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Global burden of burn and inhalation injuries and future trends: analysis of a Global Burden of Disease study 1990–2021

Population-based crosssectional analysis

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ABSTRACT

Purpose: This study aimed to assess the global, regional, and national burdens of burns and airway injuries using Global Burden of Disease (GBD) data between 1990 and 2021, and to project future trends through 2050.
Methods: Bayesian meta-regression was used to analyze the age- and sex-stratified burn prevalence and years lived with disability (YLDs). Future projections were estimated using the socio-demographic index (SDI)-adjusted regression and Das Gupta decomposition. We utilized GBD estimates from 1990 to 2021, covering burn and airway injury data stratified by age and sex across all countries and regions. Prevalence was measured as age- and sex-standardized rates per 100,000 individuals. YLDs were estimated as disability-adjusted burden measures. Future projections were derived using SDI-adjusted regression and Das Gupta decomposition.
Results: In 2021, 248 million global burn cases and 6,900 airway burns were reported globally. By 2050, burns are projected to increase by 6.42%, mainly in Latin America and Eastern Europe, whereas airway burns are expected to decline 10-fold. From 1990 to 2021, the YLDs declined by 43.34% for burns and 26.79% for airway burns, with persistent disparities between low- and middle-income countries (LMICs).
Conclusion: Burns pose substantial challenges to public health and the economy. Strengthening prevention, acute care, and rehabilitation is crucial, particularly in LMICs with limited access to healthcare.

Keywords: Burns; Disability-adjusted life years; Global Burden of Disease; Inhalation; Prevalence study

INTRODUCTION

Burns are severe injuries that affect the skin, soft tissues, and internal organs and primarily result from exposure to heat, radiation, electricity, friction, or chemicals [1]. Airway burns occur when smoke, toxic gases, chemical vapors, or hot air are inhaled, causing damage to the upper and lower respiratory tracts and the lung tissue [2]. Airway burns are a major contributor to early mortality among patients with burns and significantly increase the risk of death [3]. Furthermore, survivors often experience long-term respiratory impairment and chronic complications beyond the acute phase, which can severely affect their quality of life beyond the acute phase [4-7]. Managing airway burns typically requires prolonged hospitalization in specialized burn centers, intensive care, and surgical interventions, all contributing to substantial healthcare costs [8,9].

Prolonged hospitalization and recovery following burns can substantially reduce workforce productivity and impose a significant economic burden on both individuals and society [10]. Patients often require months of medical care and rehabilitation; however, severe cases may lead to years of absence from work or permanent disability [11]. Among employed adults, individuals with inhalation injuries were significantly less likely to return to work compared to those without such injuries [12]. This decline in workforce participation affects individual livelihoods and family support systems, and carries broader economic consequences at the national level [13].

The Global Burden of Disease (GBD) Study offers a comprehensive framework for assessing the health impacts of various injuries and diseases in diverse populations [5]. It estimates the years lived with disability (YLDs) due to burns using age-standardized rates, thus allowing for comparisons with other major health conditions [14]. Despite increasing awareness of the public health and socioeconomic implications of burns, data on burn injuries, particularly airway burns, remain limited [15]. Predicting the future prevalence of burns is essential for anticipating healthcare needs, especially in regions experiencing rapid urbanization, population aging, and high rates of household and workplace accidents [16]. To mitigate the economic burden of burns, including airway burns, national policies should incorporate GBD-driven financial support mechanisms, expand insurance coverage, and implement preventive safety measures to reduce burn-related incidents.

This study aimed to evaluate the global, regional, and national prevalence of burns and YLD estimates using GBD data, while projecting prevalence trends through 2050. By integrating demographic and socioeconomic factors, our study aims to support health care planning and policy development, ultimately enhancing burn prevention and management strategies.

METHODS

Study overview

This study used the GBD data to estimate the global prevalence and YLDs of burns between 1990 and 2021. These estimates were stratified according to age, sex, and year, with projections extending to 2050. This study followed standard GBD methodology and adhered to the Guidelines for Accurate and Transparent Health Estimates Reporting [17].

Case definition

The GBD defines burns as injuries caused by fire, heat, or hot substances from thermal, chemical, electrical, or radiation exposure. These injuries damage the skin and the underlying tissues, often leading to functional impairment. Burn-related morbidities were classified using the International Classification of Diseases, 10th Revision (ICD-10) codes X00–X19, which include injuries from fires, hot liquids, steam, and machinery [18]. Airway burns, which result from inhaling smoke, toxic gases, or hot air, affect the upper and lower respiratory tract and lung tissues. The GBD classifies these injuries under the ICD-10 code T27, regardless of the burn surface area affected. Only patients with airway burns that led to at least 24 hours of functional impairment were included in the analysis [15].

Data sources and collection

Prevalence and YLD estimates were derived from population-based studies, national health surveys, and global surveillance data collected between 1990 and 2021. Data sources included systematic reviews from MEDLINE, Embase, and Cumulative Index to Nursing & Allied Health Literature (CINAHL) as well as contributions from collaborating researchers. Information on burn risk factors such as household accidents, occupational hazards, and violence was also considered.

Modeling and data processing

A Bayesian meta-regression model was implemented using the rstanarm package to estimate the burn prevalence based on age, sex, and region of origin. Bayesian inference was applied to account for data uncertainty and variability [19].

The GBD framework primarily attributes the disease burden to direct causes of mortality. Although some burn injuries result in immediate death, others contribute to fatal secondary complications that may be the primary cause of death.

The final model used the following equation:

$$\text{Logit (predicted prevalence)} = \beta_1(\text{SDI}) + \alpha_{l,a,s}$$

where β_1 represents the fixed coefficient of the socio-demographic index (SDI), and α denotes random intercepts for location (l), age group (a), and sex (s). Projected patient numbers were derived by multiplying the predicted prevalence by the population estimates. To account for temporal trends, the GBD 2021 prevalence estimates from 2020 were used as the baseline, with adjustments applied to all projections up to 2050.

A Gupta decomposition analysis was conducted to break down the relative contributions of population growth, aging, and non-demographic prevalence changes to burn burden projections between 2021 and 2050 [20]. Model validation was performed using backward projection testing, where prevalence estimates from 1990 to 2020 were used to forecast values for 2030 to 2050, informing the YLD-based disability burden calculations.

Prevalence projections

Burn prevalence projections through 2050 were estimated using a regression model incorporating the SDI and demographic factors such as age and sex. The model accounted for SDI variations and temporal trends to project future prevalence rates. The estimated prevalence was multiplied by the expected population size to determine the total number of patients with burns. To evaluate the factors that could drive changes in burn incidence between 2021 and 2050, a Das Gupta decomposition analysis was performed, which identified contributions from population growth, aging, and non-demographic prevalence shifts.

Ethical considerations

This study was approved by the Armed Forces Medical Command (approval number: AFMC 2025-01-006). The requirement for informed consent was waived, as the analysis did not include identifiable information.

Data availability statement

The datasets generated and/or analyzed in the current study are publicly available at https://www.healthdata.org/research-analysis/gbd.

RESULTS

Global prevalence of burns and airway burns in 2021

The estimated global incidence of burns in 2021 was 248 million cases (95% confidence interval [CI], 226.9 million to 272.3 million), which reflects a slight decrease compared to 1990 (Table 1). The age-standardized prevalence rate (ASPR) of burns in 2021 was 2,974 per 100,000 (95% CI, 2,719 to 3,264), showing a 0.43% decrease (95% CI, –0.48 to 0.39) from 1990.

In 2021, the estimated global incidence of airway burns was 6,900 (95% CI, 4,093 to 11,838), a slight reduction from that in 1990. The ASPR of airway burns in 2021 was 0.19 per 100,000 (95% CI, 0.12 to 0.31), indicating a marginal decline compared to previous estimates.

Regional variations in burns and airway burns

As in Fig. 1, Among the 21 GBD regions, Southern Latin America had the highest burn prevalence in 2021, with an ASPR of 7,898 per 100,000 (95% CI, 7,003 to 9,035), followed by Central Europe (6,156 per 100,000; 95% CI, 5,633 to 6,811), and Eastern Europe (6,113 per 100,000; 95% CI, 5,577 to 6,707). The lowest prevalence was recorded in East Asia, at 2,005 per 100,000 individuals (95% CI, 1,819 to 2,211).Regarding airway burns, Southern Latin America again reported the highest ASPR at 0.19 per 100,000 (95% CI, 0.12 to 0.31), followed by Australasia at 0.22 per 100,000 (95% CI, 0.12 to 0.41). The lowest prevalence was observed in Southeast Asia, with an ASPR of 0.06 per 100,000 (95% CI, 0.04 to 0.10).

Most regions experienced a slight decline in burn prevalence between 1990 and 2021. The Caribbean recorded the largest increase (0.05%; 95% CI, 0.04 to 0.07), followed by Oceania (0.11%; 95% CI, 0.10 to 0.12). In contrast, the largest reduction was observed in East Asia (0.61%; 95% CI, –0.62 to –0.60), followed by Western Sub-Saharan Africa (0.26%; 95% CI, –0.27 to –0.25).

Regarding airway burns, the largest reduction occurred in East Asia (–0.14%; 95% CI, –0.26 to 0), followed by Sub-Saharan Africa (–0.17%; 95% CI, –0.21 to –0.13). However, Oceania (0.11%; 95% CI, 0 to 0.23) and the Caribbean (0.35%; 95% CI, 0 to 0.23) showed increased prevalence.

Regarding YLDs, the largest decline between 1990 and 2021 was observed in East Asia (–60.82%; 95% CI, –67.29 to –53.38), whereas Oceania showed an increase (11.41%; 95% CI, 12.71 to 10.49). Regarding airway burns, the North Africa and Middle East region showed the largest reduction (–43.85%; 95% CI, –41.05 to –44.47), while the Caribbean exhibited the highest increase (35.18%; 95% CI, 26.75 to 40.46).

Table 1. Prevalence, YLDs, and age-standardized prevalence rates and YLDs per 100,000 population in 2021 and the percentage change (1990–2020) for burn injuries and airway burns, by Global Burden of Disease regions and super-regions

		No. of prevalent cases	Age-standardized prevalence rate per 100,000	Percentage change in age-standardized preva-lence rate from 1990 to 2021 (%)	No. of YLDs	Age-standardized rate of YLDs per 100,000	Percentage change in age-standardized rate of YLDs per 100,000 from 1990 to 2021 (%)
Global	Burn	248,329,095 (226,904,920–272,341,392)	2,974 (2,719–3,264)	–0.43 (–0.48 to –0.39)	6,734,589 (4,787,631–9,305,088)	2,974 (2,719–3,264)	–0.43 (–0.48 to –0.39)
	Airway	6,932 (4,093–11,838)	0.09 (0.05–0.15)	–0.27 (–0.33 to –0.21)	2,608 (1,362–4,840)	0.09 (0.05–0.15)	–0.27 (–0.33 to –0.21)
Central Europe, Eastern Europe and Central Asia	Burn	31,172,382 (28,437,061–34,046,263)	6,047 (5,509–6,630)	–0.47 (–0.53 to –0.41)	651,001 (412,082–986,047)	6,047 (5,509–6,630)	–0.47 (–0.53 to –0.41)
	Airway	610 (368–1,074)	0.15 (0.09–0.26)	–0.26 (–0.31 to –0.23)	230 (117–427)	0.15 (0.09–0.26)	–0.26 (–0.31 to –0.23)
Central Asia	Burn	5,406,618 (4,930,419–5,939,444)	5,636 (5,144–6,190)	–0.44 (–0.48 to –0.39)	151,870 (107,259–209,837)	5,636 (5,144–6,190)	–0.44 (–0.48 to –0.39)
	Airway	98 (62–159)	0.1 (0.06–0.16)	–0.24 (–0.28 to –0.21)	37 (20–66)	0.1 (0.06–0.16)	–0.24 (–0.28 to –0.21)
Central Europe	Burn	9,256,826 (8,414,169–10,196,248)	6,156 (5,633–6,811)	–0.52 (–0.61 to –0.44)	172,979 (102,232–271,817)	6,156 (5,633–6,811)	–0.52 (–0.61 to –0.44)
	Airway	172 (100–305)	0.16 (0.1–0.27)	–0.24 (–0.28 to –0.2)	65 (32–130)	0.16 (0.1–0.27)	–0.24 (–0.28 to –0.2)
Eastern Europe	Burn	16,508,938 (15,042,910–18,096,435)	6,113 (5,577–6,707)	–0.47 (–0.54 to –0.41)	326,152 (197,763–504,417)	6,113 (5,577–6,707)	–0.47 (–0.54 to –0.41)
	Airway	340 (205–588)	0.17 (0.1–0.3)	–0.24 (–0.29 to –0.18)	128 (65–230)	0.17 (0.1–0.3)	–0.24 (–0.29 to –0.18)
High-income	Burn	53,397,889 (47,273,792–60,696,839)	3,768 (3,340–4,302)	–0.31 (–0.33 to –0.3)	869,130 (473,206–1,450,638)	3,768 (3,340–4,302)	–0.31 (–0.33 to –0.3)
	Airway	1,629 (898–3,146)	0.15 (0.09–0.28)	–0.21 (–0.28 to –0.16)	612 (288–1,191)	0.15 (0.09–0.28)	–0.21 (–0.28 to –0.16)
Australasia	Burn	2,014,978 (1,788,850–2,300,212)	5,333 (4,719–6,108)	–0.22 (–0.23 to –0.2)	32,789 (17,909–54,907)	5,333 (4,719–6,108)	–0.22 (–0.23 to –0.2)
	Airway	64 (36–123)	0.22 (0.12–0.41)	–0.14 (–0.24 to –0.06)	24 (11–52)	0.22 (0.12–0.41)	–0.14 (–0.24 to –0.06)
High-income Asia Pacific	Burn	10,525,683 (9,211,026–12,086,464)	3,982 (3,489–4,610)	–0.34 (–0.36 to –0.32)	170,507 (91,859–284,443)	3,982 (3,489–4,610)	–0.34 (–0.36 to –0.32)
	Airway	243 (141–445)	0.14 (0.08–0.24)	–0.3 (–0.37 to –0.25)	91 (45–178)	0.14 (0.08–0.24)	–0.3 (–0.37 to –0.25)
High-income North America	Burn	14,933,374 (13,142,480–17,014,585)	3,118 (2,739–3,558)	–0.39 (–0.4 to –0.38)	240,236 (130,854–398,951)	3,118 (2,739–3,558)	–0.39 (–0.4 to –0.38)
	Airway	558 (320–1,030)	0.14 (0.08–0.24)	–0.22 (–0.28 to –0.14)	210 (103–407)	0.14 (0.08–0.24)	–0.22 (–0.28 to –0.14)
Southern Latin America	Burn	5,993,871 (5,326,800–6,838,318)	7,898 (7,003–9,035)	–0.29 (–0.35 to –0.26)	102,430 (57,050–168,020)	7,898 (7,003–9,035)	–0.29 (–0.35 to –0.26)
	Airway	124 (78–205)	0.19 (0.12–0.31)	–0.09 (–0.13 to –0.03)	47 (24–87)	0.19 (0.12–0.31)	–0.09 (–0.13 to –0.03)

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Table 1. Continued

		No. of prevalent cases	Age-standardized prevalence rate per 100,000	Percentage change in age-standardized preva-lence rate from 1990 to 2021 (%)	No. of YLDs	Age-standardized rate of YLDs per 100,000	Percentage change in age-standardized rate of YLDs per 100,000 from 1990 to 2021 (%)
Western Europe	Burn	19,929,982 (17,714,839–22,599,425)	3,502 (3,118–3,984)	−0.28 (−0.29 to −0.27)	323,169 (174,871–542,077)	3,502 (3,118–3,984)	−0.28 (−0.29 to −0.27)
	Airway	640 (322–1,347)	0.16 (0.08–0.31)	-0.2 (-0.3 to -0.13)	240 (106–504)	0.16 (0.08–0.31)	-0.2 (-0.3 to -0.13)
Latin America and the Caribbean	Burn	29,335,854 (26,846,117–32,790,048)	4,679 (4,278–5,227)	−0.52 (−0.57 to −0.47)	902,453 (656,883–1,218,127)	4,679 (4,278–5,227)	−0.52 (−0.57 to −0.47)
	Airway	596 (365–1,001)	0.1 (0.06–0.17)	−0.23 (−0.26 to −0.19)	224 (120–405)	0.1 (0.06–0.17)	−0.23 (−0.26 to −0.19)
Andean Latin America	Burn	2,810,934 (2,548,292–3,141,047)	4,274 (3,878–4,770)	−0.55 (−0.61 to −0.47)	80,969 (57,244–112,110)	4,274 (3,878–4,770)	−0.55 (−0.61 to −0.47)
	Airway	54 (33–86)	0.08 (0.05–0.13)	−0.17 (−0.26 to −0.06)	20 (11–37)	0.08 (0.05–0.13)	−0.17 (−0.26 to −0.06)
Caribbean	Burn	3,294,710 (2,955,800–3,744,998)	6,603 (5,913–7,514)	0.05 (−0.09 to 0.3)	130,967 (96,025–173,197)	6,603 (5,913–7,514)	0.05 (−0.09 to 0.3)
	Airway	57 (35–94)	0.12 (0.07–0.2)	0.35 (0.08 to 1.06)	22 (11–39)	0.12 (0.07–0.2)	0.35 (0.08 to 1.06)
Central Latin America	Burn	13,515,252 (12,088,090–15,572,471)	5,162 (4,616–5,953)	−0.59 (−0.63 to −0.53)	422,232 (303,347–576,067)	5,162 (4,616–5,953)	−0.59 (−0.63 to −0.53)
	Airway	265 (166–434)	0.11 (0.07–0.17)	−0.28 (−0.3 to −0.26)	100 (53–180)	0.11 (0.07–0.17)	−0.28 (−0.3 to −0.26)
Tropical Latin America	Burn	9,714,957 (8,921,257–10,583,604)	3,857 (3,544–4,206)	−0.53 (−0.58 to −0.48)	268,285 (188,372–371,963)	3,857 (3,544–4,206)	−0.53 (−0.58 to −0.48)
	Airway	220 (124–389)	0.1 (0.06–0.17)	−0.26 (−0.31 to −0.22)	83 (42–158)	0.1 (0.06–0.17)	−0.26 (−0.31 to −0.22)
North Africa and the Middle East	Burn	18,812,547 (16,773,053–21,452,198)	3,106 (2,774–3,530)	−0.5 (−0.55 to −0.43)	525,009 (372,608–735,305)	3,106 (2,774–3,530)	−0.5 (−0.55 to −0.43)
	Airway	504 (293–846)	0.08 (0.05–0.13)	−0.44 (−0.67 to −0.23)	190 (99–353)	0.08 (0.05–0.13)	−0.44 (−0.67 to −0.23)
South Asia	Burn	36,124,093 (32,756,473–39,550,113)	2,015 (1,834–2,197)	−0.39 (−0.43 to −0.34)	1,336,247 (1,011,974–1,730,548)	2,015 (1,834–2,197)	−0.39 (−0.43 to −0.34)
	Airway	1,349 (787–2,386)	0.07 (0.04–0.14)	−0.18 (−0.25 to −0.1)	507 (249–967)	0.07 (0.04–0.14)	−0.18 (−0.25 to −0.1)
Southeast Asia, East Asia, and Oceania	Burn	56,966,615 (51,917,395–62,461,539)	2,228 (2,028–2,448)	−0.5 (−0.58 to −0.41)	1,407,865 (966,304–1,999,706)	2,228 (2,028–2,448)	−0.5 (−0.58 to −0.41)
	Airway	1,556 (899–2,728)	0.07 (0.04–0.12)	−0.18 (−0.27 to −0.05)	585 (297–1,090)	0.07 (0.04–0.12)	−0.18 (−0.27 to −0.05)
East Asia	Burn	36,910,311 (33,541,730–40,681,024)	2,005 (1,819–2,211)	−0.61 (−0.71 to −0.49)	754,313 (464,388–1,156,795)	2,005 (1,819–2,211)	−0.61 (−0.71 to −0.49)
	Airway	1,128 (626–2,048)	0.08 (0.04–0.13)	−0.14 (−0.26 to 0)	424 (209–819)	0.08 (0.04–0.13)	−0.14 (−0.26 to 0)

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Table 1. Continued

		No. of prevalent cases	Age-standardized prevalence rate per 100,000	Percentage change in age-standardized preva-lence rate from 1990 to 2021 (%)	No. of YLDs	Age-standardized rate of YLDs per 100,000	Percentage change in age-standardized rate of YLDs per 100,000 from 1990 to 2021 (%)
Oceania	Burn	427,858 (385,895–480,484)	3,597 (3,259–4,002)	0.11 (0.06 to 0.18)	20,306 (15,182–25,938)	3,597 (3,259–4,002)	0.11 (0.06 to 0.18)
	Airway	10 (6–17)	0.07 (0.04–0.12)	0.11 (0 to 0.23)	4 (2–7)	0.07 (0.04–0.12)	0.11 (0 to 0.23)
Southeast Asia	Burn	19,628,446 (17,778,135–21,713,704)	2,681 (2,431–2,965)	−0.37 (−0.43 to −0.31)	633,245 (471,152–841,530)	2,681 (2,431–2,965)	−0.37 (−0.43 to −0.31)
	Airway	419 (252–702)	0.06 (0.04–0.1)	−0.27 (−0.36 to −0.16)	158 (85–288)	0.06 (0.04–0.1)	−0.27 (−0.36 to −0.16)
Sub-Saharan Africa	Burn	22,519,715 (20,533,771–25,019,516)	2,629 (2,391–2,919)	−0.32 (−0.34 to −0.29)	1,042,884 (779,270–1,327,044)	2,629 (2,391–2,919)	−0.32 (−0.34 to −0.29)
	Airway	688 (443–1,090)	0.06 (0.04–0.1)	−0.17 (−0.21 to −0.13)	259 (137–453)	0.06 (0.04–0.1)	−0.17 (−0.21 to −0.13)
Central Sub-Saharan Africa	Burn	2,304,939 (2,072,552–2,623,459)	2,259 (2,034–2,553)	−0.27 (−0.32 to −0.22)	116,820 (87,198–149,846)	2,259 (2,034–2,553)	−0.27 (−0.32 to −0.22)
	Airway	79 (49–132)	0.06 (0.04–0.1)	−0.14 (−0.17 to −0.08)	30 (16–54)	0.06 (0.04–0.1)	−0.14 (−0.17 to −0.08)
Eastern Sub-Saharan Africa	Burn	9,302,268 (8,380,439–10,550,979)	2,921 (2,623–3,305)	−0.31 (−0.34 to −0.28)	454,619 (338,664–589,448)	2,921 (2,623–3,305)	−0.31 (−0.34 to −0.28)
	Airway	249 (160–382)	0.06 (0.04–0.09)	−0.18 (−0.22 to −0.14)	94 (50–164)	0.06 (0.04–0.09)	−0.18 (−0.22 to −0.14)
Southern Sub-Saharan Africa	Burn	2,380,398 (2,170,698–2,635,376)	3,141 (2,860–3,474)	−0.47 (−0.51 to −0.43)	81,282 (59,566–108,891)	3,141 (2,860–3,474)	−0.47 (−0.51 to −0.43)
	Airway	65 (40–107)	0.08 (0.05–0.13)	−0.29 (−0.33 to −0.24)	24 (13–43)	0.08 (0.05–0.13)	−0.29 (−0.33 to −0.24)
Western Sub-Saharan Africa	Burn	8,532,109 (7,833,592–9,334,930)	2,339 (2,148–2,561)	−0.26 (−0.29 to −0.22)	390,164 (288,560–497,412)	2,339 (2,148–2,561)	−0.26 (−0.29 to −0.22)
	Airway	295 (189–465)	0.06 (0.04–0.09)	−0.1 (−0.13 to −0.04)	111 (59–194)	0.06 (0.04–0.09)	−0.1 (−0.13 to −0.04)

Data in parentheses are 95% uncertainty intervals. The numbers in the region and super-region do not add to the global prevalence owing to rounding.
YLD, years lived with disability.

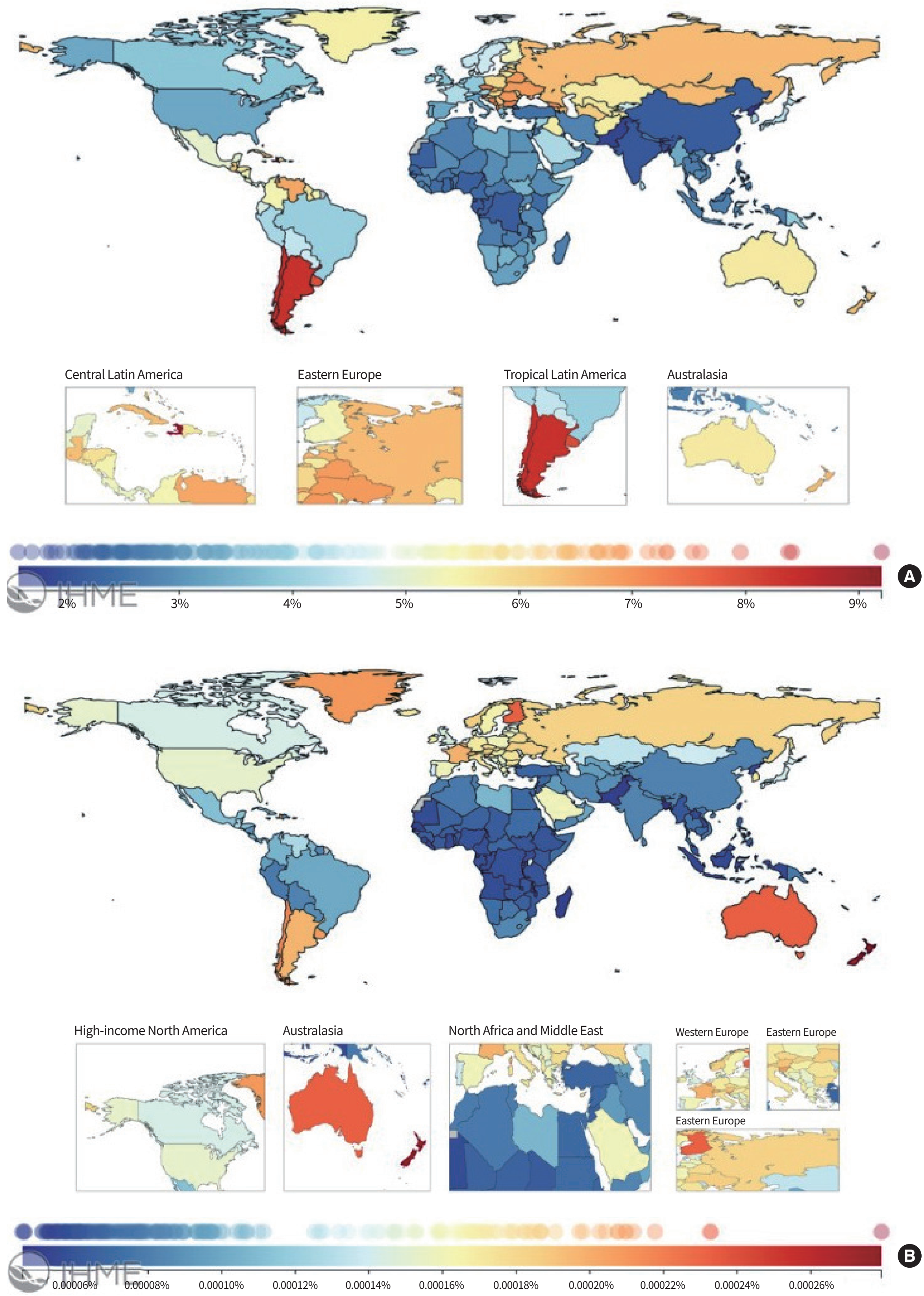

Fig. 1. Age-standardized prevalence of burns (A) and airway burn injuries (B) by country for male and female patients combined and across all ages in 2020.

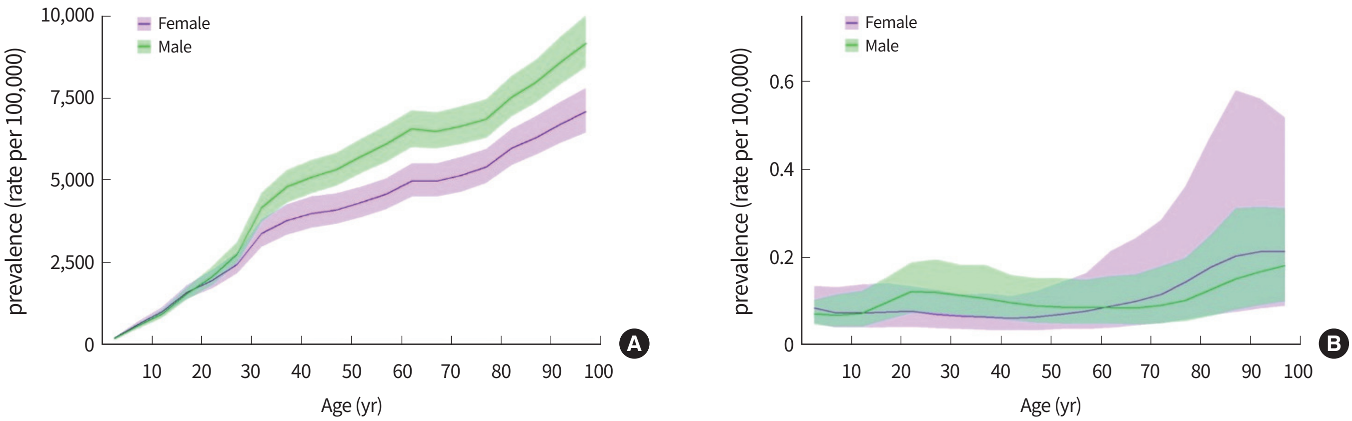

Fig. 2. Global prevalence of burns (A) and airway burn injuries (B) stratified by age and sex in 2021; shaded areas represent 95% uncertainty intervals.

Age- and sex-specific prevalence of burns and airway burns

Burn prevalence was consistently higher in males than in females across all age groups, with the greatest difference observed among older adults (≥95 years) (Fig. 2A). The global ASPR was higher in males (3,285.52 per 100,000; 95% CI, 3,011.89 to 3,580.09) than in females (2,677.39 per 100,000; 95% CI, 2,423.18 to 2,968.3). Prevalence increased with age, reaching its peak at ≥95 years. The highest YLD burden was observed in the 40–44 age group (128.54 per 100,000; 95% CI, 91.62 to 177.07).

Regarding airway burns (Fig. 2B), the prevalence was higher in females within the 0–10 year age group, whereas males had a higher prevalence within the 10–50 year age group. Among individuals aged ≥60 years, the prevalence was higher among females again. The highest YLD burden was observed in those aged ≥95 years (0.08 per 100,000; 95% CI, 0.03 to 0.18).

Major risk factors for burns and airway injuries

The leading contributors to burn-related YLDs were self-harm and interpersonal violence (13.5%; 95% CI, 13.51 to 13.76), transport-related causes (5.82%; 95% CI, 6.04 to 5.59), and unintentional injuries (80.68%; 95% CI, 77.01 to 83.07).

Regarding airway burns, the corresponding proportions were as follows: self-harm and interpersonal violence (13.0%; 95% CI, 10.49 to 14.85), transport-related causes (13.88%; 95% CI, 9.45 to 16.19), and unintentional injuries (73.12%; 95% CI, 65.08 to 78.77). Among these, unintentional injuries accounted for the largest percentage.

Projected burn and airway burn cases by 2050

By 2050, the global number of burn cases is projected to reach 613 million (95% CI, 517 million to 673 million), representing a 6.42% increase (95% CI, 5.71 to 6.62) from the 2021 levels (Table 2). In contrast, the number of airway burn cases is projected to decrease significantly, with an estimated 9,873 cases (95% CI, 5,726 to 17,202) by 2050, indicating a 10-fold reduction from that of 2021 (Table 3).

Regional and demographic trends in burn incidence by 2050

By 2050, the global number of burn cases is projected to reach 613 million (95% CI, 517 million to 673 million), reflecting a 6.42% increase (95% CI, 5.71 to 6.62) from the 2021 levels. In contrast, the number of airway burns is expected to decrease significantly, with an estimated 9,873 cases (95% CI, 5,726 to 17,202) by 2050, representing a 10-fold reduction from 2021.

Regionally, most areas are expected to experience a substantial increase in burn cases, primarily driven by the rising prevalence and aging populations. The largest increase in burn prevalence is projected for Tropical Latin America (15.63% in 2020 to 32.98% in 2050), followed by South Asia (4.22% to 6.61%). In contrast, the greatest declines are expected in Southern Sub-Saharan Africa (1.81% to 0.93%) and high-income North America (1.23% to 0.47%) (Table 2).

Regarding airway burns, regional variations were projected to be minimal, with changes <1% across all regions. Tropical Latin America is expected to experience the greatest increase (0.0001749% to 0.0005804%), while Southern Sub-Saharan Africa is projected to experience the largest decline (0.00004998% to 0.00003263%) (Table 3).

Table 2. Age-standardized prevalence of burn injuries projections to 2030, 2040, and 2050, globally and by region, with male and female sexes combined

	Age-standardized prevalence (%)			Cases		
	2030	2040	2050	2030	2040	2050
Global	1.0556 (0.6245–1.8)	1.0436 (0.6121–1.8012)	1.0337 (0.5995–1.8011)	9,098.39 (5,382.7–15,528.93)	9,579.1 (5,618.94–16,533.29)	9,873.43 (5,726.52–17,202.90)
Andean Latin America	120.96 (75.53–188)	134.9 (83.6–208.63)	150.59 (92.29–231.91)	89.92 (56.15–139.45)	111.47 (69.08–172.39)	134.83 (82.63–207.63)
Australasia	242.95 (127.1–454)	233.36 (118.02–441.5)	224.01 (109.53–429.73)	79.97 (41.83–149.36)	83.55 (42.25–158.07)	85.21 (41.66–163.45)
Caribbean	125.1 (70.94–216)	129.04 (70.76–232.57)	135.56 (71.58–254.82)	61.88 (35.09–106.72)	64.77 (35.52–116.73)	67.10 (35.43–126.12)
Central Asia	100.99 (66.97–146)	93.34 (62.9–130.2)	86.19 (59.04–115.74)	105.73 (70.11–153.33)	106.06 (71.47–147.94)	104.72 (71.74–140.64)
Central Europe	107.78 (66.96–185)	84.99 (53.39–145.54)	66.98 (42.54–114.35)	117.74 (73.15–202.34)	87.31 (54.85–149.51)	63.58 (40.38–108.53)
Central Latin America	102.97 (64.91–177)	93.26 (59.13–163.12)	84.65 (54.04–149.09)	304.11 (191.70–523.94)	295.88 (187.61–517.53)	279.88 (178.66–492.92)
Central Sub-Saharan Africa	64.74 (41.23–107)	65.23 (41.88–108.98)	65.71 (42.54–110.55)	110.30 (70.25–183.09)	136.69 (87.76–228.38)	162.10 (104.95–272.73)
East Asia	94.75 (54.18–166)	101.59 (57.1–179.98)	108.22 (60.12–195.94)	1,416.87 (810.25–2,477.35)	1,457.47 (819.09–2,582.04)	1,450.46 (805.74–2,626.09)
Eastern Europe	478.26 (286.38–831)	649.42 (384.88–1,133.82)	880.55 (515.97–1,548.38)	962.74 (576.49–1,672.05)	1,248.53 (739.94–2,179.78)	1,609.13 (942.89–2,829.53)
Eastern Sub-Saharan Africa	69.37 (44.06–109)	70.55 (44.59–112.3)	71.78 (45.12–115.37)	385.32 (244.74–606.82)	483.52 (305.57–769.61)	578.05 (363.32–929.06)
High-income Asia Pacific	81.89 (51.36–142)	58.73 (37.49–101.18)	42.08 (27.29–72.09)	149.45 (93.74–258.71)	102.06 (65.16–175.85)	67.90 (44.04–116.33)
High-income North America	56.49 (34.17–98)	36.69 (22.16–63.7)	23.87 (14.38–41.47)	219.58 (132.83–379.57)	147.44 (89.06–255.96)	97.05 (58.44–168.62)
North Africa and the Middle East	121.4 (72.81–234)	135.28 (82.26–277.52)	151.86 (92.72–327.11)	889.86 (533.67–1,716.67)	1,113.93 (677.39–2,285.2)	1,365.23 (833.55–2,940.75)
Oceania	70.23 (41.86–118)	66.71 (39.33–112.58)	62.58 (37.22–106.36)	11.49 (6.85–19.38)	12.94 (7.63–21.84)	14.18 (8.44–24.11)
South Asia	62.53 (44.6–101)	54.12 (41.94–83.75)	47.11 (39.43–69.39)	1,248.89 (890.85–2,007.8)	1,130.84 (876.23–1,749.85)	997.50 (834.77–1,469.22)
Southeast Asia	73.37 (44.81–131)	71.13 (43.46–126.9)	68.49 (42.48–126.03)	540.67 (330.21–963.62)	550.05 (336.05–981.31)	538.80 (334.13–991.37)
Southern Latin America	381.31 (251.17–604)	478.44 (318.61–752.08)	600.09 (404.6–935.87)	275.88 (181.72–437.15)	362.53 (241.42–569.87)	466.03 (314.21–726.80)
Southern Sub-Saharan Africa	49.98 (29.6–96)	38.15 (22.28–77.19)	29.12 (16.78–62.28)	46.29 (27.42–88.55)	39.30 (22.96–79.53)	32.63 (18.80–69.78)
Tropical Latin America	174.9 (91.95–376)	204.15 (104.14–473.34)	238.48 (117.86–597.28)	415.83 (218.62–893.93)	497.96 (254.01–1,154.59)	580.40 (286.85–1,453.6)
Western Europe	120.91 (74.7–268)	99.93 (65.2–233.13)	82.54 (56.9–203.06)	538.41 (332.65–1,191.53)	447.53 (292.00–1,044.04)	365.15 (251.72–898.31)
Western Sub-Saharan Africa	76.13 (49.54–124)	81.85 (53.79–134.49)	88 (58.41–146.23)	477.92 (311.04–776.14)	657.57 (432.16–1,080.51)	865.43 (574.37–1,438.05)

Data in parentheses are 95% uncertainty intervals.

Table 3. Age-standardized prevalence of airway burn projections to 2030, 2040, and 2050, globally and by region, with male and female sexes combined

	Age-standardized prevalence (%)			Cases (millions)		
	2030	2040	2050	2030	2040	2050
Global	5.04 (4.54–5.34)	5.69 (5.1–5.95)	6.42 (5.71–6.62)	434.44 (386.28–467.25)	522.51 (453.32–565.9)	613.35 (516.56–672.85)
Andean Latin America	4.83 (4.21–5.38)	4.68 (4.01–5.23)	4.55 (3.82–5.08)	3.59 (3.06–4.09)	3.87 (3.15–4.56)	4.07 (3.13–5.01)
Australasia	7.16 (6.62–8.49)	7.43 (7.01–8.93)	7.71 (7.4–9.4)	2.36 (2.15–2.83)	2.66 (2.42–3.31)	2.93 (2.64–3.82)
Caribbean	4.98 (4.43–5.66)	4.39 (3.88–4.99)	3.86 (3.38–4.39)	2.46 (2.15–2.86)	2.2 (1.85–2.64)	1.91 (1.53–2.39)
Central Asia	7.79 (7.15–8.52)	8.03 (7.37–8.79)	8.28 (7.61–9.05)	8.16 (7.34–9.12)	9.12 (7.96–10.54)	10.06 (8.41–12.09)
Central Europe	5.01 (4.54–5.67)	4.17 (3.76–4.76)	3.46 (3.11–4)	5.48 (4.9–6.26)	4.28 (3.75–5.04)	3.29 (2.8–4.01)
Central Latin America	5.92 (5.35–6.64)	5.68 (5.14–6.28)	5.44 (4.95–5.94)	17.49 (15.59–19.86)	18.02 (15.85–20.56)	17.97 (15.55–20.78)
Central Sub-Saharan Africa	3.07 (2.62–3.64)	3.29 (2.75–4)	3.53 (2.87–4.38)	5.24 (4.39–6.31)	6.9 (5.53–8.73)	8.71 (6.61–11.58)
East Asia	2.79 (2.67–2.96)	3.01 (2.94–3.15)	3.25 (3.24–3.36)	41.66 (39.18–45.4)	43.19 (40.37–48.05)	43.59 (40.1–50.82)
Eastern Europe	16.96 (15.75–18.69)	21.88 (20.49–24.13)	27.73 (26.2–30.52)	34.13 (31.14–38.35)	42.07 (37.44–49)	50.67 (43.49–61.98)
Eastern Sub-Saharan Africa	4.01 (3.46–4.68)	4.27 (3.63–5.05)	4.55 (3.8–5.45)	22.26 (19.01–26.33)	29.25 (24.17–35.67)	36.6 (29.09–46.18)
High-income Asia Pacific	2.35 (2.11–2.67)	1.67 (1.5–1.87)	1.18 (1.07–1.31)	4.3 (3.8–4.93)	2.9 (2.54–3.35)	1.9 (1.65–2.24)
High-income North America	1.23 (1.1–1.43)	0.76 (0.69–0.89)	0.47 (0.43–0.55)	4.77 (4.25–5.61)	3.04 (2.7–3.68)	1.9 (1.66–2.38)
North Africa and the Middle East	2.41 (2.19–3.29)	1.98 (1.81–2.96)	1.63 (1.5–2.66)	17.64 (15.81–24.54)	16.33 (14.4–25.37)	14.69 (12.67–25.68)
Oceania	2.84 (2.55–3.1)	2.57 (2.3–2.79)	2.33 (2.07–2.51)	0.46 (0.41–0.51)	0.5 (0.43–0.56)	0.53 (0.44–0.61)
South Asia	4.22 (3.89–4.59)	5.29 (4.89–5.74)	6.61 (6.13–7.17)	84.37 (76.01–93.78)	110.57 (97.36–126.35)	139.98 (119.88–165.71)
Southeast Asia	4.5 (3.98–5.1)	5.22 (4.56–5.99)	6.04 (5.22–7.02)	33.15 (28.89–38.15)	40.33 (34.02–48.08)	47.55 (38.65–59.12)
Southern Latin America	18.29 (16.94–22.09)	23.32 (21.93–28.51)	29.23 (27.88–35.94)	13.23 (12.07–16.25)	17.67 (16.02–22.43)	22.7 (20.26–29.84)
Southern Sub-Saharan Africa	1.81 (1.61–1.99)	1.3 (1.15–1.42)	0.93 (0.81–1.01)	1.68 (1.46–1.87)	1.34 (1.13–1.53)	1.04 (0.84–1.23)
Tropical Latin America	15.63 (14.61–17.15)	23.19 (21.88–25.37)	32.98 (31.41–35.83)	37.15 (34.23–41.42)	56.57 (51.47–64.38)	80.27 (71.51–93.67)
Western Europe	3.36 (2.96–3.87)	3.01 (2.65–3.49)	2.69 (2.36–3.14)	14.96 (13.08–17.42)	13.48 (11.59–16)	11.92 (10.03–14.53)
Western Sub-Saharan Africa	3.2 (2.89–3.48)	3.47 (3.12–3.78)	3.77 (3.36–4.1)	20.09 (17.91–22.19)	27.92 (24.23–31.46)	37.1 (31.24–42.86)

Data in parentheses are 95% uncertainty intervals. Region numbers do not add up to the global prevalence owing to rounding.

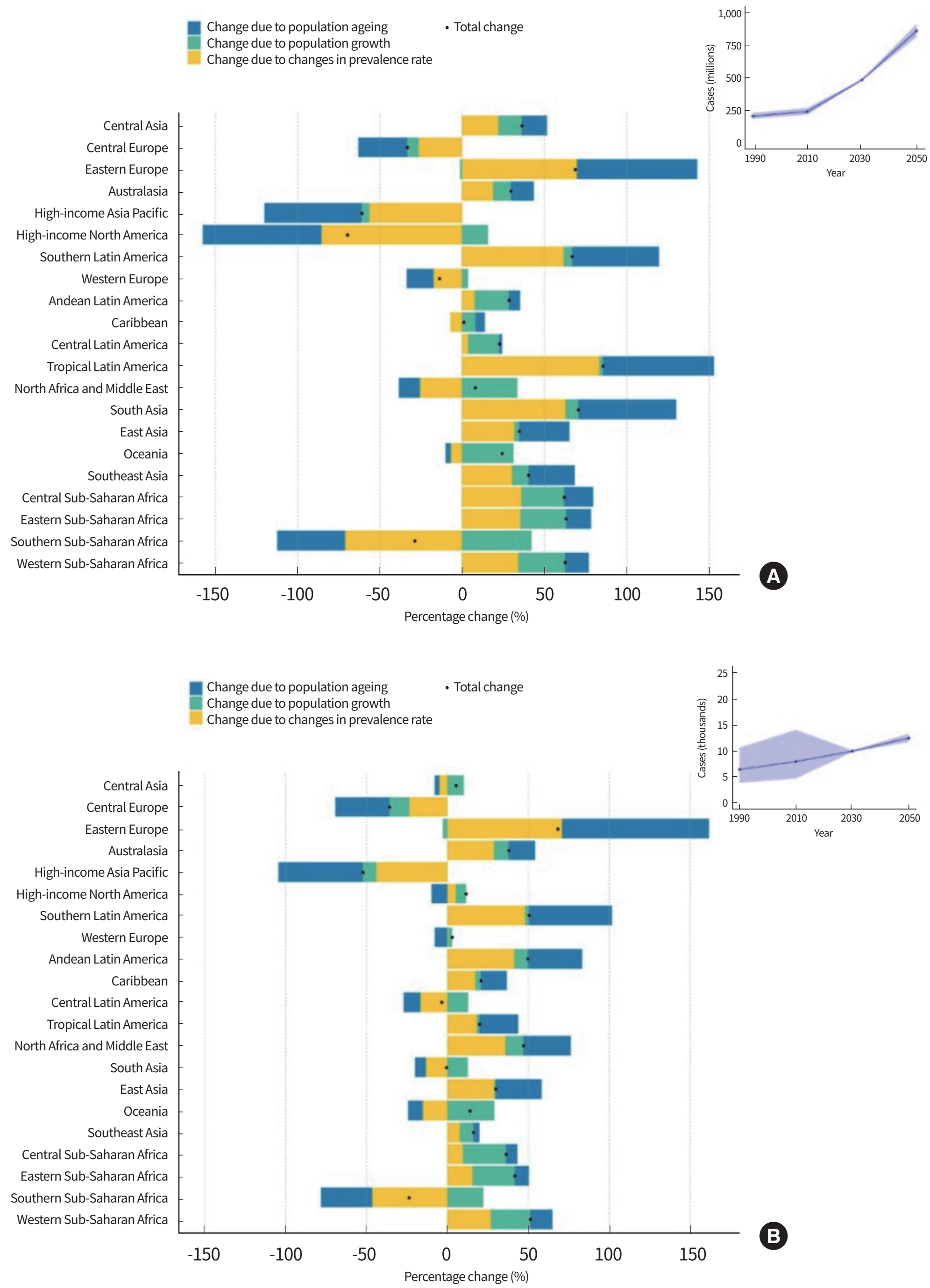

Fig. 3. **Decomposition of projected changes in the number of prevalent burns (A) and airway burn injuries (B) between 2020 and 2050.**

DISCUSSION

Burns are a major contributor to YLDs across all countries [21], and this study provides global, regional, and national estimates of burn incidence and burden. In 2021, there were an estimated 248 million burn cases globally. Burns impose a considerable economic burden owing to prolonged hospital stays and high treatment costs [22]. On average, patients with burns require 23 days of hospitalization, with the total inpatient expenses exceeding $39,600 per patient [23]. Post-treatment costs, including scar management and rehabilitation, add financial strain [24]. Burn prevalence is highest among the working-age population, resulting in substantial productivity losses at both individual and societal levels [10]. Low- and middle-income countries (LMICs) experience disproportionately high socioeconomic burdens owing to limited healthcare infrastructure and financial constraints [25]. Children are particularly vulnerable, as their thinner skin and smaller airway diameters increase the severity of airway burns [26]. Burns induce tissue necrosis, which triggers scar formation through wound-healing mechanisms, often resulting in permanent disability and diminished quality of life [27]. Airway burns are particularly severe, usually requiring intubation, and significantly increase mortality risk compared with other burn types [3]. The implementation of effective and cost-efficient interventions, particularly in LMICs, is crucial. Policies should prioritize prevention, improve acute care, and enhance rehabilitation strategies.

Age-standardized YLDs for burns decreased by 43.34% (95% CI, –44.33 to –41.49) between 1990 and 2021, primarily owing to advancements in burn prevention education and treatment; however, this finding was not uniform across countries. Although high-income countries experienced substantial reductions in burn-related mortality, some low-income countries, such as Haiti (21.64%; 95% CI, 15.42 to 37.55), exhibited an increase in the YLD burden, highlighting persistent disparities. Similarly, age-standardized YLDs for airway burns declined by 26.79% (95% CI, –29.24 to –24.77) over this timeframe. However, some countries, including Haiti (108.22%; 95% CI, 76.41 to 152.47) and São Tomé and Príncipe (50.61%; 95% CI, 47.7 to 51.98), showed significant increases, underscoring the need for targeted preventive efforts.

Looking forward, this study's projections to 2050 offer critical insights for future health policy. The absolute number of burn cases is projected to increase by 6.42% to 613 million by 2050. Our decomposition analysis reveals this growth is not driven by a rising prevalence rate but rather by demographic shifts, namely population growth and population aging (Fig. 3). The largest increases are anticipated in regions such as Tropical Latin America and Eastern Europe, which may be linked to ongoing industrialization, urbanization, and specific occupational hazards. In contrast, the absolute number of airway burn cases is also projected to increase, reaching an estimated 9,873 cases by 2050. Although this represents a smaller relative increase than for general burns, it underscores a continuing public health challenge. The differing trajectories suggest that broad public health strategies must be complemented by targeted interventions. For general burns, policies must adapt to the challenges of a growing and aging population, particularly in high-growth regions. For airway burns, the focus should remain on enhancing fire safety standards, improving emergency response, and advancing specialized medical care to manage these severe injuries.

Burn-related health losses vary widely across regions, with low-income countries experiencing a disproportionately high burden of disability and mortality owing to inadequate healthcare infrastructure and limited access to emergency care [25]. In Central Latin America, burns are primarily caused by heating and kitchen accidents; however, in Eastern and Western Europe, high burn rates are caused by industrial exposure and winter-related heat-related accidents. In Tropical Latin America, burn risks are elevated because of high temperatures and hazardous working conditions; however, reports from Asia showed a significant proportion of burns resulting from traffic accidents. In contrast, high-income countries benefit from greater access to prevention programs and advanced medical care, lowering burn-related mortality rates. Given these regional variations, tailored prevention and treatment strategies are essential to address specific risk factors effectively.

Furthermore, burn prevalence was consistently higher in men across all age groups, with the largest sex disparity observed in individuals aged ≥95 years (Fig. 2A). The global age-standardized prevalence was higher in males (3,285.52 per 100,000; 95% CI, 3,011.89 to 3,580.09) than in females (2,677.39 per 100,000; 95% CI, 2,423.18 to 2,968.3). Burn prevalence increases with age and peaks at approximately 95 years; however, the highest YLD burden occurs in the 40–44 age group (128.54 per 100,000, 95% CI, 91.62 to 177.07).

Fig. 2B illustrates the varying prevalence of airway burns based on age and sex. Among children aged 0–10 years, the prevalence was higher in females; however, in individuals aged 10–50 years, the prevalence was higher in males. Among those aged ≥60 years, females exhibited a higher prevalence. The airway burn-related YLDs peak among older adults was observed in individuals aged ≥95 years (0.08 per 100,000; 95% CI, 0.03 to 0.18).

Males exhibited a consistently higher burn prevalence and YLD burden than females; both measures increased with age (Fig. 2). However, a notable exception was observed in children aged ≤10 years, with higher burn prevalence in girls. These findings highlight the need for targeted burn prevention strategies for caregivers and young children. Among working-age adults, burn prevalence and YLD disparities become more pronounced in men aged ≥30 years, likely owing to greater occupational exposure to thermal and electrical burns. Implementing adequate workplace protective measures is essential to reduce risks [28]. For individuals aged ≥

60 years, burn prevalence remained higher in males; however, airway burn prevalence was higher in females. This trend may be linked to age-related cognitive decline (including Alzheimer's and Parkinson's diseases), which increases the risk of household accidents [29]. Preventive efforts should focus on home safety modifications, fire hazard education, and improved emergency response systems in older adults [15].

Various environmental, social, and individual factors can cause burns. This study highlighted self-harm, interpersonal violence, traffic accidents, and unintentional injuries as the major risk factors. Self-harm and interpersonal violence contribute significantly to burn injuries and are often linked to psychological distress, social conflict, and domestic violence. Traffic accidents, particularly those involving motor vehicles and motorcycles, are the leading cause of death. Moreover, unintentional injuries frequently occur in high-risk environments, such as unsafe workplaces, construction sites, and kitchens, often owing to inadequate safety measures, exposure to hot liquids, or electrical malfunctions. These risk factors vary by region and social context; however, current preventive strategies remain inadequate and lack strong supportive evidence [28]. Future studies should focus on developing targeted prevention programs and assessing their effectiveness in mitigating burn-related injuries.

Effective burn treatment requires a comprehensive approach, from initial treatment to long-term rehabilitation [13]. Acute care includes fluid resuscitation, necrotic tissue debridement, skin grafting, and infection control. The Parkland Formula prevents hypovolemic shock and multi-organ failure [30]. In addition, advancements in bioengineered skin substitutes and cell-based therapies have improved wound-healing outcomes [31]. For airway burns and inhalation injuries, early airway management, mechanical ventilation, and hyperbaric oxygen therapy are critical to address carbon monoxide and cyanide poisoning [13]. Rehabilitation includes physical and occupational therapies to prevent contractures and muscle atrophy, scar management, and reconstructive procedures to restore function and aesthetics [24]. A multidisciplinary approach that integrates these treatments can significantly improve survival and long-term recovery rates of burn patients.

This study utilized Bayesian methods and DisMod-MR 2.1 (Institute for Health Metrics and Evaluation, University of Washington) to estimate burn prevalence and burden by 2050. Risk factor attribution was incorporated to provide new insights into the relative contributions of various exposures. However, this study had some limitations worth noting [32]. First, the variability in burn classification across countries introduces data heterogeneity. Second, although the regression models attempt to standardize definitions, residual uncertainties persist. Third, this study does not fully account for indirect factors, such as the impact of coronavirus disease 2019 on healthcare access. Finally, data scarcity in LMICs remains a challenge that limits the scope of national-level analyses.

In conclusion, burns remain a major global health concern, and their prevalence and burden are expected to increase by 2050, particularly in LMICs. Implementing targeted prevention strategies, strengthening acute care, and enhancing rehabilitation efforts are essential to mitigate the long-term impact of burns.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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AUTHOR CONTRIBUTIONS

Conception or design: NL, SWL.
Acquisition, analysis, or interpretation of data: NL, YB.
Drafting the work or revising: NL, DWL, SWL.
Final approval of the manuscript: NL, SJ, YB, DWL, SWL.

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