

Richard A. Gosselin
David A. Spiegel
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Editors

Global Orthopedics

Caring for Musculoskeletal
Conditions and Injuries in
Austere Settings

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To Sherry and Pearl who made all of it possible – RAG

*To Maryam and Sophie, my partners, and all my colleagues at
HRDC – Drs. Ashok Banskota, Bibek Banskota, Om Shrestha,
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Abhiram Singh, Saroj Rijal, and Babu Kaji Shrestha – DAS*

To Orty with respect and love – MF

Preface

The burden of musculoskeletal diseases and conditions in low and middle income countries (LMICs) has increased substantially over the past 15 years, while the resources to address this are grossly inadequate. In particular, the development-fueled epidemic of injuries primarily affects young males during their most productive years, and the resulting disabilities have a profound impact on the individuals, their families, and society as a whole.

The aging of populations in these same countries has unleashed the musculoskeletal co-morbidities of chronic diseases, further increasing stresses on limited health care resources. The consequences can be social, economic, and/or political. Despite evidence of an “epidemiologic transition”, in which non-communicable diseases are eclipsing communicable diseases, only 10 % of global resources for health care are allocated for conditions that account for 90 % of the world’s disease burden. Funding for musculoskeletal conditions is negligible when compared with the resources directed to other health problems such as the infectious diseases.

Access to health services is limited for large segments of the population in developing countries, and many of those who present for care do so at a late stage in their disease. This makes the treatment of these “neglected” conditions more challenging, requires more complex and less cost-effective solutions, and often results in undesirable outcomes. In many cases, salvage treatments are all that can be offered. For every orthopedic patient who reaches a clinic or hospital, many more will have first been seen by a traditional healer or bonesetter. Even in district and provincial hospitals, most orthopedic problems are handled by nurses, orthopedic technicians, general practitioners, and general surgeons; orthopedic surgeons are usually found only in tertiary centers in major cities.

The general standards and use of technology in orthopedics in LMICs rarely match those in richer parts of the world, and health services are dependent on the available human, material, monetary, and institutional resources. Wide variations in access to and utilization of health services are seen both between and within developing countries, especially when comparing rural and urban communities. Disparities often reflect a growing gap between the rich and the poor within each setting, rather than a “north-south”, “developed-underdeveloped”, or “1st-3rd world” division.

Globalization has changed the dynamics of health care and has increased awareness of the inequities in services available in austere environments. This has led to a great interest in global health and international volunteerism,

as evidenced by the extraordinary response to recent natural disasters. In addition, institutions from high income countries have developed and promoted programs and initiatives that aim to improve education and services in LMICs. Enhanced access to travel and communication offers unprecedented opportunities to improve orthopedic services worldwide.

Given this information, how can interactions between practitioners from resource rich and resource poor settings lead to better care for patients throughout the world? We cannot overemphasize the value of the exchange of information and experiences between colleagues from these different environments, encouraging the concept of a “two way street”. Surgeons from places in which resources are readily available must necessarily adapt their knowledge and skills in a relevant manner when working in austere environments. Challenges include evaluating and treating familiar conditions, such as trauma and infections that present late or with complications that are rarely seen in the West, and unfamiliar conditions such as osteoarticular tuberculosis, the residua of poliomyelitis, and the sequelae of untreated congenital deformities. Colleagues practicing in resource constrained environments will be exposed during these interactions to problem solving skills and technologies from resource rich environments, and they must determine to what extent the information can be adapted to their needs.

Contextual variables must be recognized and addressed when choosing among treatments. Management must be individualized and adapted to the local environment, taking into account the desires of the patients and their families, the anticipated needs for activities of daily living, and the physical demands of work, the local resources, and the potential for rehabilitation. What may seem an obvious treatment in one setting may be inappropriate or harmful in another, and the differences are often subtle.

Our goal is to create a text book that is unique in scope, based on the experiences and insights of authors from a wide variety of settings around the world. This shared endeavor pairs surgeons from resource rich settings who have experience working in austere environments, with surgeons who work daily in difficult conditions in LMICs to make a balanced text that will be beneficial to all practitioners treating orthopedic conditions where resources are limited. This book does not pretend to address all musculo-skeletal conditions, but rather explores an array of commonly seen problems and solutions. There is not much “evidence” on which to base some of the recommendations, other than experience, but more importantly, we hope the principles implied by these recommendations will guide the practitioner to a rational approach. Not one of the authors will be in 100 % agreement with what is written. Rather, we have tried to tap into the cumulative experience of all authors, which totals well over 500 years.

The word “surgery” has been omitted from the title, recognizing that the management of musculoskeletal conditions and injuries in austere settings is largely non-operative. While some surgical techniques and approaches are described, this is not the main focus of the book. The primary aim is to provide volunteers or others engaged in elective or relief work in teaching and/or service provision with sound, basic principles and tools for the appropriate and effective management of orthopedic conditions. The needs are great, and a

surgeon working in a resource constrained setting will have his or her perceptions regarding the field of orthopedic surgery expanded and enhanced in ways that few other learning experiences offer. We hope in the end, the reader will appreciate the limitations of austere environments, and have acquired the knowledge to address both familiar and unfamiliar conditions in these settings.



A child with paraplegia wanted to play badminton, so a custom frame was constructed in the workshop. While some conditions cannot be cured, something can always be done to improve the lives of our patients (Courtesy of the Hospital and Rehabilitation Centre for Disabled Children, Janagal, Kavre, Nepal)

What Do We Call this Place?

There is no one set of terms that reflects the economic and human realities on the ground that can be used for every situation where a volunteer orthopedic surgeon might travel.

Some divisions that were used in the past are politically outdated, such as third world—a term previously used for countries aligned with neither free-market economies nor the communist second world. Most were poor countries and the term remains in the lexicon in an off-hand manner.

The division into developed and developing—the latter sometimes qualified as economically under-developed—has been commonly used and plays into the idea of development as it is practiced by governmental and non-governmental aid agencies working to upgrade infrastructure, build capacity, and generally improve the lives of people. A variety of spin-offs, such as, “still developing” add nuance, but little concrete information. We use these terms in this text primarily out of habit and for simplicity’s sake.

Low and middle income countries (LMICs) is a broad economic term defined by specific country-wide income brackets.¹ It is unfreighted with ambiguous or pejorative meaning, but is clumsy and encompasses a wide range of countries and situations that are difficult to place into groups to allow worthwhile comparisons.

Sometimes it is more useful not to talk about countries but to refer to settings or environments. Resource challenged, limited resources, under-resourced, transitional, and under-served are useful descriptive terms of more local conditions. Another term that has gained traction is austere environment. It seems a particularly appropriate term as for most of the countries or settings discussed in the book, austerity particularly affects the surgical fields.

Resources are not limited in the same manner or extent everywhere. Medical practice in LMICs is changing rapidly, and what used to be a rather standard lack of just about everything is being replaced piecemeal with an often unbalanced accumulation of resources that may have little to do with expectations based on gross national income per capita or need, but more on the vagaries of development money, the level and impact of corruption, the strength or weakness of the medical education system, or the presence of a few insightful and diligent people.

¹Based on gross national income (GNI) per capita in US \$, low-income is $\leq 1,025$; lower middle income is 1,025–4,035; and upper middle income is $\geq 4,036$.

Every chapter of this book starts off stating that the particular problem addressed is a challenge. It is possible that challenge isn't a word orthopedic surgeons working in the West use or think about on a daily basis. In this book the use is not hyperbole. A normally simple fracture that one would take care of as routine can transform itself in an austere setting into a significant logistics, social, economic, medical, and sometimes political problem. The approach to the fracture has to answer questions we have not been taught to ask.

Every chapter has somewhere embedded the simple caveat: 'when available'. Sometimes it reads like a Greek chorus. This phrase is intrinsically connected to the challenge one is warned about at the beginning of every chapter. In many places this simple fact of unavailability will stop the visiting surgeon cold. Other times it will be an inconvenience and the surgeon will find an answer. Often the answer lies in the basics we take for granted but rarely think about in our daily Western practices. Another way around is by consulting and listening to others. We hope this book provides options that expand the envelope of availability, while providing information to help the surgeon meet the challenge.

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Part I

Introduction

A History of Orthopedics in Austere Settings

1

Michelle Foltz, Geoffrey Walker, and James C. Cobey

With the growth of their specialty after the Second World War, orthopedic surgeons have worked to develop, expand, and improve orthopedic care and teaching in resource-poor countries. Nongovernmental and governmental organizations, religious and secular charities, and individuals have played, and continue to play, a role in the developing world, establishing and strengthening training programs and providing service. The primary nature of orthopedic injuries and disease, the significant increase in orthopedic trauma as the world relentlessly develops, and the “can-do” attitudes that shape the profession all point to an increasing involvement of Western surgeons in international work.

The history of American organized orthopedic volunteering started in the late 1950s with two groups: Medical International Cooperative Organization (Medico) and the Orthopaedic Letters Club Overseas Program. This was a time of widespread soul-searching by Americans

after the 1958 publication of the political novel *The Ugly American*. The stories of official ignorance, arrogance, and misbehavior did not sit well with Americans’ notions of themselves. As a counter to this bleak picture, the inspirational books and engaging lectures of Dr. Tom Dooley, one of the founders of Medico, showed that the citizen-doctor-diplomat could change this negative perception.

In 1960 Medico became the medical arm of Cooperative for American Relief Everywhere (CARE), a broad-based development and disaster relief organization. (In the 1980s the organization became international, changing its name to Cooperative for Assistance and Relief Everywhere.) The two orthopedic organizations interested in international work merged their efforts in the early 1960s, becoming a subgroup of Medico called Orthopaedics Overseas (OO) with their own board and earmarked donations for their international programs. The core of dedicated surgeons in OO set up service and training programs in Tunisia, Indonesia, and Afghanistan, among other countries, with the goal of attaining local self-sufficiency in orthopedic care and training.

The seeds for World Orthopaedic Concern (WOC) were planted in 1970 during Dr. Ronald Huckstep’s world lecture tour to advise on the treatment of children crippled by polio in the developing world. His colleagues agreed that there was a need to improve orthopedic care and training in low-resource countries and envisioned setting up programs similar to those of Orthopaedics Overseas under a global

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umbrella. The first formal meeting of WOC was held in Lagos, Nigeria, in 1977. In 1986 Orthopaedics Overseas and the Committee on Orthopaedics Overseas of the Canadian Orthopaedic Association became affiliated with WOC but have retained their national identities.

During its 1978 meeting in Alma-Ata, The World Health Organization (WHO) made the case that primary care programs, rather than specialty programs, would bring the most good for the highest number of people in developing countries. In turn, CARE/Medico decreased support for its specialty training programs, such as OO, to emphasize primary care.

This was not a new controversy. From the start, the founders of Medico differed about whether to promote specialty or primary care programs in developing countries. Today it remains an issue within and among nongovernmental organizations (NGOs) and the funding bodies and foundations that support them. With the increasing sophistication of surgeons in developing countries because of the training and collaboration from many groups and individuals as well as the availability of cost-effective and useful instruments, many aspects of orthopedics, particularly trauma, are now viewed—even by the WHO—as primary care.

Since no small group of surgeons can realistically tackle all the orthopedic needs in the developing world, many organizations and individuals have concentrated their efforts on teaching and training. Besides developing capacity to meet orthopedic needs locally, the personal relationships have fostered continued interaction and have been a major factor in the strong global orthopedic network.

This brings up the questions of who to teach, what to teach, and where to teach. The answers to these questions depend on the particular country and the philosophy of the volunteer or organization.

Some of the most useful and long-term advances in delivering trauma care have occurred by teaching nurses and primary care workers at the middle and lower levels of the health system. Trained to properly manage basic trauma, they can save lives by working through systems, such as Advanced Trauma Life Support (ATLS), proceeding with ABCs,

giving fluids, and recognizing life-threatening and limb-threatening situations. In most developing country hospitals general surgeons are the major providers of orthopedic care, and some training programs concentrate on providing them with the orthopedic expertise to handle common musculoskeletal problems. In some countries, such as Malawi or Mozambique, with a limited population of surgeons, nonphysician orthopedic clinical officers are trained to deliver basic orthopedic care, including surgery.

If an organization wants to provide specialized orthopedic training and care, one of the first questions is where to train. In the beginning OO brought candidates for training to the USA. These highly trained surgeons returned home but rapidly became frustrated by the lack of equipment and ancillary help. Governments did not pay for specialized care, and colleagues were mistrustful of the new ideas brought from the outside. Not able to put their skills to use, the newly trained surgeons often returned to the West.

Teaching in the local environment with locally available equipment to care for local conditions seemed a better alternative. This usually involves building training programs from scratch with curricula to address the existing limitations or working within existing institutions. Good programs evolve, increasing in their self-sufficiency as more and more individuals are trained to higher standards.

Another decision is where in a country to train. Most often, and by default, this takes place in the capital, the seat of government, the home of the university or medical school, and the site of the largest hospital with the greatest number of ancillary specialists. But sometimes the government gets in the way and has its own agenda, the university is filled with outsized egos, and the largest hospital in the country becomes a sanctuary of specialty care, out of reach for the average patient with simple but debilitating orthopedic problems.

As more surgeons are trained and as the speed of development accelerates, the substance of what to teach is rapidly evolving. The idea that only nonoperative techniques that were current 40 or 50 years ago are the most appropriate for developing countries has come under

Fig. 1.1 The bright, clean, welcoming entrance to CURE's Pediatric Orthopedic Hospital in Kijabe, Kenya



considerable debate in the last decade. However, proper reduction and casting techniques as well as the principles of treatment in traction remain the mainstays of most fracture work in developing countries. As Western surgeons increasingly lose their skills to perform such nonoperative treatments, they have much to learn from their peers in developing countries, and volunteering becomes a network of teaching *and* learning.

No matter one's philosophy of how best to treat specific injuries and orthopedic conditions, teaching the basics of clinical orthopedics is the purpose of most training programs. Teaching by example that diligence, compassion, and communication along with a thorough knowledge of the problem and the various solutions is an essential component of orthopedics everywhere.

The history of orthopedics in resource-poor environments is not solely the work of organizations. Individuals—through necessity, the ability to look at problems from novel angles, and unconventional single-mindedness—have made a huge impact in the way orthopedics is practiced in countries with few resources.

The bicycle spokes and locally manufactured rings and bars that Dr. Gavriil Ilizarov ingeniously fashioned into his external fixateurs in Siberia in the 1950s and 1960s were the result of having little else to work with. These instruments

and protocols have given orthopedic surgeons a new approach to previously poorly understood problems. The Ilizarov system is an important disruptive technology that can be equally as useful in the most sophisticated high-tech center as in the most rudimentary clinic.

When in East Africa and faced with large numbers of joint contractures and deformities in children and young adults from polio in the 1960s, Dr. Ronald Huckstep not only devised a series of successful surgeries to deal with the problems but established workshops and taught people—including those whom he had helped with his surgeries—to make low-cost braces. Despite all attempts to eradicate the disease, polio and its residua remain a problem in some developing countries, and many of the principles of Dr. Huckstep's surgeries are the basis of polio treatment today.

Another approach to orthopedic needs in resource-poor countries is exemplified by Dr. Scott Harrison, through his foundation, CURE International. Combining his expertise as a surgeon, his faith, and his organizational abilities as a businessman, CURE has established orthopedic pediatric hospitals in many poor, developing countries, making them centers of excellence through the specialized training they offer and the surgery they provide (Fig. 1.1).

Fig. 1.2 US orthopedic volunteer, Carla Smith, introducing SIGN instruments and technique to surgeons in Nepal



The history of Western practitioners working in resource-poor countries cannot be separated from the question of equipment. Some surgeons make it a point to take no donated equipment with them, knowing the problems of sustainability or the lack of experience in treating the complications that such techniques may bring, especially if used without adequate training. Most donations are made with the best intentions, but any volunteer who has walked through a gauntlet of irreparable C-arms crowding already limited space in an operating theater knows that donations have to be realistically considered from many angles.

SIGN (SIGN Fracture Care International) has shown that high-quality implants to treat long-bone fractures can be reliably used by developing country surgeons, working in less than ideal situations, if they are given a sustainable supply and are taught how to use them. SIGN's program combining feedback, mentoring, and networking has produced a new paradigm that has been especially useful in situations where poverty makes effective treatment of certain debilitating fractures extremely difficult (Fig. 1.2).

Providing disaster relief has been a major idea behind orthopedic work in developing countries, but it is one of the most difficult to put into useful action. Few volunteer orthopedic organizations

have been able to build, maintain, and put into action all the components that would allow a reasonably equipped orthopedic disaster-assistance team to become immediately operative in the field. Such an organization could be readily staffed by willing volunteers, but only government agencies, the military, and one NGO, Médecins sans Frontières (MSF or Doctors without Borders), have the necessary logistics to manage such a team. The surgery needed in disaster situations is similar to war surgery, demanding strict adherence to specialized protocols and triage principles that are unfamiliar to many volunteer orthopedic surgeons (Fig. 1.3).

Volunteer orthopedic programs have evolved over the last 50 years. Besides secular, nonprofit programs interested in training, like OO, volunteer programs with various agendas and goals have expanded the field. In organizations whose main goal is teaching, some specialize, teaching surgeons, residents, or nonsurgical clinicians. Some limit their programs to a specific region or country, such as focusing on the orthopedic problems of West Africa or Southeast Asia. Others concentrate on a specific area of orthopedics such as trauma or pediatrics or joint replacement surgery. Some NGOs are religiously affiliated, and many religious charities support programs or

Fig. 1.3 Surgeons from Haiti, Denmark, and Ghana working together under the auspices of MSF, Doctors without Borders, after the 2010 earthquake in Haiti



hospitals. Some organizations build hospitals or refurbish existing hospitals in order to maintain control. Different philosophies and goals provide a field wide enough for any volunteer to find a place to match her or his needs and skills.

The strength of the past 50-year history of orthopedics in developing countries rests on the work and determination of many surgeons who did not believe that limited resources meant limited results. As more surgeons rise to the challenge of improving orthopedic care in

developing countries, this attitude will continue to shape the future and change the face of global orthopedics.

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The Burden of Musculoskeletal Injuries

Injury is a major cause of death and disability globally. This is true in countries at all economic levels. There is a misperception that injuries are primarily a health problem of high-income countries. However, injury mortality rates are considerably higher in low- and middle-income countries (LMICs), as can be seen from Table 2.1. Globally the rates of death from all types of injury combined are 76/100,000/year. This is lowest in high-income countries (52/100,000), rises in middle-income countries, and is highest in low-income countries (103 deaths/100,000), where rates of death are twice those in high-income countries.

These high rates of death are in part due to the rising rates of injuries from increased use of

motorized transport and less developed trauma care systems [2]. Rates of injury have been coming down in high-income countries due to injury prevention schemes and improved trauma care. At the same time, rates of injury-related death and disability have been steadily rising in most LMICs and account for 90 % of the global injury deaths. As most of the world's people live in these countries, these trends have led to increasing rates of injury globally [2, 3].

For every person who dies from injury, many more suffer from nonfatal injury, leading to temporary or permanent disability. We do not have as comprehensive, global data for these nonfatal injuries as we do for death. However, the existing data show a significant burden of disability from musculoskeletal injuries affecting all economic strata, but it is especially heavy for LMICs [3].

Data on the burden of musculoskeletal injury come from several sources including hospital records and household surveys. Data from the National Health Interview Survey in the United States showed a rate for all extremity injuries of 68/1,000 persons/year. This included many minor cases that received outpatient treatment only, but excluded strains, sprains, and contusions, which did not receive medical treatment or which did not cause more than a half day of disability [4].

Data on more serious musculoskeletal injuries were obtained from the Healthcare

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Table 2.1 Numbers and rates of death from injury by economic status of countries

Economic stratum	Number of injury deaths (000)	Population (000)	Rates (deaths/100,000/year)
Low	850	826,417	103
Lower middle	2,903	3,834,641	76
Upper middle	816	999,625	82
High	561	1,076,797	52
Total	5,130	6,737,480	76

Source of data: 2008 Global Burden of Disease Study [1]

Cost Utilization Project – Nationwide Inpatient Sample (HCUP-NIS). This showed an incidence of hospitalization (for at least 24 h) for musculoskeletal injuries of 3.5/1,000/year (2.7/1,000/year for lower extremity injuries and 0.8/1,000/year for upper extremity injuries). 50 % of these injuries were due to falls and 20 % to road traffic injuries. Similar data have been reported from other high-income countries [4].

Data from LMICs is limited to a few studies from a few countries; however, even these data are instructive. A survey from Ghana showed a rate of serious musculoskeletal injury (disability time of ≥ 30 days) of 17/1,000/year. It is difficult to draw comparisons due to different methodology, and it is likely that many of these serious injuries would have been treated as inpatients in high-income countries, but injury rates in Ghana are far higher than in the United States [4, 5].

Due to difficulties accessing medical care in LMICs, many of the musculoskeletal injuries go on to poor outcomes. The Ghana survey showed that 0.83 % of Ghanaians had an injury-related disability that had lasted longer than 1 year and was likely to be permanent. Seventy-eight percent of these disabilities were due to extremity injuries. Such disabilities should be readily amenable to low-cost improvements in orthopedic care and rehabilitation, in contrast to the more difficult to treat neurological injuries that are relatively more frequent causes of disability in high-income countries [6].

Utilizing the available data from high-income countries and LMICs, the global burden of disease (GBD) study has provided some global estimates for musculoskeletal injuries. The GBD study evaluated rates of hospital admission for various nonfatal injuries from road

Table 2.2 The 20 leading nonfatal injuries sustained^a as a result of road traffic collisions, world, 2002

Type of injury sustained	Rate per 100,000 population	Proportion of all traffic injuries
Intracranial injury ^b (short term ^c)	85.3	24.6
Open wound	35.6	10.3
Fractured patella, tibia, or fibula	26.9	7.8
Fractured femur (short term ^c)	26.1	7.5
Internal injuries	21.9	6.3
Fractured ulna or radius	19.2	5.5
Fractured clavicle, scapula, or humerus	16.7	4.8
Fractured facial bones	11.4	3.3
Fractured rib or sternum	11.1	3.2
Fractured ankle	10.8	3.1
Fractured vertebral column	9.4	2.7
Fractured pelvis	8.8	2.6
Sprains	8.3	2.4
Fractured skull (short term ^c)	7.9	2.3
Fractured foot bones	7.2	2.1
Fractured hand bones	6.8	2.0
Spinal cord injury (long term ^d)	4.9	1.4
Fractured femur (long term ^d)	4.3	1.3
Intracranial injury ^b (long term ^d)	4.3	1.2
Other dislocation	3.4	1.0

Reproduced from Peden et al. [7], Table 2.8

^aRequiring admission to a health facility

^bTraumatic brain injury

^cShort term=lasts only a matter of weeks

^dLong term=lasts until death, with some complications resulting in reduced life expectancy

traffic crashes. Table 2.2 shows that the majority of these are musculoskeletal injuries. As with fatal injuries, nonfatal musculoskeletal injuries primarily affect those in LMICs. The GBD estimated that the combined rates of extremity

injury from falls and road traffic crashes range from 1,000 to 2,600/100,000/year in LMICs compared with 500/100,000/year in high-income countries [3, 4].

Although we have some global data on rates of nonfatal injuries, it is limited, and the data that exist, especially those from hospital sources, likely underestimate the significance of the problem, due to both underreporting and the large number who do not receive formal medical care. There are ongoing efforts to develop better global data on nonfatal injuries, including musculoskeletal injuries, through the work of the GBD study and the Bone and Joint Decade.

The Burden of Nontraumatic Musculoskeletal Conditions

There are fewer studies on the burden of non-injury-related musculoskeletal (MSK) conditions. The initial GBD study [8], in 1990, showed an estimated worldwide burden of 26,842 DALYs (disability-adjusted life years) for osteoarthritis, rheumatoid arthritis, spina bifida, leprosy, and polio. This represented 16 % of the burden attributable to injuries and 2 % of the entire global burden of disease. Updated data from 2004 showed a worldwide burden of 34,017 DALYs, which was still only around 16 % of the injury-related burden, but represented 2.5 % of the entire global burden [9]. The most recent data suggest that in 2010, non-injury-related MSK conditions accounted for 4.4 % of the global burden of disease, more than doubling in 20 years [10]. Conditions that were not included in the initial study, such as neck and back pain, account for a significant portion of this increase.

Bone and joint conditions with a significant incidence or prevalence, such as malignancies and infections, congenital abnormalities, developmental abnormalities, and nonrheumatoid inflammatory arthropathies, have not been

included in the GBD. Though unaccounted for, it is likely their combined contribution to the global disease burden is significant. An overall aging population and the epidemiologic transition toward noncommunicable diseases will likely see a continuation of this trend for the foreseeable future.

Disclaimer: One of the authors is a staff member of the World Health Organization. He and the other authors are responsible for the views expressed in this publication, and they do not necessarily represent the decisions or the stated policy of the World Health Organization.

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