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ORIGINAL SCIENTIFIC REPORT

Burden of Burns in Brazil from 2000 to 2014: A Nationwide Hospital-Based Study

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Abstract

Background Burns are a major public health concern, affecting mostly low- and middle-income countries. However, there is a lack of epidemiological studies on burns in these countries, particularly in Latin American countries. Our aim was to analyze nationwide demographic, epidemiological and economic characteristics of hospitalized burn patients in Brazil.

Methods A retrospective study was conducted including inpatients admitted with a diagnosis of burns (ICD-10:T20–T31) from all hospitals in Brazil from 2000 to 2014. We calculated hospitalization and in-hospital mortality rates. Length of stay (LoS), charges and premature mortality were also assessed.

Results A total of 412,541 burn hospitalizations were found, with a hospitalization rate of 14.56 hospitalizations/100,000 inhabitants/year. This rate is decreasing since 2003, mostly due to the reduction among children and elderly. Children below 5 years old accounted for 24% of all admissions. In-hospital mortality rate was 8.1% and median LoS was 5 days. Mean hospitalization charge was 856 international dollars. Substantial regional discrepancies were found in several indicators.

Conclusion In this first Latin American nationwide study of burn patients, a decreasing trend of hospitalization rate and a low charge contrasted with a high in-hospital mortality rate. This latter indicator, associated with a low LoS, may raise concerns regarding the quality of healthcare. Important discrepancies were found between regions, which may indicate important differences in regard to healthcare access and risk of burns. Targeting effective prevention, improving healthcare quality and providing more widespread and accurate burn registry are recommended.

Introduction

Burns are a serious public health problem globally, with 265,000 deaths annually from fire-related burns and approximately 11 million needing specialized care worldwide [1]. Additionally, burns lead to costly, lengthy hospitalization stay and rehabilitation programs [2], with substantial losses in quality of life [3]. In fact, fire, heat and hot substances produced a loss of 12.3 million DALYs in 2013 [4]. Low- or middle-income countries (LMICs) account for over 98% of total DALYs and over 97% of mortality associated with fire-related burns [5].

Despite this high burden of burns in LMICs and urgent need for sustained epidemiological research [6] to support

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health policies and prevention strategies, those studies are scarce, particularly in Latin America [7]. In fact, although epidemiological studies of burns have been conducted in Latin American countries, such as Colombia [8–10], Ecuador [11], Brazil [12–17], Mexico [18] and Chile [19], only the last two included nationwide analysis and both focused only on mortality. Also, there are no economic analysis regarding the impact of burns on healthcare costs in Latin America and cost studies in LMICs are limited in number and urgently needed due to limited resources [20].

Brazil was the first Latin America country to create a burn unit, in 1945 [21]. The country counts with 46 burn units (with 225 beds: 154 for adults and 71 for pediatric patients), but they still scarce and are unequally distributed as 26 burn units are located only in the southeast region [22].

Given this context, our aim was to analyze demographic and epidemiological characteristics, as well as the charges incurred by burn hospitalizations, by means of a nationwide and during a long time period in a Latin American country study.

Methods

A retrospective observational study was performed using a national hospitalization database, provided by the Brazilian Unified Health System Informatics Department (DATASUS). We included all inpatient episodes from 2000 to 2014 with a main or secondary diagnosis of burns [i.e., coded as T20–T31 using the International Classification of Diseases—10th Revision (ICD-10)]. Only one secondary diagnosis was available per episode and each hospitalization was considered as an independent episode.

The variables reflected upon were age, sex, discharge date, length of stay (LoS), charges, discharge status, hospital's region and region of patient's residence. Discharge status was only studied between 2009 and 2014 due to data quality (e.g., in registering this variable). Inpatient care charges were calculated based on the assignment of each episode of care to a procedure group, which is linked to the services and procedures performed. A national schedule containing the prices for each procedure group was then used to define inpatient care charges [23]. Charges were adjusted by purchasing power parities (PPPs) for gross domestic product (GDP) using the 2014 OECD value of 1.69 for Brazil in order to compare national charges with those of other countries.

Hospitalization rates were based on the resident Brazilian population of each respective year. Further, in order to calculate the 95% confidence interval for the hospitalization rates, the Byar's method was adopted [24]. In-hospital mortality rate was calculated as the proportion of burn admissions leading to in-hospital death. Geographic distribution of hospitalization rate, in-hospital mortality (with age direct standardization for the 2014 Brazilian population) and mean hospitalization charges were analyzed using an approach either by state or by region.

In-hospital deaths and in-hospital premature deaths were calculated as described by Pinho et al. [25]. Potential years of life lost (PYLL)—number of years lost due to death occurring earlier than a chosen reference age (75 years)—was also considered. PYLL rates and age-adjusted PYLL rates were calculated as suggested by Romeder and McWhinnie [26]. Total PYLL was the sum of all those years and the overall directly age-adjusted PYLL rates were calculated using the WHO standard population as well as the method described by Romeder and McWhinnie [26]. The age-adjusted PYLL rate is a measure of premature mortality, which highlights more deaths at younger ages and can be interpreted as the number of PYLL per 1000 population units if the actual population had the same age structure as that of the reference age.

Linear regression models were used to assess trends in the number of hospitalizations, hospitalization rates, charges and mean age, studying their relationship with the progression of time. Descriptive and inferential statistical analyses were performed using SPSS Statistics V23(IBM Corp., USA).

Results

Between 2000 and 2014, a total of 412,541 burn hospitalizations occurred, with a mean of 27,503 hospitalizations/year. Male patients accounted for 62.1% ($n = 256{,}149$) of all hospitalizations, leading to a male-to-female ratio of 1.64:1. The total hospitalization rate was 14.56 hospitalizations/100,000 inhabitants/year (95% CI 14.51–14.60 hospitalizations/100,000 inhabitants/year), 18.25 for males (95% CI 18.18–18.32 hospitalizations/100,000 inhabitants/year) and 10.93 for females (95% CI 10.88–10.99 hospitalizations/100,000 inhabitants/year). This hospitalization rate was higher among men in all age groups—Fig. 1—with a hospitalization rate ratio (male-to-female) of 1.7.

The mean age was 24.8 years (SD = 21.2 years; median = 22 years), 24.5 years in male patients and 25.1 among female—Table 1. Children below 5 years represented 23.9% of all hospitalizations (58.6% among those with less than 15 years), with a hospitalization rate (40.0 hospitalizations/100,000 inhabitants/year) nearly three times higher than the rest of the population. Among other age groups, children between 5 and 14 years old had the highest number of hospitalization (69,383 hospitalizations), while patients aged 85+ presented the highest hospitalization rate (15.2 hospitalizations/100,000 inhabitants/

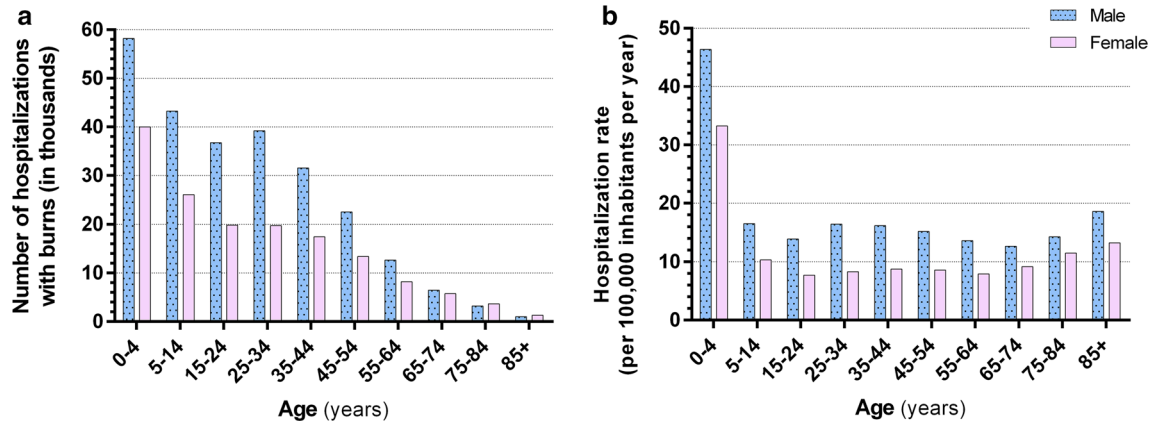

Fig. 1 Number of burn hospitalizations (**a**) and hospitalization rate (**b**) per age group and sex in Brazil between 2000 and 2014

Table 1 Baseline demographic, clinical and economic characteristics of burn hospitalisations in Brazil, between 2000 and 2014, compared by sex

Indicators	Total	Male	Female
No. of hospitalizations	412,541	256,149	156,391
Hospitalization rate (per 100,000 inhabitants/year)	14.6	18.2	10.9
Median LoS (days)	5	5	5
Mean age (SD)	24.8 (21.2)	24.5 (20.4)	25.1 (22.5)
Mean charge (R$)	1448.4	1471.1	1411.2
In-hospital deaths (*n*, % of hospitalizations), 2009–2014	12,235 (8.1%)	7603 (8.0%)	4632 (8.3%)
In-hospital premature deaths (*n*, % of all deaths), 2009–2014	11,610 (94.9%)	7300 (96.0%)	4310 (93.0%)

year). Figure 2 shows the time trends of number of hospitalizations (a) and hospitalization rates (b). Despite an overall increase in hospitalization rate from 2000 to 2003, a decreasing trend after this period was found.

The median LoS was 5 days (mean = 7). In-hospital mortality rate was 8.1%, corresponding to a total of 12,235 in-hospital deaths during 2009–2014 (2039 in-hospital deaths annually) and representing a mortality rate of 1.06 deaths/100,000 inhabitants/year (95% CI 1.04–1.08 hospitalizations/100,000 inhabitants/year). Ninety-five percent were premature deaths (11,610 deaths). Among children aged 15 or less, in-hospital mortality rate was 5.6% during 2009–2014, while the mortality rate was 0.96 deaths/100,000 inhabitants/year in 2014. In-hospital mortality rate was higher in females (8.3 vs 8.0%). Male patients had a higher proportion of premature deaths (96.0 vs 93.0%). We found no visible time trend of increase or decrease regarding in-hospital mortality rate and age-

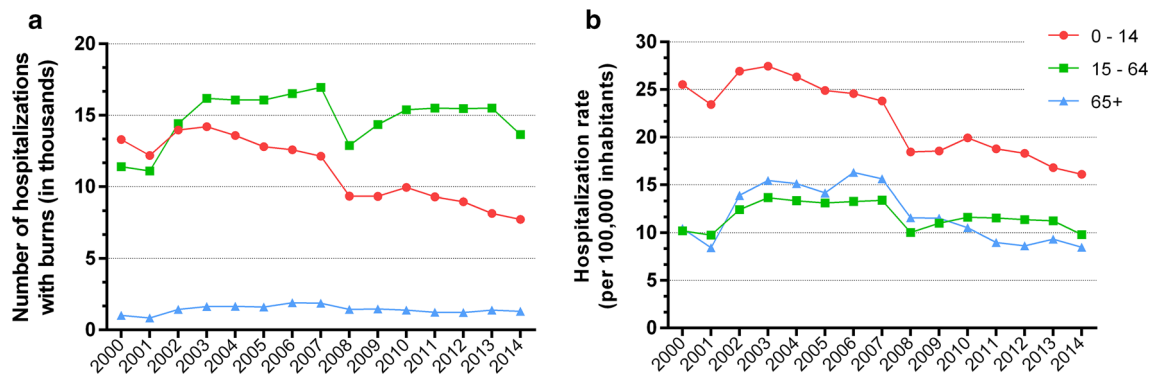

Fig. 2 Number of burn hospitalizations (**a**) and hospitalization rate (**b**) per year throughout the studied period, 2000–2014, grouped by age (0–14 years, 15–64 years, and 65+years), in Brazil

adjusted in-hospital mortality rate. In addition, from 2009 to 2014, the total PYLL due to burns was 511,077, representing a rate of 44.2 PYLL per 100,000 person-years (mean of 44). Age-adjusted PYLL rate was of 43.4 PYLL / 100,000 person-years.

The mean charge of burn hospitalizations was 1448 R$, which increased from 731 R$ in 2000 to 2359 R$ in 2014 ($\beta = 139$, SE = 11, $R^2 = 0.92$), equivalent to 857 international dollars (1396 international dollars in 2014). This represents a total annual charge of 39,824,344 R$ (i.e., 23,564,700 international dollars).

Several differences were found between regions and states—Fig. 3, Supplementary Table 1. Central-west was the region with highest hospitalization rate (28.8 hospitalizations/100,000 inhabitants/year), followed by south, northeast, southeast and north. Most states showed a decreasing trend, except Amazonas, Tocantins and Pernambuco.

South had the highest in-hospital mortality rate (17.2%), followed by northeast, southeast, central-west and north. When adjusted for age, only those regions with lowest in-hospital mortality rate switched position. North was the

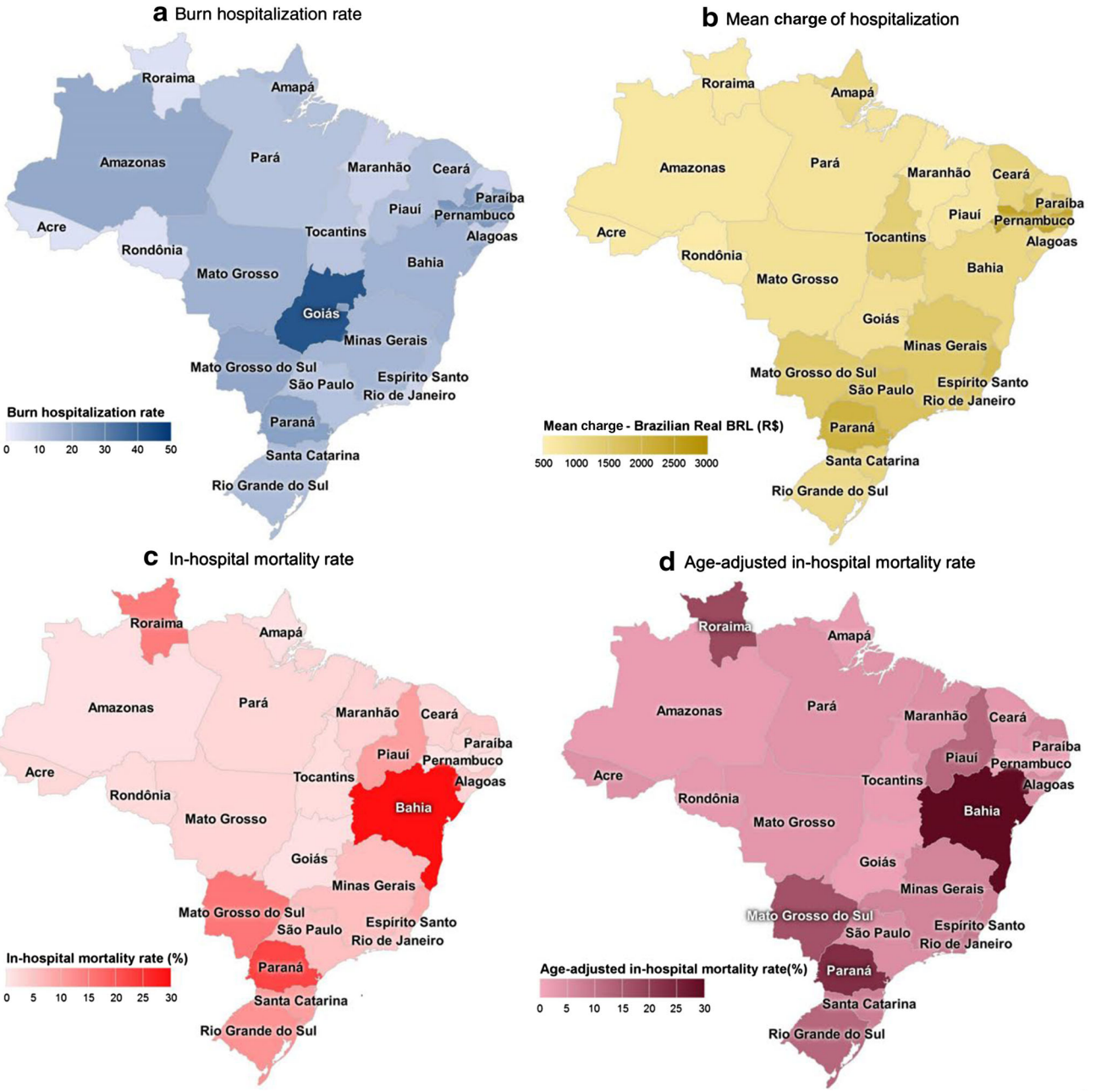

Fig. 3 Burn hospitalization rate (**a**), mean charge of hospitalization (**b**), in-hospital mortality rate (**c**) and age-adjusted in-hospital mortality rate (**d**) for all Brazilian states

only region with an increasing trend, even when adjusted for age. Bahia and Paraná had the highest in-hospital mortality rate and age-standardized in-hospital mortality rate (29.7 and 22.1%, respectively; 34.1 and 23.3%, respectively). In-hospital mortality rate was lower than 3% in 13 states. Only the states of Espírito Santo, São Paulo and Minas Gerais decreased the rate of age-adjusted in-hospital mortality.

North and central-west had a mean charge lower than 1000 R$, whereas charges ranged between 1500 and 1700 R$ for the other regions. Nevertheless, Pernambuco and Paraná had a mean charge higher than 3000 R$ (2010–2014). All states showed an increasing trend of charges throughout this period.

Discussion

To the best of our knowledge, this is the first nationwide epidemiological study of burns in Latin America. Brazil's burn hospitalization rate (14.6 hospitalizations/100,000 inhabitants/year) was considerably lower than the rate found for Chile in 1996 (57.3 hospitalizations/100,000 inhabitants/year) [19] and lies within the range estimated for Europe (i.e., between 2 and 29 hospitalizations/100,000 inhabitants/year) [27]. Hospitalization rate has been decreasing since 2003, mostly among children and elderly. Although this might be a good indicator, this rate might be related to constraints in the access to healthcare services. In fact, it was described in a Brazilian study that approximately 21% of the patients with burns resorted to emergency department by foot or public transport [16]. Moreover, it is known that in LMICs only between one-half and two-thirds of burn patients resort to treatment in a health facility [6], and among these patients only 18 to 40% are admitted for hospitalization in Brazil [16, 18].

Children below 5 years old accounted for almost a quarter of all admissions (24%), which was lower than the proportions found in other LMICs, such as Angola and Colombia (32 and 35%, respectively) [9, 28], but in-between the values found for high-income countries, such as Portugal or Sweden (20 and 27%, respectively) [29, 30]. This age group represented 16% of all patients with burns resorting to emergency department in Brazil [16]. Moreover, hospitalization rates for children below 5 years old were almost three times higher than those for the rest of the population (40 hospitalizations/100,000 inhabitants/year), though these differences were less pronounced than in Portugal and Norway (five times and seven times higher, respectively) [29, 31]. This might be an interesting indicator, as this age group usually has a disproportionally higher hospitalization rate in LMICs when compared to high-income countries indicating a lower standard of life [27, 32].This trend was not found in this study, though the possible bias of access to healthcare facilities should be kept in mind.

It is important to note that injuries in children are understandable, predicted, environmentally conditioned and can often be prevented [33, 34], with the majority occurring at home and mostly due to hot substances [6, 16]. Risk factors for burns among children include the preexisting impairment in a child, history of burn in a sibling, storage of flammable substance at home, pregnant or unemployed mother, use of clothing with synthetic fabrics, parental illiteracy, housing location in slums/congested areas, recent family relocation, lack of water supply and low socioeconomic status [6]. Thus, correcting some of these factors—i.e., improvement in socioeconomic status, parental education, improved housing, regulation of industrial products and proper storages of flammable substances—can protect children from burn injuries [6, 35, 36] Moreover, it is also important to monitor violence and abuse against children, as it is the cause of 10–12% of burn injuries in this age group [36].

In all age groups, men are more often hospitalized than women, with a hospitalization rate ratio of 1.7. This trend is similar to ratios found in other Latin American countries, such as Colombia and Ecuador [9–11] and in Europe [27]. Higher hospitalizations rates among men are especially associated with the male predominance in high-risk occupations [29]. In LMICs, it is known that burn injuries among men are mostly work-related, whereas for women they are mostly home-related. Among children, the male predominance is probably due to more freedom granted by parents and to the higher impulsiveness of this gender [32].

Regarding mortality, we described a higher annual rate than the one described in the 2000s for Mexico (i.e., approximately 0.75 deaths/100,000 inhabitants/year) [18]. This difference might be even higher as our database only relies on in-hospital deaths, while the Mexican study comprised all death certificates.

In-hospital mortality rate in Brazil during the period 2009–2014 (8,1%) was higher than that described in Colombia (i.e., 1.4–4.6%) [9, 10], but slightly lower when compared to Ecuador (10.4%) [11] and to previous Brazilian studies conducted at single hospitals (i.e., 10 and 18.8%) [12, 15]. Moreover, although this value lies within the European range of in-hospital mortality rate (i.e., between 1.4 and 18%), it is higher when compared to Portugal, England, Norway or Sweden [29–31, 37]. The median LoS of 5 days (mean = 7 days) was lower when compared to Colombia (median = 14 days) and Ecuador (mean = 23 days) [9, 11].

When compared to Portugal, though different populations were used for adjustment (i.e., Scandinavian population for Portugal and the WHO standard population for

Brazil, which is a slightly younger population), the rate of potential years of life lost was more than four times higher in Brazil, with 95% dying prematurely (in Portugal, 54% were premature) [29].

In Brazil, we found a mean hospitalization charge of 1448 R$ (i.e., 856 international dollars). Hop et al. [20] described a range between 102 and 15,555 international dollars in LMICs. Despite the increasing trend, the mean hospitalization charge in 2014 (i.e., 1396 international dollars) is still lower when compared to the median of 3559 international dollars among studies in LMICs [20].

Several outcome discrepancies were found between regions and states. Hospitalization rate ranged between 9.4 and 28.8 hospitalizations/100,000 inhabitants/year, which might be explained due to possible differences regarding risk of burns and access to healthcare services. The differences in age-adjusted in-hospital mortality rates, which ranged between 3.2 and 18.1%, might lead us to two possible explanations: (1) burn severity (e.g., most of the severe cases are referred to a certain region or inhabitants from that region have more severe burns) and/or (2) healthcare services' quality. The latter might also be associated to the wide range found in mean hospitalization charges (985–1621 R$) or, at least, might represent differences of cost-effectiveness in healthcare provision.

Limitations of this study included the reliability of the administrative database, which uses ICD-10 coding and relies on its accuracy. Moreover, we only had access to the principal diagnosis and one secondary diagnosis, and we did not include data from primary care. There are also limitations related to the definition of hospitalization charges, as previous findings have suggested that the methodology used in Brazil produces rates that are much below the cost for most inpatient care [23]. However, it is known that it is essential to use hospital statistics and administrative database to allow proper health policies [38] and to assess continuous healthcare quality.

Conclusion

It is important to highlight that in this 15 year and nationwide Brazilian study, a considerable decreasing trend of hospitalization rate was found. Nevertheless, a high in-hospital mortality rate and a low LoS were observed. Both indicators are major concerns regarding the quality of healthcare, as well as the substantial discrepancies found between states and regions. However, we described that Brazil is spending less than other countries, even when comparing only with LMICs.

In fact, it is now essential to plan a tripartite action in prevention, healthcare quality and registry of burns. Prevention must be made involving the government in order to create more protective policies and promote an increase in socioeconomic status, and the healthcare services or media to educate the population, specially those groups at higher risk. Healthcare quality must be assured by evaluating indicators and by promoting investments with cost-effective allocation of resources. Registries must also be improved making standardized health technologies available for the whole country.

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Compliance with ethical standards

Conflicts of interest The authors declare that there are no conflicts of interest.

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