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EPIDEMIOLOGICAL PROFILE OF PEDIATRIC BURNS IN BRAZIL: A SYSTEMATIC REVIEW WITH META-ANALYSIS

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ABSTRACT

Aim: This study aimed to determine the epidemiological profile of burns in Brazilian children, based on a systematic review with meta-analysis. **Methods:** The search followed the PRISMA guidelines, the protocol was registered in PROSPERO and we used STROB to investigate risk of bias. For meta-analysis, R-studio was used, adopting the random distribution model, the chi-square (X12) and I-square (I2) tests to verify heterogeneity and its amplitude, respectively. **Results:** Eleven studies were included for qualitative analysis and 4 for meta-analysis. Only one study presented a high risk of bias. The main body area affected by burns was the trunk, 77% (95% CI 0.15–0.98; X12 = 30.52, p < 0.001; I2 = 97%) of which are second-degree (95% CI 0.80–0.94; X12 = 4.55, p = 0.03; I2 = 78%) scald injuries (95% CI 0.56–0.68; X12 = 0.22, p = 0.64; I2 = 0%). Males were the most affected (95% CI 0.53–0.65; X12 = 1.62, p = 0.20; I2 = 38%), and the most prevalent age group was the one aged between 0-5 years (95% CI 0.72–0.83; X12 = 1.47, p = 0.22; I2 = 32%). **Conclusion:** This study characterized the epidemiological profile of childhood burns, pointing out the prevalence according to age, sex, affected areas and causal agents of these injuries.

Keywords: Burns. Children. Epidemiology.

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INTRODUCTION

Burn injuries are generally restricted to the skin, and they may result from several agents such as: excessive heat or cold, radiation, electricity, corrosive or chemical substances (1). Burns can be classified according to the agent causing the injury, which can be thermal burns (exposure to hot liquids and flames), chemical burns (acids, ammonia and caustic soda), radioactive or electrical burns (2).

Epidemiological studies demonstrate the prevalence of burns in the pediatric population (0-15 years) at home corresponds to approximately 92% of cases (3), and scalds are the main causative agents in younger children, whereas burns from contact with hot surfaces or flames is the main cause in older children and adolescents (4,5). Furthermore, Rigon and colleagues (2019) described a greater incidence of these injuries in the upper body segments, due to accident pattern, in which children tend to drop containers with liquids or heated substances on themselves, in a cephalo-caudal direction, such as pans and kettles with the handle sticking out of the stove, justifying the greater number of injuries in these regions. Finally, other situations are handling chemical and/or flammable products in inappropriate places, heated metals, firecrackers and sparklers, and bare wires within the reach of children, using tablets and cell phones while charging (6,7).

Depending on the wound depth, burns can be: (a) first degree, when it affects the superficial layer of the skin, which becomes hyperemic and painful, but with no formation of blisters, as it is the case of sunburns; (b) second degree, when they reach deeper into the skin, forming blisters painful to the touch, frequently seen in burns caused by hot liquids; and (c) third degree, when there are injuries to all layers of the skin (also including ligaments, tendons, muscles and bones), generating white or brown wounds, generally painless due to nerve damage, frequently observed in chemical and electrical burns (8). It is also worth highlighting that deep burns are more common in young children, due to the thinner epidermis and dermis (9).

Parallel to this, regarding the extent affected, burns are identified according to the percentage of affected body area, known as Burned Body Surface (BBS), which is directly related to patient mortality (10). Romanoski and colleagues (2018) observed that the impacts of burns are much more intense in the pediatric population with BBS greater than 10%, since it compromises functionality, appearance and satisfaction with the current state. These complications arise from the intense release of cytokines and inflammatory

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mediators that generate systemic and metabolic repercussions throughout the entire body (5).

Burn injuries are considered a serious public health problem and constitute an important accidental cause of morbidity and mortality worldwide, with a high frequency among children (7). In Brazil, it is estimated that children represent approximately 50% of burn victims, and they are the second leading cause of death in this population (2). Depending on the severity and level of involvement, they can culminate in multiple serious adverse consequences in the long term, with significant functional, psychological, and social limitations, when they do not lead to death (4).

Therefore, this study aimed to describe, through a systematic review with meta-analysis, the epidemiological profile of children victims of burns from 2013 to 2023, and to analyze the pattern of accidents in terms of individual characteristics, events and the evolution of cases in Brazil.

METHOD

This study was a systematic review with meta-analysis, which was carried out respecting the guidelines proposed by PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis), updated version of 2020, to proceed with systematic review and meta-analysis reports (11) All steps including search, screening and full-text analysis were performed in a double-checking system by two researchers independently (I.M.Z and T.M.R.). The protocol adopted throughout the study was registered in PROSPERO and it is available online.

RESEARCH STRATEGY AND STUDY SELECTION

We carried out an electronic search in PubMed, SCOPUS and Virtual Health Library (VHL) databases to select studies that addressed burns in the Brazilian pediatric population. The search was restricted to studies published in Portuguese, between 2013 and 2023, in the following study designs: prevalence and incidence studies, case reports and series, observational, etiological, screening studies and qualitative research. The searches were carried out simultaneously in the databases between July 10th and July 15th, 2023, using the following keywords: “Child”; “Burn”; “Epidemiology”, all recognized by Health Sciences Descriptors (DeCS). The Boolean operator applied was AND, used to

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combine the three descriptors in the search tool. After this stage, duplicate studies were eliminated between July 16th and 19th, 2023.

INCLUSION AND EXCLUSION CRITERIA

Screening was divided into two stages, the first selection was according to titles and abstracts (carried out from July 25th to July 31st, 2023) and the second selection was a full-text analysis (between August 14th and August 28th).

Original articles were selected, in Portuguese, which analyzed burns in children aged between 0 and 12 years, published from 2013 to 2023 in Brazil. Exclusion criteria were studies that a) did not categorize the age of burn victims; b) outlined the epidemiological profile in a time limit prior to 2013; c) were published in other languages. Studies that did not present epidemiological descriptions of the analyzed variables were also excluded.

DATA EXTRACTION AND CALCULATIONS

From the studies selected in this review, the following information was collected: publication data (author, journal, volume, number and year of publication), objective and study design, setting, method and characteristics of the sample (age group, sex, burned body surface, etiological agent, degree of burn, environment and complications).

Data were gathered and organized as follows: a) Quantitative analysis: carried out using statistical tests (meta-analysis) using studies with epidemiological data, in which the prevalence of each variable investigated was calculated considering the participants included in the sample; b) Qualitative analysis: through the characteristic's description observed in the population, therefore including report studies and case series.

ASSESSMENT OF STUDY QUALITY

The study quality was assessed by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement, in which two authors determined a global quality score for each selected article, establishing 1 point for each article item answered with YES according to the 22 criteria structured in the STROBE guideline. A score of 12 was used as the cutoff point, with studies with a score of up to 11 considered as high risk, and 12 and above as being low risk (12).

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STATISTICAL ANALYSIS

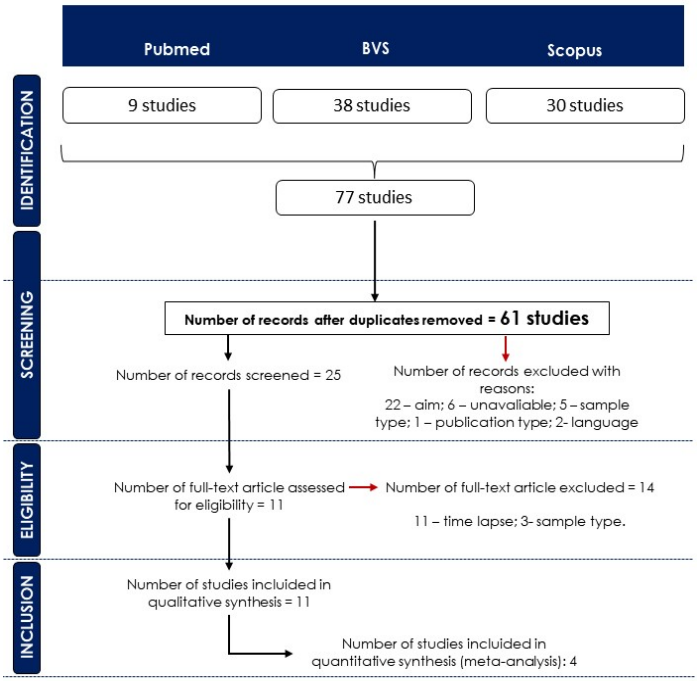
For qualitative and quantitative analysis, data were organized in digital Microsoft Excel® spreadsheets, 2016. The spreadsheet for meta-analysis contained the author, the number of events observed and the number of total events, and each event was a characteristic analyzed in the pediatric population victims of burns (13).

The meta-analysis was carried out using the statistical software R-Studio version 4.3, with the random distribution method. The chi-square test was used to determine the significance of heterogeneity, adopting a more conservative p-value than usual, $p < 0.10$. The I-square test was also used to evaluate the amplitude of heterogeneity, where values above 50% were considered as substantial heterogeneity and above 75% as considerable heterogeneity (14).

RESULTS

We found 77 studies in the databases. After duplicates were removed, there were 61studies. In the screening by titles and abstracts, 36 studies were excluded, and 25 were screened by full-text analysis. After that, 14 articles were excluded, and 11 were used for qualitative analysis, 4 of which were used for meta-analysis (**Figure 1**).

Figure 1: Flowchart of study selection



Source: Authors

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RISK OF BIAS ASSESSMENT

From the included studies, only 1 presented a high risk of bias. Among the studies selected for meta-analysis, all presented a score greater than 12, indicating a low risk of bias (Table 1). All studies developed a title and abstract appropriately, containing the study design and clear objectives, in addition to establishing data regarding data collection. Only 1 study presented the source of funding, and all studies did not establish criteria related to the risk of bias. Only 1 study used the STROBE tool for risk assessment, but it was not clear how it was applied.

Table 1: Risk of bias assessment of the included studies based on STROBE criteria.

STUDY ID	SCORE	RISK OF BIAS
(Barbosa *et al.*, 2021)	11	High
(Barcellos *et al.*, 2018)	16	Low
(Barros *et al.*, 2019)	15	Low
(Bartholo *et al.*, 2022)	17	Low
(Botelho Filho *et al.*, 2019)	19	Low
(Correia *et al.*, 2019)	17	Low
(Malta *et al.*, 2016)	17	Low
(Martins; Vinhal; Morais, 2021)	18	Low
(Morais; Daga; Prestes, 2016)	17	Low
(Queiroz; Barreto; Lima, 2019)	16	Low
(Rigon *et al.*, 2019)	13	Low

QUALITATIVE ANALYSIS

Burns are an important reason for hospital care due to external causes in the pediatric population (15), representing 15.8% of all patients affected by burns, according to Barbosa and colleagues (2021). They mostly occurred in home environments (2,16,17), and can represent up to 85% of all burns (9). For this reason, it is essential to carry out non-formal and informal preventive education processes for the general population, alerting the main locations of risks and impacts caused by this type of injury (18), which are considered the worst accident to which a healthy human being can be suddenly exposed, generating marks and scars for the rest of their life, in addition to physical, psychological and functional consequences (17).

The higher prevalence of domestic accidents occurs due to several factors such as, long periods of staying home of younger children, as they are not yet at school and do not have advanced neuropsychomotor development, which leaves them more susceptible to domestic accidents (17). Furthermore, the lack of supervision by those responsible contributes to the increase in the incidence of cases, as children easily access

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environments such as the kitchen, culminating in a situation known as Hot Kettle Syndrome, in which the child pulls a container with heated liquids located on the stove, causing burn injuries, mainly in the anterior body segments (1). This type of injury was present in the study by Barcellos and colleagues (2018) and Morais, Daga and Prestes (2016), that reported the main etiological agent of burns in children under 5 years of age was scald, and it was associated with high morbidity.

Among the most prevalent complications resulting from burns are infections, cardiac and respiratory disorders, respectively (2). Infection occurs due to the loss of the protective barrier against microorganisms due to the vulnerability of the tissue and the inability to regulate water loss (16). Prognosis of these children depends on the initial approach and treatment applied (2). The involvement of the cardiovascular system is the result of hypovolemia and dehydration, resulting in an increase in heart rate and a decrease in blood pressure (2).

An aspect that is related to greater complexity in care is the involvement of the upper airways (19). In the case series published by Botelho-filho and colleagues (2019), all pediatric burn victims suffered an inhalation injury, thus requiring rapid clinical management and orotracheal intubation. It is essential for greater survival of these patients, as it is considered the best therapy for this type of condition (20).

Finally, physiotherapy is extremely important for the rehabilitation of patients suffering from burns, in order to obtain a better recovery result and minimal sequelae, which may occur due to injuries (2,6,8). In this sense, physiotherapy acts on the various consequences of burns, not only in the motor part, preventing musculoskeletal complications and in the treatment of contractures, but also acting on hypertrophic scars and in the respiratory function, presenting significant results for the restoration of individuals' functionality (4,18).

QUANTITATIVE ANALYSIS: META-ANALYSIS

Affected body areas

Regarding the affected body areas, injuries were observed mainly in the trunk in 77% (95% CI 0.15–0.98; $X_1^2 = 30.52$, $p < 0.001$; $I^2 = 97\%$), and upper limbs, in 52% (95% CI 0.27–0.76; $X_1^2 = 20.52$, $p < 0.001$; $I^2 = 95\%$). The lower limbs, 39% (95% CI 0.14–0.71; $X_1^2 = 32.65$, $p < 0.001$; $I^2 = 97\%$), and head and neck 42% (95% CI 0.10–0.83; $X_1^2 = 52.50$, $p < 0.001$; $I^2 = 98\%$) were less frequent, as can be seen in **Figure 2**. Additionally, it should be

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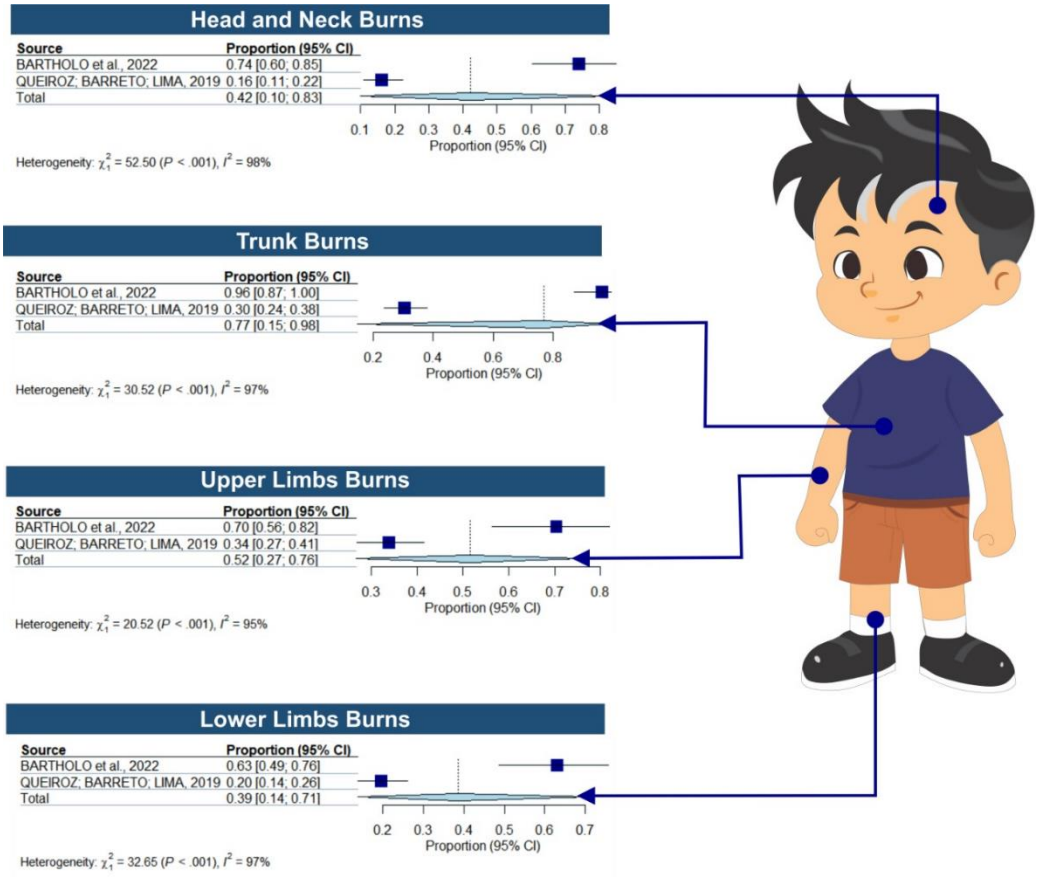
noted that most children involved in the studies included in this meta-analysis suffered burns in more than one body area (2,21).

In the literature, similar results were found in children and adolescents (4,19,22), and the main affected body regions are the same of those in this study: trunk, upper limbs, head and neck. This may be explained by the position in which the child is regarding the agent causing the burn. In the preschool age group, children begin to be more interested in the environment that surrounds them, thus meeting potentially harmful agents (9,23). In this sense, there is a tendency to drop objects on themselves, in a cephalo-caudal direction, such as pans and kettles with heated liquids in areas such as the chest, upper limbs, head and neck (9,17).

Figure 2: Infographic representing body areas affected by burns in children in Brazil.



Source: Authors

Causal agent

The most prevalent etiological agent of pediatric burns in Brazil was scald, representing a total of 62%. Then, burns caused by hot surfaces were observed as the second causal agent (15%); burns by fire (13%), sunburns and fireworks (3%), electric

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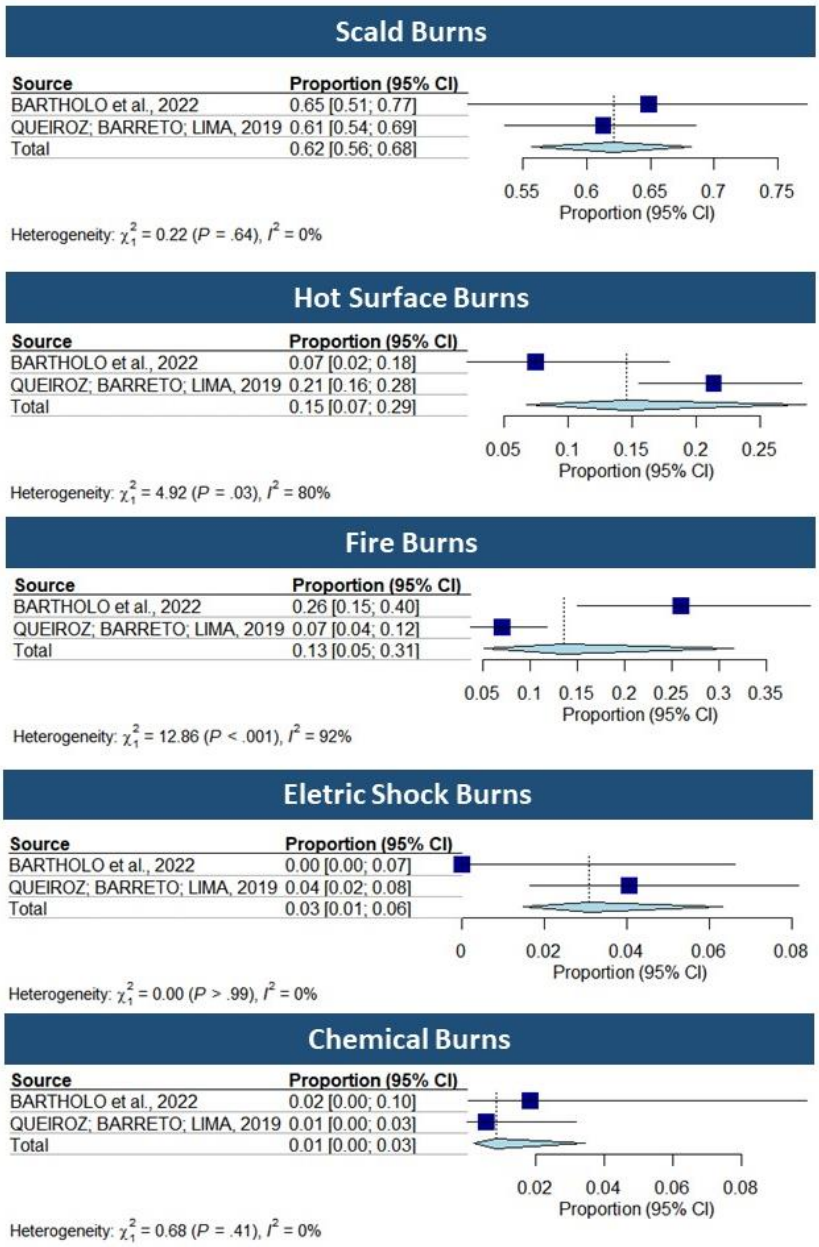
shock (3%), explosion injuries (2%) and, finally, chemical products (1%), as seen in **Figure 3**.

Figure 3: Meta-analysis of data regarding the types of causal agents of burns.



Source: Authors.

Distribution by sex

Regarding sex, 59% of burns were in boys, while girls represented a percentage of 41% (**Figure 4**).

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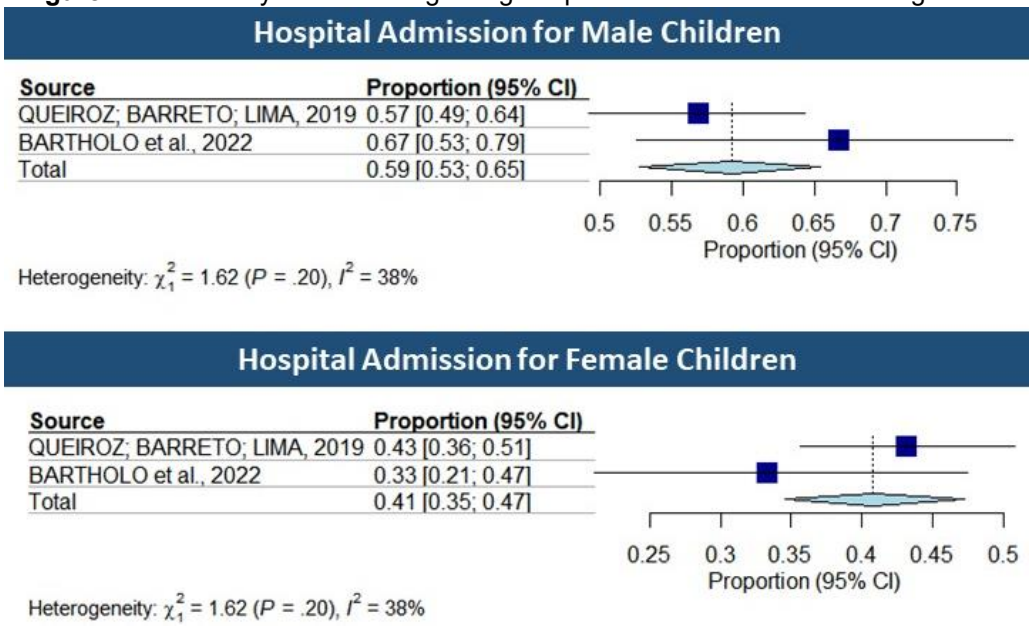
Figure 4: Meta-analysis of data regarding hospitalization for burns according to sex.



Source: Authors.

Distribution by age group

In this meta-analysis, the hospitalization rate of children victims of burns aged 0-10 years was observed, with a predominance of cases in the population between 0-5 years, representing 79% (95% CI 0.72–0.83; X_1^2 = 1.47, p = 0.22; I^2 = 32%).

Most prevalent degree of burn in burned children

Regarding wound depth, the present study shows that 89% (95% CI 0.80–0.94; X_1^2 = 4.55, p = 0.03; I^2 = 78%) of victims of pediatric burns suffered second-degree injuries, while 7% (95% CI 0.02–0.25; X_1^2 = 12.65, p < 0.001; I^2 = 92%) were affected by third-degree injuries.

DISCUSSION

In the literature, when it comes to affected body areas, similar results were found in children and adolescents (4,19,22), and the main affected body regions are the same of those in this study: trunk, upper limbs, head and neck. This may be explained by the position in which the child is regarding the agent causing the burn. In the preschool age group, children begin to be more interested in the environment that surrounds them, thus meeting potentially harmful agents (4,9). In this perspective, there is a tendency to drop objects on themselves, in a cephalo-caudal direction, such as pans and kettles with heated liquids in areas such as the chest, upper limbs, head and neck (9,17).

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During the bibliographical investigation, it was observed that the most common causal agents of burns found converge with other published studies (4,17,23), which reported scald as the most prevalent agent in infants (0-1 year) and preschoolers (2-6 years). On the other hand, these studies mention that in the age group that includes schoolchildren (7-9 years old), the main cause of burns is direct fire, associated with flammable liquids; At this age, children are in a more curious phase, and have more advanced motor development, being able to initiate higher risk activities and games. However, in the study by Gradim and colleagues (2021), the most prevalent thermal agent was alcohol, surpassing burns caused by hot water and oil.

The rate of burn frequence being higher in boys when compared to girls identified in our study is similar to those observed in other previously studies. (3,10,16,19). This result can be explained by behavioral differences between sexes, in which the male population is more likely to participate in risky situations, with less caution, and greater chance of accidents.

The distribution by age-group is the aspect with most diverse findings in literature, some studies seem to corroborate with our results showing that cases in the population between 0-5 years are the most common ones (2,15,24,25). Fact that can be explained by the lack of recognition of dangerous situations and the inability to defend themselves against such events, making them more vulnerable and thus explaining the higher prevalence of burns in this age group. (25). Contrasting this study, Martins and colleagues (2021), examined the hospitalization rate of children and adolescent victims of burns in a public hospital in Goiânia, Brazil, and they reported that this population, aged between 10-17 years, was the most affected, exceeding the numbers of infants, preschoolers and schoolchildren. This might be explained as a result of the greater handling of flammable liquids.

Furthermore, the second-degree burn being the most common one was also observed in the literature (4,16). Gradim and colleagues (2021) also observed a percentage of 90.3% of children and adolescents affected by second-degree injuries, compared to 34.8% with third-degree injuries. Second-degree burns tend to occur with changes in the pigmentation of the affected area, possibly developing into hypertrophic scars - generating restrictions and functional damage, if the healing process lasts more than 3 weeks (4).

This study demonstrated that the Brazilian pediatric population most affected by burns corresponds to male children aged under 5 years. The main causative agent involved

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was scald, affecting the trunk, upper limbs, head and neck, respectively. Finally, it was found that, regarding depth, second-degree injuries were the most prevalent.

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