.000
Others (reference)								
Regional housing conditions								
Capital city/Metropolitan region	1.05 (1.03; 1.08)	0.000	1.03 (1.02; 1.03)	0.000	1.05 (1.03; 1.08)	0.000‡	1.03(1.02; 1.03)	0.000
Countryside (reference)								
¥ *Municipal HDI*								
High	- -	-	1.01 (1.00; 1.02)	0.000	- -	-	1.02 (1.01; 1.02)	0.000
Low (reference)								
‖ *Year 2016*								
Sim	0.96 (0.93; 0.98)	0.002	0.99 (0.99; 1.00)	0.007	0.96 (0.93; 0.98)	0.001	0.99 (0.98; 0.99)	0.006
No (reference)								
‖ *Year 2019*								
Yes	0.97 (0.94; 0.99)	0.013	0.99 (0.98; 0.99)	0.000	0.97 (0.94; 0.99)	0.008	0.99 (0.98; 0.99)	0.000
No (reference)								
‖ *Year 2017*								
Yes	1.00 (0.98; 1.03)	0.633	0.99 (1.01; 1.02)	0.000	- -	-	1.01 (1.01; 1.02)	0.000
No (reference)								

* Complete model = Inclusion of all covariates, simultaneously, with p <15% in tables 2 or 3 in either sex. ‡ Final model = The display variables that show p <5%, or that adjusted p values by at least 10% were maintained in the final multiple models. § OR = odds ratio. ‖ CI = confidence interval. § Yes, it includes only firearm death rates, within the reference period, and does not include deaths due to other types of weapons, within periods other than the reference period. ‖ Yes, the category includes only firearm death rates, and it does not include deaths due to other types of weapons. ¥ High municipal HDI, for values greater than or equal to its median value (0.68), and low municipal HDI, for values less than the median value of municipal HDI. ∞ High population density, people who live in regions with more than 200,000 inhabitants, and low population density, people who live in regions with 200,000 inhabitants or less. Notes: The symbol (-) means the case with covariates greater than p >15%;The covariables that showed p >15% in univariate analysis were not shown in the table (year 2014 and year 2015).

may have been accompanied by other factors of a macroeconomic and/or demographic nature (IPEA 2019). In this study, the high firearm death rates in the State of Ceará (83.8%), within the period under analysis, have men as the most victimized individuals (92.6%) (p <0.001), supporting the relevance of this study's design in a stratified way by sex. This discrepancy may express the gender issue, i.e. there seems to be a social influence for a greater number of firearm deaths among men. This predominance of male death is a trend observed in all Brazilian states in a historical series of number of deaths by murder as a whole. In surveys carried out in the State of Ceará, based on the Observatory of Violence Against Women (Observatório da Violência Contra a Mulher [OBSERVEM]), in the years 2009 and 2010, the women murdered by their partners were in the age group between 18 and 42 years (Frota et al. 2012), something which coincides with the analysis of murders of women of childbearing age, carried out in Recife, Pernambuco, Brazil, within the period from 2003 to 2007, pointed out that more than 80% of deaths occurred as a result of assaults involving the use of firearms (Silva et al. 2011). The findings of this study were consistent with those of others conducted in Brazil and abroad regarding the predominance of men as victims (Geberth 2010; IPEA 2019; Meel 2018; Melo and Garcia 2017). Men's vulnerability is exacerbated by their social and cultural origins, which puts them in the position of dominators, instituting violence as an attribute of their nature and conditioning them to be both victims and perpetrators of violent acts (Alves et al. 2012). However, among women, the number of firearm murders increased in the State of Ceará, going from 132 cases in 2016 to 281 cases in 2017 and 373 cases in 2018. Within the same period, in Brazil, among women, the number of firearm murders grew by 10%, going from 2,349 in 2016 to 2,583 in 2017, although it was less intense comparing the entire country with the State of Ceará. When crime was committed at home, with women as victims, that increase was 15% (IPEA 2019). However, this study points out that, in 2019, there was a decrease in firearm deaths for both sexes, in the State of Ceará, by 42.5% and 45.4% (from 373 in 2018 to 155 in 2019 and from 3,577 in 2018 to 1,624 in 2019), between women and men, respectively. In this scenario, data in this study point out the need for cooperative policy between the various entities of the Brazilian Federation involved (Union, states, the Federal District, and municipalities) in the economic, social, and public security areas. One of the groups most vulnerable to violence, either as aggressors or as victims, consists of young people (Beato 2012). Thus, the results of this study point out the existence of high firearm death rates in the mortality indicators of young people, among men, in the State of Ceará. Likewise, in Latin America, generally, most murder victims are among men, and 69% of them are aged between 15 and 19 years (Matsueda 1992). Youth gangs are one of the most recurrent images on the contemporary scene of violence in Latin America. Therefore, the main aspect of the current patterns of urban violence, which mainly affects the age group from 15 to 19 years, may indicate a 'juvenilization' process of violence in the State of Ceará. Other similar studies, one of them carried out in Argentina, within the period from 1991 to 2006, showed that 48.5% of the fatal victims of firearm injuries were aged between 15 and 29 years (Zunino, Roux and Souza 2012). This reveals an in-depth study on premature loss of life, in order to grasp the aspects that most contribute to this type of violence.

In this study, living in a capital city and/or a metropolitan region stands out as the most frequent place of firearm deaths among male victims, something which is compatible with the greater men's involvement in urban violence (Melo and Garcia 2017). Also, this study has shown that firearm deaths are more frequent in regions of greater population density only among women (Ganiyu 2018) and it is believed that the larger the population, the higher the rate of crime, and vice versa. A study carried out by Beato (2012) reveals that the larger the population, the higher the mortality indicators – this suggests that something has been happening in large cities. In this context, regions with a higher population density and greater urbanization have higher homicide rates, reinforcing the role played by demographic features as explanatory components of the growth of violence in Brazil (Moura et al. 2015). Starting from this approach, urbanization is the phenomenon related to the increased number of murders (Beato 2012), particularly to the incidence of firearm deaths. From this perspective, we may say that violent crimes are urban phenomena associated with the process of disorganization in large urban centers, where the control mechanisms deteriorate, just in other countries (Wilson and Petersilia 2011). Likewise, in this study, there is a positive relationship between firearm death rates and living in regions with high HDI among men, something which may have to do with the fact that violence is concentrated in population sectors that have seen a considerable improvement in their living conditions (Beato 2012). It is worth mentioning that the HDI results do not indicate the dynamics of regions where groups at high wage levels and in high poverty areas coexist (e.g. in the metropolitan regions of the Northeastern Brazil). This study has a limitation inherent to its nature: as this is an ecological study, it was hard to include some explanatory variables in economic terms (e.g. victim's educational level and skin color) and in psychological terms (e.g. consumption of alcohol and drugs), identified in the literature as relevant to explain the event in focus (McPhedran and Baker 2011).

The lack of relevant variables in the ecological study database was already predicted, additionally there may have been typos and incomplete information provided by the web portal of the SSPDS Ceará (2014), which generated 6.9% of missing data. An attempt was made to overcome this shortcoming by promoting adjustments based on missing data imputation, thus improving data accuracy. This survey points out a high firearm death rate (83.8%) in the State of Ceará. As for the incidence of firearm deaths, a significant difference was observed between ages and sexes. Men were more victimized (92.6%) and they died more in the years 2017 and 2018. However, an overall decrease in the incidence of firearm deaths was noticed when disregarding stratification by sex in the years 2016 and 2019. Among women, there was a positive relationship between firearm death rates and population density, at a 10% significance level (an area with more than 200,000 inhabitants/denser has higher rates), age group (young people are more victimized by crimes), living in a capital city or a metropolitan region (contrary to what is claimed by some studies – living in the countryside might tend to show higher firearm death rates), and social inequality. As observed in the states of Northeastern Brazil, the dynamics of metropolitan regions consists of populations at high wage levels coexisting with high poverty areas. Likewise, among male individuals, there is a positive relationship between firearm death rates and living in a capital city or a metropolitan region and the age group. There was also a positive relationship between the years 2017 and 2018 and living in regions with a high HDI. In both sexes there were lower firearm death rates in the years 2016 and 2019. These findings highlight that not only population density does affect firearm crime rates, but other factors also contribute to firearm crime rates in a given area, namely: a) poverty; b) social inequality; c) age group; d) temporal exposure; and e) psychological and cultural factors (e.g. chauvinism, homophobia, and prejudice). Although factors indicating social inequality, such as high HDI and living in a capital city or a metropolitan region, are positively associated with firearm death rates, further studies may point out a change in this pattern. However, in this study, Ceará municipalities' HDI was taken as a reference. This research finding stresses that the relationship between socioeconomic status and murders is influenced by the role that Fortaleza plays in the State of Ceará. The capital city has a huge urban concentration and population density at the state level. Thus, it is a hotspot in economic activities and a destination of those who flee the terrible living conditions of countryside municipalities. Yet municipal HDI does not reflect social inequality between the various population areas and this may have generated a bias regarding this finding. Further studies taking into account HDI by neighborhood may identify that, although the highest number of murders occur in the municipality with the highest HDI, such crimes could take place in more vulnerable areas, with lower HDI. This study had as its main source the criminal data available on the web portal of the SSPDS Ceará (2014), obtained through the data scraping technique and its respective indicators. This is one of the few population studies, at the national or international level, estimating factors associated with firearm death rates resorting to a multiple Poisson's regression model adjusted by the robust variance estimate. Ultimately, this study shows relevant data concerning the significance assigned to public managers or officials in defining strategies to formulate and deploy public security and social development policies aimed to fight crime, especially among men, because they commit this type of crime more frequently and, at the same time, this study seeks to contribute to reduce crime in Ceará's municipalities.

REFERENCES

Alves, Rejane Aparecida, Lauriza Maria Nunes Pinto, Andréa Maria Silveira, Graziella Lage Oliveira, and Elza Machado de Melo. 2012. "Homens, Vítimas e Autores de Violência: A Corrosão do Espaço Público e a Perda da Condição Humana." *Interface: Comunicação, Saúde, Educação* 16(43): 871-83.

Asaro, M. Regina. 2001. "Working with Adult Homicide Survivors, Part I: Impact and Sequelae of Murder." *Perspectives in Psychiatric Care* (37): 95-101.

Batrinca, Bogdan, and Philip Treleaven. 2014. "Social Media Analytics: A Survey of Techniques, Tools and Platforms." *AI & Society* 30(1): 89-116.

Beato, Claudio. 2012. *Crimes e Cidades*. Belo Horizonte: Ed. UFMG.

Burgette, Lane F., and Jerome P. Reiter. 2010. "Multiple Imputation for Missing Data via Sequential Regression Trees." *American Journal of Epidemiology* 72(9): 1070-76.

Costa, Daniella Harth da, Kathie Najaine, and Miriam Schenker. 2017. "Repercussões do Homicídio em Famílias das Vítimas: uma Revisão da Literatura." *Ciência & Saúde Coletiva* 22(9): 3087-97.

Equipe RStudio. 2018. *RStudio: Desenvolvimento Integrado para R*. Sebastopol, CA: O'Reilly Media.

Frota, Maria Helena de Paula, Vivian Matias dos Santos, Hayesca Costa Barros, Daniele Ribeiro Alves, Sarah Dayanna Lacerda Martins Lima, and Janaína de Sousa. 2012. *Assassinato de Mulheres no Ceará*. Fortaleza: Ed. UECE.

Ganiyu, Musa. 2018. *Factors Affecting Crime Rates: Social, Economic, Security and Pyschological (A Case Study of New York State Crime Rates)*. New York: City University of New York.

Geberth, Vernon. 2010. *Sex-Related Homicide and Death Investigation: Practical and Clinical Perspectives*. Boca Raton, FL: CRC Press.

Hertz, Marci Feldman, Deborah Prothrow-Stith, and Clementina Chery. 2005. "Homicide Survivors. Research and Practice Implication." *American Journal of Preventive Medicine* 29(5): 288-95.

IBGE (Instituto Brasileiro de Geografia e Estatística). 2010. *Censo Demográfico 2010*. Rio de Janeiro: IBGE.

IPEA (Instituto de Pesquisa Econômica Aplicada). 2019. *Atlas da Violência 2019. Homicídios por Armas de Fogo*. Brasília, DF: IPEA.

Lavor, Thays. 2019. *Open Data Day Fortaleza 2019: Os Destaques do Evento*. Fortaleza: Open Knowledge Brasil.

Lolis, Dione. 2008. *Um Jeito Jovem de Morrer: Homicídio de Jovens por Arma de Fogo em Londrina, 2000-2003*. Araraquara, SP: Universidade Estadual Paulista.

Matsueda, Ross. 1992. "Reflected Appraisals, Parental Labeling, and Delinquency: Specifying a Symbolic Interactionist Theory." *American Journal of Sociology* 97(6): 1577-611.

McPhedran, Samara, and Jeanine Baker. 2011. "Firearm Homicide in Australia, Canada, and New Zealand: What Can We Learn From Long-Term International Comparisons?" *Journal of Interpersonal Violence* 26(2): 348-59.

Meel, Banwari. 2018. "Twenty-Three-Year Trend in Firearm Deaths in the Transkei Subregion of South Africa." *Medicine, Science and the Law* 58(2): 102-8.

Melo, Alice Cristina Medeiros, and Leila Posenato Garcia. 2017. "Atendimentos de Jovens Vítimas de Agressões em Serviços Públicos de Urgência e Emergência, 2011: Diferenças entre Sexos." *Ciência & Saúde Coletiva* 22(4): 1333-41.

Minayo, Maria Célia de Souza. 2005. "Violence: A New Old Challenge for Health Care." *Revista Brasileira de Educação Médica* 29(1): 55-63.

Moura, Erly Catarina de, Romeu Gomes, Marcia Thereza Couto Falcão, Eduardo Schwarz, Alice Cristina Medeiros das Neves, and Wallace Santos. 2015. "Gender Inequalities in External Cause Mortality in Brazil, 2010." *Ciência & Saúde Coletiva* 20(3): 779-88.

R Core Team. 2019. *R: Language and Environment for Statistical Computing and Graphics*. Vienna: R Foundation.

Redmond, Lula Moshoures. 1989. *Surviving: When Someone You Know was Murdered. A Professional's Guide to Group Grief Therapy for Families and Friends of Murder Victims*. Clearwater, FL: Psychological Consultations and Education Serices.

Rubin, Donald B. 1987. *Multiple Imputation for Nonresponse in Surveys*. New York: John Wiley & Sons.

Silva, Leonildo Severino da, Maria Lúcia Neto de Menezes, Cyntia Lins de Almeida Lopes, and Maria Suely Medeiros Correa. 2011. "Anos Potenciais de Vida Perdidos por Mulheres Vítimas de Homicídio na Cidade do Recife, Pernambuco, Brasil." *Cadernos de Saúde Pública* 27(9): 1721-30.

SSPDS Ceará (Secretaria da Segurança Pública e Defesa Social do Estado do Ceará). 2014. *Indicadores criminais dos anos anteriores*. Fortaleza: SSPDS Ceará.

UNODC (United Nations Office on Drugs and Crime). 2011. *Global Study on Homicide*. Vienna: UNODC.

WHO (World Health Organization). 2014. *Global Status Report on Violence Prevention*. Geneva: WHO.

Wilson, James Q., and Joan Petersilia. 2011. *Crime and Public Policy*. Oxford: Oxford University Press.

Zangirolami-Raimundo, Juliana, Jorge de Oliveira Echeimberg, and Claudio Leone. 2018. "Tópicos de Metodologia de Pesquisa: Estudos de Corte Transversal." *Journal of Human Growth and Development* 28(3): 356-60.

Zunino, Marina Gabriela, Ana Roux, and Edinilsa Souza. 2012. "Homicides Involving Firearms in Argentina Between 1991 and 2006: A Multilevel Analysis." *Ciência & Saúde Coletiva* 17(12): 3219-32.

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