Risk factors for cooking-related burn injuries in children, WHO Global Burn Registry
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Objective To assess the characteristics of cooking-related burn injuries in children reported to the World Health Organization Global Burn Registry.

Methods On 1 February 2021, we downloaded data from the Global Burn Registry on demographic and clinical characteristics of patients younger than 19 years. We performed multivariate regressions to identify risk factors predictive of mortality and total body surface area affected by burns. 

Findings Of the 2957 paediatric patients with burn injuries, 974 involved cooking (32.9%). More burns occurred in boys (532 patients; 54.6%) than in girls, and in children 2 years and younger (489 patients; 50.2%). Accidental contact and liquefied petroleum caused most burn injuries (729 patients; 74.8% and 293 patients; 30.1%, respectively). Burn contact by explosions (odds ratio, OR: 2.8; 95% confidence interval, CI: 1.4–5.7) or fires in the cooking area (OR: 3.0; 95% CI: 1.3–6.8), as well as the cooking fuels wood (OR: 2.2; 95% CI: 1.3–3.4), kerosene (OR: 1.9; 95% CI: 1.0–3.6) or natural gas (OR: 1.5; 95% CI: 1.0–2.2) were associated with larger body surface area affected. Mortality was associated with explosions (OR: 7.5; 95% CI: 2.2–25.9) and fires in the cooking area (OR: 6.9; 95% CI: 1.9–25.7), charcoal (OR: 4.6; 95% CI: 2.0–10.5), kerosene (OR: 3.9; 95% CI: 1.4–10.8), natural gas (OR: 3.0; 95% CI: 1.5–6.1) or wood (OR: 2.8; 95% CI: 1.1–7.1).

Conclusion Preventive interventions directed against explosions, fires in cooking areas and hazardous cooking fuels should be implemented to reduce morbidity and mortality from cooking-related burn injuries.

Introduction
Globally, burn injuries remain among the most prominent and preventable injuries in children. Childhood burns can have devastating physical, psychological and socioeconomic consequences. Cooking-related burns have emerged as a particularly damaging subset of childhood burns, representing up to an estimated 85% of childhood scalds, and these types of burns carry a greater patient injury burden and long-term morbidity than burns of other etiologies. Young children and girls are more likely to experience paediatric burns. Low socioeconomic status and its associated circumstances, such as lack of water supply and volatile cooking materials, are also reported to be key risk factors for childhood cooking burns.

Research on paediatric cooking burns has been largely restricted to local or national studies, limiting generalizability of conclusions, especially to global systemic factors underlying disparities in burn injuries. Wide variability in research methods has made meaningful comparisons of clinical outcomes and risk factors between high- and low-income countries difficult. While rapid declines in mortality from childhood burns have been reported in high-income countries over the past decades, the same trend has not been documented in low- and middle-income countries.

We aim to address this gap in the literature by analysing data from the first large-scale, global data repository for burn injuries, the World Health Organization (WHO) Global Burn Registry. The registry, launched in January 2018, is a global instrument to standardize the reporting of hospital admissions due to burn injury across the world and was developed for public health officials and researchers after a thorough evaluation of existing national and international burn registries. The registry comprises data submitted voluntarily by hospital staff members. A study evaluating the instrument reported that mostly physicians entered data into the system, followed by nurses. The registry records hospital admissions, injury characteristics and patient demographics. The aim of our research was to identify the key risk factors predictive of paediatric cooking burns and mortality following these burns by using the data submitted to the registry, and to inform strategies for prevention and management.

Methods

Data source
We searched the Global Burn Registry for all cooking-related burns injuries on 1 February 2021. From the registry, we retrieved details about patients’ demographics, burn characteristics (e.g. total body surface area), mode of contact causing the burn injury, cooking fuel sources, hospital characteristics (e.g. length of stay) and discharge outcomes of the index admission. We de-identified and uploaded the data onto a preformatted Excel spreadsheet, Version 16.33 (Microsoft, Redmond, United States of America, USA). The data in the registry are anonymized and available to academic institutions, and therefore are not considered protected health information so institutional review board approval is not required. We followed the terms and conditions given by WHO for using the data and/or information in the registry.
Study cohort

The study cohort included all paediatric burn injuries recorded in the Global Burn Registry from 1 January 2018 to 1 February 2021. Following the National Institute of Child Health and Human Development, we considered patients younger than 19 years as paediatric patients.17

Variables

The primary outcome was burn severity as determined by two proxy metrics: (i) total percentage of body surface area affected; and (ii) mortality. We assessed five primary risk factors: sex, age, World Bank income category of country of residence, mode of contact causing burn injury, and cooking fuel. We used the National Institute of Child Health and Human Development age group categories,17 a validated categorization of the biopsychosocial changes that occur from birth to adulthood.18 The age categories are: children 2 years and younger; 3–5 years; 6–11 years; and 12–18 years. We included sex and age as risk factors, since they are well-documented predictors in regional studies and therefore merit further investigation on an international scale.19-21 The global nature of the registry also allows study of the relationship between childhood burn injuries and socioeconomic factors, for which World Bank income classification is often used as a proxy measure.19 The World Bank classify countries into four groups based on their gross national income per capita: high income, upper-middle income, lower-middle income and low income.20 Information on the mode of contact causing the burn injury and cooking fuel used are entered for every patient with a cooking burn. These data provide valuable insight to inform preventive measures. One of the following modes of contact can be chosen when entering data: deliberate movement (e.g. deliberate touch to hot surface); accidental contact (e.g. fall/spill); exposure to open fire in the cooking area; explosion in the cooking area; or an unspecified other. Cooking fuel was categorized as: natural gas, liquefied petroleum, kerosene (paraffin), electricity, wood, charcoal and other. We categorized fuel sources that were infrequently reported in the registry as other (e.g. ethanol, traditional biomass, and unspecified sources).

Statistical analysis

For data analysis we used SPSS software, Version 26 (IBM Corp., Armonk, USA). Frequencies and percentages were calculated for categorical variables. Medians and interquartile ranges (IQR) were calculated for continuous data. We found that total percentage of body surface area affected was a skewed continuous variable (skewness: 2.1), therefore the Kruskal–Wallis test was used to find factors associated with increased total body surface area affected and mortality, and the Mann–Whitney U test was used to compare subgroups. We assessed the five selected risk factors as predictors for mortality and the severity of total body surface area affected, using logistic regression. The median total body surface area affected of the cohort (15%) was used as the threshold for logistic regression. All statistical tests were considered to be significant at two-sided \( P < 0.050 \).

Results

In total, 17 countries across all WHO regions reported 6965 burn injuries to the registry (Table 1). Of these, 2957 (42.4%) documented cases involved paediatric patients. Of the paediatric burn injuries, 974 (32.9%) were explic-
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itily cooking related (Table 1). Besides cooking burns, other sources of burn injuries in the registry included washing, house fires, lighting and intentional flame burns. The median total body surface area affected by cooking burns was 15.0% (IQR: 10.0–25.0%) and the overall mortality was 8.5% (83/974; Table 2). Average duration of hospital stay was 16.4 days among patients who survived and 9.2 days among patients who died (P value: < 0.001). Patients who survived were more likely to have undergone surgery during their hospital stay than patients who died (44.2%; 394/891 vs 26.5%; 22/83; P value: 0.002).

Sex and age

Burn injuries occurred more often in boys (532 patients; 54.6%) and children 2 years and younger (489 patients; 50.2%; Table 2). Girls suffered burns with a higher mortality rate (P value: 0.002) compared to boys. Although children 2 years and younger experienced the highest number of burns, they suffered less deadly burns than children in other age groups (vs 3–5 years P value: 0.003; vs 6–11 years P value: 0.114; vs 12–18 years P value: 0.002; Table 2).

Country income classification

Most paediatric cooking burns in the registry were reported in upper-middle-income countries (475 injuries; 48.8%). There was no significant difference in total percentage of body surface area affected by burns (P value: 0.520) or in mortality (P value: 0.614) between the different income categories (Table 2).

Mode of contact

Most children were exposed to burns by accidental contact (729 patients; 74.8%) followed by deliberate touch (108 patients; 11.1%). Compared to the least deadly burns (those caused by deliberate touch), burns caused by explosions, fires in the cooking area and unspecified other sources caused significantly higher mortality (all P values < 0.001). Explosions (P value < 0.001), fires in the cooking area (P value < 0.001), other sources (P value: 0.003) as well as accidental contact (P value: 0.014) caused significantly larger body surface burns than deliberate touch (Table 2).

Cooking fuel

The most commonly used cooking fuel in childhood burns was liquefied petroleum (30.1%), followed by charcoal (18.2%), gas (26.6%), electricity (8.7%) and wood (10.4%). Most children exposed to burns by explosions were burned by liquefied petroleum (P value < 0.001), charcoal (P value: 0.001), natural gas (P value: 0.001) and kerosene (P value < 0.001), whereas those exposed to burns by fires in the cooking area were burned by liquefied petroleum (P value: 0.001), charcoal (P value < 0.001), and gas (P value < 0.001) (Table 2).

Table 2. Characteristics of children with burn injuries included in the study on identifying risk factors for cooking burns, 2018–2021

| Characteristic                          | Patients, no. (%) | Total body surface area affected | Mortality |
|----------------------------------------|-------------------|----------------------------------|-----------|
|                                        | (n = 974)         | Median % (IQR) |  | % (no. deaths/no. admissions) |  |
| **Sex**                                |                   |                   | P |                   | P  |
| Male*                                  | 532 (54.6)        | 15.0 (10.0–20.0) | – | 6.0 (32/532)        | –  |
| Female                                 | 442 (45.4)        | 15.0 (10.0–25.0) | 0.093 | 11.5 (51/442)     | 0.002  |
| **Age, years**                         |                   |                   | P |                   | P  |
| 0–2                                   | 489 (50.2)        | 15.0 (5.0–28.75) | – | 5.5 (27/489)        | –  |
| 3–5                                   | 261 (26.8)        | 15.0 (10.0–25.0) | 0.358 | 11.5 (30/261)     | 0.003  |
| 6–11                                  | 116 (11.9)        | 15.0 (10.0–25.0) | 0.005 | 9.5 (11/116)      | 0.114  |
| 12–18                                 | 108 (11.1)        | 15.0 (10.0–20.0) | 0.151 | 13.9 (15/108)     | 0.002  |
| **Income category of country of residence** |                   |                   | P |                   | P  |
| High-income*                          | 69 (7.1)          | 10.0 (5.0–25.0) | – | 4.3 (3/69)         | –  |
| Upper-middle-income                   | 475 (48.8)        | 15.0 (10.0–20.0) | 0.237 | 8.8 (42/475)      | 0.206  |
| Lower-middle-income                   | 180 (18.5)        | 15.0 (10.0–20.0) | 0.270 | 9.4 (17/180)      | 0.186  |
| Low-income                            | 250 (25.7)        | 15.0 (10.0–25.0) | 0.136 | 8.4 (21/250)      | 0.259  |
| **Mode of contact**                   |                   |                   | P |                   | P  |
| Deliberate touch*                     | 108 (11.1)        | 10.0 (5.0–20.0) | – | 3.7 (4/108)       | –  |
| Accidental contact                    | 729 (74.8)        | 15.0 (10.0–20.0) | 0.014 | 6.0 (44/729)      | 0.331  |
| Explosion                             | 55 (5.6)          | 20.0 (10.0–45.0) | < 0.001 | 23.6 (13/55)     | < 0.001  |
| Other                                 | 46 (4.7)          | 15.0 (10.0–30.0) | 0.003 | 26.1 (12/46)      | < 0.001  |
| Fire in cooking area                  | 36 (3.7)          | 22.5 (10.0–40.0) | < 0.001 | 27.8 (10/36)     | < 0.001  |
| **Cooking fuel**                      |                   |                   | P |                   | P  |
| Electricity*                          | 85 (8.7)          | 15.0 (10.0–20.0) | – | 0.0 (0/85)        | –  |
| Liquefied petroleum                   | 293 (30.1)        | 15.0 (10.0–20.0) | 0.913 | 4.4 (13/293)      | 0.048  |
| Wood                                  | 101 (10.4)        | 15.0 (10.0–27.5) | 0.060 | 8.9 (9/101)       | 0.005  |
| Unspecified                           | 9 (0.9)           | 10.0 (10.0–20.0) | 0.543 | 11.1 (1/9)        | 0.002  |
| Charcoal                              | 177 (18.2)        | 15.0 (10.0–20.0) | 0.610 | 11.3 (20/177)     | 0.001  |
| Natural gas                           | 259 (26.6)        | 15.0 (10.0–25.0) | 0.301 | 12.4 (32/259)     | 0.001  |
| Kerosene                              | 50 (5.1)          | 15.0 (10.0–35.0) | 0.029 | 16.0 (8/50)       | < 0.001  |

IQR: interquartile range.

* Reference category used for subgroup comparison.

† Country income category as World Bank Classification in 2021.

Note: Inconsistencies arise in some values due to rounding. We used Kruskal–Wallis for determining group significance and Mann–Whitney U for subgroup significance.
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Risk factors

Children injured by a fire in the cooking area or an explosion were more likely to have more than 15% of the total body surface area affected than children who were injured by deliberate touch (odds ratio, OR: 3.0; 95% confidence interval, CI: 1.4–10.5), kerosene (OR: 3.9; 95% CI: 1.4–10.8), natural gas (OR: 3.0; 95% CI: 1.5–6.1) or wood (OR: 2.8; 95% CI: 1.1–7.1) were more likely to die (Table 3).

Discussion

We used WHO Global Burn Registry to understand the cause of and risk factors for cooking burns in children. Unlike previous work that used single-centre and national databases, this study compared burn causes and health outcomes on an international scale to better inform and advance global surgical initiatives.

Our findings corroborate previous research on the demographics of children injured by cooking-related burns.3,7,9,21 Although more than half of these burns occurred in boys, girls were nearly twice as likely to die from these burns. The female predominance in burn severity may relate to the relegation of women to cooking roles and hence girls might spend more time in places with dangerous cooking fires and hot liquids than boys.25–28 We found that half the burn injuries reported to the registry were in children 2 years and younger. Infants are known to be disproportionately affected by all types of burn injuries.6,25 Younger children are more impulsive, curious and lack self-awareness, putting them at greater risk of accidental burns exposure.7 To prevent burn injuries in young children, caretakers should be informed about preventive measures. For example, written and pictorial education material should be available at places frequented by such caretakers.26 In our study sample, we found no correlation between age and burn size or severity.

Previous regional work has shown that paediatric burns are more common and more deadly in low- and middle-income countries.7 Here we report that burn injuries did not differ significantly by burn size or mortality across country income group, and no income group was an independent risk factor for burn severity. This contradictory finding is likely due to the skewed distribution of burns.6,25

Table 3. Risk factors associated with total burn surface area and mortality of paediatric cooking burn patients, 2018–2021

| Characteristic | OR (95% CI) Total burn surface area* Mortality |
|---------------|-----------------------------------------------|
| Sex           |                                               |
| Male          | 1.0                                          |
| Female        | 1.0 (0.5–2.2)                                |
| Age, years    |                                               |
| 0–2           | 1.0                                          |
| 3–5           | 1.0 (0.5–2.0)                                |
| 6–11          | 2.0 (0.9–4.7)                                |
| 12–18         | 1.3 (0.5–3.0)                                |
| Income category of country of residence# |         |
| High income   | 1.0                                          |
| Upper-middle income | 1.2 (0.7–2.2)  |
| Lower-middle income | 1.0 (0.5–1.8)  |
| Low income    | 1.5 (0.8–2.7)                                |
| Mode of contact|                                             |
| Deliberate touch   | 1.0                                          |
| Accidental contact | 1.3 (0.8–2.1)  |
| Explosion      | 2.8 (1.4–5.7)                                |
| Other          | 1.9 (0.9–4.1)                                |
| Fire in cooking area | 3.0 (1.3–6.8)  |
| Cooking fuel   |                                               |
| Electricity    | 1.0 (0.6–1.8)                                |
| Liquefied petroleum | 1.0                                           |
| Wood           | 2.2 (1.3–3.4)                                |
| Unspecified    | 0.9 (0.2–4.0)                                |
| Charcoal       | 1.4 (0.9–2.1)                                |
| Natural gas    | 1.5 (1.0–2.2)                                |
| Kerosene       | 1.9 (1.0–3.6)                                |
|                |                                               |
| Characteristic | OR (95% CI) Total burn surface area* Mortality |
|                |                                               |
|                |                                               |
|                |                                               |

CI: confidence interval; NA: not applicable; OR: odds ratio.
* a The median total body surface area affected of the cohort (15%) was used as the threshold for the logistic regression analysis.
# b Country income category as World Bank Classification in 2021.

petroleum (293 patients; 30.1%). Burns involving kerosene caused the highest mortality (eight patients; 16.0%). Compared to the least deadly cooking fuel, electricity (no deaths), all other fuels caused burns with significantly higher mortality (kerosene P value < 0.001; natural gas P value: 0.001; charcoal P value: 0.001; wood P value: 0.005; liquefied petroleum P value: 0.048 and other fuels P value: 0.002). Kerosene was the only fuel source that caused significantly larger body surface burns than electricity (P value: 0.029; Table 2).
results indicate that preventive initiatives that shift cooking methods away from hazardous fuels, like wood and kerosene, towards safer cooking fuels, like electricity and liquefied petroleum, could result in large gains in severe burn prevention. Currently, many countries subsidize rather than disincentivize the use of fuels such as kerosene; the current analysis adds a medical perspective to the growing momentum of international and economic research advising against these subsidies.27–28

This study has several limitations. First, entry of data in the Global Burn Registry is voluntary and subject to reporting bias and selective data input. Although interrater reliability is potentially problematic in multicentre databases, we mitigated this risk by studying objective and quantitative variables, such as mortality and total body surface area affected. Second, the registry is a relatively new instrument, with so far limited breadth and number of hospitals involved, as well as the period of data collection. At the time of study, only 17 countries had reported data for up to 3 years. Third, our cohort of cooking-related burns came from 14 of those countries, with an uneven case distribution, limiting generalizability to socioeconomic groups as a whole. Lastly, though this study reports on possible risk factors of paediatric cooking burns, these associations are observational and no causal links can be identified from this work.

In conclusion, cooking-related burns represent a sizeable and actionable subset of burn injuries in children; in this study a third of all paediatric burns were cooking-related. Our study reinforces existing literature and suggests that policy-makers need to implement initiatives that transition fuel sources from kerosene, charcoal, wood and natural gas towards liquefied petroleum and electricity. Such actions will reduce the risk for explosions and fire in cooking areas and, in addition to protecting children, also increase the safety of all people who reside in close proximity to the hazardous fuels.

Competing interests: None declared.

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Competing interests: None declared.
Résumé

Facteurs de risque de brûlures liées à la cuisine chez les enfants, Registre mondial des brûlures de l’OMS

Objectif Définir les caractéristiques des brûlures de la cuisine chez les enfants, et signalées au Registre des brûlures de l’Organisation mondiale de la Santé.

Méthodes Le 1er février 2021, nous avons téléchargé les données du Registre mondial des brûlures concernant les caractéristiques démographiques et cliniques des patients âgés de moins de 19 ans. Nous avons employé un modèle de régression multivariée afin d’identifier les facteurs de risque permettant de prédire la mortalité et la surface corporelle totale touchée par les brûlures.

Résultats Sur les 2957 patients pédiatriques présentant des brûlures, 974 avaient subi des accidents domestiques liés à la cuisine (32,9%). Cela concernait plus de garçons (532 patients; 54,6%) que de filles et des enfants de 2 ans ou moins (489 patients; 50,2%). Le contact accidentel et le pétrole liquide sont à l’origine de la majorité des brûlures (729 patients; 74,8% et 293 patients; 30,1%, respectivement). Les brûlures de contact dues à des explosions (odds ratio, OR: 2,8 ; intervalle de confiance de 95%; IC: 1,4–5,7) ou les incendies dans l’espace dédié à la cuisine (OR: 3,0; IC de 95%: 1,3–6,8), ainsi que les combustibles de cuisson tels que le bois (OR: 2,2 ; IC de 95%: 1,3–3,4), le kérosène (OR: 1,9 ; IC de 95%: 1,0–2,2) et le gaz naturel (OR: 1,5; IC de 95%: 1,0–2,2) allaient de pair avec de plus vastes surfaces corporelles affectées. La mortalité était causée par des explosions (OR: 7,5; IC de 95%: 2,2–25,9) et des incendies dans l’espace dédié à la cuisine (OR: 6,9; IC de 95%: 1,9–25,7), ainsi que des combustibles comme le charbon (OR: 4,6; IC de 95%: 2,0–10,5), le kérosène (OR: 3,9; IC de 95%: 1,4–10,8), le gaz naturel (OR: 3,0; IC de 95%: 1,5–6,1) ou le bois (OR: 2,8; IC de 95%: 1,1–7,1).

Conclusion Des actions préventives pour éviter les explosions, les incendies dans les espaces dédiés à la cuisine et les combustibles de cuisson dangereux devraient être menées afin de diminuer la morbidité et la mortalité qu’engendrent les brûlures liées à la cuisine.

Resumen

Factores de riesgo de lesiones por quemaduras relacionadas con la cocina en niños, Registro Mundial de Quemaduras de la OMS

Objetivo Evaluar las características de las lesiones por quemaduras relacionadas con la cocina en niños notificadas al Registro Mundial de Quemaduras de la Organización Mundial de la Salud.

Métodos El 1 de febrero de 2021, descargamos los datos del Registro Mundial de Quemaduras sobre las características demográficas y clínicas de los pacientes menores de 19 años. Realizamos regresiones multivariantes para identificar los factores de riesgo que predicen la mortalidad y la superficie corporal total afectada por las quemaduras.

Resultados De los 2.957 pacientes pediátricos con lesiones por quemaduras, 974 tenían que cocinar (32,9%). Se produjeron más quemaduras en niños (532 pacientes; 54,6%) que en niñas, y en niños de 2 años o menos (489 pacientes; 50,2%). El contacto accidental y el petróleo licuado causaron la mayoría de las lesiones por quemaduras...
(729 pacientes, 74,8% y 293 pacientes; 30,1%, respectivamente). El contacto con quemaduras por explosiones (odds ratio, OR: 2,8; intervalo de confianza del 95%, IC: 1,4-5,7) o los incendios en la zona de cocción (OR: 3,0; IC del 95%: 1,3-6,8) así como los combustibles para cocinar de madera (OR: 2,2; IC del 95%: 1,3-3,4), queroseno (OR: 1,9; IC del 95%: 1,0-3,6) o gas natural (OR: 1,5; IC del 95%: 1,0-2,2) se asociaron con una mayor superficie corporal afectada. La mortalidad se asoció a las explosiones (OR: 7,5; IC 95%: 2,2-25,9) y a los incendios en la zona de cocción (OR: 6,9; IC 95%: 1,9-25,7), el carbón vegetal (OR: 4,6; IC 95%: 2,0-10,5), queroseno (OR: 3,9; IC 95%: 1,4-10,8), gas natural (OR: 3,0; IC 95%: 1,5-6,1) o la madera (OR: 2,8; IC 95%: 1,1-7,1).

Conclusión Deben llevarse a cabo intervenciones preventivas contra las explosiones, los incendios en las zonas de cocción y los combustibles peligrosos para cocinar, a fin de reducir la morbilidad y la mortalidad por quemaduras relacionadas con la cocina.