Original article

Trend in mortality due to ill-defined causes in the state of Tocantins and in its capital Palmas, Brazil, 1998-2014*

doi: 10.5123/S1679-49742018000300011

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Abstract

Objective: to evaluate the time trend of proportional mortality due to ill-defined causes, in Tocantins and Palmas, Brazil, 1998-2014. **Methods**: this was a time trend study using data from the Mortality Information System (SIM) and the Death Verification Service (SVO); we evaluated the time trend of this type of this mortality using Joinpoint Regression. **Results**: between 1998 and 2014, proportional mortality from ill-defined causes fell 88.5% in Tocantins and 88.1% in Palmas; the trend test indicated statistically significant inflection points in 1998-2004 (-4.14; p=0.001) for Tocantins and in 1998-2000 (-7.92; p<0.005) for Palmas; a certain degree of stability was observed with effect from 2004. **Conclusion**: there was a significant decline in proportional mortality due to ill-defined causes in Tocantins; however, it is still necessary to intensify actions aimed at improving the quality of information on mortality in some municipalities.

Keywords: Mortality; Cause of Death; Time Series Studies.

*Article originated from the Master's dissertation entitled 'Trend of mortality due to ill-defined causes in Tocantins, Palmas, 1998-2014", written by Cristina Prestes, defended in 2017 as part of her Professional Masters course in Public Health at the Institute of Collective Health of Federal University of Bahia. Sources of funding None.

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Introduction

Mortality statistics are one of the most frequently used tools in the analysis of the population's health situation. The Mortality Information System (SIM), the main source of death data in Brazil, has been progressively and consistently improving. In 2011, its coverage was 96.1% and in most states of the Southern and Southeast regions it had already reached 100%.[1] Likewise, the quality of the diagnosis of the underlying cause of death has improved, given the reduction in the proportion of deaths classified as being due to ill-defined causes. Between 1980 and 1986, on average, 21.2% of total deaths in Brazil were classified in this group of causes. Since then, this proportion began to decrease, reaching 14.3%, 10.4% and 5.8% in 2000, 2005 and 2014, respectively.[2]

> *In spite of the decrease obtained in mortality due to ill-defined causes in Brazil, its magnitude can still be reduced if compared to the levels presented by the United States, Canada, Mexico and Chile.*

Among the actions highlighted as important for the improvement of SIM are Brazilian Ministry of Health initiatives and the example of including the 'Reduction of the percentage of deaths with an ill-defined cause' program in the Multiannual Plan 2004-2007, defining as a goal the reduction of the proportion of such deaths to less than 10% with effect from 2006, especially in the Northern and Northeast, regions where this percentage was around 20% in some municipalities. A specific handbook was prepared for the investigation of deaths due to ill-defined cause. Investigation must be carried out at health centers, registrars' offices, Institutes of Forensic Medicine (IML) and the Death Verification Service (SVO). In addition to these guidelines on how to conduct such an investigation, a Death Investigation form template and a 'Verbal Autopsy' (VA) form template were made available. This latter research strategy, established in Brazil in 2008, consists of performing standardized interviews with people close to the deceased, seeking to clarify the cause of death in geographic areas where the SIM system has low coverage and information on deaths is not reliable. The information obtained in these interviews must be analyzed by certifying physicians (general practitioners).[3,4] Other important measures taken by the Ministry of Health were: (i) creation of the National Death Verification Service Network in 2006, with the aim of elucidating the cause of natural deaths with or without medical assistance, which did not have an accurate diagnosis;[5] and (ii) the regulation of financial incentives for deployment and maintenance of strategic public health surveillance actions and services, including for the SVO.[4]

Between 1990 and 2004, the five major Brazilian regions showed a reduction in the proportion of deaths due to ill-defined causes, especially in the Northeast (77.4%) and Midwest (60.5%).[6] Progressively, with the employment of the actions described in the preceding paragraph, various states of the federation began to show favorable results for that indicator, including reduction in the rates of underreporting. For example, in a sample of municipalities of the northeast macro region of Minas Gerais state in 2007, VA enabled the clarification of 87.0% of the causes of deaths investigated and detected 206 deaths that had not been registered on SIM.[7] In Fortaleza, Ceará state, although SVO and IML were already available, the application of the verbal autopsy methodology reduced the proportion of deaths due to ill-defined causes from 21.7% to 6.1% in the period from 2003 to 2008.[8]

It is noteworthy, however, that in spite of the decrease obtained in mortality due to ill-defined causes in Brazil, its magnitude can still be reduced if compared to the levels presented by the United States, Canada, Mexico and Chile, countries where the participation of deaths classified as such was 1.6%, 1.2%, 1.7% and 2.6%, respectively, in the year 2012.[9]

In Tocantins state, in the Northern region of Brazil, the proportion of deaths due to ill-defined causes was 28.6% in 1998.[2] SVO activities in that state began in the same year, but were coupled to the IML and it was only in 2007 that the service was deployed officially.[10]

It is consensus that health evaluation is fundamental for guiding the processes of deploying, consolidating and reformulating of public health practices, programs and policies, as well as for informing as to the fulfilment of established goals.[11] The possibility of contributing to the identification of patterns in the evolution of the levels of morbidity and mortality indicators and patterns in the structure of their causes demonstrates the importance and usefulness of time series studies

for evaluating trends in the event investigated and the impact produced by possible interventions. The objective of this study was to evaluate the time trend of deaths due to ill-defined causes in the state of Tocantins and in its capital, Palmas.

Methods

Based on the information about deaths of residents in Tocantins state and in its capital Palmas, we carried out an epidemiological study with two different analyses: (i) ecological time series study from 1998 to 2014; and (ii) cross-sectional descriptive study, with analysis of individual characteristics of deaths due to ill-defined causes, between 1998 and 2014. In 2014, Tocantins had a Gini index of 0.468 and an estimated population of 1,497,000 inhabitants, of which 265,409 were resident in Palmas.[12,13]

The data about deaths were extracted from the SIM system, provided by the Brazilian Unified Health System IT Department (DATASUS) website (access on 02/01/2017), while data referring to deaths confirmed by autopsy came from the Palmas SVO. The causes of ill-defined deaths correspond to Chapter XVIII of the 10th revision of International Statistical Classification of Diseases and Related Health Problems - (ICD-10), Categories R00 to R99: 'symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified'.[14]

We calculated proportional mortality (%) from ill-defined causes, year by year, for Tocantins and Palmas, the values of ehich were represented on a linear curve. The analysis of the time evolution of this type of mortality was performed through the description of the magnitude and fluctuations that indicator, its percentage variation (Δ%) year by year, and through the variation in the ratio of deaths due to ill-defined causes and those with defined causes.

The time trend was evaluated with the use of segmented linear regression.[15] The dependent variable (Y) was proportional mortality to ill-defined causes, while the independent variable (X) was the calendar year, admitting $p<0.05$. This type of regression allows adjustment of multiple linear models to data for different X intervals, and tests whether one or more points should be added to the model, using the Monte Carlo permutation method. In the final model, each inflection point indicates a change in the trend. For this analysis we used Joinpoint Regression software version 4.1.0.

We calculated the absolute and relative frequencies (%) of the sociodemographic characteristics of deaths due to ill-defined causes according to sex (male; female), age range (in years: 0-14; 15-29; 30-59; 60 and older), ethnicity/skin color (white; black; brown; indigenous; yellow), education level (in years of study: none; 1-11; 12 and over) and marital status (single; married; widowed; other). With respect to the deaths confirmed by autopsy found at Palmas SVO, those referring to the year 2014 were considered because they were more complete. These deaths were analyzed for the state of Tocantins as a whole (and not separately for Palmas), due to the small number of deaths (119). The frequencies of the same sociodemographic variables mentioned above were calculated for these deaths, as well as family income (in monthly minimum wages: <1; 1-2; 3-4; 5-8; 9 and more) and place of residence (Palmas; Porto Nacional; other municipalities; other states). Porto Nacional was selected because it is the second municipality with the highest number of autopsies performed. When calculating the proportions relating to the strata of each variable, deaths were excluded if there was no information regarding the variable.

The study project was approved by the Federal University of Bahia Institute of Public Health Research Ethics Committee (Opinion No. 2,088.282) and received consent of the Tocantins State Health Department (SES/Tocantins) for access to SVO databases, as per SES/Tocantins Decree No 796/2014, which regulates scientific research in Tocantins State health facilities.

Results

Mortality due to ill-defined causes in the state of Tocantins

In 1998, deaths due to ill-defined causes accounted for 28.6% (n=1,173) of the total number of deaths of residents in the state of Tocantins, coming in first place among all groups of causes; 53.8% of these cases did not receive medical care. In 2014, the proportion of deaths due to this group of causes fell to 3.3% (n=236) (an 88.5% reduction), now coming in 7th place among all groups of causes. 5.9% of total cases in 2014 did not

receive medical assistance, representing a reduction of 89.0% over the period studied (data not shown).

The highest positive annual variations of proportional mortality from ill-defined causes were found in 2008 (25%) and 2007 (20.0%). More pronounced reductions occurred in 2006 (-45.5%), 2003 (-44.1%), 2002 (-40.7%) and 2010 (-38.6%). Between the beginning and end of the study period, the ratio between deaths due to ill-defined causes and those with defined causes decreased from 0.76 to 0.03 - although the fall was greater with effect from 2003 (0.07), when the average value of this ratio was 0.04 (Table 1 and Figure 1).

The segmented linear regression analysis indicated a declining trend in mortality due to ill-defined causes, with points of inflection in the periods 1998-2004 and 2004-2014, presenting slopes (average annual percentage variation in the period) of -4,14 (p=0.001) and -0.14 (p=0.324), respectively.

Among the deaths due to ill-defined causes that occurred in the state and that had the following information recorded, the proportion in males was 57.4% in 1998, and 68.1% in 2014. In each of these two years, the following sociodemographic characteristics were predominant: age range 60 years and older (64.1% and 55.3%); ethnicity/skin color, brown (51.9% and 62.5%); marital status, single (42.2% and 39.8%); and no schooling (95.5% and 42.1%). In 2014, however, 54.1% of deaths due to ill-defined causes were among people with 1-11 years of schooling, and only 4.5% were of indigenous ethnicity/skin color (Table 2). In 1998, the variables with the highest percentage of unknown information or information left blank were ethnicity/skin color (85.5%), education (80.1%) and marital status (47.6%); and in 2014, schooling (32.6%) and marital status (21.2%).

Of the 3,089 deaths classified as due to ill-defined causes between 2007 and 2014 in Tocantins, 1,307 cadavers were sent to the State SVO, where all had cause of death confirmed by autopsy. The other (1,782) remained without clarification of the underlying causes of death, and of these, 159 (8.9%) were resident in Palmas.

Table 1 – Number of deaths, proportional mortality and annual variation of proportional mortality from ill-defined causes, and the ratio between the number of deaths from ill-defined causes and deaths from defined causes, Tocantins and Palmas, 1998-2014

Year	Tocantins				Palmas			
	n	PM[a] (%)	Δ%[b]	DIDC/DDC[c]	n	PM[a] (%)	Δ%[b]	DIDC/DDC[c]
1998	1,173	28.6	x[d]	0.76	67	20.2	x[d]	0.25
1999	1,050	24.6	-14.0	0.33	32	8.3	-58.9	0.09
2000	926	21.2	-13.8	0.27	24	5.5	-33.7	0.06
2001	951	19.9	-6.1	0.25	36	7.9	43.6	0.09
2002	569	11.8	-40.7	0.13	9	1.8	-77.2	0.02
2003	327	6.6	-44.1	0.07	9	1.8	–	0.02
2004	255	5.0	-24.2	0.05	1	0.2	-88.9	0.00
2005	276	5.5	10.0	0.06	7	1.4	600.0	0.01
2006	155	3.0	-45.5	0.03	3	0.6	-57.1	0.01
2007	201	3.6	20.0	0.04	8	1.5	150.0	0.01
2008	262	4.5	25.0	0.05	21	3.5	133.3	0.04
2009	268	4.4	-2.2	0.05	8	1.2	-65.7	0.01
2010	173	2.7	-38.6	0.03	5	0.7	-41.7	0.01
2011	204	3.1	14.8	0.03	14	1.8	157.1	0.02
2012	209	3.1	–	0.03	15	1.9	5.8	0.02
2013	229	3.3	6.5	0.03	18	2.1	10.5	0.02
2014	236	3.3	–	0.03	22	2.4	14.3	0.02

a) PM: proportional mortality.
b) Δ%: annual variation of proportional mortality.
c) DIDC/DDC: ratio between the number of deaths from ill-defined causes and deaths from defined causes.
d) x: omitted data.

Table 2 – Sociodemographic characteristics (number and percentage)a of deaths due to ill-defined causes, by year of occurrence and place of residence, Tocantins and Palmas, 1998 and 2014

Characteristics	Tocantins				Palmas			
	1998 (N=1,173)		2014 (N=236)		1998 (N=67)		2014 (N=22)	
	n	%	n	%	n	%	n	%
Sex								
Male	671	57.4	158	68.1	34	51.5	17	77.3
Female	499	42.6	74	31.9	32	48.5	5	22.7
Total	1,170	100.0	232	100.0	66	100.0	22	100.0
Age group (in years)								
0-14	94	8.3	19	8.4	6	11.0	–	–
15-29	54	4.8	16	7.1	5	9.3	4	19.0
30-59	258	22.8	66	29.2	13	24.1	9	42.9
≥60	726	64.1	125	55.3	30	55.6	8	38.1
Total	1,132	100.0	226	100.0	54	100.0	21	100.0
Ethnicity/skin color								
White	76	29.5	45	20.1	9	22.5	7	33.3
Black	34	13.2	29	12.9	5	12.5	4	19.0
Brown	134	51.9	140	62.5	24	60.0	10	47.7
Indigenous	7	2.7	10	4.5	–	–	–	–
Other	7	2.7	–	–	2	5.0	–	–
Total	258	100.0	224	100.0	40	100.0	21	100.0
Education level (in years of schooling)								
None	336	95.5	67	42.1	13	86.6	2	20.0
1-11	12	3.4	86	54.1	1	6.7	6	60.0
≥12	4	1.1	6	3.8	1	6.7	2	20.0
Total	352	100.0	159	100.0	15	100.0	10	100.0
Marital status								
Single	401	42.2	74	39.8	20	38.5	6	35.3
Married	386	40.6	39	21.0	18	34.6	2	11.8
Widowed	147	15.5	40	21.5	12	23.1	1	5.9
Other	16	1.7	33	17.7	2	3.8	8	47.0
Total	950	100.0	186	100.0	52	100.0	17	100.0

a) Deaths having no information for the variable were excluded.

In 2014, of the 139 municipalities of the state of Tocantins, 17 (12.2%) still showed a proportion of deaths due to ill-defined causes equal or greater than to 10%. All of these 17 municipalities were small-sized municipalities: 3 had populations of between 10,579 and 16,016 inhabitants; whilst 14 had between 7,236 and 10,091 inhabitants.

Table 3 shows that of the 119 deaths submitted to autopsy in 2014, 53.8% were of male sex, 16.0% were aged 60 or more, 53.1% had brown skin color, 36.7% had incomplete elementary education, 33.0% had income of between 1 and 2 minimum wages, 48.7% lived in Palmas and 7.6% in Porto Nacional.

Mortality due to ill-defined causes Palmas/TO

Of the total number of deaths of residents in Palmas, 20.2% (n=67) and 2.4% (n=22) had the causes classified as ill-defined in 1998 and 2014, respectively (a reduction of 88.1%). This group of causes of death was in 1st place, when compared to all groups of causes, and 53.7% did not receive medical care; in 2014, deaths due to ill-defined causes came in 12th place and there

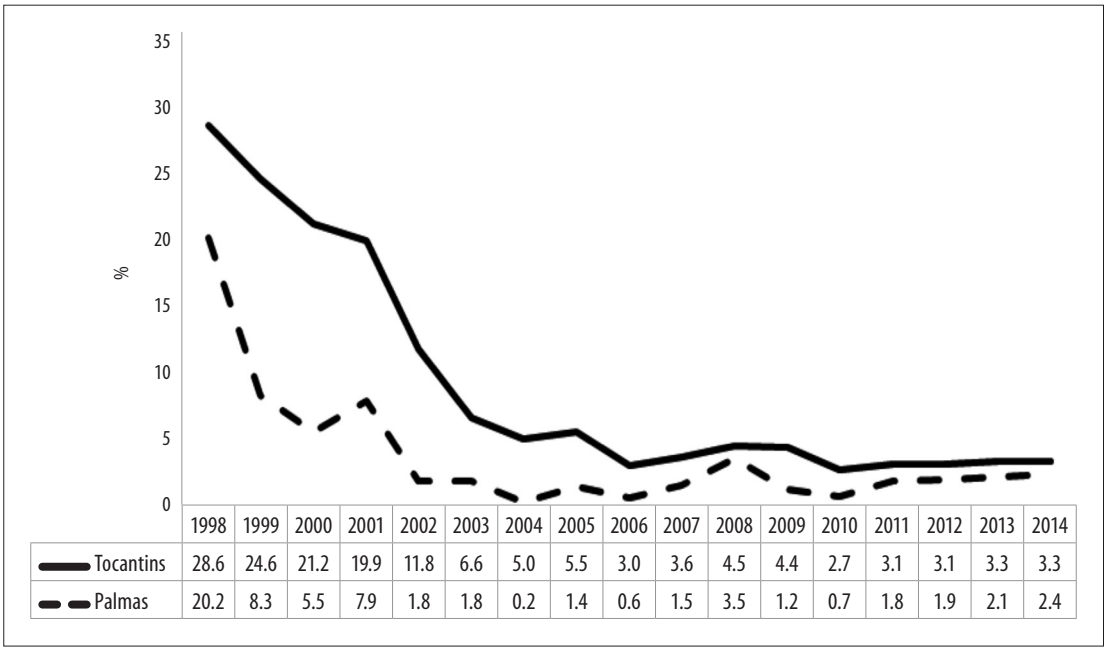
Table 3 – Number and percentage of deaths from ill-defined causes submitted to autopsy (N=119), according to demographic and socioeconomic variables, Tocantins, 2014

Characteristics	n	%
Sex		
Male	64	53.8
Female	55	46.2
Total	119	100.0
Age group (in years)		
0-14	10	4.3
15-29	7	4.3
30-59	44	8.4
≥60	53	16.0
Total	114	100.0
Ethnicity/skin color		
White	31	27.4
Black	22	19.5
Brown	60	53.1
Total	113	100.0
Education level		
None	27	24.8
Incomplete elementary school	40	36.7
Complete elementary school	12	11.0
Incomplete High School	8	7.3
Complete High School	14	12.8
Complete higher education	8	7.4
Total	109	100.0
Family income (in monthly minimum wages)		
<1	31	27.0
1-2	38	33.0
3-4	29	25.2
5-8	12	10.4
≥9	5	4.4
Total	115	100.0
Place of residence		
Palmas/TO	58	48.7
Porto Nacional	9	7.6
Other municipalities[b]	44	37.0
Other States[c]	8	6.7
Total	119	100.0

a) only those deaths with information recorded about each variable were included.
b) 0-4 autopsies per municipality in the interior of the state of Tocantins.
c) Refer to the neighboring states of Pará, Mato Grosso and Goiás.
Source: Social Services questionnaire answered by bereaved families at Palmas SVO.
Note:
Total number of deaths from ill-defined causes in Tocantins in 2014 = 1,173.

was no record of death without medical assistance (data not shown).

Positive annual variations of proportional mortality from ill-defined causes occurred, mainly, in 2011 (157.1%), 2007 (150.0%) and 2008 (133.3%), and the biggest reductions in 2004 (-88,9%), 2002 (-77,2%) and 2009 (-65,7%). Higher fluctuations resulted from low numbers of this form of mortality. Considering only the



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Tocantins	28.6	24.6	21.2	19.9	11.8	6.6	5.0	5.5	3.0	3.6	4.5	4.4	2.7	3.1	3.1	3.3	3.3
Palmas	20.2	8.3	5.5	7.9	1.8	1.8	0.2	1.4	0.6	1.5	3.5	1.2	0.7	1.8	1.9	2.1	2.4

Source: Mortality Information System (SIM).

Figure 1 – Temporal evolution of proportional mortality (%) from ill-defined causes, Tocantins and Palmas, 1998-2014

initial year (1998) and the final year (2014) of the selected time period, there was a decrease of 92.0% (0.25 to 0.02) in the ratio between deaths due to ill-defined causes and those with defined causes (Table 1 and Figure 1).

The segmented linear regression analysis indicated that the downward trend in proportional mortality to ill-defined causes was statistically significant only in the period 1998-2000, where the average annual percentage variation in the period was -7,92 ($p<0.005$). The other point of inflection occurred in 2000-2014, when variation was -0.17 ($p=0.138$); i.e., this decrease was not statistically significant, indicating a certain degree of stability.

In the year 1998, in Palmas, 51.5% of these deaths with the following information recorded were of the male sex, 55.6% were in the 60 years and older age range, 86.6% had no schooling, 60.0% were mulattos and 38.5% were single. In 2014, 77.3% of deaths due to ill-defined causes reported in Palmas were of the male sex, 42.9% were 30-59 years old, 60% had 1-11 years of schooling, 47.7% were mulattos and 35.3% were single (Table 2). In 1998, ethnicity/skin color (40.3%) and schooling (77.6%) were the variables with the greatest proportion of unknown/not recorded information; whilst in 2014 these proportions were schooling (68.8%), marital status (46.9%) and ethnicity/color (34.4%).

Discussion

In the period from 1998 to 2014, there was a sharp and significant decrease in proportional mortality from ill-defined causes, in both Tocantins and Palmas, especially in the first five years of this period. Despite the improvement observed in the year 2014, some municipalities in the state still showed a high proportion of deaths due to this group of causes, as well as Death Certificates (DC) with fields left blank. There was also a significant reduction of these deaths without medical assistance, especially in Palmas, where there was no record of deaths in this category among those classified as ill-defined causes in 2014. The majority of deaths in the group of causes analyzed here related to males, the elderly and those with a low education level.

In general, the falling trend in mortality from ill-defined causes in the state of Tocantins was similar to that observed for Brazil as a whole, especially in the late 1990s.[16-18] The goal defined by the Brazilian Ministry of Health of less than 10%, as being acceptable for this type of mortality in the Northern and Northeast regions of Brazil[3] was achieved with effect from 1999 in Palmas and in 2003 in Tocantins. Lower levels have been achieved in a more consistent

manner, particularly in the capital, since 2010, when the rates of this type of mortality began to get closer to those of some developed countries.[9] Despite the progress made, the average value of this indicator in Tocantins makes it evident that actions aimed at improving the quality of information on mortality need to be intensified, especially in the 17 municipalities where the proportion of deaths due to ill-defined causes has not yet reached the recommended target. As many of these municipalities have small populations, one of the hypotheses for explaining this finding may be the low coverage and/or quality of medical assistance, these being problems which are known to be reflected in the diagnosis of the underlying cause of death. Another equally plausible hypothesis would be the existence of operational and workflow barriers in sending the deceased to Palmas SVO.

It was not possible to find documents that effectively prove the achievement of initiatives aimed at reducing the proportion of deaths due to ill-defined causes in Tocantins, with the exception of the implementation of the SVO in 1998.[10] However, according to verbal information provided by Tocantins Department of Health technicians, since 2008 the state has: (i) done active tracing of births and deaths; (ii) used the 'Verbal Autopsy' form for investigation of deaths due to ill-defined causes; (iii) monitored such investigations; (iv) trained physicians and staff who code causes of deaths in the adequate filling in of DC and (v) made partnerships with hospitals for analysis of medical records and definition of underlying causes of deaths.

During the period in question, progress was made in health care in Brazil regarding the organization of service structure, expansion of access, advances in the quantity and quality of human resources, as well as in the incorporation of new primary care practices, among others. It is possible that these improvements have also occurred in Tocantins, which are undoubtedly reflected in the quality of information.[19] It is therefore plausible to assume that the falling trend of this type of mortality has arisen from such interventions. However, if the strategy is in fact being adopted, it is not resulting in the desired coverage, since a high percentage of missing information in various fields of DC for ill-defined causes was still found in 2014.

The sociodemographic characteristics those who died due to ill-defined causes, including those confirmed by autopsy, are in line with the literature, such as the predominance of deaths of elderly individuals, male sex, black ethnicity/skin color and low education level.[20-22] The higher proportion of males may reflect a gender issue, involving both the abusive use of alcoholic beverages[23,24] and also less use of medical care on the part of men. The higher frequency of Black people (brown and black skin color) may portray the structure of the racial composition of the state's population[12] as well as racial and social inequality in Brazil, given that the majority of these deaths relate to illiterate and low income people.[25] Characteristics that predominate among the Brazilian population may also reflect the low socioeconomic conditions of individuals whose cause of death was classified as ill-defined, as observed in this study and also by other authors.[26]

The fact that most of the deaths confirmed by autopsy were of people resident in Palmas may possibly be because the SVO headquarters is located in this capital, thus facilitating access to the service. Given that Porto National is 65 km away and one of its neighborhoods is 8 km from the capital, this should facilitate the sending of deceased people with ill-defined causes of death to the Palmas SVO.

Although all deaths sent to this SVO in 2014 underwent autopsy and had the underlying cause of death elucidated, the number of autopsies performed is still low, representing only about 10% of deaths due to ill-defined causes registered on the SIM system in relation to Tocantins. And even though SIM coverage in Tocantins had reached 92.8% in 2014, this does not rule out the possibility of underreporting of deaths, especially those from ill-defined causes, thus contributing to an increase in this percentage.

It should be emphasized that the results of the present study may be affected by underreporting of deaths, incompleteness and/or lack of SVO data for years prior to 2014, apart from the unavailability of documents certifying the deployment of actions capable of contributing to the reduction of deaths due to ill-defined causes. In spite of these limitations, it is evident that the mortality rate for this group of causes has presented a remarkable and continuous decrease, possibly as a result of actions aimed at improving the quality of information about deaths implemented in Tocantins and, especially, in Palmas,

a city which in 2010 already investigated more than 90% of these deaths.[18]

The findings presented here show that currently better quality mortality data is available, suitable for informing analyses of the health situation of Tocantins state and revealing an epidemiological profile closer to the reality of that state. This progress enables the health services to plan actions and activities based on more reliable information, and thus achieve greater efficiency and effectiveness in actions to be implemented.

Authors' contributions

Prestes C, Costa MCN, Lima RC, Barreto FR e Teixeira MG contributed to the concept and/or design of the study, analysis and interpretation of the results, writing and critical review of the manuscript. All the authors participated in the critical review of the manuscript's intellectual content, approved the final version and declared themselves to be responsible for all aspects of the study, ensuring its accuracy and integrity.

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Received on 27/10/2017
Approved on 28/02/2018