

## RESEARCH ARTICLE

# Clinical spine care partnerships between high-income countries and low-and-middle-income countries: A scoping review

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## Abstract

### Background

Clinical collaboration between spine professionals in high-income countries (HICs) and low-and-middle-income countries (LMICs) may provide improvements in the accessibility, efficacy, and safety of global spine care. Currently, the scope and effectiveness of these collaborations remain unclear. In this review, we describe the literature on the current state of these partnerships to provide a framework for exploring future best practices.

### Methods

PubMed, Embase, and Cochrane Library were queried for articles on spine-based clinical partnerships between HICs and LMICs published between 2000 and March 10, 2023. This search yielded 1528 total publications. After systematic screening, nineteen articles were included in the final review.

## Results

All published partnerships involved direct clinical care and 13/19 included clinical training of local providers. Most of the published collaborations reviewed involved one of four major global outreach organizations with the majority of sites in Africa. Participants were primarily physicians and physicians-in-training. Only 5/19 studies reported needs assessments prior to starting their partnerships. Articles were split on evaluative focus, with some only evaluating clinical outcomes and some evaluating the nature of the partnership itself.

## Conclusions

Published studies on spine-focused clinical partnerships between HICs and LMICs remain scarce. Those that are published often do not report needs assessments and formal metrics to evaluate the efficacy of such partnerships. Toward improving the quality of spine care globally, we recommend an increase in the quality and quantity of published studies involving clinical collaborations between HICs and LICs, with careful attention to reporting early needs assessments and evaluation strategies.

## Introduction

Musculoskeletal disorders are a leading cause of disability worldwide, with low-and-middle income countries (LMICs) being the most severely impacted [1, 2]. Spinal disorders and injury have long been recognized as a major public health issue and cause of disability, economic hardship, and morbidity in developed countries. In 2010, the World Health Organization (WHO) Global Burden of Disease study reported that spinal disorders and injuries also place a substantial burden of disability on people in LMICs [3]. As following the World Bank income level classifications, LMICs have a gross national income (GNI) less than or equal to \$13,205 and HICs have a GNI per capita greater than \$13,205 [4].

LMICs represent 48% of the global population but only 19% of all surgeons, resulting in a ratio of 5.5 providers per 100,000 people compared to 56.9 providers per 100,000 people in HICs [5]. The surgical specialist workforce is even more inequitably distributed. Major barriers to safe surgical care include limited resources, insufficient surgical workforce, and inadequate training and education programs [6]. Effective partnerships with HICs provide a potential pathway to addressing some of these challenges.

Historically, some specialized surgical care in LMICs has relied on visiting surgical teams from HICs to serve selected local patients [6–8]. This model, however, can neglect the importance of investment in local health infrastructure and staff training for more long-term impact [9]. A more sustainable model of high-quality surgical care involves a strong health investment in LMICs, with emphasis on creating sustainable systems with training and resource allocation [6].

In the past few decades, spine-based partnerships involving clinical care and training collaborations between HICs and LMICs have arisen as a response to the need for accessible, safe, and affordable spine care globally [10, 11]. Currently, there are several leading organizations, such as World Spine Care (WSC) and the Scoliosis Research Society Global Outreach Program (SRS-GOP), pursuing these clinical spine care partnerships. However, to the authors' knowledge, there is no centralized summary of all such functioning clinical partnerships.

This scoping review aims to describe the current landscape of peer-reviewed literature reporting on HIC-LMIC spine-based clinical care partnerships. This will provide a framework for future determination of effective practices and inform the sustainable, equitable, and accountable implementation of future partnerships.

## Methods

### Search strategy

A curated PubMed search was created using a combination of controlled keywords, including “global health,” “medical missions,” “education,” “training,” “clinical,” “resource limited,” “spine,” and “spinal,” then translated for use in Embase and the Cochrane Library databases. The complete search strategy ([S1 Appendix](#)) and a completed PRISMA-ScR checklist ([S1 Table](#)) are included for transparency. The search limited publication dates to January 1, 2000 through March 10, 2023, and animal studies were excluded. Covidence, a systematic review software package, was used for deduplication of references, title/abstract screening, full text screening, and data extraction. Reference lists of relevant papers were also screened for potential articles. Each study was screened by three team members to reduce bias.

### Study selection

Three reviewers independently screened titles, abstracts, and full texts obtained from the above search. Articles were included if they were experimental studies, observational studies,

or reviews and excluded if they were abstracts or not peer-reviewed. Articles that explicitly reported on partnerships between HICs and LMICs focused on clinical training of healthcare providers and/or direct clinical care of patients were included. All studies reporting on partnerships with an exclusive or significant focus on spine care were included, and studies reporting on partnerships with broader focuses on orthopedic or neurosurgical interventions with no mention of spine-specific interventions were excluded.

### Data extraction and analysis

The following data were extracted from the final included studies utilizing a Covidence-designed standardized extraction form: first author and publication year, reported date range of study partnership, HIC/organization, LMIC/organization, reported primary focus of the intervention (eg., spinal trauma, spinal deformity, degenerative/arthritis disease), reported partnership activities (e.g., direct clinical care, clinical training), reported partnership participants (e.g., physicians, nonphysicians), reporting of needs assessments, article's main focus of evaluation, and main evaluation tools used. Data from studies were independently extracted by two reviewers and discrepancies were resolved by consensus.

## Results

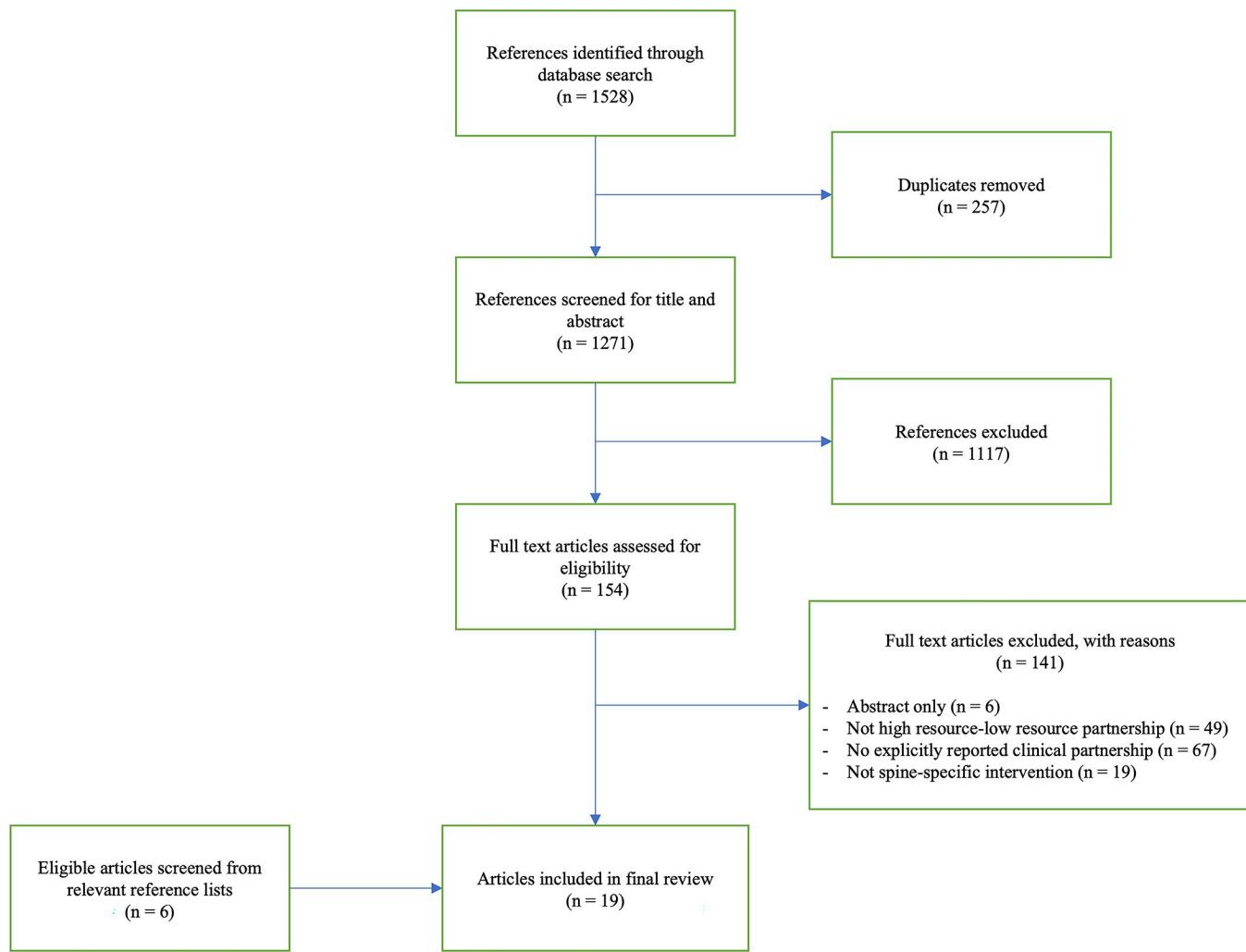
The electronic search retrieved 1528 articles. After removal of duplicate articles, 1271 underwent title and abstract screening and 154 underwent full text review. After additional screening of relevant reference lists, 19 unique papers were included in the final review (Fig 1) [1, 10, 12–28]. Extracted data from all included articles can be found in Table 1.

### Dates and settings of partnerships

Although our literature search encompassed articles published from 2000 until early 2023, all of the studies that fit the final inclusion criteria (19/19, 100%) were published in or after 2010. All reported study partnerships took place between 1998 and 2019. 10/19 (53%) of the articles reported on long-term partnerships with a duration of three years or more.

The included articles revealed four leading global outreach organizations that served as HIC partners in their respective collaborations. The SRS-GOP and the Foundation of Orthopedics and Complex Spine (FOCOS), two organizations focused on spinal deformity care and education of local surgeons, were involved as HIC partners together in six studies (32%) [12, 14, 16, 18, 20, 23]. SRS-GOP also featured in one other article as a HIC partner alongside Project Perfect World (PPW), an organization aiming to improve pediatric orthopedic care in Ecuador [17]. WSC, an organization providing evidence-based spine care to LMIC communities, was the reported HIC partner in four articles (21%) [1, 10, 25, 27]. Three articles (16%) involved Madaktari Africa, an organization dedicated to training healthcare workers in Sub-Saharan Africa, as a HIC partner [15, 26, 28]. Other organizations featured as HIC partners were the Foundation for International Education in Neurological Surgery (FIENS) and Reach-AnotherFoundation (RAF) [19, 21]. Three studies (16%) did not report affiliations with any specific global outreach organizations, instead involving individuals or teams of surgeons from hospitals in various HIC countries [13, 22, 24].

Reported LIC partners spanned across four global regions: Africa (18/19, 95%) [1, 10, 12–16, 18–28], the Caribbean (3/19, 16%) [10, 25], South Asia (2/19, 11%) [24, 27], and South America (1/19, 5%) [17]. Interventions were most concentrated in Africa, where Ghana (7/19, 37%) [12, 14, 16, 18, 20, 23, 27] was the most frequently involved LIC partner country, while Tanzania (6/19, 32%) [13, 15, 19, 24, 26, 28] and Botswana (4/19, 21%) [1, 10, 25, 27] were also involved in multiple partnerships. Of the 19 reported partnerships, 18 (95%) involved middle-



**Fig 1. The study selection flowchart.**

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income (lower-middle or upper-middle) countries as LMIC partners, including Ghana, Tanzania, Botswana, Dominican Republic, India, and Ecuador, as following the World Bank's country classifications by income level [4].

All six articles in which SRS-GOP and FOCOS worked together as HIC partners centered around care provided at the FOCOS Orthopedic Hospital in Accra, Ghana [12, 14, 16, 18, 20, 23]. WSC partnerships occurred in Botswana, Dominican Republic, Ghana, and India [1, 10, 25, 27]. Partnerships based in Tanzania took place at two different institutions: Bugando Medical Center in Mwanza [15, 26, 28] and Muhimbili Orthopedic Hospital in Dar es Salaam [13, 19, 24, 28].

## Reported partnership focuses, activities, and participants

Nine studies (47%) [12–14, 16–18, 20, 22, 23] focused specifically on spinal deformity care, while five (26%) [1, 10, 21, 25, 27] focused on general spinal disorders, one (5%) [19] focused on spinal trauma, and four (21%) [15, 24, 26, 28] focused on a combination of brain and spinal disorders and trauma.

Table 1. Extracted details from final studies.

First author, Publication year	Reported date range of study partnership	High-income country/organization/institution	Low-and-middle-income country/organization/institution	Reported partnership primary focus	Reported clinical partnership activities	Reported partnership participants	Needs assessments reported?	Main focus of evaluation	Main evaluation tools used
Ahmad, 2023	Unspecified (<1 year duration)	Weill Cornell Global Neurosurgery Initiative	College of Surgeons of East, Central and Southern Africa (COSECSA)	Spinal deformity	Direct clinical care; clinical training	Physicians/physicians-in-training	Yes	Efficacy of surgical training initiative	Benchmark needs assessment surveys and surgical quizzes
Boachie-Adjei, 2014	Unspecified	Scoliosis Research Society Global Outreach Program (SRS-GOP); Foundation of Orthopedics and Complex Spine (FOCOS)	Ghana (FOCOS Orthopedic Hospital)	Spinal deformity	Direct clinical care	Physicians/physicians-in-training	No	Clinical outcomes	Clinical/radiographic measures and complications
Boachie-Adjei, 2015	1998–2012	Scoliosis Research Society Global Outreach Program (SRS-GOP); Foundation of Orthopedics and Complex Spine (FOCOS)	Ghana (FOCOS Orthopedic Hospital)	Spinal deformity	Direct clinical care	Physicians/physicians-in-training; nonphysicians	No	Clinical outcomes	Clinical, radiographic, and demographic measures to assess complications
Brady, 2016	2009–2016	World Spine Care (WSC)	Botswana (Mahalapye District Hospital, Shoshong Clinic); Dominican Republic (Moca Clinic)	Spinal disorders	Direct clinical care; Clinical training	Physicians/physicians-in-training	Yes	Development of partnership	Narrative description and reflection
Chihambakwe, 2019	2011–2017	World Spine Care (WSC)	Botswana (Mahalapye District Hospital)	Spinal disorders	Direct clinical care	Physicians/physicians-in-training; nonphysicians	No	Local perceptions of partnership	Qualitative interviews conducted in English and coded for thematic content analysis
Coburger, 2014	2009–2011	Madaktari Africa; USA; Germany	Tanzania (Bugando Medical Center)	Brain disorders/trauma; spinal disorders/trauma	Direct clinical care; Clinical training	Physicians/physicians-in-training	Yes	Efficacy of surgical training initiative	Qualitative/quantitative evaluation of ability of local surgeons to safely perform spine procedures

(Continued)

Table 1. (Continued)

First author, Publication year	Reported date range of study partnership	High-income country/organization/institution	Low-and-middle-income country/organization/institution	Reported partnership primary focus	Reported clinical partnership activities	Reported partnership participants	Needs assessments reported?	Main focus of evaluation	Main evaluation tools used
Fletcher, 2019	2008–2016	Scoliosis Research Society Global Outreach Program (SRS-GOP); Project Perfect World (PPW)	Ecuador (Roberto Gilbert Elizalde Children's Hospital)	Spinal deformity	Direct clinical care; Clinical training	Physicians/physicians-in-training; nonphysicians	Yes	Development of partnership; clinical outcomes	Narrative description of partnership development and challenges; radiographic measures; patient-reported outcomes (Spanish SRS-22r)
Haldeman, 2015	2012–2014	World Spine Care (WSC)	Botswana (Mahalapye District Hospital, Shoshong Clinic); Dominican Republic	Spinal disorders	Direct clinical care; clinical training	Physicians/physicians-in-training; nonphysicians	Yes	Development of partnership	Narrative description and reflection
Kahamba, 2013	2011	USA; Spain; Turkey	Tanzania (Muhimbili Orthopedic Institute); India	Brain disorders/trauma; spinal disorders/trauma	Direct clinical care; clinical training	Physicians/physicians-in-training; nonphysicians	No	Efficacy of surgical training initiative	Course evaluation survey
Kancherla, 2021	2006–2019	Norway (Haukeland University); Foundation for International Education in Neurological Surgery (FIENS); ReachAnother Foundation (RAF)	Ethiopia (Addis Ababa University, Myungsung Christian Medical Center)	Spinal disorders	Direct clinical care; clinical training	Physicians/physicians-in-training	No	Efficacy of surgical training initiative	Benchmark aims for patient care and surgeon graduation rate
Nemani, 2015	2012–2013	Scoliosis Research Society Global Outreach Program (SRS-GOP); Foundation of Orthopedics and Complex Spine (FOCOS)	Ghana (FOCOS Orthopedic Hospital)	Spinal deformity	Direct clinical care	Physicians/physicians-in-training; nonphysicians	No	Clinical outcomes	Clinical/radiographic measures and complications; patient-reported outcomes (SRS-22)
Verma, 2019	1998–2016	Scoliosis Research Society Global Outreach Program (SRS-GOP); Foundation of Orthopedics and Complex Spine (FOCOS)	Ghana (FOCOS Orthopedic Hospital)	Spinal deformity	Direct clinical care; Clinical training	Physicians/physicians-in-training; nonphysicians	No	Surgeon's personal experience of partnership	Informal narrative reflection

(Continued)

Table 1. (Continued)

First author, Publication year	Reported date range of study partnership	High-income country/organization/institution	Low-and-middle-income country/organization/institution	Reported partnership primary focus	Reported clinical partnership activities	Reported partnership participants	Needs assessments reported?	Main focus of evaluation	Main evaluation tools used
Njoku, 2016	2014	Weill Cornell Neurosurgery; Foundation for International Education in Neurological Surgery (FIENS)	Tanzania (Muhimbili Orthopedic Institute)	Spinal trauma	Direct clinical care; clinical training	Physicians/physicians-in-training	No	Feasibility of technological system for surgical assistance in resource-limited regions	Postoperative X-rays to visualize placement of instrumentation; postoperative tracking of complications and stability
Outerbridge, 2017	2011–2017	World Spine Care (WSC)	Botswana (Mahalapye District Hospital, Shoshong Clinic, Princess Marina Hospital); Ghana (Ridge Hospital); India (Mahatma Gandhi Mission University); Dominican Republic (Moca Clinic)	Spinal disorders	Direct clinical care; clinical training	Physicians/physicians-in-training; nonphysicians	No	Development of partnership	Narrative description and reflection; clinical/demographic statistics
Papadopoulos, 2015	2002–2009	Scoliosis Research Society Global Outreach Program (SRS-GOP); Foundation of Orthopedics and Complex Spine (FOCOS)	Ghana (FOCOS Orthopedic Hospital)	Spinal deformity	Direct clinical care	Physicians/physicians-in-training	No	Clinical outcomes	Clinical/radiographic measures and complications; patient-reported outcomes (SRS-22)
Sommer, 2022	Unspecified (<1 year duration)	USA (New York Presbyterian Hospital/Weill Cornell Medicine)	Tanzania (Muhimbili Orthopedic Institute)	Spinal deformity	Direct clinical care; Clinical training	Physicians/physicians-in-training	No	Feasibility of novel technology for telemedical surgical guidance	Visualization clarity and quality measures; standardized internet speed test tool
Verma, 2018	2013–2016	Scoliosis Research Society Global Outreach Program (SRS-GOP); Foundation of Orthopedics and Complex Spine (FOCOS)	Ghana (FOCOS Orthopedic Hospital)	Spinal deformity	Direct clinical care	Physicians/physicians-in-training	No	Clinical outcomes	Radiographic measures; intraoperative blood loss measures

(Continued)

Table 1. (Continued)

First author, Publication year	Reported date range of study partnership	High-income country/organization/institution	Low-and-middle-income country/organization/institution	Reported partnership primary focus	Reported clinical partnership activities	Reported partnership participants	Needs assessments reported?	Main focus of evaluation	Main evaluation tools used
Wait, 2010	2009	Madaktari Africa; USA (Weill Cornell Medical College, Barrow Neurological Institute)	Tanzania (Muhimbili Orthopedic Institute, Bugando Medical Center)	Brain disorders/trauma; spinal disorders/trauma	Direct clinical care; clinical training	Physicians/physicians-in-training; nonphysicians	No	Surgeons' personal experiences of partnership	Narrative description and reflection
Wilson, 2012	2009–2010	Madaktari Africa; USA (Barrow Neurological Institute)	Tanzania (Bugando Medical Center)	Brain disorders/trauma; spinal disorders/trauma	Direct clinical care; clinical training	Physicians/physicians-in-training	No	Efficacy of surgical training initiative	Patient outcomes; narrative reflection

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All of the partnerships included direct clinical care of patients (19/19, 100%). A slight majority of the studies (13/19, 68%) involved clinical training of healthcare providers by HIC country physicians. All of the studies (19/19, 100%) involved physicians and physicians-in-training (e.g. residents, medical students) as partnership participants. Eight of the studies (42%) also included non-physician participants, such as nursing staff [16, 24, 28], research assistants [14, 28], chiropractors and physiotherapists [1, 17, 25, 27], and other clinic staff [17].

### Reported needs assessments

A majority of the reviewed articles (14/19, 74%) did not report needs assessments (e.g. literature reviews, focused assessments, interviews with stakeholders) prior to beginning their programs. The five articles that reported needs assessments used various strategies: Coburger et al. [15] and Fletcher and Schwend [17] both reported initial trips to partnership sites intended to assess surgical need, feasibility of complex surgical procedures, and patient population characteristics, while Brady et al. [10] reported a search of existing spine surgery training programs available globally to assess need for surgical trainees. Ahmad et al. [22] utilized needs assessment surveys before, during, and after their training course to plan content and analyze course efficacy, and Haldeman et al. [25] described their assessment of existing facilities prior to officially setting up a clinic.

### Main evaluation focuses and tools

The reviewed articles are split in terms of evaluation focus: twelve studies (63%) [1, 10, 15, 17, 18, 21, 22, 24–28] evaluated some aspect of the partnership itself (e.g. development, effectiveness of training initiative, challenges, local perceptions), six studies (32%) [12, 14, 16, 17, 20, 23] evaluated the clinical outcomes of the care provided through their partnerships, and two studies (11%) [13, 19] evaluated the feasibility of a technological system for surgical assistance.

The articles that evaluated aspects of their partnerships utilized mostly narrative and other qualitative approaches, such as reflections [10, 17, 18, 25–28] and interviews [1]. The five studies that evaluated the efficacy of their partnerships' surgical training initiatives utilized a mixture of quantitative and qualitative assessment tools, such as surveys, patient outcomes, and narrative reflections [15, 21, 22, 24, 26]. The articles that evaluated clinical outcomes utilized largely quantitative tools such as radiographic measures and clinical indicators [12, 14, 16, 17],

[20](#), [23](#)], and three of these articles also utilized the SRS-22, a validated scoliosis patient-reported outcome questionnaire [[16](#), [17](#), [20](#)].

## Discussion

To the authors' knowledge, this is the first review to present and analyze the available literature reporting on spine-based clinical partnerships between HICs and LMICs. Overall, this review identified several HIC outreach organizations that are consistently involved in clinical spine partnerships, but there was significant variety in the evaluative focus of published articles and a relative paucity of peer-reviewed articles reporting on partnerships despite the long durations of some interventions.

### **Large focus on spinal deformity over other spine care needs in majority of partnerships**

In LMICs, traumatic spine injury (TSI) and degenerative spine disease are widely reported as significant needs. LMICs carry a heavier burden of TSI than HICs, with an incidence of 13.7 per 100,000 people per year compared to 8.7 per 100,000 people per year [[29](#)]. Researchers have published numerous studies on TSI and spinal cord injury (SCI) in LMICs in East and Sub-Saharan Africa and Southeast Asia [[30–34](#)]. An analysis of ten years of spine surgery patients at a Nigerian hospital showed that degenerative spine disease was the most common indicator of surgery, accounting for an overwhelming 52.3% of all cases [[35](#)].

Given these data, it appears that the reviewed articles show an overrepresentation of spinal deformity care as a focus of HIC-LMIC partnerships. Only five of the 19 reviewed studies report surgical care of TSI and degenerative spine disease [[15](#), [19](#), [24](#), [26](#), [28](#)]. The reviewed studies show that several organizations are already dominating the spinal deformity field in LMICs, but Madaktari Africa seems to be the only organization regularly publishing studies on TSI or degenerative spine disease. Those considering expanding or initiating partnerships in the future may find it helpful to conduct formal needs assessments at resource-limited sites to consider targeting partnership resources toward conditions most closely matching clinical needs.

### **Balance between direct clinical care and capacity building as main reported partnership activities**

All reviewed studies reported direct clinical care of patients, and a majority also reported clinical training of local physicians—a significant component of capacity building in a LMIC. Several research groups have pinpointed the essential role of capacity building as the guiding goal of ethical global surgery initiatives in order to justify the involvement of outreach volunteers from HICs [[27–29](#)]. Although direct clinical care is a crucial immediate need to address, it may be most effective when it is accompanied by clinical training of local physicians, with the long-term goal of strengthening local health systems and transferring full ownership of sustainable programs to local healthcare providers [[25](#)]. Ultimately, this is crucial in improving access to quality care for communities, as both the capacity and number of spine care providers increases with effective training.

Access to care is also improved by the location of providers and the clinical technologies available to them. For instance, World Spine Care established clinics in facilities where people were known to receive care for other health needs, increasing their visibility in the community and their ability to bring new spine patients in for diagnosis and treatment [[25](#)]. To increase local clinical capabilities, Sommer et al. utilized smart glasses to support procedures at

Muhimbili Orthopedic Institute in Tanzania [13]. Similarly, Njoku et al. studied the use of an inexpensive, portable spinal navigation system with the potential to become an integrated part of training for a new generation of spine surgeons, facilitating complex spinal procedures through increasingly accessible technologies [19]. Although these are positive examples, there are still significant barriers to surmount, as reported by Coburger et al. with the lack of CT and MRI imaging capabilities at the Bugando Medical Centre, limiting the scope and quantity of surgeries available to patients [15].

Future publications on spine care partnerships should continue to report the specific efforts taken to sustainably strengthen health systems, particularly in regards to provider education besides access to diagnostic and other important technological modalities.

### Varied focuses and tools of partnership evaluation

A majority of the reviewed articles focused on evaluating some aspect of the development, efficacy, or perceptions of the partnership. The rest of the articles focused on either evaluating the clinical outcomes of the care provided by partner surgeons or the technology used during the partnership; in essence, these studies had already accepted the partnership as an established environment for clinical care to be carried out and therefore did not evaluate the nature of the partnership itself.

Although some articles that evaluated the efficacy of their training initiatives utilized surveys for feedback and assessment, there is room for more established frameworks to be used, such as the Kirkpatrick [36], REAIM [37], or CFIR [38] methods, which are already regularly utilized to evaluate training and education interventions. For studies that focus on evaluating training initiatives [15, 21, 22, 24, 26], standardized tools may prove additionally useful in the future. More formal frameworks may be employed to facilitate comparison with other initiatives or specialties and may guide future steps to ensure evidence-based improvement.

### Promising needs assessments reported

Most of the reviewed articles did not report any needs assessments at their planned sites prior to the start of their programs. However, the five studies that reported needs assessments demonstrate feasible steps for future program partners to build on in order to plan ethical and effective partnerships: systematic literature searches, surveys, discussions with local hospital staff, and preliminary trips to the partnership site. This crucial step allows partners to mutually define a clear goal and scope of their program based on a current comprehensive evaluation of clinical and structural needs.

Various groups in other surgical specialties have published their work on developing needs assessments to build a foundation for their outreach programs, providing other models that future spine-based partnerships might also consider [39, 40]. Future spine clinical care partnerships should conduct and report comprehensive qualitative and quantitative needs assessments with involved stakeholders through interviews, focus groups, observational studies, focused surveys, and other evaluative methods to provide a strong foundation for the development of an evidence-based partnership.

### Opportunity for increased reporting on spine-based clinical partnerships

Despite an extensive literature search, only nineteen studies qualified for final review. Other reviews surveying the current state of global clinical partnerships in anesthesiology [41] and trauma [42] have found at least two times as many qualifying articles, signaling that spine-based clinical partnerships are not as well-reported in peer-reviewed literature. There is good reason to believe that this results from under-reporting of existing partnerships: for instance,

an internet search for spine global partnerships returns various websites of organizations already included in this review, but other organizations with accessible online evidence of functioning partnerships also appear (e.g., Butterfly Foundation Spine, Global Spine Outreach). It is likely that these organizations are having a substantial impact on clinical care, and it would be helpful to have more accessible information in the literature about their impact and approaches.

Although the nineteen studies reviewed in this paper revealed that some of these organizations already work together, such as SRS and FOCOS, it is possible that the concentrated areas in which these programs tend to operate (e.g. Ghana, Tanzania) may have already generated other unreported collaborations between organizations. Because spine care uniquely unites two surgical specialties—orthopedic surgery and neurosurgery—as well as non-surgical specialists like physiatrists and chiropractors, there is immense potential for interdisciplinary collaboration. Increasing publication on partnership development, implementation, and outcomes could aid in awareness that in turn stimulates further collaboration.

To ensure optimal knowledge of the efforts being taken by HIC spine care outreach groups in LMIC settings, it may be useful for authors to report the nature of their collaborations in all published articles, even if the partnership itself is not the focal point of their study. In this way, articles arising from even informal collaborations may still be used as a foundation for improved, effective partnerships in the future.

### Limitations

This review was only able to analyze studies on spine-based clinical partnerships published in three online research databases. Many rejected articles included authors representing both HIC institutions and LMIC institutions but did not report any partnership details in their text [31, 32, 34]. The existence of these articles illuminates the prevalence of peer-reviewed articles produced by HIC-LMIC partnerships that either are not formalized or focus purely on non-clinical research collaborations, leaving room for further analysis of the larger scope of informal global spine care partnerships operating without the involvement of large outreach organizations.

Additionally, since the search strategy was conducted in English, articles in different languages may have been excluded. Therefore, more articles on these partnerships may exist that were not identified and the reported findings should be interpreted with these limitations in mind.

### Conclusion

To the authors' knowledge, this scoping review is the first study to search for and analyze the current literature available on spine-based clinical partnerships between HICs and LMICs. Overall, this review revealed the relative scarcity of published studies on global spine clinical care partnerships despite the clear presence and continued work of many HIC global outreach organizations in LMICs. The current studies varied in their evaluation focuses, but the articles that evaluated aspects of their partnerships showed promising needs assessments and capacity building efforts. We recommend an increase in the quantity of formal evaluations and peer-reviewed studies on spine-based clinical partnerships to inform the successful, equitable, and accountable implementation of future partnerships and to promote quality spine care worldwide.

### Supporting information

**S1 Appendix. Scoping review search strategy.**  
(DOCX)

**S1 Table. PRISMA-ScR checklist.**  
(DOCX)

## Author Contributions

**Conceptualization:** Hannah Lin, Sariah Khormaee.

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