Global Epidemiology of Pediatric Traumatic Spine Injury: A Systematic Review and Meta-Analysis

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Key words
- Global
- Incidence
- Pediatric
- Surgical management
- Traumatic spine injury

Abbreviations and Acronyms
AFR: Africa region
AMR: Region of the americas
EMR: Eastern mediterranean region
EUR: European region
GRADE: Grading of recommendations, assessment, development and evaluations
HIC: High income country
LIC: Low income country
LMIC: Low and middle income country
MIC: Middle income country
PICO: Population, intervention, comparator, outcome
PRISMA: Preferred reporting items for systematic review and meta-analyses
ROBINS-I: Risk of bias in non-randomized studies of interventions
SEAR: Southeast asia region
TSCI: Traumatic spinal cord injury
TSI: Traumatic spine injury
WHO: World health organization
WPR: Western pacific region

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OBJECTIVE: **Traumatic spine injury (TSI) leads to significant morbidity and mortality in children. However, the global epidemiology of pediatric TSI is currently unknown. We conducted a systematic review and meta-analysis to estimate the global incidence of pediatric TSI and the burden of cases.**

METHODS: **PubMed, Embase, and Scopus were searched for reports in June 2021 and updated in March 2023 with no restrictions on language or year of publication. A meta-analysis was conducted to estimate the global incidence of pediatric TSI and, subsequently, the number of cases of pediatric TSI worldwide and the proportion requiring spine surgery.**

RESULTS: **Of 6557 studies, 25 met the inclusion criteria. Road traffic accidents (64%) were responsible for most cases reported in the literature, followed by falls (18%). The global incidence of TSI in children aged ≤20 years was estimated to be 14.24 of 100,000 children, or 375,734 children, with an estimated 114,975 requiring spine surgery. Across the World Bank income classification groups, lower middle-income countries had the highest pediatric TSI case burden (186,886 cases, with 57,187 requiring spine surgery). Across the World Health Organization regions, countries in the Southeast Asia region had the largest number of projected cases at 88,566, with 27,101 requiring surgical management, followed closely by the African region, with 87,235 projected cases and 26,694 requiring surgical management.**

CONCLUSIONS: **Pediatric TSI represents a large healthcare burden globally. Interventions targeting both injury prevention and strengthening of neurosurgical capacity, especially in low resource settings, are needed to address this global health challenge.**

INTRODUCTION

Traumatic spinal injury (TSI) is injury to any part of the spinal column. Associated damage can occur to the spinal cord (TSCI) that potentially leads to temporary or permanent changes in function. The etiology of TSI varies widely, but most injuries arise from blunt trauma and, especially in TSCI, can be further complicated by secondary injury from vascular or chemical changes.[1] The overall morbidity and mortality associated with TSI is high, ranging from 1.8% to 60%.[2-4] For the pediatric population, TSI can represent a critical cause of long-term morbidity and, even, death.

Although some studies have identified an overall global incidence of TSI in the adult population of 10.5 cases per 100,000 persons, with a higher incidence in low and middle income countries (LMICs) than in high income countries (HICs; 13.7 per 100,000 persons vs. 8.7 per 100,000 persons), no such efforts exist for pediatric patients.[3,5] Limited studies from single institutions or countries have been reported that describe the incidence of pediatric TSI at a regional or national level. Pediatric TSI accounts for 2.7%–10% of all reported spinal injuries.[6,7] Despite the significant effects of TSI on a child's life, the global burden of pediatric TSI and the proportion requiring neurosurgical intervention is currently unknown. In this study, we conduct a systematic review and meta-analysis of

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the literature to estimate the global incidence and case burden of pediatric TSI. These findings could also help catalyze context-specific efforts to expand pediatric neurosurgical care worldwide.

METHODS

Database Searches

A systematic review and meta-analysis was conducted in accordance with the PRISMA (preferred reporting items for systematic review and meta-analyses) guidelines to evaluate the global incidence of pediatric spinal trauma.[8] A comprehensive literature search was initially conducted in June 2021 and updated in March 2023, querying PubMed (National Library of Medicine), Embase (Elsevier), and Scopus (Elsevier). No restrictions on language, year of publication, or study design were applied during the search phase. The search strategy used broad vocabulary terms for spine trauma, spinal cord injury, epidemiology, pediatrics, and outcome measures using the PICO (population, intervention, comparator, outcome) framework.[9] We also examined the reference lists of retrieved articles to find additional relevant reports. A full list of search terms is detailed in **Supplementary Table 1**.

Screening Process

After duplicates were removed via an automated de-duplication feature in Endnote X9 (Clarivate Analytics, London, United Kingdome), the articles were screened by title and abstract then via full text (R.T., J.H.C., M.S., and N.S). Each article was reviewed by a minimum of 2 of us to ensure concordance in selection and a comprehensive review. The inclusion criteria were as follows: 1) published in a peer-reviewed journal; 2) presenting primary pediatric TSI and TSCI data; and 3) presenting the incidence of TSI and/or TSCI in children or metrics that allowed for calculation of the incidence rates (i.e., number of children with TSI and/or TSCI and entire population of children). Studies presenting incidence data for adults and children were included if separate incidence data could be extracted for the children. The pediatric age range was as defined by the articles included and varied from 0 to 20 years, with a minimum age of inclusion ranging from 0 to 14 years and maximum age of inclusion ranging from 0 to 20 years. The exclusion criteria were as follows: 1) publications of adult TSI and/or TSCI only; 2) case reports, literature reviews, and meta-analyses; 3) studies not reporting the incidence of spinal trauma in pediatric patients or not providing data from which the incidence could be calculated; 4) studies providing incidence data for selected cohorts (i.e., only children presenting to a neurological clinic); and 5) studies that focused on diagnostics, interventions, or outcomes. All differences were reconciled in consultation with the senior author (M.C.D.).

Data Extraction

The articles selected for final review were analyzed, and information on bibliographic data, mechanism of injury, sample size, type of injury, and epidemiological data was extracted. The World Health Organization (WHO) region and World Bank income group of the country of origin for each article was reported according to the WHO designation (region of the Americas [AMR], European region [EUR], African region [AFR], Western Pacific region [WPR], Southeast Asia region [SEAR], and Eastern Mediterranean region [EMR]) and World Bank income classification (low income countries [LICs], lower and upper middle income countries [MICs], and HICs).[10,11] The GRADE (grading of recommendations, assessment, development and evaluations) framework was used to assess the quality of the selected studies.[12] The ROBINS-I (risk of bias in non-randomized studies of interventions) tool was used for the risk of bias assessment.[13] The overall risk of bias for our systematic review was determined by aggregating the risk of bias for all included studies.

Data Reporting and Quantitative Analysis

Descriptive data are reported as the proportion, median, and interquartile range, as appropriate. The epidemiological data for pediatric TSIs from the studies reviewed was insufficient to conduct a meta-analysis to estimate the global incidence of pediatric TSI. We, thus, estimated the global incidence of pediatric TSI from the epidemiologic data derived from pediatric TSCI studies. First, we obtained the ratio of TSI/TSCI cases based on the reported number of pediatric TSI and TSCI cases. The weighted sample of TSCI cases and TSI cases across the studies that reported both TSCI and TSI cases was calculated. The calculated TSCI and TSI samples were then used to compute the ratio of TSI/TSCI cases. Using a random effects model, a meta-analysis to estimate the global incidence rate of pediatric TSCI (age, 0–20 years) was then conducted. This meta-analysis was performed using software R, version 4.2.1 (R Project for Statistical Computing, Vienna, Australia) and its package "meta" with double arcsine transformation and inverse variance method. Heterogeneity is expressed as the I^2 statistic. For studies that did not explicitly report the incidence of TSCI, the incidence was calculated by dividing the number of pediatric patients with TSCI by the total person-years during the study period and reported per 100,000 children:

$$\text{TSI Incidence} = \text{TSCI Incidence}_{\text{Global}} \times \text{Ratio}(\text{TSI} / \text{TSCI})$$

$$\text{TSCI Incidence} = \text{TSCI}_{\text{Pediatric}} \times 100{,}000$$

$$\text{Total person years}_{\text{Pediatric}} \text{ At Risk}$$

The calculated global incidence of pediatric TSCI and the TSI/TSCI ratio was then used to estimate the global incidence of TSI:

$$\text{TSI}_{\text{Burden}} = \text{TSI Incidence} \times \text{Population}_{\text{Pediatric}}$$

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To calculate the number of cases of pediatric TSI globally, the global pediatric TSI incidence was multiplied by the total number of children aged 0–14 years worldwide as reported by the World Bank.[14] Additional calculations were completed for the burden of pediatric TSI cases stratified by WHO region and World Bank income group:

Additionally, we calculated the proportion of pediatric TSI cases globally and across the different WHO regions and World Bank income groups that would require surgical management based on the proportion of patients from the review who received surgery:

$$TSI_{Surgical} = TSI_{Burden} \times \text{proportion of patients requiring spine surgery}$$

RESULTS

The initial literature query yielded 6557 articles, of which 2501 were from PubMed, 775 were from Embase, and 3301 were from Scopus. After excluding 1858 articles via automated de-duplication, 4699 titles remained. After a primary review of the abstracts, 516 studies were selected for inclusion in the full text review, and 25 met the inclusion criteria for data extraction. The PRISMA flowchart is presented in Figure 1.

The 25 studies included in the present study were from 13 countries (Table 1). All the included studies were retrospective cohort studies. Stratified by WHO region, 10 studies (40%) were from the AMR, 10 (40%) from the EUR, 2 (8%) from the EMR, 2 (8%) from the WPR, and 1 (4%) from the AFR. Using World Bank income status, 22 studies (88%) were from HICs, 2 (8%) from lower MICs, and 1 (4%) from an upper MIC. The United States (10 studies; 40%) contributed the greatest number of studies. The quality grades included 4 studies (16%) with low quality and 21 (84%) with moderate quality. The risk of bias judgments demonstrated 23 studies (92%) with a moderate risk of bias, 1 study (4%) with a low risk of bias, and 1 study (4%) with a serious risk of bias.

Mechanism of Injury, TSI Incidence, Total Case Burden, and Surgical Burden

Based on data from 16 reports from the EUR, AMR, WPR, and EMR, road traffic accidents (64%) were responsible for most TSI/TSCI cases reported in the literature, followed by falls (18%; Figure 2). Stratifying the data by WHO region, road traffic accidents were the leading cause of TSIs in all WHO regions, ranging from 46% to 74%, with the WPR having the highest proportion of road traffic accidents and the EUR having the least proportion. The EMR had the highest proportion of falls (22%) compared with the EUR, which had 12% of TSIs contributed to by falls. Only 1 of those 16 articles was from a lower MIC, with the remaining from HICs. Both the HICs and the lower MIC reported road traffic accidents as the leading cause of TSIs at 64% and 56%, respectively. The lower MIC reported about twice the burden of falls reported in the HICs (36% vs. 17%).

Twelve studies provided sufficient data for a meta-analysis to estimate the global incidence. The annual global incidence of TSCI for children aged ≤20 years was estimated to be 1.55/100,000 children (95% confidence interval, 0.80–2.55; Figure 3). Annually, this amounted to 106,449 children aged ≤20 years. Based on the available data from the sample of TSCI and TSI cases from 11 articles (5 from the AMR, 4 from the EUR, and 1 from the EMR; 10 HICs and 1 lower MIC), the TSI/TSCI ratio was estimated to be 9.19:1. Hence, the TSI incidence was estimated to be 14.24/100,000 children. Based on data from 8 studies that reported on the management of patients, 30.6% of the patients underwent spine surgery.

On extrapolation, the projected number of children aged ≤20 years with TSIs worldwide was 375,734, with an estimated

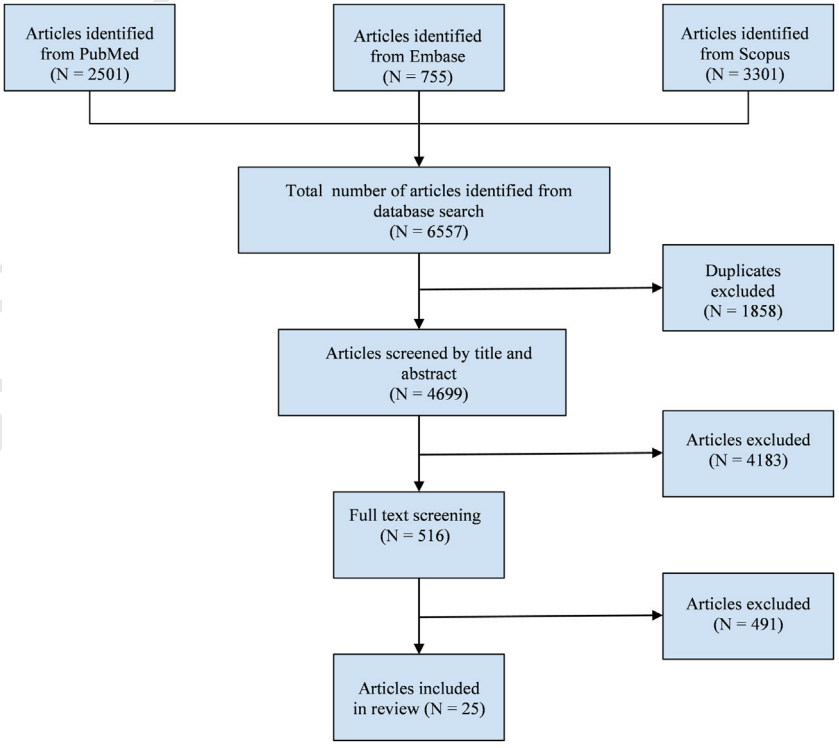

Figure 1. PRISMA (preferred reporting items for systematic reviews and meta-analyses) flow diagram for the literature search.

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Table 1. Studies Included in Present Study

Investigator	Study Design	Study Period	Country	WHO Region	Country Income Status	Grade	Risk of Bias	Pediatric Patients (*n*)	Spine Surgery Total (*n*)	TSCI or TSI
Hadley et al.,[34] 1988	RC	1972–1986	USA	AMR	High	Low	Moderate	122	22	TSCI or TSI
Surkin et al.,[35] 2000*	RC	1992–1994	USA	AMR	High	Moderate	Moderate	14	NR	TSCI
Augutis et al.,[4] 2003*	RC	1985–1996	Sweden	EUR	High	Low	Serious	92	NR	TSCI
Martin et al.,[36] 2004	RC	1989–2000	UK	EUR	High	Moderate	Low	662	NR	TSCI or TSI
Wang et al.,[37] 2004	RC	1993–2001	USA	AMR	High	Moderate	Moderate	91	11	TSCI or TSI
Vitale et al.,[38] 2006*	RC	1997–2000	USA	AMR	High	Moderate	Moderate	1455	NR	TSCI
Puisto et al.,[39] 2010*	RC	1997–2006	Finland	EUR	High	Moderate	Moderate	749	243	TSCI
Hagen et al.,[40] 2011*	RC	1952–2001	Norway	EUR	High	Moderate	Moderate	57	NR	TSCI
Chien et al.,[41] 2012*	RC	1998–2008	Taiwan	WPR	High	Moderate	Moderate	4,949	NR	TSCI
Oliver et al.,[42] 2012	RC	1996–2008	USA	AMR	High	Moderate	Moderate	74	NR	TSCI or TSI
Perez et al.,[43] 2012*	RC	2000–2009	Spain	EUR	High	Moderate	Moderate	526	NR	TSCI
Al-Habib et al.,[44] 2014	RC	2001–2009	Saudi Arabia	EMR	High	Low	Moderate	120	49	TSCI or TSI
Nijendijk et al.,[45] 2014*	RC	2010	Netherlands	EUR	High	Moderate	Moderate	19	11	TSCI
Selvarajah et al.,[46] 2014*	RC	2007–2010	USA	AMR	High	Moderate	Moderate	6132	NR	TSCI
Piatt,[47] 2015*	RC	2009	USA	AMR	High	Moderate	Moderate	14968	NR	TSCI or TSI
Saunders et al.,[48] 2015*	RC	1998–2012	USA	AMR	High	Moderate	Moderate	490	NR	TSCI
Majdan et al.,[49] 2016	RC	2002–2012	Austria	EUR	High	Moderate	Moderate	30	NR	TSCI
Moshi et al.,[50] 2017	RC	2010–2014	Tanzania	AFR	Lower middle	Low	Moderate	8	NR	TSCI
Piatt et al.,[51] 2018	RC	1997, 2000, 2003, 2006, 2009, 2012	USA	AMR	High	Moderate	Moderate	871	NR	TSCI
Smits et al.,[52] 2020	RC	2010–2017	Netherlands	EUR	High	Moderate	Moderate	891	NR	TSCI or TSI
Booker et al.,[53] 2021	RC	2011–2018	UK	EUR	High	Moderate	Moderate	72	27	TSCI or TSI
Rezaee et al.,[54] 2021	RC	2011–2018	Iran	EMR	Lower Middle	Moderate	Moderate	61	20	TSCI or TSI
Jiang et al.,[55] 2022*	CS	2013	China	WPR	Upper Middle	Moderate	Moderate	85,462	NR	TSCI

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Table 1. Continued

Investigator	Study Design	Study Period	Country	WHO Region	Country Income Status	Grade	Risk of Bias	Pediatric Patients (*n*)	Spine Surgery Total (*n*)	TSCI or TSI
Habermehl et al.,[56] 2022	RC	2011–2016	USA	AMR	High	Moderate	Moderate	20,062	NR	TSCI or TSI
Utheim et al.,[57] 2022	RC	2015–2019	Norway	EUR	High	Moderate	Moderate	125	33	TSCI or TSI

WHO, world health organization; TSCI, traumatic spinal cord injury; TSI, traumatic spine injury; RC, retrospective cohort; AMR, region of the Americas; NR, not reported; EUR, European region; EMR, eastern mediterranean region; CS, cross-sectional; WPR, western Pacific region.

*Articles included in meta-analysis.

114,975 requiring surgical intervention. Across the World Bank income classification groups, the lower MICs had the highest pediatric TSI case burden (186,886 cases, with 57,187 requiring surgical intervention), and the HICs had the lowest case burden (38,688 cases, with 11,839 requiring surgical intervention; Figure 4). Across the WHO regions, the countries in the SEAR had the largest number of projected cases at 88,566, with 27,101 requiring surgical management, followed closely by the AFR, with 87,235 projected cases and 26,694 requiring surgical management (Figure 5).

DISCUSSION

To the best of our knowledge, our study is the first attempt to characterize the epidemiology of TSIs specifically in the pediatric population on a global scale. We quantitatively estimate the global incidence of pediatric TSI and project the TSI case burden and surgical burden across the WHO regions and World Bank income classification groups. From the available data, the annual global incidence of TSI in children aged <14 years was estimated to be 14.24 per 100,000 population, leading to a projected 375,734 cases worldwide and an estimated 114,975 children requiring surgical management of their injuries annually.

Overall, road traffic accidents dominated the mechanism of TSIs in children, followed by unintentional falls and falling objects, similar to that reported for adults.[3] Globally, gunshot is reported as the most common act of violence causing TSIs in children and adolescents.[15,16] The leading cause of injuries might, however, differ by WHO region or World Bank income group. Although we made an attempt to delineate these differences, the data in our meta-analysis were not sufficient to draw conclusions, especially with no representation of data from the AFR and SEAR or LICs and upper MICs. Previous reports, however, have indicated that motor vehicle and sporting accidents are more frequently seen in HICs, with motorcycle accidents and falls from heights more common in LMICs.[3,17] Falls from a height appear to be most common in the home and from buildings in LMICs.[18,19] Together, these might result from a lack of safety regulations or enforcement, less strict safety codes, and/or fewer resources dedicated to road safety, home inspection, safety, and repair in LMICs.

When the estimated global incidence was extrapolated to the different WHO regions and World Bank income classification groups, significant differences were found in the burden of pediatric TSIs across the different regions according to the pediatric population estimates. The estimated burden of TSI was 2–5 times higher in LMICs than in HICs. Across the WHO regions, the highest burden of TSI was found in the SEAR (88,566 cases with 27,101 anticipated surgeries) and AFR (87,235 projected cases with 26,694 anticipated surgeries). The EUR and AMR experienced about one quarter to one third of this burden.

Injuries involving the spine and spinal cord require timely intervention to improve functional outcomes.[20,21] This poses

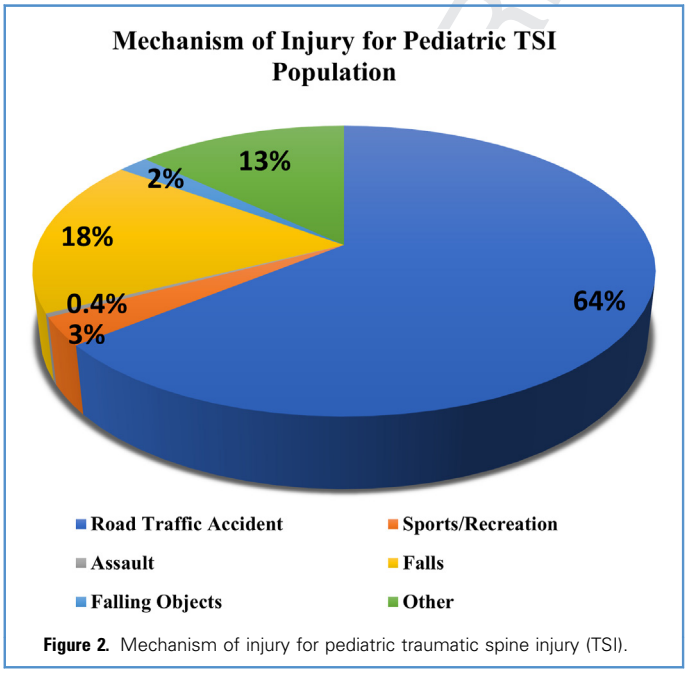

Figure 2. Mechanism of injury for pediatric traumatic spine injury (TSI).

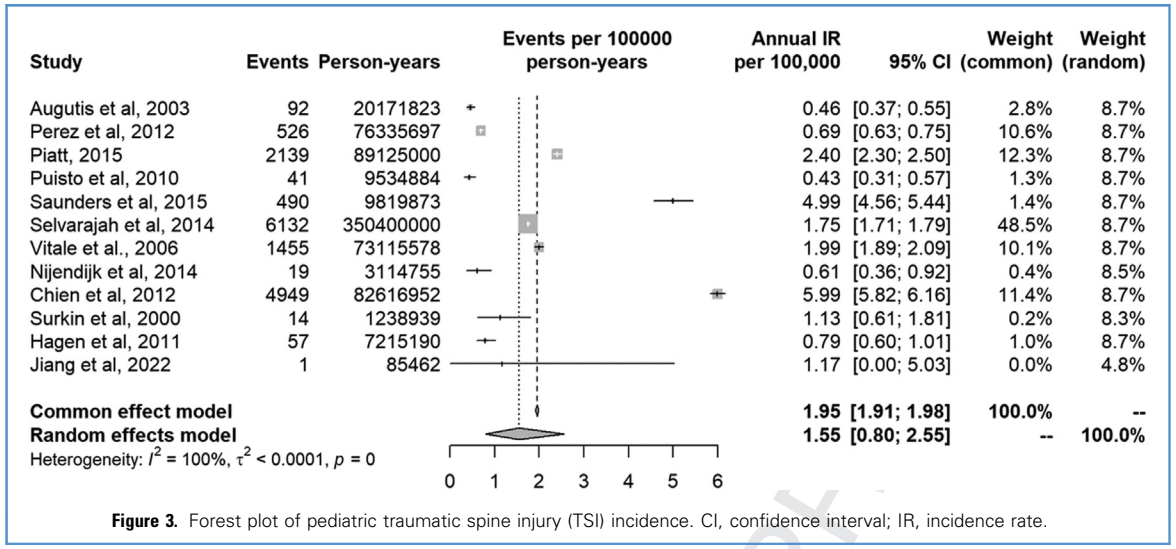

Figure 3. Forest plot of pediatric traumatic spine injury (TSI) incidence. CI, confidence interval; IR, incidence rate.

significant challenges for LMICs, where resources are limited, leading to both delays in surgical intervention and a significant number of patients not receiving the indicated surgery.[22-24] Understanding the epidemiology, incidence, and trends of pediatric TSI globally is a vital step for planning and allocating resources and developing prevention programs. It is imperative to understand these geographical and income level differences and differences in road and building designs and safety regulations to appropriately direct resources to prevent and treat spine injuries in the regions most affected and those that currently have the least support, including furthering child road safety, safety gear use, and school, home, and recreational ground safety campaigns.[25,26]

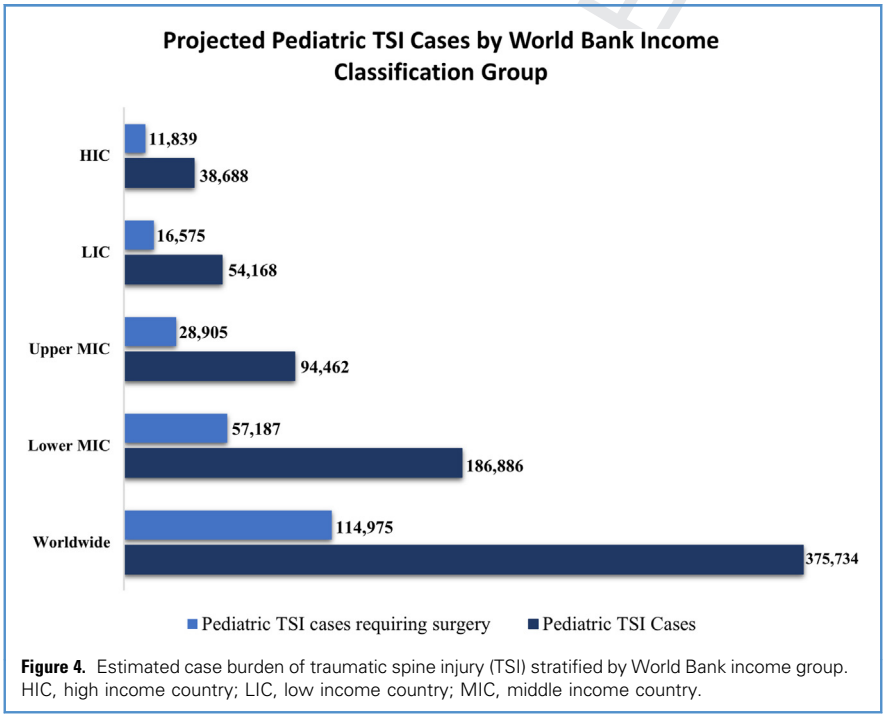

Figure 4. Estimated case burden of traumatic spine injury (TSI) stratified by World Bank income group. HIC, high income country; LIC, low income country; MIC, middle income country.

In addition to directing trauma prevention resources, it is important to understand the need to increase capacity for trauma care, including emergency trauma response, effective referral systems, and surgical capacity, to help improve outcomes. Mukhopadhyay et al.[27] found that the SEAR had 0.51 neurosurgeon per 1 million people and that the AFR had 2.59 neurosurgeons per 1 million people. These are the regions in which we found the highest burden of pediatric TSI and surgery requirements.[27] In contrast, the EUR has a neurosurgeon density of 11.76 per 1 million people. This is consistent with previous findings that many LMICs are unable to meet the pediatric neurosurgical needs of their regions and would benefit from further educational and training interventions in these arenas.[28,29] Furthermore, many hospitals are ill-equipped to treat the needs of TSI patients because of limited intensive care unit beds, operating room capacity, and availability of surgical spinal implants. The substantial disability associated with TSI, especially in the absence of adequate surgical management or delays in surgical management, leads to detriments in health, with financial and social implications that affects the quality of life of the patients and their families.[3,24,30] Further investigation of the potential implications of TSI reveals that it can cause premature mortality, negatively affect community participation, depression, and decrease the quality of life and could increase

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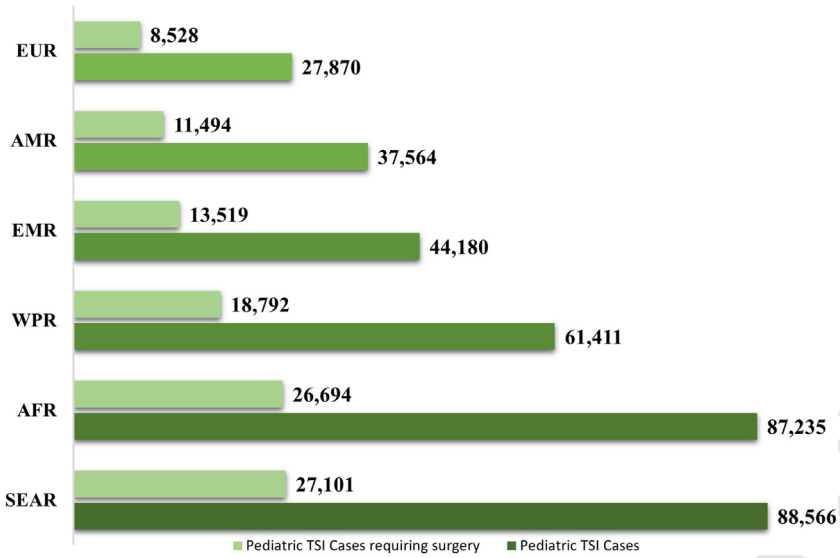

Figure 5. Estimated case burden of traumatic spine injury (TSI) stratified by World Health Organization (WHO) region. AFR, African region; AMR, region of the Americas; EMR, Eastern Mediterranean region; EUR, European region; SEAR, Southeast Asian region; WPR, Western Pacific region.

comorbidities in the pediatric population.[31,32] Although this list of complications after TSI is not exhaustive, it provides some insight into understanding the far-reaching effects of TSI, beyond the initial accident. This adds additional burden to the already fragile health infrastructure available in these countries.

Study Limitations

A major limitation of the present study is the paucity of publications that met the inclusion criteria, in particular, the scarcity of primary data from LMICs. Regional differences in TSI incidence could not be measured with this method. As with any meta-analysis, these results depend on the validity of the primary data extracted. To ensure transparency, the GRADE framework was used to assess and report the study quality before inclusion in our analysis. Additionally, there is a scarcity of data originating from LMICs and most of the WHO regions other than the AMR and EUR. Assuming a uniform population across the income classifications, this lack of data could result in an underestimation of the global incidence of pediatric TSI cases. We were also unable to estimate the specific incidence for each World Bank income group and WHO region owing to insufficient data. The age range reported in the included studies was heterogeneous. Thus, the results must be interpreted with caution, remembering that the risk and cause of TSIs differ across different age groups.[33] Additionally, specific details regarding the subtypes of injury (e.g., pedestrian or passenger in road traffic accident), adherence to road safety laws (e.g., helmets or seatbelts), and type of treatment intervention were not available and likely varies by age and region, with resultant effects on injury severity and treatment outcomes. Extrapolating the calculated global incidence to identify the number of cases in the different WHO regions and World Bank income groups from which no studies are available could have introduced a measurement bias into our model, because even small differences in the incidence across different regions will lead to large differences in the number of cases estimated in our study. This could have resulted in an overestimation or underestimation of the case burden in some regions or income groups. Despite these limitations, the present study provides information on the global burden of pediatric TSIs worldwide, using the best available reported data. Quantifying the incidence and volume of TSI globally is an important early step toward reducing the morbidity and mortality associated with spinal injuries worldwide.

CONCLUSIONS

Globally, there is substantial volume of pediatric TSI, with low-resource settings bearing a disproportionately greater burden of injuries owing to the larger pediatric population in these regions compared with HICs. Road traffic accidents and falls were the leading causes worldwide. Transportation infrastructure improvements and child safety policy reforms, along with strengthening the neurosurgical capacity in LICs and LMICs, could help reduce both the incidence and the morbidity associated with TSIs.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Joseline Haizel-Cobbina: Data curation, Formal analysis, Writing — original draft, Visualization, Project administration. **Rut Thakkar:** Data curation, Formal analysis, Writing — original draft, Visualization. **Megan Still:** Data curation, Formal analysis, Writing — review & editing, Visualization. **Nathan A. Shlobin:** Data curation, Formal analysis, Writing — review & editing, Visualization. **Justine Izah:** Formal analysis, Writing — review & editing, Visualization. **Liping Du:** Formal analysis, Writing — review & editing. **Christopher M. Bonfield:** Writing — review & editing. **Ricardo Gepp:** Writing — review & editing. **Michael C. Dewan:** Conceptualization, Methodology, Literature Review, Writing — review & editing, Supervision.

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Supplementary Table 1. List of Search Terms

Database	Search Terms
PubMed	
	("Spinal Cord Injuries"[MeSH] OR "spine trauma*"[tiab] OR "spinal trauma*"[tiab] OR (("spinal cord"[tiab] OR "vertebral" OR "vertebral column" OR "cervical spin*" OR "thoracic spin*" OR "lumbar spin*") AND ("injur*"[tiab] OR "fracture*"[tiab]))) AND ("pediatrics"[MeSH] OR "infant, newborn"[MeSH] OR "infant"[MeSH] OR "child, preschool"[MeSH] OR "child"[MeSH] OR "adolescent"[MeSH] OR "pediatric*"[tiab] OR "paediatric*"[tiab] OR "fetal*"[tiab] OR "fetus*"[tiab] OR "newborn*"[tiab] OR "infant*"[tiab] OR "preschool*"[tiab] OR "child*"[tiab] OR "adolescent*"[tiab] OR "neonate*"[tiab] OR "toddler*"[tiab]) AND ("epidemiology" [Subheading] OR "Epidemiology"[MeSH] OR epidemiolog*[tiab] OR population[tiab] OR population-based[tiab] OR inciden*[tiab] OR prevalen*[tiab] OR burden OR ratio[tiab] OR DALY[tiab] OR "disability adjusted life year*"[tiab] OR "disability-adjusted life year*"[tiab] OR YLL[tiab] OR "years of life lost"[tiab] OR YLD[tiab] OR "years lost to disability"[tiab] or "years lost due to disability"[tiab] OR ratio[tiab] OR QALY[tiab] OR "quality adjusted life year*"[tiab] OR "quality-adjusted life year*" OR "single center"[tiab] OR "single-center"[tiab] OR "single institution*"[tiab] OR "single-institution*"[tiab] OR "multicenter"[tiab] OR "multiple center*"[tiab]) AND ("Africa"[MeSH] OR "Asia"[MeSH] OR "Central America"[MeSH] OR "Developing Countries"[MeSH] OR "Geographical Locations Category"[MeSH] OR "Internationality"[MeSH] OR "Latin America"[MeSH] OR "South America"[MeSH] OR "Dominican Republic"[tiab] OR "Principe"[tiab] OR "Puerto Rico"[tiab] OR "Sao Tome"[tiab] OR "Saudi Arabia"[tiab] OR "Sierra Leone"[tiab] OR "Virgin Islands"[tiab] OR Afghanistan*[tiab] OR Africa*[tiab] OR Albania*[tiab] OR Algeria*[tiab] OR America*[tiab] OR Andorra*[tiab] OR Angola*[tiab] OR Antarct*[tiab] OR Antigua*[tiab] OR Arab Emirate*[tiab] OR Argentin*[tiab] OR Armenia*[tiab] OR Aruba*[tiab] OR Asia*[tiab] OR Atlantic[tiab] OR Australia*[tiab] OR Austria*[tiab] OR Azerbaijan*[tiab] OR Azores[tiab] OR Baham*[tiab] OR Bahra*[tiab] OR Bangladesh*[tiab] OR Barbad*[tiab] OR Barbuda*[tiab] OR Barthelemy[tiab] OR Barthélemy[tiab] OR Belarus*[tiab] OR Belgi*[tiab] OR Belize[tiab] OR Bengali[tiab] OR Benin*[tiab] OR Bermuda*[tiab] OR Bhutan*[tiab] OR Bissau[tiab] OR Bolivia*[tiab] OR Bosnia*[tiab] OR Botswana*[tiab] OR Brazil*[tiab] OR Brunei[tiab] OR Bulgaria*[tiab] OR Burkina Faso[tiab] OR Burma[tiab] OR Burmese*[tiab] OR Burundi*[tiab] OR Cabo Verd*[tiab] OR Caicos[tiab] OR Cambodia*[tiab] OR Cameroon*[tiab] OR Canad*[tiab] OR Cape Verd*[tiab] OR Cayman[tiab] OR Central[tiab] OR Chad*[tiab] OR Chile[tiab] OR China[tiab] OR Chinese[tiab] OR Colombia*[tiab] OR Comoros[tiab] OR Congo*[tiab] OR Costa Rica*[tiab] OR Cote[tiab] OR Cote d'Ivoire[tiab] OR Croatia*[tiab] OR Cuba[tiab] OR Cuban[tiab] OR Cyprus[tiab] OR Czech Republic[tiab] OR Denmark[tiab] OR developing countr*[tiab] OR developing nation*[tiab] OR Djibouti[tiab] OR Dominica*[tiab] OR East[tiab] OR East Timor[tiab] OR Ecuador*[tiab] OR Egypt*[tiab] OR El Salvador*[tiab] OR Eritrea*[tiab] OR Estonia*[tiab] OR Eswatini*[tiab] OR Ethiopia*[tiab] OR Europ*[tiab] OR Fiji*[tiab] OR Finland[tiab] OR France[tiab] OR French Guiana[tiab] OR Gabon*[tiab] OR Gambia*[tiab] OR Gaza*[tiab] OR Georgia*[tiab] OR German*[tiab] OR Ghana*[tiab] OR Greece[tiab] OR Grenada*[tiab] OR Grenadines[tiab] OR Guadeloupe[tiab] OR Guatemala*[tiab] OR Guinea*[tiab] OR Guyan*[tiab] OR Haiti*[tiab] OR Herzegovina*[tiab] OR high income[tiab] OR high-income[tiab] OR Hondura*[tiab] OR Hungary[tiab] OR Iceland*[tiab] OR income[tiab] OR India[tiab] OR Indian*[tiab] OR Indonesia*[tiab] OR Iran*[tiab] OR Iraq*[tiab] OR Ireland[tiab] OR Israel*[tiab] OR Italian[tiab] OR Italy[tiab] OR Ivory Coast[tiab] OR Jamaica*[tiab] OR Japan*[tiab] OR Jordan*[tiab] OR Kazakh*[tiab] OR Kenya*[tiab] OR Kiribati[tiab] OR Kitts[tiab] OR Korea*[tiab] OR Kosovar*[tiab] OR Kosovo[tiab] OR Kuwait*[tiab] OR Kyrgyz*[tiab] OR Lao[tiab] OR Laos*[tiab] OR Laotian*[tiab] OR latin america[tiab] OR Latvia[tiab] OR Lebanes*[tiab] OR Lebanon[tiab] OR Lebanese[tiab] OR Lesotho[tiab] OR less developed countr*[tiab] OR less developed nation*[tiab] OR Liberia*[tiab] OR Libya*[tiab] OR Liechtenstein[tiab] OR Lithuania[tiab] OR Imic[tiab] OR Imics[tiab] OR low and middle income[tiab] OR low-and-middle income[tiab] OR low income[tiab] OR low-income[tiab] OR low resource[tiab] OR low-resource[tiab] OR limited resource[tiab] OR limited-resource[tiab] OR Lucia[tiab] OR Luxembourg[tiab] OR Macedonia*[tiab] OR Madagascar*[tiab] OR Madeira[tiab] OR Malawi*[tiab] OR Malaysia*[tiab] OR Maldives[tiab] OR Mali[tiab] OR Malta[tiab] OR Marshall Island*[tiab] OR Martinique[tiab] OR Mauritania*[tiab] OR Mauriti*[tiab] OR Mexican*[tiab] OR Mexico[tiab] OR Micronesia*[tiab] OR middle income[tiab] OR middle-income[tiab] OR Moldova[tiab] OR Moldova*[tiab] OR Monaco[tiab] OR Mongolia*[tiab] OR Montenegr*[tiab] OR Montserrat[tiab] OR Morocc*[tiab] OR Mozambique[tiab] OR Myanmar[tiab] OR Namibia*[tiab] OR Nauru[tiab] OR Nepal*[tiab] OR Nevis[tiab] OR New Zealand[tiab] OR Nicaragua*[tiab] OR Niger*[tiab] OR Nigeria*[tiab] OR North[tiab] OR Norway[tiab] OR Oman*[tiab] OR Pacific[tiab] OR Pakistan*[tiab] OR Palau[tiab] OR Palestin*[tiab] OR Panama*[tiab] OR Papua[tiab] OR Paraguay*[tiab] OR Peru*[tiab] OR Philippin*[tiab] OR Poland[tiab] OR poor countr*[tiab] OR poor nation*[tiab] OR Portug*[tiab] OR Principe[tiab] OR Qatar*[tiab] OR Romania*[tiab] OR Russia*[tiab] OR Rwanda*[tiab] OR Saint Lucia[tiab] OR Saint Vincent[tiab] OR Samoa*[tiab] OR San Marino[tiab] OR Sao Tome[tiab] OR Senegal*[tiab] OR Serbia*[tiab] OR Seychelles[tiab] OR Sierra Leone*[tiab] OR Singapore[tiab] OR Slovakia*[tiab] OR Slovenia*[tiab] OR Slovene[tiab] OR Solomon[tiab] OR Solomon Island*[tiab] OR Somalia*[tiab] OR South [tiab] OR Spain[tiab] OR Sri Lanka[tiab] OR Sudan*[tiab] OR Suriname*[tiab] OR Swaziland*[tiab] OR Swed*[tiab] OR Switzerland[tiab] OR Syria*[tiab] OR Taiwan[tiab] OR Tajik*[tiab] OR Tanzania*[tiab] OR Thai*[tiab] OR third world countr*[tiab] OR third world nation*[tiab] OR Timor Leste[tiab] OR Timor*[tiab] OR Tobago[tiab] OR Togo*[tiab] OR Tonga*[tiab] OR Trinidad*[tiab] OR Tunisia*[tiab] OR Turkey[tiab] OR Turkish[tiab] OR Turkmen*[tiab] OR Turks[tiab] OR Tuvalu*[tiab] OR Uganda*[tiab] OR Ukrain*[tiab] OR under developed countr*[tiab] OR under developed nation*[tiab] OR underdeveloped country*[tiab] OR underdeveloped nation*[tiab] OR under-developed countr*[tiab] OR under-developed nation*[tiab] OR United Kingdom[tiab] OR United States[tiab] OR Uruguay[tiab] OR Uzbek*[tiab] OR Vanuatu*[tiab] OR Vatican[tiab] OR Venezuela*[tiab] OR Viet nam*[tiab] OR Vietnam*[tiab] OR Vincent[tiab] OR West[tiab] OR West Bank[tiab] OR Yemen*[tiab] OR Zambia*[tiab] OR Zimbabw*[tiab])
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Supplementary Table 1. Continued

Database	Search Terms
	('spine trauma*':ti,ab,kw OR 'spinal trauma*':ti,ab,kw OR (('spinal cord':ti,ab,kw OR 'vertebral ':ti,ab,kw OR 'vertebral column':ti,ab,kw OR 'cervical spin*':ti,ab,kw OR 'thoracic spin*':ti,ab,kw OR 'lumbar spin*':ti,ab,kw) AND ('injur*':ti,ab,kw OR 'fracture*':ti,ab,kw))) AND ('pediatric*':ti,ab,kw OR 'paediatric*':ti,ab,kw OR 'fetal*':ti,ab,kw OR 'fetus*':ti,ab,kw OR 'newborn*':ti,ab,kw OR 'infant*':ti,ab,kw OR 'preschool*':ti,ab,kw OR 'child*':ti,ab,kw OR 'adolescent*':ti,ab,kw OR 'neonate*':ti,ab,kw OR 'toddler*':ti,ab,kw) AND ('epidemiolog*':ti,ab,kw OR 'population':ti,ab,kw OR 'population-based':ti,ab,kw OR 'inciden*':ti,ab,kw OR 'prevalen*':ti,ab,kw OR 'burden':ti,ab,kw OR 'daly':ti,ab,kw OR 'disability adjusted life year*':ti,ab,kw OR 'disability-adjusted life year*':ti,ab,kw OR 'yll':ti,ab,kw OR 'years of life lost':ti,ab,kw OR 'yld':ti,ab,kw OR 'years lost to disability':ti,ab,kw OR 'years lost due to disability':ti,ab,kw OR 'ratio':ti,ab,kw OR 'qaly':ti,ab,kw OR 'quality adjusted life year*':ti,ab,kw OR 'quality-adjusted life year*':ti,ab,kw OR 'single center':ti,ab,kw OR 'single-center':ti,ab,kw OR 'single institution*':ti,ab,kw OR 'single-institution*':ti,ab,kw OR 'multicenter':ti,ab,kw OR 'multiple center*':ti,ab,kw) AND ('dominican republic':ti,ab,kw OR 'puerto rico':ti,ab,kw OR 'saudi arabia':ti,ab,kw OR 'sierra leone':ti,ab,kw OR 'virgin islands':ti,ab,kw OR 'afghanistan*':ti,ab,kw OR 'africa*':ti,ab,kw OR 'albania*':ti,ab,kw OR 'algeria*':ti,ab,kw OR 'america*':ti,ab,kw OR 'andorra*':ti,ab,kw OR 'angola*':ti,ab,kw OR 'antarct*':ti,ab,kw OR 'antigua*':ti,ab,kw OR 'arab emirate*':ti,ab,kw OR 'argentin*':ti,ab,kw OR 'armenia*':ti,ab,kw OR 'aruba*':ti,ab,kw OR 'asia*':ti,ab,kw OR 'atlantic':ti,ab,kw OR 'australia*':ti,ab,kw OR 'austria*':ti,ab,kw OR 'azerbaijan*':ti,ab,kw OR 'azores island*':ti,ab,kw OR 'baham*':ti,ab,kw OR 'bahra*':ti,ab,kw OR 'bangladesh*':ti,ab,kw OR 'barbad*':ti,ab,kw OR 'barbuda*':ti,ab,kw OR 'barthelemy':ti,ab,kw OR 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Scopus	

Continues

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Supplementary Table 1. Continued

Database	Search Terms
	TITLE-ABS-KEY(("spine trauma*" OR "spinal trauma*" OR (("spinal cord" OR "vertebral" OR "vertebral column" OR "cervical spin*" OR "thoracic spin*" OR "lumbar spin*") AND ("injur*" OR "fracture*"))) AND ("pediatric*" OR "paediatric*" OR "fetal*" OR "fetus*" OR "newborn*" OR "infant*" OR "preschool*" OR "child*" OR "adolescent*" OR "neonate*" OR "toddler*") AND ("epidemiolog*" OR "population" OR "population-based" OR "inciden*" OR "prevalen*" OR "burden" OR "ratio" OR "DALY" OR "disability adjusted life year*" OR "disability-adjusted life year*" OR "YLL" OR "years of life lost" OR "YLD" OR "years lost to disability" OR "years lost due to disability" OR "ratio" OR "QALY" OR "quality adjusted life year*" OR "quality-adjusted life year*" OR "single center" OR "single-center" OR "single institution*" OR "single-institution*" OR "multicenter" OR "multiple center*") AND ("Dominican Republic" OR "Principe" OR "Puerto Rico" OR "Sao Tome" OR "Saudi Arabia" OR "Sierra Leone" OR "Virgin Islands" OR "Afghanistan*" OR "Africa*" OR "Albania*" OR "Algeria*" OR "America*" OR "Andorra*" OR "Angola*" OR "Antarct*" OR "Antigua*" OR "Arab Emirate*" OR "Argentin*" OR "Armenia*" OR "Aruba*" OR "Asia*" OR "Atlantic" OR "Australia*" OR "Austria*" OR "Azerbaijan*" OR "Azores Island*" OR "Baham*" OR "Bahra*" OR "Bangladesh*" OR "Barbad*" OR "Barbuda*" OR "Barthelemy" OR "Barthélemy" OR "Belarus*" OR "Belgi*" OR "Belize" OR "Bengali" OR "Benin*" OR "Bermuda*" OR "Bhutan*" OR "Bissau" OR "Bolivia*" OR "Bosnia*" OR "Botswana*" OR "Brazil*" OR "Brunei" OR "Bulgaria*" OR "Burkina Faso" OR "Burma" OR "Burmese*" OR "Burundi*" OR "Cabo Verd*" OR "Caicos" OR "Cambodia*" OR "Cameroon*" OR "Canad*" OR "Cape Verd*" OR "Cayman" OR "Central" OR "Chad*" OR "Chile" OR "China" OR "Chinese" OR "Colombia*" OR "Comoros" OR "Congo*" OR "Costa Rica*" OR "Cote" OR "Cote d'Ivoire" OR "Croatia*" OR "Cuba" OR "Cuban" OR "Cyprus" OR "Czech Republic" OR "Denmark" OR "developing countr*" OR "developing nation*" OR "Djibouti" OR "Dominica*" OR "East" OR "East Timor" OR "Ecuador*" OR "Egypt*" OR "El Salvador*" OR "Eritrea*" OR "Estonia*" OR "Eswatini*" OR "Ethiopia*" OR "Europ*" OR "Fiji*" OR "Finland" OR "France" OR "French Guiana" OR "Gabon*" OR "Gambia*" OR "Gaza*" OR "Georgia*" OR "German*" OR "Ghana*" OR "Greece" OR "Grenada*" OR "Grenadines" OR "Guadeloupe" OR "Guatemala*" OR "Guinea*" OR "Guyan*" OR "Haiti*" OR "Herzegovina*" OR "high income" OR "high-income" OR "Hondura*" OR "Hungary" OR "Iceland*" OR "income" OR "India*" OR "Indonesia*" OR "Iran*" OR "Iraq*" OR "Ireland" OR "Israel*" OR "Italian" OR "Italy" OR "Ivory Coast" OR "Jamaica*" OR "Japan*" OR "Jordan*" OR "Kazakh*" OR "Kenya*" OR "Kiribati" OR "Kitts" OR "Korea*" OR "Kosovar*" OR "Kosovo" OR "Kuwait*" OR "Kyrgyz*" OR "Lao" OR "Laos*" OR "Laotian*" OR "latin america" OR "Latvia" OR "Lebanes*" OR "Lebanon" OR "Lebanese" OR "Lesotho" OR "less developed countr*" OR "less developed nation*" OR "Liberia*" OR "Libya*" OR "Liechtenstein" OR "Lithuania" OR "Imic" OR "Imics" OR "low and middle income" OR "low-and-middle income" OR "low income" OR "low-income" OR "low resource" OR "low-resource" OR "limited resource" OR "limited-resource" OR "Lucia" OR "Luxembourg" OR "Macedonia*" OR "Madagascar*" OR "Madeira Island*" OR "Malawi*" OR "Malaysia*" OR "Maldives" OR "Mali" OR "Malta" OR "Marshall Island*" OR "Martinique" OR "Mauritania*" OR "Mauriti*" OR "Mexican*" OR "Mexico" OR "Micronesia*" OR "middle income" OR "middle-income" OR "Moldova*" OR "Monaco" OR "Mongolia*" OR "Montenegr*" OR "Montserrat" OR "Morocc*" OR "Mozambique" OR "Myanmar" OR "Namibia*" OR "Nauru" OR "Nepal*" OR "Nevis" OR "New Zealand" OR "Nicaragua*" OR "Niger*" OR "Nigeria*" OR "North" OR "Norway" OR "Oman*" OR "Pacific" OR "Pakistan*" OR "Palau" OR "Palestin*" OR "Panama*" OR "Papua" OR "Paraguay*" OR "Peru*" OR "Philippin*" OR "Poland" OR "poor countr*" OR "poor nation*" OR "Portug*" OR "Principe" OR "Qatar*" OR "Romania*" OR "Russia*" OR "Rwanda*" OR "Saint Lucia" OR "Saint Vincent" OR "Samoa*" OR "San Marino" OR "Sao Tome" OR "Senegal*" OR "Serbia*" OR "Seychelles" OR "Sierra Leone*" OR "Singapore" OR "Slovakia*" OR "Slovenia*" OR "Slovene" OR "Solomon" OR "Solomon Island*" OR "Somalia*" OR "South" OR "Spain" OR "Sri Lanka" OR "Sudan*" OR "Suriname*" OR "Swaziland*" OR "Swed*" OR "Switzerland" OR "Syria*" OR "Taiwan" OR "Tajik*" OR "Tanzania*" OR "Thai*" OR "third world countr*" OR "third world nation*" OR "Timor Leste" OR "Timor*" OR "Tobago" OR "Togo*" OR "Tonga*" OR "Trinidad*" OR "Tunisia*" OR "Turkey" OR "Turkish" OR "Turkmen*" OR "Turks" OR "Tuvalu*" OR "Uganda*" OR "Ukrain*" OR "under developed countr*" OR "under developed nation*" OR "underdeveloped country*" OR "underdeveloped nation*" OR "under-developed countr*" OR "under-developed nation*" OR "United Kingdom" OR "United States" OR "Uruguay" OR "Uzbeki*" OR "Vanuatu*" OR "Vatican" OR "Venezuela*" OR "Viet nam*" OR "Vietnam*" OR "Vincent" OR "West" OR "West Bank" OR "Yemen*" OR "Zambia*" OR "Zimbabw*"))

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