




Spatial analysis of traffic accidents involving older adults in a city in the northeast of Brazil

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Abstract

Objective: to describe the epidemiological characteristics of traffic accidents involving older victims, responded to by the Mobile Emergency Service (or SAMU), and to analyze the spatial distribution of these events in the city of Olinda, Pernambuco, Brazil, from 2015 to 2018. **Method:** a composite cross-sectional study was performed, using SAMU service records as a data source. Descriptive statistics were applied, based on frequency distribution. For the mapping and detection of spatial clusters, the Kernel intensity estimator was used. **Results:** SAMU responded to 137 traffic accidents with older victims. The most affected age group were older adults aged 60 to 69 years (81; 59.1%), and there was a predominance of male victims (90; 65.7%). The day of the week when most accidents occurred was Wednesday (29; 21.25%), and the highest number of accidents occurred in the morning (46; 33.6%). As for the nature of the accident, accidents involving pedestrians (80; 58.4) predominated over collisions (57; 41.6%). The Kernel intensity estimator identified a significant focus in the Peixinhos neighborhood, with other foci distributed throughout the coastal area. **Conclusion:** the study identified the characteristics of older victims of traffic accidents and areas of greatest risk for their occurrence in the city studied. This information can be useful when planning environmental engineering measures to be carried out in the regions identified, in order to reduce the frequency of accidents and injuries.

Keywords: Accidents, Traffic. Health of the Elderly. Prehospital Care. Emergency Medical Services. Spatial Analysis.

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INTRODUCTION

The development of human societies has been accompanied by an increase in life expectancy and in the number of older adults. Between 2000 and 2050, the proportion of the world's population aged over 60 years will double from around 11% to 22%, with the number of people in this age group expected to increase from 605 million to two billion in the same period¹. In Brazil, projections by the Brazilian Institute of Geography and Statistics (or IBGE) indicate that, in 2060, the percentage of the population aged 65 or over will reach 25.5% (58.2 million older adults). In 2018, this proportion was 9.2% (19.2 million)².

With population aging, there has been a corresponding increase in the total number of older users of roadways, either as vehicle occupants or as pedestrians³. A number of challenges associated with natural aging, including sensory, perceptual, cognitive and motor declines, can affect reaction time and the ability to drive^{4,5}. Older adults are therefore a vulnerable group of road users, with high mortality and morbidity from traffic accidents^{3,6}.

Geographic Information Systems (GIS) are commonly used to analyze traffic accidents⁷, allowing accident data to be presented visually, and the locations of such events to be analyzed⁸. By identifying the most common locations and/or sections of roads with high accident rates, traffic authorities can adopt preventive measures and apply regulations to reduce the frequency of accidents, deaths, injuries and financial losses⁷. The Kernel intensity estimation method, meanwhile, allows a simple assessment of data relating to the density of points or clusters of sites of accidents involving older adults^{9,10}.

As traffic accidents represent one of the most important current public health problems, the analysis of the geographical distribution of such accidents involving the older population can help policy makers devise measures aimed at reducing them. The present study aimed to describe the epidemiological characteristics of events involving older victims of traffic accidents, responded to by the Mobile Emergency Service (or SAMU), and to

analyze the spatial distribution of these events in the city of Olinda, Pernambuco, from 2015 to 2018.

METHOD

A cross-sectional study was carried out in the city of Olinda, Pernambuco, Brazil (Figure 1). The city has a territorial extension of 41,681 km², with an estimated population of 389,494 inhabitants, distributed over 31 neighborhoods. Its demographic density rate is 9,360.236 inhabitants/km², the highest in the state of Pernambuco and the fifth largest in Brazil².

The study included SAMU responses to traffic accidents (collisions and being run over), the victims of which were 60 years of age or older, between January 1, 2015 and December 31, 2018. The data source was SAMU the response forms, which are filled out by the teams at the time of the call-out. These data were analyzed from September 2017 to January 2018. The variables analyzed were: demographic (sex and age group) and those related to the accident (type of accident, day of the week, time of occurrence and place of occurrence). The variables duration of call-out and type of vehicle involved in the accident were excluded due to the high non-completion rate: 25.5% and 35.8%, respectively. Descriptive statistics were used for data analysis, using the R program (version 3.6.1).

For spatial analysis, the responses were categorized according to the neighborhood of occurrence and geocoded. The QGIS program, version 2.18, was used to map and detect spatial clusters with the Kernel intensity estimator. This is a non-parametric method used to identify spatial patterns, which calculates the density of events around each point, weighted by the distance from the point of each event¹¹. Thus, peaks represent the presence of clusters or hot spots in the distribution of events, while low values represent events that occur less frequently in the area^{10,12}. In the present study, a radius of 500 meters was adopted.

The project was approved by the Research Ethics Committee of the Complexo Hospital da Universidade de Pernambuco (the University of Pernambuco Hospital Complex), Hospital

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(29; 21.25) and Fridays (28; 20.4%). The months of October (20; 14.6%) and January (18; 13.1%) had the highest number of call-outs. As to the nature of the accident, those involving pedestrians (80; 58.4) predominated over collisions (57; 41.6%) (Table 1).

RESULTS

During the study period, 137 SAMU responses to traffic accidents with older victims were recorded. Most of the victims were male (90; 65.7%), while the average age was 70.4 years (± 0.7), and ranged from 60 to 98 years. The highest frequency was for the group aged from 60 to 69 years (81; 59.1%)

The spatial analysis, performed using the Kernel density estimator, showed that traffic accidents involving older adults responded to by SAMU in Olinda were concentrated in the neighborhoods of Peixinhos (the main focus), along Avenida Presidente Kennedy. Medium intensity areas were identified on the coast, located in the neighborhoods of Casa Caiada and Bairro Novo, intersected by the avenues Governador Carlos de Lima Cavalcanti and Getúlio Vargas, respectively, while there were less significant areas in the neighborhoods of Carmo, Varadouro, Fragoso, Bultrins and Salgadinho (Figure 2).

Regarding the characteristics of the responses, the highest frequency was in the morning, from 6 am to 11:59 am (46; 33.6%), followed by the afternoon, from 12 pm to 5:59 pm (44; 32.1%), on Wednesdays

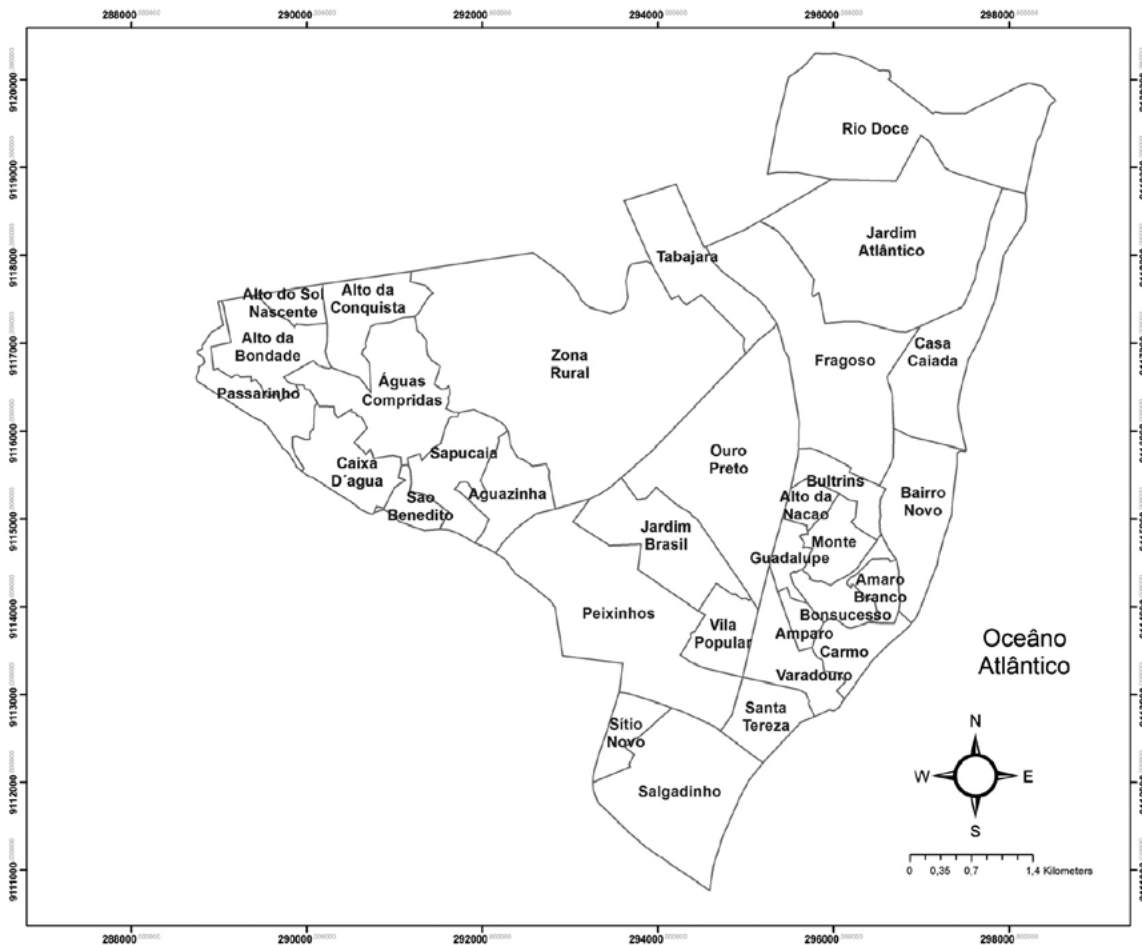


Figure 1. Location and divisions of neighborhoods in the city of Olinda, Pernambuco, Brazil.

Table 1. Epidemiological characteristics of older victims of traffic accidents responded to by SAMU 192, between 2015 and 2018 in the city of Olinda, Pernambuco, Brazil, 2018.

Variables	n(%)
Sex	
Female	47(34.3)
Male	90(65.7)
Age group (in years)	
60 to 69	81(59.1)
70 to 79	35(25.5)
80 and over	21(15.3)
Time of occurrence	
00:00 to 05:59	7(5.1)
06:00 to 11:59	46(33.6)
12:00 to 17:59	44(32.1)
18:00 to 23:59	40(29.2)
Day of the week	
Sunday	16(11.7)
Monday	16(11.7)
Tuesday	9(6.6)
Wednesday	29(21.2)
Thursday	20(14.6)
Friday	28(20.4)
Saturday	19(13.9)
Month	
January	18(13.1)
February	10(7.3)
March	15(10.9)
April	7(5.1)
May	5(3.6)
June	10(7.3)
July	8(5.8)
August	10(7.3)
September	12(8.8)
October	20(14.6)
November	10(7.3)
December	12(8.8)
Nature of the accident	
Run over	80(58.4)
Collision	57(41.6)

Source: Prepared by the authors based on data from SAMU. Olinda, Pernambuco.

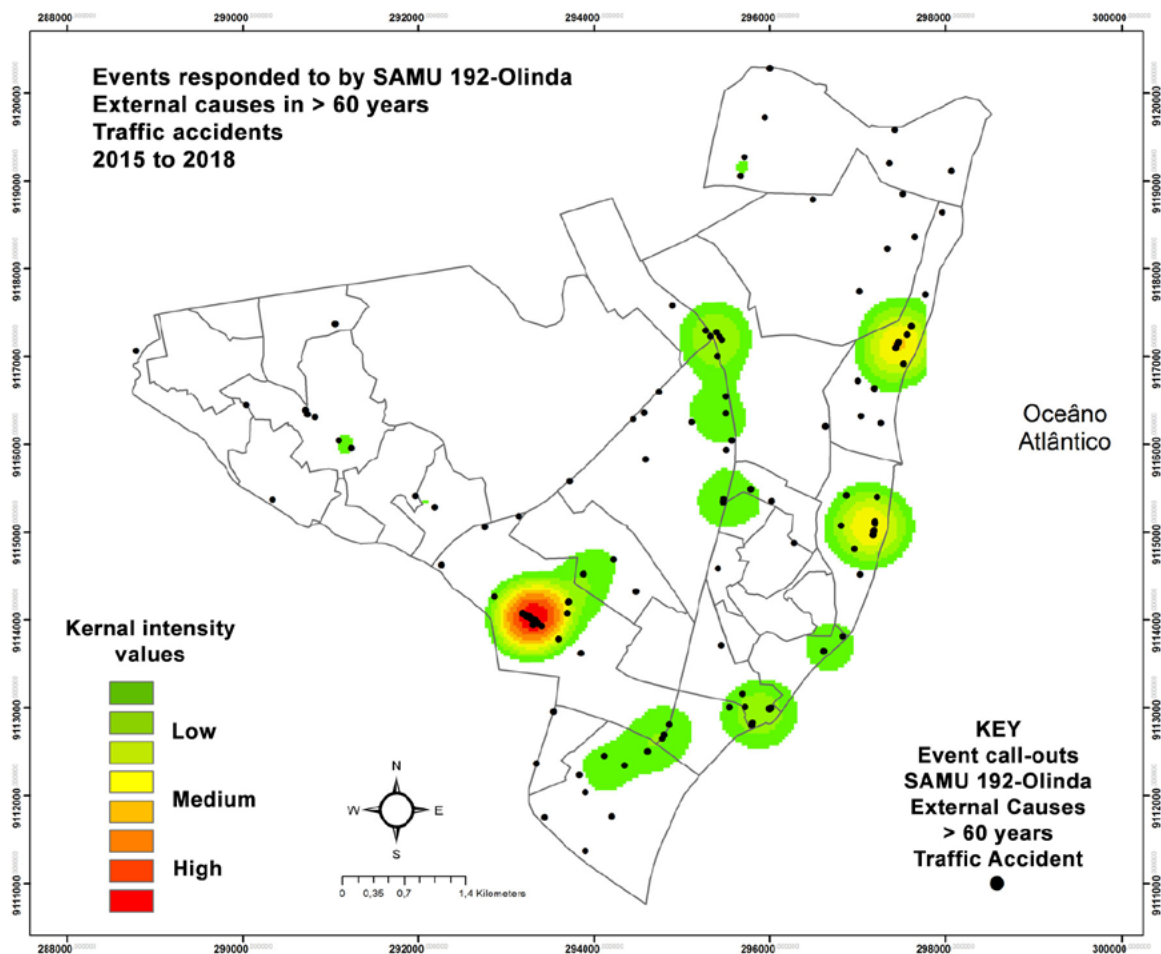


Figure 2. Spatial distribution and intensity of traffic accidents involving older adults responded to by SAMU from 2015 to 2018, Olinda, Pernambuco, Brazil.

DISCUSSION

Older adults account for a substantial number of hospitalizations and deaths caused by traffic accidents⁶. The present study investigated the demographic and occurrence profiles of pre-hospital emergency care in accidents involving older adults. Individual characteristics, such as sex, health conditions and socioeconomic status can provide a better understanding of individuals' vulnerability to old age, in combination with urban infrastructure and traffic conditions¹³.

The demographic characteristics of the present study demonstrated that the highest frequency of call-

outs involved older adults, aged 60 to 69 years old. A recent review study on traffic accidents involving such older adults identified, as a demographic profile, the male sex and the age group from 60 to 69 years¹⁴. The fact that younger older adults are the most affected shows is most likely because such adults have a more active life, with independence and autonomy, and activities outside the home form part of their daily routine¹⁵. A study¹⁶ that aimed to estimate the burden of traffic accidents and mortality among older adults found that the highest occurrence was in the 60 to 74 year old age group, among men, and involved mild trauma. In terms of mortality, older adults over 75 years old and pedestrians had a greater chance of death.

In accidents of equal severity, the morbidity and mortality of older adults are higher than those of young adults^{17,18}. A study in Chile identified greater vulnerability among older adults, with a 0.5 times higher rate of suffering a traffic accident, a 0.6 times higher rate of suffering an injury as a result of such accident, and a 1.3 times higher rate of mortality as a result of said accident, than young adults¹⁹. In Brazil, in 2017, the Mortality Information System recorded 6,030 deaths from traffic accidents among people aged over 60 years²⁰.

The occurrences mostly occurred during the day, during the week and in the months of January and October. A study that analyzed the risk of collisions according to age, sex and time of day showed that the risk of fatal injury remained constant throughout the day for drivers over 70 years old, reinforcing the greater frailty of this population to this type of accident²¹. Older adults experience a decline in driving skills and other body functions, increasing the likelihood of dying as a result of a traffic accident²². In Sweden, the spatial-temporal analysis of accidents involving older adults found that they occur on weekdays, during the day and in the coldest months of the year¹³. In a review of accidents involving older adults¹⁴, it was observed that such adults use self-regulatory behaviors, that is, those involving the self-reported decision to protect oneself, with the adoption of strategies such as reducing exposure to traffic, driving at a reduced speed and avoiding driving at night.

Being knocked down was the main type of accident found. Literature highlights the significance of being run over as a result of traffic accidents involving older adults^{9,14,15}. This can be explained by declining reflexes, a loss of hearing and vision, a loss of strength and agility, the presence of chronic diseases and the use of polypharmacy to treat comorbidities, which can negatively affect older adults when crossing public roads. Being run over is the main cause of morbidity and mortality from traffic accidents in this population group^{14,16,23}.

When accidents were analyzed by the type of occurrence, it was observed that older pedestrians can be up to seven times more likely to die from traffic accidents than other age groups^{6,24}, which can be

explained both by the functional conditions of the older adults, by the traffic conditions in cities and, most of all, by poorly educated and reckless attitudes among drivers and motorcyclists^{14,22}.

Improving services for pedestrians, urban traffic systems and hospital care are potential areas of intervention, especially in the health sector, with the aim of reducing the burden of traffic deaths among this population¹⁴⁻¹⁶. The need to establish comprehensive trauma management guidelines, adapted for and largely aimed at older adults, has been observed, considering the mortality rates among this population¹⁶.

Spatial analysis revealed that the areas with the highest concentration of accidents were those where most activities occur, and where the population is concentrated during the day. This seems to be a pattern of traffic accidents among older adults^{13,15}.

The Kernel intensity map identified the Peixinhos neighborhood as a hot spot, in other words, an area with a greater number of accidents. This neighborhood has a dense commercial area, predominantly located on Avenida Presidente Kennedy, the main access road to the neighborhood, and is one of the main corridors in the city for buses and other vehicles, as well as having a poorly maintained road surface. The other hot spots, according to the Kernel density estimator, were Avenida Governador Carlos Lima and Avenida Getúlio Vargas, both of which have shops, banks, stores and a large flow of people, contributing to the occurrence of accidents, including those involving older adults. Inspections should be performed in these areas and preventive interventions carried out, including signaling for pedestrians and the installation of traffic lights with an audible warning and more time to cross, to allow the safe passage of older adults. Traffic education campaigns should also be promoted, and traffic speed reducers, improved lighting and pedestrian crossing layouts should be installed.

The implementation of preventive and corrective measures, based on studies using the Geographic Information System, provides spatial analysis through the surveillance of land transport accidents and allows the planning of preventive and protective measures for the affected populations in a timely

manner^{9,25}. In a spatial analysis study of deaths from traffic accidents in the micro-regions of the state of São Paulo, it is possible to identify the places with the highest mortality rates, allowing inspection actions to prevent accidents²⁶.

Therefore, the potential of studies that use data georeferencing in urban centers can be seen, in order to identify the critical points for health promotion and accident prevention interventions.

The study has certain limitations: a) the source of data used does not cover the totality of occurrences, and call-outs by the Fire Department are not included, nor victims rescued by third parties and referred to health services, or those who refused emergency care; b) the outcome relating to pre-hospital care could not be described due to the lack of communication between SAMU and hospital care, and so this information is not included in the database; c) in relation to secondary data, incompleteness and flaws in the completion of forms are inherent, and some variables could not be analyzed due to the high non-completion rate; and d) the limited number of observations made it impossible to carry out more robust statistical

analyses. Despite these limitations, the results of the present study confirm that a large number of accidents involving older adults occurred in certain areas of the city, which can assist in carrying out integrated preventive actions between the health sector and urban planning.

CONCLUSION

The present study showed that the age group with the highest frequency of accidents was younger older adults, with a predominance of men, and that most occurrences occurred on Wednesday, in the morning. Being knocked down was the main type of accident and the Kernel density estimator identified a highly expressive focus in the Peixinhos neighborhood, and other foci distributed throughout the coastal area. This is important information for health surveillance actions and for planning the emergency care network. Such information is also useful for urban planners, who may consider implementing environmental engineering measures in the regions identified to reduce the frequency of accidents and injuries.

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