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REVIEW

Global Health Inequities in Orthopaedic Care: Perspectives Beyond the US

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Abstract

Purpose of Review The burden of musculoskeletal disease is increasing globally and disproportionately affecting people in low and middle income countries (LMIC). We sought to review global access to orthopaedic care, burden of trauma, research infrastructure, impact of surgical mission trips, implant availability, and the effect of COVID-19 upon the delivery of orthopaedic care worldwide.

Recent Findings The majority of people in LMIC do not have access to safe, quality surgical care, and there are few fellowship-trained orthopaedic traumatologists. Road traffic accidents are the leading cause of long bone fractures in LMIC and result in significant morbidity and mortality. Of the orthopaedic literature published globally in the last 10 years, less than 15% had authors from LMIC. There has been growth in surgical mission trips to LMIC, but few organizations have established bidirectional partnerships. Among the challenges to delivering quality musculoskeletal care in LMIC is timely access to quality orthopaedic implants. Implant options in LMIC are more limited and subjected to less rigorous testing and regulation than high income countries (HIC). The COVID-19 pandemic dramatically reduced elective surgeries but saw the increase in telemedicine utilization which has prevailed in both HIC and LMIC.

Summary Awareness of global inequities in orthopaedic care is growing. Much can be learned through collaborations between orthopaedic surgeons from HIC and LMIC to advance patient care worldwide. There is a need for high quality, accurate data regarding incidence and prevalence of musculoskeletal disease, care utilization/availability, and postoperative outcomes so resources can be allotted to make orthopaedic care more equitable globally.

Keywords Global health · Orthopaedic inequities · Low and middle income countries (LMIC) · Orthopaedic trauma · Surgical mission trips · Global orthopaedic implants

Introduction

In 1966, Dr. Martin Luther King Jr. boldly proclaimed, "Of all the forms of inequity, injustice in health is the most shocking and the most inhumane" [1]. Globally, there is an increasing burden of musculoskeletal disease in both high income countries (HIC) and low and middle income countries (LMIC) [2]. Though the acronym LMIC is used liberally, [3] LMIC are technically defined by the World Bank as any country that has a gross national income (GNI) less than $13,846 per capita, with further subsets within LMIC defined as low income ($1,135 or less), lower middle-income ($1,136 to $4,465), and upper middle-income ($4,466 to $13,845) [4]. Musculoskeletal disease is an umbrella term that includes any health condition that affects the musculoskeletal system which is comprised of bone, joint, muscle, and connective tissues [5]. The Global Alliance for

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Musculoskeletal Health (G-MUSC) began collecting data in 2020 and has since published an international blueprint that can be adapted to the individual needs of each country to improve overall musculoskeletal health of the population and expand the musculoskeletal infrastructure [6].

Access to Care

In 2014, *The Lancet* launched a commission on global surgery spanning 110 countries and found that 90% of people living in LMIC do not have access to safe and affordable basic surgical care (Fig. 1) [7]. Even if surgical care is available, many people in LMIC face financial hardship after surgery due to the high costs associated. It is perceived that low operative volumes in LMIC may be due to high case fatality associated with common surgical procedures, which dissuades further expansion of surgical services [7]. The geographic regions which lack access to surgical care, yet have high need and potential for utilization, are South Asia and central, eastern, and western Africa. *The Lancet* Commission proposed the goal that by 2030, 66% of countries would be able to provide 5,000 surgical procedures per 100,000 people [7]. Though expanding surgical care may not be at the top of the agenda for LMIC, there is great benefit including a decrease in premature death and disability along with contributing to development, both economically and socially [7]. Expanding surgical infrastructure alone is insufficient, as without proper postoperative wound care and rehabilitation, postoperative infection and preventable functional impairment may ensue, leaving the patient potentially in a worse state than they were preoperatively [8]. Furthermore, the care must be high quality. To increase quality and safety, surgical checklists have been adopted (Table 1) [9] with a modified version by the World Health Organization (WHO) that has been shown to decrease morbidity and mortality [10].

Specifically regarding orthopaedic subspecialties, access to trauma care is most widespread in LMIC, comprising the cornerstone of orthopaedic care [11]. Second to trauma, 113 countries have documented use of the Ponseti method for clubfoot casting demonstrating the widespread availability of treatment for congenital orthopaedic conditions

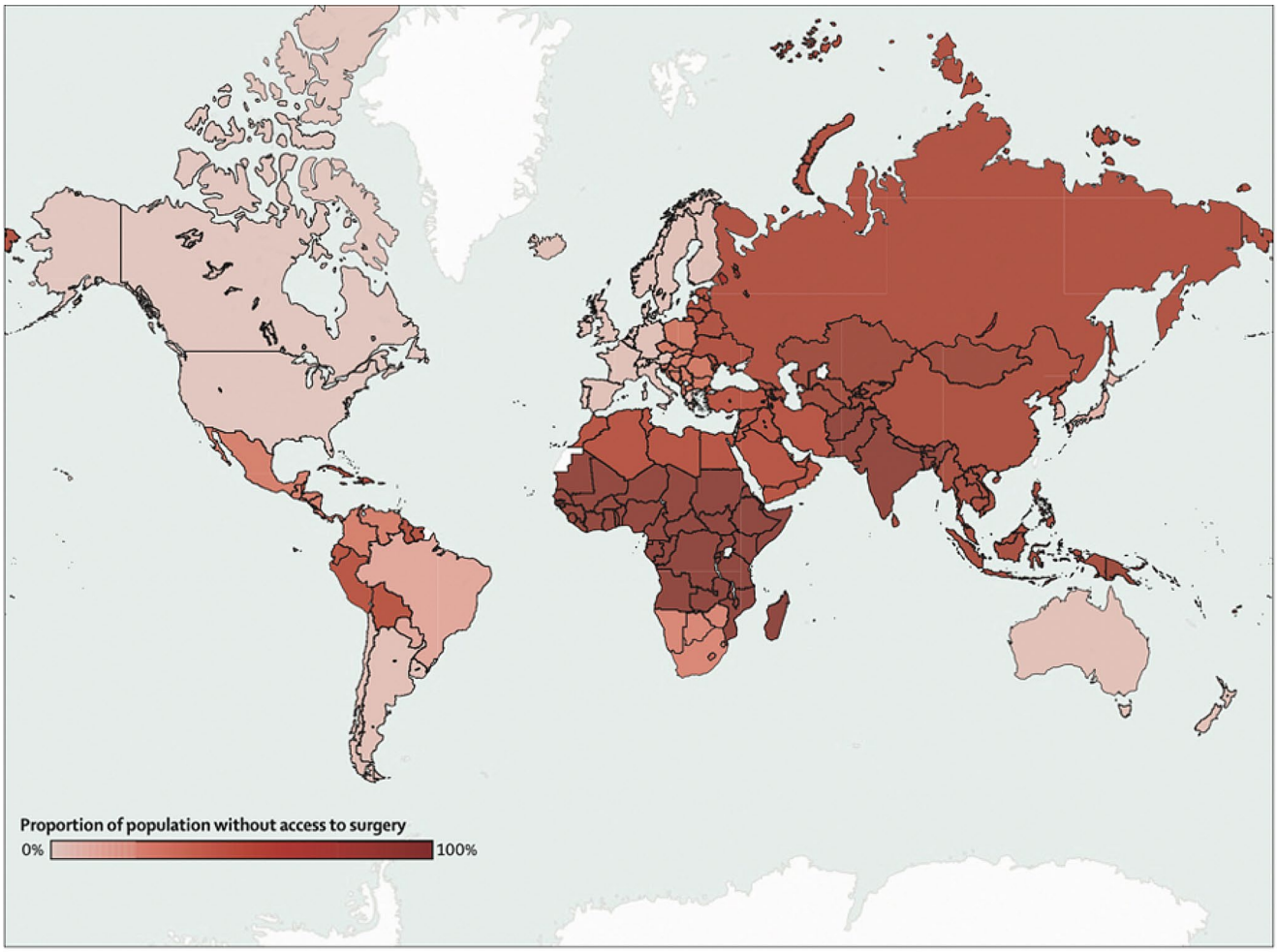

Fig. 1 Proportion of population without access to surgery. Reproduced with permission from Meara et al. [7]

Table 1 Elements of a Surgical Safety Checklist. Reproduced with permission from Haynes et al. [9]

Sign in
Before induction of anesthesia, members of the team (at least the nurse and an anesthesia professional) orally confirm that:
The patient has verified his or her identity, the surgical site and procedure, and consent
The surgical site is marked or site marking is not applicable
The pulse oximeter is on the patient and functioning
All members of the team are aware of whether the patient has a known allergy
The patient's airway and risk of aspiration have been evaluated and appropriate equipment and assistance are available
If there is a risk of blood loss of at least 500 ml (or 7 ml/kg of body weight, in children), appropriate access and fluids are available
Time out
Before skin incision, the entire team (nurses, surgeons, anesthesia professionals, and any others participating in the care of the patient) orally:
Confirms that all team members have been introduced by name and role
Confirms the patient's identity, surgical site, and procedure
Reviews the anticipated critical events
Surgeon reviews critical and unexpected steps, operative duration, and anticipated blood loss
Anesthesia staff review concerns specific to the patient
Nursing staff review confirmation of sterility, equipment availability, and other concerns
Confirms that prophylactic antibiotics have been administered ≤60 min before incision is made or that antibiotics are not indicated
Confirms that all essential imaging results for the correct patient are displayed in the operating room
Sign out
Before the patient leaves the operating room:
Nurse reviews items aloud with the team
Name of the procedure as recorded
That the needle, sponge, and instrument counts are complete (or not applicable)
That the specimen (if any) is correctly labeled, including with the patient's name
Whether there are any issues with equipment to be addressed
The surgeon, nurse, and anesthesia professional review aloud the key concerns for the recovery and care of the patient

[12]. Recently, access to arthroplasty has been increasing in LMIC with Davies et al. finding similar complication rates after total hip and knee arthroplasty in Sub-Saharan Africa as compared to HIC [13]. Likewise, access to arthroscopy is increasing in LMIC but is more limited due to the specialized equipment and training required [14, 15].

Physical distance to a hospital is a major barrier to orthopaedic care worldwide with the median distance being 30–35 kilometers (km) in LMIC versus less than 5 km in HIC [7]. Especially where there is not an established public transit system, this can be a major obstacle. As early as the 2000s, telemedicine was proposed as a solution to expand access in areas without orthopaedic surgeons [16]. It began as phone calls and expanded to video conferencing for consultation and diagnosis [16]. Today, telemedicine is used in orthopaedic care in both HIC and LMIC, though there is more published research about its use in HIC [17–19].

Trauma Burden

Given regional, cultural, and population differences, the World Bank recognized the challenges of quantifying disease burden globally and commissioned the Institute for Health Metric and Evaluation (IHME) to create the Global Burden of Disease (GBD) research group which has been collecting data since 1990 and most recently published its updated findings in 2019 [20]. With increased global industrialization, fracture incidence has been increasing worldwide with 178 million fractures reported in 2019, comprising a 33% increase since 1990, though years lived

with disability (YLD) decreased, perhaps due to advances in musculoskeletal care [21].

Whereas the GBD publishes conglomerate worldwide data, it is helpful to review studies from individual LMIC to better understand the orthopaedic trauma burden [22]. Cordero et al. [23] conducted a literature review of incidence and prevalence of pelvic and appendicular fractures in LMIC, finding 21 articles published in 14 countries that met their inclusion criteria. The only data available for incidence of all fracture types across all ages ranged from an average of 779 (Nepal) to 1,574 (Sierra Leone) per 100,000 person years and was based on population sampling [24]. Of those studies that analyzed fragility fractures in adults, Ethiopia had the highest incidence with 285.9 per 100,000 person years derived from hospital based convenience sampling [25]. Amongst pediatric patients with fractures and dislocations, the highest reported incidence was in Bolivia where there were 5,925.3 per 100,000 person years derived from a school based survey [26]. Cordero et al. points out that these studies largely include convenience sampling and may not be representative of fracture burden throughout LMIC [23]. In an injury population analysis from Bangladesh, Alonge et al. [27] found the highest injury mortality rates by occupation to be for rickshaw and bus drivers. Of deaths caused by injury, 17% were due to road traffic accidents, and the leading cause of injury death amongst adolescents and young adults from age 15–24 was suicide [27]. There is a high prevalence of psychiatric comorbidities amongst orthopaedic trauma patients that can be seen worldwide, regardless of the country's economic status [28, 29].

O'Hara et al. [30] highlighted how devastating isolated femur and tibia fractures can be for individuals living in LMIC by performing a longitudinal study after road traffic accidents in Uganda. Due to limited access to surgery and financial barriers, and despite all patients being admitted to the national referral hospital after their injury, only 56% of patients with femur and tibia fractures had operative intervention. Of the entire cohort, only 12% returned to their pre-injury level of function and recovered their work earning potential at two years post injury [30]. Whiting et al. [31] in surveying orthopaedic surgeons in LMIC who treat pelvic and acetabular fractures strikingly showed that 33% of responding trauma centers do not have an orthopaedic surgeon equipped to manage these fractures operatively with only 60% having access to a CT scanner, 78.7% having intraoperative fluoroscopy, and 21.3% having interventional radiologists capable of performing angiography and embolization. There is difficulty in getting these patients to a trauma center for evaluation as only 45.3% of trauma centers had a ground ambulance system so instead, the transport burden falls upon patients, family, and friends with some travelling up to 1,000 km or 20 h to receive care. This results in a delay to care for patients with operatively treated acetabular and pelvic fractures being treated on average 15 and 8.9 days postinjury, respectively. For those patients that did have surgically treated pelvis and acetabular fractures, 78.7% of hospitals had inpatient physical therapy (PT) but postoperative disposition was limited with only 22.7% having home PT available and 12% having availability to discharge patients to subacute rehab (SAR) or a skilled nursing facility (SNF). Many of the surgeons caring for patients with pelvic and acetabular fractures had minimal subspecialty trauma training with only 18.7% having completed a 1 year trauma fellowship and 53.3% with no formal training in pelvic/acetabular surgery [31]. Programs have emerged in LMIC to expand specialized trauma care such as the Orthopaedic Trauma Care Specialist (OTCS) program, a 2 year residency created by the University of Maryland for orthopaedic surgeons in Haiti with the future goal of expanding to other LMIC [32].

Research

In 2004, Doyal [33] drew attention to the fact that globally only 10% of research funding goes to the countries with the highest disease burden, affecting approximately 90% of the world's population. Since the publication of the landmark editorial, this has been referred to as the 10/90 health research gap [33]. In HIC, patient reported outcome measures (PROMs) have become the standard to advance evidence based medicine (EBM) with the Centers for Medicaid and Medicare Services (CMS) requiring reporting of PROMs for all patients undergoing hip and knee arthroplasty by 2027 [34]. Bernstein et al. [35] called for the importance of creating PROMs that are relatable and applicable in LMIC so that unique priorities can be set for each community, and it can be analyzed if surgical interventions being carried out are actually beneficial to patients. There are many barriers to collecting PROMs in LMIC, which include but are not limited to, lack of patient follow-up, lack of validated, applicable PROMs, availability of electronic platforms to collect and analyze the PROMs, and low health literacy amongst patients [35, 36].

Elliott et al. [37] in interviewing academic orthopaedic surgeons in East Africa found that the greatest barriers to research were funding, lack of protected research time and research training, and data management. The participants expressed how data collection was challenging with the largely paper medical records. Despite these barriers, 86% of participants stated that there was a research requirement for promotion and resident education. Rather than focusing on publishing in international journals, authors from LMIC emphasized the importance of supporting local and regional journals [37]. Only 14.3% of orthopaedic literature

published globally in the last 10 years was published by authors from LMIC [38]. To address this publishing inequity, Brown et al. [39] calls for the establishment of HIC-LMIC partnerships and provides recommendations for how to go about this. One such partnership is the Institute for Global Orthopedics and Traumatology (IGOT) at the University of California San Francisco (UCSF) which was created in 2006 and provides research training and publication assistance to LMIC in addition to bidirectional educational partnerships [40]. Clearly, partnerships such as IGOT have been successful as Young et al. [41] conducted a systematic review of all published orthopaedic articles from 2009 to 2018 with cohorts based in LMIC and identified 1,573 articles with 89.8% having first authors from LMIC and 87.8% having last authors from LMIC, though multivariate analysis showed funded studies were less likely to have LMIC last authors ($p = 0.0297$), those with higher impact factors were less likely to have LMIC first ($p = 0.0351$) and last author ($p = 0.0434$), and those articles that spanned multiple countries as the population of interest were less likely to have LMIC first or last authors ($p < 0.0001$). Furthermore, institutional and hospital registries can be a source of publications though the majority of joint arthroplasty registries (JAR) are found in HIC, with the only LMIC having such registries being China and Colombia [42].

Surgical Mission Trips

In 1961, Orthopaedics Overseas was born from the Orthopaedics Letters Club and the Association of Bone and Joint Surgeons (ABJS) conducting its first surgical outreach mission to Jerusalem and Jordan [43, 44]. The organization thereafter expanded to not only provide care on weeklong surgical mission trips but to also expand local orthopaedic infrastructure [43]. Since that time, there have been innumerable orthopaedic mission trips carried out by a range of individual surgeons and nongovernmental organizations (NGOs) after wars, natural disasters, and to impoverished areas with seemingly minimal oversight and documented outcomes tracking, raising concern for medical voluntourism [45, 46]. Though arduous and requiring partnership with local surgeons, Torchia et al. [47] has shown that it is possible to develop an effective follow-up program after short duration missions of less than one week which includes providing local health officials with a digital camera so that they can provide postoperative photographic documentation and sending local health officials out to the patients' last known address for follow-up if the patients did not come to their scheduled postoperative visits. Furthermore, the question of cost effectiveness of such missions has been raised and analyzed with the metric of cost of Disability Adjusted Life Year (DALY) averted, which is defined as the cost of an intervention to avoid a year of life that would be lost to morbidity or mortality [48]. This metric was created by the WHO Choosing Interventions that are Cost Effective (CHOICE) initiative which defines surgery that costs less than or equal to the per capita gross domestic product (GDP) as "very cost effective" and up to three times the per capita GDP as "cost effective;" anything above this is deemed "not cost effective." [49] Nolte et al. [48] in systematically reviewing published global orthopaedic outreach found that all ten included studies were very cost effective. The orthopaedic surgeries included and deemed to be very cost effective were fracture stabilization, wound debridement, amputation, and surgical release of contractures [48]. Going forward, it would be beneficial for medical mission trips performing other procedures, such as arthroplasty, to report on cost of DALY averted to measure their impact and cost effectiveness. Measuring cost of DALY averted also provides opportunity for HIC-LMIC research partnerships.

As aforementioned, IGOT has not only increased research output from LMIC but has also been pivotal in building local infrastructure in LMIC and promoting bidirectional education of orthopaedic surgeons and trainees adapted to meet the unique needs of each individual community [40]. Out of IGOT emerged the Surgical Management and Reconstructive Training (SMART) course when it was realized that many orthopaedic surgeons lack basic tools of soft tissue coverage and handling which is vital for the treatment of open fractures [50]. This was not unique to LMICs but was found in HICs also as many orthopaedic surgeons are afforded the luxury of working in tertiary care centers where they can collaborate with plastic surgeons who assist with soft tissue coverage [50]. Initially, the SMART course was held in the United States (US) with international attendees, but to decrease barriers to participation, it is now held in multiple continents around the world, showcasing the teaching of local faculty [40]. Carey et al. [50] studied the effectiveness of the course by surveying attendees' use of flaps after the course with 34 course attendees having performed a total of 594 flaps with 93% success rate and 121 faps reportedly preventing amputation. Amongst the flaps used, all of which do not require microscope or loupe access, the five most commonly performed were gastrocnemius, VY advancement, soleus, cross finger, and reverse sural [50].

The exchange of orthopaedic educational content between HIC and LMIC has been deemed to have the greatest lasting impact on patient outcomes [51, 52]. The expansion of internet connectivity has made on-demand technique videos more accessible worldwide on platforms such as Hand-e from the American Society for Surgery of the Hand (ASSH), American Academy of Orthopaedic Surgery's Orthopaedic Video Theater (AAOS OVT), YouTube, Touch Surgery, and VuMedi [8, 53]. It has also

been recognized that some complex surgeries are not safe to be carried out in LMIC, even when expert surgeons and specialized equipment are brought in [54]. To remedy this situation, the ASSH has formed partnerships with Shriners Hospitals for Children and various NGOs to facilitate what they term a "reverse commute," bringing pediatric patients and families with complex surgical problems that would be unsafe to execute in their home countries to the US for care [54].

Implant Availability

Whereas orthopaedic surgeons in the US are highly dependent on sophisticated implants and custom cutting guides, internationally, orthopaedics operates on more simple principles such as external fixation with minimal need for advanced equipment [55]. Meara et al.'s [7] global analysis emphasized the need for five basic orthopaedics procedures: amputation, closed treatment of fracture, clubfoot repair, drainage of osteomyelitis or septic arthritis, and joint dislocation treatment. For open reduction internal fixation, implants are largely limited to Kirschner wires (k wires) as plates and screws incur much higher cost or may be unavailable [8]. However, the Surgical Implant Generation Network (SIGN) nail was created in 1999 as a low cost fixation option in LMIC for adult femoral, tibial, and humeral shaft fractures [56] but now has pediatric uses [57] and has been expanded to knee [58] and tibiotalocalcaneal (TTC) fusions [59]. SIGN nails are unique and applicable to LMIC in that they do not require intraoperative fluoroscopy or power reaming and achieve high rates of union with minimal complications [60, 61]. Whiting et al. [31] found that at LMIC trauma centers that regularly treat pelvis and acetabular fractures, only 53.3% of hospitals had cannulated screws, 56% had pelvic reconstruction plates, and 68% had pelvic reduction clamps and retractors. Likewise, sterilized power instruments may not be available so manual insertion with hand powered drilling or malleting may be employed [8]. Interestingly, malleting k wires into place rather than using power creates less heat necrosis and can optimize postoperative healing [62].

In 2018, Henshaw et al. [63] drew attention to the lack of published engineering standards for arthroplasty (hip and knee) and trauma implants in LMIC and HIC countries. The authors detailed their plan to systematically review the top ten manufacturers with three major standards: biocompatibility, materials, and implant type. Clearly this is no small undertaking as the full review is still not yet published [63]. Similarly, Ikwuegbuenyi et al. [64] conducted a systematic review of regulatory oversight and availability of spinal implants in LMIC, specifically focusing on Africa, and of the six identified studies, did not find any specific standards for spinal implants. Gupta et al. [65] in evaluating acetabular fractures treated in India noted a higher failure rate of locally produced, less expensive implants than those available worldwide and preferentially used by HIC. It was hypothesized that despite higher failure rates, patients opted for the locally produced implants because the patient had to fully bear the cost [65]. Likewise, higher failure was seen in Cambodia with locally produced arthroplasty implants [66].

Though not technically an implant, attention should also be drawn to limited prosthetic availability in LMIC with an estimated 29 million people in need of prosthetics and orthotics [67]. Donnelly et al. [68] showed that prosthetics for transfemoral amputees were cost effective in Tanzania, and multiple studies shows these prosthetics can be manufactured with 3D printers [69, 70].

COVID-19

The COVID-19 pandemic had a direct impact on musculoskeletal care from closing hospitals and clinics to causing a shortage of trained, well-educated staff due to the lockdowns that affected in-person, medical education [71, 72]. One of the greatest changes, which is presumed to have lasting impact, was the more widespread adoption of telemedicine within orthopaedic surgery [73]. Though orthopaedic telemedicine predates the pandemic, [74] its use expanded during 2020 and has prevailed even after lockdowns have ended [75]. In LMIC, orthopaedic telemedicine has primarily been adopted to aid in postoperative care but has potential for further expansion such as telerehabilitation, increasing access to orthopaedic care. [18, 19, 76] There was no difference in patient satisfaction rates with telemedicine between HIC and LMIC with both reporting at least 90% satisfaction [17, 77].

Conclusion

This review highlights the global inequities in orthopaedic care that can no longer be ignored and must be brought to the forefront. Orthopaedic surgeons can unite through HIC-LMIC partnerships to lessen the burden of disease by producing high quality, accurate data regarding incidence and prevalence of musculoskeletal disease, care utilization/availability, and postoperative outcomes. Access to care can be expanded through telemedicine and surgical mission trips that publish their outcomes data. It is up to us to devise unique solutions so that orthopaedic care can be more equitable worldwide.

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