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Homicides among women in the different Brazilian regions in the last 35 years: an analysis of age-period-birth cohort effects

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Abstract *The aim of this study is to estimate the effects of age-period-birth cohort (APC) on female homicides. This is an ecological study which analyzed the violence-related death records of women aged 10 years and older, in the Brazilian geographic regions, between 1980 and 2014. Data on mortality were extracted from the Mortality Information System. The trend analysis was conducted using negative binomial regression and APC effects were analyzed using estimable functions. The average mortality rate for the period was 5.13 deaths per 100,000 women, with the highest rates observed in the Central-West (7.98 deaths), followed by the Southeast (4.78 deaths), North (4.77 deaths), Northeast (4.05 deaths) and South (3.82 deaths) regions. All regions presented a decrease in the risk of death in the period from 2010 to 2014, except for the Northeast region (RR = 1.06, 95% CI 1.02 to 1.10). There was a progressive increase in the homicide risk for women born from 1955 to 1959 in all Brazilian regions. Younger women are at higher risk of dying from homicides in all Brazilian geographic regions. The upward trend of homicide mortality rates according to birth cohort was significant and the highest risk was observed in women born between 2000 and 2004.*

Key words *Feminicide, Cohort effect, Period effect, Age effect, Logistic models*

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Introduction

Gender violence is understood as actions undertaken in the private or public realm, occurring in a wide-range of contexts. However, it happens most frequently in the domestic environment. It is often perpetrated by male family members who exert power over their victims, since they are generally protected by emotional bonds, where power relations may be taken to the extreme[1-3].

According to WHO, violence against women is a public health concern[4] and may occur in the form of psychological, sexual, physical, economic and patrimonial violence, potentially culminating in murder, the maximum expression of gender-based violence against women, also known as femicide[5,6].

Femicide was first used as a term in the 1970s. It was coined as a legal and political term, in order to conceptualize all instances in which unequal power relations between men and women result in the death of one or more women[6-8]. According to Meneghel et al.[6], female homicides across a wide-range of situations can be described as femicide: deaths perpetrated by intimate partners, serial crimes, sexual violence followed by death and revenge killings, especially where there is high socio-economic inequality or in places controlled by organized crime.

Femicide-related mortality rates vary according to regions and between countries. However, an increase in this type of violence is observed in places where a patriarchal culture remains in place and where the State is negligent[6-8]. Within this context, it is possible to observe differences in the types of femicides committed: in the United States and the United Kingdom femicide is mainly perpetrated by partners or former partners[9-11], whereas in Mexico it is strongly associated with drug trafficking and structural violence[12].

In Brazil, the 'Violence Map: Homicide among women'[13] shows that there has been a progressive rise in the number of female deaths from homicide, an increase of 111.1% between 1980 and 2013. During the 2011-2013 three-year period, there were 17,581 homicides among women, equivalent to 5.87 deaths per 100,000 women[14]. It is thought that this high rate is associated to the belief that crimes against women are justified because they are private matters. In these cases, impunity is the result of historical evolution and the fact that there is no political will to adequately address violence against women in a more incisive way[7,15-18].

Aware of this need, the Brazilian State has developed actions to combat violence against women. Particularly important are the Maria da Penha law that established mechanisms to curb violence against women[15] and Law 13.104 that classifies femicide as a heinous crime, providing for harsh penalties[18]. However, although a legal framework is in place to suppress this type of violence, there are shortfalls in the application of legislation, ranging from invisibility that leads to the under-reporting of violence against women[16] to the difficulties in establishing a substantive network of care for addressing this issue effectively[19,20].

Recently published studies in Brazil analyzed female homicide mortality trends using summary rates by age and period of death[5,13,15,17,18]. These were extremely important in order to give visibility to the issue of gender-based violence in Brazil[5,13,16,18]. However, they did not analyze the effect of birth cohorts, a significant factor in the evolution of the incidence and mortality rates for diseases and health problems[21-23].

Given the above, and taking into account the recommendations of the Brazilian National Agenda of Priorities in Health Research[24], which set out as one of its recommendations the development of research on women's mortality attributable to violence, the aim of this study was to analyze the effects of age-period-birth cohorts on female mortality due to homicide in different regions of Brazil, in the last 35 years.

Methodology

This study presents an analysis of female homicide in the five Brazilian geographic regions, between 1980 and 2014. Official homicide mortality data were used, extracted from the Brazilian Ministry of Health's Mortality Information System (SIM/Datasus). Homicide information took into account codes E960 and E969 as established by the International Classification of Diseases and Health Related Problems, ninth revision (ICD-9) and codes X85 and Y09 of the International Classification of Diseases and Health Related Problems, tenth revision (ICD-10).

In this study, the total number of female homicides was taken as an approximation for the number of homicides caused by gender-related violence. It is thought that this method does not overestimate the occurrence of femicide, given this is compensated by the problems that exist in relation to under-reporting and the high number of deaths registered as events of undetermined intent, especially in the poorer regions of the country[6,13,15,17,18]. In addition, SIM/Datasus data

were also extracted regarding the means used to commit homicide, according to geographic region and place of death.

Mortality trends of diseases and health problems can be affected by changes in the recording of death and the quality of mortality information systems[21-23]. Thus, the current study also sought to analyze the mortality trends of events of undetermined intent, represented by the ICD-9 E980 to E989 and ICD-10 Y10 to Y34 codes, respectively.

Population data were obtained from the Information Department of the Brazilian National Health System (DATASUS), based on the 1980, 1991, 2000 and 2010 population censuses. Inter-census forecasts for populations for the 1st July of each of the inter-census years were estimated by the Brazilian Institute of Geography and Statistics (IBGE).

Once death records and population data were obtained, specific rates for age group, per year were calculated and standardized using the direct method, where the standard population was taken to be the Brazilian population, according to the 2010 Census.

Age groups were divided into 5-year intervals, starting with the 10-14 age group and ending with 75 years and over age group, 14 in total. Periods were also grouped into 5-year intervals, a total of seven periods (1980 to 1984, 1985 to 1989, 1990 to 1994, 1995 to 1999, 2000 to 2004, 2005 to 2009 and 2010 to 2014). Finally, birth cohorts started in 1905 and ended in 2000, a total of 20 cohorts. In this study, the 1950 to 1954 cohort and the 1995 to 1995 period were used as references.

In order to analyze the evolution of homicide death rates across 35 years, the mortality rate trends for homicide and events of undetermined intent were analyzed for women in age groups 10 to 14 through to 75 and over, from 1980 to 2014, using a negative binomial regression analysis, given that the number of deaths represent data that originated from censuses.

In this analysis, the number of expected deaths per year was a dependent variable and the centralized calendar year an independent variable. Trend is classified as stationary, decreasing or increasing according to the Relative Risk value (RR), obtained from the regression coefficient exponents and 95% confidence intervals (IC95%). Trend series were considered stationary when the lower value of the confidence interval was smaller than 1 and the higher value greater than 1. Series were considered decreasing when the RR and the lower and higher IC95% limits were smaller than 1. Whereas increasing series had RR values greater than 1, as well as lower and higher limits greater than 1[25].

Age-period-birth cohort (APC) effects were analyzed in relation to homicide mortality for the five geographic regions, assuming a Poisson distribution for the number of deaths and that temporal effects (age-period-birth cohort) have a multiplicative impact on this rate[21-23]. Thus, the logarithm of the expected value is a linear function of the effect of age, period and cohort:

$$ln(E[r_{ij}]) = ln\left(\frac{\theta_{ij}}{N_{ij}}\right) = \mu + \alpha_i + \beta_j + \gamma_k ,$$

where $E[r_{ij}]$ is the expected mortality rate at age i in period j, θ_{ij} the number of deaths at age i in period j, and N_{ij} is the population at risk of death at age i in period j; μ is the mean response, α_i is the effect of age group i, β_j is the effect of period j and γ_k is the effect of cohort k[21-23].

The main limitation of estimating the parameters of APC effects is what is called the *nonidentifiability problem*, that is, the inability to estimate the full model. This is due to the exact linear relation between temporal effects (age-period-birth cohort)[21-23]. It is important to highlight there is no consensus in the literature on the best method to overcome this problem. Therefore, this study chose to calculate APC effects parameters by using estimable functions[21-23]. The fit of the models to the data was verified through deviance statistics, where results are considered statistically significant if $p \leq 0.05$. Analyses to estimate the APC model were conducted using the Epi 1.1.18 library and the R program, version 3.2.1.

The use of age-period-cohort (APC) models allows for the disaggregation of the age, period and birth cohort effects. It enables us to analyze which of these factors have a greater impact on the evolution of the rates of incidence and mortality of illnesses and health problems[21]. Furthermore, it facilitates making assumptions about the factors that could have contributed to changes in the mortality rate, such as the improvement in and the quality of death records, the enforcement of legislation (Maria da Penha) and implementation of public policies (period effects). It also allows us to observe whether changes in the rates may be correlated to distinct levels of exposure of the different generations to risk factors such as drug trafficking, rapid and unplanned urbanization and socio-economic inequalities that increase the vulnerability of certain population groups (birth cohort effects).

Results

In the last thirty-five years, over 100,000 female homicide deaths were recorded in Brazil, representing an average standardized rate of 5.13 deaths per 100,000 women. In this period, the highest standardized average mortality rates, per 100,000 women, were observed in the Center-West region (7.98 deaths). In the other regions rates are slightly lower: Southeast (4.78 deaths), North (4.77 deaths), Northeast (4.05 deaths) and South (3.82 deaths). The study highlights that there was a progressive rise in mortality rates across all quintiles studied, with the highest rates observed from 2010 to 2014, with the exception of the Southeast region, where the highest rates occurred during the 1995 to 1999 period.

Firearms stand out as the main means used in homicides, followed by sharp and blunt objects and strangulation. Deaths caused by firearms represented 44.03% of homicide deaths in the North region, 56.04% in the Northeast, 45.97% in the Southeast, 48.60% in the South and 46.8% in the Center-West region. Sharp and blunt objects were responsible for 40.61% deaths in the North region, 33.62% in the Northeast, 22.43% in the Southeast, 31.8% in the South and 35.57% in the Center-West. At the same time, the percentage of deaths caused by strangulation varied between 3.76% (Northeast region) to 6.78% (South region). It is important to highlight that this profile is maintained across all the quintiles analyzed.

In Brazil in the last 35 years, the place of death was somewhat evenly distributed between the home (28.89%), hospitals (28.32%) and public roads (26.58%). This was not the case when geographic regions were observed in isolation: In the South, North and Center-West, the greatest number of deaths occurred within the home (37.56%, 30.30% and 33.82%, respectively); followed by hospitals (23.61%, 27.43% and 26.29%, respectively). By contrast, in the Northeast, the greatest number of deaths occurred in public roads (31.03%), followed by the home (27.58%); in the Southeast, the main locations of deaths were hospitals (32.05%) with lower numbers of deaths occurring in public roads (26.83%%) and in the home (26.04%). Furthermore, it is important to note that, in the quintiles analyzed, it is possible to observe a change in the main place of occurrence of death.

During the period from 1980 to 2014, the homicide-related death rates among women in the South region of Brazil shows an upward trend from 1994 onward, when a reduction in the rates for events of undetermined intent is observed. Similarly, in the North there was an increase in the mortality rates due to homicide and a reduction in events of undetermined intent rates, in particular from 1999 onward. By contrast, in the Northeast region, from 1995, there is an increase both in the rates of homicide and events of undetermined intent (Figure 1).

The Southeast region saw a downward trend in mortality rates until 1997, when rates increased until 2005, and subsequently decreased in the following years. It is important to highlight that mortality rates associated to events of undetermined intent moved in the opposite direction to homicide mortality rates: when one increased, the other decreased and vice-versa. In the Center-West there was a significant reduction in mortality rates related to events of undetermined intent, particularly during the 1980s and the second half of the 1990s (Figure 1).

With regard to mortality rates according to the age and periods under analysis, all the Brazilian geographic regions saw a progressive increase from the age of 15 onward, peaking at the 30 to 34 age group, when there is a progressive reduction in the rates. The lowest rates for all age groups were observed from 1980 to 1984, and the highest from 2010 to 2014, except for the Southeast region, which saw the highest mortality rates for the 20-24 to 35-39 age groups, during the 1995-1999 period (Figure 2).

Homicide mortality rates by birth cohort and age group, in all Brazilian regions showed a strong increase among women born from 1950 onward, where the highest rates were observed among women of the 1980s generation, in the 30-34 age group (Figure 3).

The negative binomial regression analysis revealed an upward trend in the homicide-related mortality rate among women in the Center-West (RR = 1.10, IC95% 1.003-1.103), North (RR = 1.02, IC95% 1.01-1.04), Northeast (RR = 1.03, IC95% 1.01-1.04) and South (RR = 1.02, IC95% 1.01-1.03). In the Southeast region, no evolution was observed (RR = 0.99, IC95% 0.98-1.001). During the same period, the evolution of rates for undetermined intent events was negative for the Center-West (RR = 0.95, IC95% 0.96-0.97), North (RR = 0.98, IC95% 0.97-0.99) and South (RR = 0.98, IC95% 0.96-0.98); and rose in the Northeast (RR = 1.003, IC95% 1.001-1.004) and Southeast (RR = 1.003, IC95% 1.001-1.004).

With regard to the results of the APC analysis, in all regions, all the age-cohort (AC) models and age-period (AP) models fitted best to data

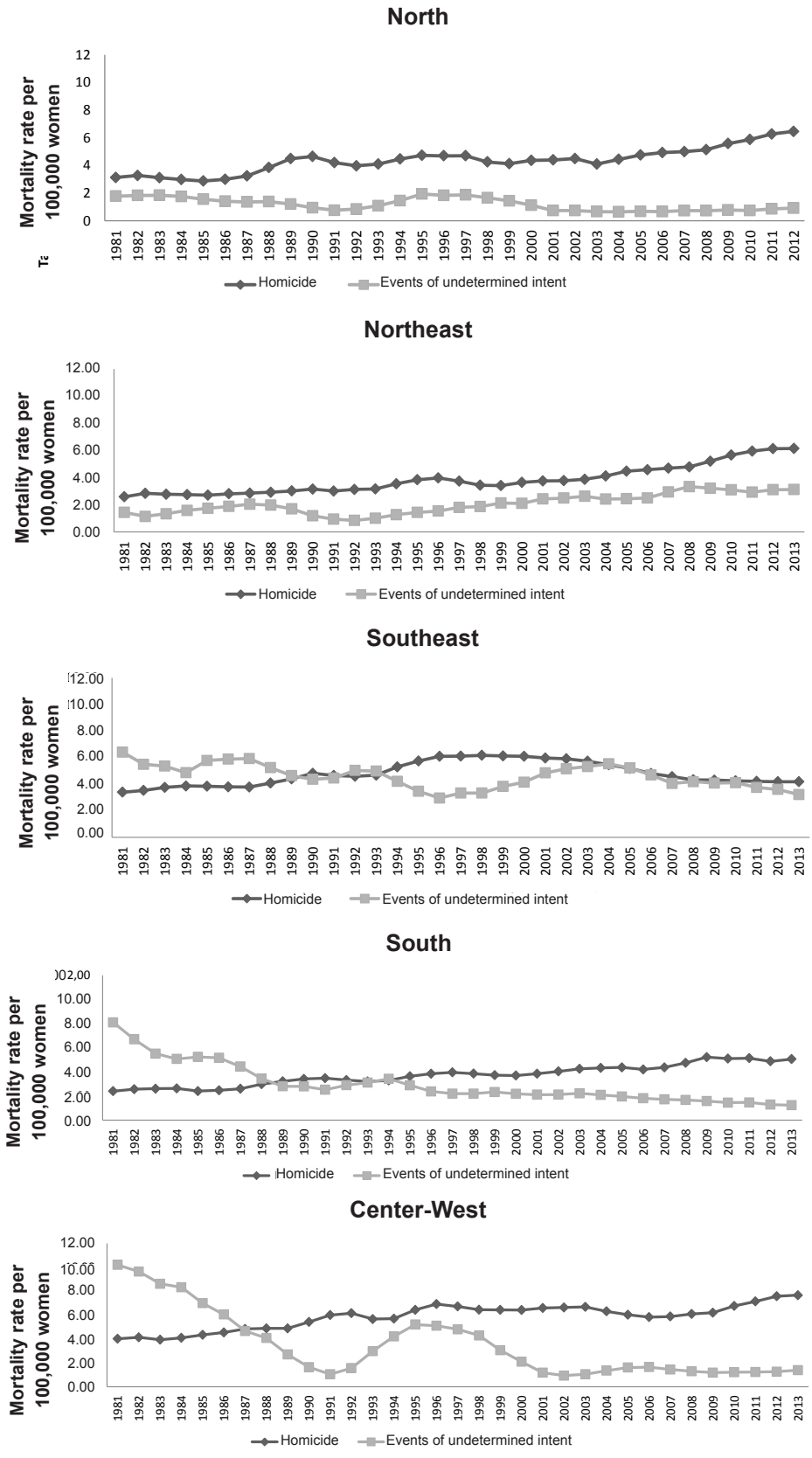

Figure 1. Rates of homicide mortality and events of undetermined intent among women, by Brazilian region, smoothed by three-year moveable averages, from 1980 to 2014.

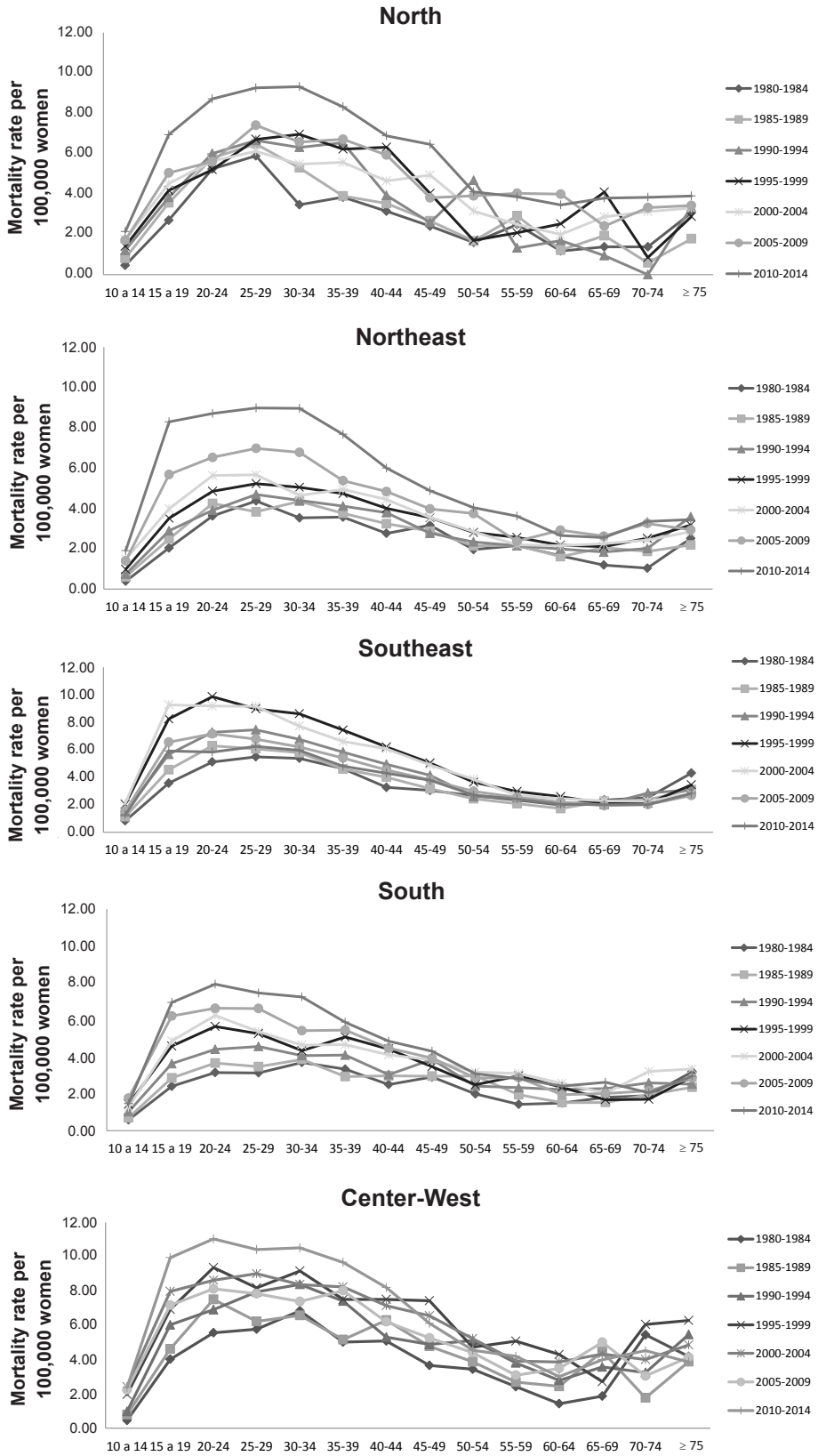

Figure 2. Homicide mortality rates among women in the Brazilian regions, by age group and period of death, from 1980 to 2014.

when compared to the age-only model and the age-drift model. The full model was significantly better than the models with only two factors, AP ($p < 0.0001$) and AC ($p < 0.0001$). It is important to emphasize that the null hypothesis for the AC model was no period effect on mortality rates and that of the AP model, no birth cohort effect.

After fitting the APC models, it was observed that in all regions, younger women had a higher risk of dying from homicides when compared to older women, peaking at the 30-34 age group (Table 1 and Figure 4).

It can be observed that with regard to the period effect adjusted by age and birth cohort effects, in the Center-West, South and Southeast regions, the risk of death by homicide was lower than 1 in all periods when compared to the reference period (1995 to 1999) (Table 1 and Figure 4). By contrast, an increase in the risk of death in the North was observed for the 1985 to 1989, 1990 to 1994, and 2010 to 2014 periods. However, the increase in the risk of death was only statistically significant for the 1990 to 1994 period (RR = 1.06, IC95 1.008 - 1.11); in all other periods, the risk of death was smaller than one and only statistically significant in the two five-year periods in the 2000s. Similarly, there was an increase in the risk of death in the Northeast from 1980 to 1984, 1990 to 1994, and from 2010 to 2014. However, the only statistically significant increase (RR = 1.06, IC95% 1.02 - 1.10) occurred in the last period of the analysis (Table 1 and Figure 4).

With regard to birth cohort effects, after adjustments for period and age, a progressive increase in the risk of death for women born between 1955 to 1959 was observed when compared to the reference cohort (1950 to 1954). This was the case in all Brazilian regions with the exception of the Northeast which saw an upward surge since the 1960 to 1964 cohort. It is important to note that the greatest risk was observed in relation to women born between 2000 and 2004 (Table 1 and Figure 4).

Discussion

Sociability is increasingly marked by different forms of inhuman expressions of violence and women stand out as one of the most vulnerable groups, together with children and the elderly[15,17,18]. In this situation, femicide is the cruelest form of gender violence and is considered a serious public health concern, influenced by socio-cultural and political aspects.

This study revealed that the most frequent place of death varied according to geographic region, but mainly occurred in the home, public roads and hospitals. Academics claim that these characteristics point to the fact that this type of homicide is caused by gender violence because it tends to take place in the home[5,15,17,18]. However, there has been a growth in the number of deaths occurring in public roads, since many partners or former partners are aware of their victim's routine and may attack her as she leaves home, work or educational activities. Furthermore, in places where women are extremely socially vulnerable, they can be killed due to drug trafficking[6,12], often in the form of revenge killings which also constitutes a type of femicide[6].

In all Brazilian regions and five-year periods analyzed, violence was inflicted by the use of firearms, followed by sharp/blunt objects and strangulation. This is in line with observations in the United States[9,26] and other studies conducted in Brazil[5,13,15,17,18], but contrasts with findings in studies conducted in England and Wales, where more deaths were caused by sharp objects and through strangulation[9].

Age group and place of occurrence of deaths among women in Brazilian regions revealed a similar profile to findings in studies about women victims of domestic violence, observed in the emergency services in Brazil, between 2008 and 2009[26], as well as in two emergency departments in the municipality of Rio de Janeiro studied by Deslandes et al.[27].

The evolution of mortality rates associated to health problems reflect changes in the age structure of the population. It also points to changes in risk factor exposure and structural protection. This may partly explain the differences observed between the various Brazilian geographic regions. Therefore, it is essential to analyze age-period-birth cohort effects[21-23]. Furthermore, it is important to stress improvements in the quality of mortality information systems which may have affected the findings of this study. Measures have been proposed to amend death records associated to external causes[5], which reveal weaknesses. Therefore, it was decided that this study should evaluate both mortality trends attributable to aggression and to events of undetermined intent.

With regard to age effects, higher mortality rates can be observed among younger women, especially those in their twenties and thirties. These findings corroborate other studies conducted in Brazil[5,13,15,16,18], in the United States[26], Argenti-

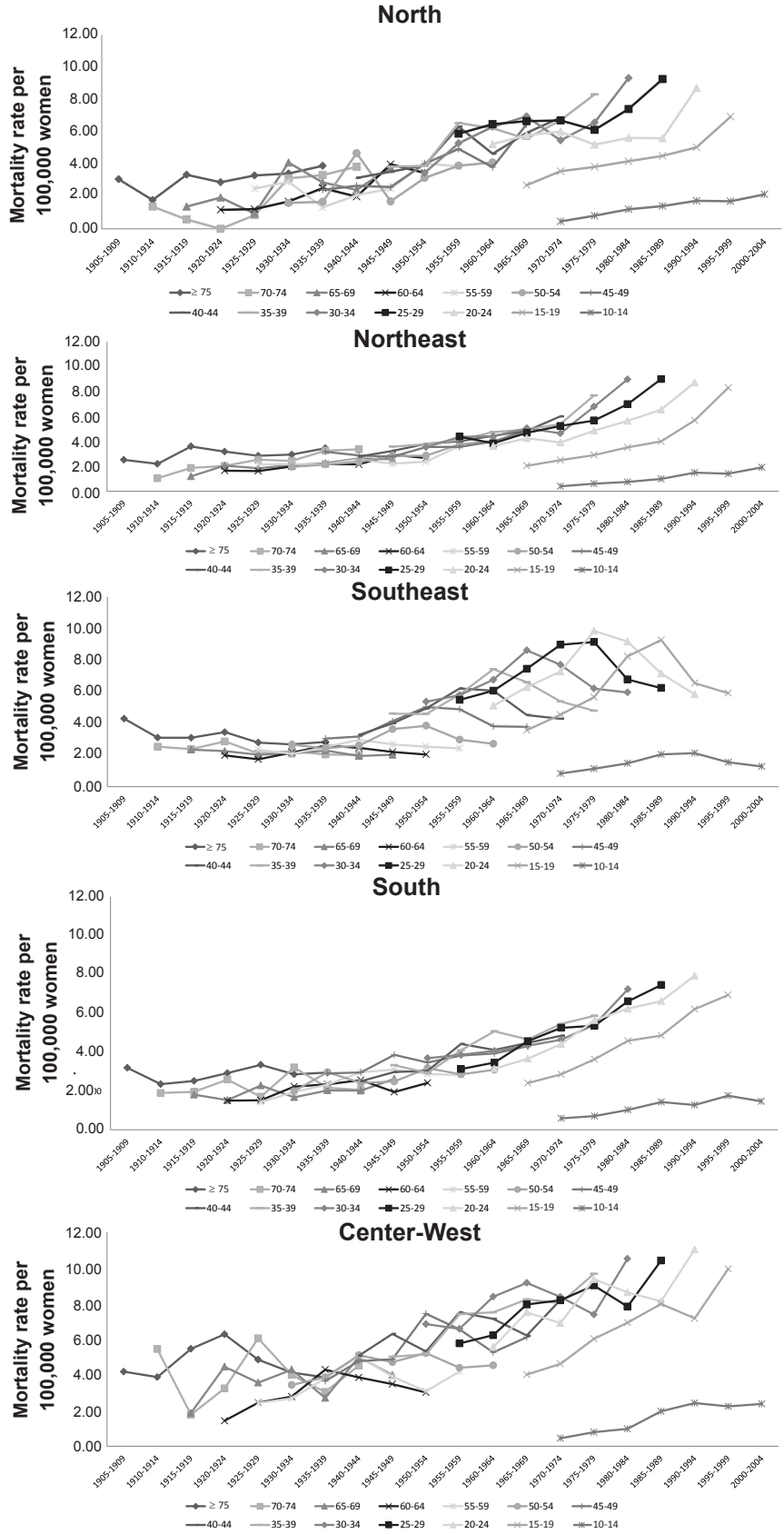

Figure 3. Homicide mortality rates among women in the Brazilian regions, by birth cohort and age group, between 1980 and 2014.

Table 1. Estimates of homicide mortality rates among women, by age group and of the relative risks and respective 95% confidence intervals by period and birth cohort, after adjustments to the APC model, according to Brazilian regions from 1980 to 2014.

	N	NE	SE	S	CO
Age					
Mortality rate (CI95%)					
10 a 14	0.74(0.63 -0.85)	0.41 (0.37- 0.44)	1.81 (1.70 -1.91)	0.58 (0.51- 0.65)	1.11 (0.98- 1.27)
15 a 19	2.06 (1.84 -2.30)	1.40 (1.31- 1.48)	5.15 (4.93- 5.39)	1.83 (1.68- 2.00)	3.63(3.29 -4.01)
20 a 24	3.87 (3.48 -4.29)	2.88 (2.73- 3.05)	8.64 (8.28- 9.01)	3.40 (3.14- 3.68)	6.74 (6.15- 7.38)
25 a 29	4.25 (3.84- 4.71)	3.06 (2.90- 3.24)	7.30 (7.00- 7.61)	3.14 (2.91- 3.40)	6.14 (5.60- 6.72)
30 a 34	4.88 (4.44- 5.36)	3.74 (3.55- 3.94)	7.66 (7.37- 7.96)	3.66 (3.41- 3.92)	7.47 (6.88- 8.11)
35 a 39	4.71 (4.31- 5.150)	3.85 (3.66- 4.04)	7.01 (6.76- 7.26)	3.96 (3.70- 4.23)	7.65 (7.09- 8.26)
40 a 44	4.06 (3.75- 4.39)	3.41 (3.28- 3.56)	5.58 (5.42- 5.75)	3.71 (3.50- 3.93)	6.55(6.14- 7.00)
45 a 49	3.70 (3.40- 4.02)	3.11 (2.99- 3.24)	4.59 (4.45- 4.73)	3.3 (3.15- 3.52)	5.74 (5.37- 6.14)
50 a 54	3.63 (3.33- 3.95)	2.99 (2.87- 3.13)	3.99 (3.86- 4.12)	3.10 (2.92- 3.29)	5.32 (4.95 -5.70)
55 a 59	3.77 (3.43- 4.13)	3.01 (2.87- 3.16)	3.64 (3.51- 3.78)	3.02 (2.83- 3.23)	5.13 (4.74- 5.55)
60 a 64	4.06 (3.62- 4.55)	3.14 (2.98- 3.32)	3.45 (3.30- 3.60)	3.06 (2.84- 3.29)	5.12 (4.65-5.64)
65 a 69	4.45 (3.83- 5.18)	3.37 (3.15- 3.60)	3.36 (3.18- 3.55)	3.18 (2.90- 3.49)	5.22 (4.60- 5.92)
70 a 74	4.90 (4.03- 5.96)	3.67 (3.37- 4.01)	3.34 (3.11- 3.59)	3.37 (2.99- 3.80)	5.38(4.56- 6.34)
75 e mais anos	5.39 (4.23- 6.88)	4.05 (3.62- 4.52)	3.35 (3.06- 3.66)	3.60 (3.09- 4.20)	5.55 (4.51-6.83)
Period (CI95%)					
1980-1984	0.93 (0.86- 1.02)	1.01 (0.96- 1.06)	0.63 (0.61- 0.65)	0.86 (0.81-0.91)	0.77 (0.71- 0.83)
1985-1989	1.02 (0.97- 1.08)	1.01 (0.99- 1.04)	0.68 (0.66- 0.70)	0.90 (0.86- 0.95)	0.83 (0.80- 0.87)
1990-1994	1.06 (1.008- 1.11)	1.01 (0.99- 1.02)	0.80 (0.78- 0.82)	0.95 (0.91-1.006)	0.91 (0.87 -0.95)
1995-1999		1			
2000-2004	0.91(0.88- 0.95)	0.96(0.93- 0.99)	0.93(0.90- 0.95)	0.95 (0.92- 0.98)	0.92 (0.89 -0.95)
2005-2009	0.90 (0.84- 0.97)	0.97(0.93- 1.01)	0.68(0.66- 0.70)	0.88 (0.83- 0.93)	0.73 (0.69- 0.78)
2010-2014	1.07 (0.99- 1.14)	1.06 (1.02- 1.10)	0.60(0.58- 0.62)	0.87 (0.83- 0.92)	0.83 (0.78-0.88)
Birth Cohort (CI95%)					
1905-1909	0.25 (0.17- 0.38)	0.48 (0.40- 0.57)	1.007 (0.87- 1.15)	0.63 (0.49 -0.80)	0.72 (0.52- 1.012)
1910-1914	0.29 (0.20- 0.42)	0.52 (0.45- 0.61)	0.99 (0.88- 1.12)	0.65 (0.53-0.81)	0.75 (0.56 -1.002)
1915-1919	0.34 (0.25- 0.47)	0.56 (0.49- 0.64)	0.98 (0.89- 1.09)	0.69 (0.57- 0.82)	0.77 (0.60-0.99)
1920-1924	0.40 (0.31- 0.52)	0.61 (0.54 -0.67)	0.97 (0.89- 1.06)	0.72 (0.62- 0.83)	0.79 (0.64- 0.98)
1925-1929	0.47 (0.38- 0.58)	0.65 (0.60 -0.71)	0.96 (0.90- 1.03)	0.75 (0.67- 0.84)	0.82 (0.69- 0.97)
1930-1934	0.55 (0.46- 0.64)	0.71 (0.66- 0.75)	0.95 (0.91- 1.007)	0.79 (0.72- 0.86)	0.84 (0.74- 0.96)
1935-1939	0.64 (0.57- 0.72)	0.76 (0.73 -0.80)	0.95 (0.92- 0.98)	0.82 (0.78- 0.87)	0.87 (0.80-0.95)
1940-1944	0.74 (0.69- 0.80)	0.83 (0.81- 0.85)	0.95 (0.93- 0.97)	0.87 (0.84- 0.90)	0.90 (0.86- 0.95)
1945-1949	0.86 (0.84- 0.89)	0.84 (0.82-0.88)	0.97 (0.96- 0.97)	0.93 (0.91 -0.94)	0.94 (0.92 -0.97)
1950-1954	1				
1955-1959	1.14 (1.11- 1.17)	0.90 (0.89- 0.92)	1.05 (1.03- 1.06)	1.08 (1.06- 1.11)	1.07 (1.04 -1.09)
1960-1964	1.29 (1.22- 1.36)	1.11 (1.09- 1.12)	1.12 (1.08- 1.15)	1.20 (1.14- 1.26)	1.16 (1.09- 1.23)
1965-1969	1.43 (1.31 -1.56)	1.24 (1.20- 1.29)	1.15 (1.11- 1.19)	1.33 (1.25- 1.42)	1.25 (1.15- 1.36)
1970-1974	1.52 (1.37 -1.68)	1.40 (1.33- 1.47)	1.13 (1.09- 1.17)	1.49 (1.39- 1.59)	1.33 (1.23- 1.44)

* N (North), NE (Northeast), SE (Southeast), S (South) and CW (Center-West).

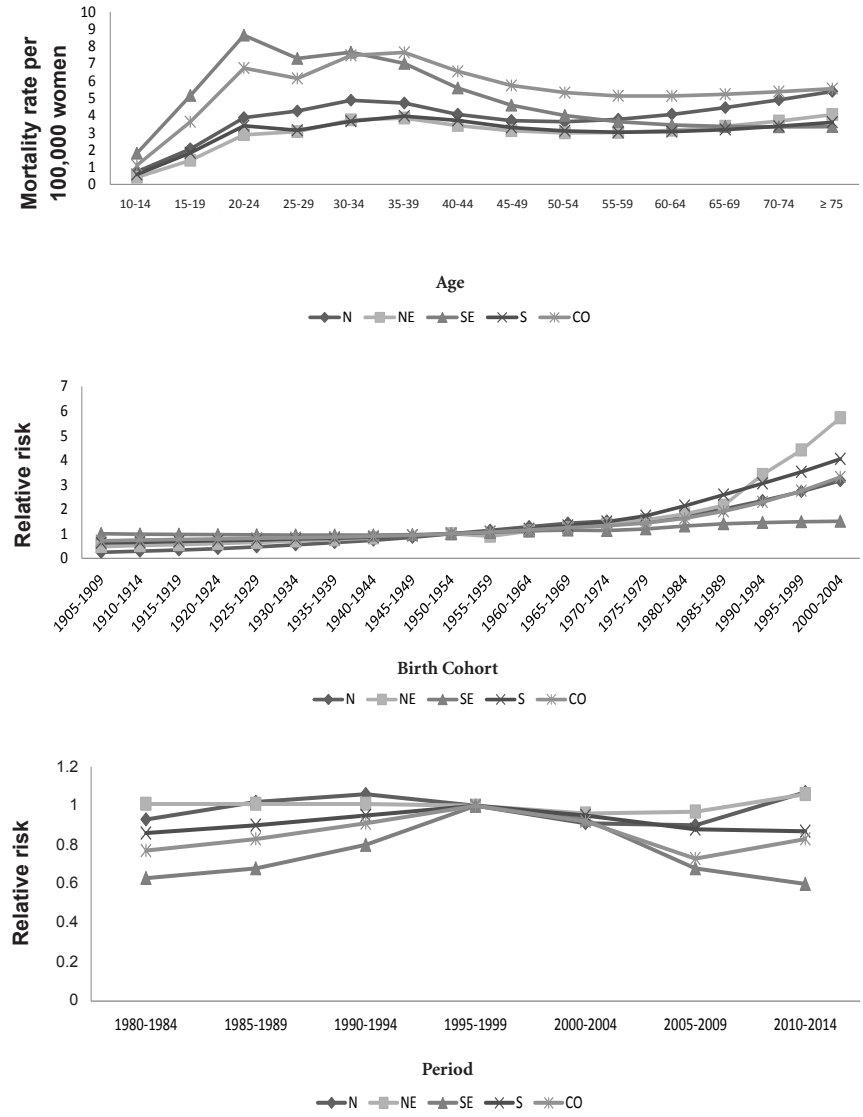

Figure 4. Adjusted results for the APCa model for homicide mortality among women in the Brazilian geographic regions from 1980 and 2014.

[a] The so-called APC (age-period-cohort) models take into account the interaction between age, period and birth cohort.
N = North; NE = Northeast; SE = Southeast; S = South and CW = Center-West.

na[29], Colombia[29]and Mexico[29]. Deaths occurring at this stage of life cause significant negative socio-economic impact, as many potential years of life are lost. They also impose a burden on legal and prison systems and public health, causing inordinate physical and psychological suffering for the relatives of victims[15,30,31].

The stationary trend observed for the mortality rates among women in the Southeast should be analyzed with caution, given that there is a rise in the number of deaths associated to events of undetermined intent. This could mean that female homicide rates may be underestimated in the region. Similarly, homicide mortality

rates among women in the Northeast may also be underestimated, given the rise in mortality rates associated to events of undetermined intent, which could signal problems in the registration of deaths due to external causes. It is worth stressing that, in percentage terms, deaths related to events of undetermined intent have reduced with time in Brazil, but this has been occurring at different rates in the various geographic regions. The Northeast and Center-West saw the smallest reductions during the 2009 to 2013 period. They were strongly influenced by the relative increase in the number of cases in the State of Pernambuco (72.6%) and in the Federal District (228.2%)[13].

The analysis of period effects after adjustments for age and birth cohort revealed that there was an improvement in the risk of homicide-related deaths among women living in the Center-West, South and Southeast regions in relation to the reference period. In the South and Southeast regions, this reduction has been continuous, with the lowest risk occurring in the last period analyzed (2010 to 2014). In the other regions, however, no defined pattern was observed. Nevertheless, it is important to draw attention to the situation in the Northeast, where there was no reduction in the risk of homicide-related deaths during the 2005 to 2014 period.

Results observed in the South and Southeast may be a reflection of the reductions in structural violence that occurred in these regions, especially during the 2000s. According to some authors, this was the result of wide-reaching public policies and specific public security policies such as the Disarmament Campaign[5,29]. In the other regions, there was an increase in structural violence, the so-called 'interiorization' (in Brazil, the spread of a phenomenon from the metropolis to the hinterlands) of violence. According to Meneghel and Hirata[18], there is a correlation between urban (structural) and gender violence. The study shows that during the 2003 to 2007 period, the Brazilian states with the highest rates of urban violence also saw higher rates of femicide.

The disparities observed in the evolution of rates and in the effect of period on femicide-related mortality rates in the Brazilian geographic regions may be associated to the difficulties in enforcing the Maria da Penha law, given the small number of specialized services to meet demands, which may corroborate the fact that no reduction in the rates of homicide mortality among women were observed[15,17].

A progressive reduction in the risk of death was observed in the Brazilian regions with a larger number of specialized services for protecting women suffering from violence. Within this context, the North and Northeast regions stand out, as there was no reduction in the risk of homicides among women in the last period analyzed, despite the fact that the Maria da Penha Law was adopted in 2006. The mere existence of a law does not result in significant changes in practice, if no efforts are made to change a patriarchal culture in which gender asymmetries are considered normal. It is important to ensure that efforts are made to train human resources to assist women suffering from violence, otherwise, these professionals will often end up contributing to a vicious cycle of domestic and institutional violence[5,6,15,31].

Another factor that must be considered when evaluating the results of this study is the quality of information about deaths due to external causes. The upward trend and the (positive or negative) risk of death observed in the mortality rates in these places may be a reflection of both the real increase in the number of homicide-related deaths among women and the effect of a period of improvement in death recordings, given that there has been a reduction in death rates associated to events of undetermined intent in all regions, except for the Southeast and the Northeast[32].

With regard to birth cohort effects, the study showed a significant increase in the rates and the risk of death among the younger birth cohorts. These findings coincide with results in the United States[26], where there was an increase in the risk of death both for women and men born from 1965 onward, which was responsible for an increase in homicides from 1985 to 1994. In Brazil, there was also a rise in mortality risk for both sexes. A study by Araújo Júnior[33] shows the differences in birth cohort effects when Brazilian states are analyzed from 1981 to 1996. In the states where the trend in homicide rates seems to rise, the cohort effect shows an upward trend, whereas in the states with a reduction in rates, the trend is downward. The findings of all these studies are in line with the fact that the age-crime slope does not change in relation to period, locality, type of crime or sex.

Some phenomena taking place in Brazil and the world can elucidate these results. The 1950s and 1960s were periods when the world was influenced by the so-called *baby boom* - characterized by the high number of children born after the second world war (also known as war babies), with a consequent increase in the absolute and proportional number of young people in the following decades. Changes in cohort size can greatly in-

fluence the volume of crime, given that the older cohorts have more restricted life opportunities[33].

In Brazil, the phenomenon of the increase in size of young cohorts coincided with the acceleration in urbanization and the growth of badly-planned cities to which large parts of the population migrated. People arrived from rural and less developed regions and were pushed to the peripheries of cities. After more than 50 years, the social facilities and services needed for survival and leading a decent life are still precarious in these places[34]. The urbanization and industrialization of Brazil came hand in hand with great inequality. During the military dictatorship, in order to implement the capitalist model, a large part of the population was excluded from the benefits brought about by the ensuing development. Historical inequalities were reproduced and intensified, gaining visibility within urban spaces and generating conflicts which were expressed in different forms of violence, including gender violence[5,12,18,29]. Furthermore, the most socially vulnerable regions are more exposed to the powerful influence of organized crime and drug trafficking, increasing structural violence and, consequently, domestic violence[5,12,18].

Thus, the protective effect against female homicides observed for women born until the 1955-1959 period ceased. The relative risk for women born from the 1960s onward is greater than 1, peaking with the cohort born between 2000 and 2004. In 2014, this cohort was between 10 and 14 years of age.

Another hypothesis is that the younger generation of men, especially in the most socially vulnerable regions, are more exposed to alcohol and drug abuse and, therefore, are more likely to become victims and perpetrators of violence, including gender violence[5,6,11,26]. This thesis is corroborated by systematic review studies that have shown that when a partner is a heavy alcohol user, women are more likely to become victims of fatal and non-fatal domestic violence[9,11,35].

Furthermore, changes promoted by the 1960s and 1970s sexual and behavior revolutions questioned inequalities and traditional gender relations. They also criticized the role historically expected of women within a patriarchal society, which may have increased the exposure of some women to gender violence. According to Bandeira[7] feminine resistance to the patriarchal culture puts pressure on women because they are outside the predominant heteronormativity. Any feminine behavior that questions the established order, for example, separation, may be punished, even by death[5,7,16,18]. Within this context, a study was conducted in Brazil that identified lower mortality rates in the states with higher fertility rates. The authors argue that changes in gender roles are a risk factor for homicide-related deaths among women[18].

The present study offers a valuable contribution by providing an evaluation of the age-period-birth cohort effects in homicide related mortality among women in the different Brazilian geographic areas, allowing for an understanding of temporal trends and enabling the development of hypotheses for this evolution.

However, the disparities between the different Brazilian regions in relation to the quality of death records in the period analyzed are well-known. Therefore, this study also sought to analyze rates associated to events of undetermined intent, because its authors were aware that events recorded in this way interfere with the homicide related deaths trends.

Furthermore, it is also important to highlight the limitations related to the APC model, given it is still in development and there is no consensus in the literature on the best methodology to overcome the problem of the inability to identify and estimate the full model. Therefore, the findings vary according to assumptions used to construct the model[21-23].

Conclusion

This study confirmed an upward trend in femicide mortality in all Brazilian geographic regions, except for the Southeast, as well as an increase in the risk of death due to femicide in cohorts born from the 1960s onward in all geographic regions.

Upward trends will continue, unless measures are taken to increase public spending to combat violence against women, by increasing the number of shelters, women's police stations and educational measures in order to train health and legal professionals, as well as increasing the number of police officers so that they can assist these women in an appropriate way and steer them toward protective services. Similarly, protective and punitive measures provided in the Maria da Penha law should be enforced.

In addition, a wide-reaching discussion on gender inequalities in Brazilian society should take place, in particular within the school environment, at all levels from pre-school to university. It is important to highlight that discussions on gender are part of the National Education

Plan. However, they have been removed from the municipal education plans of many municipalities, particularly due to intense pressure applied by religious blocs in legislative chambers, which once more reflects the patriarchal and chauvinistic nature of Brazilian society.

Collaborations

ER Souza, KC Meira, AP Ribeiro, J Santos, TC Simões and RM Guimarães took part in the study design. LF Borges collected data and calculated all the rates and set up the database. TC Simões, KC Meira and RM Guimarães assisted with the analysis, description and discussion of statistics. ER Souza, KC Meira, AP Ribeiro, J Santos, LV Oliveira and LF Borges also helped in the organization and critical analysis of the text. All authors analyzed and approved the final version of this article.

References

1. Gomes ICR. Enfrentamento de mulheres em situação de violência doméstica após agressão. *Revista Baiana de Enfermagem* 2014; 28(2):134-144.
2. Edelstein A. Culture transition, acculturation and intimate partner homicide. *Springer Plus* 2013; 2(338):1-12.
3. Costa MC, Lopes MJM, Soares JSF. Violência contra mulheres rurais: gênero e ações de saúde. *Esc. Anna Nery* 2015; 19(1):162-168.
4. World Health Organization (WHO). *Multi-country study on womens´s health and domestic violence against women. Initial results on prevalence, health outcomes and women´s responses*. Geneva: WHO; 2011.
5. Garcia LP, Freitas LRS, Silva GDM, Hofelmann DA. Estimativas corrigidas de feminicídios no Brasil, 2009 a 2011. *Rev Panam Salud Publica* 2015; 37(4/5):251-257.

6. Meneghel SN, Ceccon RF, Hesler LZ, Margarites AF, Rosa S, Vasconcelos VD. Femicídios: narrativas de crimes de gênero. *Interface (Botucatu)* 2013; 17(46):523-533.
7. Bandeira L. Três décadas de resistência feminista contra o sexismo e a violência feminina no Brasil: 1976 a 2006. *Sociedade e Estado* 2009; 24(2):401-438.
8. Leites GT, Meneghel SN, Hirakata VN. Homicídios femininos no Rio Grande do Sul, Brasil. *Rev. bras. Epidemiol* 2014; 17(3):642-653.
9. Aldridge ML, Browne. Perpetrators of spousal homicide: a review. *Trauma, Violence & Abuse* 2003; 4(3):256-257.
10. Garcia L, Soria C. Homicides and intimate partner violence: a literature review. *Trauma, violence, & abuse* 2007; 8(4):370-383.
11. Eckhardt K, Pridemore WA. Differences in female and male involvement in lethal violence in Russia. *J Crime Justice* 2009; 37(2):55-64.
12. Wright MW. Necropolitics, narcopolitics, and femicide: gendered violence on the Mexico-U.S. border. *Signs* 2011; 36(3):707-731.
13. Waiselfisz JJ. *Mapa da Violência 2015: homicídio de mulheres no Brasil*. Brasília: Flacso; 2015. [acessado 2016 nov 20]. Disponível em: http://www.onumulheres.org.br/wp-content/uploads/2016/04/MapaViolencia_2015_mulheres.pdf
14. Albarran J. Referentes conceptuales sobre femicidio / feminicidio: Su incorporación en la normativa jurídica Venezolana. *Comunidad y Salud* 2015; 13(2):75-80.
15. Garcia LP, Freitas LRS, Hofelmann DA. Avaliação do impacto da Lei Maria da Penha sobre mortalidade de mulheres por agressões no Brasil, 2001-2011. *Epidem. serv. Saúde* 2011; 22(3):383-394.
16. Saffioti HIB. Já se mete a colher em briga de marido e mulher. *São Paulo em Perspectiva* 1999; 13(4):81-92.
17. Garcia LP, Silva GBM. *Mortalidade de mulheres por agressão no Brasil: perfil e estimativas corrigidas (2011-2013)*. Rio de Janeiro: Instituto de Pesquisa Econômica Aplicada (IPEA); 2016. Texto para discussão.
18. Meneghel SN, Hirata VN. Feminicídio: homicídios femininos no Brasil. *Rev Saude Publica* 2011; 45(3):564-574.
19. Brasil. Lei nº 13.104, de 9 de março de 2015. Altera o art. 121 do Decreto-Lei no 2.848, de 7 de dezembro de 1940 - Código Penal, para prever o feminicídio como circunstância qualificadora do crime de homicídio, e o art. 1º da Lei nº 8.072, de 25 de julho de 1990, para incluir o feminicídio no rol dos crimes hediondos. *Diário Oficial da União* 2015; 10 mar.
20. Meinhardt YM, Maia GF. Não é uma rede que flui - da invisibilidade às possibilidades de novos modos de cuidar: a violência contra as mulheres na saúde mental. *Barbarói* 2015; 44(Ed. esp.):120-136.
21. Holford TR. Understanding the effects of age, period, and cohort on incidence and mortality rates. *Annu Rev Publ Health* 1991; 12:425-457.
22. Holford TR. The estimation of age, period and cohort effects for vital rates. *Biometrics* 1983; 39(2):311-324.
23. Robertson C, Gandini S, Boyle P. Age-Period-Cohort Models: A Comparative Study of Available Methodologies. *J Clin Epidemiol* 1999; 52(6):569-583.
24. Brasil. Ministério da Saúde (MS). *Agenda Nacional de Prioridades e Pesquisa em Saúde*. 3ª ed. Brasília: MS; 2011.
25. Conceição GMS, Saldiva PHN, Singer JM. Modelos MLG e MAG para análise da associação entre poluição atmosférica e marcadores de morbi-mortalidade: uma introdução baseada em dados da cidade de São Paulo. *Rev. Bras. Epidemiol* 2001; 3(4):206-219.
26. Shahpar C, Li G. Homicide Mortality in the United States, 1935-1994: Age, Period, and Cohort Effects. *Am J Epidemiol* 1999; 150(11):1213-1222.
27. Brasil. Ministério da Saúde (MS). *Viva: vigilância de violências e acidentes, 2008 e 2009*. Brasília: MS; 2010.
28. Deslandes SF, Gomes R, Silva CMPF. Caracterização dos casos de violência doméstica contra a mulher atendidos em dois hospitais públicos do Rio de Janeiro. Cad *Saude Publica* 2000; 16(1):129-137.
29. Souza ER, Melo NA, Silva JG, Franco SA, Alazraqui M, González-Peres GJ. Estudo multicêntrico da mortalidade por homicídios em países da América Latina. *Cien Saude Colet* 2012; 17(12):3183-3193.
30. Fernandes MCC. A tutela penal patriarcal: por que a criminalização do feminicídio não é uma conquista para o feminismo? *Revista Transgressões-Ciências criminais em debate* 2015; 3(1):131-149.
31. Vilella WV, Vieira TF, Vieira ML, Vianna LAC, Sala DCP, Lima LFP, Oliveira EM. Ambiguidades e contradições no atendimento de mulheres que sofrem violência. *Saúde Soc*. 2011; 20(1):113-123.
32. Alazraqui MA, Spinelli H, Zunino MG, Souza ER. Calidad de los sistemas de información de mortalidad por violencias en Argentina y Brasil - 1990-2010. *Cien Saude Colet* 2012; 17(12):3279-3288.
33. Araujo Júnior AF. Decomposição dos efeitos idade, período e coorte de taxas de homicídios: uma análise por Estados – 1981-1996. *Economia & Gestão* 2002; 2(3):91-108.
34. Castellanos PL. Epidemiologia, Saúde Pública, Situação de Saúde e Condições de Vida. Considerações Conceituais. In: Barata RB, organizador. *Condições de Vida e Situação de Saúde*. Rio de Janeiro: Ed. Abrasco; 1997. p. 31-75.
35. Sharps PW, Campbell J, Campbell D, Gary F, Webster D. The Role of Alcohol Use in Intimate Partner Femicide. *Am J Addict* 2001; 10(2):122-135.

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