e-ISSN: 3068-3742
Journal of Surgery Research and Practice

ATHENAEUM SCIENTIFIC PUBLISHERS

Research Article

Domestic Burn Injuries: Epidemiological Patterns and Targeted Preventive Strategies from a Retrospective Cohort Study (2024-2025)

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Citation: Melloni C, et al. Domestic Burn Injuries: Epidemiological Patterns and Targeted Preventive Strategies from a Retrospective Cohort Study (2024-2025). J Surg Res Prac. 2026;7(2):1-11.

https://doi.org/10.46889/JSRP.2026.7208

Received Date: 13-05-2026

Accepted Date: 01-06-2026

Published Date: 08-06-2026

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Abstract

Burn injuries continue to represent a substantial global health burden, not only due to their acute clinical impact but also because of their long-term physical, psychological and socioeconomic consequences. Importantly, a large proportion of these injuries occur in domestic environments and are associated with identifiable and modifiable risk factors. This makes burns uniquely positioned among traumatic injuries as highly preventable events, provided that risk patterns are correctly identified and translated into effective interventions.

This study aims to characterize the epidemiological and clinical features of burn injuries within a recent cohort and, more critically, to reinterpret these findings through a prevention-oriented framework. The goal is to identify high-risk mechanisms and populations and to define targeted, evidence-based preventive strategies applicable in domestic settings.

A retrospective observational analysis was conducted on 224 burn cases recorded between 2024 and 2025. Variables included demographic data, burn etiology and burn severity measured as percentage of Total Body Surface Area (%TBSA). Burn mechanisms were systematically categorized to allow meaningful comparison across groups. Statistical analyses were used not only to detect associations but also to highlight priority areas for preventive intervention.

The analysis revealed a clear predominance of flame/explosion burns, which accounted for nearly half of all cases and were associated with the greatest injury severity. Scald burns emerged as the second most common mechanism but demonstrated a strong concentration in pediatric patients. The statistically significant association between age and burn etiology underscores that burn risk is structured and predictable, rather than random. Importantly, a non-negligible proportion of patients sustained severe burns, reinforcing the need for upstream prevention.

The findings confirm the presence of two dominant and preventable burn profiles: pediatric scald injuries and adult flame-related burns. Effective prevention requires a targeted, stratified approach that addresses specific mechanisms of injury, environmental hazards and behavioral risk factors within the domestic setting.

Keywords: Burn Injury; Domestic Burns

Introduction

Burn injuries remain a critical issue in global health, contributing significantly to morbidity, mortality and long-term disability [1-4]. However, unlike many other forms of trauma, burns frequently arise from routine, everyday activities, particularly within the home [1,2,5]. This distinguishes them as injuries that are not only treatable but, more importantly, largely preventable through environmental control and behavioral modification [2,5,6].

Domestic environments inherently concentrate multiple burn hazards within confined and frequently used spaces. Kitchens, bathrooms and heating areas represent high-risk microenvironments where exposure to hot liquids, open flames, heated surfaces and chemical agents is routine. The risk is further amplified by human factors such as distraction, fatigue, lack of awareness and unsafe practices [1].

A crucial aspect of burn epidemiology is that risk is not evenly distributed across populations. Instead, it follows reproducible patterns shaped by age, behavior and functional capacity. Children are particularly vulnerable due to their developmental stage, limited hazard awareness and dependence on caregivers. Adults are more exposed to burns through active engagement in potentially hazardous activities such as cooking and handling flammable substances. Older adults, in contrast, face compounded risks due to physiological decline, including reduced mobility and slower reaction times.

Recognizing these patterns allows for a shift from a reactive clinical approach to a proactive prevention model, in which interventions are tailored to specific risk profiles. The present study is therefore designed not only to describe burn epidemiology but to operationalize prevention, translating statistical findings into concrete safety strategies.

The aim of this study was to characterize the epidemiological and clinical patterns of domestic burn injuries in a contemporary cohort and to identify mechanism-specific and age-targeted preventive strategies capable of reducing burn incidence and severity

Materials and Methods

This retrospective cohort study was based on a systematically collected dataset of burn injuries managed over a two-year period. The inclusion of consecutive cases ensures that the cohort reflects real-world clinical exposure, including a wide spectrum of injury severity and patient demographics. By focusing on a defined and recent timeframe, the study captures current patterns of domestic burn risk, which are essential for designing relevant prevention strategies.

The selection of variables was oriented toward both clinical relevance and preventive interpretation. Burn mechanism, in particular, was categorized into standardized groups to enable the identification of mechanism-specific risk profiles. This classification is essential because prevention strategies differ fundamentally depending on whether the injury is caused by flame, hot liquids, contact surfaces or chemical exposure.

Age stratification was intentionally structured to reflect clinically meaningful and prevention-relevant categories. Each age group corresponds to a distinct risk ecology, characterized by different exposure patterns and vulnerability factors. This approach allows for a more precise alignment between epidemiological findings and targeted interventions.

The statistical framework was designed not only to identify significant differences but also to support risk stratification and prioritization of preventive measures. By demonstrating associations between age, mechanism and severity, the analysis provides a quantitative basis for directing prevention efforts toward the most impactful targets.

Results

The cohort demonstrates a broad age distribution, indicating that burn injuries affect individuals across the lifespan. The relatively balanced representation of pediatric, adult and older populations highlights that prevention strategies must be comprehensive yet differentiated, addressing the specific needs of each group rather than relying on generalized approaches.

A critical implication of the present findings is the need to reinterpret burn injuries not as isolated accidental occurrences but as failures within a broader system of environmental safety, behavioral regulation and risk awareness. The reproducibility of burn patterns across age groups and mechanisms suggests that these injuries arise from predictable interactions between individuals and modifiable domestic hazards. This systems-based perspective aligns with modern injury prevention models, in which outcomes are determined by the interplay between host, agent and environment. Within this framework, the home emerges not merely as a setting but as a dynamic risk system, where design, supervision and behavior converge. Consequently, effective prevention must extend beyond individual responsibility and incorporate structural interventions, including safer product design, regulation of hazardous materials and standardized safety practices (Fig. 1).

Figure 1: Main burn risk factors divided by age and prevention strategies.

Flame/explosion burns represent a high-energy transfer mechanism, often resulting in deeper tissue damage and larger total body surface area involvement. From a prevention standpoint, this identifies flame-related incidents as a high-leverage target, where even modest reductions in incidence could yield significant decreases in morbidity, healthcare utilization and long-term disability. Importantly, many of the underlying risk factors such as the use of accelerants, unsafe ignition practices and poorly maintained gas systems are entirely modifiable. This positions flame burn prevention as one of the most cost-effective and impactful interventions within domestic injury prevention strategies (Fig. 2).

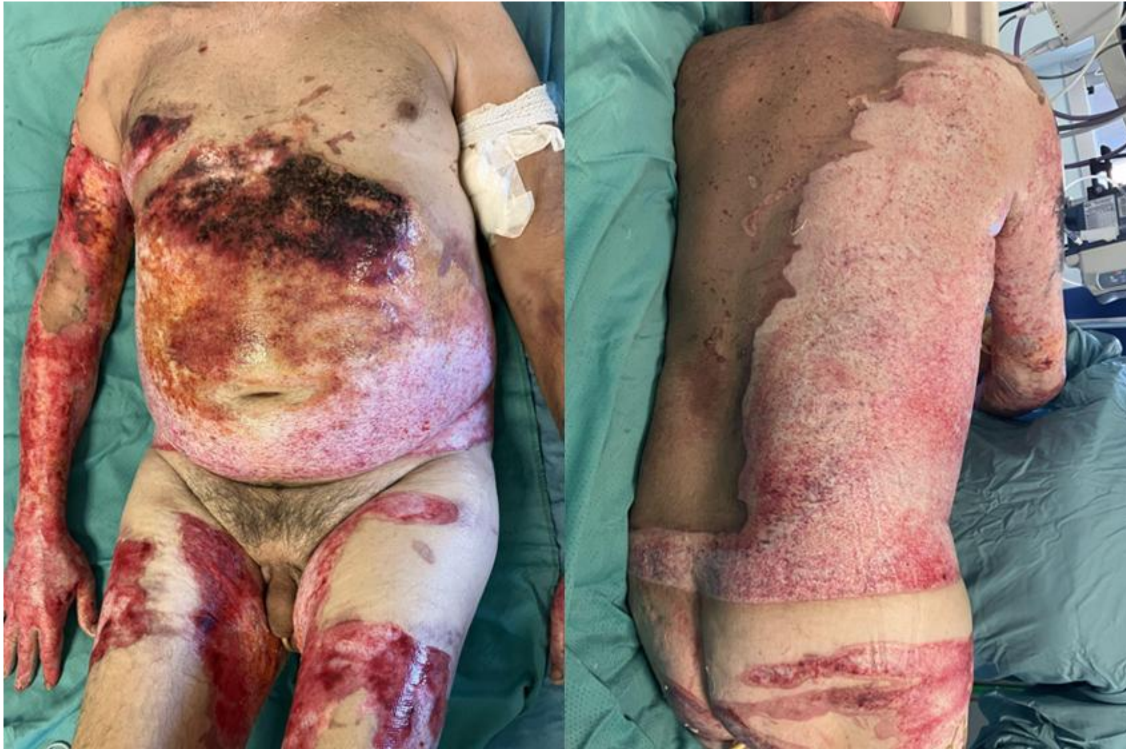

Figure 2: Flame burn injury following barbecue ignition using alcohol as an accelerant, resulting in extensive mixed-depth burns involving the anterior and posterior trunk and upper and lower extremities. This case illustrates the severe consequences of unsafe ignition practices and highlights the importance of prevention through avoidance of flammable accelerants during domestic barbecue use.

The strong statistical association between age and burn etiology provides a compelling argument for adopting a precision prevention approach in burn care. Rather than implementing broad, non-specific safety campaigns, interventions should be risk-stratified and mechanism-specific, targeting the highest-yield populations and exposures. Pediatric scald burns (Fig. 3-5) and adult flame injuries represent two distinct epidemiological entities with fundamentally different causal pathways. As such, they require divergent preventive strategies, ranging from passive environmental controls in children to active behavioral modification in adults. This stratified approach mirrors advances in other areas of medicine, where interventions are increasingly tailored to defined risk profiles. In the context of burns, such a model has the potential to significantly improve the efficiency, scalability and measurable impact of prevention programs.

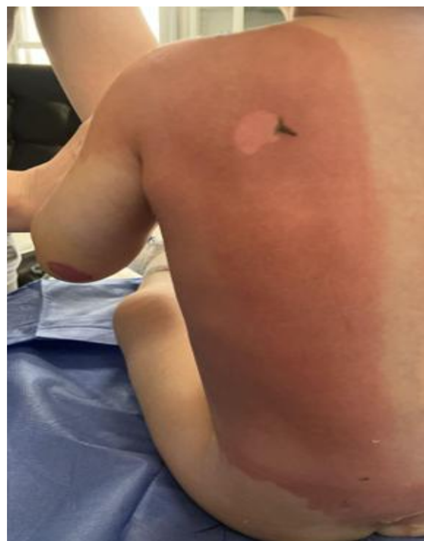

Figure 3: Pediatric scald burn caused by exposure to excessively hot bath water, illustrating the risk associated with inadequate water temperature control and lack of supervision during bathing.

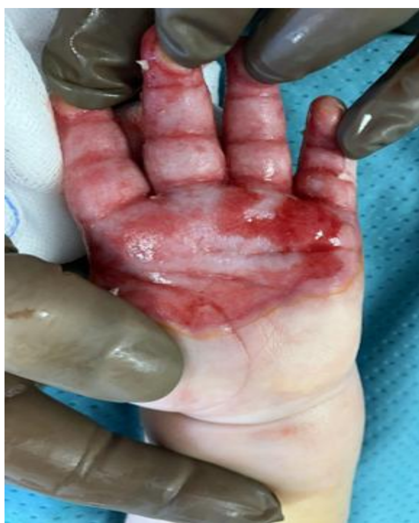

Figure 4: Pediatric scald injury resulting from accidental opening of a hot-water faucet, highlighting the importance of temperature-regulating devices and child-safe bathroom environments.

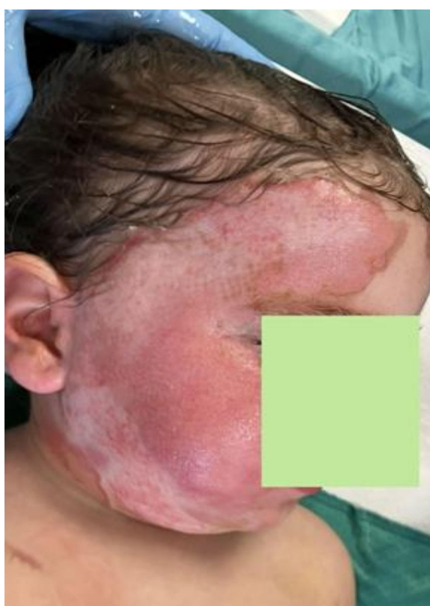

Figure 5: Facial scald burn in a child caused by accidental splash of hot food, emphasizing the domestic risk associated with handling hot liquids and meals in the presence of children.

Older adults represent a uniquely vulnerable subgroup within burn epidemiology due to the combined effects of physiological aging, multimorbidity, reduced functional reserve and increased dependence on environmental safety. Although older individuals may sustain burns through mechanisms similar to those observed in younger populations, the consequences are often substantially more severe because aging significantly impairs the body's ability to tolerate thermal injury and recover from physiological stress.

Several age-related factors contribute to increased burn susceptibility in this population. Reduced mobility, impaired balance, visual decline, cognitive impairment and delayed reaction times increase the likelihood of accidental exposure to hot liquids, heating devices and open flames. In addition, older adults frequently rely on domestic heating systems, electric blankets, hot water devices and cooking appliances, thereby increasing cumulative exposure to thermal hazards within the home environment. Social isolation and reduced caregiver support may further amplify risk by limiting the ability to respond rapidly to dangerous situations (Fig. 6,7).

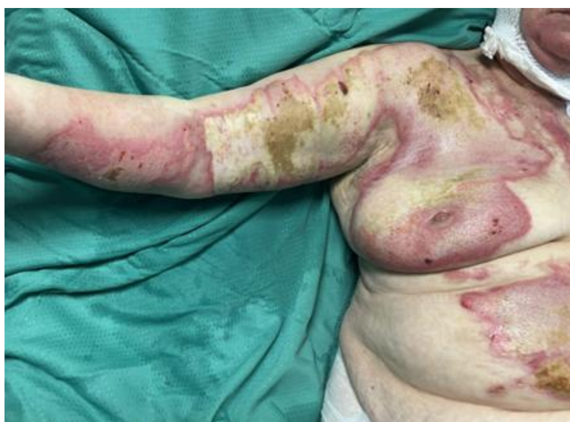

Figure 6: Scald burn injury in an older woman caused by rupture of a hot water bag, illustrating the increased vulnerability of elderly patients to domestic thermal injuries and the importance of safe use and regular inspection of heating devices.

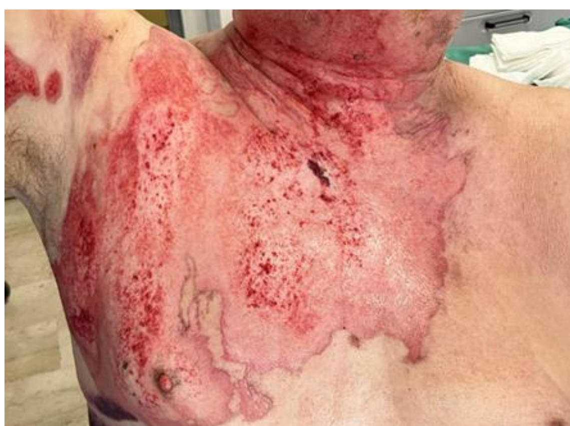

Figure 7: Flame burn injury in an older man caused by ignition of flammable clothing during unsafe movement near a domestic stove, highlighting the combined role of mobility limitations, hazardous clothing materials and proximity to open flames in elderly burn risk.

Importantly, burns in older patients are associated with disproportionately high morbidity and mortality compared with younger individuals, even at lower percentages of total body surface area involvement. Age-related physiological changes including reduced skin thickness, impaired immune response, decreased cardiovascular reserve and diminished wound-healing capacity contribute to poorer outcomes and increased susceptibility to infection, sepsis and prolonged hospitalization. Consequently, injuries that may be clinically manageable in younger adults can become life-threatening in elderly patients.

From a prevention perspective, these findings reinforce the importance of adopting a vulnerability-centered approach to domestic burn prevention in aging populations. Unlike younger adults, prevention in older patients must extend beyond behavioral education and incorporate environmental adaptation and functional support. Interventions such as safer appliance design, elimination of open-flame heating systems, installation of automatic shut-off devices, improved household accessibility and caregiver involvement may substantially reduce risk exposure.

The growing proportion of elderly individuals in many populations further increases the public health relevance of this issue. As demographic aging continues globally, burn prevention strategies must increasingly account for the specific needs of older adults. Failure to address this vulnerable population will likely result in a growing burden of severe burns, prolonged rehabilitation and increased healthcare utilization. Therefore, integrating geriatric principles into burn prevention frameworks should be considered a critical component of future public health and injury prevention strategies.

The presence of severe burns within the cohort underscores the clinical consequences of prevention failure. The significantly greater severity associated with flame burns highlights the importance of prioritizing interventions that target high-energy mechanisms. Preventing these injuries has a disproportionate impact on reducing overall morbidity.

The data strongly support the interpretation of burn injuries as non-random, pattern-driven events that arise from identifiable interactions between individuals and their environment. This perspective shifts the focus from treatment to prevention, emphasizing the importance of addressing upstream risk factors.

The consistent identification of household-related exposure patterns underscores the central role of the domestic environment as a modifiable determinant of burn risk. Kitchens, in particular, function as high-risk nodes where multiple hazards converge thermal, chemical (Fig. 8) and flame-related. From an injury prevention perspective, this suggests that environmental engineering and design optimization represent underutilized but highly effective strategies. Interventions may include safer appliance design, improved stability of cookware, automatic shut-off systems and clearer hazard labeling. Additionally, the integration of safety features into building codes and consumer products could shift prevention from an individual responsibility to a built-in system property, thereby reducing reliance on behavior alone.

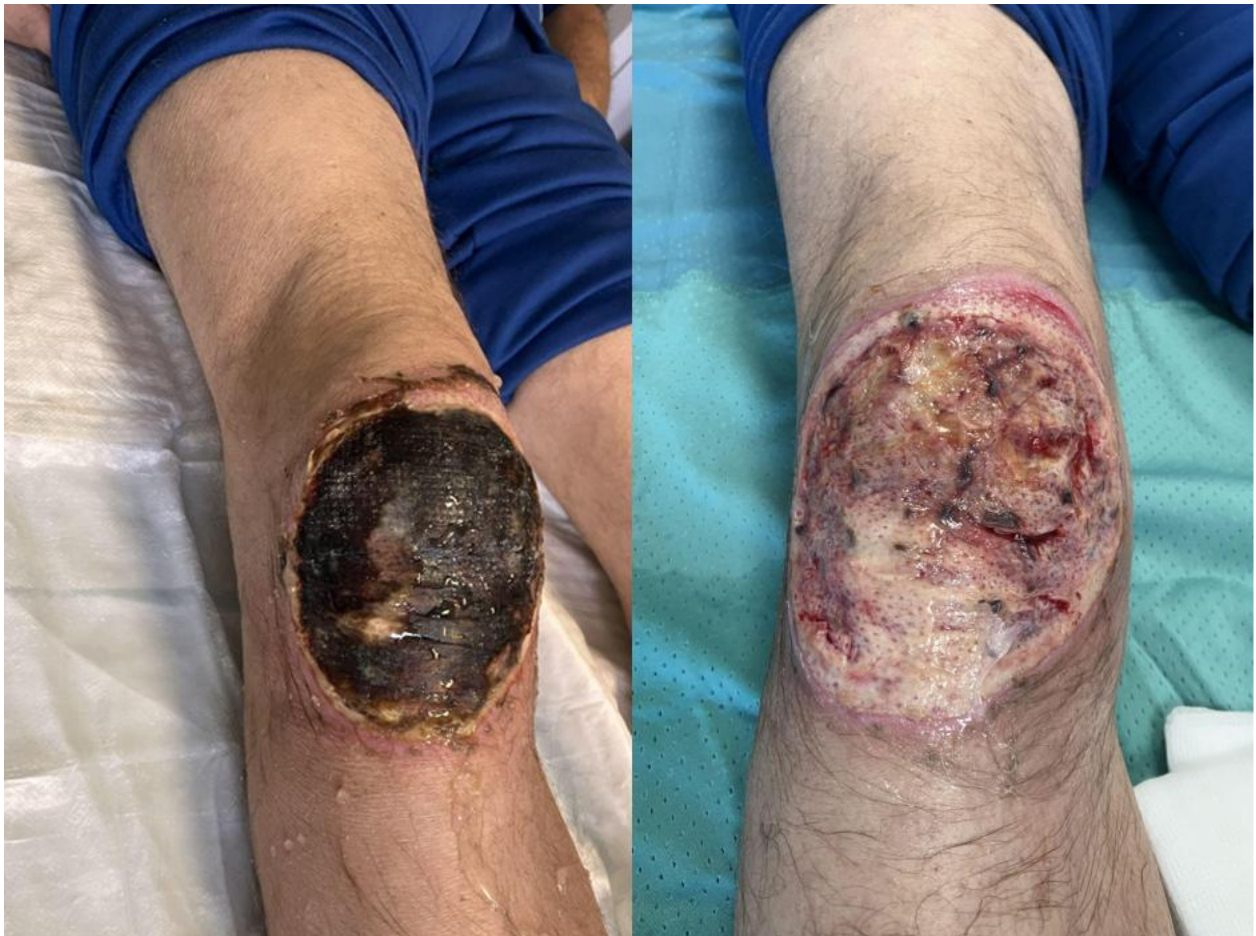

Figure 8: Chemical burn injury (knee) in a young adult caused by exposure to a sulfuric acid-based drain cleaner, demonstrating the severe tissue damage associated with improper handling of corrosive household cleaning agents and underscoring the importance of safe storage, protective equipment and hazard awareness.

Prevention of Pediatric Scald Burns

Pediatric scald burns represent a classic example of environmentally mediated injury, where risk is primarily determined by the configuration of the domestic setting and the level of supervision. Children lack the cognitive and physical capacity to recognize and avoid hazards, making them dependent on caregivers for protection.

Effective prevention therefore requires passive safety measures, such as environmental modification, combined with active supervision. Simple interventions can significantly reduce risk. Importantly, these measures are low-cost and highly scalable, making them ideal targets for public health initiatives.

Prevention of Flame/Explosion Burns in Adults

Flame-related burns in adults are predominantly behavior-driven, arising from unsafe practices during cooking, heating or ignition activities. These injuries are particularly concerning due to their severity and potential for rapid escalation.

Prevention in this group requires a focus on risk awareness and behavioral change, supported by environmental safeguards. Eliminating the use of accelerants, ensuring proper maintenance of appliances and promoting safe ignition techniques are critical steps. Additionally, the installation of safety devices such as smoke detectors provides an essential layer of protection.

Prevention in Older Adults

Older adults represent a population in which burn risk is amplified by physiological vulnerability. Reduced mobility, impaired vision and slower reaction times increase the likelihood of both exposure and injury severity.

Preventive strategies must therefore prioritize adaptation of the living environment, reducing reliance on hazardous devices and improving accessibility. Support systems, whether familial or institutional, play a crucial role in mitigating risk.

Severity as a Function of Preventable Risk

The observed relationship between burn mechanism and severity highlights that not all burns carry equal clinical weight. High-energy mechanisms, particularly flame injuries, are associated with significantly greater morbidity. This reinforces the concept that prevention should be risk-weighted, focusing on mechanisms that contribute most to severe outcomes.

Public Health Implications

The findings of this study support the development of an integrated, multi-level model of burn prevention, combining:

- Individual-level interventions (education, behavior change)
- Household-level modifications (environmental safety, device use)
- Community-level strategies (awareness campaigns)
- Policy-level actions (regulation, product safety standards)

Such a model recognizes that no single intervention is sufficient in isolation. Instead, effective prevention emerges from the synergistic interaction of multiple layers of control, each addressing different components of risk. Future research should focus on evaluating the effectiveness of integrated prevention programs and identifying the most impactful combinations of interventions.

One of the persistent challenges in burn prevention is the gap between epidemiological evidence and real-world implementation. The present study contributes to bridging this gap by providing mechanism-specific and population-specific data that can directly inform policy decisions. For example, the high prevalence of flame-related injuries supports stricter regulation of flammable substances and public education on safe ignition practices. Similarly, the burden of pediatric scald injuries justifies the promotion of temperature-regulating devices and child-safe product standards. Embedding these findings into national and regional health policies could facilitate a transition from reactive care models to proactive, prevention-oriented systems.

Prevention Strategies for Domestic Burn Injuries

1. General (Cross-Cutting) Prevention Principles

- Implement risk-aware household design, minimizing exposure to heat sources and flammable materials
- Promote routine safety checks of domestic appliances (gas, electrical, heating systems)
- Install and maintain smoke detectors and fire extinguishers in key household areas
- Ensure clear separation between high-risk zones (kitchen, heating areas) and living spaces
- Encourage public education programs focused on burn risk awareness and first-line prevention
- Adopt product safety standards (temperature regulators, automatic shut-off devices)
- Improve labeling and hazard communication for flammable and corrosive substances

2. Pediatric Burn Prevention (Scald-Focused, Passive Strategies)
- Keep hot liquids and food out of reach and out of sight of children
- Turn pot and pan handles inward on stoves
- Avoid placing hot beverages near table edges or unstable surfaces
- Never hold a child while handling hot liquids or cooking
- Set water heater temperatures to safe limits (≤48°C)
- Always test bath water temperature before use
- Use spill-resistant containers and lids where possible
- Ensure constant adult supervision in kitchens and bathrooms
- Install physical barriers or childproof gates in high-risk areas
- Educate caregivers on developmental vulnerability and risk anticipation

3. Adult Burn Prevention (Flame/Explosion-Focused, Active Strategies)
- Avoid use of flammable accelerants (e.g., alcohol, gasoline) for ignition
- Use only approved ignition devices for barbecues and stoves
- Ensure regular maintenance of gas appliances and connections
- Check for gas leaks and ensure proper ventilation
- Keep flammable materials away from heat sources
- Wear non-flammable, fitted clothing during cooking
- Never leave open flames unattended
- Maintain safe distances from ignition sources

4. Older Adult Prevention (Vulnerability-Adapted Strategies)
- Simplify domestic environments to reduce exposure to open flames and hot surfaces
- Replace hazardous devices with safer alternatives (e.g., induction cooktops, electric heaters)
- Improve lighting and visibility in key areas
- Ensure easy access to frequently used items to avoid risky movements
- Install automatic shut-off systems for appliances
- Provide assistive devices or caregiver support when needed
- Conduct regular home safety assessments
- Address mobility and cognitive limitations in safety planning

5. Contact/Thermal Burn Prevention
- Install protective guards on ovens, heaters and radiators
- Clearly identify and label hot surfaces
- Turn off and cool appliances immediately after use
- Use heat-resistant gloves or tools when handling hot objects
- Keep children away from recently used appliances

6. Chemical Burn Prevention
- Store chemicals in original, clearly labeled containers
- Keep hazardous substances out of reach of children
- Use personal protective equipment (gloves, eye protection)
- Avoid mixing incompatible chemicals (e.g., bleach and ammonia)
- Ensure adequate ventilation during use
- Dispose of chemicals according to safety guidelines

7. Electrical Burn Prevention
- Regularly inspect and maintain electrical wiring and outlets
- Avoid overloading sockets and extension cords

- Use certified and compliant electrical devices
- Keep electrical appliances away from water sources
- Install Residual Current Devices (RCDs) where applicable

Discussion

This study demonstrates that burn injuries occurring in predominantly domestic contexts are not random events, but rather follow clearly identifiable and statistically robust epidemiological patterns linking age, mechanism of injury and burn severity. The consistency of these patterns supports a paradigm shift in how burn injuries are conceptualized—from unavoidable accidents to predictable and preventable outcomes of modifiable risk exposures.

Two major and distinct prevention targets emerge from the analysis. First, pediatric scald burns represent a classic environmentally mediated injury pattern, driven primarily by exposure to hot liquids within inadequately controlled domestic settings. These injuries occur early in life, often in the context of routine household activities and are strongly influenced by supervision and environmental configuration. Second, adult flame/explosion burns constitute the most frequent and clinically severe category, characterized by higher %TBSA involvement and a greater burden on healthcare resources. These injuries are predominantly associated with unsafe ignition practices, improper handling of flammable substances and inadequate control of domestic fire hazards.

From a clinical and public health standpoint, the coexistence of these two profiles highlights the necessity of age-specific and mechanism-targeted prevention strategies. A uniform, non-differentiated approach to burn prevention is unlikely to achieve meaningful reductions in incidence or severity. Instead, effective prevention must be risk-stratified, addressing the distinct causal pathways underlying different burn mechanisms. In pediatric populations, priority should be given to passive preventive measures, including environmental modification, safer kitchen design, temperature regulation and caregiver education. In adults, interventions must focus on behavioral risk reduction, emphasizing safe practices in cooking, heating and the use of flammable materials, supported by appropriate safety devices and infrastructure.

The findings also underscore the importance of the domestic environment as a central and modifiable determinant of burn risk. The repeated identification of household-related exposure patterns suggests that a substantial proportion of burn injuries could be prevented through relatively simple and scalable interventions. These include improved product safety standards, safer appliance design, regulation of hazardous substances and the integration of safety features into everyday domestic settings. In this context, prevention should be understood not only as an individual responsibility but as a shared societal and structural objective, involving healthcare systems, policymakers, industry and communities.

An additional key implication of this study is the relationship between burn mechanism and injury severity. Flame-related burns, which were associated with significantly greater %TBSA, represent a high-impact target for prevention, as reducing their incidence would disproportionately decrease the burden of severe burns. This has direct consequences for healthcare systems, as severe burns require intensive resource utilization, including surgical management, prolonged hospitalization and rehabilitation. Therefore, preventive strategies targeting high-severity mechanisms have the potential to improve not only patient outcomes but also health system efficiency and sustainability.

Despite its retrospective design and inherent limitations, this study provides clinically actionable insights that can inform both practice and policy. Future research should aim to enhance data granularity by incorporating detailed information on injury setting, behavioral factors and environmental conditions. Prospective studies and intervention-based research will be essential to evaluate the effectiveness of targeted prevention strategies and to identify the most cost-effective approaches for reducing burn incidence.

Conclusion

In conclusion, the present analysis reinforces the concept that burn injuries in domestic settings are largely preventable through targeted, evidence-based interventions. The integration of epidemiological data into prevention frameworks offers a powerful tool for reducing the burden of burns. Moving forward, the challenge lies in translating these insights into coordinated, multi-level prevention strategies that are implemented at scale and sustained over time.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding Statement

This research did not receive any specific grant from funding agencies in the public, commercial or non-profit sectors.

Acknowledgement

The authors have no acknowledgments to declare.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Statement

The project did not meet the definition of human subject research under the purview of the IRB according to federal regulations and therefore was exempt.

Informed Consent Statement

Informed consent was obtained from all participants included in the study.

Authors' Contributions

All authors contributed equally to this paper.

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