

## FIRES IN BRAZIL: MAPPING AND LETHALITY INCÊNDIOS NO BRASIL: MAPEAMENTO E LETALIDADE

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### ABSTRACT

Fires in Brazil, their mapping and lethality is a challenge for researchers and institutions. This work tried to shed light on the issue by presenting the geographic distribution of the 737,199 fires recorded by the Fire Departments of the 26 states of the Federation and the Federal District in a triennium (2017 - 2019). The number of possible deaths resulting from these events in the same period was also investigated, reaching numbers that exceed 2,500 deaths. Statistical documents from the 10 (ten) states with the largest population in Brazil (São Paulo, Minas Gerais, Rio de Janeiro, Bahia, Paraná, Rio Grande do Sul, Pernambuco, Ceará, Pará and Santa Catarina) were analyzed for, among other considerations, to know the characteristics of the fires that most affect Brazilian cities. It is noteworthy that, on mean, three out of every four Brazilians live in these states and in 2017, in these same territories, 78.42% of deaths from fires in the country were recorded. Finally, the numbers of fires in Brazil are compared with the world standard and more specifically with six countries that have a population above 50 million inhabitants (United States of America, Russia, Vietnam, France, United Kingdom and Italy), observing coincidences such as the proximity in the percentage of fires in buildings and discrepancies as in the number of Professional Firefighters per 10 (ten) thousand inhabitants.

**Keywords:** Casualties in fires. Fire mapping. Fires in Brazil.

### RESUMO

Afirmar a quantidade de incêndios no Brasil, seu mapeamento e letalidade é um desafio para pesquisadores e instituições. Este trabalho tenta lançar luz a questão, apresentando a distribuição geográfica dos 737.199 incêndios registrados pelos Corpos de Bombeiros dos 26 Estados da Federação e Distrito Federal, em um triênio (2017 – 2019). Investigou-se também a quantidade de possíveis mortes derivantes destes eventos, no mesmo período, chegando a números que ultrapassam os 2,5 mil óbitos. Documentos estatísticos dos 10(dez) Estados com maior população no Brasil (São Paulo, Minas Gerais, Rio de Janeiro, Bahia, Paraná, Rio Grande do Sul, Pernambuco, Ceará, Pará e Santa Catarina) foram analisados para, entre outras ponderações, conhecer as características dos incêndios que mais acometem as cidades brasileiras. Destaca-se que nestes Estados habitam, em média, três de cada quatro brasileiros e no ano de 2017, nestes mesmos territórios, foram registrados 78,42% das mortes em incêndios no país. Finalmente os números de incêndios no Brasil são comparados com o padrão mundial e mais especificamente com seis países que tem população acima de 50 milhões de habitantes (Estados Unidos da América, Rússia, Vietnam, França, Reino Unido e Itália), observando coincidências como a proximidade no percentual de incêndios em edificações e discrepâncias como na quantidade de Bombeiros Profissionais por 10 (dez) mil habitantes.

**Palavras-chave:** Letalidade em incêndios. Mapeamento de incêndios. Incêndios no Brasil.

### INTRODUCTION

Fires in Brazil are numerous and affect the most diverse corners of the country (OLIVEIRA JÚNIOR et al., 2021; ARCE et. al, 2021). Among these fires, structural fires or fires in buildings occur at significant frequency, especially in urban agglomerations and large cities (CORRÊA et al., 2015a; KRISTOFFERSON e LOG, 2022).

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However, the exact number of fires, their typicality (structural, vegetation, vehicles, etc.) (ARCE et al., 2021; CORRÊA et al., 2015b) and number of victims (wounded and fatal) (DOYLE, LYONS e LYNN, 2019; CARLOTTI, PARISSÉ e RISLER, 2017) are still an open question in official and international statistics.

This study sought to launch a proposal for the systematization and presentation of basic data related to fires in Brazil based on the crossing of data obtained from various sources. The data available in the profiles of Public Security Institutions, a document edited through the Ministry of Justice and Public Security, public statistics from the Military Fire Brigades of the states and data from the 'Data SUS' System, also of public access, were used, all as described in the methodology section.

The time interval covered was the triennium between the years 2017 to 2019 and the study focused on the 10 most populous Federated States, where more than three quarters of the Brazilian population reside.

## BRIEF REVIEW

The first consolidated statistical information on fires in Brazil was exposed in the 'Anuários' of the Brazilian Institute of Geography and Statistics - IBGE published from 1937 to 1991 (this last year with data of 1990), going through various stages and methodologies (DUARTE; RIBEIRO, 2008).

In 1992 Negrísolo presented a proposal entitled 'Standardized National Data Collection and Tabulation System', referring to the assistance provided by the Brazilian Fire Departments and consequently contemplating the activities of Fire Fighting (NEGRISOLO, 1992).

The 'Fire Statistics Workshop' held on December 7, 1995 (RIBEIRO, 1996), in the city of São Paulo, drew attention to the topic, seeking ways to consolidate and analyze data, where some experts were heard seeking a consensus on the issue.

In 1997, the Brazilian Technical Standard entitled 'NBR 14.023: Registration of Firemen's Activities', produced by the Brazilian Fire Safety Committee, is promulgated, not being revoked or updated since then (CORRÊA; DUARTE; BRAGA, 2018).

With the creation of the National Secretariat for Public Security - SENASP within the scope of the then Ministry of Justice, efforts began to build a system for receiving and tabulating data, police information gained considerable prominence and obtained in a degree of interesting evolution when compared to those related to fires and other disaster events. The most tangible document issued by SENASP was the 'Profiles of Public Security Institutions', available until the present time (SENASP, 2018; SENASP, 2019, SENASP, 2020).

In 2006, after a long debate at the Brazilian Military Fire Brigade Council – LIGABOM, standardized forms were suggested for the systematization of data on occurrences, including fires, in order to simplify the tabulation and issuance of national statistics. However, given the federative pact and the peculiarities of the Federated Units and their Fire Departments in this matter, the standardization was not adopted by most states (CORRÊA, DUARTE; BRAGA, 2018; CORRÊA, *et al.*, 2017, CORRÊA, *et al.*, 2018).

## METHODS

As previously stated, the method for tabulating and preliminary data analysis was carried out in two stages: data collection in public databases and (a) research with the Fire Departments (b), using the years 2017, 2018 and 2019 as temporal references.

### **Data collection in public databases**

It was carried out through documents and systems made available for public consultation, of which the following stand out:

Profile of Public Security Institutions – available on the website of the Ministry of Justice and Public Security, in the words of the prosecutor itself 'The tool used gathers data related to equipment, personnel, training, structures and activities developed by agents of these institutions'; of this profile data were extracted, such as the number of general assistance and fires specifically, the existing number of Military Firefighters in each state, among others. As a major limitation, the profile does not delve into the typification of fires and the number of injured and fatal victims thereof" (SENASP, 2018; SENASP, 2019, SENASP, 2020).

DATASUS – System of the Ministry of Health for exposing data measured within the scope of the Unified Health System. DATASUS was used as a provider of information related to the number of deaths (fatal victims) resulting from fires, using the filters 'Deaths due to external causes' and subclass 'exposure to smoke, fire and flames'. There were some limitations regarding these data, the first concerns the

epidemiological logic of DATASUS, which assesses the place of residence of the deceased person as a place related to death and not the event that gave rise to death. Another issue to be considered was the possibility that victims of work accidents not related to commercial and industrial fires, are being computed as deaths in fires; through the crossing of two filters in the system mechanisms, a statistical coincidence of less than 3% can be observed, which makes the approximation (BRASIL, 2021) acceptable (since there is no tabulation of these data).

FIRE DEPARTMENT YEARBOOKS – some Military Fire Brigades traditionally issue yearbooks which express, among other information, the number of calls made by these bodies, including those that include firefighting. The biggest limitation of this source comes from the lack of standardization in the tabulation and presentation of data, varying substantially in detail and typification (MINAS GERAIS, 2020; MINAS GERAIS, 2019; MINAS GERAIS, 2018; RIO DE JANEIRO, 2019, RIO DE JANEIRO, 2018; RIO DE JANEIRO, 2017).

IBGE – demographic data, with emphasis on the year 2020 and territorial data were accessed in the database, made available for public consultation by this body.

World Fire Statistics – document issued annually by the Center of Fire Statistics, which seeks to present data from more than 30 countries. Despite Brazil not being included in the annual editions of the document, we use some references (death per million, fire rate per death, etc.) and data from nations with more than 50 million inhabitants to establish comparative parameters (CTIF, 2018).

### **Research with the Fire Departments**

Ten (10) Military Fire Departments were elected so that the refinement of the data, from the 10 most populous states in Brazil (São Paulo, Minas Gerais, Rio de Janeiro, Bahia, Paraná, Rio Grande do Sul, Pernambuco, Ceará, Pará and Santa Catarina), given the significant portion of the Brazilian population (78.42%) who live there (BAHIA, 2021; CEARÁ, 2021; PARÁ, 2021; PARANÁ, 2021; RIO GRANDE DO SUL, 2021; SANTA CATARINA, 2021; SÃO PAULO, 2021).

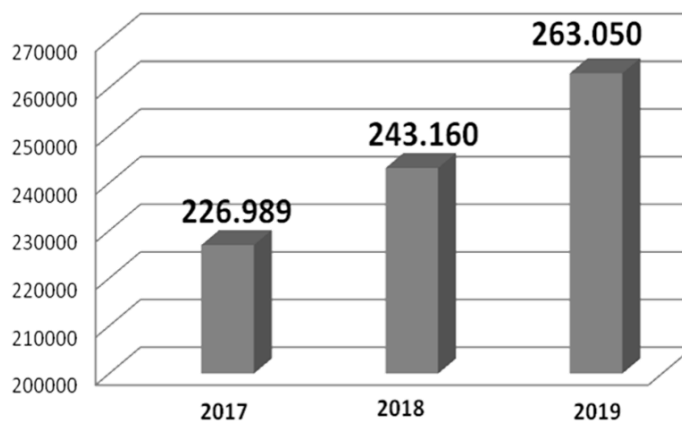
For the Fire Departments that already had a Yearbook published in the period in question (2017 - 19), additional data or clarifications were requested in order to reconcile different classifications from different origins. For those who did not have published Yearbooks, the following data were requested (via electronic correspondence):

- All Occurrences by Type (General);
- Fires by Subtype (Buildings, vegetation, vehicular...), with emphasis on **dead and injured**;
- Fires in Buildings detailing: Constructive Type (Masonry, Wood...) and Use (house, apartment, commercial, industrial...). Information was received from the 10 Military Fire Brigades requested, with different presentations and degree of completeness.

## **RESULTS**

Observing the measured data, it can be said that the Brazilian Military Fire Brigade responded to a total of more than 730 thousand fires in the three years studied (2017-19). It is still seen in three years in Brazil that more than 2,700 people lost their lives in these fires. The information is presented below through the historical line in the triennium:

Figure 1 – Evolution of Fires in Brazil in the Triennium 2017 to 2019



Source: Own elaboration.

**Deaths due to Fires in Brazil**

Observing the population distribution in the states of the Federation, the fires in these states and deaths associated with these events, the following table 1 can be seen, which also explores the ratio between population and deaths in fires:

Table 1 – Brazil: Fires and Fire Deaths, 2017-2019

STATE	Population 2020 (IBGE)	Total of attended occurrences (2018 or 2017*)	FIRES (2018 or 2017*)	DEATH IN FIRES** 2017/18/19 Mean	Death Rate/1 million in hab. 2017- 2019	Death Rate/ 1,000 Fires (2018)
São Paulo	46,289,333	527,602	54,936	173/212/152 (179)	3.87	3.86
Minas Gerais	21,292,666	299,293	20,485	90/110/68 (89,3)	4.19	5.37
Rio de Janeiro	17.366.189	451,830	37,530	120/133/148(133,7)	<b>7.70</b>	3.54
Bahia	14,930,634	45,997	5,431	64/61/47 (57,3)	<b>6.91</b>	<b>11.23</b>
Paraná	11,516,840	139,715	19,340	61/69/93 (74,3)	<b>6.45</b>	3.57
Rio Grande do Sul	11,422,973	59,508	16,365	87/69/81 (79,0)	<b>6.92</b>	4.22
Pernambuco	9,616,621	39,623	5,758	42/34/41 (39,0)	4.06	5.90
Ceará	9,187,103	36,481	15,856	20/20/13 (17,7)	1.92	1.26
Pará	8,690,745	61,745	4,776	17/11/16 (14,7)	1.69	2.30
Santa Catarina	7,252,502	163,103	9,223	42/34/37 (37,7)	5.20	3.68
Maranhão	7,114,598	29,974	4,845	14/25/13(17,3)	2.43	5.16
Goiás	7,113,540	131.533	9,571	41/31/22(31,3)	4.40	3.24
Amazonas	4,207,714	3,777	664	14/13/11(12,7)	3.02	<b>19.58</b>
Espírito Santo	4,064,052	22,273*	3,340*	22/18/11 (17)	4.18	6.58*
Paraíba	4,039,277	24,835*	4,022	06/08/10 (8)	1.98	1.99
Rio Grande do Norte	3,534,165	10,651	1,572	08/07/02 (5,7)	1.61	4.45
Mato Grosso	3,526,220	43,184	4,860	17/18/12(15,7)	4.45	3.70
Alagoas	3,351,543	10,774	1,375	15/17/24(18,7)	5.58	<b>12.36</b>
Piauí	3,281,480	4,957	957	05/10/07 (8,3)	2.53	<b>10.45</b>
Distrito Federal	3,055,149	98,871	3,521	08/09/04 (7,0)	2.29	2.56
Mato Grosso do Sul	2,809,394	182,707	6,047	19/17/10(15,3)	5.45	2.81
Sergipe	2,318,822	7,055	1,955	07/09/09(8,3)	3.58	4.0
Rondônia	1,796,460	35,058	2,130	04/06/08(6,0)	3.34	2.82
Tocantins	1,590,248	15,294	1,675	06/06/03(5,0)	3.14	3.58
Acre	894,470	3,756	3,699	01/02/03 (2,0)	2.24	0.54
Amapá	861,773	8,728	1,097	08/04/01 (4,3)	4.99	3.64
Roraima	631,181	6,821	2,130	02/00/08 (3,3)**	5.23	155
<b>BRAZIL</b>	<b>207,755,692</b>	<b>2,465,145</b>	<b>243,160</b>	<b>907.6</b>	<b>4.37</b>	<b>3.73</b>

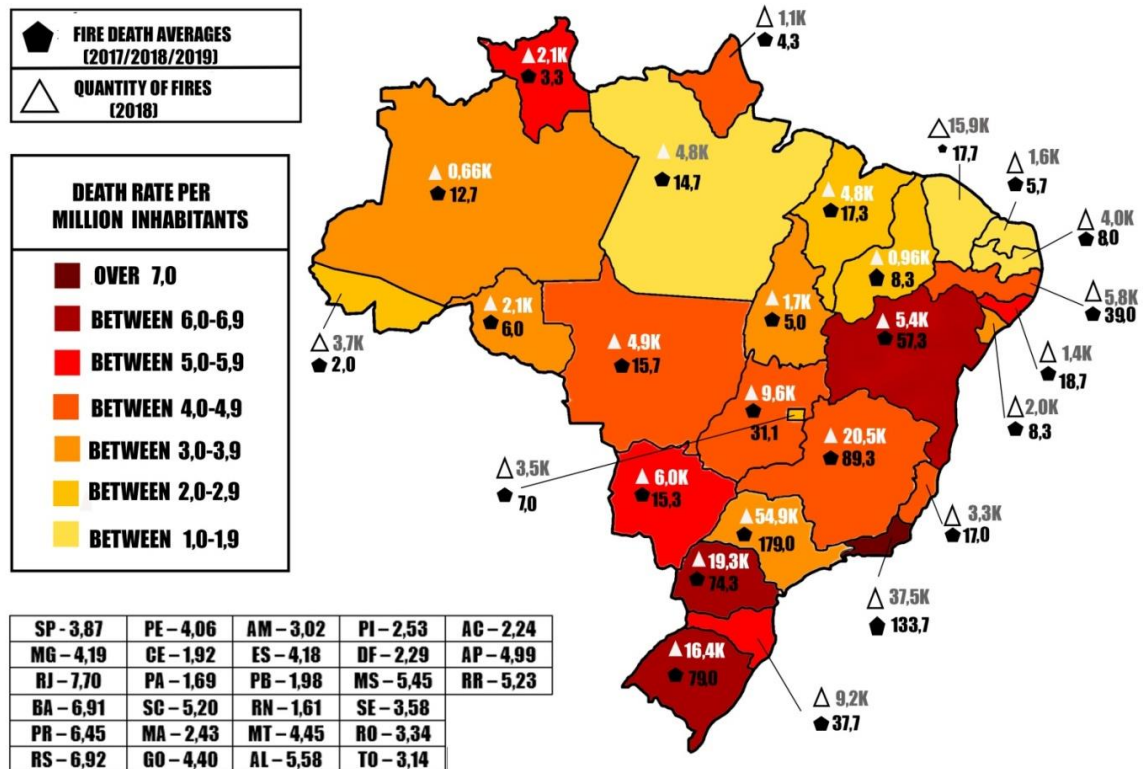
Source: Own elaboration.

It can be seen in Table 1 that in Brazil in 2018 alone, more than 2.46 million occurrences were attended by the Military Fire Brigade, of which 243,160 were related to fires.

It is also seen that there was a mean of 907.6 deaths in fires per year, in the studied period, offering a rate of 4.37 deaths per million inhabitants, in another perspective, for every 1,000 fires attended, 3.73 fatal victims are recorded, using the year 2018 as a base.

The following infographic illustrates the numbers presented through the geographic distribution by state:

Figure 2 – Infographic Deaths in Fires in Brazil (2017-2019)



Source: Own elaboration.

When analyzing the numbers of fires and deaths resulting from these in the states of the Federation, one sees an expected compatibility of the absolute numbers with the size of the populations of the states. When considering the number of deaths due to fires per million inhabitants, the states of Rio de Janeiro, Rio Grande do Sul, Bahia, and Paraná have the highest rates (7.70 / 6.92 / 6.91 and 6.45); these States are among the 6 largest in terms of population, with the exception of the states of São Paulo and Minas Gerais with rates below the national level (respectively 3.87 and 4.19).

Considering the number of firesto cause one death, the states of Amazonas, Alagoas, Bahia and Piauí have the worst rates, with respectively: 19.59 / 12.36 / 11.23 and 10.45 deaths for every 1,000 recorded fires.

**Fires and Military Firefighters in Brazil**

Seeking to better discuss the issue of deaths by fire in the Federated States, the number of Firefighters, professionals consecrated in the 26 State Constitutions as responsible for the Fire Fighting service, being today additionally supported in some states (especially São Paulo and Santa Catarina) by Municipal Public Firefighters.

Table 2 – Brazil: Firefighters, Population, Fires and Fire Deaths, 2017-2019

STATE	Population 2020 (IBGE)	FIRES (2018 or 2017*)	EFFECT IVE MFD 2018	DEATH IN FIRES ** 2017/18/19 (Mean)	Firefighter Ratio / 10,000 inhab. (2018)
São Paulo	46.289.333	54.936	8.570	173/212/152 (179)	<b>1,85</b>
Minas Gerais	21.292.666	20.485	6.056	90/110/68 (89,3)	2,84
Rio de Janeiro	17.366.189	37.530	12.673	120/133/148(133,7)	<u>7,29</u>
Bahia	14.930.634	5.431	2.941	64/61/47 (57,3)	<b>1,97</b>
Paraná	11.516.840	19.340	3.340	61/69/93 (74,3)	2,90
Rio Grande do Sul	11.422.973	16.365	2.835	87/69/81 (79,0)	2,48
Pernambuco	9.616.621	5.758	2.739	42/34/41 (39,0)	2,85
Ceará	9.187.103	15.856	1.604	20/20/13 (17,7)	<b>1,75</b>
Pará	8.690.745	4.776	2.846	17/11/16 (14,7)	3,27
Santa Catarina	7.252.502	9.223	2.661	42/34/37 (37,7)	3,67
Maranhão	7.114.598	4.845	1.521	14/25/13(17,3)	2,14
Goiás	7.113.540	9.571	2.734	41/31/22(31,3)	3,84
Amazonas	4.207.714	664	692	14/13/11(12,7)	<b>1,64</b>
Espírito Santo	4.064.052	3.340*	1174	22/18/11 (17)	2,89
Paraíba	4.039.277	4.022	1.212	06/08/10 (8)	3,00
Rio Grande do Norte	3.534.165	1.572	665	08/07/02 (5,7)	1,88
Mato Grosso	3.526.220	4.860	1.372	17/18/12(15,7)	3,89
Alagoas	3.351.543	1.375	1.116	15/17/24(18,7)	3,33
Piauí	3.281.480	957	308	05/10/07 (8,3)	<b>0,94</b>
Distrito Federal	3.055.149	3.521	5.721	08/09/04 (7,0)	<u>18,73</u>
Mato Grosso do Sul	2.809.394	6.047	1.436	19/17/10(15,3)	5,11
Sergipe	2.318.822	1.955	511	07/09/09(8,3)	2,20
Rondônia	1.796.460	2.130	734	04/06/08(6,0)	4,09
Tocantins	1.590.248	1.675	540	06/06/03(5,0)	3,40
Acre	894.470	3.699	515	01/02/03 (2,0)	5,76
Amapá	861.773	1.097	684*	08/04/01 (4,3)	<u>7,52</u>
Roraima	631.181	2.130	529	02/00/08 (3,3)	<u>8,38</u>
<b>BRAZIL</b>	<b>207.755.692</b>	<b>243.160</b>	<b>67.729</b>	<b>907,6</b>	<b>3,26</b>

Note: \* Data from 2017, as in specific cases date from 2018 were not available; \*\*Mean of deaths in Fires in Brazil in the triennium 2017-2019.

Source: Own elaboration.

Examining the numbers in Table 2, it can be seen that Brazil has a number of Professional Firefighters in the specific case of Military Firefighters at a level below that of nations with similar economies and population, accounting for only 3.26 Military Firefighters on mean for each group of 10,000 inhabitants.

Despite the deficient number of these professionals, the distribution, using the population criterion, is quite uneven. There are territories like the Federal District that has 20 times more firefighters than states like Piauí, with rates respectively 18.73 and 0.94 Military Firefighters per 10,000 inhabitants. It should be noted that the number of Firefighters in the Federal District is compatible, in fact a little lower, with those found in North America and Western Europe, yet it is striking when compared to some Federated States.

### ***Fires and Deaths in Brazil in a Comparative Perspective***

Seeking to compare Brazil with other countries, the last 'World Fire Statistic' (CTIF, 2018) was used with data from more than 30 nations, highlighting countries that had a population of over 50 million inhabitants. Below is a table 3 that summarizes the main comparisons made:

Table3 – Fires and Fire Deaths in countries with more than 50 million inhabitants, 2017-2019

Country	Population (X 1000)	Calls / Calls	Fires	Professional firefighters /Military	Deaths fires	Fire Death Rate / 1 million inhabitants	Death Rate/ 1,000 Fires
EUA	323.128	35.320.000	1.342.000	345.600	3.221	10,49	2,54
<b>Brazil</b>	<b>207.755</b>	<b>2.465.145</b>	<b>243.160*</b>	<b>67.729</b>	<b>908**</b>	<b>4,37</b>	<b>3,73</b>
Russia	146.270	-	139.500	271.000	8.204	59,81	62,71
Vietnam	93.000	-	3.306	10.579	98	1,05	29,64
France	66.628	4.542.400	285.661	40.646	289	4,33	1,01
UK	63.786	654.758	201.009	40.100	367	5,75	1,82
Italy	61.000	952.129	245.727	28.870	295	4,84	1,20

\*Data from Brazil for 2018 (Total Fires in 2017, 2018 and 2019 - 733,199); \*\*Mean of deaths in Fires in Brazil in the triennium 2017-2019. Reference: Report 23 - CTIF, 2018 and research data.

Source: Own elaboration.

Analyzing Table 3, it can be seen that Brazil has a fire death rate per million inhabitants higher than France, the United Kingdom and Italy. In this perspective, Russia has extremely worrying numbers, followed at a great distance by the United States of America.

Regarding the number of deaths per 1,000 fires recorded, the number in Brazil is just no worse than that of Russia and Vietnam. This high lethality of fires in Brazil can be associated with the low rate of firefighters per 10,000 inhabitants, in this particular among the seven nations compared only Vietnam has a lower proportion.

## CONCLUSIONS AND RECOMENDATIONS

This article preliminarily presented the fires in Brazil in the 2017-19 triennium, identifying the total amount in the highlighted years. Noting a growth in the general number of fires attended, in the order of 7% and 15% comparing 2018 and 2019 with the year 2017.

The article also presented the deaths possibly resulting from fires, recorded in Brazil, breaking down the numbers and means by Federated States. The numbers of general attendances by the Military Fire Brigades and their respective results, as well as a total number of 2,723 deaths from fires (**exposure to smoke, fire and flames**) were observed.

It can be intuited that in the Federated States and the Federal District the distribution of Military Firefighters is completely irregular, using the number of inhabitants as a criterion, and this may be associated with high death rates per 1,000 fires in some states. It is also concluded that the absolute numbers of deaths in fires are, as a rule, directly associated with the most populous states and with the largest urban agglomerations. However, not in a linear way and admitting exceptions, such as the case of Minas Gerais, which with the second population does not have the second sum of deaths in fires.

Finally, the numbers found in Brazil were compared with six countries that have a population of more than 50 million inhabitants and have their data available in Report 23 of the World Fire Statistic [23]. Noting that the rate of Professional/Military Firefighters in Brazil is the lowest when compared to the population, with the exception of Vietnam, among the 07 countries compared (USA, Brazil, Russia, Vietnam, France, United Kingdom and Italy).

It can also be seen that the death rate from fires per million inhabitants of Brazil is higher than those of France, the United Kingdom and Italy and lower than those of the USA and Russia.

Complementary studies are recommended that inventory which fires are the most lethal in Brazil, by their subtype (buildings, vegetation, means of transport, etc.) and also by the nature of the occupation (commercial, residential, industrial, etc.).

It is also seen as important the application of this way of identifying and analyzing the data, in other time periods, as well as that, after improvement, it can be systematized in a national model that places Brazil in International Statistics.

Finally, we identified as limitations of the work: the non-accounting of some data, as they do not exist in the public consultation instruments or have not been made available by the institutions that hold them, after a formal request; The generalization of the item '**exposure to smoke, fire and flames**' as deaths in fires in the files of the Ministry of Health, since there is no specific scope; The non-accounting of all municipal public professional firefighters, since these data were not obtained in the lapse of the research; And the exposure of other data collected from the states that are still under analysis.

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