“AMONG DEAD AND WOUNDED”: MAPPING, CHARACTERIZATION AND ANALYSIS OF FIRES WITH VICTIMS IN RECIFE’S METROPOLITAN ZONE

Roberto Ryanne Ferraz de Menezes
Cristiano Corrêa
José Jéferson Rêgo e Silva
Tiago Ancelmo Pires

Abstract

This article presents the mapping and analysis of fires with dead and wounded people in the Metropolitan Region of Recife (MRR) served by the Firefighters Department from 2013 to 2016. There was an average rate of 1 death per million inhabitants, similar to countries such as Singapore and Vietnam. The weighted number of fires per wounded or dead person results in rates of 0.5 and 1.7 per 100 recorded fires, respectively. These numbers are concerning, especially when compared to rates from other regions in the world. The victims of fires in MRR were shown to generally not be a perceivable problem in terms of common sense, yet they are real and require accurate analysis and effective measures.

Keywords: Fires. Deaths. Injured people. Metropolitan Region of Recife. Residential buildings.
2013 a 2016. Verificou-se uma taxa média de 1 morte por milhão de habitantes, semelhante a países como Singapura e Vietnam. Quando se pondera a quantidade de incêndios para que haja um ferido ou morto, as taxas se apresentam respectivamente em 0,5 e 1,7 por 100 incêndios registrados – sendo estes números preocupantes, principalmente quando comparados com taxas de outras regiões no mundo. Conclui-se que as vítimas de incêndios na Região (RMR) são um problema silente ao senso comum, mas real e que exige análise acurada e providências efetivas.

**Palavras-chave:** Incêndios. Mortes. Feridos. Região Metropolitana do Recife. Edificações residenciais.

“ENTRE MUERTOS Y HERIDOS”: CARTOGRAFÍA, CARACTERIZACIÓN Y ANÁLISIS DE LOS INCENDIOS CON VÍCTIMAS EN LA ZONA METROPOLITANA DE RECIFE

**Resumen**

Este artículo presenta la cartografía y análisis de incendios con muertes y heridos en la Zona Metropolitana de Recife (ZMR), atendidos por el Cuerpo de Bomberos, en el período de 2013 a 2016. Se ha verificado un promedio de 1 muerte por millón de habitantes, semejante a países como Singapur y Vietnam. Cuando se examina la cantidad de incendios para que haya un herido o muerto, los promedios se presentan respectivamente de 0,5 y 1,7 por 100 incendios registrados, lo cual es preocupante, principalmente en comparación con los promedios de otras regiones del mundo. Se concluye que las víctimas de incendios en la ZMR son un problema silencioso y real, lo que exige un análisis cuidadoso y diligencias efectivas.

**Palabras clave:** Incendios. Muertes. Heridos. Zona Metropolitana de Recife. Edificaciones residenciales.

**INTRODUCTION**

Despite its importance for the development of civilizations, fire has always been a serious threat to human beings when out of control. The great tragedies lived during the last centuries were the milestone in the search to know better the behavior of fires and its consequences. In urban centers, fires often causes major tragedies with a considerable loss of patrimony and, more importantly, human lives, especially in crowded areas.
Our study was conducted in the Metropolitan Region of Recife (MRR), state of Pernambuco, located in the Northeast Brazil and formed by 14 municipalities, including the capital city. MRR has a population of more than 3.7 million people, representing over 45% of the population of the entire state of Pernambuco, residing in a territory that corresponds to less than 3% of the state extension (IBGE, 2016).

Besides this high population density, there are substandard constructions, known as favelas and slums, as well as tall buildings not always accompanied by the precautionary concerns appropriate to the risks. These factors catalyze the outbreak of fires and represent a challenge for fire safety in terms of minimizing deaths and injuries. During the triennium 2011-2013, the number of fires in the MRR increased more than 15%. Nevertheless, the losses that affect not only the economy, but also social welfare, point to the cruelest aspect of these fires, that is, the victims: people who died or were wounded in fires.

Regarding fire-related mortality and lethality, Paes points out that a statistical control would be very useful. However, this tool is underused in several Latin American countries, providing incomplete, outdated and imprecise data. In a global study performed by IAFRS/CTIF, no data from Brazil or from another Latin American country was described, which can be interpreted as the non-existence or inconsistency of data.

In 2016 alone, 2,503 fires were registered in the Metropolitan Region of Recife, of which 835 were fires in buildings, representing 33.3% of the total number of fires in the MRR. The high population density is a catalytic factor. Therefore, analyzing the fires in buildings by their mapping, constructive peculiarities, type of occupation, local estimation of primary foci, as well as the existing fire load, can effectively contribute to the implementation of public policies aimed at reducing the problem.

**METHODOLOGY**

The method used in our research to measure and present data is based on the tabulation of data on events in MRR buildings that caused deaths and wounded people in the period from 2013 to 2016 obtained from the Military Firefighters Department of Pernambuco.

Thus, our study is based on the hypothetical deductive logic proposed by Lakatos and Marconi. They suggest that the research hypothesis should collect subsidies for proof, considering the possible relation between lethal fires and their characterization in the area studied.
For such purpose, we selected all the occurrence reports of fires in buildings in the MRR from the Military Firefighters Department of Pernambuco between 2011 and 2013, and analyzed those that resulted in deaths and wounded people.

The analysis of the selected occurrence reports follows a pattern established in Brazil and allows a better appreciation of the fires, as well as the drawing of a profile of the scenario. Among the points observed are: victim’s information (gender and age), emergency address, event characteristics, rescue vehicles used, distance, response time, occurrence history, building characteristics, existing preventive systems, presumed origin of the fire, affected area, type of construction, and fields for observations, which may include, the place where the victim was found, injury site, damaged furniture, victims’ schooling, among other data judged important by the on-site team leader.

Some information received by the Fire Department was not collected directly with the affected family, but with neighbors and friends due to the emotional state of the relatives of the deceased or injured persons. In some cases, this result in the absence of some information. Furthermore, in a few cases, there was no one present to provide the data to firefighters, thus resulting in a limited number of information about the occurrence.

Demographic databases of the Brazilian Institute of Geography and Statistics (IBGE) were also used in our research.

DISCUSSION AND RESULTS

Fires in Brazilian urban centers result from the disorderly growth and the insufficient fire safety infrastructure of cities. Other factor is the creation and maintenance of favelas or conglomeration of sub-dwellings, composed of precarious constructions made almost exclusively of very flammable materials, with precarious facilities and equipment, becoming a “powder keg”[^8].

Out of the 3,961 fires in the state of Pernambuco assisted by the Firefighters Department in 2016, 2,503 occurred in the MRR, of which 835 (33.3%) corresponded to fires in buildings, that is, in residences, shops, warehouses, hospitals, factories, schools, among others.

The predominance of fires in buildings is evident; with a percentage very close to that worldwide (38.8%), according to IAFRS/CTIF[^4].

By computing the analyzed data of fires in buildings that caused deaths from 2013 to 2016, we found 16 occurrences with 16 deaths. Fires that resulted in wounded people, in turn, consisted in 49 occurrences with 61 victims, according to Table 1.
Table 1 – Occurrences with deaths and injuries from 2013 to 2016 in the MRR

| Fire         | Date     | City         | Type of building | Number of deaths | Gender | Age       |
|--------------|----------|--------------|------------------|------------------|--------|-----------|
| Occurrence1  | 21FEB13  | Olinda       | Single-family    | 01               | Male   | 01 year   |
| Occurrence 2 | 16MAR13  | Recife       | Single-family    | 01               | Male   | ×*        |
| Occurrence 3 | 26DEC13  | Olinda       | Single-family    | 01               | Male   | ~ 45 years ** |
| Occurrence 4 | 05FEB14  | Recife       | Single-family    | 01               | Male   | 66 years  |
| Occurrence 5 | 22MAR14  | Recife       | Single-family    | 01               | Female | 28 years  |
| Occurrence 6 | 17OCT14  | Recife       | Single-family    | 01               | Female | 77 years  |
| Occurrence 7 | 22DEC14  | Recife       | Single-family    | 01               | Male   | 01 years  |
| Occurrence 8 | 07MAY15  | Olinda       | Single-family    | 01               | Male   | 41 years  |
| Occurrence 9 | 25OCT15  | Recife       | Single-family    | 01               | Female | ~ 40 years ** |
| Occurrence 10| 26OCT15  | Abreu e Lima | Single-family    | 01               | Male   | 47 years  |
| Occurrence 11| 08DEC15  | Jaboatão dos Guararapes | Single-family | 01 | Female | 6 years |
| Occurrence 12| 11DEC15  | São Lourenço da Mata | Single-family | 01 | Male | 41 years |
| Occurrence 13| 01AUG16  | Recife       | Single-family    | 01               | Female | 4 years |
| Occurrence 14| 03AUG16  | Jaboatão dos Guararapes | Single-family | 01 | Male | 10 months |
| Occurrence 15| 05AUG16  | Cabo de S. Agostinho | Single-family | 01 | Male | ~ 40 years ** |
| Occurrence 16| 21DEC16  | Jaboatão dos Guararapes | Single-family | 01 | Male | 43 years |

Table 1 (continued)

| Fire         | Date     | City         | Type of building | Amount of wounded individuals | Gender | Age       |
|--------------|----------|--------------|------------------|--------------------------------|--------|-----------|
| Occurrence1  | 03FEB13  | Paulista     | Multifamily      | ×*                             | ×*     | ×*        |
| Occurrence 2 | 17FEB13  | Olinda       | Single-family    | Male                           | ×*     | ×*        |
| Occurrence 3 | 21FEB13  | Olinda       | Single-family    | Female                         | 62 years | × * |
| Occurrence 4 | 26MAR13  | Recife       | Single-family    | Male                           | × *    | × *        |
| Occurrence 5 | 07JUN13  | Recife       | Single-family    | Male                           | 62 years | × * |
| Occurrence 6 | 16SEPT13 | Recife       | Single-family    | Male                           | 63 years | × * |
| Occurrence 7 | 27SEPT13 | Olinda       | Single-family    | Male                           | 82 years | × * |
| Occurrence 8 | 01NOV13  | Recife       | Single-family    | Male                           | 35 years ** | × * |
| Occurrence 9 | 18NOV13  | Recife       | Single-family    | Male                           | 35 years ** | × * |
| Occurrence 10| 06DEC13  | Olinda       | Single-family    | Male                           | ~ 35 years ** | × * |
Table 1 – Occurrences with deaths and injuries from 2013 to 2016 in the MRR (continued)

| Fire       | Date     | City         | Type of building | Amount of wounded individuals | Gender          | Age       |
|------------|----------|--------------|-----------------|------------------------------|-----------------|-----------|
| Occurrence 11 | 08JAN14  | Recife       | Single-family    | 01                           | Female          | 94 years  |
| Occurrence 12 | 21JAN14  | Recife       | Single-family    | 01                           | Male            | 35 years  |
| Occurrence 13 | 05FEB14  | Recife       | Single-family    | 01                           | Female × *      |           |
| Occurrence 14 | 17FEV14  | Recife       | Multifamily      | 02                           | Female and Male 65 and 32 years |            |
| Occurrence 15 | 22FEB14  | Recife       | Single-family    | 01                           | Female          | 31 years  |
| Occurrence 16 | 17MAR14  | Recife       | Single-family    | 01                           | Female × *      |           |
| Occurrence 17 | 22MAR14  | Recife       | Single-family    | 01                           | Male            | 49 years  |
| Occurrence 18 | 27MAR14  | Recife       | Single-family    | 01                           | Male × *        |           |
| Occurrence 19 | 01JUL14  | Recife       | Single-family    | 01                           | Female          | 59 years old |
| Occurrence 20 | 14AUG14  | Paulista     | Single-family    | 02                           | Male and Female × * and × * |           |
| Occurrence 21 | 07SEPT14 | Olinda       | Single-family    | 02                           | Female and Female 35 and 40 years |            |
| Occurrence 22 | 11DEC14  | Recife       | Single-family    | 02                           | Female and Male × * and 4 years |            |
| Occurrence 23 | 15DEC14  | Paulista     | Single-family    | 01                           | Male            | ~ 40 years ** |
| Occurrence 24 | 03JAN15  | Olinda       | Single-family    | 01                           | Female          | 42 years  |
| Occurrence 25 | 16JAN15  | Recife       | Single-family    | 01                           | Male            | ~ 45 years ** |
| Occurrence 26 | 26MAR15  | Olinda       | Single-family    | 02                           | Male and Female × * and × * |            |
| Occurrence 27 | 19APR15  | Recife       | Single-family    | 01                           | Female          | × *       |
| Occurrence 28 | 07MAIO15 | Olinda       | Single-family    | 01                           | Female          | 63 years  |
| Occurrence 29 | 08MAY15  | Olinda       | Single-family    | 03                           | 2 Male and 1 Female and Male 4, × * and × 4 years |            |
| Occurrence 30 | 12MAY15  | Olinda       | Single-family    | 01                           | Female          | × *       |
| Occurrence 31 | 11SEPT15 | Paulista     | Single-family    | 01                           | Male            | 33 years  |
| Occurrence 32 | 19SEPT15 | Recife       | Single-family    | 01                           | Female          | 58 years  |
| Occurrence 33 | 22OCT15  | Recife       | Multifamily      | 01                           | Male            | × *       |
| Occurrence 34 | 14NOV15  | Jaboatão dos Guarárapes Recife | Single-family | 02                           | 2 Male          | 3 and 4 years |
| Occurrence 35 | 16NOV15  | Recife       | Single-family    | 02                           | Female and Male 25 and 17 years |            |
| Occurrence 36 | 08DEC15  | Recife       | Single-family    | 01                           | Male            | ~ 15 years ** |
| Occurrence 37 | 20JAN16  | Jaboatão dos Guarárapes Recife | Single-family | 01                           | Male            | × *       |
| Occurrence 38 | 24FEB16  | Recife       | Multifamily      | 01                           | Female          | 39 years  |
Table 1 – Occurrences with deaths and injuries from 2013 to 2016 in the MRR (conclusion)

| Occurrence | Date   | City                  | Type of building | Amount of wounded individuals | Gender          | Age               |
|------------|--------|-----------------------|------------------|-------------------------------|-----------------|------------------|
| 39         | 27FEB16| Recife                | Multifamily      | 02                            | Male and Female | 66 and 60 years  |
| 40         | 24MAY16| Jaboatão dos Guararapes | Single-family   | 01                            | Female          | 82 years         |
| 41         | 25MAY16| Recife                | Single-family    | 02                            | 2 female        | 46 and 21 years  |
| 42         | 27MAY16| Recife                | Single-family    | 01                            | Male            | ×                 |
| 43         | 30MAY16| Jaboatão dos Guararapes | Single-family   | 01                            | Female          | 41 years         |
| 44         | 20JUL16| Pau Jau               | Single-family    | 02                            | Female and Male | 49 and 53 years  |
| 45         | 28AUG16| Jaboatão dos Guararapes | Single-family   | 01                            | Male            | ×                 |
| 46         | 02SEPT16| Olinda               | Single-family    | 02                            | Female and Male | 49 and 57 years  |
| 47         | 26SEPT16| Recife               | Multifamily      | 01                            | Male            | ×                 |
| 48         | 15NOV16| Recife                | Single-family    | 01                            | ×                | ×                 |
| 49         | 26DEC16| Itapissuma            | Single-family    | 01                            | Female          | 22 years         |

Source: Research data.
* Information not given to the MFDPE and not known by the community during the completion of the report.
** Approximate ages due to lack of documents for confirmation.

Among the cases that resulted in death, 15 of the 16 buildings involved single-family residences, corresponding to 94% of the cases. Of those that resulted in wounded people, 88% were single-family residences, whereas 12% were classified as multifamily residences.

We can clearly observe the predominance of lethal fires in the MRR in single-family residences, or simply “houses”, usually built with a single floor and intended for single-family housing. We emphasize that this is the only Type of Building (TYPE A) without a preventive system against fires, according to the main laws and standards of fire safety in Brazil. Fires in these households out of standards are characterized by confinement of flames in the rooms and free spread of smoke throughout the environment, thus generating a greater probability of injuries and even deaths.

In a study by Santos, in which he compared general fires with residential fires in the state of São Paulo in 2014. The author demonstrated that, although there is a small proportion of fires in households, the percentage of deaths in this type of building was high, close to 90%, in line with the data shown in Table 1. He also mentions that, in some countries, the strategy of using fire detectors as primary prevention is well accepted to mitigate fires with deaths, mainly night fires and those involving older adults and vulnerable people. The primary prevention of deaths in residential fires in Brazil is public education, seeking to avoid the main causes of fire.
For Zago et al.\textsuperscript{12}, the likelihood of a fire to spread is reduced in buildings with smoke detectors, automatic showers, fire brigade and adequate divisions, which are not found in the houses.

According to Corrêa et al.\textsuperscript{6}, fires in single-family buildings account for almost 3/4 of household fires.

Table 2 shows some other observations made during data analysis.

**Table 2** – Fires with deaths and injuries in the MRR from 2013 to 2016

| Date      | City          | Schedule warning | Distance from the MFDPE | Response time | Type of building |
|-----------|---------------|------------------|--------------------------|---------------|------------------|
| 21FEB13   | Olinda        | 11:40 h          | 25 Km                    | 15 min        | wood             |
| 16MAR13   | Recife        | 08:20 h          | 11 Km                    | 10 min        | × *              |
| 26DEC13   | Olinda        | 14:45 h          | 23 Km                    | 13 min        | Masonry          |
| 05FEB14   | Recife        | 01:13 h          | 8 Km                     | 7 min         | Masonry          |
| 22MAR14   | Recife        | 15:11 h          | 11 Km                    | 26 min        | Masonry          |
| 17OCT14   | Recife        | 03:04 h          | 5 Km                     | 10 min        | Masonry + Concrete |
| 22DEC14   | Recife        | 03:50 h          | 3 Km                     | 4 min         | Masonry          |
| 07MAY15   | Olinda        | 02:59 h          | 4 Km                     | 8 min         | Masonry          |
| 25OCT15   | Recife        | 03:59 h          | 22 Km                    | 19 min        | Masonry          |
| 26OCT15   | Abreu e Lima  | 11:20 h          | 16 Km                    | 24 min        | Masonry          |
| 08DEC15   | Jaboatão dos Guararapes | 23:20 h | 4 Km | 16 min | Masonry |
| 11DEC15   | São Lourenço da Mata | 22:43 h | 3 Km | 6 min | Masonry |
| 01AUG16   | Recife        | 21:05 h          | 6 Km                     | 16 min        | Masonry          |
| 03AUG16   | Jaboatão dos Guararapes | 21:01 h | 6 Km | 12 min | Masonry |
| 05AUG16   | Cabo de S. Agostinho | 21:00 h | 19 Km | 24 min | wood |
| 21DEC16   | Jaboatão dos Guararapes | 23:19 h | 2 Km | 3 min | Masonry |

| Date      | City          | Time of the call | Distance from the MFDPE | Response time | Type of building |
|-----------|---------------|------------------|--------------------------|---------------|------------------|
| 03FEB13   | Paulista      | 11:36 h          | 25 Km                    | 27 min        | Masonry + Concrete |
| 17FEB13   | Olinda        | 21:35 h          | 10 Km                    | 24 min        | Masonry          |
| 21FEB13   | Olinda        | 11:40 h          | 25 Km                    | 15 min        | wood             |
| 26MAR13   | Recife        | 19:00 h          | 10 Km                    | 23 min        | Masonry          |
| 07JUN13   | Recife        | 19:47 h          | 7 Km                     | 17 min        | Masonry          |
| 16SEPT13  | Recife        | 16:05 h          | 7 Km                     | 12 min        | Masonry          |
| Date        | City            | Time of the call | Distance from the MFDPE | Response time | Type of building |
|-------------|-----------------|------------------|-------------------------|---------------|-----------------|
| 27SEPT13    | Olinda          | 12:55 h          | 6 Km                    | 17 min        | Masonry         |
| 01NOV13     | Recife          | 21:28 h          | 13 Km                   | 17 min        | Masonry         |
| 18NOV13     | Recife          | 12:20 h          | 7 Km                    | 16 min        | Masonry         |
| 06DEC13     | Olinda          | 08:00 h          | 2 Km                    | 5 min         | Masonry         |
| 08JAN14     | Recife          | 15:17 h          | 7 Km                    | 17 min        | Masonry         |
| 21JAN14     | Recife          | 08:14 h          | 4 Km                    | 5 min         | Masonry         |
| 05FEB14     | Recife          | 01:13 h          | 8 Km                    | 7 min         | Masonry         |
| 17FEB14     | Recife          | 03:00 h          | 3 Km                    | 7 min         | Masonry + Concrete |
| 22FEB14     | Recife          | 03:50 h          | 6 Km                    | 20 min        | Masonry         |
| 17MAR14     | Recife          | 18:20 h          | 16 Km                   | 30 min        | Masonry         |
| 22MAR14     | Recife          | 15:11 h          | 11 Km                   | 26 min        | Masonry         |
| 27MAR14     | Recife          | 13:52 h          | 9 Km                    | 27 min        | Masonry + Wood  |
| 01JUL14     | Recife          | 06:14 h          | 6 Km                    | 10 min        | Masonry         |
| 14AUG14     | Paulista        | 12:10 h          | 10 Km                   | 17 min        | Masonry         |
| 07SEPT14    | Olinda          | 13:59 h          | 9 Km                    | 20 min        | Masonry         |
| 11DEC14     | Recife          | 10:17 h          | 9 Km                    | 17 min        | Masonry         |
| 15DEC14     | Paulista        | 23:03 h          | 14 Km                   | 19 min        | Masonry         |
| 03JAN15     | Olinda          | 00:08 h          | 12 Km                   | 20 min        | Masonry         |
| 16JAN15     | Recife          | 13:15 h          | 2 Km                    | 6 min         | Masonry         |
| 26MAR15     | Olinda          | 00:20 h          | 4 Km                    | 8 min         | Masonry         |
| 19APR15     | Recife          | 20:09 h          | 18 Km                   | 18 min        | wood            |
| 07MAY15     | Olinda          | 02:59 h          | 4 Km                    | 8 min         | Masonry         |
| 08MAY15     | Olinda          | 01:49 h          | 2 Km                    | 10 min        | Masonry         |
| 12MAY15     | Olinda          | 00:15 h          | 8 Km                    | 14 min        | Masonry         |
| 11SEPT15    | Paulista        | 18:27 h          | 12 Km                   | 21 min        | Masonry         |
| 19SEPT15    | Recife          | 13:05 h          | 8 Km                    | 15 min        | Masonry         |
| 22OCT15     | Recife          | 10:27 h          | 1 Km                    | 1 min         | Masonry + Concrete |
| 14NOV15     | Jaboatão dos Guararapes | 14:21 h  | 7 Km                    | 20 min        | Masonry         |
In Table 2, we can verify that fires involving dead and injured people occurred mostly from 21:00 to 06:00h, representing 43% of the total number of occurrences. This often shows the fragility of residential buildings, mainly single-family dwellings. This type of house does not have internal preventive systems to recognize the beginning of a fire and equipment to control it, especially in hours when a large part of the population is already sleeping or less attentive, resting after an intense day of activities. However, 25% of the occurrences began between 10h and 14h, when many people cook, largely due to negligence and malpractice in the handling of gas cylinders.

The buildings that were burned in fires in the MRR during the studied period had diverse construction modalities. However, residential buildings, either single- or multi-family, were mostly made of masonry.
Masonry buildings have walls with structural and divisive function in the environments (structural masonry, resistant masonry). In the MRR, masonry buildings are mostly made of ceramic bricks, according to Figure 1.

**Figure 1** – Damage caused in the structural masonry of some houses due to fire and some access way to sites where fires happened

Source: Research data.
Figure 1 shows that the resistance of the structure is compromised not only by the absence of the coating layer, but also by the damages caused in the ceramic bricks. According to Leite et al.\textsuperscript{13}, resistance to fires consists in the ability of a structural element to maintain the functions for which it was designed after a certain time on fire. Moreover, the building must remain fire resistant to ensure safe escape of occupants, as well as to ensure the safety of firefighting operations by firefighters and minimize the damage to adjacent buildings and to public infrastructure.

An average response time of approximately 13 minutes is seen for occurrences with fatalities, and 17 minutes for those, in which victims had only injuries. The average displacement was 10.5 km for fires with dead people and 8.8 km for those with injured people. Most of the occurrences happened between the night and dawn, which favors a low response time due to a smaller flow of vehicles. However, the night period hinders the aid of passers-by to access the affected places, which is important for the military firefighters, since the place is unknown in a considerable number of fires. Another complicating factor is the likelihood of risk related to the firefighters’ own physical safety when they arrive at the place of the fire, and the support and presence of the Military Police is required to enter certain neighborhoods; this specific situation can lead to a delay in the response time. Furthermore, almost half of the reports filled by firefighters pointed out the distance of more than 6 km from the base to the place of the fire as a difficulty in the response, followed by 20% that pointed out the lack of data and signs to find the address of the occurrence.

In the occurrences in the morning or afternoon, the heavy flow of vehicles combined with small streets makes the transit of large vehicles difficult. For Corrêa et al.\textsuperscript{14}, the response to fires in buildings in the MRR comes from the base of the Military Firefighter Department of Pernambuco – MFDPE. These bases or barracks with fire fighting vehicles arrive to only six addresses, which is obviously a limiting factor, especially with the increase of the vehicle fleet in the MRR of more than 380% in 24 years (1990-2014), from 251.420 to 1.22 million motor vehicles, resulting in mobility difficulties\textsuperscript{15}.

It is noteworthy that among the deaths, five of the sixteen victims were less than 10 years old, showing the risk of both lack of knowledge and limitations in distinguishing and evaluating the danger. Table 2 shows the fire of November 14, 2015, in which the two children involved were 3 and 4 years old and the fire started when the two boys played with a cigarette lighter in a room. This case exemplifies the preponderant factor of harmful events of fires when children are involved, which is mainly their lack of awareness of the danger and their limitations to take action in the beginning of a tragedy.
Another factor associated with deaths is criminal action. This was the case of the fire that caused the death of a woman aged approximately 40 years, on October 25, 2015; a man apparently 40 years old, on August 05, 2016; and a man aged 43 years, on December 21, 2016. Another point to be mentioned is the involvement of people with mental disorders that can lead to suicidal actions, such as the case in five occurrences involving deaths and other five involving wounded people. Regarding the fire-generating factors, 20% of the reports indicated that the fire started due to bad handling of the cooking gas cylinders.

Among the 65 occurrences involving deaths and injured people, only 10% occurred in multi-family residences, whereas 90% occurred in single-family residences, mostly located on the suburb of cities. In addition to the existence of preventive systems, although restricted, in multifamily buildings, is another characteristic favorable to lower percentage of lethal events is the profile of the people living in these buildings, generally located in rich areas of the cities. These people have a higher schooling when compared with the population living in
the suburbs, in houses with poor facilities\textsuperscript{16}. The higher level of schooling and, consequently, the knowledge of what to do in emergencies were possibly factors that minimized greater damages to these people.

Since wounds and deaths caused by fires are a concern not only of the local Firefighter Department, we tried to compare the MRR with other countries and cities. Regarding the number of deaths, the MRR presents a proportion of 0.1 deaths per 100,000 inhabitants (2014), very close to the figures in countries such as Singapore and Vietnam\textsuperscript{4}. Regarding injured victims, the MRR presented close values to those in Ukraine and Bulgaria, and worse values than Singapore, Vietnam, Croatia and Slovenia, with a proportion of 0.35 per 100,000 inhabitants.

In an analysis that estimates the proportion of the number of dead and injured people in relation to the number of fires assisted in the MRR, it was seen the proportion of 1 death each 195.5 fires and 1 wounded person each 60.1 fires. Compared to Table 3, regarding the number of deaths per 100 fires, the MRR has the worst rate among all countries/regions listed, whereas in the case of the number of injured individuals per 100 fires, the MRR is ahead only of France, Great Britain and Singapore.

Table 3 – Fires with dead and injured people in the MRR and in the world in 2014

| Country/City/Region | Number of fires | Number of dead people | Number of injured people | 1 dead person per 100 fires | 1 injury person per 100 fires |
|---------------------|-----------------|-----------------------|--------------------------|-----------------------------|-------------------------------|
| MRR\*               | 782             | 4                     | 13                       | 0.5                         | 1.7                           |
| USA                 | 1,298,000       | 3.275                 | 15.775                   | 0.3                         | 1.2                           |
| France              | 270,900         | 280                   | 13.703                   | 0.1                         | 5.1                           |
| Great Britain       | 212,500         | 322                   | 9.748                    | 0.2                         | 4.6                           |
| Poland              | 145,237         | 493                   | -                        | 0.3                         | -                             |
| Singapore           | 4,724           | 8                     | 111                      | 0.2                         | 2.3                           |
| Croatia             | 7,317           | 21                    | 71                       | 0.3                         | 1.0                           |
| Slovenia            | 5,917           | 0                     | 53                       | 0.0                         | 0.9                           |
| New York            | 42,043          | 71                    | -                        | 0.2                         | -                             |
| Hong Kong           | 767,215         | 23                    | 295                      | 0.1                         | 0.8                           |
| Berlin              | 6,456           | 27                    | -                        | 0.4                         | -                             |

Source: Report 21 International Association Fire and Rescue Services\textsuperscript{4}.

\* Results of search.

CONCLUSION

With a considerable number of fires that have generated deaths and injured people over the last 4 years, compared to other places in the world, the probability of the occurrence of new events in the Metropolitan Region of Recife is not low, mainly due to the high population density allied to substandard constructions and vertical constructions that are not always planned considering the precautionary concerns appropriate to the risks.
Present in 1/3 of all fires recorded in the MRR, house fires stand out as the leading cause of dead and injured people. The lack of preventive systems in single-family buildings is a catalytic factor. According to the data collected in our research, single-family residences were involved in 94% of the fires that resulted in deaths and 88% of those that caused injuries to the victims.

A factor that must be improved to provide more accurate data for possible studies is the completion of the reports by the Firefighter Department. Despite the absence of documents of some fires, all information collected should be considered in the report of the occurrence, including those provided by informants, even in the fields of observations.

Thus, the population’s awareness on preventive measures to be adopted is an important task of the Military Firefighter Department of Pernambuco in the fight against the minimization of problems produced by the fires. Moreover, it is necessary to work with children so that they not only pass on the knowledge to their families, but also develop the perception of risks and dangers from fire-propagating actions, since they are statistically the most involved in this scenario of human losses.

Therefore, the monitoring and evaluation of public strategies and policies that strengthen the mitigation of problems are essential to minimize fire-related accidents, especially those involving residential buildings.

Due to the high risk of fires in single-family and multi-family dwellings, we recommend to study a technical standard for this type of buildings, raising questions such as equipment that may contribute to the identification of the beginning of a fire, the attitude of the population in response to the incident, and improved response time of firefighting teams and other measures that preserve people’s integrity.

Further studies are needed to deepen questions related to fatality related to fires and to ratify the figures presented in our study by quantitative and qualitative assessments, thus allowing us to increasingly provide information to managers for decision making to reduce the number of dead and injured people.

**AUTHORS’ CONTRIBUTION**

1. Study conception, data analysis and interpretation: Roberto Ryanne Ferraz de Menezes, Cristiano Corrêa, José Jéferson Rêgo e Silva and Tiago Ancelmo Pires.

2. Article writing and critical review: Roberto Ryanne Ferraz de Menezes and Cristiano Corrêa.
3. Critical review and/or approval of final version: José Jéferson Rêgo e Silva and Tiago Ancelmo Pires.

4. Public responsibility of the intellectual content: Roberto Ryanne Ferraz de Menezes.

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