



Original research

Backlog and burden of fractures in Sierra Leone and Nepal: Results from nationwide cluster randomized, population-based surveys



Barclay T. Stewart^{a, o, *}, Adam L. Kushner^{b, c, d}, Thaim B. Kamara^{e, f}, Sunil Shrestha^g, Shailvi Gupta^{b, h}, Reinou S. Groen^{b, i}, Ben Nwomeh^{b, j}, Richard A. Gosselin^{k, l}, David Spiegel^{m, n}

^a Department of Surgery, University of Washington, Seattle, WA, USA

^b Surgeons OverSeas (SOS), New York, NY, USA

^c Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

^d Department of Surgery, Columbia University, New York, NY, USA

^e Department of Surgery, Connaught Hospital, Freetown, Sierra Leone

^f Ministry of Health and Sanitation, Freetown, Sierra Leone

^g Department of Surgery, Nepal Medical College, Kathmandu, Nepal

^h Department of Surgery, University of California San Francisco East Bay, Oakland, CA, USA

ⁱ Department of Obstetrics and Gynecology, Johns Hopkins Hospital, Baltimore, MD, USA

^j Department of Pediatric Surgery, Nationwide Children's Hospital, Columbus, OH, USA

^k School of Public Health, University of California, Berkeley, CA, USA

^l Institute for Global Orthopedics and Traumatology, Orthopaedic Department, University of California, San Francisco, USA

^m Division of Orthopedic Surgery, Children's Hospital of Philadelphia, PA, USA

ⁿ Hospital and Rehabilitation Centre for Disabled Children, Janagal, Banepa, Kavre, Nepal

^o Department of Interdisciplinary Health Sciences, Stellenbosch University, Cape Town, South Africa

H I G H L I G H T S

- More than 2 million DALYs incurred by fractures could be averted by 2025 in Sierra Leone and 2.5 million DALYs could be averted in Nepal.
- Averting the aforementioned DALYs will require an estimated US\$ 4,049,932 (range US\$ 2,011,500–6,088,364) and US\$ 4,962,402 (range US\$ 2,464,701–7,460,103), respectively.

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Background: The burden of injury is increasing worldwide; planning for its impact on population health and health systems is urgently needed, particularly in low- and middle-income countries (LMICs). This study aimed to model the burden of fractures and project costs to eliminate avertable fracture-related disability-adjusted life-years (i.e., a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or premature death; DALYs) in Sierra Leone and Nepal.

Methods: Data from nationwide, cluster-randomized, community-based surveys of surgical need in Sierra Leone and Nepal were used to model the incidence and prevalence of fractures stratified by met and unmet needs. DALYs incurred from treated and untreated fractures were estimated. Additionally, the investment necessary to eliminate avertable incident fracture DALYs was modeled through 2025 using published cost per DALY averted estimates.

Results: The incidence of treated and untreated fractures in Sierra Leone was 570 and 1004 fractures per 100,000 persons, respectively. There could be more than 2 million avertable fracture DALYs by 2025 in Sierra Leone and 2.5 million in Nepal requiring an estimated US\$ 4,049,932 (range US\$ 2,011,500–6,088,364) and US\$ 4,962,402 (range US\$ 2,464,701–7,460,103) to address this excess burden, respectively.

Conclusion: This study identified a significant burden of untreated fractures in both countries, and an opportunity to avert more than 4.5 million DALYs in 10 years in a cost-effective manner. Prioritizing funding mechanisms for orthopaedic care and implants should be considered given the large burden of

* Corresponding author. University of Washington, Department of Surgery, 1959 NE Pacific St., Suite BB-487, PO Box 356410, Seattle, WA 98195-6410, USA.
E-mail address: stewarb@uw.edu (B.T. Stewart).

untreated fractures found in both countries and the long-term savings and functional benefit from properly treated fractures.

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1. Introduction

Given the large and increasing burden of injuries worldwide, better planning for its impact on health systems is urgently needed [1,2]. Inopportunistly, the burden of injury falls disproportionately on low- and middle-income countries (LMICs), which are least equipped to deliver essential trauma care [3,4]. Therefore, LMICs have the greatest need for accurate estimates of injury burden to plan targeted health system strengthening interventions [5].

For each traumatic death there are an estimated 20 patients who survive, one of whom will be permanently disabled, often from a musculoskeletal injury [6]. The delivery of safe and timely care for musculoskeletal injuries can prevent disability and minimize healthcare costs, as the treatment of neglected fractures and dislocations is more complex, more costly, and less likely to achieve satisfactory outcomes [7,8].

A number of studies have documented deficiencies in infrastructure, physical resources, and human resources for trauma care in LMICs [9]. Currently, essential fracture care is inadequate to meet the needs of most LMIC populations [10–12]. In Gujarat State India, X-ray capabilities were available to less than half of patients in need, even in high-income district tertiary centers [11]. Further, basic fracture care (e.g. closed reduction, traction, external or internal fixation and prosthetic fitting) was not reliably available in nearly all hospitals sampled. Similar findings from assessments of surgical and trauma care capacity in Ghana, Sierra Leone, Nicaragua and Malawi suggest a systemic problem in LMIC healthcare systems that needs urgent investment [13–16]. The summative effect of this lack of capacity on patients, their families and communities remains poorly understood and underappreciated [17].

This study aimed to use nationwide survey data from Sierra Leone and Nepal to model the backlog (i.e., current or prevalent unmet need for orthopaedic care) and incident (i.e., new need for orthopaedic care) disability-adjusted life years (DALYs) from fractures and project the financial resources required to eliminate avertable fracture-related DALYs. DALYs are a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or premature death. By doing so, baseline estimates for future benchmarking can be documented and an evidence base for healthcare planning to support fracture care in LMICs can be strengthened.

2. Methods

2.1. Setting

Sierra Leone is a small West African country with a population of around 6 million and ranked 183rd of 187 nations by the United Nations Development Index (UNDI) in 2014 [18]. In a survey of surgical capacity, none of the hospitals sampled had uninterrupted power or oxygen supply and most hospitals were critically deficient in essential surgical equipment and medical consumables [19]. After the tragic Ebola deaths of two surgeons, the country has only eight trained general surgeons (0.13 per 100,000 persons vs 9 per 100,000 persons in the United States) and three orthopedists (0.05 per 100,000 persons vs 9 per 100,000 persons in United States) [20–23].

Nepal is a low-income country in South Asia with 27.8 million inhabitants transitioning from a decade-long conflict that ended in 2006 [24]. Political unrest has left the national healthcare system fragile, under-resourced and unable to adequately care for the population's disease burden [25]. In addition, Nepal's rugged terrain and deficiencies in infrastructure limit access to healthcare for much of the population [26]. Nonetheless, Nepal's healthcare system is somewhat more developed than that of Sierra Leone, evidenced by being ranked 138th by the UNDI and having 158 orthopaedic surgeons (0.57 per 100,000 persons) [18,27].

2.2. Survey

The Surgeons OverSeas Surgical Assessment Survey (SOSAS) is a validated, cluster randomized, cross sectional, countrywide survey that identifies potentially treatable surgical conditions. Detailed methods have been previously reported from both Sierra Leone and Nepal [4,28]. Briefly, heads of randomly selected households are interviewed for household demographics and deaths attributable to lack of surgical care in the preceding year. Then, two household members are randomly selected to participate in a verbal head-to-toe examination. History and symptoms are verbally elicited for surgical conditions specific to anatomic regions occurring in the last year (i.e. incident condition) and before one year prior to survey (i.e. prevalent condition). A fracture was defined as: i) an isolated extremity acquired deformity from injury; or ii) having been diagnosed with a fracture by a healthcare provider in the absence of other injuries that required hospital care.

The definition used for fracture care was purposefully inclusive, comprised of: manipulation, casting, traction, external fixation, internal fixation or 'major surgery requiring anesthesia.' SOSAS was performed in 2012 in Sierra Leone and 2014 in Nepal [4,28]. All results from Sierra Leone were population adjusted to 2014 for apposite comparison. Lastly, confidence intervals were calculated with Taylor-linearized variance estimation; the inverse probability of being sampled from each sampling unit (e.g. region, district) was applied as sampling weights [29].

2.3. Backlog

Given a remote census in Sierra Leone, current World Bank figures were used to geometrically extrapolate the population from 2012 to 2025 [30]. Conversely, Nepal has had several censuses [24]; these estimates were used to perform second-degree parabolic extrapolation to estimate the population from 2014 to 2025 [31]. Subsequently, a 10-year open cohort was constructed to represent fracture incidence and prevalence from 2014 to 2025, stratified by met and unmet need. Backlog was defined as the sum of incident and prevalent unmet need. Data were analyzed using Stata v13 (College Station, TX, USA).

2.4. DALYs incurred in 2014

Incident DALYs were calculated using the World Health Organization's methods with modifications based on the following assumptions [3]. First, disability weights by fracture site were retrieved from the Global Burden of Disease Database, separately

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