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Overview of Trauma Injuries Caused by Traffic Accidents in Baixada Santista, Brazil

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SUMMARY

Background: In Brazil, traffic accidents have been on the rise. There is a very high social and economic impact in the country, either by the direct sequelae that are left by the trauma, or by the deaths caused by it.
Objective: This study aims to analyze the medical care associated with traffic accident-induced trauma in Baixada Santista, a Brazilian region comprising nine cities (six of which were included in this paper), along with the causes and consequences of such incidents for the population.
Methods: For data collection, DATA SUS BRASIL, which is a governmental website, was used. The impact that trauma causes on people and the main bodily injuries produced in them, the most affected groups and the cities of the Baixada Santista where the accidents occurred were collected. The data were analyzed using descriptive statistics / relative frequencies.
Results: The analysis reveals that young men, particularly those who ride motorcycles, are most susceptible to traffic accidents. In relation to the cities of the Baixada Santista, we verified that the city of Santos emerges as the primary location for these accidents, primarily due to its substantial motorcycle fleet.
Conclusions: There is a pressing need to implement preventive measures targeting young male motorcyclists in this region. It is through awareness that it will be possible to act in the prevention of accidents and reinforce to the public power, not only the need for consciousness, but also the importance of qualifying the nurses and professionals involved in the treatment and rescue of victims.

Keywords: trauma, traffic injuries, prevention, traffic accidents.

INTRODUCTION

The World Health Organization (WHO) regards traffic accidents as predictable, and thus, they are no longer seen as a fatality, but rather as a disease. Traffic accidents are subject to interventions that involve multidisciplinary efforts aimed at their prevention, which means that the leading cause of traumatic death in the world can be significantly reduced or avoided [1]. Traffic injuries result in significant economic losses for individuals, their families, and nations as a whole. These losses arise from both the cost of treatment and the reduced productivity for those disabled due to the sequelae left by the trauma. Additionally, other family members may need to take time off work or school to care for the injured patients. In most countries, traffic injuries cost about 3% of their Gross Domestic Product (GDP), and this figure can go up to 5% in developing countries [2,3]. In 2021, in Geneva, the WHO launched the Decade of Action for Road Safety 2021-2030, with the ambitious goal of preventing at least 50% of deaths and injuries in road traffic by 2030.

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Every year, the lives of approximately 1.2 million people worldwide are cut short as a result of traffic accidents. Additionally, between 20 and 50 million more people suffer non-fatal injuries [1].

There are several risk factors for Road Traffic Injuries (RTIs), such as the average speed increases, driving under the influence of alcohol or any psychoactive substance or drug and distracted driving caused, for example, by cell phones. After the occurrences, care for injuries is extremely time-sensitive: delays of minutes can make the difference between life and death. Enhancing post-RTI care necessitates timely access to pre-hospital services and the improvement of both pre-hospital and hospital care quality through specialized training programs [4].

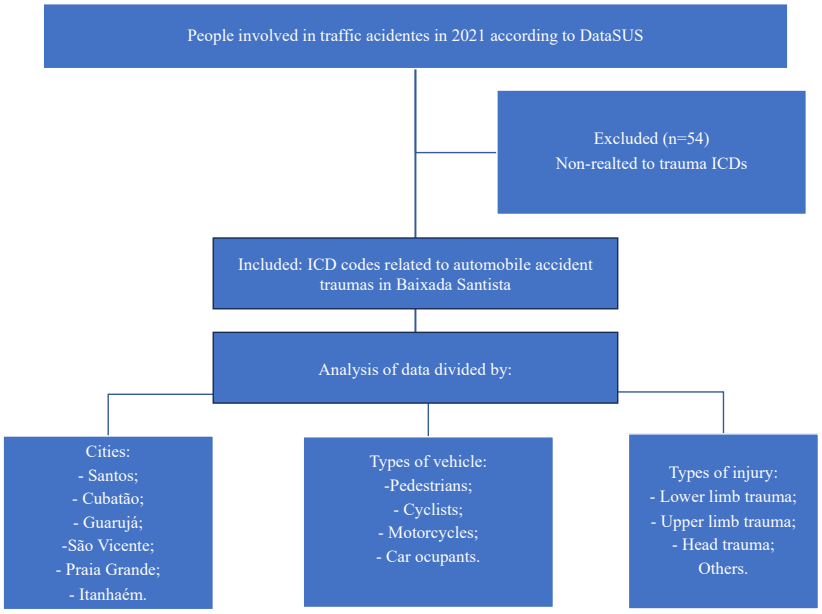
Road traffic injuries are a global health challenge. The number of road traffic deaths continues to rise steadily, from 1.15 million in 2000 to 1.35 million in 2018. Of the 56.9 million deaths worldwide, road traffic injuries account for about 2.37% and are the eighth cause of global death [1,5].

In Brazil, RTIs have been on the rise, following the global trend. In the year 2020, 32,000 deaths were caused. The cumulative numbers from 1980 to 2010 show that almost one million deaths were recorded and this statistic reached one million and three hundred thousand deaths in 2020. As early as 1990, it was already envisioned that, if appropriate measures were not taken, injuries resulting from traffic accidents would become the third leading cause of death by 2020. In 1998, the new Brazilian Traffic Code, governed by Law No. 9,503, came into effect, regarded as the hope for reducing the increasing number of ITRs. However, the new laws, municipal traffic control, vehicle safety improvements, and electronic enforcement have not succeeded in significantly reducing deaths or disabilities resulting from trauma [6].

Baixada Santista is comprised of 9 cities. These are Santos, São Vicente, Cubatão, Guarujá, Praia Grande, Itanhaém, Peruíbe, Mongaguá, and Bertioga. Our study will focus on the first six cities in the Baixada, as the latter three did not have sufficient data related to traffic accidents and were therefore excluded from the study. Santos is the most populous city, with 418,608 inhabitants, and has the largest vehicle fleet, consisting of 139,336 motorcycles and 80,231 automobiles. Itanhaém is the city with the largest territorial area, but the smallest vehicle fleet, with 30,970 automobiles and 14,147 motorcycles. Cubatão is the city with the smallest territorial area, covering 142,879 square kilometers. It has one of the smallest vehicle fleets, 14,547 motorcycles and 30,786 automobiles. The city of Guarujá has the third-largest vehicle fleet, with 67,608 automobiles and 65,135 motorcycles, and it also has the third-highest population density in Baixada Santista, with 1,986.73 inhabitants per square kilometer. The city of Praia Grande has the second-largest population in the Baixada region, with 349,935 inhabitants. São Vicente has the fourth largest vehicle fleet, consisting of 91,064 automobiles and 14,013 motorcycles [7].

This article aims to analyze medical care related to traffic accidents, according to hospitalizations in the hospital network (public or private), in the year 2021, in Baixada Santista. With this data, a better understanding of traffic accidents that occur in this region could be achieved, so that prevention measures could be taken.

Figure 1. Study flowchart.



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METHODS

Study design

This study is characterized as: retrospective, cross-sectional and observational. The study flowchart is shown in Figure 1.

Studied population

The population studied in this research comprises patients of all ages, both men and women, from Baixada Santista, involved in traffic accidents and treated in both public and private hospitals.

The year 2021 was chosen as it was the year following the onset of the COVID-19 pandemic, which affected the entire global population. Therefore, we excluded the year 2020. Due to people staying in their homes and fewer vehicles on the roads and highways, the study would be compromised in its evaluation. In 2021, the vehicle movement returned to normalcy.

Inclusion criteria

Patients involved in traffic accidents, whose ICD codes (International Classification of Diseases) were related to automobile accident traumas, occurring in Baixada Santista, in the year 2021.

Exclusion criteria

Fifty-four patients were excluded from this study (representing a total of 4.7% of the sample of 1,137 patients). These exclusions account for 0.88% of women and 3.8% of men in the total studied sample, who were hospitalized in hospitals, whose primary hospitalization ICD code (International Classification of Diseases) was not directly related to trauma caused by a traffic accident. They had the following codes: T81.3 (35 patients), R02 (3 patients), T88.8 (2 patients), T85.8 (1 patient), T84.6 (1 patient), T84.0 (1 patient), T81.4 (1 patient), L97 (2 patients), J90 (2 patients), Z47.0 (2 patients), C43.0 (1 patient), M84.1 (1 patient), M20.2 (1 patient), and M19.1 (1 patient).

Data collection

The procedure used in this research was data collection through the DATASUS BRASIL website, ftp://ftp.datasus.gov.br/dissemin/publicos/SIHSUS/200801_/ Dados/ [8], accessing the DATASUS FTP server and downloading the files with the specified extension.dbc (RDUFYYMM.DBC) containing SIH data for each city, in the year of 2021.

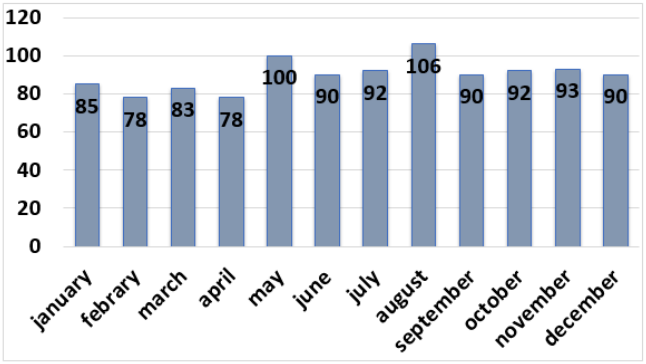
Data analysis

Hospitalizations both by ICD and by the location of the accident occurrence in different cities in Baixada Santista were categorized. The mechanisms that led to the accidents, stratifying them into traffic accidents involving pedestrians, bicycles, motorcycles, or automobiles were also analyzed. Therefore, a comprehensive view of the accident mechanisms and their physical consequences for the studied population could be achieved. The diseases caused by the vast array of different trauma mechanisms were also assessed. The data was presented through descriptive statistics, in relative frequencies.

RESULTS

Firstly, the distribution of hospital admissions due to traffic trauma in Baixada Santista in general, in the year 2021, divided into the number of admissions per month, was analyzed. These results are presented in Figure 2.

Figure 2. Distribution of hospital admissions in Baixada Santista in the year 2021, divided into the number of admissions per month.



Pedestrians

Pedestrians comprised the smallest group, with 103 patients (9.5%) out of all analyzed patients (1,077), consisting of 76% men and 24% women. Despite this, due to their physical vulnerabilities during a traffic accident, they proportionally suffered more from lower limb traumas (the primary point of contact between the pedestrian and the colliding vehicle, regardless of the vehicle type). There was a total of fifty-four lower limb fractures, which accounts for 52.40% of the group of 103 pedestrians traumatized throughout the year 2021. In second place were Traumatic Brain Injuries (TBI), with twenty-one patients hospitalized due to collisions with vehicles, representing 20.4% of all analyzed pedestrians, followed by upper limb injuries in only twelve patients (11.7%). It is easy to understand that during a pedestrian fall, the likelihood

of their head striking the ground or object colliding with them is very high. This leads to severe injuries, as the head lacks any protection. The age group of the pedestrian group, as well as all the other groups studied, was divided into three groups: Group 1 included ages 0 to 15, Group 2 included ages 16 to 54, and Group 3 included individuals over 55 years old. Group 1 represented 9.7% of the patients, Group 2 represented 53.4%, and Group 3 represented 36.9% of the analyzed patients. Regarding the location of accidents involving pedestrians, only 9 (8.7%) accidents occurred in Cubatão, 19 (18.5%) in Santos, 3 in Praia Grande (2.9%), 55 (53.4%) in São Vicente, 13 (12.6%) in Itanhaém, and 4 (3.9%) in Guarujá.

Cyclists

Cyclists accounted for 15.3% of all analyzed patients, totaling 165 accident victims. Among them, 24 (14.5%) suffered from Traumatic Brain Injury (TBI). The most common injury among cyclists was lower limb trauma, with a total of 52 fractures in patients, representing 31.5% of cases. Upper limb traumas were present in 32 (19.4%) patients. Clavicle fractures were present in 11 patients (6.6%). Analyzing these data, it becomes clear that lower limb fractures occur more frequently, as this is the most affected area of the body in falls and collisions with automobiles. On the other hand, traumatic brain injury was statistically less common than in pedestrians, as cyclists often use helmets, which protect them against head injuries, while pedestrians do not have any head protection.

The most common geographic location of accidents involving cyclists was in the city of Itanhaém, with 79 traumatized cyclists requiring hospitalization (47.9%), followed by the city of Santos with 51 patients (30.9%), and then Cubatão with 13 (7.9%), Guarujá with 12 (7.3%), São Vicente with 10 (6.0%), and Praia Grande recorded no accidents involving cyclists. This group consisted of 121 males (73.3%) and forty-four females (26.7%). Regarding the patients' age groups, Group 1 represented patients aged 0 to 15 years, with twenty-four patients (14.5%), Group 2 represented patients aged 16 to 54 years, with 116 patients (70.3%), and Group 3 represented patients over 55 years old, with 25 patients (15.2%). In the group of cyclists, there were no hospitalized patients who suffered fatalities.

Motorcyclists

Motorcyclists accounted for the largest analyzed group, totaling 728 patients admitted to hospitals in Baixada Santista due to traffic accidents. Out of this group, fifty-four patients were excluded as their admission ICD was not compatible with trauma. This group represented 67.6% of all analyzed patients. It is evident that motorcyclists are more susceptible to traffic accidents. Men represented 83.2% of this group (606), and women 16.8% (122). The age group was divided into three groups, similar to pedestrians and cyclists. Group 1 (0 to 15 years old) had five patients (0.7%), Group 2 was composed of 678 patients (93.1%), and Group 3 consisted of 45 patients (6.2%). The group of motorcyclists presented a distribution of the main body injuries as follows: 354 patients with lower limb trauma (48.6%), 151 patients with upper limb trauma (20.7%), sixty-four patients with head trauma (8.8%). Regarding the location of the accidents, the geographical distribution was as follows: in Santos, there were 288 accidents (39.6%), in Itanhaém, there were 185 accidents (25.4%), followed by São Vicente with 106 accidents (14.6%), Guarujá with 88 (12.0%), Cubatão with 34 (4.7%), and finally, the municipality of Praia Grande with 27 (3.7%). There were sixteen recorded deaths, corresponding to 2.2% of the patients studied in this sample.

Car and truck occupants

The last group analyzed was car and pickup truck occupants, representing eighty-one patients (7.5%). This group consisted of sixty-three men (77.7%) and eighteen women (22.3%). The age group was distributed as follows: group 1 (0-15 years) with seven patients (8.7%), group 2 (16-54 years) with fifty-eight patients (71.6%), and group 3 (55 years or older) with sixteen patients (19.7%). The most common traumas were lower limb injuries with thirty-eight patients (47.5%), traumatic brain injuries in twelve patients (15%), upper limb fractures in eight cases (10%), abdominal traumas in seven cases (8.8%), and finally, facial traumas in five cases (6.3%). As for the geographical location of the accidents, twenty-seven occurred in São Vicente (33.3%), twenty in Santos (24.7%), twelve in Cubatão (14.8%), eleven in Praia Grande (13.6%), six in Guarujá (7.4%), and five in Itanhaém (6.2%).

The gender and ages distribution of accidents, divided by means of transportation, can be observed in Figure 3. The most common types of bodily injuries (lower limb fractures, upper limb fractures, and traumatic brain injuries) are presented in Figure 4. The geographical distribution of accidents, by city in the Baixada Santista, is presented in Figure 4, 5. Total victims and fatalities are represented in Figure 6.

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Figure 3: Distribution by gender (pedestrians - blue, cyclists - green, motorcyclists - gray and car occupants- yellow) and age (0 to 5 years – blue, 16 to 54 years – green; 55 years or more – gray) of accidents, divided by groups.

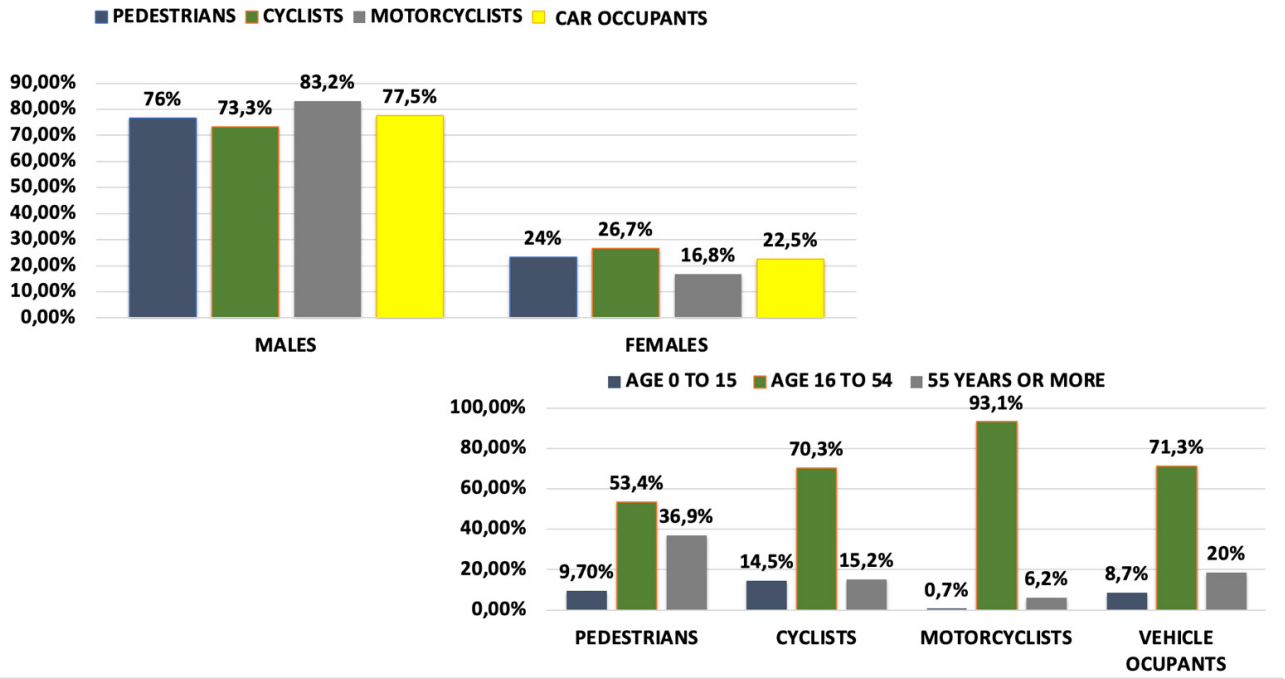


Figure 4: Injuries in traffic accidents in Baixada Santista in 2021, by groups. The blue color represents lower limb injuries, orange represents upper limb injuries, and the gray color represents head and brain injuries, in pedestrians, cyclists, motorcyclists and vehicle occupants.

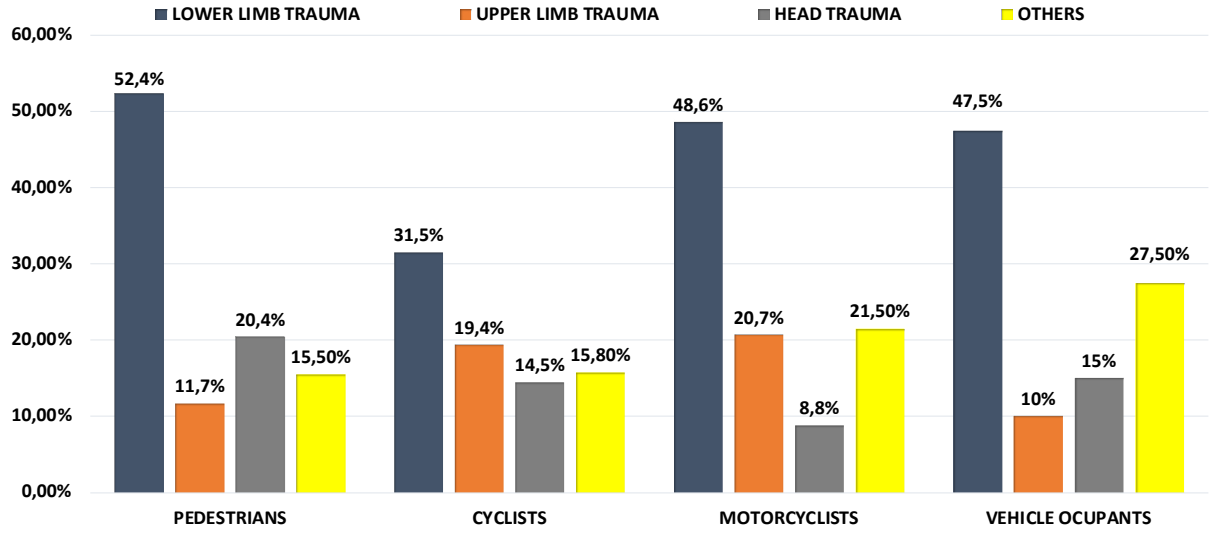


Figure 5: Geographical distribution of accidents, by city (Santos, Cubatão, Guarujá, Itanhaém, Praia Grande and São Vicente) in Baixada Santista. The blue color represents pedestrians, orange represents cyclits, the gray color represents motorcyclists, and yellow represents vehicle occupants.

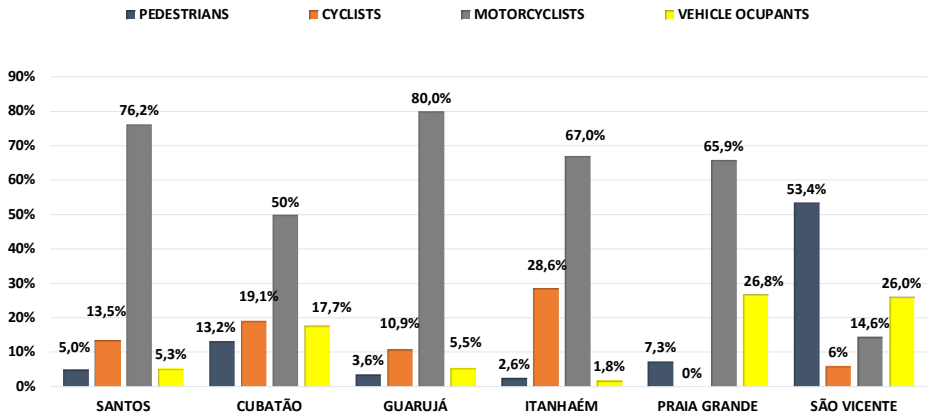
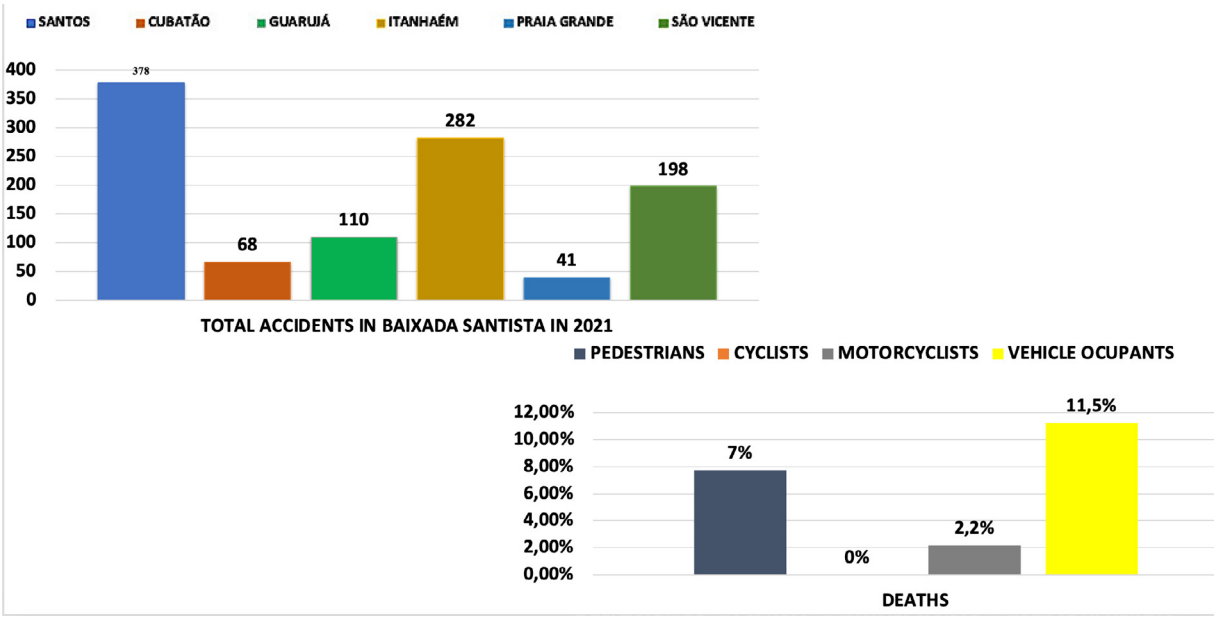


Figure 6: Incidence of traffic accident victims in Santos (light blue), Cubatão (orange), Guarujá (green), Itanhaém (dark yellow), Praia Grande (blue) and São Vicente (green), and deaths during hospitalizations of traffic accident victims that occurred in Baixada Santista in 2021 (the blue color represents pedestrians, orange represents cyclits, the gray color represents motorcyclists, and yellow represents vehicle ocupants).



DISCUSSION

Traffic accidents follow a trimodal curve regarding patient mortality. The first peak of mortality is related to the severity of the accident at the scene. The second peak is linked to pre-hospital care and its quality; to the time involved between the care and the patient's transfer to the hospital unit where they will be admitted. The third peak is associated with complications arising from trauma-induced injuries.

We can only intervene in the first peak with awareness campaigns involving the population on how to prevent accidents, emphasizing the importance of seatbelt use for all vehicle occupants, ensuring children are properly secured in age-appropriate safety seats, promoting respect for traffic signs and speed limits on public roads, and advocating for the use of protective gear for motorcyclists (closed helmets with visors, jackets, protective pants, and closed-toe footwear).

During the second peak, intervention can be achieved by providing high-quality, specialized care delivered by qualified trauma care specialists. This requires ambulances with advanced extrication tools and life support equipment for pre-hospital care.

In the third peak, high-quality hospital care can be provided with all the necessary support equipment

for performing complex surgeries and modern diagnostic equipment, such as CT scans available in all hospitals, and the use of FAST (Focused Assessment with Sonography for Trauma) in trauma rooms. Acute treatment for polytrauma patients is administered by specialized trauma care professionals [9].

The way accidents occur, depending on the environment, type of vehicle, whether the driver was wearing a seatbelt or was speeding, and the mechanism of the accident (such as pedestrian collision, motorcycle or car collision, or involvement of bicycles), is of great importance. Each mode has its peculiarities regarding the type and severity of organic injury inflicted. This directly impacts both patient mortality and survival, as well as the recovery time and resulting sequelae. This is because each type of injury depends on the intensity of the trauma and the exposure of our body to that trauma (Figure 4) [10-12].

Analyzing the factors leading to a traffic accident, William Haddon Jr, an American epidemiologist, was a pioneer in classifying traffic accidents as an epidemic. In his 1980 article, he examined the factors related to accidents and developed a matrix where he divided these factors into phases. The phases include pre-event (what occurs before the event and facilitates its occurrence), the event itself (the accident), and post-event (after the accident has occurred). Haddon further subdivides the factors that interfere with each phase, such as human factors, the causative agent, and environmental factors (physical and socio-cultural). This is of great significance because it allows us to understand the mechanisms involved before, during, and after the accident, enabling us to take action in each phase to minimize the impacts of traffic incidents. Furthermore, establishing campaigns focused on prevention and reduction of accidents, directly targeting all three phases, leads to a reduction in accidents (the primary objective), as well as an improvement in the care provided to accident victims and a reduction in the resulting sequelae [12,13].

The factors related to traffic incidents can be divided into: predisposing factors (such as gender, age, marital status, level of education), facilitating factors (such as income level, healthcare access conditions), precipitating factors (such as road and highway maintenance, driver distraction, and vehicle fleet maintenance quality), and reinforcing factors like lack of awareness while driving, dangerous driving, obesity, and advanced age (9-14). Patients without protection, such as, for example, not wearing helmets for motorcyclists and cyclists or not using seat belts for car occupants, are more likely to sustain severe injuries at the time of the accident [10,14].

The type of injury is directly related to the mode of transportation and its speed at the time of the accident (Figure 3); because the higher the speed and energy of the impact, the greater the trauma inflicted on the body of individuals, as the energy formula is $E = m \times c^2$ (energy equals mass (m) times the velocity (c) squared). Therefore, speed is the variable that exerts the most influence on the energy of the trauma, and hence, we must control it through active and passive enforcement [15].

Observing the dynamics of traffic incidents worldwide, we realize that the most exposed group to trauma remains the same, consisting of men between the ages of 18 and 60 who are motorcycle users [16]. We believe the main reasons for the prevalence of this population lies in the fact that many men work with their motorcycles, making deliveries, which usually have a time deadline. So many of them end up speeding or crossing red lights in order to make it to destinations on time. Moreover, young men usually seek the adrenaline of high speed, even if not for a particular reason. The installation of more speed cameras and the full use of personal protective equipment could help to avoid accidents and, if they do occur, the risk would be lower.

Socio-economic factors, such as income levels, that sometimes make it necessary for the population to work with their cars / motorcycles, urbanization, and healthcare accessibility, might influence the incidence and severity of traffic-related injuries in Baixada Santista. Healthcare accessibility outside of the public health system is expensive, and therefore, not accessible to a great part of the population. Consequently, a lot of public health investments need to go the treatment of accident sequalae, and some of these accidents could be prevented thorough caution and awareness.

After a thorough study of the accidents that occurred in Baixada Santista, and the stratification of the causes leading to traffic accidents and understanding how we can address this issue, we observe how it is possible to act in the prevention of accidents by controlling speed on the roads and improving the quality of care, both at the scene of the accident and in hospital care [10,18]. The government plays a crucial role in this matter, as the development of accident prevention policies and the enforcement of traffic laws, including speed control on roads, are the cornerstone of accident reduction [17,18]. In the city of Santos, the Traffic Engineering Company (CET) is aligned with the Sustainable Development Goals, aiming to enhance this aspect in the city [19]. It is crucial for public health policies like this to be aligned in order to enable better care, both pre-hospital and intra-hospital.

Although this study is limited to the results of datasets of a specific region, its finding can be applied to general population, seeing as the results seem to show similar characteristics worldwide. A study in Nigeria showed that the leading causes of road traffic accidents there are human factors; speed violation, loss of vehicle control and dangerous driving. They agree with our study, emphasizing that the accidents are preventable, and that sensitization and enforcement of safe road principles among commercial vehicles and car drivers would help curb this menace. The authors also believe that government at all levels should implement strong policies aimed at reducing the speed of vehicles on roads [20]. A survey that was conducted in China examined 234 major road traffic accidents recorded

in 27 Chinese provinces from 1997 to 2014. They analyzed the relationships among the contributing factors. At the preconditions for unsafe acts level, "visual limitation", "fatigue driving," and "vehicle faults" were strong predictors [21].

After analyzing all the data collected in this study, we conclude that the dynamics of traffic accidents occurring in Baixada Santista follow common causes and mechanisms seen worldwide. Young male motorcyclists constitute the most affected demographic group. Imprudent driving, particularly distraction and excessive speed, are the main causes of accidents and fatalities. It is crucial to focus on prevention through awareness campaigns, but enforcement and punishment for speeding violations need to be carried out. A video campaign was released after this research was conducted, and it available on YouTube [22], to show data and make people more aware of preventive measures. Specific infrastructure improvements, such as better road lighting, dedicated motorcycle lanes, and improved pedestrian crossings should also be made. Policy changes, such as stricter enforcement of traffic laws, mandatory helmet use, and targeted public awareness campaigns should be more and more conducted. Finally, improving medical care, both pre-hospital and hospital, is essential to minimize the sequelae produced by traffic incidents.

Data availability statement

The datasets used in this study are from public domain, available from DATASUS, a Brazilian government website. Available from https://datasus.saude.gov.br/.

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