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Hidden deaths: corrected estimates of homicides in Bahia, Brazil, 1996-2015

Muertes ocultas: estimaciones corregidas de homicidios en Bahía, Brasil, 1996-2015

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ABSTRACT The objective of this study was to correct and estimate five-year homicide rates in Bahia, Brazil, for the 1996-2015 period. An ecological study of the homicides was carried out using official data from the Mortality Information System of the Ministry of Health. Deaths due to assault are classified in the codes X85-Y09 of the *International Classification of Disease* 10th Revision (ICD-10). A proportional redistribution of deaths classified as events of undetermined intent (Y10-Y34) was carried out and mortality correction factors were applied. In the analyzed period, 67,599 homicides were registered in the Mortality Information System; after the second correction, 88,429 homicide deaths were estimated. Comparing the official and adjusted figures, there was an underreporting of 30.8%. The highest corrected homicide rates were observed in the eastern region, in Pojuca (129.8 homicides per 100,000 inhabitants), Lauro de Freitas (117.7) and Simões Filho (114.3); in the southern region, in Santa Luzia (121.4), Valença (87.6) and Itabuna (86.5); and in the far south, Santa Cruz Cabrália (128.2), Itabela (113.3) and Porto Seguro (106.8). After correction, there was an increase in homicides in all of the five-year periods in the municipalities analyzed, which resulted in an even higher mortality rate.

KEY WORDS Homicide; Mortality; Estimation Techniques; Health Information Systems; Temporal Distribution; Brazil.

RESUMEN El objetivo del estudio fue corregir y estimar las tasas quinquenales de homicidios en Bahía, Brasil, en el período 1996-2015. Se realizó un estudio ecológico de los homicidios a partir de datos oficiales del Sistema de Información sobre Mortalidad del Ministerio de Salud. Estas defunciones por agresiones corresponden a los códigos X85-Y09 de la *Clasificación internacional de enfermedades* 10ª revisión (CIE 10). Se realizó una redistribución proporcional de las defunciones clasificadas como eventos de intención indeterminada (Y10-Y34) y se aplicaron factores de corrección de la mortalidad. En el período analizado, se registraron 67.599 homicidios en el Sistema de Información sobre Mortalidad y, luego de la segunda corrección, se estimaron 88.429 homicidios. Al comparar los números oficiales a los ajustados, se observó una subnotificación del 30,8%. Las mayores tasas de homicidio corregidas se observaron en la región este, en Pojuca (129,8 homicidios por 100.000 habitantes), Lauro de Freitas (117,7) y Simões Filho (114,3); en la región sur, en Santa Luzia (121,4), Valença (87,6) e Itabuna (86,5); y en el extremo sur, en Santa Cruz Cabrália (128,2), Itabela (113,3) y Porto Seguro (106,8). Luego de las correcciones, se observó un incremento de los homicidios en todos los quinquenios en los municipios analizados, lo que resultó en una tasa de mortalidad aún más elevada.

PALABRAS CLAVES Homicidio; Mortalidad; Técnicas de Estimación; Sistemas de Información en Salud; Distribución Temporal; Brasil.

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INTRODUCTION

Homicide, as an expression of interpersonal violence and a specific cause of death, has been widely discussed in the area of collective health since it is an important social and health indicator. Its impacts, magnitude, and direct and indirect, individual and collective, and micro and macro social consequences have been highlighted in debates as well as local and international publications.[1]

According to the 2014 World Health Organization (WHO) report, 10% of the homicides in the world are committed in Brazil.[2] National data[3] shows that in 2015 in Brazil there were 58,138 deaths due to homicide, of which 39.6% (22,999 cases) took place in the northeast region of the country. In the same year the state of Bahia recorded the highest absolute number of homicides (5,787) in Brazil, representing 25.2% of the homicide deaths in the northeast region, ahead in absolute numbers of more populous states, such as São Paulo (5,150 homicides) and Rio de Janeiro (4,786 homicides).

Some decades earlier, the same official records showed another reality.[3] In 1996 the state had a total of 1,883 deaths due to homicide in 1996, a figure significantly lower than that of states which it now surpasses: the same year São Paulo registered 12,320 cases, while Rio de Janeiro and Pernambuco registered 8,030 and 3,022 homicides respectively.

According to the *Mapa da Violência 2014* [Map of Violence 2014],[4] between 1998 and 2012, Bahia rose from the 22nd to the 5th position in the ranking of Brazilian states according to homicide rate (per 100,000 inhabitants) in the general population. In this 14-year period, the homicide rate in the state jumped from 9.7/100,000 inhabitants in 1998 (1,271 cases) to 41.9/100,000 inhabitants in 2012 (5,936 cases).

A publication by the Ministry of Justice showed Bahia to be the state with the highest concentration in absolute numbers of homicides in 2014. Bahia registered 5,450 homicides that year, representing more than 10% of all the homicide cases among Brazilian states. The report highlights that Bahia's homicide rate per 100,000 inhabitants was also elevated, the sixth highest in the country. According to the Ministry of Justice's National Pact for the Reduction of Homicide [*Pacto de Redução de Homicídios*] (PNRH), cited in the same document, Bahia had the highest number of municipalities including in this pact (ten municipalities), which covered a total of 81 cities in the country.[5]

In relation to the epidemiological profile of external causes, the Ministry of Health showed in 2010 that male youth and young adults in the 15-39 year age group living in the Northeast region were most vulnerable to death by homicide in all the regions of Brazil. Homicide represented 36.8% of the total deaths by external causes in 2009 and was the first cause of death for the above mentioned age group.[6]

On the other hand, in the ranking of the quality of information regarding violent mortality in Brazilians states, between 2007 and 2010 Bahia had the second highest rate of deaths of undetermined intent in the country. Moreover, this state has the highest difference between the growth of the official and estimated/corrected homicide rates for the 1996-2010 period.[7] This means that a considerable part of the homicides which occur in Brazil, and more specifically in the state of Bahia, are not counted in the official statistics and a large proportion of those captured by vital statistics cannot be classified as homicides, since the intention which led to the violent death is not known.

In relation to the underlying cause of death, the elevated number of deaths classified as external causes of undetermined intent is an obstacle to the construction of more reliable indicators of mortality and has an important weight in limiting inferences made using these health indicators.[8] In other words, it is not possible to move forward in the creation of a profile of the homicides, variables characterizing the deaths and the victims, or other variables in the study of mortality, without understanding the limitation caused by the under-notification of deaths in relation to the

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classification/accounting of the underlying cause of death, above all in violent causes, such as homicides.

In relation to this groups of deaths, it is known that they result from an injury (therefore an external cause), but the intentionality is not specified, therefore they receive the denomination of events of non-determined intent.[9] The greater percentage of this group in the set of external causes signifies less scrutiny regarding the underlying cause of death and less adequate classification of deaths in the specific groups of external causes (such as homicide, suicide, and accident) where intentionality is identified.

In this way, errors in the process of classification or elucidation of information referring to the underlying cause of death both distort and underestimate certain results, such as altering the epidemiological profiles referring to a specific cause of death. Therefore, data analyses based on information systems without any correction can in some cases mask the reality and reduce the reliability of findings.[10]

In relation to the problem of the cause of death, in mortality studies the indetermination of a cause of death is an important obstacle which can significantly alter the mortality rate for specific causes. This makes it difficult to outline the epidemiological profile of homicides, for example, and subsequently imposes a barrier in "thinking about" or "applying" strategies to deal with the problem, allocate resources, and draft policies. It is therefore extremely important to take into account the limitations resulting from indetermination of the cause of death.[11]

For this reason, to determine the underlying cause of death when dealing with deaths due to homicide it is necessary to take into account the methods used in the fatal assault, in addition to the injuries, trauma, and wounds resulting from the inflicted action. Whenever the cause of death is assault inflicted by another person, the underlying cause should be selected in accordance with the relevant code. For prevention strategies to be feasible, it is not enough to simply know the nature of the lesions, for example, cranial traumatism, wounds caused by firearms, or others of undetermined intent;[11] it is crucial that the types of assault be known (for example by handgun discharge; rifle, shotgun and larger firearm discharge; sharp object).

Given the above situation, the aim of this study is to estimate corrected five-year homicide rates through the proportional redistribution of deaths and the application of correction factors, so as to offer more reliable mortality indicators for Bahia in the 1996-2015 period.

MATERIALS AND METHODS

An ecological study of deaths due to homicide in the state of Bahia was carried out using data from the Mortality Information System [*Sistema de informação em saúde*] (SIM) administered by the Information Technology Department of the National Health System [*Departamento de Informática do Sistema Único de Saúde*] (DATASUS) of the Ministry of Health,[3] for the period 1996-2015.

The deaths were aggregated into four five-year periods (quinquennials) to reduce the random fluctuation of the calculated indicators and instability in the municipal analysis when using restricted temporal and spatial foci.[10] The quinquennial periods are presented in the following way: 1996 to 2000 (Q1), 2001 to 2005 (Q2), 2006 to 2010 (Q3), 2011 to 2015 (Q4).

The study included cases of homicide (assaults) classified as X85 to Y09 according to the 10th Revision of the International Classification of Diseases (ICD-10), referring to the population living in the 417 municipalities of the state of Bahia, and using the population estimates of the Brazilian Institute of Geography and Statistics [*Instituto Brasileiro de Geografia e Estatistica*] (IBGE) for the denominators of mortality rates in the study period.[9,12] For the analysis, the municipalities were grouped into nine health macro-regions which, for the effects of the health care regionalization process, are delimitated by demographic and socioeconomic characteristics: east-central,

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north-central, far south, east, northeast, north, west, southwest, and south.

Considering that Bahia is one of the seven states in the country with the highest number of violent deaths of undetermined intent, the deaths classified in this group of events (codes Y10-Y34) were proportionally redistributed, with the correction factors applied to the mortality rates afterwards.

This redistribution was based on the other external cause groups: transport accidents (V01-V99), other external causes of accidental injury (W00-X59), intentional self-harm (X60-X84), assault (X85-Y09), legal interventions (Y35), and complications of medical and surgical care (Y40-Y89). It involved the following phases: 1) the calculation of the proportion of deaths due to assault (as well as the other groups of causes) in relation to the total deaths due to external causes of determined intent (excluding undetermined causes); 2) the multiplication of this proportion by the number of deaths of undetermined intent, obtaining a proportional share of deaths due to assault in relation to deaths due to undetermined causes; 3) the sum of the proportional share and the official number of deaths due to assault registered in the SIM. The result of these calculations corresponds to the number of deaths due to homicide in the first stage of the correction.

Next, the correction factors were applied (multiplied) to the corrected deaths due to homicide from the first stage, in accordance with the study of Szwarcwald et al.,[13] who estimated mortality correction factors for Brazilian municipalities, states, and macro-regions. After this procedure, the number of deaths resulting from the second correction stage was obtained.

The correction factors used took into account the population size of the municipalities in 2010, with categories that also followed the classification of Szwarcwald et al.[13]: up to 20,000 inhabitants (small); 20,001 to 50,000 inhabitants (small/medium); 50,001 to 200,000 inhabitants (medium/large); over 200,000 inhabitants (large).

The mortality rates due to homicide were calculated for each year of the studied period. For the numerator the corrected number of deaths from the second stage was used, that is, after multiplication by the correction factors; for the denominator the resident population of each year of the study was used. In this way, corrected mortality rates were obtained. Next, the average rate of homicide per 100,000 inhabitants was calculated for each five-year period, using a simple mathematical average. In the presentation of the results, the 20 municipalities with the highest rates of homicide were ranked according to the last five-year period (Q4), from 2011-2015. Finally, for each health macro-region the three municipalities with highest rates were listed, referring to the last five-year period.

Initially TabNet and TabWin were used for the data tabulation, construction of the database, and the calculation of rates, estimates, and corrections. The data were then consolidated in Excel© and processed using Statistical Package for Social Science (SPSS©) version 23. Only data from the public domain and with unrestricted access was used, without the identification of individuals, in accordance with Resolution 466/2012 of the National Health Council of the Ministry of Health.

RESULTS

In Bahia, 67,599 homicides were officially registered by the SIM in the period 1996-2015, resulting in a crude rate of 24.4 deaths per 100,000 inhabitants. In the first correction, after the proportional redistribution of deaths of undetermined intent, this total rose to 78,948 homicides.

In the second correction, after applying the correction factors, 88,429 deaths due to homicide were estimated (Table 1), with a corrected mortality rate of 31.1 deaths per 100,000 inhabitants for the last five-year period (Q4) (Table 2). Comparing the official number of deaths with those of the second correction, a sub-notification of 30.8% (a difference of 20,830 deaths) was found for the data obtained directly from the SIM, for all of

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the municipalities of the state and the total period of the analysis.

Looking at the quinquennial periods, the second (Q2), 2001-2005, had the highest underestimation of deaths (50.2%), with a difference of more than 5,000 homicides between the official data (SIM) and the number of deaths estimated in the second correction.

In ranking the 20 municipalities with the highest corrected homicide rates in the last five-year period (Q4), the 2011-2015 period, it can be seen that these are located in the east, far south, and south health macro-regions (Table 2). The three municipalities with the highest rates in each of these regions were as follows: in the east, the municipalities of Pojuca (129,8 homicides per 100,000 inhabitants), Lauro de Freitas (117.7) and Simões Filho (114.3); in the south, Santa Luzia (121.4), Valença (87.6) and Itabuna (86.5); and in the far south, the municipalities of Santa Cruz Cabrália (128.2), Itabela

Table 1. Absolute and corrected number of homicides by five-year period, in the 20 municipalities with the highest homicide rates. State of Bahia, Brazil, 1996-2015.

State / Municipalities	Number of homicides												Correction Factor[d]
	SIM[a]				First Correction[b]				Second Correction[c]				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Bahía	7,071	10,464	22,179	27,885	7,932	14,106	25,878	31,032	8,868	15,714	28,864	34,983	-
Pojuca	13	17	44	186	16	23	51	193	20	27	61	233	1.21
Santa Cruz Cabrália	8	15	51	147	8	17	55	147	10	21	67	178	1.21
Santa Luzia	4	13	41	59	4	15	44	67	5	18	54	82	1.22
Lauro de Freitas	172	183	627	879	202	280	746	947	226	314	835	1,061	1.12
Simões Filho	64	155	442	592	69	234	527	647	77	262	590	725	1.12
Itabela	36	49	69	123	39	53	75	142	47	64	91	172	1.21
Mata de São João	22	36	57	185	25	48	69	197	30	58	84	239	1.21
Porto Seguro	103	211	526	645	110	225	562	656	123	252	629	735	1.12
Eunápolis	109	161	410	414	115	175	440	480	129	196	493	538	1,12
Valença	56	54	166	358	58	61	184	367	65	69	206	411	1.12
Teixeira de Freitas	101	120	345	517	111	164	420	578	124	184	470	648	1.12
Itabuna	246	442	794	816	261	499	837	859	280	534	895	919	1.07
Uruçuca	28	30	57	69	32	39	61	72	39	47	74	88	1.22
Amélia Rodrigues	8	6	43	80	8	10	55	89	10	12	67	108	1.21
Dias d'Ávila	32	52	205	258	38	76	245	273	42	85	274	306	1.12
Itapebi	12	17	23	33	13	18	28	37	15	22	34	45	1.22
Vera Cruz	14	10	83	133	17	13	91	140	21	15	110	169	1.21
Barro Preto	4	2	11	21	4	2	11	21	5	2	13	26	1.22
Candeias	55	98	199	274	64	150	250	305	71	169	280	342	1.12
Camaçari	135	284	590	929	160	412	714	995	171	440	763	1,064	1.07

Source: Own elaboration based on data from the Mortality Information System of the Information Technology Department of the National Health System (SIM/DATASUS).

[a]Number of homicide deaths in the five-year period obtained directly from the SIM, without correction.

[b]Number of homicide deaths corrected via the calculation of the proportion of deaths due to assault in relation to total deaths due to external causes, multiplied by the number of deaths of undetermined intent, added to the official number of deaths due to assault in the SIM, resulting in the number of deaths due to homicide obtained in the first stage of the correction.

[c]Number of homicide deaths obtained in the first stage of the correction multiplied by the correction factors, taking into account the population size of municipalities in 2010.

[d]Correction factors based on Szwarcwald *et al.*[13] according to municipal population size.

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(113.3) and Porto Seguro (106.8). Among the 20 municipalities shown in Table 2, only Amélia Rodrigues is part of a health macro-region different from those already mentioned. This municipality belongs to the east-central region and its corrected homicide rate is 83.7/100,000 inhabitants.

Another finding is that in some municipalities the rates increased enormously between the first (Q1) and last quinquennial periods (Q4). Small municipalities such as Santa Cruz Cabrália (where the rate oscillated between 10.1 and 128.2 deaths per 100,000) and Santa Luzia (which oscillated between 6.6 and 121.4) had an increase of more than 1000% between Q1 and Q4. Larger municipalities, such as Simões Filho, also rose by over 400%, increasing their homicide rate fivefold between the initial and final quinquennial periods, varying from 19.2/1000,000 in Q1 to 114.3/100,000 inhabitants in Q4 (Table 2).

The state of Bahia had a total underestimation of data obtained from the SIM of 25.5% for the 2011-2015 period (Q4). Although the western region has the lowest corrected mortality rate for homicide (12.2/100,000 inhabitants) in Q4, it was the one which suffered the greatest effect of the correction process, with a variation of 124.1% between the uncorrected number of deaths and the total deaths after the second correction. One of the municipalities in this region, Bom Jesus da Lapa, even duplicated the number of homicides with the corrections (Table 3).

In Table 3, in the ranking of homicide deaths and homicide mortality rates according to health macro-regions, other municipalities emerge as important in terms of population

Table 2. Corrected homicide rate, by quinquennial, macro-region and population size, in the 20 municipalities with the highest rates of homicide. State of Bahia, Brazil, 1996-2015.

State/ municipalities	Macro-region	Population Size	Corrected homicide rate[a]			
			Q1	Q2	Q3	Q4[b]
Bahía	-	-	7.4	12.2	21.7	31.1
Pojuca	East	Small/Medium	16.1	19.9	38.8	129.8
Santa Cruz Cabrália	Far South	Small/Medium	10.1	13.6	44.4	128.2
Santa Luzia	South	Small	6.6	23.6	73.1	121.4
Lauro de Freitas	East	Medium/Large	43.8	48.5	107.6	117.7
Simões Filho	East	Medium/Large	19.2	51.6	102.7	114.3
Itabela	Far South	Small/Medium	34.0	46.6	64.1	113.3
Mata de São João	East	Small/Medium	18.5	34.8	43.7	110.6
Porto Seguro	Far South	Medium/Large	33.3	41.9	97.0	106.8
Eunápolis	Far South	Medium/Large	28.9	44.1	100.7	100.1
Valença	South	Medium/Large	16.4	17.1	46.7	87.6
Teixeira de Freitas	Far South	Medium/Large	24.1	31.8	73.4	86.6
Itabuna	South	Large	30.1	53.2	85.8	86.5
Uruçuca	South	Small	34.5	58.2	86.9	84.2
Amélia Rodrigues	East-Central	Small/Medium	8.3	9.7	54.6	83.7
Dias d'Ávila	East	Medium/Large	20.7	34.0	92.9	83.4
Itapebi	Far South	Small	27.3	39.4	60.5	83.4
Vera Cruz	East	Small/Medium	14.1	9.2	59.8	83.3
Barro Preto	South	Small	14.9	6.1	40.0	80.3
Candeias	East	Medium/Large	20.2	42.2	67.8	78.9
Camaçari	East	Large	23.6	49.1	68.8	78.9

Source: Prepared by authors based on data from the Mortality Information System of the Information Technology Department of the National Health System (SIM/DATASUS).
[a]Calculation of five-year homicide rate, using as the numerator the number of deaths corrected and multiplied by correction factors (per 100,000 inhabitants), second correction.
[b]The quinquennial periods used were: 1996-2000 (Q1), 2001-2005 (Q2), 2006-2010 (Q3), 2011-2015 (Q4), with municipalities ranked by highest homicide mortality rate in the final five-year period (Q4).

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and absolute number of deaths due to homicide. Feira de Santana, Lauro de Freitas, Vitória da Conquista, and Itabuna were those with the highest number of homicides after the correction stages. In Feira de Santana, a municipality in the metropolitan region of the state, located in the east-central health macro-region, homicides rose from 1,297 (SIM data) to 2,045 cases (after correction), an underestimation of 57.7% in Q4.

Table 3. Corrected number of homicide deaths and homicide rates in the 20 municipalities with the highest homicide rates by macro-region. State of Bahia, Brazil, 2011-2015.

Municipality/ Macro-region	Number of homicides			Correction Factor[d]	Corrected Rate[e]
	SIM[a]	First Correction[b]	Second Correction[c]		
Bahia	27,885	31,032	34,983	-	31.1
East Central	2,723	3,721	4,180	-	24.2
Amélia Rodrigues	80	89	108	1.21	83.7
Terra Nova	39	41	49	1.22	73.8
Feira de Santana	1,297	1,911	2,045	1.07	69.2
North Central	998	1,054	1,253	-	26.4
Irecê	184	186	209	1.12	59.1
Presidente Dutra	32	32	39	1.22	54.0
Capim Grosso	51	57	69	1.21	48.8
Extreme South	2,595	2,837	3,263	-	66.6
Santa Cruz Cabrália	147	147	178	1.21	128.2
Itabela	123	142	172	1.21	113.3
Porto Seguro	645	656	735	1.12	106.8
East	12,313	13,397	14,707	-	47.1
Pojuca	186	193	233	1.21	129.8
Lauro de Freitas	879	947	1,061	1.12	117.7
Simões Filho	592	647	725	1.12	114.3
Northeast	1,538	1,634	1,922	-	34.2
Alagoinhas	483	512	573	1.12	76.7
Esplanada	99	103	125	1.21	70.8
Catu	154	160	180	1.12	66.6
North	1,502	1,558	1,796	-	28.3
Juazeiro	534	549	615	1.12	58.5
Rodelas	20	20	24	1.22	57.2
Paulo Afonso	254	266	298	1.12	51.7
West	295	563	661	-	12.2
São Félix do Coribe	26	34	41	1.22	57.6
Santa Maria da Vitória	34	53	64	1.21	31.3
Bom Jesus da Lapa	46	87	97	1.12	29.0
Southwest	1,947	2,050	2,335	-	15.8
Vitória da Conquista	845	886	948	1.07	57.7
Itororó	41	42	51	1.22	50.0
Itambé	39	41	50	1.21	43.0
South	3,974	4,218	4,866	-	45.1
Santa Luzia	59	67	82	1.22	121.4
Valença	358	367	411	1.12	87.6
Itabuna	816	859	919	1.07	86.5

Source: Own elaboration based on data from the Mortality Information System of the Information Technology Department of the National Health System (SIM/DATASUS).
[a]Number of homicide deaths in the five-year period obtained directly from the SIM, without correction.
[b]Number of homicide deaths corrected via the calculation of the proportion of deaths due to assault in relation to total deaths due to external causes, multiplied by the number of deaths of undetermined intent, added to the official number of deaths due to assault in the SIM, resulting in the number of deaths due to homicide obtained in the first stage of the correction.
[c]Number of homicide deaths obtained in the first stage of the correction multiplied by the correction factors, taking into account the population size of municipalities in 2010.
[d]Correction factors based on Szwarcwald *et al.*[13] according to municipal population size.
[e]Calculation of homicide rate for the quinquennial period, using as the numerator the number of deaths corrected and multiplied by correction factors (per 100,000 inhabitants) in the second correction.

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DISCUSSION

Homicide rates in Bahia and its municipalities, in accordance with the results of this study, had significant increases over the two decades analyzed. The adjustment in the total number of deaths between 1996 and 2015, after corrections, reached 100% in one Bahian municipality. It has been shown in one study that there was a growth of 242.1% in the number of homicides in Bahia between 2002 and 2012.[4] Therefore, the adjustment made to information on external causes and homicides based on events of undetermined intent with the aim of improving their quality is responsible for only part of the rising homicide rates in the state.[4]

An example which illustrates the latter is present in the findings of this study, which discovered a greater underestimation of deaths in the data referring to 2001-2005. In this period, according to Cerqueira,[7] there was also a higher proportion of deaths of undetermined intent. The author states that from 2007 to 2010, Bahia had the highest rate of such deaths (12.9/100,000 inhabitants) among Brazilian states with the exception of Rio de Janeiro (18.1/100,000 inhabitants). In addition, this work highlights that Bahia was the Brazilian state with the greatest difference between the growth of official and estimated homicide rates in the 1996-2010 period, in other words, when comparing the rates calculated based on SIM data and those after the correction of deaths taking into account the group of events of undetermined intent.[7]

In the period of this study the underestimation of deaths due to homicide in Bahia numbered more than 20,000 cases, which represented almost one third of the homicides officially registered in the state by the Mortality Information System. According to the Ministry of Justice,[5] Bahia registered the sixth highest homicide rate in the country, 36.0 per 100,000 inhabitants in 2014. In some municipalities in the state the rates are even higher: Porto Seguro (86.5/100.000), Simões Filho (84.3/100.000), Camaçari (77.1/100.000), Lauro de Freitas (77.1/100.000), Itabuna (69.0/100.000), Ilhéus (62.0/100.000), Feira de Santana (54.9/100.000), Juazeiro (49.4/100.000), Vitória da Conquista (47.9/100.000), and Salvador (43.6/100.000).

The ranking of homicide deaths and according to those that were highest in the last quinquennial period (Q4) corroborates both studies carried out locally, with the state of Bahia and its municipalities as the only units of analysis, and those that are nationally based.[4,14,15] The ranking method allowed previous five-year periods and the evolution of deaths over time to be taken into account, as well as focusing the analysis on more up-to-date data. Of the 417 municipalities in the state of Bahia, many stand out in the national scenario. Of the ten cities with more than 10,000 inhabitants that had the highest homicide rates in 2012, half were in Bahia; according to the *Mapa da Violência 2014*,[4] Mata do São João (149.3) occupied the second position, Simões Filho (131.0) the third, Ibirapitanga (123.4) the sixth, Itaparica (119.1) the eighth, and Porto Seguro (115.5) the tenth position in the country's ranking.

Other studies[14,15,16] have highlighted the intensification of this phenomenon. In certain parts of the state it is probably potentiated by the expansion of tourism and the re-emergence of the economy related to cocoa production, which attract migrants and generate opportunities, but also expand social problems and conflicts. Although the risk of death by homicide is widely spread across all of Bahia, in the coastal municipalities, those from the metropolitan region (east), and in the triangle formed by Porto Seguro, Vitória da Conquista, and Itabuna, the phenomenon has an alarming profile.

Noteworthy in this study is that it takes into account the population size of municipalities, both for the application of the correction factor and for the description and ordering of municipalities. Of the 20 municipalities highlighted, Itabuna and Camaçari were the only ones classified as large (over 200,000 inhabitants) in the ordering of the quinquennial homicide rates. There were also six small/medium municipalities, eight that were medium/large, and four that were small. Given that out of a total of twenty municipalities, eight are medium/large (50,001 to 200,000

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inhabitants), this could suggest that in these cities there exists more socio-economic inequality than in small and small/mid-sized ones. The medium sized municipalities tend to have an active but concentrated economy, and do not guarantee the services and opportunities existing in large municipalities. However, probably because they occupy this "place in the middle" they suffer the effects of local inequalities and heterogeneities.[17]

Corroborating this hypothesis, an ecological study of Brazilian municipalities revealed significant temporal increases in four-year homicide rates, especially in mid-sized municipalities, characterized by lower socio-economic development and greater economic inequality.[17,18] Even though the municipalities with larger populations and greater urbanization have higher homicide rates, the highest risks of homicide were observed in municipalities with greater social inequalities and intermediate levels of poverty and income.

However, many other factors need to be considered to understand this "seesaw" in the distribution of homicide rates among the cities of a determined region and the reasons for the increase in homicide in some locations and its decline in others.[15,17,19] It is not the focus of this study and its findings to discuss aspects referring to inequalities or the economic development of municipalities, but rather the possibility of correcting and estimating more reliable mortality rates.

Although measures have been adopted to reduce the instability of rates and to correct the number of deaths, it is believed that underestimation still persists in the years and municipalities studied, above all in the smaller municipalities or those which do not have a Forensic Medicine Institute [*Instituto Médico Legal*] or Death Verification Service [*Serviço de Verificação de Óbitos*].[10,20,21] Some propositions can be raised in relation to the low level of use of information technology in many smaller municipalities, the lack of qualified professionals, and work overload, not only of post-necropsy forensic experts, but also of doctors in hospital facilities (especially emergency ones) and other health services, who are responsible for identifying violent or suspicious deaths and sending the body to the Forensic Medicine Institute or Death Verification Service.[20,21]

Other factors which also contribute to the underestimation are clandestine cemeteries and the number of disappeared persons, which can cover up cases of homicide and legal interventions/deaths resulting from the action of police or other agents of the law/military.[20,21,22] Moreover, the increase in the coverage of deaths in Brazil, especially from 2000 onwards, occurred alongside the municipalization process, which incorporated municipalities and held them responsible for the procedures and processing of mortality data at a national level. The date from 1997 shows 56.2% coverage in the northeast, while the average for Brazil was 80%.[20,21]

In an analysis of the quality of Brazilian vital statistics in relation to homicides, Mello Jorge et al.[11] observed changes in the panorama of deaths due to external causes, showing that in 2000 in some areas of the country, total homicides were over five times what was declared in the official databases, after an active search for information among the primary sources in the Forensic Medicine Institute clarifying the underlying cause of death, not transcribed in the official death certificates.

Furthermore, the difficulty establish linkages between information systems or secondary data bases which deal with violence in Brazil and its states, such as data from public safety and health sectors, prevents (or at least greatly hinders) the possibility for complementarity of such systems with the SIM, with the perspective of reducing the underestimation of deaths.[23]

Another limitation is related to the coverage of mortality information in Bahia, based on SIM registries. According to the Ministry of Health, in the 1996-2013 period the coverage rose from 62.87% to 88.75%. Despite being considered good coverage, it is still below than national average, which was 94.9%[3] in 2013. In this study, with the aim of adjusting the underestimation of coverage, correction factors were applied. However, these factors

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refer to a 2008 study,[10] while the rates were corrected for 1996-2015. This could mean that in the years furthest from 2008, such as in the first quinquennial of 1996-2000, the correction factors possibly lead to more imprecise estimates, because both the coverage and quality of information were worse than in more recent quinquennials.

Nevertheless, this study showed that it is possible to deal with the sub-registration of official data and to look for more reliable homicide rates[20,21] in certain locations and in a given period of time. These tools are useful for research with methodologies which propose discussing these problems.[8,10]

It can be concluded that in the municipalities analyzed, after the adjustments, there was an increase in deaths due to homicide every five-year period, which resulted in an even higher corrected mortality rate. Therefore, it is believed that these results are closer to the local realities.

Furthermore, results which do not consider the limitations of information systems, whether at the state level or more regional and municipal levels, impede understandings of the phenomenon of deaths due to assault – homicides – in the national context. This can confuse the perception of risks and of the areas of greater concentration of these events due to the lower quality of information. As a result, the allocation of resources and the directing of policies to reduce homicide as a question of health and public safety can also be badly oriented, since they are based on information that is not very reliable.[20,21]

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