



Review article

Prehospital care for traumatic spinal cord injury by first responders in 8 sub-Saharan African countries and 6 other low- and middle-income countries: A scoping review

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ABSTRACT

Introduction: Traumatic spinal cord injury (TSCI) constitutes a considerable portion of the global injury burden, disproportionately affecting low- and middle-income countries (LMICs). Prehospital care can address TSCI morbidity and mortality, but emergency medical services are lacking in LMICs. The current standard of prehospital care for TSCI in sub-Saharan Africa and other LMICs is unknown.

Methods: This review sought to describe the state of training and resources for prehospital TSCI management in sub-Saharan Africa and other LMICs. Articles published between 1 January 1995 and 1 March 2020 were identified using PMC, MEDLINE, and Scopus databases following PRISMA-ScR guidelines. Inclusion criteria spanned first responder training programs delivering prehospital care for TSCI. Two reviewers assessed full texts meeting inclusion criteria for quality using the Newcastle-Ottawa Scale and extracted relevant characteristics to assess trends in the state of prehospital TSCI care in sub-Saharan Africa and other LMICs.

Results: Of an initial 482 articles identified, 23 met inclusion criteria, of which ten were set in Africa, representing eight countries. C-spine immobilization precautions for suspected TSCI patients is the most prevalent prehospital TSCI intervention for and is in every LMIC first responder program reviewed, except one. Numerous first responder programs providing TSCI care operate without C-collar access (n = 13) and few teach full spinal immobilization (n = 5). Rapid transport is most frequently reported as the key mortality-reducing factor (n = 11). Despite more studies conducted in the Southeast Asia/Middle East (n = 13), prehospital TSCI studies in Africa are more geographically diverse, but responder courses are shorter, produce fewer professional responders, and have limited C-collar availability.

Discussion: Deficits in training and resources to manage TSCI highlights the need for large prospective trials evaluating alternative C-spine immobilization methods for TSCI that are more readily available across diverse LMIC environments and the importance of understanding resource variability to sustainably improve prehospital TSCI care.

African relevance

- First responders in sub-Saharan Africa have limited access to C-collars, considered useful for spinal immobilization in the prehospital

setting, with just two of ten studies included in the scoping review reporting availability for TSCI in the prehospital setting in Africa

- First responder courses in sub-Saharan Africa produce fewer professional responders than other LMIC counterpart courses and are shorter in duration relative to those led in other LMICs.

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- Deficits in training and resources to effectively manage TSCI in sub-Saharan Africa suggest alternative C-spine immobilization methods that are more readily available across diverse LMIC environments should be evaluated, demonstrating the importance of understanding resource variability in local contexts to sustainably improve pre-hospital TSCI care in sub-Saharan Africa and other LMICs.

Introduction

Low- and middle-income countries (LMICs) disproportionately bear the brunt of injury; >90% of the 5.8 million annual deaths due to injury occur in LMICs [1]. Mortality from injury accounts for 10% of the world's deaths, a volume that is 32% greater than the deaths from malaria, tuberculosis, and HIV/AIDS combined [1]. Though traumatic spinal cord injury (TSCI), which is defined as damage to the spinal cord nerve tissue, and vertebral or ligamentous injuries that comprise spinal cord integrity, is a significant contributor to the global burden of injury, epidemiological data regarding TSCI in LMICs are limited [2]. The 2019 Global Burden of Disease Traumatic Brain Injury and Spinal Cord Injury Collaborators group found that TSCI constitutes a considerable portion of the global injury burden, with almost one million new TSCI cases in 2016 alone, caused primarily by falls and road traffic injuries [3]. TSCI morbidity and mortality is higher in low- and middle-income African countries than high-income countries, due to inadequate prehospital care, limited availability of inpatient specialty TSCI care, and limited post-TSCI rehabilitation [2]. Regional trends suggest that with continued motorization across LMICs, increasing road traffic injuries will add to the future global TSCI burden [4].

The excess burden of TSCI in LMICs starts before patients even arrive at the hospital. Over half of the global population lives in areas without formal emergency medical services (EMS) [5], including over 90% of the African population [6]. As a result, TSCI patients in LMICs rarely receive spinal immobilization with a c-collar or backboard and rarely receive transport by trained personnel [7]. Well-organized and efficient pre-hospital transport systems and prehospital management after injury are essential for increasing survival [2,8]. However, EMS development has been incongruous and inconsistent across LMICs [9], and there is a paucity of information on prehospital training programs and emergency transport of patients with TSCI and its relation to mortality [2,10].

Deficits in prehospital care for TSCI in sub-Saharan Africa and other resource-limited LMICs are poorly defined. The aim of this scoping review is to broadly examine the existing literature on training programs for prehospital first responders to inform future priorities in prehospital training for TSCI care in resource-limited settings. Our objective is to review and describe the state of training and resources for management of TSCI in sub-Saharan Africa and other LMICs in the prehospital setting.

Methods

A scoping review was conducted of published works regarding pre-hospital TSCI interventions in LMICs. Studies focusing on prehospital care, defined as care provided in the immediate setting of an injury event or en route to definitive care, and emergency medical services were selected. Studies describing both professional and lay first responders operating in the prehospital setting were included in the review, while studies focused on physician interventions or not conducted with a focus in one or more LMICs were excluded. Professional first responders (EMS personnel) are defined as individuals with previous training whose occupation (full-time or part-time) is to respond to the injured, including patient transport from injury scenes to definitive care. Lay first responders (LFRs) are not first responders by occupation and include law enforcement (police officers), transportation providers, or community members. LFRs are often not expected to secure transportation for injured patients but instead to provide initial stabilization and call for additional help. For the purpose of this review, LMICs were classified as countries with GNI of \$12,615 per capita or less as defined by the World

Bank [11].

All studies included in the review were published in English (Table 1). Under these criteria, any description of a discrete prehospital training program, both quantitative and qualitative, that included mention of care for TSCI was included. Following a predefined protocol, PMC, MEDLINE, and Scopus databases were all searched for manuscripts published between January 1st, 1995 and October 1st, 2020 using the following keywords: “(spinal cord injury OR spinal trauma OR cervical OR spine) AND (low- and middle-income country OR LMIC OR developing country OR developing countries OR low- and middle-income countries) AND (prehospital OR emergency medical services OR first responder OR first aid).” This search comprised the full search strategy of this review so as to avoid the introduction of reviewer bias.

Study selection and data extraction

Two authors and independently searched PMC, MEDLINE, and Scopus databases. Both authors independently performed study selection and extracted data. All manuscripts matching search keywords were compiled in Microsoft Excel and duplicates were removed electronically before assessing abstracts. Titles, abstracts, and full texts were reviewed independently in duplicate where any discrepancies were resolved via discussion until a consensus was reached. Full texts were then reviewed together by both authors prior to final inclusion.

Data were similarly extracted by two authors, and compiled in Microsoft Excel (Microsoft Corporation, Redwood WA), and analyzed in R (R Foundation for Statistical Computing, Vienna, Austria). Extracted data consisted of: authors and study title, journal, year of publication, setting, occupation of responders providing prehospital TSCI care and level of training (“bystander training” or “professional EMS”), training protocol, method of prehospital care provision, equipment used in the provision of prehospital care, length of training, and clinical impact of prehospital interventions.

Critical appraisal

Due to the heterogeneous nature of EMS and related research in LMICs, authors determined that a critical appraisal of the quality of included studies would allow for a better understanding of present knowledge gaps, informing further study. Each eligible manuscript was scored using the Newcastle-Ottawa scale to assess source reliability and risk of bias (Table 2) [30]. The scored domains consisted of “Selection,” assessing the representativeness of each nonrandomized cohort, “Comparability,” assessing the inclusion of experimental controls for each study's design, and “Outcome,” assessing the adequacy of author assessment and follow up. Study appraisal followed an identical protocol as study selection, two authors scored each manuscript and discrepancies were resolved via discussion until consensus was reached.

Results

The initial search resulted in 482 articles between PMC, MEDLINE,

Table 1
Inclusion and exclusion criteria for scoping review.

	Inclusion criteria	Exclusion criteria
Location	Low- and middle-income countries	High-income countries
Setting	Prehospital	Hospital
Clinical scope	Traumatic spinal cord injury (TSCI)	Not related to TSCI
Care provider	Non-physician	Physician ^a
Language	English	Not English
Dates	Jan. 1st, 1995 to Mar. 1st, 2020	Before Jan. 1st, 1995
Study types	All study types	

^a Any individual having received a degree of: MD, DO, DM, DS, MSurg, MBBS, DCM, DMSc, or MCM.

Table 2
Characteristics of EMS programs reviewed.

Program setting	Level of responder training	Responder occupation	Length of responder training	TSCI precautions taken	Equipment used	Newcastle-Ottawa score ^a	Source of funding	Study summary
<i>Sub-Saharan African countries</i>								
Chad [44]	Bystander training	Drivers	5 h	C-spine immobilization, transportation	Towel	4, 1, 3	Academic	Cohort of motorcycle taxi drivers trained in short course and assessed as lay first responders via pre/post assessment and skill usage
Ghana [12]	Bystander training	Drivers	6 h	C-spine immobilization, transportation	Towel	NA	Academic, governmental	Cohort of commercial drivers trained in short course and assessed as lay first responders via survey
Ghana [19]	Bystander training	Drivers	6 h	C-spine immobilization, extrication	None	3, 1, 2	Academic, governmental	Cohort of commercial drivers trained in short course and assessed as lay first responders via self report
Madagascar [28]	Bystander training	Drivers	1 day	C-spine immobilization, thoracic and lumbar spinal immobilization, transportation	NA	1, 0, 1	Academic, NGO	Cohort of commercial drivers trained in day-long course as lay first responders and provided qualitative feedback
Mozambique [29]	Bystander training	Varying	1 day	C-spine immobilization, transportation	Cervical collar	3, 1, 3		Cohort of civilians and hospital personnel trained in day-long course, assessed as first responders via pre/post assessment
Nigeria [23]	Bystander training, professional EMS	Varying	NA	C-spine immobilization, thoracic and lumbar spinal immobilization, transportation	Backboard	NA	Hospital, NGO	Robust formal EMS developed to address road traffic injury and assessed through qualitative analysis
Nigeria [2]	Bystander training	Varying	1 day	Transportation	None	2,1,2	Academic	Prehospital emergency transport for patients with TSCI analyzed with respect to six-week mortality
Sierra Leone [45]	Bystander training	Varying	5 h	C-spine immobilization, transportation	Towel	3,1,3	Academic, NGO	Cohort of civilians trained in short course, assessed as lay first responders via pre/post assessment and skill usage
Tanzania [14]	Bystander training, professional EMS	Varying	Varying ^b	C-spine immobilization, transportation	NA	3,0,3	NGO	Several courses of varying length to train both professional and lay first responders developed and qualitatively assessed
Uganda [20]	Bystander training	Drivers	5 h	C-spine immobilization, transportation	Towel, cervical collar	3,0,3	Academic	Cohort of motorcycle taxi drivers trained in short course and assessed as lay first responders via pre/post assessment and skill usage
<i>Non-African low- and middle-income countries</i>								
India [24]	Bystander training	Varying	1 day	C-spine immobilization, transportation	NA	4, 2, 3	Academic, governmental	Two courses of varying length to train both basic and advanced lay first responders developed and assessed via confidence self report
India [26]	Bystander training, professional EMS	Varying	NA	C-spine immobilization	Cervical collar	3,1,3	Hospital, governmental	Observational study of TBI/TSCI patients assessing outcomes with respect to prehospital care provided
India [27]	Bystander training	Varying	Self-paced (online)	C-spine immobilization	NA	2,1,2	Academic	Cohort of civilians trained in short course and assessed as lay first responders via pre/post assessment
India [10]	Professional EMS	Professional EMS	NA	C-spine immobilization, thoracic and lumbar spinal immobilization, transportation	Brace, traction, cervical collar, backboard	NA	NGO	Observational study of TSCI patients assessing outcomes with respect to care provided including prehospital care
India [5]	Bystander training	Varying	Varying ^b		NA	NA	Governmental	Qualitative Interviews of frontline EMS providers and

(continued on next page)

Table 2 (continued)

Program setting	Level of responder training	Responder occupation	Length of responder training	TSCI precautions taken	Equipment used	Newcastle-Ottawa score ^a	Source of funding	Study summary
Iran [13]	Professional EMS	Professional EMS	>3 months	C-spine immobilization, transportation C-spine immobilization, thoracic and lumbar spinal immobilization, transportation	Cervical collar, backboard	3, 0, 3	Academic	bystanders to assess the transport of trauma victims Observational study of trauma patients assessing interventions taken in the prehospital setting
Iran [17]	Professional EMS	Professional EMS	>3 months	C-spine immobilization, thoracic and lumbar spinal immobilization, transportation	NA	NA	Academic	Qualitative interviews of frontline EMS providers to assess factors influencing prehospital transport intervals of trauma victims
Iran [18]	Bystander training, professional EMS	Varying	>3 months	C-spine immobilization, transportation	Cervical collar	NA	Academic	Qualitative interviews of frontline EMS providers and RTI prevention experts to assess prehospital management of preventable RTI deaths
Iran [22]	Professional EMS	Professional EMS	>3 months	C-spine immobilization, thoracic and lumbar spinal immobilization, transportation	Cervical collar, backboard	NA	Academic	Qualitative interviews of hospital setting and prehospital EMS providers to assess factors contributing to preventable RTI deaths
Mexico [21]	Professional EMS	Professional EMS	>3 months	C-spine immobilization, thoracic and lumbar spinal immobilization, transportation	Cervical collar, backboard	4,1,3		Cohort of professional EMS providers trained in PHTLS course while status of prehospital care quantitatively assessed pre/post-intervention
Nepal [25]	Bystander training	Mountaineers	2 day	C-spine immobilization, transportation	Towel, local materials	1,0,2	Academic	Cohort of mountaineering guides trained in two-day course and assessed as lay first responders via confidence self report
Pakistan [16]	Professional EMS	Professional EMS	>3 months	C-spine immobilization, thoracic and lumbar spinal immobilization, transportation	NA	NA	Governmental	Descriptive study of the development of formal EMS following the Rescue 1112 model of prehospital care
Trinidad and Tobago [15]	Professional EMS	Professional EMS	>3 months	C-spine immobilization, transportation	NA	4, 1, 3	Academic	Observational cohort study of patients transported in the prehospital setting before and after the implementation of a PHTLS training course for professional EMS

^a Scores provided in the form: selection, comparability, and outcome.

^b Programs with varying program length offered more than one option for program duration but were not self-paced.

and Scopus (Fig. 1). Seventy-three articles were initially excluded based on duplicate elimination. Abstracts of the remaining 409 articles were screened and 356 articles were further excluded, leaving 53 articles. Full-text versions of the remaining 53 articles were then obtained and screened. After eliminating 30 articles, 23 were deemed eligible for review (Table 2).

Study reliability and risk of bias

Fifteen manuscripts (65.2%) were non-randomized studies classified either as cohort or case control studies eligible for scoring using the Newcastle-Ottawa scale to assess included study quality. Scores determined for each manuscript are reported for selection, comparability, and outcome in Table 2 [29].

Characteristics of included studies

Ten studies were conducted in Africa, representing findings from 8 countries (Fig. 2). Despite a greater number of studies being conducted in the Middle East/Southeast Asia, studies of prehospital care for TSCI in Africa represent greater geographic diversity and more countries overall than in studies from other continents. Findings demonstrate first responder courses in Africa produce fewer professional responders and more lay first responders and are shorter in duration (half-day vs. multiple months). While all professional training programs lasted at least 3 months, the length of bystander training programs varied widely, with a median program length of one day. One program was self-paced, utilizing pre-recorded digital training materials and in-person skills practice sessions. First responders in Africa have limited access to C-collars, with just two of ten studies included in the scoping review

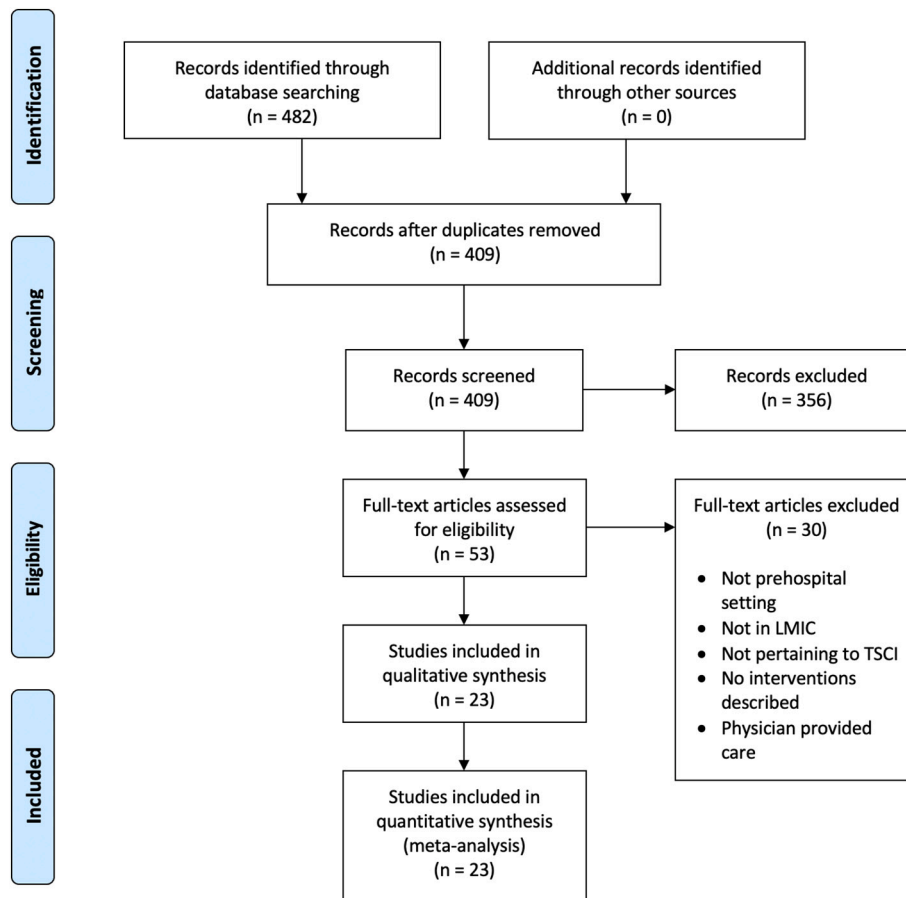


Fig. 1. Systematic review protocol.

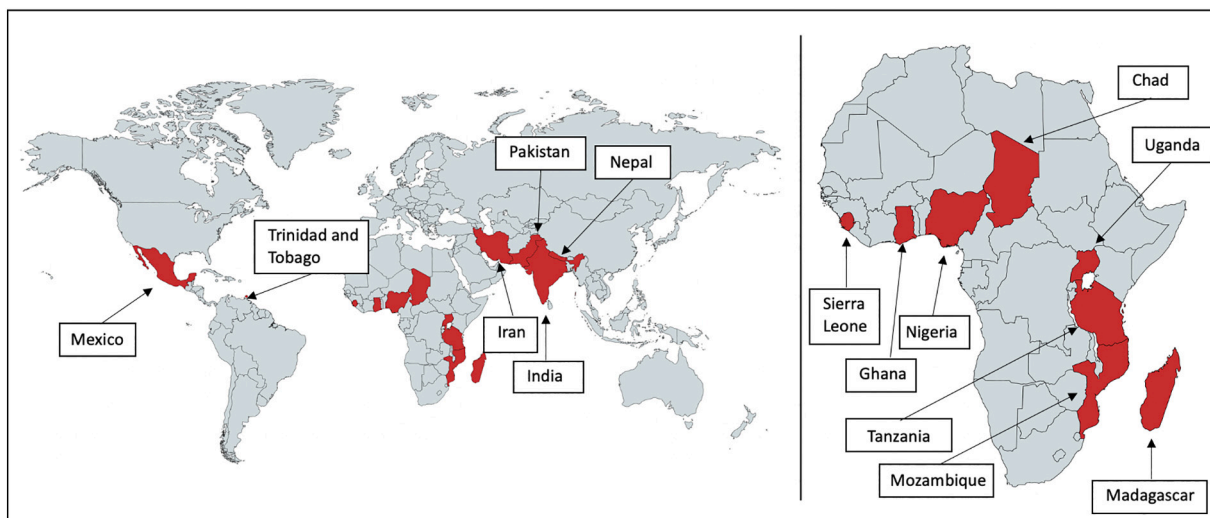


Fig. 2. Countries with studies of prehospital TSCI care included in the review.

*Highlighted in red indicates a study included in the review was set in that country. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

reporting availability for TSCI in the prehospital setting in Africa.

C-spine immobilization precautions for suspected TSCI patients are the most prevalent prehospital intervention for TSCI. In program courses, 95.6% (n = 22) of studies described teaching cervical spine (C-spine) stabilization training protocols while 86.9% (n = 20) of programs described training protocols for TSCI patient transport. Just 34.8% (n =

8) of programs described training protocols for thoracic or lumbar spine immobilization. Only one article described a program that taught its participants safe extrication protocols and procedures for patients in vehicles with suspected cases of TSCI. Numerous first responder programs operate without access to C-collars, as 34.7% (n = 8) reported programs provided first responders with cervical collars. Fewer than half

of programs teach full spinal immobilization (C-spine precautions and back-boarding), as 21.7% (n = 5) of articles reported programs provided first responders with backboards for full spinal immobilization. In 21.7% (n = 5) of programs described by articles included in the review, first responders were provided with towels for C-spine stabilization.

Prehospital trauma care program course participant occupations were: 43.5% (n = 10) varying layperson, non-clinical occupations including law enforcement, 30.4% (n = 7) full-time, professional first responders, 21.7% (n = 5) professional drivers, and 4.3% (n = 1) mountaineers. 52.1% (n = 12) of articles described exclusively training bystanders, while 30.4% (n = 7) of articles reported exclusively training professional first responders and 17.4% (n = 4) of articles reported training bystanders and professional first responders (Table 2).

Interventions and training uptake

43.5% (n = 10) of programs monitored the frequency of prehospital TSCI interventions administered by course participants. The median frequency of prehospital C-spine intervention across all studies was 24% (IQR: 11, 73) per emergency incident. The frequency of full spinal immobilization with a backboard and cervical collar was only reported in 8.9% (n = 2) of articles: administered in 41.0% of all emergency incidents in a study from Iran and 63.0% of all emergency incidents in a study from Mexico.

Clinical impact

In 13.0% (n = 3) of articles reviewed, authors measured the clinical impact of prehospital C-spine immobilization on patient mortality or complications. No study demonstrated that C-spine immobilization was associated with an improvement in patient outcomes. No article included in the review assessed the clinical impact of full spinal immobilization on patient outcomes.

A reduction in mortality was reported in 8.9% (n = 2) of articles but analysis was limited to prehospital emergency care broadly and did not specify outcomes for TSCI patients with/without spinal immobilization. Mortality reductions reported in two articles were a 5.1 percentage point reduction in mortality (15.7% to 10.6%) over five years in Trinidad and Tobago and a 3.5 percentage point reduction in mortality (8.2% to 4.7%) over six months in Mexico. The extent to which spinal precautions and TSCI care contributed to reductions in mortality is unknown. However, rapid transport was most frequently reported as the key contributing factor to mortality reduction in patients presenting with TSCI in LMICs in 47.8% (n = 11) of articles reviewed.

Discussion

With deficits in prehospital care for TSCI in resource-limited settings poorly defined, this scoping review sought to broadly examine the existing literature on training programs for prehospital first responders to inform future priorities for prehospital TSCI care in resource-limited settings of sub-Saharan Africa and other LMICs. Most studies included in this review were cohort studies, with a minority of identified manuscripts describing observational or qualitative studies. Of the 23 studies meeting inclusion criteria, C-spine immobilization precautions for suspected TSCI patients is the most prevalent prehospital intervention for TSCI and is a curricular element in every LMIC first responder program article reviewed, except one.

Though C-collars are universally understood to be an important precaution to protect injuries to the cervical spine, we found numerous first responder programs caring for TSCI in the prehospital setting operate without access to C-collars and fewer than half teaching full spinal immobilization (C-spine precautions and back-boarding). First responders in Africa have limited access to C-collars, with just two of ten studies included in the scoping review reporting availability for TSCI in the prehospital setting in Africa. First responder courses in Africa also

produce fewer professional responders than other LMIC counterpart courses and are shorter in duration. As the first study describe the status of prehospital care for TSCI by first responders in sub-Saharan Africa and other LMICs, the deficit in training and resources to effectively manage TSCI in Africa suggests alternative C-spine immobilization methods that are more readily available across diverse LMIC environments should be evaluated and highlights the need for future large prospective trials to assess the clinical impact of the presence or absence of prehospital spinal immobilization.

The clinical benefit of C-spine precautions and spinal immobilization in high-income countries has been debated in the published medical literature. Historically, it was estimated that up to 25% of TSCI may be exacerbated after the initial injury by incompetent prehospital care or transport, necessitating spinal immobilization usage [31]. Though the National Association of EMS Physicians and American College of Surgeons Committee on Trauma jointly recommend patients with the potential for spine injury should be transported with spinal precautions such as cervical collars, they have questioned the benefit of back-boarding [32]. As standard North American protocol mandates prehospital spinal immobilization for patients with suspected spinal injuries [33], it is estimated that >50% of North American trauma patients with no neck or back pain are transported with full spinal immobilization [34]. A systematic review of 17 randomized, controlled, crossover trials comparing various types of spinal immobilization devices in a total of 529 healthy volunteers found evidence supporting spinal immobilization [35].

Meanwhile, some authors have questioned the routine use of spinal immobilization in the prehospital setting in emergent situations [36–38], finding little evidence for the routine use of prehospital immobilization in TSCI patients [39]. A qualitative study in India found that medical respondents often overstated the incidence of laypeople exacerbating spinal injuries, while senior medical respondents noted the benefits incurred by rapid transport likely outweigh any potential exacerbating injuries [5]. Some authors posit that spinal cord damage occurs at the time of injury and subsequent movement is insufficient to exacerbate injury, as TSCI patients may have fractures or spinal ligament injuries that do not cause instability that would benefit from spinal immobilization in the first place [40]. This belief is supported by a recent prospective, multicenter study of TSCI patients in India, which found just 44% of TSCI patients received spinal immobilization in the prehospital setting and noted no evidence of association between spinal immobilization and clinical outcomes [10]. Other authors have also found little evidence between prehospital spinal immobilization and neurological outcomes [41]. In a study comparing neurologic outcomes of TSCI patients in New Mexico (where patients received full spinal immobilization) and Malaysia (where patients received no spinal immobilization), authors found that when subject to proper controls, the odds ratio for neurologic disability was counterintuitively higher in TSCI patients in New Mexico than in Malaysia [40]. Nonetheless, these observational data are subject to confounding, and thus no evidence of association is not the same as evidence of *no* association.

Unfortunately, there are no high-quality data to inform this ongoing debate based on our review of prehospital management of TSCI in LMICs. Only 13.0% (n = 3) of articles in this review reported the impact of prehospital TSCI intervention on morbidity and mortality. Multiple authors have highlighted the need for large, multicenter prospective studies assessing different spinal immobilization protocols on clinical outcomes [10,41]. However, such trials are often impractical—especially in environments where there is such limited access to timely prehospital care at baseline. We found that many first responders caring for TSCI in LMICs operate without access to C-collars, despite universal understanding of C-collars as an important precaution to protect injuries to the cervical spine. This highlights the fact that practice guidelines should be informed by an awareness of resource variability in the local context. Additionally, these findings suggest that alternative methods for C-spine immobilization that are more readily

available may be needed. First responder courses in LMICs currently without access to C-collars are teaching responders to utilize towels, braces, and available local materials for spinal immobilization as substitutes for C-collars. However, data on the efficacy of these alternative interventions are lacking. As lay first responder (LFR) programs continue to be expanded and implemented to provide basic emergency care in LMICs, this merits particular attention moving forward [42].

Rapid transport was most frequently reported as the key factor to reduce mortality, encouraging some investigators to reduce prehospital response time intervals in light of traffic congestion as a barrier delaying transport to definitive care [17]. With the apparent value of rapid transport, future training of bystanders or professional first responders in safe rapid extrication should be as prevalent as teaching spinal precaution in first responder courses. In a previous systematic review identifying barriers to prehospital emergency care in low- and low-middle-income countries, high traffic density restricting emergent transport was revealed as an issue facing EMS development in low-income settings, in addition to transportation infrastructure deficits like road quality, lack of road signs, and eroded terrain [43]. Most articles in this review included training in safe TSCI transport. However, only one article described teaching safe extrication procedures for patients involved in road traffic incidents, an area for future improvement given increasing road traffic injury prevalence in these settings [8].

Multiple authors cited a lack of trained personnel as the reason spinal precautions are not taken in LMICs, highlighting the need for expanded skills education efforts as rapid arrival on scene and patient management by trained bystanders or professional first responders may reduce mortality [8]. Prehospital care provided for TSCI patients in LMICs is currently split equally between trained bystanders and professional first responders. With recent expansion of LFR programs across LMICs using transportation providers to make prehospital TSCI treatment feasible where it had not been previously [20,43–45], the near-absent rehabilitation of people with TSCI should be addressed simultaneously or post-injury rehabilitations resources may be overwhelmed as an unintended consequence of improving prehospital TSCI care [2].

Next steps to improve future prehospital TSCI care in LMICs should include lessons on the importance of rapid transport and procedures for early identification of TSCI and safe rapid extrication of TSCI patients in trainings of bystanders and professional EMS. Professional EMS in LMICs should consider the benefits of providing fluid administration and supplemental oxygen to TSCI patients to avoid secondary injury after acute TSCI from hypotension and hypoxia, respectively [46].

This scoping review was limited given the limited number of articles meeting inclusion criteria. Additional limitations to our work include limited search capacity, as only English articles indexed in PMC, MEDLINE, and Scopus were searched. Our findings indicate that there is a deficit in prehospital care for TSCI research conducted in LMICs. Ten studies representing efforts from 8 African countries are insufficient to make strong conclusions regarding deficits in the quality of prehospital care for TSCI across sub-Saharan Africa, but as the first scoping review to address this area, the consistent paucity in training and prehospital resources for TSCI management indicates this is likely a continental trend. Resources cannot be allocated in an expedient fashion to address needs that are not yet identified. This scoping review is foundational and suggests future areas meriting research and identifies areas in Africa where research has yet to be conducted on prehospital care for TSCI.

First responder courses in Africa produce fewer professional responders and more lay first responders and are shorter in duration than other LMIC courses. First responders in Africa have limited access to C-collars, with just two of ten studies included in the scoping review reporting availability. These findings suggest alternative C-spine immobilization methods that are more readily available across diverse LMIC environments should be evaluated and highlight the importance of understanding resource variability in the local context. Rapid transport was most frequently reported as the key factor to reduce mortality, highlighting the need for expanded training efforts for bystander and

professional first responders in LMICs while data is lacking regarding the association between prehospital spinal immobilization techniques and clinical outcomes in LMICs. As the first study to describe the status of prehospital care for TSCI by first responders in sub-Saharan Africa and other LMICs, deficits in resources and training to effectively manage TSCI highlights the need for large prospective trials assessing prehospital care in the context of TSCI and alternative means for prehospital TSCI care.

Dissemination of results

As this study was conducted as a scoping review, results have yet to be disseminated to any one community but will be shared upon publication.

Authors' contribution

Authors contributed as follow to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: ZJE and PGD each contributed 30%, PW, KR, and JWS each contributed 10%, and ISA and DGT each contributed 5%. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of competing interest

The authors declared no conflicts of interest.

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