SPINE20 Recommendations 2024 -Spinal Disability: Social Inclusion as a Key to Prevention and Management

Cristiano M. Menezes, MD[1], Carlos Tucci, MSc[2], Koji Tamai, MD[3] ,
Harvinder S. Chhabra, MD[4], Fahad H. Alhelal, MD[5], André E. Bussières, PhD[6],

[1] Department of Locomotor Apparatus, Federal University of Minas Gerais, Belo Horizonte, Brazil
[2] Centro de Estudos e Promoção de Políticas em Saúde, Hospital Israelita Albert Einstein, São Paulo, Brazil
[3] Department of Orthopedic Surgery, Osaka Metropolitan University, Osaka, Japan
[4] Department of Spine and Rehabilitation, Sri Balaji Action Medical Institute, New Delhi, India
[5] Department of Orthopedics, Ministry of National Guard-Health Affairs, Riyadh, Saudi Arabia
[6] Department of Chiropractic, Université du Québec à Trois-Rivières, Trois-Rivieres, QC, Canada
[7] Executive Office, North American Spine Society, Chicago, USA
[8] School of Health Sciences, University of Southampton, Southampton, UK
[9] Department of Rehabilitation Sciences, King Saud University, Riyadh, Saudi Arabia
[10] Department of Orthopedics, University of Florence, Florence, Italy
[11] Department of Orthopedic Surgery, New York University Grossman School of Medicine, New York, NY, USA
[12] Institute for Disability and Rehabilitation Research and Faculty of Health Sciences, Ontario Tech University, Oshawa, ON, Canada
[13] Department of Neurosurgery and Spine Surgery, Center for Neurological Diseases, UPEA/UCEBOL, Santa Cruz, Bolivia
[14] Department of Orthopedic Surgery, University of São Paulo, São Paulo, Brazil
[15] The Spinal Foundation, Delhi, India
[16] Department of Orthopaedic Surgery, National Defense Medical College, Saitama, Japan
[17] Department of Orthopedic, Santa Casa Spine Center, São Paulo, Brazil
[18] Department of Orthopedic, Universidade Estadual de Campinas, São Paulo, Brazil
[19] Division of Neurosurgery, Stellenbosch University, Cape Town, South Africa
[20] Department of Physical Medicine and Rehabilitation, All India Institute of Medical Sciences, New Delhi, India
[21] Department of spine, Michel Spine Center, Hamburg, Germany
[22] Department of Orthopedic, University del Desarrollo, Clinica Alemana, Santiago, Chile
[23] Department of Orthopedic, Interdisciplinary Spine Center, Ingolstadt, Germany
[24] Department of Orthopedic Surgery, Università Sapienza Roma, Rome, Italy
[25] Department of Orthopedic Surgery, Gading Pluit Hospital, Jakarta, Indonesia
[26] Departments of Orthopaedics and Environmental Medicine, New York University, New York, NY, USA
[27] Department of Orthopedic services, Presidency of State Security, Riyadh, Saudi Arabia
[28] Department of Orthopedic, King Faisal Specialist Hospital & Research Center, Jeddah, Saudi Arabia
[29] Department of Spinal Surgery, Sir Ganga Ram Hospital, New Delhi, India
[30] Department of Orthopedics, Klinikum Magdeburg gGmbH, Magdeburg, Germany
[31] Department of Orthopedic Surgery, National Hospital Organization Hokkaido Medical Center, Sapporo, Japan
[32] Department Trauma-, Reconstructive- and Orthopaedic Surgery, General Hospital and Trauma Center Ludwigsburg, Ludwigsburg, Germany
[33] Department of Neurosurgery, ULS São João, University of Porto, Porto, Portugal
[34] Public Health Department, Federico II University Napoli, Napoli, Italy
[35] Department of Pediatric Orthopedic Surgery, Hospital Infantil Joana de Gusmão, Florianópolis, Brazil
[36] Executive Office, Sociedade Brasileira de Coluna, Rio de Janeiro, Brazil
[37] Department of Traumatoloy and Orthopedics, National Institute of Traumatology and Orthopaedics, Rio de Janeiro, Brazil
[38] Departament of Psychology, Vale do Itajaí University – Univali, Itajaí, Brazil
[39] Business School, Pontifical Catholic University of Rio Grande do Sul, Porto Alegre, Brazil
[40] Department of Orthopedics, King Abdulaziz Medical City, Riyadh, Saudi Arabia

Corresponding Author:
Koji Tamai, Department of Orthopedics Surgery, Osaka Metropolitan University Graduate School of Medicine, 1-4-3, Asahimachi, Abenoku, Osaka, 545-8585, Japan.
Email: koji.tamai.707@gmail.com

**Eric J. Muehlbauer, MJ, CAE[7], Lisa Roberts, PhD[8], Hana I. Alsobayel, PhD[9],
Guido Barneschi, MD[10], Marco A. Campello, PhD[11], Pierre Côté, PhD[12],
Luís Miguel Duchén Rodríguez, MD[13], Alexandre F. Cristante, MD[14], Komal Kamra, PhD[15],
Kazuya Kitamura, MD[16] ⦿, Robert Meves, MD[17], Marcelo I. Risso-Neto, MD[18],
Adriaan J. Vlok, PhD[19], Sanjay Wadhwa, DNB[20], Karsten Wiechert, MD[21],
Ratko Yurac, MD[22] ⦿, Thomas Blattert, MD[23], Giuseppe Costanzo, MD[24],
Bambang Darwono, MD[25], Margareta Nordin, PhD[26], Yahya S. Al Athbah, MD[27],
Ahmed Alturkistany, MD[28], Rupinder Chahal, DNB[29], Joerg Franke, MD[30],
Manabu Ito, MD[31], Markus Arand, MD[32], Paulo Pereira, PhD[33], Carlo Ruosi, MD[34],
William J. Sullivan, MD[7], André L. F. Andújar, MD[35], Carlos Henrique Ribeiro, MD[36],
Luis Eduardo Carelli, MD[37], Jamir Sardá Jr., PhD[38], Ana Lígia G. E. Machado, MBA[39], and
Sami AlEissa, MD[40]**

Abstract

Spine disorders are the leading cause of disability worldwide. To promote social inclusion, it is essential to ensure that people can participate in their societies by improving their ability, opportunities, and dignity, through access to high-quality, evidence-based, and affordable spine services for all.

To achieve this goal, SPINE20 recommends six actions.

- SPINE20 recommends that G20 countries deliver evidence-based education to the community health workers and primary care clinicians to promote best practice for spine health, especially in underserved communities.
- SPINE20 recommends that G20 countries deliver evidence-based, high-quality, cost-effective spine care interventions that are accessible, affordable and beneficial to patients.
- SPINE20 recommends that G20 countries invest in Health Policy and System Research (HPSR) to generate evidence to develop and implement policies aimed at integrating rehabilitation in primary care to improve spine health.
- SPINE20 recommends that G20 countries support ongoing research initiatives on digital technologies including artificial intelligence, regulate digital technologies, and promote evidence-based, ethical digital solutions in all aspects of spine care, to enrich patient care with high value and quality.
- SPINE20 recommends that G20 countries prioritize social inclusion by promoting equitable access to comprehensive spine care through collaborations with healthcare providers, policymakers, and community organizations.
- SPINE20 recommends that G20 countries prioritize spine health to improve the well-being and productivity of their populations. Government health systems are expected to create a healthier, more productive, and equitable society for all through collaborative efforts and sustained investment in evidence-based care and promotion of spine health.

Keywords

social inclusion, primary care, value-based spine care, economy, health policy and system research, digital spine care, implementation strategies, rehabilitation

Introduction

Spine disorders, including low back and neck pain, are leading causes of global disability.[1-4] Low back pain alone affects 619 million people worldwide and is the most common cause of disability in adults under 45. These disorders cause more disability than conditions like heart disease, cancer, dementia, and stroke. Chronic spine pain significantly impacts quality of life, leading to poor physical and mental health, sleep issues, social isolation, and financial challenges.[5-7] Economically, spine disorders are a major contributor to reduced productivity and job absenteeism.[8-10] In the US alone, back pain results in over 264 million lost workdays annually, affecting global economic output. Spine disorders also contribute to high healthcare costs, with low back pain in the US exceeding US$135 billion in economic impact annually. Despite their burden, most G20 countries lack comprehensive strategies for spine care.[8-10] In Brazil, where 25 million people suffer from low back pain, the prevalence has increased by 27% since 1990.[11-13] Although Brazil's healthcare system is well-organized, it lacks a national spine care program, leaving many without adequate treatment for rising spine care needs.

In 2019, in an effort to address these global challenges, four large spine care professional organizations (EUROSPINE, the North American Spine Society, the German Spine Society, and the Saudi Spine Society) founded SPINE20, an advocacy group to bring global attention to spine disorders and spine care. By August 2024, 35 professional societies have joined SPINE20. (Table 1) To advance the uptake of the current United Nations Sustainable Development Goals (SDGs), SPINE20 advocates to improve spine health globally to achieve good health and well-being, quality education, and decent work.[14] Additionally, SPINE20 activity is echoing the current World Health Organization (WHO) initiatives including the WHO Low Back Pain Guidelines and the World Rehabilitation Alliance statements on the management of disability-related low back pain.[15,16]

SPINE20 aims to develop evidence-based policy recommendations for the G20 governments.[17-20] The recommendations are intended to benefit individuals with spine disorders, thereby benefitting the community and ultimately the country adopting the recommendations. SPINE20 aligns its recommendations with the needs and priorities of all G20 countries, and the host country for the corresponding fiscal year of the G20 summit. This strategy embodies a dual-focused approach, designed to address local challenges and deliver the broader strategic goals. By focusing on specific priorities of the host country, SPINE20 provides tailored solutions that contribute to local economic

Table 1. Societies Participating in SPINE20 (May, 2024).

Category	Society Name	Country
Patient Entity	Amar Seva Sangam	India
Academic Entity	Asociacion Mexicana de Cirujanos de Columna	Mexico
Academic Entity	Association of Spine Surgeons of India (ASSI)	India
Academic Entity	Australian Physiotherapy Association	Australia
Academic Entity	Brazilian Spine Society (BSS)	Brazil
Academic Entity	Chandigarh Spinal Rehab	India
Academic Entity	Chilean Spine Society and Spine Committee of Chilean Orthopaedic and Traumatology Society SCHOT	Chile
Academic Entity	EUROSPINE	Switzerland, UK, Canada, Portugal and Germany
Academic Entity	German Spine Society (DWG)	Germany
Academic Entity	Hellenic Spine Society	Greece
Academic Entity	Indian Association of Physical Medicine and Rehabilitation	India
Patient Entity	Indian Head Injury Foundation	India
Academic Entity	Indonesia Spine Society	Indonesia
Academic Entity	Italian Spine Society (SICV&GIS)	Italy
Patient Entity	Japanese Association for Patients with Spinal Ligament Ossification	Japan
Academic Entity	Japanese Society for Spine Surgery and Related Research	Japan
Patient Entity	Nina Foundation	India
Academic Entity	North America Spine Society (NASS)	United States
Commercial Entity - Education Focused	NSPINE	Germany
Academic Entity	Renè Perdriolle Academy for Scoliosis Study	Italy
Academic Entity	Saudi Association of Neurological Surgery	Saudi Arabia
Academic Entity	Saudi Spine Society (SSS)	Saudi Arabia
Academic Entity	Sociedad Iberolatinoamericana de Columna - Silaco	Uruguay
Academic Entity	Society of Indian Physiotherapists	India
Academic Entity	Society of Spine Surgeons of Pakistan	Pakistan
Academic Entity	Spinal Cord Society	India
Academic Entity	Spine Society Delhi Chapter	India
Academic Entity	Spine Society of Belgium (SSBe)	Belgium
Patient Entity	The Ability People	India
Patient Entity	The Association of People with Disability (APD)	India
Academic Entity	The Indonesian Association of Physical Medicine and Rehabilitation	Indonesia
Patient Entity	The Spinal Cord Injury Association	India
Patient Entity	The Spinal Foundation	India
Academic Entity	World Federation of Chiropractic	Canada
Patient Entity	World Spine Care	United States

cooperation, align with the goals of the G20 summits and the broad SDGs, and the solutions identified within specific regions can be generalized and extended globally. This strategic alignment enhances the effectiveness of SPINE20's recommendations and ensures they are relevant to the global community, which is a key feature of the G20 summits.

The three priorities of G20 2024 held in Brazil are (i) social inclusion and the fight against hunger, (ii) energy transition and sustainable development and (iii) reform of global governance institutions.[16] This year, SPINE20 focuses on "Social inclusion" as an essential target to reduce the burden of spine disorders by improving access to societal benefits and healthcare services. Here, we report on the recommendations developed by the SPINE20 entitled "**Spinal Disability: Social Inclusion as a Key to Prevention and Management."**

Methods to Develop Recommendations 2024

Authors

SPINE20 'Scientific Program Task Force' members and 'Recommendation Task Force' members, from 19 international spine related societies, coordinated and developed the recommendations. Both task forces involved multidisciplinary panels including patient representatives, surgeons, rehabilitation clinicians, researchers, epidemiologists, primary care physicians, education professionals, and strategic health leaders.

Domains

The SPINE20 recommendations were built on domains selected by consensus following SPINE20 in 2023. All domains were reviewed and updated by December 2023 and stratified into six groups by the SPINE20 program task forces (Determinants of social inclusions group, Strategies promoting social inclusion group, Benefits of social inclusion group, Quality of care group, Policy & impact group, and Health Information Systems group; Table 2) to achieve SPINE20's main theme "*Spinal Disability: Social Inclusion as a Key to Prevention and Management*".

Selection of Domains

We held an online real-time Delphi consensus meeting on January 10, 2024 to select one domain from each of the six groups. Two facilitators (KT from Japan and HA from Saudi Arabia) facilitated the meeting, and 44 international, multidisciplinary experts from 25 spine societies participated in the meeting. Domains were selected using an online voting software (Microsoft Forms, Redmond, WA). A week prior to the Delphi consensus meeting, participants scored each domain (from 1 to 10) to provide an initial prioritization by the group. Domains with a level of agreement ≥75% were moved to the next round of voting. A maximum of four rounds of voting were allowed per group. Domains from any group that did not reach the 75% level of agreement after four rounds were excluded (Tables 3 and 4). The final selected domains include: Determinants of social inclusions: Primary care; Strategies promoting social inclusion: Implementation; Benefits of social inclusion: Economy; Quality of care: Value based care; Policy & impact: Health Policy and Systems Research; and Health Information Systems: Digital spine care.

Development of Recommendations

Each domain elected three writers who were assigned by the SPINE20 scientific committee to draft the recommendations.

- Social inclusion: CM (Brazil), KK (Japan), IV (South Africa)
- Primary care: CT (Brazil), MC (US), KK (India)
- Implementation: HC (India), HA (Saudi Arabia), LMD (Bolivia)
- Economy: EM (US), KW (Germany), MR (Brazil)
- Value based care: LR (UK), RM (Brazil), RY (Chile)
- Health Policy and Systems Research: AB (Canada), PC (Canada), SW (India)
- Digital spine care: FA (Saudi Arabia), AF (Brazil), GB (Italy)

If necessary, domain leads invited collaborators to develop the recommendation and provide the rationale for its content. Each group submitted recommendation outlines that were discussed

Table 2. Domains and Groups in SPINE20 2024.

Groups for Main Theme	Domains
Determinants of social inclusions	Primary care; aging spine; education; pediatric spine; spinal cord injury; patient safety; frailty; workplace; lifestyle for environment
Strategies promoting social inclusion	Implementation; education; primary care; prevention; access to care; multiprofessional approach; rehabilitation; universal access system; capacity building; patient safety; digital spine care
Benefits of social inclusion	Economy; access to care; poverty; wellness; implementation
Quality of care	Value based care; primary care; education; prevention; capacity building; rehabilitation; economy; universal access system
Policy & impact	Health policy and systems research; universal access system; capacity building; economy; health of the health provider
Health information systems	Digital spine care; social security data; health policy and systems research; research; rehabilitation

Table 3. Results of Pre-Scoring.

Groups for Main Theme	Domains with Average Point (min:0, max:5)
Determinants of social inclusions	Primary care 3.90, aging spine 3.69, education 3.57, pediatric spine 3.40, spinal cord injury 3.29, patient safety 3.07, frailty 3.07, workplace 2.98, lifestyle for environment 2.93
Strategies promotion social inclusion	Implementation 3.93, education 3.90, primary care 3.86, prevention 3.81, access to care 3.74, multiprofessional approach 3.64, rehabilitation 3.64, universal access system 3.48, capacity building 3.36, patient safety 3.24, digital spine care 3.05
Benefits of social inclusion	Economy 3.88, access to care 3.79, poverty 3.79, wellness 3.43, implementation 3.24
Quality of care	Value based care 3.83, primary care 3.76, education 3.67, prevention 3.57, capacity building 3.55, rehabilitation 3.31, economy 3.17, universal access system 3.60
Policy & impact	Health policy and systems research 3.98, universal access system 3.60, capacity building 3.55, economy 3.36, health of the health provider 3.10
Health information systems	Digital spine care 3.86, social security data 3.40, health policy and systems research 3.36, Reseach 3.29, rehabilitation 3.05

Table 4. Results of Delphi Consensus Voting.

	1st Vote (%)	2nd Vote (%)	3rd Vote (%)	4th Vote (%)
Determinants of Social Inclusions				
Primary care	69.0	85.2		
Aging spine	10.3	7.4		
Education	3.4	3.7		
Poverty	3.4	0.0		
Pediatric spine	13.8	3.7		
Strategies promoting social inclusion				
Implementation	41.40	48.10	81.00	
Education	20.70	11.10		
Primary care	0			
Prevention	17.20			
Access to care	20.70	40.70	19.00	
Benefits of social inclusion				
Economy	37.9	65.4	57.1	90.9
Access to care	31.0	34.6	42.9	9.0
Poverty	10.3			
Wellness	17.2			
Implementation	3.4			
Quality of care				
Value based care	53.6	70.4	85.7	
Primary care	21.4	29.6	16.7	
Education	3.6			
Prevention	7.1			
Capacity building	14.3			
Policy & impact				
Health policy and systems research	58.6	74.1	85.7	
Universal access system	17.2	25.9	16.7	
Capacity building	13.8			
Economy	3.4			
Health of the health provider	6.9			
Health information systems				
Digital spine care	62.1	62.9	90.5	
Social security data	6.9	0.0	10.5	
Health policy and systems research	17.2	22.2		
Research	6.9	0.0		
Rehabilitation	6.9	14.8		

and refined by the Scientific Task Force during weekly online meetings between February 7 and May 29, 2024.

Publication of Recommendations

The proposed recommendations and their underpinning rationale were reviewed by all partner societies before they were made available in the public domain. The recommendation statements and supporting rationales were published on the SPINE20 website (https://spine20.net) 14 days before the SPINE20 summit which took place on August 9-10, 2024, in Rio de Janeiro, Brazil. Public comments were collected via the website and considered, as the recommendations were refined. These recommendations were then discussed at the SPINE20 Summit 2024, allowing participants to debate the recommendations and suggest any further modifications. The recommendations were voted on at the SPINE20 summit, and only those that were approved were officially published as SPINE20 2024 Recommendations.

SPINE20 2024 Recommendation

Summary Statement

Spine disorders are the leading cause of disability worldwide. To promote social inclusion, it is essential to ensure that people can participate in their societies by improving their ability, opportunities and dignity, through access to high-quality, evidence-based, and affordable spine services for all. To achieve this goal, SPINE20 recommends six actions.

Context to the Topic

Social inclusion is highlighted as one of the three G20 priorities to realize "Building a Just World and a Sustainable Planet", which is supported by the United Nations.[21] The concept of social inclusion can be understood as 'Leaving no one Behind' in the overarching SDGs philosophy, which explicitly include disability and persons with disabilities in relation to education, growth and employment, inequality, accessibility of human settlements.[22] Social inclusion of people with spine disorders is also determined by a variety of health and socioeconomic factors.

Primary Care and Value Based Care. Primary care is the entry point when Community Health Workers and clinicians come into contact with people who have /or are at a risk of having spine disorders for which high value-based spine care is needed. However, in most low- and middle-income countries, as well as many underserved communities in high-income countries, there is an ongoing disconnect between clinicians and patients with spine disorders where little, if any, evidence-based spine care is available and delivered.[23] Furthermore, while high quality, evidence-based guidelines on the management of spine disorders are available, many people with spine symptoms continue to be neglected and/or receive unnecessary and potentially harmful investigations, treatments, or experimental procedures, together resulting in wasted resources and socioeconomic burden.[24]

Economic Burden of Spine Disorders. Spinal disability including low back pain is highly prevalent and burdensome, affecting up to one billion individuals worldwide, with a lifetime prevalence of up to 84%.[24-26] Neck pain and back pain accounted for the highest health care spending followed by diabetes and ischemic heart disease.[27] In addition to the direct cost, the indirect cost of low back pain is at least twice as high, with an estimated 150 to 250 million workdays lost annually due to low back pain, accounting for 5% of lost workdays from any cause.[28] In addition to the significant impact of low back pain on economy, low back pain itself is largely attributed to socioeconomic factors.[29] Lower educational attainment was identified as a risk factor for back pain. Hence, spine disorders, including low back pain, are deemed both a cause and a consequence of a deteriorating economy and this cycle needs to be broken by implementing appropriate and effective health policies.

Implementation, Health Policy, and System Research (HPSR). Standardization of healthcare system helps to decrease variation, minimize the risk of clinical errors, and increase patient safety.[30,31] However, there is inherent complexity and variability in spine care practice, due to the wide spectrum of spine disorders, diversity of treatment options, and the multiple professional backgrounds involved, in addition to many other contextual factors. Therefore, customization and personalization could provide a framework to address deviations from the standardized guidelines. This process requires careful consideration, and should be a paramount goal of organizational leadership, standards developers, and regulators.[32] It is essential to develop evidence-based standardized health systems policies including National Spine Care programs, tailored to the domestic population needs. Implementation and monitoring of these policies can lead to optimal care and improve patient health outcomes at the lowest cost, while reducing inequalities, and help countries achieve the SDGs.[20,21]

Digital Spine Care. Digital spine care is another key factor that contributes to social inclusion, offering improvements and efficiencies in diagnostics, treatment, evaluation, and delivery of spine care.[20] The digitization of spine care potentially facilitates the evaluation of clinical practice through the use of internationally shared digital registries of surgical and rehabilitation records. Despite the potential benefit of digital spine health, only limited guidelines can be available on promoting or supporting digital spine health.[33] Therefore, the implementation and evaluation of cost-effective, and evidence-based practice for digital transformation in spine care is needed.

Based on the above context and as a mean to promote social inclusion, considering the domestic culture and socioeconomic situations in low-, middle-, and high-income countries, SPINE20 emphasizes the importance of establishing policies that deliver equitable high-value and evidence-based spine

care across health systems and propose recommendations focusing on (1) Primary care, (2) Value-based spine care, (3) Economy, (4) Health policy and system research, (5) Digital spine care, (6) Implementation strategies.

Domain: Primary Care

SPINE20 recommends that G20 countries deliver evidence-based education to the community health workers and primary care clinicians to promote best practice for spine health, especially in underserved communities.

Relevance to United Nations SDGs: #1 (No Poverty), #3 (Good Health and Well-Being), #5 (Gender Equality), #8 (Decent Work and Economic Growth), #10 (Reduced Inequalities)

Context to the Focused Topic. Primary care is the entry point to health care systems and in most cases, primary care clinicians act as gate keepers, coordinating all aspects of the care of individuals.[34] Primary care focuses on prevention, early interventions and appropriate referral, avoiding unnecessary health, financial, economic and social burden.[35] While research on the efforts to prevent low back pain has not yielded any favorable results, early interventions tackling risk factors associated with chronicity and permanent disability have been shown to be most impactful.[23]

Problem. In 2020, low back pain affected 1 in 13 people in the world (619 million people), with a projection of the cases rising to 843 million by 2050.[3] The magnitude of this problem remains under-appreciated by policy makers. The absence of clear health policies and accurate data play a crucial role in this lack of engagement. Primary care is the most appropriate setting to shift the paradigm and mitigate the negative impact on spine health in society at large.

Potential Solutions. Based on the best available evidence, training and education are ways to positively impact back pain indicators by promoting self-care and pain management to counter misinformation. The action plan must then include the following:

1. Accurate education and training for Community Health Workers (CHW) and primary care clinicians that includes strategies to raise awareness about spine problems, simple self-care information and tools to demystify preconceived ideas and unhelpful or erroneous beliefs, and inform when and how individuals should seek primary care.
2. Creation of multi-professional teams in primary care services to address spine health needs
3. Assessment of training of CHWs and primary care clinicians
4. Dissemination of this information to families by the trained primary care delivery staff

5. Regular evaluation of the program
6. Regular updates of the program, incorporating new evidence as it becomes available.

Expected Outcomes
- as a result of the CHW education, the community will receive care at the acute and subacute stage;
- reducing the rate of spinal disability and chronicity, by continuing CHWs and primary care clinician support;
- reduction in unnecessary clinical diagnostics referrals and interventions;
- adherence to the proposed education strategy;
- improvements in multi-professional collaborations in spine care;
- reduction in the burden on the individual, family and society in general.

Domain: Value-Based Spine Care

SPINE20 recommends that G20 countries deliver evidence-based, high-quality, cost-effective spine care interventions that are accessible, affordable and beneficial to patients.

Relevance to United Nations SDGs: #3 (Good Health and Well-Being), #10 (Reduced Inequalities), #16 (Peace, justice, and strong institutions)

Context to the Focused Topic. Value-based healthcare is the "equitable, sustainable and transparent use of available resources to achieve better outcomes and experiences for every person".[36] There is, however, no universally accepted definition for 'value' in relation to health systems.[37] At its most basic level, it is commonly thought of as a ratio of outcomes to cost,[38] and high value occurs when 'health benefits justify its costs'.[39] The situation is more complex however, as patients may have concerns or preferences, interventions may generate benefits for some patients in particular situations, and these may be difficult to measure.[40]

Problem. As the demand for healthcare exceeds capacity, driven by changing population demographics, innovation and new technologies, increasing patient expectations and rising levels of multi-morbidity,[37] realistic decisions are required based on the available resources, in the quest to maintain quality and deliver value for money. Challenges arise in evaluating and adopting new technologies in spine care to ensure they deliver value. To improve value and benefits for patients, better coordination and rigorous evaluation are required.[41]

Potential Solutions. Both research and implementation science are needed to deliver value-based spine care. Research is needed to determine the benefits and impact of interventions and establish a robust evidence-base of effective treatments. There needs to be common terminology and a shared

understanding of value, with learning from existing exemplars of successful value-based initiatives. Identifying unwarranted variations in healthcare and standardizing best practice will enhance quality and reduce waste.[36] It is therefore, essential that clinicians have the necessary skills to measure outcomes, patient experience, and resource use, and share findings of high-quality, cost-effective interventions.[36]

Evidence-based spine pathways and guidelines can help reduce the use of interventions of limited clinical value, and decrease the likelihood of patients not requiring surgery being admitted to hospital.[41] The 2023 WHO guideline for chronic low back pain recommends non-surgical interventions including educational programs to support self-care strategies, exercise programs, manual therapy (including spine manipulative therapy and massage), psychological therapies (such as cognitive behavioral therapy) and medicines such as non-steroidal anti-inflammatory medicines.[42] Furthermore, the guideline identifies 14 interventions that are not recommended, including lumbar supports, some physical therapy (including traction) and some medicines, such as opioids, which can be associated with dependence.[42]

Expected Outcomes. It is important to consider the ethical, legal, commercial and quality aspects of delivering value-based spine care. In delivering value-based spine care, it is paramount that interventions are evidence-based, high- quality and cost-effective. Alongside being accessible and affordable for healthcare systems however, the most important outcome is that they must be able to demonstrate clear benefit to people with back pain.

Domain: Health Policy and System Research

SPINE20 recommends that G20 countries invest in Health Policy and System Research (HPSR) to generate evidence to develop and implement policies aimed at integrating rehabilitation in primary care to improve spine health.

Relevance to United Nations SDGs: #3 (Good Health and Well-Being)

Context to the Focused Topic. The field of Health Policy and System Research (HPSR) seeks to understand and improve how societies organize themselves in achieving collective health goals, and how different actors interact in the policy and implementation processes to contribute to policy outcomes.[43] Using an interdisciplinary lens, HPSR blends economics, sociology, anthropology, political science, public health and epidemiology to draw a comprehensive picture of how health systems respond and adapt to health policies, and how health policies can shape − and be shaped by − health systems and the broader determinants of health.[44]

Problem. Spine disorders impose a significant burden on individuals and healthcare systems globally.[45] They contribute to disability, reduced functioning and quality of life, and substantial healthcare costs.[3] By investing in HPSR focused on spine disorders, policymakers can better understand the prevalence, risk factors, and impact of these conditions, thus guiding resource allocation and policy development.[44,46,47]

Potential Solutions. Investment in HPSR to inform primary care and rehabilitation policies for spine disorders is imperative for several reasons.[48-50]

- 1. HPSR can help identify and address disparities in access to evidence-based spine rehabilitation services.
- 2. HPSR can identify which models of care are most effective for specific population and promote the integration of rehabilitation into primary, secondary and tertiary care through inclusion in universal health coverage.
- 3. By investing in HPSR to generate essential evidence, countries can identify gaps in service delivery, assess the impact of policy interventions, implement reforms to enhance the accessibility, quality, and efficiency of spine care, and improve the overall well-being of marginalized individuals and communities.
- 4. Collaborative investment in HPSR will incentivize countries to share best practices and knowledge, and learn from country-specific experiences when developing policies to improve access to rehabilitation for spine disorders.

Expected Outcomes. By establishing expected outcomes and accountability measures, governments can effectively evaluate the impact of their investments in promoting HPSR. Expected outcomes include:[48-52]

- improvements in healthcare delivery, ensuring better access to primary care and rehabilitation services;
- implementation of evidence-informed policies leading to more effective and efficient allocation of resources, and enhanced quality of care;
- improved patient outcomes; potentially reducing the burden of spine disorders on individuals, families, and healthcare systems;
- long-term cost savings by preventing complications, reducing unnecessary emergency department visits and hospitalizations, and improving overall health outcomes.

Domain: Digital Spine Care

SPINE20 recommends that G20 countries support ongoing research initiatives on digital-technologies including Artificial Intelligence, regulate digital technologies, and promote evidence-based, ethical digital solutions in all aspects of spine care, to enrich patient care with high value and quality.

Relevance to United Nations SDGs: #3 (Good Health and Well-Being)

Context to the Focused Topic. The adoption of new digital technologies, including Artificial Intelligence (AI), has the

potential to revolutionize spine care by enhancing the quality of patient care and operational efficiency. SPINE20 emphasizes the importance of supporting ongoing research, regulating digital technologies, and promoting evidence-based, ethical digital solutions in spine care.

Problem. Spine care faces significant challenges that hinder the provision of high-quality, efficient patient care. As the diagnosis of spine disorders continues to increase globally, healthcare systems encounter issues such as:

1. Diagnosis and Treatment Variability: Traditional diagnostic methods and treatment protocols for spine disorders vary widely, leading to inconsistent patient outcomes and sub-optimal care.
2. Resource Constraints: The rising incidence of spine disorders places a heavy burden on healthcare resources, leading to longer wait times and higher costs.
3. Clinical Decision-Making: Spine care often involves complex decision-making processes that can benefit from the precision and data analysis that AI offers.[53]

Potential Solutions. Supporting ongoing research initiatives in digital technologies can address these challenges effectively. Several actions can be taken:

1. Development of AI Tools: AI can markedly improve the accuracy and speed of diagnosing spine disorders.[53] Machine learning algorithms can analyze vast datasets to identify patterns and make predictions that surpass human capabilities in terms of speed and accuracy.[54]
2. Regulation of Digital Technologies: Establishing regulatory frameworks ensures that these technologies are used safely, effectively, and ethically. Regulation mitigates the risks associated with AI, such as data privacy issues and algorithmic biases.[55]
3. Promotion of Evidence-Based Solutions: Encouraging the development and deployment of digital tools that are grounded in robust clinical evidence ensures that innovations translate into real-world improvements in patient care.[56]

Expected Outcomes. The successful implementation of these initiatives is anticipated to yield several positive outcomes:

- Enhanced Patient Care: AI-driven diagnostics and treatment plans will lead to more accurate and tailored care for patients with spine disorders. This can improve patient outcomes and overall quality of life.[57]
- Resource Optimization: Efficient use of AI and other digital tools can streamline clinical workflows and reduce the strain on healthcare resources by minimizing unnecessary procedures and optimizing treatment plans.[58]
- Global Standardization: Establishing regulatory standards will harmonize spine care practices across G20 countries, leading to more consistent and equitable care.[59]
- Ethical and Evidence-Based Practice: Promoting evidence-based and ethical digital solutions ensures that patient safety and quality of care remain paramount, fostering trust in new technologies and facilitating broader adoption.[60]

Domain: Implementation

SPINE20 recommends that G20 countries prioritize social inclusion by promoting equitable access to comprehensive spine care through collaborations with healthcare providers, policymakers, and community organizations.

Relevance to United Nations SDGs: #1 (No Poverty), #3 (Good Health and Well-Being), #4 (Quality Education), #5 (Gender Equality), #8 (Decent Work and Economic Growth), #10 (Reduced Inequalities), #16 (Peace, justice, and strong institutions)

Context to the Focused Topic. Building on the core principle of universal healthcare access embodied by the Unified Health System (SUS), Brazil's G20 proposal advocates strengthening global health governance in the context of the "Resilient Health Systems" theme. This approach aims to address challenges impacting global health. Reflecting this commitment to inclusivity, the Brazilian G20 presidency prioritizes "Health Equity" as a key health objective. This initiative focuses on strengthening health systems to ensure greater accessibility and place people at the heart of all healthcare actions.

Problem. Despite a growing body of evidence highlighting the significant economic and psychosocial costs associated with managing spine disorders,[61] this knowledge often fails to translate into policy changes. In doing so, SPINE20 advocates for equitable access to the most effective resources for managing these disorders.[17-20]

Potential Solutions. Advocacy initiatives in this field can have desired outcomes, evidenced by the SPINE20 2023 initiative, where the Indian Government is considering the implementation of a National Spine Care Program.[20] The SPINE20 initiative urges G20 nations to prioritize investments in solutions that enhance social inclusion and ensure equitable access to comprehensive spine care. Achieving this necessitates collaborative efforts among healthcare professionals, policymakers, and community organizations. This collaboration would focus on prioritizing, implementing, and evaluating the recently-developed SPINE20 recommendations for integration within healthcare systems. The ultimate aim is to improve equitable access to spine care and achieve positive health outcomes. The proposed solution involves establishing a comprehensive system for delivering safe, effective, culturally-relevant, and evidence-based non-operative care.

This care continuum would encompass preventive care, primary care, rehabilitation, as well as emergent and surgical interventions when necessary.[46,62] Additionally, SPINE20 will provide educational plans for the implementation of SPINE20 initiatives.

Expected Outcomes. A national comprehensive and inclusive spine care program has the potential to revolutionize how we address spine health. Early detection and intervention through improved access to screening and preventative measures would become a reality, potentially leading to a significant reduction in the disease burden. This, in turn, could translate to substantial cost savings for the healthcare system. By implementing a program that emphasizes cost-effective resource distribution, we can ensure that necessary services are readily available across all demographics. Ultimately, such a program would prioritize consumer satisfaction by offering a person-centered approach to spine care, ensuring patients' needs are effectively met.

Domain: Economy

SPINE20 recommends that G20 countries prioritize spine health to improve the well-being and productivity of their populations. Government health systems are expected to create a healthier, more productive, and equitable society for all through collaborative efforts and sustained investment in evidence-based care and spine health promotion.

Relevance to United Nations SDGs: #1 (No Poverty), #3 (Good Health and Well-Being), #5 (Gender Equality), #8 (Decent Work and Economic Growth), #10 (Reduced Inequalities)

Increased Workforce Productivity. By promoting social inclusion in spine care, individuals with spine disorders are more likely to receive timely and appropriate medical attention. Effective spine care can lead to better health outcomes, reducing absenteeism and improving the productivity of individuals in the workforce.[63]

Reduced Healthcare Costs. Early intervention and appropriate spine care can prevent the progression of spine disorders, reducing the need for subsequent costly and invasive treatments. Socially inclusive healthcare models may improve patient adherence, leading to better management of chronic conditions and ultimately reducing healthcare costs.[64]

Enhanced Quality of Life. Socially included individuals are more likely to adhere to treatment plans and rehabilitation programs, leading to improved overall health and quality of life. Better mental health outcomes can result in decreased reliance on mental health services, reducing the economic burden on healthcare systems.[65]

Decreased Disability Costs. Social inclusion in spine care can contribute to preventing or minimizing disability associated with spine disorders. Reduced disability rates can result in lower direct and indirect costs associated with disability benefits, rehabilitation services, and workplace adjustments.[66]

Improved Public Health. Socially inclusive healthcare practices can contribute to a healthier population, reducing the overall burden of disease. A healthier population requires fewer resources for emergency care and acute interventions, contributing to cost savings in healthcare systems.[67]

Prevention of Long-Term Socioeconomic Burden. Addressing spine disorders through inclusive healthcare practices can prevent long-term socioeconomic burdens associated with chronic disability, unemployment, and dependence on social welfare programs.[68]

Stimulated Economic Activity. When individuals have access to adequate spine care and rehabilitation services, they are more likely to participate in economic activities, contributing to the overall economic growth of a community or society.[69]

Reduced Workplace Injuries. Social inclusion in spine care can lead to proactive measures in workplaces to prevent spine injuries, reducing the number of workplace accidents and related medicolegal and compensation costs.[70]

Conclusion

Spine disorders are the leading cause of disability worldwide, necessitating comprehensive strategies to promote social inclusion and access to high-quality, evidence-based spine care services. SPINE20, through its evidence-based recommendations, emphasizes the importance of primary care, value-based spine care, health policy and systems research, digital spine care, and effective implementation strategies to address this global challenge. By prioritizing these areas, G20 countries can improve the well-being and productivity of their populations, leading to a healthier, more equitable society, whilst reducing the huge social and economic burden caused by spine disorders.

Acknowledgments

Author Contributions

CM, CT, KT and SA managed in developing the paper all steps. CM, CT, HC, EM, LR, AB, and FA led the drafting of this paper in collaboration with the other authors and were part of the team that coordinated the production of papers. KK, IV, MC, KK, HA, LMD, KW, MR, RM, RY, PC, SW, AF, and GB closely revised many sections. Thereafter all authors contributed to all sections of the paper and edited it for key intellectual content. All other authors have read and provided substantive intellectual comments to the draft and have approved the final version of the paper.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Consent to Participate

All authors have read and approved the final version of the paper.

Consent for publication

All authors give our consent for the publication of identifiable details to be published in the Global Spine Journal.

ORCID iDs

Koji Tamai https://orcid.org/0000-0003-1467-2599
Kazuya Kitamura https://orcid.org/0000-0003-0117-4152
Ratko Yurac https://orcid.org/0000-0003-3603-6294

Data Availability Statement

The datasets generated during the current study are available from the corresponding author on reasonable request.

References

1. Diseases GBD, Injuries C. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet*. 2020;396(10258):1204-1222.

2. Cieza A, Causey K, Kamenov K, Hanson SW, Chatterji S, Vos T. Global estimates of the need for rehabilitation based on the global burden of disease study 2019: a systematic analysis for the global burden of disease study 2019. *Lancet*. 2021; 396(10267):2006-2017.

3. GBD 2021 Low Back Pain Collaborators. Global, regional, and national burden of low back pain, 1990-2020, its attributable risk factors, and projections to 2050: a systematic analysis of the Global Burden of Disease Study 2021. *Lancet Rheumatol*. 2023; 5(6):e316-e329.

4. Hoy D, Bain C, Williams G, et al. A systematic review of the global prevalence of low back pain. *Arthritis Rheum*. 2012; 64(6):2028-2037.

5. Chou R. Low back pain. *Ann Intern Med*. 2021;174(8): ITC113-ITC128.

6. Maher C, Underwood M, Buchbinder R. Non-specific low back pain. *Lancet*. 2017;389(10070):736-747.

7. Roux CH, Guillemin F, Boini S, et al. Impact of musculoskeletal disorders on quality of life: an inception cohort study. *Ann Rheum Dis*. 2005;64(4):606-611.

8. Initiative USBaJ. The hidden impact of musculoskeletal disorders on Americans. 2021. https://www.boneandjointburden.org/docs/BMUSImpactofMSKonAmericansbooklet_4thEdition%282018%29.pdf. (accessed May 2024).

9. Yong RJ, Mullins PM, Bhattacharyya N. Prevalence of chronic pain among adults in the United States. *Pain*. 2022;163(2): e328-e332.

10. World health organization: low back pain. https://www.who.int/news-room/fact-sheets/detail/low-back-pain (accessed May 2024).

11. de David CN, Deligne LMC, da Silva RS, et al. The burden of low back pain in Brazil: estimates from the Global Burden of Disease 2017 Study. *Popul Health Metrics*. 2020;18(Suppl 1): 12.

12. Fatoye F, Gebrye T, Mbada CE, Useh U. Clinical and economic burden of low back pain in low- and middle-income countries: a systematic review. *BMJ Open*. 2023;13(4):e064119.

13. Carregaro RL, Tottoli CR, Rodrigues DDS, Bosmans JE, da Silva EN, van Tulder M. Low back pain should be considered a health and research priority in Brazil: lost productivity and healthcare costs between 2012 to 2016. *PLoS One*. 2020;15(4): e0230902.

14. United Nations. Sustainable development goals. https://sdgs.un.org/goals. (accessed March 2023).

15. WHO releases guidelines on chronic low back pain. https://www.who.int/news/item/07-12-2023-who-releases-guidelines-on-chronic-low-back-pain (accessed July 2024).

16. World rehabilitation alliance. https://www.who.int/initiatives/world-rehabilitation-alliance (accessed July 2024).

17. AlEissa SI, Tamai K, Konbaz F, et al. SPINE20 A global advocacy group promoting evidence-based spine care of value. *Eur Spine J*. 2021;30(8):2091-2101.

18. Costanzo G, Misaggi B, Ricciardi L, et al. SPINE20 recommendations 2021: spine care for people's health and prosperity. *Eur Spine J*. 2022;31:1333-1342.

19. Darwono B, Tamai K, Cote P, et al. SPINE20 recommendations 2022: spine care-working together to recover stronger. *Eur Spine J*. 2022;31:3262-3273.

20. Chhabra HS, Tamai K, Alsebayel H, et al. SPINE20 recommendations 2023: one Earth, one family, one future without spine disability. *Brain Spine*. 2023;3:102688.

21. United Nations. Remarks at briefing by the Brazilian G20 presidency to the general assembly. https://www.un.org/en/desa-en/remarks-briefing-brazilian-g20-presidency-general-assembly#:~:text=TheUnitedNationsfullysupports,reformofglobalgovernanceinstitutions. (accessed May 2024).

22. United Nations. https://social.desa.un.org/issues/disability/envision-2030/17goals-pwds. (accessed May 2024).

23. Foster NE, Anema JR, Cherkin D, et al. Prevention and treatment of low back pain: evidence, challenges, and promising directions. *Lancet*. 2018;391(10137):2368-2383.

24. Package of interventions for rehabilitation. 2023. https://www.who.int/activities/integrating-rehabilitation-into-health-systems/service-delivery/package-of-interventions-for-rehabilitation (accessed May 2024).

25. Hurwitz EL, Randhawa K, Yu H, Cote P, Haldeman S. The Global Spine Care Initiative: a summary of the global burden of low back and neck pain studies. *Eur Spine J*. 2018;27(Suppl 6): 796-801.

26. Nicholl BI, Sandal LF, Stochkendahl MJ, et al. Digital support interventions for the self-management of low back pain: a systematic review. *J Med Internet Res*. 2017;19(5):e179.

27. Dieleman JL, Cao J, Chapin A, et al. US health care spending by payer and health condition, 1996-2016. *JAMA*. 2020;323(9): 863-884.

28. Milken institute: the costs of chronic disease in the U.S. https://milkeninstitute.org/report/costs-chronic-disease-us?psafe_param=1&gad_source=1&gclid=CjwKCAjw0YGyBhByEiwAQmBEWtD0QN6CMw0kkFQDi57U1JxN7DPDv_0RW4K2jpNUV9S56qB8H_9GbxoCC7gQAvD_BwE (accessed May 2024).

29. Das B. An evaluation of low back pain among female brick field workers of West Bengal, India. *Environ Health Prev Med*. 2015; 20(5):360-368.

30. Mannion R, Exworthy M. (Re) making the procrustean bed? Standardization and customization as competing logics in healthcare. *Int J Health Pol Manag*. 2017;6(6):301-304.

31. Collden C, Hellstrom A, Gremyr I. Value configurations for balancing standardization and customization in chronic care: a qualitative study. *BMC Health Serv Res*. 2021;21(1):845.

32. Sinsky CA, Bavafa H, Roberts RG, Beasley JW. Standardization vs customization: finding the right balance. *Ann Fam Med*. 2021;19(2):171-177.

33. NICE guideline. Chronic pain (primary and secondary) in over 16s: assessment of all chronic pain and management of chronic primary pain. 2021. https://www.nice.org.uk/guidance/ng193. (accessed May 2024).

34. Centers for mrdicare and medicaid service; primary care. https://www.cms.gov/priorities/innovation/key-concepts/primary-care (accessed June 2024).

35. World health organization; primary care. https://www.who.int/teams/integrated-health-services/clinical-services-and-systems/primary-care (accessed June 2024).

36. Defining value-based healthcare in the NHS. https://www.cebm.ox.ac.uk/resources/reports/defining-value-based-healthcare-in-the-nhs (accessed July 2024).

37. The value of health: improving outcomes. https://www.efpia.eu/news-events/newsletter/efpia-newsletter-external/efpia-newsletter-27-september-2018/

38. Defining value: connecting quality and safety to costs of care. https://accessmedicine.mhmedical.com/content.aspx?bookid=1371&sectionid=77694074 (accessed July 2024).

39. Owens DK, Qaseem A, Chou R, Shekelle P, Clinical Guidelines Committee of the American College of Physicians. High-value, cost-conscious health care: concepts for clinicians to evaluate the benefits, harms, and costs of medical interventions. *Ann Intern Med*. 2011;154(3):174-180.

40. Landon SN, Padikkala J, Horwitz LI. Defining value in health care: a scoping review of the literature. *Int J Qual Health Care*. 2021;33(4):mzab140.

41. Hutton M. Spinal services GIRFT programme national specialty report. https://gettingitrightfirsttime.co.uk/wp-content/uploads/2019/01/Spinal-Services-Report-Mar19-L1.pdf. (accessed July 2024).

42. WHO guideline for non-surgical management of chronic primary low back pain in adults in primary and community care settings. https://www.who.int/publications/i/item/9789240081789 (accessed July 2024).

43. World rehabilitation alliance (WRA) - world health organization (WHO) hosted network. https://www.who.int/initiatives/world-rehabilitation-alliance (accessed July 2024).

44. Frontera WR, DeGroote W, Ghaffar A, Health Policy & Systems Research for Rehabilitation Group. Importance of health policy and systems research for strengthening rehabilitation in health systems: a call to action to accelerate progress. *Am J Phys Med Rehabil*. 2023;102(11):951-952.

45. Traeger AC, Buchbinder R, Elshaug AG, Croft PR, Maher CG. Care for low back pain: can health systems deliver? *Bull World Health Organ*. 2019;97(6):423-433.

46. Buchbinder R, van Tulder M, Oberg B, et al. Low back pain: a call for action. *Lancet*. 2018;391(10137):2384-2388.

47. Briggs AM, Woolf AD, Dreinhofer K, et al. Reducing the global burden of musculoskeletal conditions. *Bull World Health Organ*. 2018;96(5):366-368.

48. Briggs AM, Jordan JE, Sharma S, et al. Context and priorities for health systems strengthening for pain and disability in low- and middle-income countries: a secondary qualitative study and content analysis of health policies. *Health Pol Plann*. 2023;38(2):129-149.

49. Lewis R, Gomez Alvarez CB, Rayman M, Lanham-New S, Woolf A, Mobasheri A. Strategies for optimising musculoskeletal health in the 21(st) century. *BMC Muscoskel Disord*. 2019;20(1):164.

50. World Health Organization (WHO). Strengthening rehabilitation in health systems. https://www.who.int/southeastasia/activities/strengthening-rehabilitation-in-health-systems. (accessed July 2024).

51. Stenberg K, Hanssen O, Edejer TT, et al. Financing transformative health systems towards achievement of the health Sustainable Development Goals: a model for projected resource needs in 67 low-income and middle-income countries. *Lancet Global Health*. 2017;5(9):e875-e887.

52. Oxman AD, Lavis JN, Lewin S, Fretheim A. SUPPORT Tools for evidence-informed health Policymaking (STP). *Health Res Pol Syst*. 2009;7 Suppl 1(Suppl 1):I1.

53. Mallow GM, Siyaji ZK, Galbusera F, et al. Intelligence-based spine care model: a new era of research and clinical decision-making. *Global Spine J*. 2021;11(2):135-145.

54. Tamai K, Terai H, Hoshino M, et al. Deep learning algorithm for identifying cervical cord compression due to degenerative canal stenosis on radiography. *Spine*. 2023;48(8):519-525.

55. European union: white paper on artificial intelligence: a European approach to excellence and trust. https://commission.europa.eu/publications/white-paper-artificial-intelligence-european-approach-excellence-and-trust_en (accessed July 2024).

56. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. *Nat Med*. 2019;25(1):44-56.

57. Johnson KW, Torres Soto J, Glicksberg BS, et al. Artificial intelligence in cardiology. *J Am Coll Cardiol*. 2018;71(23): 2668-2679.

58. Krittanawong C, Zhang H, Wang Z, Aydar M, Kitai T. Artificial intelligence in precision cardiovascular medicine. *J Am Coll Cardiol*. 2017;69(21):2657-2664.

59. World health organization: global strategy on digital health 2020-2025. https://www.who.int/publications/i/item/9789240020924 (accessed July 2024).

60. Floridi L, Cowls J, Beltrametti M, et al. AI4People-An ethical framework for a good AI society: opportunities, risks, principles, and recommendations. *Minds Mach*. 2018;28(4):689-707.

61. Farrar MA, Carey KA, Paguinto SG, Chambers G, Kasparian NA. Financial, opportunity and psychosocial costs of spinal muscular atrophy: an exploratory qualitative analysis of Australian carer perspectives. *BMJ Open*. 2018;8(5):e020907.

62. Speerin R, Needs C, Chua J, et al. Implementing models of care for musculoskeletal conditions in health systems to support value-based care. *Best Pract Res Clin Rheumatol*. 2020;34(5): 101548.

63. Cedraschi C, Nordin M, Haldeman S, et al. The Global Spine Care Initiative: a narrative review of psychological and social issues in back pain in low- and middle-income communities. *Eur Spine J*. 2018;27(Suppl 6):828-837.

64. International association for the study of pain: prevention of low back pain: the importance of intervention from an early age. https://www.iasp-pain.org/resources/fact-sheets/prevention-of-low-back-pain-the-importance-of-intervention-from-an-early-age/ (accessed July 2024).

65. World health organization. Rehabilitation 2030 initiative. https://www.who.int/initiatives/rehabilitation-2030 (accessed Febrary 2024).

66. Haldeman S, Nordin M, Chou R, et al. The Global Spine Care Initiative: world Spine Care executive summary on reducing spine-related disability in low- and middle-income communities. *Eur Spine J*. 2018;27(Suppl 6):776-785.

67. Jack L Jr. Advancing health equity, eliminating health disparities, and improving population health. *Prev Chronic Dis*. 2021; 18:E79.

68. Dutmer AL, Schiphorst Preuper HR, Soer R, et al. Personal and societal impact of low back pain: the groningen spine cohort. *Spine*. 2019;44(24):E1443-E1451.

69. World health organization: rehabilitation. https://www.who.int/health-topics/rehabilitation/rehabilitation-is-about-health-and-functioning-in-everyday-life#tab=tab_1 (accessed July 2024).

70. Soares CO, Pereira BF, Pereira Gomes MV, Marcondes LP, de Campos Gomes F, de Melo-Neto JS. Preventive factors against work-related musculoskeletal disorders: narrative review. *Rev Bras Med Trab*. 2019;17(3):415-430.