Title

Supracondylar humerus fractures in low- and lower middle-income countries: a scoping review of the current epidemiology, treatment modalities and outcomes

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Full Title:	Supracondylar humerus fractures in low- and lower middle-income countries: a scoping review of the current epidemiology, treatment modalities and outcomes.
Article Type:	Original Paper
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Author Comments:	

Response to Reviewers:	Please find our responses to the reviewers attached as a separate document. We sincerely appreciate your time and effort towards improving our research.

Title: Supracondylar humerus fractures in low- and lower middle-income countries: a scoping review of the current epidemiology, treatment modalities and outcomes.

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Declarations

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Ethics approval: This study is a systematic review and therefore exempt from IRB review.

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Abstract

Background: The purpose of this scoping review was to examine the nature and quality of research regarding pediatric supracondylar humerus (SCH) fractures in low and lower-middle income countries (LICs).

Methods: We searched PubMed, Embase, Web of Science, and African Journals Online on January 9, 2018 for studies of SCH fractures in LICs. Studies were categorized by geographic region, Gartland classification of included patients, and study design. We evaluated each study's methodology and conclusions.

Results: Out of 1805 results, we analyzed 105 studies, most of which included Type 3 fractures only (66%). Many were conducted in South Asia (58%) and assessed treatment outcomes (78%). Most of the studies had level IV evidence (67%). Common limitations of research were small sample size (12%) and inadequate follow-up (6%). Epidemiological studies concluded that SCH fractures are more common among male children, are usually secondary to falls, and rarely present with nerve injuries. Most therapeutic studies reported outcomes of surgery (91%). Thirteen studies concluded that all-lateral versus cross-pinning techniques have similar outcomes. Seven studies reported preference for closed reduction over open reduction, when intraoperative fluoroscopy was available.

Most common outcome measures were Flynn criteria (77%) and range of motion (53%). None of the papers looked at treatment costs.

Conclusions: Our data show a predominance of small level IV studies from LICs, with few studies of higher level of evidence. Many studies examined controversies with surgical technique, similar to studies performed in HICs. Few studies examined non-operative treatment, which is commonly the predominant treatment available for patients in LICs. Further investigation of common treatment modalities and outcomes for SCH fractures in LICs is needed.

Introduction

Supracondylar humerus fractures are amongst the most common musculoskeletal injuries in children less than 7 years old. In children younger than 16 years of age, they make up 18% of musculoskeletal injuries, second only to distal radius fractures [1]. These injuries occur more commonly in boys, are usually due to a fall and involve the non-dominant extremity [2]. The Gartland classification is most commonly used to describe these fractures and defines Type 1 fractures as nondisplaced, Type 2 as having an intact posterior hinge and Type 3 fractures as involving complete displacement [3].

In high-income (HIC) or upper-middle income countries, while there has been historical controversy regarding the management of supracondylar humerus (SCH) fractures, current standards indicate nonsurgical treatment for Gartland Type 1 fractures, and non-surgical versus surgical intervention for Gartland Type 2 injuries depending on varus malalignment and degree of extension, and prompt surgical treatment of Gartland Type 3 injuries, most commonly by closed reduction and percutaneous pinning using intraoperative fluoroscopy [3].

In contrast, many surgeons in low-income countries, often hindered by lack of essential resources and training in operative techniques, may treat displaced supracondylar humerus fractures nonoperatively – with traction, closed reduction with or without fluoroscopy, and splinting/casting [4]. This disparity in treatment may result in poor clinical and functional outcomes for children in low- and lower-middle income countries (LICs) given the concern that mal-reduced supracondylar humerus fractures can lead to angular deformity and restrictions of

motion. One study from India demonstrated that only 30% of patients undergoing closed reduction with casting of Gartland Type 2-3 fractures achieved satisfactory results [5]. In Nepal, elbow deformities were commonly a result of treatment failure or delayed presentation [6].

The treatment modalities, rationale, and outcomes of SCH in LICs remain poorly understood. From the published literature, we sought to: 1) identify research and management trends in pediatric SCH fractures in LICs and 2) assess the nature and quality of that research.

Methods

This study adhered to the Arksey and O'Malley six-stage framework for a scoping review, and PRISMA ScR and PRISMA-S guidelines were followed (Appendices 1 & 2) [7]. We searched PubMed, Embase, Web of Science, and African Journals Online on January 9, 2018. Our search strategy was created in collaboration with a medical librarian, using keywords and controlled vocabulary (e.g., MeSH and Emtree terms) and combining the concepts of supracondylar, fractures, pediatric, and low-income countries. Complete search strategy details are available in Appendix 3. Thirty-four low-income and 47 lower-middle-income countries were identified through the 2017 World Bank Classification as "Low-income" or "Lower-middle-income" and were included in our search strategy (Appendix 4) [8]. No date or language limits were used in the search. A second librarian peer reviewed the search using Peer Review of Electronic Search Strategies (PRESS) guidelines [9].

All studies that dealt primarily with LICs, included human subjects under the age

of 18 and constituted original peer-reviewed work were included. Studies were excluded if they dealt primarily with a high-income (HIC) or upper-middle income country, included animals or adults as study subjects, or were in a language other than English for which translations could not be found.

Four reviewers performed screening of all titles and abstracts for eligibility using EndNote. Discrepancies in article selection were settled through discussion with all authors, including a fellowship-trained pediatric orthopedic surgeon (C.S.S). A REDCap survey was created to store extracted data from each included article. Each paper was reviewed by one of the authors and further exclusions were made based on the above criteria. Study settings and country affiliations were assigned according to eight World Bank Region categories: Europe and Central Asia, Latin America and the Caribbean, East Asia and Pacific, Latin America and the Caribbean, Sub-Saharan Africa, Middle East and North Africa, North America, and South Asia.

In addition to geography, studies were categorized by research methodology—as epidemiological, diagnostic, prognostic or therapeutic. Population data including mean age, sex, and type of SCH fracture studied was recorded for each study. Based on research type, data about each research study, including methods, treatments compared, conclusions, limitations and publication information were recorded. If not explicitly stated in the paper, level of evidence for each paper was evaluated based on the Oxford Centre for Evidence-Based Medicine guidelines for Levels of Evidence [10].

Results

Of the 1805 studies initially identified by the search strategy, 1431 non-duplicate articles were included in title and abstract screening, after which 177 further studies were identified and fully reviewed. After further exclusion of case studies, articles from HICs and those in a language other than English, 105 articles were included in final analysis (Figure 1). Many of the studies were conducted in South Asia (n-60, proportion of total studies-58%) and assessed treatment outcomes (79, 78%).

Epidemiology

Only 3 out of the 15 epidemiological studies specifically examined SCH fractures. The remaining 12 were studies inclusive of all injuries in children treated at trauma centers in various LMICs, which found that SCH fractures were among the most common injuries in children. Most of the epidemiological studies were conducted in Sub-Saharan Africa (7, 47%). The general conclusions were that SCH fractures were extremely common among children (17-35% of all traumatic injuries in children), especially males; most frequently occurred in the summer, in the non-dominant extremity, usually secondary to a fall, and rarely presented with nerve injuries.

Management

Of the 82 therapeutic studies, most were conducted in South Asia (51, 62%), and investigated outcomes of surgery (75, 91%) in Type 3 SCH fractures (65, 80%). Thirty studies compared outcomes of two interventions. Twenty-five studies compared surgical treatments, of which most investigated cross-pinning versus

lateral-only pinning (13, 52%), followed by closed versus open reduction with percutaneous pinning (7, 28%). Of the 13 studies comparing pin technique, most concluded that there was no significant difference in functional or cosmetic outcomes between cross-pinning and lateral-only pinning (7, 54%) and some argued that lateral-only pinning may be safer due to reduced risk of ulnar nerve injury (4, 31%). The majority of papers comparing closed versus open reduction concluded that closed reduction was preferred (4, 57%) unless fluoroscopy was unavailable or there was severe soft tissue injury (3, 43%). Most commonly studied outcome measures included Flynn criteria (61, 77%), range of motion (42, 53%), clinical alignment (35, 44%) and radiological alignment (26, 33%). None of the papers looked at cost of treatment and only two studies examined return to regular activity.

Research Trends

Most studies were conducted in South Asia (60, 58%) followed by the Middle East and North Africa (16, 16%). Latin America and the Caribbean were the least represented (2, 2%). Research was published in a wide variety of journals, the most common being the Journal of Orthopedic Surgery (7, 6.5%), International Orthopedics (6, 5.7%), Injury (5, 4.8%), Journal of Pediatric Orthopedics B (5, 4.8%) and Pakistan Journal of Medical Sciences (5, 4.8%). Collaborative studies were uncommon: Five (5%) were multicenter studies, and three (3%) were conducted in partnership with a HIC institution.

The number of research studies investigating SCH fractures in LICs has increased steadily since the 1970s, though this increase was primarily seen in

148 articles from South Asia and Middle East/North Africa, whereas few articles came
149 from Latin America and the Caribbean since 2000 (Figure 2).
150 Studies most frequently assessed treatment outcomes (79, 78%), followed by
151 injury epidemiology (15, 15%), injury prognosis (7, 7%), and diagnostic methods
152 (2, 2%). Most studies were of low level of evidence (68, 67% of level IV, 7.5% of
153 level III). Studies most commonly included patients with Type 3 SCH fractures
154 (67, 66%), followed by all types of SCH fractures (25, 25%). Most papers did not
155 discuss study limitations (80, 76%); the most common limitations identified were
156 limited sample size (12%), limited planned follow up (6%) and a variety of
157 resource-associated limitations.

158 **Discussion**

159 In our review of 105 studies from LICs concerning supracondylar humerus
160 fractures in children, we found that while SCH fractures are frequently
161 encountered and there is little high quality research targeting the understanding
162 of these fractures and their management in a manner relevant to low-resource
163 settings, or the outcomes of children treated with non-operative treatment
164 methods.
165 Most of the research on the topic focuses on surgical treatment, which is not a
166 widely available management option for children in LICs outside of large
167 metropolitan areas with academic centers [4,11,12]. The closed reduction and
168 percutaneous pinning procedures most commonly compared are especially
169 inapplicable to many children in LICs because of limited availability of
170 fluoroscopy in these settings [13]. The goal for the treatment of SCH fractures in

children should be to have access to safe, timely care regardless of where they are. However, safe and timely surgical care is not available to many children in LICs who may need it, especially in rural areas [14]. Therefore, it is extremely important to conduct research that examines outcomes and optimize the availability of nonoperative treatment modalities – including types of traction, closed reduction and casting techniques or open interventions. Investment in surgical services and training is essential to ensure that all appropriate treatment modalities are available, with context-specific research informing best practices. We also believe that developing mechanisms for reliable triage is important to allow surgical capacity to be prioritized for injuries that require it. This could be in the form of educating community centers about these injuries and providing them with resources for nonoperative treatment, including imaging as well as systems of triage to improve access to surgical care when possible.

While there are a significant number of publications from academic institutions in South Asia, it is difficult to ascertain the true burden and treatment modalities used in rural settings in LICs. There is a significant dearth of information on the burden of SCH fractures and their management from Latin America and East Asia, demonstrating a role for clinical research to examine access to care and treatment outcomes in these regions.

We found no studies examining the economic and public health burden of SCH fractures in LICs, or studies investigating the cost-effectiveness of adequate treatment for these injuries in low-resource settings. In resource-constrained environments where health policy involves prioritization of treatment of the most

burdensome diseases, the implications of burden of disease and cost-effectiveness data are vital [15,16]. Future research in LICs concerning SCH fractures should address this gap.

We believe that salient gaps in research on SCH fractures in LICs can be mitigated by refocusing both academic expectations from journals and surgeons as well as incentivizing research in LICs. If journals were to accept more research that focused on populations without access to surgery and on management practices relevant to LICs, researchers from LICs may have higher success publishing context-specific research. Additionally, restructuring academic practice to encourage research in LICs would help alleviate resource barriers to conducting research and lead to higher quality publications from LICs. Another barrier to publication in high-impact journals is potential language-associated bias against research from non-English speaking countries, which may be improved with editing support services both for the authors and journals.

This was a broad literature review of all studies pertaining to SCH fractures from low- and lower-middle income countries. The trends that we identified are useful for developing research studies that examine the availability of surgery, and the prevalence of nonoperative treatment modalities and outcomes, which are relevant to low-resource settings. Future studies including needs assessments and mobilizing resources needed to address salient knowledge and equipment gaps for the care of SCH fractures in LICs would be invaluable.

A limitation of our study is the exclusion of papers published in a language other than English. Having this information in future studies would ensure that we have the most accurate estimate of regional differences in research interests and data.

Conclusion

Our data show that there is paucity of research about supracondylar humerus fractures from LICs with long-term follow up and stronger than Level IV evidence. Many studies investigated surgical treatment modalities available in high-income (HIC) or upper-middle income countries and did not address issues unique to LICs. Few studies focused on non-operative treatment, which remains the predominant treatment available for many patients in LICs without access to surgical care. Studies examining the burden of disease, clinical and functional outcomes of the most commonly available treatments, and cost-effectiveness of treatment may help determine whether supracondylar humerus fractures should be a priority for surgical capacity building.

229 **Figure Legends**

230 **Figure 1.** Methods for article selection.

231 **Figure 2.** Number of publications by decade from each World Bank Region.

232 **Appendices**

233 **Appendix 1.** PRISMA ScR checklist.

234 **Appendix 2.** PRISMA-S checklist.

235 **Appendix 3.** Search strategy details. All searches were conducted on January 9,

236 2018.

237 **Appendix 4.** List of World Bank “Low income” and “Low-middle income”

238 countries

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Table 1. Studies by World Bank region

Region	Number of studies	Percentage
South Asia	60	58.82
Middle East and North Africa	16	15.69
Sub-saharan Africa	11	10.78
East Asia and Pacific	4	3.92
Europe and Central Asia	9	8.82
Latin America and the Caribbean	2	1.96

Table 2. Outcome measures included in research

Outcome Measure	**Number of studies reporting**	**% of studies reporting**
Flynn's criteria	61	77.2
ROM	42	53.2
Clinical alignment	35	44.3
Infection	28	35.4
Radiological	26	33.9
Pain	4	5.1
Return to regular activity	2	2.5
Amputation	1	1.3

Figure 2

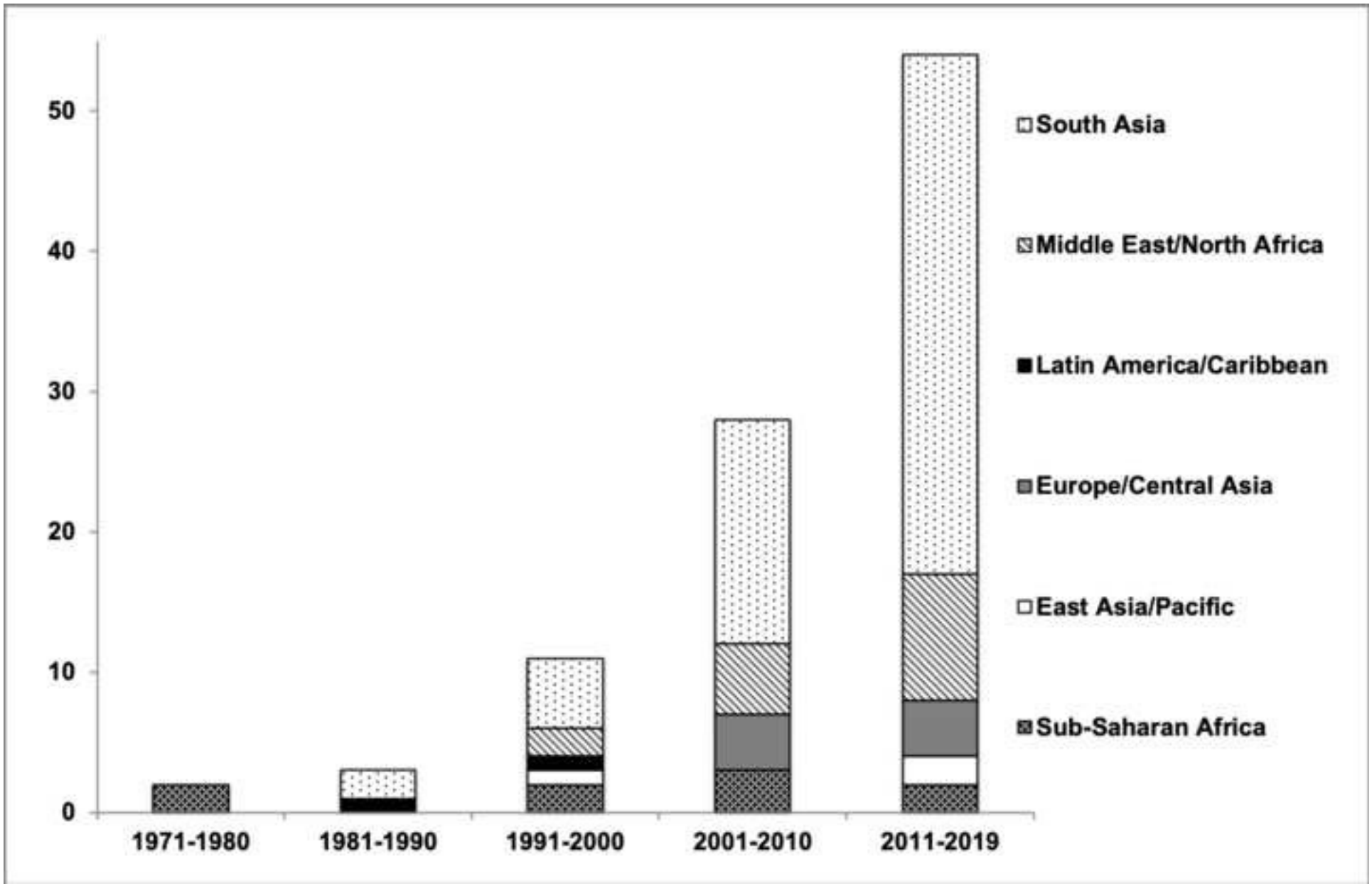
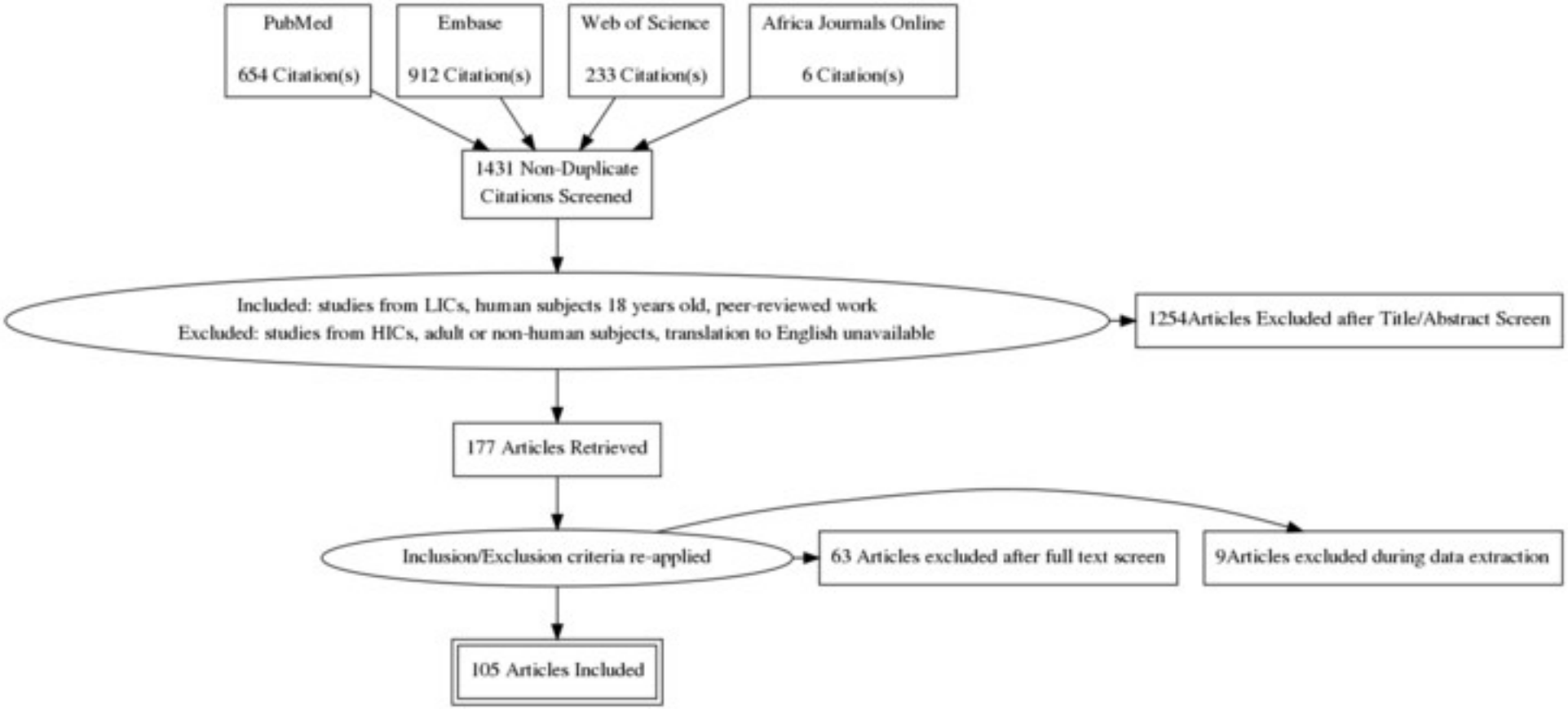


Figure 1

Click here to access/download;Figure;Figure1_SCHFx_INOR.png



Appendix3

Appendix4

Appendix 1. PRISMA-ScR Checklist.

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	3
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	n/a
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	4-5
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	4
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Appendix 3
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	5
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	5
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	n/a

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	5
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Figure 1
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	n/a
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	n/a
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	6-8
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	6-8
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	8-9
Limitations	20	Discuss the limitations of the scoping review process.	9
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	9-10
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	3

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. ;169:467–473. doi: 10.7326/M18-0850

Section/topic	#	Checklist item	Reported on page #	Reported in abstract	Reported in Suppl.
DATABASES					
Databases	1	Describe fully all databases searched.	4	x	x
Database name	1A	Name each individual database searched.	4	x	x
Interface	1B	State the platform, interface, provider, vendor, or host system for each database searched.			x
Dates of Coverage	1C	List the dates of coverage for each database searched.			x
Multidatabase Searching	1D	If databases were searched simultaneously through a single interface, state the name of the interface and list all of the databases included and their dates of coverage individually.			x
ADDITIONAL INFORMATION SOURCES					
Additional information sources	2	Describe all other information sources and methods used as part of the search process.	n/a		
Online resources	2A	List any trials registries, web search engines, specific web sites, conference proceedings, or other resource searched, including their dates of coverage.	n/a		
Manual searching	2B	If manual searching or handsearching was conducted, list the names of all handsearched sources, including the dates of coverage.	n/a		
Citation searching	2C	Indicate whether cited references or citing references were examined, and describe any methods used for locating cited/citing references (e.g., manual search; name, platform, and dates of coverage for any citation index used; email alerts).	n/a		
Text analysis methods	2D	Describe or cite pre-defined individual or sets of records and/or software or applications used for textual analysis to derive search terms or for other automated text-mining techniques.	n/a		
Contacts	2E	Indicate whether additional studies or data were sought by contacting authors, experts, manufacturers, or other contacts.	n/a		
Other methods	2F	Describe any additional supplementary search methods used.	n/a		
LIMITS AND RESTRICTIONS					
Limits and restrictions	3	Specify that no limits were used or describe any limits or restrictions applied to each search and provide justification for their use, including: a. Date or time period; b. Language; c. Publication status; d. Human or Organism; e. Study design; f. Database subsets; g. Pre-specified cut-off points for inclusion of search results (e.g. from internet searches); h. Other restriction	4		x
FILTERS AND PRIOR WORK					
Search filters	4	Indicate and cite when published search filters or hedges were used for any search, and whether they were modified or adapted from their published versions.	n/a		
Prior work	5	Indicate and cite when search strategies from other literature reviews were adapted or reused for part or all of the search.	n/a		
FULL SEARCH STRATEGIES					
Full search strategies	6	Include the search strategies for each database and resource, copied and pasted exactly as run, including any updates.			x
DATES OF SEARCHES					
Dates of searches	7	For each source, provide the date when the search and any subsequent update(s) occurred.	4	x	x
UPDATES					
Updates	8	Report the methods used to update the search(es).	n/a		
SEARCH DESIGNER(S)					
Search designer(s)	9	Describe who designed and/or executed the search.	4		
PEER REVIEW					
Peer review	10	Describe any search peer review process.	4		
MANAGING RECORDS					
Total records	11	Document the total number of references identified from each database and additional information source.	Figure 1		x
Deduplication	12	Describe the processes and any software used to deduplicate records from multiple database or other resource searches.			
Records screened	13	Document the number of records for screening after duplicates removed.	Figure 1		x

Appendix 2. PRISMA-S checklist.

Preferred Reporting Items for Systematic review and Meta-Analysis Searches (PRISMA-S) 2019 statement
Rethlefsen ML, Koffel JB, Kirtley S, Waffenschmidt S, Ayala AP, PRISMA-S Group.
Version 1.0, released March 20, 2019.

Appendix 3. Search strategies.

Database	Search strategy	Number of results
PubMed (1966-)	((Supracondylar[tiab] OR "Elbow Joint"[Mesh] OR "Elbow"[Mesh] OR humerus[tiab] OR humeral[tiab] OR “upper arm”[tiab]) AND (fracture[tiab] OR fractures[tiab] OR break[tiab] OR breaks[tiab] OR broken[tiab] OR "Fractures, Bone"[Mesh] OR volkman[tiab] OR "cubitus varus"[tiab] OR "ulnar neuropathy"[tiab] OR "median neuropathy"[tiab] OR gartland[tiab] OR salter[tiab]) OR "humeral fractures"[MeSH Terms]) AND (africa OR uganda OR kenya OR mozambique OR swaziland OR zambia OR tanzania OR	654

	nigeria OR cameroon OR malawi OR ethiopia OR congo OR lesotho OR botswana OR angola OR burundi OR "central african republic" OR chad OR guinea OR gabon OR rwanda OR sudan OR djibouti OR eritrea OR somalia OR comoros OR madagascar OR mauritius OR namibia OR seychelles OR benin OR mali OR "burkina faso" OR "cape verde" OR gambia OR ghana OR liberia OR niger OR senegal OR "sierra leone" OR togo OR mauritania OR ivoire OR ivory OR "sao tome" OR afghanistan OR albania OR algeria OR samoa OR angola OR argentina OR armenia OR azerbaijan OR bangladesh OR belarus OR belize OR Bhutan OR Bolivia OR Bosnia OR Brazil OR Bulgaria OR “Cabo Verde” OR Cambodia OR China OR Colombia OR “Costa Rica” OR Cuba OR Dominica OR “Dominican Republic” OR Ecuador OR Egypt OR “El Salvador” OR Fiji OR Georgia OR Grenada OR Guatemala OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan	

	OR Kiribati OR Korea OR Kosovo OR Kyrgyz OR Laos OR Lao OR Lebanon OR Libya OR Macedonia OR Malaysia OR Maldives OR “Marshall Islands” OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Myanmar OR Nepal OR Nicaragua OR Pakistan OR Panama OR Paraguay OR Peru OR Philippines OR Romania OR “Russian Federation” OR Russia OR Serbia OR “Solomon Islands” OR “Sri Lanka” OR “St. Lucia” OR “St. Vincent” OR Grenadines OR Suriname OR Syria OR Tajikistan OR Thailand OR Timor-Leste OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR “West Bank” OR Gaza OR Yemen OR low-resource[tiab] OR low-income[tiab] OR developing[tiab] OR undeveloped[tiab] OR underdeveloped[tiab] OR lmic[tiab] OR lmics[tiab] OR "middle income"[tiab] OR "resource poor"[tiab] OR "limited resource"[tiab]	

	OR disadvantaged[tiab] OR "third world"[tiab]) AND ("child"[MeSH Terms] OR children[tiab] OR child[tiab] OR pediatrics[MeSH] OR pediatrics[tiab] OR pediatric[tiab] OR paediatric[tiab] OR paediatrics[tiab] OR "infant"[MeSH Terms] OR infant[tiab] OR infants[tiab] OR "infant, newborn"[MeSH Terms] OR newborn[tiab] OR newborns[tiab])	
Embase (1947-)	((Supracondylar:ab,ti OR 'elbow'/exp OR elbow:ab,ti OR humerus:ab,ti OR humeral:ab,ti OR “upper arm”:ab,ti) AND (fracture:ab,ti OR fractures:ab,ti OR break:ab,ti OR breaks:ab,ti OR broken:ab,ti OR 'fracture'/exp OR volkman:ab,ti OR "cubitus varus":ab,ti OR	912

	"ulnar neuropathy":ab,ti OR "median neuropathy":ab,ti OR gartland:ab,ti OR salter:ab,ti) OR 'humeral supracondylar fracture'/exp) AND (africa OR uganda OR kenya OR mozambique OR swaziland OR zambia OR tanzania OR nigeria OR cameroon OR malawi OR ethiopia OR congo OR lesotho OR botswana OR angola OR burundi OR "central african republic" OR chad OR guinea OR gabon OR rwanda OR sudan OR djibouti OR eritrea OR somalia OR comoros OR madagascar OR mauritius OR namibia OR seychelles OR benin OR mali OR "burkina faso" OR "cape verde" OR gambia OR ghana OR liberia OR niger OR senegal OR "sierra leone" OR togo OR mauritania OR ivoire OR ivory OR "sao tome" OR afghanistan OR albania OR algeria OR samoa OR angola OR argentina OR armenia OR	

	azerbaijan OR bangladesh OR belarus OR belize OR Bhutan OR Bolivia OR Bosnia OR Brazil OR Bulgaria OR “Cabo Verde” OR Cambodia OR China OR Colombia OR “Costa Rica” OR Cuba OR Dominica OR “Dominican Republic” OR Ecuador OR Egypt OR “El Salvador” OR Fiji OR Georgia OR Grenada OR Guatemala OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kiribati OR Korea OR Kosovo OR Kyrgyz OR Laos OR Lao OR Lebanon OR Libya OR Macedonia OR Malaysia OR Maldives OR “Marshall Islands” OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Myanmar OR Nepal OR Nicaragua OR Pakistan OR Panama OR Paraguay OR Peru OR Philippines OR Romania OR “Russian Federation” OR Russia OR Serbia OR “Solomon Islands” OR “Sri Lanka” OR “St. Lucia” OR “St. Vincent” OR Grenadines OR Suriname OR Syria OR Tajikistan OR Thailand OR Timor-Leste OR	

	Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR “West Bank” OR Gaza OR Yemen OR low-resource:ab,ti OR low-income:ab,ti OR developing:ab,ti OR undeveloped:ab,ti OR underdeveloped:ab,ti OR lmic:ab,ti OR lmics:ab,ti OR "middle income":ab,ti OR "resource poor":ab,ti OR "limited resource":ab,ti OR disadvantaged:ab,ti OR "third world":ab,ti) AND (children:ab,ti OR child:ab,ti OR pediatrics:ab,ti OR pediatric:ab,ti OR paediatric:ab,ti OR paediatrics:ab,ti OR infant:ab,ti OR infants:ab,ti OR newborn:ab,ti OR newborns:ab,ti)	
Web of Science (1900-)	(Supracondylar OR elbow OR humerus OR humeral OR “upper arm”)	233

	AND (fracture OR fractures OR break OR breaks OR broken OR volkman OR "cubitus varus" OR "ulnar neuropathy" OR "median neuropathy" OR gartland OR salter) AND (africa OR uganda OR kenya OR mozambique OR swaziland OR zambia OR tanzania OR nigeria OR cameroon OR malawi OR ethiopia OR congo OR lesotho OR botswana OR angola OR burundi OR "central african republic" OR chad OR guinea OR gabon OR rwanda OR sudan OR djibouti OR eritrea OR somalia OR comoros OR madagascar OR mauritius OR namibia OR seychelles OR benin OR mali OR "burkina faso" OR "cape verde" OR gambia OR ghana OR liberia OR niger OR senegal OR "sierra leone" OR togo OR	

	mauritania OR ivoire OR ivory OR "sao tome" OR afghanistan OR albania OR algeria OR samoa OR angola OR argentina OR armenia OR azerbaijan OR bangladesh OR belarus OR belize OR Bhutan OR Bolivia OR Bosnia OR Brazil OR Bulgaria OR “Cabo Verde” OR Cambodia OR China OR Colombia OR “Costa Rica” OR Cuba OR Dominica OR “Dominican Republic” OR Ecuador OR Egypt OR “El Salvador” OR Fiji OR Georgia OR Grenada OR Guatemala OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kiribati OR Korea OR Kosovo OR Kyrgyz OR Laos OR Lao OR Lebanon OR Libya OR Macedonia OR Malaysia OR Maldives OR “Marshall Islands” OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Myanmar OR Nepal OR Nicaragua OR Pakistan OR Panama OR Paraguay OR Peru OR Philippines OR Romania OR “Russian Federation” OR Russia OR Serbia OR “Solomon Islands”	

	OR “Sri Lanka” OR “St. Lucia” OR “St. Vincent” OR Grenadines OR Suriname OR Syria OR Tajikistan OR Thailand OR Timor-Leste OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR “West Bank” OR Gaza OR Yemen OR low-resource OR low-income OR developing OR undeveloped OR underdeveloped OR lmic OR lmics OR "middle income" OR "resource poor" OR "limited resource" OR disadvantaged OR "third world") AND (children OR child OR pediatrics OR pediatric OR paediatric OR paediatrics OR infant OR infants OR newborn OR newborns)	
Africa Journals Online (2004-)	(supracondylar OR elbow OR humerus OR humeral) AND (fracture OR fractures OR break OR broken) AND (child OR children OR paediatric OR	6

	paediatrics OR pediatric OR pediatrics OR infant OR infants OR newborn OR newborns)	
Total number of results		1805
Number of duplicates		374
Total after de-duplication		1431

Appendix 4. List of low-income and lower-middle income countries included in our search.

Low-income countries	Lower-middle income countries
Afghanistan	Angola
Benin	Bangladesh
Burkina Faso	Bhutan
Burundi	Bolivia
Central African Republic	Cabo Verde
Chad	Cambodia
Congo, Dem. Rep	Cameroon
Eritrea	Comoros
Ethiopia	Congo, Rep
Gambia	Côte d'Ivoire
Guinea	Djibouti
Guinea-Bissau	Egypt, Arab Rep.
Haiti	El Salvador
Korea, Dem. People's Rep.	Eswatini
Liberia	Ghana
Madagascar	Honduras
Malawi	India
Mali	Indonesia
Mozambique	Kenta
Nepal	Kiribati
Niger	Kyrgyz Republic
Rwanda	Lao PDR
Sierra Leone	Lesotho
Somalia	Mauritania
South Sudan	Micronesia, Fed. Sts.
Syrian Arab Republic	Moldova
Tajikistan	Mongolia
Tanzania	Morocco
Togo	Myanmar
Uganda	Nicaragua
Yemen, Rep.	Nigeria
	Pakistan
	Papua New Guinea
	Philippines
	Sao Tome and Principe
	Senegal
	Solomon Islands
	Sudan
	Timor-Leste
	Tunisia
	Ukraine
	Uzbekistan

	Vanuatu
	Vietnam
	West Bank and Gaza
	Zambia
	Zimbabwe