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The State of Craniomaxillofacial Trauma Care in Low- and Middle-Income Countries: A Scoping Review

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Abstract

Objective. This scoping review aims to contribute a descriptive analysis of the craniomaxillofacial trauma (CMF trauma) literature in low- and middle-income countries (LMICs) to identify knowledge gaps, direct future research, and inform policy.

Data Sources. PubMed/MEDLINE, Cochrane Review, EMBASE, ClinicalTrials.gov, and Google Scholar from January 1, 2012 to December 10, 2023.

Review Methods. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guided reporting, and the PRISMA flowchart documented database searches. Specific, predefined search terms and inclusion criteria were used for screening, and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist was used for quality assessment. The search yielded 54 articles, with 13 meeting the inclusion criteria. Key findings were summarized and divided into 7 categories.

Results. There were 10,420 patients (7739 [74.3%] male, 2681 [25.7%] female) with a male-to-female ratio of 2.9:1. The mean peak age of incidence of CMF trauma was 30.8 years, ranging from 20 to 40 years. Road traffic accidents were the leading cause (60.4%), followed by assault (27.2%) and falls (12.2%). The most common injuries were soft tissue injury (31.7%), isolated mandibular fracture (22.8%), and isolated middle-third of mandible fracture (18.1%). The most common treatments were closed reduction and immobilization (29.5%), conservative management (27.6%), and open reduction and internal fixation (19.6%). Most patients (77.8%) experienced a treatment delay due to a lack of fixation materials (54.8%) or surgeon unavailability (35.7%).

Conclusion. CMF trauma remains a significant cause of global morbidity, yet there remains a lack of high-quality, CMF trauma-specific data in LMICs. Country-specific investigations are required to enhance knowledge and inform novel interventions. Implementing policy change must be community-specific and account for unique cultural barriers, attitudes, and behaviors to maximize patient care outcomes.

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All Trauma Burden of Disease in Low- and Middle-income Countries (LMICs)

The objective of this article is to contribute a comprehensive descriptive analysis of the available literature focused on the management of craniomaxillofacial trauma (CMF trauma) in LMICs. We structured this analysis into 7 categories to best describe the state of CMF trauma care in LMICs, identify knowledge gaps, direct future research, and inform policy. We conducted our analysis as a scoping review, a literary tool that provides an overview of the current evidence on a specific topic.[1] Before beginning our discussion of the CMF trauma literature, it is helpful first to review the burden of all traumatic injuries within the context of LMICs.

Traumatic injuries and violence are responsible for an estimated 4.4 million deaths worldwide, making up nearly 8% of all deaths annually and 11% of years of potential healthy life lost.[2,3] Relative to traditional global health priorities such as the infectious diseases human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), malaria, and tuberculosis (TB), the number of deaths due to trauma and violence exceeds the number of deaths from HIV/AIDS, malaria, and TB combined by over 1.5 times (**Table 1**).[4-6] Of the 4.4 million annual deaths from injury and violence, 1.35 million (30.7%) are due to road traffic accidents (RTAs).[7] Strikingly, 93% of the world's fatalities from RTAs occur in LMICs, despite these countries only having 60% of the world's vehicles.[7] World Health Organization data further illustrates this disparity with a road traffic death rate of 27/100,000 people in Africa compared to 15-18/100,000 people in the Eastern Mediterranean, Western Pacific, Southeast Asia, and the Americas, and 7/100,000 people in Europe.[8]

In addition to the effect on health and well-being, RTAs result in a staggering economic impact, primarily due to their disproportionately high prevalence among young people. Three of the top 5 causes of death among people aged 5 to 29 years are injury-related, specifically RTAs, homicide, and suicide.[2,3] RTAs were the sixth leading cause of disability-adjusted life years in 2019 and cost most countries 3% of their gross domestic product (GDP). Additionally, nearly 1 billion people sustain injuries in RTAs that require health care.[7,9-11] For every death from trauma, 20 to 50 nonfatal injuries result in permanent disability, causing an irreparable impact on quality of life, productivity, and financial security.[7,11-13]

Table 1. WHO Data on Mortality Related to Injury and Violence, HIV/AIDS, Malaria, and TB[2,4-7]

Cause of death	Estimated number of deaths (2021)
Injury and violence[a]	4,400,000[b]
HIV/AIDS	650,000
Malaria	619,000
TB	1,600,000
HIV/AIDS, malaria, TB combined	2,869,000

Abbreviations: HIV/AIDS, human immunodeficiency virus/acquired immunodeficiency syndrome; TB, tuberculosis.

[a]Three of the top 5 causes of injury-related death for people aged 5 to 29 years are road traffic injuries, homicide, and suicide.[1,3-6]

[b]Of the 4.4 million annual deaths due to injury and violence, 1.35 million are due to road traffic accidents.[2,4-7]

CMF Trauma Burden of Disease in LMICs

CMF trauma represents a significant subset of traumatic injuries. Within LMICs, it is difficult to describe the incidence, prevalence, and years of potential life lost due to disability (YLDs). The Lancet's 2019 Global Burden of Disease (GBD) study provides objective data on injury mechanisms, including transport, intentional, and unintentional injuries.[3] However, further granularity of the types of injuries sustained is unavailable. A 2017 study by Lalloo et al utilized the results of the GBD 2017 to estimate the global incidence, prevalence, and YLDs of facial fracture due to falls at 98/100,000, 23/100,000, and 2/100,000, respectively, with the highest concentration in Central Europe.[14] While this is one of the only studies providing estimates of incidence, prevalence, and YLDs derived from GBD data, it is necessary to note that these estimates are from falls alone as the mechanism of facial fracture. Based on GBD 2019 data, the burden of disease from injury due to falls is concentrated among people aged 60 to 74 years, accounting for the distribution of this population in Central Europe. Most CMF injuries resulting in facial fractures in LMICs are due to RTAs and interpersonal violence, which are more prevalent among a younger demographic.[2,3,7,8,15]

In addition to limited estimates of the incidence and prevalence of CMF trauma in LMICs, large-scale multisite trauma registries with broad geographic coverage are rare.[16] As such, there is limited data on the burden of CMF trauma in LMICs. A 2022 study by Chokotho et al provided epidemiology of adult trauma injuries in Malawi, utilizing data from a multisite trauma registry within the country. For all trauma cases (n = 49,241) from September 2018 to March 2020, 3447 (7%) were to the head and neck, and 3939 (8%) were to the face.[16] Patients aged 15 to 30 comprised nearly 50% of the study population.[16] The most common mechanism of injury was RTAs. Most trauma patients sustained a delay in care, which resulted in higher acuity presentations and poorer outcomes.[16] This study further quantifies the burden of CMF trauma in Malawi. However, this study is limited to all trauma and does not offer insight into CMF trauma specifically. Clinical investigations of the

burden of CMF trauma independent of other forms of trauma remain rare.

Access to CMF Trauma Care in LMICs

Access to safe, affordable surgical and anesthesia care is imperative to CMF trauma treatment. In 2015, Alkire et al published a modeling study in *The Lancet* investigating access to surgical care globally.[17] They modeled access to surgical services in 196 countries considering 4 key factors: timeliness, surgical capacity, safety, and affordability.[17] The study found that at least 4.8 billion people cannot access surgical care.[17] Further, more than 95% of people in South Asia and central, eastern, and western sub-Saharan Africa do not have access to care, whereas less than 5% of the population in Australia, high-income North America, and Western Europe lack access.[17] Most of the world's population does not have access to surgical care, and when available, access to surgery is inequitably distributed.[17] This severe gap in access to surgical care applies to patients with CMF trauma.

Methods

A comprehensive electronic literature review was performed using English-language publications investigating CMF trauma in LMICs. The authors adopted the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist to guide reporting on this topic. Readers may review the specific checklist used for this investigation in the Supplemental Materials, available online.

Specific search terms were used to identify articles on our selected topic. The complete list of terms is as follows: CMF trauma, CMF, low- and middle-income, low- and middle-income countries, LMIC, low-income, low-income countries, LIC, middle-income, middle-income countries, MIC, low resource, low-resource setting. Specific keyword inputs were utilized, and all associated search permutations were organized by their associated databases, which readers may find in the CMF Trauma Database Search table in the Supplemental Materials, available online.

Inclusion and exclusion criteria were adopted to screen publications identified by keyword search that fit the objectives of our investigation. The inclusion criteria are as follows: all full-text studies completed by authors from high-income countries (HICs)/LMICs, study populations must consist of adult patients ≥18 years old, study populations must consist of patients from nations classified as low-income countries (LICs)/LMICs as defined by the World Bank economic classification criteria 2023 (WBECC 2023),[18] studies must be published in electronic, peer-reviewed, English-language journals, studies must focus on CMF trauma specifically, studies must provide information on any 1 of the following components: the epidemiology, most common causes, and/or barriers to CMF trauma care in LMICs, specialist surgical workforce density, training, and education in LMICs, quantification of CMF trauma case volume, perioperative morbidity, mortality, or postoperative outcomes in LMICs, quantification of the financial burden of CMF trauma in LMICs, and quantification of the operative capacity dedicated to CMF trauma in LMICs.

The exclusion criteria are as follows: studies including any individual ≤17.99 years old, studies including patients from LICs/LMICs presenting to upper middle-income countries (UMIC)/HIC centers for CMF trauma care as defined by the WBECC 2023,[18] studies conducted at UMIC/HIC institutions as defined by the WBECC 2023,[18] editorials and commentaries, studies investigating operative or clinical techniques/interventions, studies published in the non-English language literature, studies not published in peer-reviewed journals (including doctoral theses published in non-peer-reviewed university databases), studies investigating non-CMF trauma in HICs/LMICs, studies without a clear definition of CMF trauma, studies on HIC-LMIC partnerships not focused on CMF trauma, studies that did not contain a complete abstract or full-text article with complete datasets, and studies that are inaccessible due to faulty websites, domains, or inaccessible repositories.

A comprehensive search of the electronic, English-language literature was completed from January 1, 2012, to December 10, 2023. Our initial database search identified a total of 54 records from the following sources: PubMed/MEDLINE (n = 9), Cochrane Review (n = 0), EMBASE (n = 12), ClinicalTrials.gov (n = 0), and Google Scholar (n = 33). Of these 54 articles, we removed 3 duplicates before screening. Next, 51 articles underwent first-round title and abstract screening, excluding 32 articles that did not fulfill the inclusion and exclusion criteria. The remaining 19 articles underwent second-round full-text review, excluding 6 articles that did not satisfy the inclusion and exclusion criteria or the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist(s) as a guideline for quality of evidence.[19] Thirteen articles met the inclusion criteria and contained high-quality evidence based on the STROBE checklist(s).[19] We reviewed the references sections of articles passing the first and second rounds of screening to identify additional studies to include. However, we identified no new manuscripts that met the inclusion and exclusion criteria. The authorship team developed and reviewed this research protocol and illustrated the process using the PRISMA-2020 flow diagram for systematic reviews (**Figure 1**). **Table 2** summarizes the 13 included publications in chronological order and reports their level of evidence, study subjects, study design, key findings, and the associated Global Surgery 2030 core indicators that best correspond with each investigation.[20-32]

Results

To summarize the findings of the 13 articles meeting inclusion criteria, reported data from each study was reviewed and organized into 7 broad categories: demographics, etiology

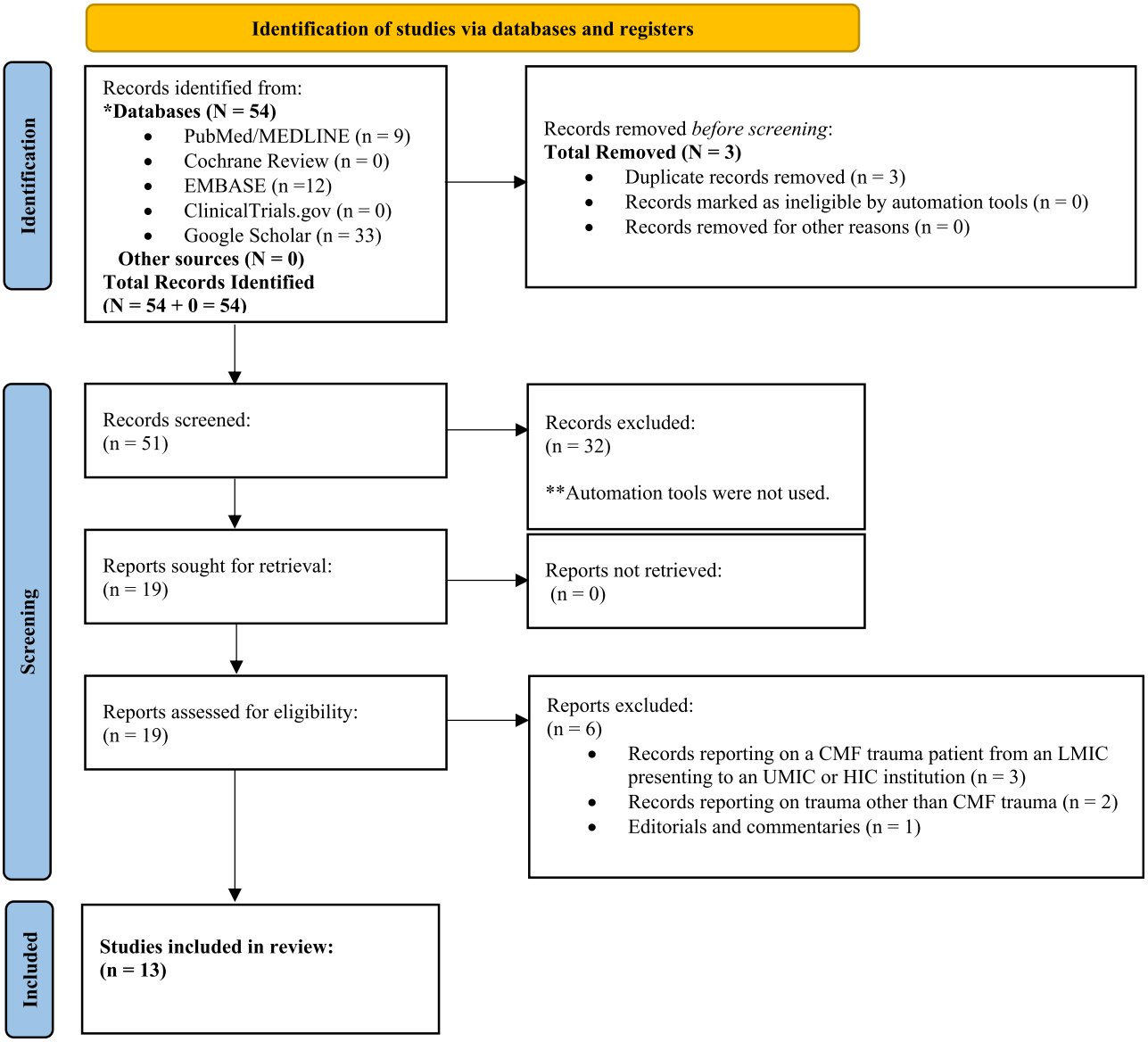

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 flow diagram. CMF, craniomaxillofacial; HIC, high-income countries; LMIC, low- and middle-income countries; UMIC, upper middle-income countries.

and complicating factors affecting trauma, injuries, treatment, outcomes, barriers to care, and finance. A composite table was created to summarize and compare the published literature on CMF trauma in LMICs (**Table 2**).

Demographics

Eight studies (61.5%) reported demographic information (**Table 3**). The composite number of trauma patients was n = 10,420 with 7739 (74.3%) males, 2681 (25.7%) females, and a male-to-female ratio of 2.9:1. The mean peak age of incidence of CMF trauma is 30.8 years with a range of 20 to 40 years. Three studies (23.1%) reported the socioeconomic status (SES) of CMF trauma victims with SES strata defined by different criteria. These include high, intermediate, or low SES, literate versus illiterate populations, and income stratified across 4 SES categories. Overall, Olusanya et al reported that 140 (54.1%, n = 259) patients were of intermediate SES, and 109 (42.0%, n = 259) patients were of low SES.[21] Davé et al reported that, among 4 countries (Nepal, Rwanda, Sierra Leone, and Uganda), 684 (48.0%, n = 1423) patients were illiterate.[25] Stanford-Moore et al found that 21 (38.9%, n = 54) and 28 (51.9%, n = 54) patients with CMF trauma were listed as SES category 2 and 3, respectively.[29] An additional indirect indicator of SES is the location of CMF trauma. Three studies (23.1%) reported on the location of trauma, with 1130 (65.5%, n = 1726) incidences of CMF trauma occurring in rural areas.

Etiology and Complicating Factors Affecting Trauma

Five studies (38.5%) report on the etiology of trauma (**Table 4**). The most common cause of CMF trauma was

Table 2. Summary of Publications Examining CMFT in LMICs[20-32]

Author(s) (year)[citation]	Level of Evidence[a]	Subjects	Study Design	Key Findings	Associated GS2030 Core Indicator(s)[b]
Chrcanovic (2012)[20]	5	The author performed an electronic search without language restrictions using the PubMed database in March 2011, including articles published between 1980 and 2011 with the terms "facial fractures" and "maxillofacial fractures" in the title only. The team reviewed all epidemiological studies identified to specify factors influencing the incidence of maxillofacial fractures.	Systematic review	From the selected articles, the author identified 10 factors that may influence the incidence of maxillofacial fractures: 1. Age: CMFT victims are ≤35 y old (range: 20-40 y), regardless of socioeconomic status (SES). 2. Gender: Men predominate CMFT 65%-95% of the time, with a male-to-female ratio ranging from 2:1 to 32:1. 3. Geographic region and cultural aspects: Countries with developing infrastructure and greater reliance on road transportation have rising incidences of CMFT. 4. SES: SES is inversely proportional to the incidence of CMFT, with worse outcomes for patients traveling long distances to referral centers for care. 5. Temporal and climatic influence: Most temporal and climatic studies are confounded by alcohol and drug use, making it difficult to draw statistically significant conclusions. 6. Use of alcohol and drugs: Alcohol and drug use are directly proportional to the incidence of CMFT. 7. Compliance with road traffic legislation: Use of airbags, seatbelts, and helmets, in addition to compliance with road traffic legislation, results in statistically significant reductions in the incidence of CMFT. 8. Domestic violence (DV): Women are most affected. Hospital records describe concomitant alcohol use in 33% of cases and illicit drug use in ≥50% of cases. Due to underreporting, the authors likely underestimated the incidence of DV. 9. Osteoporosis: Significant concomitant factor for the increased incidence of CMFT, especially in women. 10. The etiology of maxillofacial trauma: RTAs are the most common cause, followed by interpersonal violence and ground-level falls.	1. Access to timely essential surgery 2. Perioperative mortality
Olusanya et al (2014)[21]	4	Patients suffering from CMFT who presented to the University College Hospital, Ibadan, in Nigeria from January to December 2010.	Single center prospective cohort study.	The authors documented 259 patients (79.5% male, 20.5% female; male-to-female ratio 4:1) during the study period. The mean age was 32.21 ± 16.59 y. The most common cause of CMFT was RTAs (42.1% due to motorcycle crashes), followed by physical assault (69.0% due to armed robbery). The most common fracture was a mandibular fracture (37.8%), and closed reduction and immobilization was the most common treatment (88.0%). The mean length of hospitalization was 12.6 ± 4.423 d. The authors concluded that CMFT represents a significant socioeconomic burden on affected individuals in the study population, a finding made worse by the presence of other associated injuries to other body systems in CMFT victims.[18] This single-institution study represented one of the only investigations of its kind from an LMIC in 2010, highlighting the need for more local observational studies to quantify the epidemiology and clinical outcomes of the management of CMFT in LMICs.	1. Surgical volume 2. Perioperative mortality

(*continued*)

Table 2. (continued)

Author(s) (year)[citation]	Level of Evidence[a]	Subjects	Study Design	Key Findings	Associated GS2030 Core Indicator(s)[b]
Singaram et al (2016)[22]	4	Patients suffering from CMFT who presented to the ESIC Medical College and Post Graduate Institute of Medical Sciences and Research, Chennai in India from May 2014 to November 2015.	Single center retrospective cohort study.	The authors documented 267 patients (74.5% male, 25.5% female; male-to-female ratio of 3:1) during the study period. The mean age was 35.0 ± 11.8 y. The most common etiology of CMFT was RTAs (73.8% of injuries), followed by falls (18% of injuries) and assaults (6.7% of injuries). In RTAs, motorcycle crashes were the most common mechanism of CMFT. Most victims of RTAs were young adult males between 20 and 40 y.	1. Surgical volume 2. Perioperative mortality
Shaye et al (2018)[23]	3	Health professionals with diverse training backgrounds who care for CMFT patients in low-resource settings.	Controlled trial without randomization.	The authors produced a 1.5-d facial injuries curriculum. They evaluated core competencies using pre- and postcourse assessments. Two courses were conducted and evaluated. After completing the first course, the mean competency scores improved by 30%, from 49.3% to 79.2%. After completing course 2, the mean competency scores improved by 13.7% from 79.2% to 92.9%. Finally, the authors collected postcourse evaluations for qualitative assessment and formal course feedback. Shaye et al concluded that the backward planning method for designing a CMFT course with direct input from LMIC providers is a promising tool for increasing surgical workforce education and capacity. Surgeons and educators from diverse geographic backgrounds found the backward planning curriculum development method effective in creating a competency-based facial injuries (trauma) course for health professionals in low-resource settings.	1. Access to timely essential surgery 2. Specialist surgical workforce density
Shah et al (2019)[24]	5	Articles published between 2003 and 2018 with select publications from 1947, 1960, and 1994 examining the management of CMFT in low-resource settings.	Scientific briefing.	The authors wrote a review describing the management of CMFT in LMICs. Shah et al state that CMFT is a multifactorial global epidemic in which patients face many barriers to surgical care. These barriers include the inability to reach surgical facilities, the lack of capable surgeons to operate, the lack of available surgical facilities, and patients' inability to access care without significant expenditure. Regardless of the cause, delays in presentation result in worse postoperative outcomes. Additionally, the diagnosis of CMFT in LMICs is often restricted to plain radiographs, as computed tomography is not readily available or affordable for all patients. Further, plating materials are often unavailable or costly, resulting in many patients undergoing treatment with closed reduction, maxillomandibular fixation, and transosseous wiring instead of open reduction and internal fixation, yielding acceptable but suboptimal results. Each of the deficiencies identified by this review represents an area of focus for future study, advocacy, and policy investment to improve CMFT care in LMICs.	1. Access to timely essential surgery 2. Specialist surgical workforce density 3. Protection against impoverishing/ catastrophic expenditure[c]

Table 2. (continued)

Author(s) (year)[citation]	Level of Evidence[a]	Subjects	Study Design	Key Findings	Associated GS2030 Core Indicator(s)[b]
Davé et al (2019)[25]	4	Respondents to the Surgeons OverSeas Assessment of Surgical Need survey administered in Nepal, Rwanda, Sierra leone, and Uganda from 2011 to 2014.	Multicountry cross sectional study.	The authors report an incidence of 1413 diseases of the head and neck, with trauma representing 32.8% of reported pathology.[23] Of the 4 target countries, Rwanda reported the most significant proportion of trauma (52.65%, $P < .001$), followed by Sierra Leone (31.38%, $P < .001$), Uganda (15.23%, $P < .001$), and Nepal (10.61%, $P < .001$). The uneven distribution of CMFT and other head and neck pathology across the 4 target countries highlights the differences in epidemiology and barriers to seeking care among LMICs. The authors conclude that CMF pathology represents a substantial burden in LMICs. Many factors contribute to its cause, including literacy, SES, the presence and efficacy of a triage referral system, and plastic and reconstructive surgeons' training and clinical expertise. Future efforts to improve CMFT prevention, care, and outcomes should focus on these areas of need.	1. Access to timely essential surgery 2. Surgical volume 3. Perioperative mortality
Gurung et al (2019)[26]	4	All victims of road traffic accidents with maxillofacial injuries who reported to either Sardar Patel Post Graduate Institute of Dental and Medical Sciences or Dr. OP Chaudhary Hospital and Trauma Center, Lucknow, India between January 2013 and December 2017.	Multicenter retrospec-tive cohort study.	The authors documented 1110 patients aged 20-29 with a mean age of 25.95 ± 9.35 y. The most common associated injuries were head injury, laceration, and tooth luxation. The most common etiology was a violation of traffic rules ($P < .05$), with a noted correlation between a higher risk of facial bone fractures and decreased use of protective helmets and seatbelts.	1. Surgical volume 2. Perioperative mortality
Wu J. et al (2021)[27]	5	Facial fracture data, including the incidence, prevalence, and years lived with disability (YLDs) from 1990 to 2017, were obtained from the Global Burden of Disease study.	Correlational study using secondary data	The incident and prevalent cases and YLDs of facial fractures increased worldwide from 1990 to 2017. The ratio between males to females is approximately 2:1. Facial fractures are most common in men aged 25-29 y and in both sexes aged >80 y.	1. Surgical volume 2. Perioperative mortality 3. Protection against impoverishing/ catastrophic expenditure

(*continued*)

Table 2. (continued)

Author(s) (year)[citation]	Level of Evidence[a]	Subjects	Study Design	Key Findings	Associated GS2030 Core Indicator(s)[b]
Wu C. et al (2021)[28]	5	Articles published between 2004 and 2021 found by electronic search using the keywords craniofacial trauma, head and neck cancer, and plastic and reconstructive surgery.	Scientific briefing.	CMFT is prevalent in LMICs and should be given greater priority in global surgery. Global surgical treatment gaps in CMFT include poor prehospital care, lack of surgical fixation devices, inadequate surgical workforce capacity, poor availability of advanced imaging, and lack of surgical equipment and facilities.	1. Access to timely essential surgery
Stanford-Moore et al (2022)[29]	4	All patients with CMFT presenting to the University Teaching Hospital of Kigali (CHUK), Rwanda, between June 1 and October 1, 2020 (n = 54).	Single center prospective cohort study.	The authors collected epidemiological data and performed a logistic regression analysis to delineate risk factors for delays in care and postoperative complications. The authors documented 54 patients (94.4% men) meeting the inclusion criteria. They had a mean age of 30 y, and most were from a rural setting (n = 34, 63%). The most common cause of trauma was RTAs (n = 18, 33%), and the most common injury was mandibular fracture (n = 28, 35%). Furthermore, 78% of patients had delayed fracture treatment after arrival at CHUK, and 81% experienced a complication (n = 43, $P = .03$). Delay in treatment was associated with a 4-times increased likelihood of complication (OR = 4.25 [95% CI, 1.08-16.70]; $P = .038$). The authors conclude that there is a correlation between delays in treating CMFT and higher rates of complications. Delays were most commonly due to a lack of surgeon or OR availability or were related to transfers from rural districts. Expanding the CMFT surgical workforce, increasing operative capacity, and developing a coordinated transfer system may improve trauma care at CHUK and in similar low-resource trauma settings.	1. Access to timely essential surgery 2. Surgical volume 3. Perioperative mortality
Adeleke et al (2023)[30]	5	An electronic literature search of English-language publications on maxillofacial injuries in adults ≥18 y conducted in Scopus, Medline, PubMed, Science Direct, CINAHL, Health Source: Nursing/ Academic Edition, and grey literature.	Scoping review.	The authors conducted a database search yielding 8246 studies, with 30 meeting the inclusion criteria. Data was extrapolated from the included studies, resulting in a total of 7317 patients, of whom 79.3% were male, with the peak age of incidence between 18 and 40 y.[28] CMFT victims and their families were responsible for the cost of treatment, ranging from $200 to $469 (USD). This investigation is one of the first of its kind, providing a unified overview of the epidemiology of CMFT in sub-Saharan Africa.	1. Surgical volume 2. Perioperative mortality 3. Protection against impoverishing/ catastrophic expenditure

Table 2. (continued)

Author(s) (year)[citation]	Level of Evidence[a]	Subjects	Study Design	Key Findings	Associated GS2030 Core Indicator(s)[b]
Shaye et al (2023)[31]	6	Fourteen established CMF surgeons, currently practicing in LMICs.	Scientific briefing.	The authors published a scientific briefing quantifying the cost burden of rigid internal fixation in CMFT care in LMICs. Shaye et al gathered information from 14 established CMF surgeons practicing in LMICs. They found the mean cost of a six-hole plate with six screws (SHPS) was $238.38 ($4.72 [Rwanda]-$1000 [Gabon]), the mean cost burden (SHPS cost /GDP per capita) among sampled LMICs was 10.2% (0.6% [Rwanda]-23.2% [Cameroon]), and the mean SHPS cost at 3 local Boston academic centers was $692.21, representing 1.1% of GDP per capita in the United States. This work highlights the manufacturing costs, import tax rates, and lack of subsidized health care as factors that contribute significantly to the cost burden of treating CMFT in different contexts. Future investigations seeking to expand access to CMFT care should characterize additional financial and socioeconomic barriers to CMF care.	1. Access to timely essential surgery 2. Protection against impoverishing/ catastrophic expenditure
Kantar et al (2023)[32]	4	International comprehensive cleft care workshop with 489 participants from 70 countries and 5 continents.	Cross-sectional survey-based evaluation	The total number of participants was 489, with 103 (52.8%) attending in person and 195 (39.9%) completing the workshop satisfaction survey. The majority (96.4%) reported they would participate in a similar workshop again. The most significant reported barriers facing comprehensive cleft care delivery in the participants' home counties were financial challenges (30.3%), absence of multidisciplinary cleft teams (21.1%), patient travel distance (17.4%), poor training (15.6%), lack of awareness about cleft lip and palate (8.3%), and the absence of cleft centers (7.3%). The reported best interventions for improving comprehensive cleft care delivery were better training (39.8%), establishing multidisciplinary cleft teams (18.4%), financial support (17.3%), establishing cleft centers (15.3%), and raising awareness about cleft lip and palate (9.2%).	1. Access to timely essential surgery 2. Specialist surgical workforce density

Abbreviations: CI, confidence interval; CMF, craniomaxillofacial; CMFT, craniomaxillofacial trauma; GDP, gross domestic product; GS2030, Global Surgery 2030; LMIC, low- and middle-income countries; OR, odds ratio; RTA, road traffic accident.

[a]Adapted from Melnyk and Fineout-Overholt.[33]

[b]The Lancet Commission's Executive Summary in GS2030 describes 6 core surgical indicators to be tracked and reported by all countries and global health organizations to monitor universal access to safe, affordable surgical and anesthesia care when needed. These indicators are access to timely essential surgery, specialist surgical workforce density, surgical volume, perioperative mortality, and protection against impoverishing and catastrophic expenditure.[34] When used and interpreted together, the 6 indicators provide a model for the critical appraisal of global surgical and anesthesia care. It is helpful to consider CMFT as a specific pathology within the broader picture of advancing global surgical care, as defined by the GS2030 indicators.

[c]Impoverishing expenditure is defined as any expenditure on health care that results in a household falling below the prevailing poverty line or deepening its impoverishment if it is already poor.[34] Similarly, catastrophic expenditure measures the burden of health care expenditure on a household's available resources.[35]

Table 3. Composite Data Illustrating the Demographics of Patients Affected by CMF Trauma[20-32]

			Demographics							
Author(s) and year	Country/countries investigated	Sample size	Peak age range of incidence, y	Male, n (%)	Female, n (%)	Male:female ratio, n (%)	Socioeconomic status, n (%)		Location of trauma, n (%)	
Chrcanovic (2012)	N/A	N/A	<35	N/A	N/A	Range: 2:1 - 32:1	N/A	N/A	N/A	N/A
Olusanya et al (2014)	Nigeria	N = 259	Mean: 32.21 ± 16.588 Median: 30	206 (79.5)	53 (20.5)	3.9:1	High	10 (3.9)	Intracity	214 (82.6)
							Intermediate	140 (54.1)	Intercity	45 (17.4)
							Low	109 (42.0)		
Singaram et al (2016)	India	N = 267	21-40	199 (74.5)	68 (25.5)	2.9:1	N/A	N/A	N/A	N/A
Shaye et al (2018)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shah et al (2019)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Davé et al (2019)	Nepal	N = 179	Mean: 33.8	94 (52.5)	84 (47.5)	1.1:1	Literate	114 (63.69)	Rural	119 (66.48)
							Illiterate	65 (36.31)	Urban	60 (33.52)
	Rwanda	N = 452	Mean: 27.1	196 (43.4)	256 (56.6)	0.77:1	Literate	222 (49.12)	Rural	423 (93.58)
							Illiterate	230 (50.88)	Urban	29 (6.42)
	Sierra Leone	N = 515	Mean: 27.9	239 (46.4)	276 (53.6)	0.87:1	Literate	232 (45.22)	Rural	284 (55.15)
							Illiterate	281 (54.78)	Urban	231 (44.85)
	Uganda	N = 267	Mean: 26.1	129 (48.3)	138 (51.7)	0.93:1	Literate	151 (58.3)	Rural	225 (84.27)
							Illiterate	108 (41.7)	Urban	42 (15.73)
Gurung et al (2019)	India	N = 1110	20-39	823 (74.1)	287 (25.9)	2.9:1	N/A	N/A	N/A	N/A
Wu J. et al (2021)	N/A	N/A	25-29	N/A	N/A	2.0:1	N/A	N/A	N/A	N/A
Wu C. et al (2021)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stanford-Moore et al (2022)	Rwanda	N = 54	Mean: 30	51 (94.4)	3 (5.6)	17.0:1	Category 1	4 (7.4)	City	20 (37)
							Category 2	21 (38.9)	Rural	34 (63)
							Category 3	28 (51.9)		
							Category 4	1 (1.9)		
Adeleke et al (2023)	Sub-Saharan Africa[a]	N = 7317	18-40	5802 (79.3)	1515 (20.7)	3.8:1	N/A	N/A	N/A	N/A
Shaye et al (2023)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kantar et al (2023)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Abbreviation: CMF, craniomaxillofacial.

[a]This scoping review included 30 publications representing the following countries: Nigeria (n = 10), Tanzania (n = 5), Kenya (n = 4), Uganda (n = 3), South Africa (n = 3), Rwanda (n = 2), Somalia (n = 1), Ethiopia (n = 1), and Cameroon (n = 1).

Table 4. Composite Data Illustrating the Etiology and Complicating Factors Affecting the Etiology of CMF Trauma[20-32]

			Etiology of trauma						Complicating factors affecting the etiology of RTA			
Author(s) and year	Country/ countries investigated	Sample size	RTA, n (%)		Fall, n (%)	Assault, n (%)		Other, n (%)	Seat belt/helmet use		Alcohol intoxication	
Chrcanovic (2012)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Olusanya et al (2014)	Nigeria	N = 259	Motor bike crashes	109 (42.1)	22 (8.5)	Armed robbery	20 (69.0)	4 (1.5)	Yes	21 (10.3)	Yes	23 (11.3)
			Motor vehicular crashes	95 (36.7)		Domestic assault	4 (13.8)		No	130 (63.7)	No	181 (88.7)
						Acquaintance	3 (10.3)		Not applicable	53 (26.0)		
						Animal	2 (6.9)					
Singaram et al (2016)	India	N = 267	N/A	197 (73.8)	48 (18.0)	N/A	18 (6.7)	4 (1.5)	N/A	N/A	N/A	N/A
Shaye et al (2018)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shah et al (2019)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Davé et al (2019)	Nepal	N = 179	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Rwanda	N = 452	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Sierra Leone	N = 515	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Uganda	N = 267	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gurung et al (2019)	India	N = 1110	N/A	1110 (100)	N/A	N/A	N/A	N/A	Yes	18 (3.6)	Yes	186 (16.8)
									No	484 (96.4)	No	924 (83.2)
Wu J. et al (2021)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wu C. et al (2021)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stanford-Moore et al (2022)	Rwanda	N = 54	Motorcycle	18 (33.3)	1 (1.9)	N/A	16 (29.6)	15 (27.8)	N/A	N/A	Yes	10 (18.5)
			Motor vehicle	4 (7.41)							No	44 (81.5)
Adeleke et al (2023)	Sub-Saharan Africa[a]	N = 7317	Motorcycle	4346 (59.4)	N/A	N/A	2085 (28.5)	N/A	N/A	N/A	N/A	N/A
Shaye et al (2023)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kantar et al (2023)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Abbreviations: CMF, craniomaxillofacial; RTA, road traffic accident.

[a]This scoping review included 30 publications representing the following countries: Nigeria (n = 10), Tanzania (n = 5), Kenya (n = 4), Uganda (n = 3), South Africa (n = 3), Rwanda (n = 2), Somalia (n = 1), Ethiopia (n = 1), and Cameroon (n = 1).

RTA, affecting 4769 (60.4%, n = 7897) patients across 4 studies.[21,22,29,30] The article by Gurung et al reported exclusively on RTAs and was, therefore, excluded from this calculation because it falsely inflated the proportion of patients affected by RTAs.[26] The second most common cause of CMF trauma was assault, involving 2148 (27.2%, n = 7897) patients across 4 studies.[21,22,29,30] The third and fourth most common causes of CMF trauma were falls and other causes of trauma, affecting 71 (12.2%, n = 580) and 23 (4.0%, n = 580) patients, respectively.[21,22,29] Additionally, 3 studies (23.1%) reported on complicating factors affecting the etiology of trauma (**Table 4**). Specifically, 614 (44.9%, n = 1369) CMF trauma victims across 2 studies were not wearing a seat belt or helmet.[21,26] Further, 219 (15.4%, n = 1423) CMF trauma victims across 3 studies tested positive for alcohol intoxication.[21,26]

Mechanisms of Injury and Associated Injuries

One study (7.7%) reported on the type of injury, including the associated mechanism of injury. Two studies (15.4%) reported concomitant injuries, with 1 study (7.7%) providing information on the mechanism of concomitant injury (**Table 5**).[21,26] Of the types of injuries reported, soft tissue injury was the most common, with 82 (31.7%, n = 259) patients affected, followed by isolated mandibular fractures with 59 (22.8%, n = 259) patients affected, and middle-third of mandible fractures alone, with 47 (18.1%, n = 259) patients affected.[21,26] The most common mechanism of injury was RTA, followed by assault and falls, with 204 (78.8%, n = 259), 29 (11.2%, n = 259), and 22 (8.5%, n = 259) patients affected, respectively.[21] When examining associated injuries, Olusanya et al reported that 185 (71.4%, n = 259) patients suffered an associated head injury, with 115 (44.4%, n = 259) patients presenting with an isolated head injury, 60 (23.2%, n = 259) patients presenting with concomitant head and orthopedic injuries, and 10 (3.9%, n = 259) patients with concurrent head and thoracic injuries.[21] Similarly, Gurung et al reported that 414 (37.3%, n = 1110) and 324 (29.2%, n = 1110) patients with CMF trauma secondary to RTA alone presented with isolated maxillofacial and isolated neurologic injuries, respectively.[26]

Types of Soft Tissue Injury, Mandibular, and Midface Fractures

Several studies provided data describing the types of soft tissue injuries and fractures diagnosed in patients with CMF trauma (**Table 6**). Specifically, 4 (30.8%) studies report on the site or type of soft tissue injury.[21,22,26,29] Olusanya et al and Gurung et al stated that all patients included in their studies—1369 CMF trauma victims—experienced some soft-tissue injury.[21,26] The most common type was multiple superficial injuries, with 456 (41%, n = 1369) patients affected, followed by skin lacerations with 430 (31.4%, n = 1369) patients affected.[21,26] Singaram et al and Stanford-Moore et al reported 18 (6.7%, n = 267) and 8 (9.9%, n = 54) patients with CMF trauma who presented with concomitant soft tissue injury, respectively.[22,29]

Additionally, 4 (30.8%) studies reported on the type of mandibular fracture, with 1 (7.7%) providing data on the combinations of mandibular fractures reported.[21,22,26,29] Of 1690 patients across 4 studies, 779 (64.1%) sustained mandibular fractures.[21,22,26,29] Of the 2 studies providing data on the subtypes of mandibular fracture, parasymphyseal fractures were the most common, with 248 (37.4%, n = 663) patients affected.[21,26]

Further, 4 (30.8%) studies reported on the type of midface fracture, with 1 (7.7%) providing data on the combinations of midface fractures reported.[21,22,26,29] Out of 1690 patients across 4 studies, there were 521 (30.8%) midface fractures and 167 (9.9%) dentoalveolar fractures.[21,22,26,29] Zygomaticomaxillary complex (ZMC) fractures were the most common midface fractures, with 161 (30.9%, n = 521) patients affected.[21,22,26,29] Of those 161 ZMC fractures, 131 were isolated ZMC fractures, while 30 were ZMC fractures with a concomitant fracture as follows: Le Fort II, n = 18; Le Fort III, n = 8; Le Fort II and Le Fort III, n = 4.[21,22,26,29]

Treatment and Outcomes

Two (15.4%) studies provided information on CMF trauma treatment (**Table 7**). The most common treatments were closed reduction and immobilization (155 [29.5%, n = 526] patients), conservative management (145 [27.6%, n = 526] patients), and open reduction and internal fixation (ORIF) (103 [19.6%, n = 256] patients).[21,22] Only 1 (7.7%) study by Olusanya et al provided information on posttreatment outcomes.[21] They conducted a subjective assessment of patient satisfaction with aesthetic outcomes and occlusion after treatment. Most patients were very satisfied (70 [31.8%, n = 259]) or moderately satisfied (98 [44.5, n = 259]) with their aesthetic results.[21] Similarly, most patients were very satisfied (35 [38%, n = 259]) or moderately satisfied (53 [57.6%, n = 259]) with their occlusive result.[21]

Barriers to Care

Three (23.1%) studies report on barriers to care (**Table 8**).[21,25,29] Olusanya et al reported that 134 (51.7%, n = 259) patients first arrived at the hospital of study, with 71 (27.4%, n = 259) reporting to a private hospital, 16 (6.2%, n = 259) reporting to a primary health center, 24 (9.3%, n = 259) reporting to a secondary health center, and 14 (5.4%, n = 259) reporting to another tertiary health center.[21] Davé et al assessed the timing of injury of patients presenting to 4 different hospitals located in Nepal (n = 179), Rwanda (n = 452), Sierra Leone (n = 515), and Uganda (n = 267).[25] Of these patients, 244 (17.3%, n = 1413) reported CMF trauma

Table 5. Composite Data Illustrating the Mechanisms of Injury and Associated Injuries of Patients With CMF Trauma[20-32]

			Injuries											
				Mechanism of injury						Mechanism of injury				
Author(s) and year	Country/countries investigated	Sample size	Type of injury	RTA	Assault	Fall	Other	Total, n (%)	Associated injury	RTA	Assault	Fall	Other	Total, n (%)
Chrcanovic (2012)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Olusanya et al (2014)	Nigeria	N = 259	Soft tissue alone	72	6	2	2	82 (31.7)	None	27	7	7	0	41 (15.8)
			Mandibular fracture alone	52	1	6	0	59 (22.8)	Head injury alone	80	20	12	3	115 (44.4)
			Middle third fracture alone	29	11	7	0	47 (18.1)	Head injury and orthopedic injury	57	1	1	1	60 (23.2)
			Upper third fracture alone	22	2	6	0	30 (11.6)	Head injury and thoracic injury	10	0	0	0	10 (3.9)
			Mandibular and middle third fracture	27	9	1	2	(39 (15.1)	Orthopedic injury alone	16	0	2	0	18 (6.9)
			Upper third and middle third fracture	2	0	0	0	2 (0.8)	C-spine injury	18	0	0	0	18 (6.9)
			Total	204	29	22	4	259 (100.0)	Other	14	1	0	0	15 (5.8)
									Total	222	29	22	4	259 (100.0)
Singaram et al (2016)	India	N = 267	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shaye et al (2018)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shah et al (2019)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Davé et al (2019)	Nepal	N = 179	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Rwanda	N = 452	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Sierra Leone	N = 515	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Uganda	N = 267	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gurung et al (2019)	India	N = 1110	N/A	N/A	N/A	N/A	N/A	N/A	Isolated maxillofacial injury	414				37.3
									Neurologic	324				29.2
									Orthopedic	238				21.4
									Ophthalmic	134				12.1
									Tooth luxation	313				47.4
									Tooth fracture	239				36.2
									Tooth avulsion	109				16.5

(*continued*)

Table 5. (continued)

			Injuries											
				Mechanism of injury						Mechanism of injury				
Author(s) and year	Country/countries investigated	Sample size	Type of injury	RTA	Assault	Fall	Other	Total, n (%)	Associated injury	RTA	Assault	Fall	Other	Total, n (%)
Wu J. et al (2021)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wu C. et al (2021)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stanford-Moore et al (2022)	Rwanda	N = 54	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Adeleke et al (2023)	Sub-Saharan Africa[a]	N = 7317	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shaye et al (2023)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kantar et al (2023)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Abbreviations: CMF, craniomaxillofacial; RTA, road traffic accident.

[a]This scoping review included 30 publications representing the following countries: Nigeria (n = 10), Tanzania (n = 5), Kenya (n = 4), Uganda (n = 3), South Africa (n = 3), Rwanda (n = 2), Somalia (n = 1), Ethiopia (n = 1), and Cameroon (n = 1).

within the past month compared to 851 (60.2%, n = 1413) patients who reported CMF trauma >12 months ago.[25] Additionally, when assessed on reasons for not receiving care, 424 (30.0%, n = 1413) patients reported no trust in health facilities or no skilled physicians/nurses available.[25]

Stanford-Moore et al identified that 45 (83.3%, n = 54) patients did not have a delay in presentation to the hospital.[29] However, of the 9 patients who did report a delay in presentation, 2 (22.2%) cited delayed diagnosis, 3 (33.3%) cited delayed referral, 1 (11.1%) cited delayed transfer, and 3 (33.3%) cited economic hardship. Interestingly, while 83.3% of patients denied a delay in presentation to the hospital, 42 (77.8%, n = 54) cited a delay in treatment after presentation to the hospital.[29] These delays were most commonly due to plating material unavailability (23 [54.8%, n = 54] patients) and surgeon unavailability (15 [35.7%, n = 54] patients).[29] Similarly, 39 (72.2%, n = 54) patients presented to the hospital within 1 day of their injuries, but 42 (77.8%, n = 54) patients experienced a delay >4 days between arrival to the hospital and treatment with 14 (26.0%, n = 54) patients experiencing a delay >7 days.[29]

Finance

Three (23.1%) studies report on the financial aspects of CMF trauma management in LMICs (**Table 9**).[25,30,31] Davé et al found that, of the 1413 patients evaluated from Nepal, Rwanda, Sierra Leone, and Uganda, 307 (21.7%) cited no money for health care or transportation.[25] Adeleke et al and Shaye et al investigated the management cost of CMF trauma in LMICs in USD.[30,31] Adeleke et al reported a cost range between $200 and $469.[30] Shaye et al calculated the average cost of plating materials across 14 LMICs to be $238.38 and a cost burden to the patient of 10.2%, with cost burden defined as the cost of plating materials divided by the GDP per capita.[31]

Discussion

Demographics

CMF trauma victims are disproportionately of low and intermediate SES, illiterate, and from rural communities. Of note, while 8 studies (61.5%) reported on demographic data, only 3 (23.1%) provided data on direct or indirect indicators of SES, including the location of trauma. As such, the relationship between SES and CMF trauma remains poorly defined. Future investigations should focus on country-specific data to describe the relationship among SES, literacy status, geographic location, and CMF trauma.

Etiology and Complicating Factors Affecting Trauma

The most common cause of CMF trauma in LMICs is RTAs, followed by assault, falls, and other causes of trauma. This is supported by investigations outside of the scope of our review. For example, Romeo et al performed a prospective, multicenter epidemiologic study investigating

Table 6. Composite Data Illustrating Types of Soft Tissue Injury, Mandibular, and Midface Fractures in CMF Trauma[20-32]

			Injuries											
Author(s) and year	Country/countries investigated	Sample size	Site of soft tissue injury	n (%)	Type of soft tissue injury	n (%)	Type of mandibular fracture	n (%)	Combination of mandibular fractures	n (%)	Type of midface fracture	n (%)	Combination of midface fractures	n (%)
Chrcanovic (2012)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Olusanya et al (2014)	Nigeria	N = 259	Cheek and zygomaticotemporal region	103 (39.8)	Contusion/ Abrasion	115 (44.4)	Dentoalveolar fracture	12 (4.6)	Parasymphyseal and body fractures	5 (1.9)	Dentoalveolar fracture	9 (3.5)	Le Fort II and ZMC	18 (7.0)
			Forehead	58 (23.4)	Laceration	103 (39.8)	Parasymphyseal fracture	17 (6.6)	Parasymphyseal and ramus fractures	7 (2.7)	Le Fort I	5 (1.9)	Le Fort II and NOE	5 (1.9)
			Periorbital region	32 (12.4)	Degloving injury	28 (10.8)	Body fracture	32 (12.4)	Parasymphyseal and condylar fractures	5 (1.9)	Le Fort II	8 (3.1)	Le Fort III and ZMC	8 (3.1)
			Lip	30 (11.6)	Avulsion	15 (5.8)	Ramus fracture	15 (5.8)	Symphyseal and condylar fractures	2 (0.8)	Le Fort III	5 (1.9)	Le Fort I and Le Fort II	6 (2.3)
			Nose	17 (6.6)	Total	261 (100)	Condylar fracture	3 (1.2)	Total	19 (7.3)	ZMC fracture	11 (4.2)	Le Fort II, Le Fort III, and ZMC	4 (1.5)
			Ears	10 (3.9)			Combination of fractures	19 (7.3)			Nasoorbitalethmoidal fracture	9 (3.5)	Total	41 (15.8)
			Chin	9 (3.5)			Total	98 (37.8)			Combination of fractures	41 (15.8)		
			Total	259 (100.0)							Total	88 (34.0)		
Singaram et al (2016)	India	N = 267	Soft tissue injury	18 (6.7)	N/A	N/A	Mandible fracture	88 (33.0)	N/A	N/A	Skull and facial bone fracture	21 (7.9)	N/A	N/A
											Nasal bone fracture	17 (6.4)		
											Malar bone and maxilla fracture	112 (41.9)		
											Orbital floor fracture	23 (8.6)		
											Tooth fracture	70 (26.2)		
Shaye et al (2018)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shah et al (2019)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(*continued*)

Table 6. (continued)

			Injuries											
Author(s) and year	Country/countries investigated	Sample size	Site of soft tissue injury	n (%)	Type of soft tissue injury	n (%)	Type of mandibular fracture	n (%)	Combination of mandibular fractures	n (%)	Type of midface fracture	n (%)	Combination of midface fractures	n (%)
Davé et al (2019)	Nepal	N = 179	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Rwanda	N = 452	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Sierra Leone	N = 515	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Uganda	N = 267	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gurung et al (2019)	India	N = 1110	N/A	N/A	Laceration	327 (29.5)	Mandible	565 (64.5)	N/A	N/A	Midface	226 (25.8)	N/A	N/A
					Abrasion	194 (17.5)	Symphysis	8 (1.4)			Le Fort I	19 (8.4)		
					Contusion	133 (12.0)	Parasymph-ysis	231 (40.9)			Le Fort II	40 (17.7)		
					Multiple superficial injuries	456 (41.0)	Body	68 (12.0)			Le Fort III	6 (2.7)		
					Total	1110 (100)	Angle	98 (17.3)			ZMC	112 (49.6)		
							Ramus	10 (1.8)			Nasal bone	49 (21.7)		
							Condyle	143 (25.3)			Dentoalveolar	86 (9.8)		
							Coronoid	7 (1.3)						
Wu J et al (2021)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wu C. et al (2021)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stanford-Moore et al (2022)	Rwanda	N = 54	N/A	N/A	Soft tissue injury	8 (9.9)	Mandible	28 (34.6)	N/A	N/A	Eye injury	3 (3.7)	N/A	N/A
											Le Fort I	3 (3.7)		
											Le Forte II	7 (8.6)		
											Le Forte III	4 (4.9)		
											Maxillary	2 (2.5)		
											Nasal bone	4 (4.9)		
											Zygomatic	8 (9.9)		
											Orbital	4 (4.9)		
											Frontal bone	8 (9.9)		
											Dental injury	2 (2.5)		
Adeleke et al (2023)	Sub-Saharan Africa[a]	N = 7317	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shaye et al (2023)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kantar et al (2023)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Abbreviations: CMF, craniomaxillofacial; NOE, naso-orbito-ethmoidal; ZMC, zygomaticomaxillary complex.

[a]This scoping review included 30 publications representing the following countries: Nigeria (n = 10), Tanzania (n = 5), Kenya (n = 4), Uganda (n = 3), South Africa (n = 3), Rwanda (n = 2), Somalia (n = 1), Ethiopia (n = 1), and Cameroon (n = 1).

Table 7. Composite Data Illustrating the Treatment and Outcomes of Patients With CMF Trauma[20-32]

			Treatment		Outcomes			
Author(s) and year	Country/countries investigated	Sample size	Type of treatment	n (%)	Aesthetic	n (%)	Occlusion	n (%)
Chrcanovic (2012)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Olusanya et al (2014)	Nigeria	N = 259	Conservative	62 (23.9)	Very satisfied	70 (31.8)	Very satisfied	35 (38.0)
			Soft tissue repair only	66 (25.5)	Moderately satisfied	98 (44.5)	Moderately satisfied	53 (57.6)
			Closed reduction and immobilization	81 (31.3)	Fairly satisfied	32 (14.5)	Fairly satisfied	4 (4.3)
			Open reduction and immobilization	11 (5.8)	Not satisfied	20 (9.1)	Total	92 (100)
			None due to lack of funds	21 (8.1)	Total	220 (100)	Not applicable[a]	167
			Died before OMS definitive treatment	11 (5.8)				
			Discharged against medical advice	7 (2.7)				
			Total	259 (100)				
Singaram et al (2016)	India	N = 267	Conservative management	83 (31.1)	N/A	N/A	N/A	N/A
			Closed reduction	74 (27.7)				
			Open reduction and internal fixation	92 (34.5)				
			Wound debridement	18 (6.7)				
			Total	267 (100.0)				
Shaye et al (2018)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shah et al (2019)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Davé et al (2019)	Nepal	N = 179	N/A	N/A	N/A	N/A	N/A	N/A
	Rwanda	N = 452	N/A	N/A	N/A	N/A	N/A	N/A
	Sierra Leone	N = 515	N/A	N/A	N/A	N/A	N/A	N/A
	Uganda	N = 267	N/A	N/A	N/A	N/A	N/A	N/A
Gurung et al (2019)	India	N = 1110	N/A	N/A	N/A	N/A	N/A	N/A
Wu J. et al (2021)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wu C. et al (2021)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stanford-Moore et al (2022)	Rwanda	N = 54	N/A	N/A	N/A	N/A	N/A	N/A

(*continued*)

Table 7. (continued)

Author(s) and year	Country/countries investigated	Sample size	Treatment		Outcomes			
			Type of treatment	n (%)	Aesthetic	n (%)	Occlusion	n (%)
Adeleke et al (2023)	Sub-Saharan Africa[b]	N = 7317	N/A	N/A	N/A	N/A	N/A	N/A
Shaye et al (2023)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kantar et al (2023)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Abbreviations: CMF, craniomaxillofacial; OMS, oral maxillofacial surgery.
[a]Not applicable to patients who had conservative treatment and soft tissue repair alone and/or patients not treated for the following reasons: lack of funds, patients discharged against medical advice, and patients who died.
[b]This scoping review included 30 publications representing the following countries: Nigeria (n = 10), Tanzania (n = 5), Kenya (n = 4), Uganda (n = 3), South Africa (n = 3), Rwanda (n = 2), Somalia (n = 1), Ethiopia (n = 1), and Cameroon (n = 1).

the characteristics of CMF trauma across 14 maxillofacial surgery departments over 5 continents (Africa, the Americas, Asia, Europe, and Oceania). The most common cause of CMF trauma in younger populations (≤65 years) in LMICs (African and Asian centers) was RTAs, while the most common cause in older populations (≥65 years) in HICs (European, Australian, and Brazilian centers) was ground level falls.[36]

Appreciating the relationship between the etiology of CMF trauma and patient demographics is essential to developing community-specific solutions for CMF trauma prevention. For example, given the greater proportion of young CMF trauma victims secondary to RTAs in LMICs, LMIC hospital systems and ministries of health may conduct further investigations into the prevention and management of road traffic safety, trauma systems management, and hospital equipment and staffing to care for CMF trauma victims secondary to RTAs. The management of CMF trauma must be context-specific, requiring an intimate understanding of the local population.

Additionally, 10 (76.9%) and 11 (84.6%) of the 13 studies in our review did not report seat belt/helmet use or alcohol intoxication, respectively. This lack of reporting highlights the importance of recognizing additional factors contributing to CMF trauma in these datasets. Analysis of complicating factors affecting CMF trauma is another underrepresented area for future investigation. Subsequent findings may be used to inform revisions to road safety legislation, especially given that 44.9% of patients with CMF trauma were not seat-belted or helmeted during their RTA.[21,26] Improving compliance with road safety legislation represents a low-cost and potentially highly effective means of reducing CMF trauma secondary to RTAs, a conclusion supported by Chrcanovic et al in their systematic review investigating the factors influencing maxillofacial fractures in LMICs.[20] Such interventions must be implemented in a community-specific fashion, accounting for the unique cultural barriers, attitudes, and behaviors that may limit adherence to governmentally mandated preventative efforts.

Mechanisms of Injury and Associated Injuries

Of the 13 studies in our review, 11 (84.6%) do not report the type of injury, associated mechanism, or concomitant injuries associated with CMF trauma. This represents a significant knowledge gap in the etiology of CMF trauma in LMICs. Additional country-specific investigations are required to delineate the relationships between the kinds of CMF trauma, associated injuries, and their mechanisms of trauma. Identifying patterns of injury and common mechanisms may guide ministries of health toward actionable solutions to improve outcomes for patients with CMF trauma. This may be enacted through injury prevention and resource allocation to ensure the

Table 8. Composite Data Illustrating the Barriers to Care Encountered by Patients With CMF Trauma[20-32]

			Barriers to care									
Author(s) and year	Country/ countries investigated	Sample size	First health facility visited posttrauma	n (%)	Delayed presentation to the hospital	n (%)	Delayed treatment after presentation	n (%)	Timing of Injury	n (%)	Time between arrival to hospital and treatment	n (%)
Chrcanovic (2012)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Olusanya et al (2014)	Nigeria	N = 259	Hospital of study	134	(51.7)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A			Private hospital	71	(27.4)							
			Primary health center	16	(6.2)							
			Secondary health center	24	(9.3)							
			Other tertiary health center	14	(5.4)							
Singaram et al (2016)	India	N = 267	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shaye et al (2018)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shah et al (2019)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Davé et al (2019)	Nepal	N = 179	N/A	N/A	N/A	N/A	N/A	N/A	In the last month	44 (22.39)	N/A	N/A
									During the past 12 mo	19 (10.61)		
									Longer than 12 mo ago	116 (64.8)		
									Total	179 (100)		
	Rwanda	N = 452	N/A	N/A	N/A	N/A	N/A	N/A	In the last month	56 (12.39)	N/A	N/A
									During the past 12 mo	99 (21.9)		
									Longer than 12 mo ago	297 (65.71)		

(*continued*)

Table 8. (continued)

			Barriers to care									
Author(s) and year	Country/ countries investigated	Sample size	First health facility visited posttrauma	n (%)	Delayed presentation to the hospital	n (%)	Delayed treatment after presentation	n (%)	Timing of Injury	n (%)	Time between arrival to hospital and treatment	n (%)
	Sierra Leone	N = 515	N/A	N/A	N/A	N/A	N/A	N/A	Total In the last month During the past 12 mo Longer than 12 mo ago	452 (100) 115 (22.37) 125 (24.32) 274 (53.31)	N/A	N/A
	Uganda	N = 267	N/A	N/A	N/A	N/A	N/A	N/A	Total In the last month During the past 12 mo Longer than 12 mo ago	514 (100) 29 (10.86) 56 (20.97) 182 (68.16)	N/A	N/A
Gurung et al (2019)	India	N = 1110	N/A	N/A	N/A	N/A	N/A	N/A	Total N/A	267 (100) N/A	N/A	N/A
Wu J. et al (2021)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wu C. et al (2021)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stanford-Moore et al (2022)	Rwanda	N = 54	N/A	N/A	No	45 (83.3)	No	12 (22.2)	<1 d	39 (72.2)	<1 d	3 (5.6)
					Yes, delayed diagnosis	2 (22.2)	Yes, admission to ICU	2 (4.8)	1-3 d	6 (11.1)	1-3 d	9 (16.7)
					Yes, delayed referral	3 (33.3)	Yes, associated injury	1 (2.4)	4-7 d	6 (11.1)	4-7 d	28 (51.9)

Table 8. (continued)

			Barriers to care									
Author(s) and year	Country/ countries investigated	Sample size	First health facility visited posttrauma	n (%)	Delayed presentation to the hospital	n (%)	Delayed treatment after presentation	n (%)	Timing of Injury	n (%)	Time between arrival to hospital and treatment	n (%)
					Yes, delayed transfer	1 (11.1)	Yes, material unavailability	23 (54.8)	>7 d	3 (5.6)	>7 d	14 (26.0)
					Yes, economic hardship	3 (33.3)	Yes, neglected	1 (2.4)				
							Yes, surgeon unavailable	15 (35.7)				
Adeleke et al (2023)	Sub-Saharan Africa[a]	N = 7317	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shaye et al (2023)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kantar et al (2023)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Abbreviations: CMF, craniomaxillofacial; ICU, intensive care unit.

[a]This scoping review included 30 publications representing the following countries: Nigeria (n = 10), Tanzania (n = 5), Kenya (n = 4), Uganda (n = 3), South Africa (n = 3), Rwanda (n = 2), Somalia (n = 1), Ethiopia (n = 1), and Cameroon (n = 1).

Table 9. Composite Data Illustrating the Financial Barriers Encountered by Patients With CMF Trauma[20-32]

Author(s) and year	Country/countries investigated	Sample size	Finance		
			Reason for not receiving care	n (%)	Cost of management (USD)
Chrcanovic (2012)	N/A	N/A	N/A	N/A	N/A
Olusanya et al (2014)	Nigeria	N = 259	N/A	N/A	N/A
Singaram et al (2016)	India	N = 267	N/A	N/A	N/A
Shaye et al (2018)	N/A	N/A	N/A	N/A	N/A
Shah et al (2019)	N/A	N/A	N/A	N/A	N/A
Davé et al (2019)	Nepal	N = 179	No money for health care	22 (17.6)	N/A
			No money for transportation	1 (0.8)	
			No time	2 (1.6)	
			No trust in health facility	15 (12)	
			No skilled physicians/nurses available	24 (19.2)	
			No need	61 (48.8)	
			Total	125 (100)	
	Rwanda	N = 452	No money for health care	61 (14.81)	N/A
			No money for transportation	1 (0.24)	
			No time	9 (2.18)	
			No trust in health facility	44 (10.68)	
			No skilled physicians/nurses available	270 (65.53)	
			No need	27 (6.55)	
			Total	412 (100)	
	Sierra Leone	N = 515	No money for health care	187 (46.52)	N/A
			No money for transportation	2 (0.5)	
			No time	12 (2.99)	
			No trust in health facility	19 (4.73)	
			No skilled physicians/nurses available	30 (7.46)	
			No need	152 (37.81)	
			Total	402 (100)	
	Uganda	N = 267	No money for health care	32 (37.65)	N/A
			No money for transportation	1 (1.18)	
			No time	3 (3.53)	
			No trust in health facility	8 (9.41)	
			No skilled physicians/nurses available	14 (16.47)	
			No need	27 (31.76)	
			Total	85 (100)	

Table 9. (continued)

Author(s) and year	Country/countries investigated	Sample size	Finance		
			Reason for not receiving care	n (%)	Cost of management (USD)
Gurung et al (2019)	India	N = 1110	N/A	N/A	N/A
Wu J. et al (2021)	N/A	N/A	N/A	N/A	N/A
Wu C. et al (2021)	N/A	N/A	N/A	N/A	N/A
Stanford-Moore et al (2022)	Rwanda	N = 54	N/A	N/A	N/A
Adeleke et al (2023)	Sub-Saharan Africa[a]	N = 7317	N/A	N/A	Range: $200-$469
Shaye et al (2023)	N/A	N/A	N/A	N/A	Average of 14 LMICs: $238.38
Kantar et al (2023)	N/A	N/A	N/A	N/A	N/A

Abbreviations: CMF, craniomaxillofacial; LMIC, low- and middle-income countries.
[a]This scoping review included 30 publications representing the following countries: Nigeria (n = 10), Tanzania (n = 5), Kenya (n = 4), Uganda (n = 3), South Africa (n = 3), Rwanda (n = 3), Somalia (n = 2), Ethiopia (n = 1), and Cameroon (n = 1).

proper materials and personnel are present at hospitals to manage the most common presentations of CMF trauma.

Types of Soft Tissue Injury, Mandibular, and Midface Fractures

Despite our review's robust dataset providing detailed information regarding the types and combinations of mandibular and midface fractures, none of the 13 studies provided information regarding the diagnostic techniques used. Shah et al state that, given hospital resource constraints and lack of patient financial resources, the diagnosis of CMF trauma in LMICs may be limited to plain radiographs because computed tomography is not readily available in all medical centers. Even when available, many patients may be unable to afford advanced imaging.[24] None of the studies in the current literature have investigated the relationship between CMF trauma diagnosis and the associated imaging technology, the treatment course provided based on initial imaging assessment, and subsequent posttreatment outcomes. CMF trauma care would benefit from investigating the relationship between diagnostic imaging modalities, treatment course selected, and posttreatment outcomes.

Treatment and Outcomes

There is a significant lack of data in the current literature describing the postoperative course of patients with CMF trauma in LMICs. None of the articles in our review provided information on postoperative complications, length of hospitalization, total cost of hospitalization and treatment, rates of return to the hospital, rates of postoperative clinic follow-up, and quality of reconstruction at predefined postoperative endpoints. Further, the included articles did not discuss the physician workforce, operating room availability, or types and availability of plating materials. Therefore, it is impossible to appreciate the external factors influencing clinical decision-making using the currently available data. Further studies are needed to investigate the specific details of the treatment and postoperative outcomes of CMF trauma in LMICs.

Barriers to Care

Two (15.4%) studies describe the implementation of solutions to address barriers to care (**Table 2**). In 2018, Shaye et al partnered with health professionals from LMICs to develop a 2-part facial injuries training curriculum based on the clinical needs of the LMIC providers. Pre- and postcourse assessments were created and implemented to evaluate progress. After completing both parts of the course, mean competency scores improved from 49.3% to 92.9%.[23] Backward planning curriculum development, as demonstrated by this course, may improve physician competence in managing CMF trauma.

Similarly, in 2023, Kantar et al developed and hosted an international comprehensive cleft care workshop that reached 489 participants representing 70 countries over 5 continents. The postworkshop analysis found that 96.4% of participants reported improved awareness and capacity for managing cleft care and willingness to participate in a similar workshop again.[32]

Solutions described by Kantar et al and Shaye et al demonstrate the potential for community-specific strategies to improve access to educational resources, thereby bolstering the CMF trauma workforce in LMICs. Further studies are needed to investigate the specific barriers to care, particularly barriers that impact patients after their initial presentation to the hospital. Country-specific analyses will provide the foundational objective data to develop novel interventions to eliminate barriers to CMF trauma care in LMIC communities.

Finance

The substantial difference between the cost burden in LMICs and HICs illustrates a significant barrier to treatment. The catastrophic expenditure associated with the cost of essential medical equipment prevents patients with CMF trauma in LMICs from receiving standard-of-care therapy. Despite these data, 10 (76.9%) of the 13 studies in this scoping review did not report any information on the cost of care. Shah et al report that, in low-resource settings, wire osteosynthesis is a cost-effective way of treating facial fractures but carries a 5% to 12% infection rate.[24] In a recent biomechanical force analysis, Shaye et al report that figure-of-eight interosseous wiring provides significant stability to a mandibular fracture.[37] Figure-of-eight interosseous wiring provides stability that compares favorably but is not superior to the use of plates and screws.[37] Intermediate measures like the use of interosseous wiring may be used until standard-of-care therapy for CMF trauma becomes affordable in LMICs. Further investigations to quantify financial barriers and investigate potential solutions are needed to make the timely and cost-effective management of CMF trauma more accessible to patients living in LMICs.

Limitations of This Review

While the evidence summarized in this scoping review is compelling, limitations remain that are important to address. This review contains a small number of publications, with 13 meeting the inclusion criteria. The articles screened were from the electronic, English-language literature, which may have excluded additional high-quality investigations. Additionally, the studies meeting inclusion criteria have different designs and evidence levels. While the small number of publications on this topic may limit this study's power, it highlights the need for more attention directed at evidence-based management of CMF trauma in LMICs. Finally, the relationship between ORIF material costs and GDP per capita only functions as a proxy measure of median income and does not fully capture the cost burden or complete economic impact of CMF trauma care on patients in low-resource settings. A targeted review of the cost burden of CMF trauma diagnosis, treatment, and management would be valuable for providing a comprehensive description of the economic impact on LMIC communities.

Conclusion

CMF trauma remains a significant cause of global morbidity, yet there remains a lack of high-quality, CMF trauma-specific data in LMICs. Country-specific investigations are required to enhance knowledge and inform novel interventions. Implementing policy change must be community-specific and account for unique cultural barriers, attitudes, and behaviors to maximize patient care outcomes.

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Author Contributions

Zachary Elwell, created the study design and contributed significantly to all manuscript sections, reviewed the literature, analyzed the data, drew original conclusions, and created original figures and tables; **Estephania Candelo**, contributed to the study design, specifically the methodology, contributed significantly to all manuscript sections, and offered significant edits to the early and final drafts of the manuscript; **Tarika Srinivasan**, contributed significantly to all manuscript sections and offered significant edits to the early and final drafts of the manuscript, particularly the organization of the results and discussion sections; **Sarah Nuss**, contributed to all manuscript sections and offered significant edits to the early and final drafts of the manuscript, particularly the presentation of information in the results and discussion sections; **Nader Zalaquett**, contributed to the study design, specifically the methodology, contributed significantly to all manuscript sections, and offered significant edits of the early and final drafts of the manuscript; **Gratien Tuyishimire**, contributed significantly to all manuscript sections, offered specific insight into CMF trauma care in Rwanda, and contributed significant edits to the final drafts of the manuscript; **Isaie Ncogoza**, contributed significantly to all manuscript sections, offered specific insight into CMF trauma care in Rwanda, and contributed significant edits to the final drafts of the manuscript; **Patrick Marc Jean-Gilles**, contributed significantly to all manuscript sections, offered specific insight into CMF trauma care in Haiti, and contributed significant edits to the final drafts of the manuscript; **Jacob Ndas Legbo**, contributed significantly to all manuscript sections, offered specific insight into CMF trauma care in Nigeria, and contributed significant edits to the final drafts of the manuscript; **Travis Tollefson**, contributed significantly to the initial structure, methodology, and organization of the manuscript, provided edits from an editorial standpoint, and contributed to the final drafts of the manuscript; **David Shaye**,

senior author on the project, gathered a diverse authorship team from both high-income countries and low- and middle-income countries, reviewed the literature, analyzed the data, and contributed significant edits to all manuscript sections.

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Supplemental Material

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