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Introduction to a new series of narrative reflections in chiropractic

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Introduction to a new series of narrative reflections in chiropractic

(JCCA. 2025;69(2):100-106)

KEY WORDS: narrative, chiropractic, low back pain, health service accessibility, interprofessional relations, patient advocacy, disabled persons, self disclosure, professional role, attitude of health personnel, interprofessional collaboration, materiality, rehabilitation

Introduction à une nouvelle série de réflexions narratives en chiropratique

(JCCA. 2025;69(2):100-106)

MOTS CLÉS : narration, chiropractique,douleur lombaire, accessibilité des services de santé, relations interprofessionnelles, défense des droits des patients, personnes en situation de handicap, auto-divulgation, rôle professionnel, attitude du personnel de santé, collaboration interprofessionnelle, matérialité, réhabilitation

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Introduction

Jordan A. Gliedt, DC
Silvano Mior, DC, PhD

"The unexamined life is not worth living." - Socrates

Jasmine is a 32-year-old female who is living with back pain during pregnancy. This is her second pregnancy and her first time in life experiencing back pain. She worries that her back pain will worsen over time. Consistent with their training, Jasmine's chiropractor unconsciously follows best practices in patient-centered care, including the act of active listening mannerisms.

Over the course of several weeks of visits, Jasmine opens up and begins to speak with the chiropractor about more than just back pain. Her back pain is improving, and she begins to feel better. Her mood improves and she begins to smile more often during her chiropractic visits. Her pain progressively decreases, and she gives birth to a healthy baby boy. She notes having lingering, mild postpartum back pain. She continues to visit the chiropractor periodically over the following few months. Jasmine describes a decreasing perceived need for chiropractic visits and ultimately discharges herself from care. At her last chiropractic visit she joyously cries and hugs the chiropractor revealing to the chiropractor that her first pregnancy resulted in a stillbirth. Unbeknownst to the chiropractor, Jasmine describes that the chiropractor's kindness, listening, and empathy provided a safe space for her to internally grieve, experience healing, and return to a life at peace. Upon reflection, the chiropractor experiences a profound meaningfulness in healing that is found through human connectedness. This experience has transformed the chiropractor, who now consciously recognizes the true value of engaging in patient- and relationship-centered care.

Insights into illness and healing can be shared and experienced through narrative acts, described as "narrative medicine".[1] Narrative medicine is grounded in biopsychosocial and patient-centered care frameworks.[2] Narrative medicine provides a pathway to appreciating the interpersonal binds between various aspects of health, disease, clinical care, and learning in the health professions.[2] Narrative medicine can enable individuals to confer reflection, empathy, compassion, professionalism, and trustworthiness to clinical practice, professionalism, and learning, which may otherwise not be as obtainable.[1,2]

Narrative medicine can take on many different forms. According to Charon, there are at least five main forms of narrative medicine with varying intentions and methods.[1] Narrative writings can include non-fictional or fictional essays on patient care or professional practice with intent to provide a lesson or enhance perspectives and reflection.[1] In addition, narrative medicine can involve story telling of an individual's experiences and perspectives (e.g., patient, clinician, student, layperson) with an intent to enhance reflection, professionalism and diversity of perspectives. Lastly, narrative medicine can be expressed through various mediums, such as short essays, poems, songs, pictures, or films.

The practice of narrative medicine is increasing in the health professions, as well as health professions education.[1,3] For example, the journals *JAMA* and *Health Affairs* have longstanding series of narrative medicine entitled, *"A piece of my mind"* and *"Narrative matters"*, respectively.[4,5] Narrative medicine has been fostered in health professions education and has been shown to yield favorable changes in attitudes, perceptions, knowledge acquisition, skills, and collegial collaboration that is transferable to professional practice.[3] Despite the increase in narrative medicine in health professions, including peer-reviewed literature, narrative medicine in chiropractic related scientific literature is limited.

In the spirit of Socrates pursuit of lifelong reflection and learning, we introduce a new series of narrative medicine in chiropractic, titled "*Narrative reflections"*. We invite chiropractic clinicians, educators, students, patients, and community members to submit brief narratives to the *JCCA*. This series of narratives in chiropractic is dedicated to telling stories that explore experiences and perspectives in health, health care, learning, and the chiropractic profession through brief non-fictional or fictional narratives. It is our hope that this creative series of narratives facilitates reflection and communal learning, embracing the convergence of humanities and chiropractic healthcare. Please consider sharing your meaningful and reflective experiences in clinical practice, chiropractic education, community engagement, or other professional practice in this creative series (see Box 1 for suggested template).

Box 1.
Author template for narrative reflections in chiropractic.

Title Page
• Short, informative title • No abstract is needed • Keywords • Patient authorization (if applicable)
Narrative
• Personal vignettes, fictional or non-fictional stories, short poems, or photo-story exploring the experiences or perspectives of clinicians, patients, community members, educators, or students taken from a wide range of experiences within the chiropractic profession • ≤ 3 authors • ≤ 1500 words, ideally 750-1000 words for vignettes and stories • ≤ 5 references

Navigating fragmented care pathways in complex spine cases: a reflective clinical narrative

Nora Bakaa, DC, PhD

As clinicians, we may encounter a patient whose worsening spinal symptoms are overlooked— drowned out by a fragmented and overburdened health care system. These silent struggles can lead to delayed diagnoses and prolonged suffering. In such moments, our role extends beyond diagnosis and treatment. By leaning on trusted interprofessional relationships and engaging in meaningful advocacy, we have the power to amplify the patient's voice, bring clarity to clinical uncertainty, and ensure that their voice is heard.

Case summary

Hope (pseudonym) is a 45-year-old physically active woman with a five-year history of progressively worsening neck and low back pain, bilateral numbness in both upper and lower extremities, and marked functional decline. Over the last five years, she visited the emergency department multiple times, was prescribed different pain medications, told to go on bed rest, and referred by her physician to a pain clinic, where she received drugs and injections, all with little to no relief. Two separate referrals to orthopedic surgeons did not result in a diagnosis nor further intervention, but referral back to pain management. When I saw Hope, she reported episodes of urinary incontinence, severe sleep disturbance, gait instability, and difficulty with sitting, driving, and walking. Her MRI showed cervical spinal stenosis and degenerative changes in the lumbar spine. Despite these findings and obvious red flags, her care remained focused on pain control. Concerned about her clinical presentation, including a positive Hoffman's sign, brisk reflexes, multilevel sensory deficits, and motor weakness, I arranged for her to be seen by a neurosurgeon, with whom I had a trusting relationship. Upon consultation, we agreed on a diagnosis of lumbar spondylolisthesis with instability and proceeded with spinal fusion surgery.

When I first met Hope, I could tell she had already given up. It wasn't just the pain, though it was obvious and profound; it was the quiet resignation in her voice, the way she said, "I've already seen everyone." She wasn't looking for another opinion. She wasn't even expecting to be believed. She was tired. A woman in her 40s who had once run 5Ks and worked full-time now struggled to stand from a chair. She had been through every rung of the system: emergency departments, pain clinics, multiple specialists. No one had given her answers—no one had taken responsibility for her care.

Our first few sessions were not about treatment in the traditional sense. There were no hands-on techniques, no protocols—*just conversation*. Instead, the focus was on understanding her history, her frustrations, and the profound sense of abandonment she carried. She had lost faith in the process, and rushing into physical care would have ignored the emotional burden that preceded it. Those early sessions were foundational. They were not passive; they were essential. They gave her space to be heard and gave me space to understand what had not been working.

Hope's symptoms were complex: constant numbness in her hands and intermittent numbness in her legs, pain in the lower back that severely limited her function, and even episodes of urinary incontinence. Red flags were present, but the system's response was rote. She was offered injections, NSAIDs, and repeated referrals back to the same pathways that had already failed her. Her imaging showed cervical stenosis, but the source of her most debilitating symptoms, her low back pain and leg symptoms, remained unexplained.

What struck me was that she no longer expected anyone to help. Hope had become background noise—a "chronic pain" file passed between providers, each treating their part but not the whole, not the patient. I did not diagnose Hope—that came later. Instead, I did what had not yet been done: I paused. I looked at the full trajectory. I asked why nothing had helped and whether something might be missing. I referred her to a trusted neurosurgeon; someone I knew would take a more comprehensive look at Hope's case. Ultimately, we ordered flexion-extension imaging, which revealed lumbar spondylolisthesis with instability. While the surgeon initially followed standard protocols, including another trial of injections despite her poor response in the past—a sequence not uncommon in spine care[6]—they ultimately confirmed the diagnosis and initiated the process for spinal fusion surgery.

At this decision point, nearly two years had passed since I first saw her. But this stage of her care was different. The process became more hopeful, anchored in clearer provider communication, focused on functional goals, and individualized strength-based rehabilitation. She was no longer navigating the system alone. Her care became coordinated. Hope now regained a sense of agency and participated more actively in her recovery, even before the operation. Upon self-reflection, it was not about *solving the problem but rather* struck by how easily she had been forgotten, dismissed as another patient with chronic pain. Hope was treated but not *cared for* by the system. Her case showed me, again, that we must challenge default assumptions, especially when patients are not improving. We must recognize that when someone has exhausted the system, they need more than another treatment; they need someone who will advocate.

Hope's case exemplifies the toll of repetitive, low-value interventions when care lacks continuity and diagnostic clarity. Despite presenting with serious symptoms, she was repeatedly cycled through standard pain management pathways without progress. Unfortunately, this is common in musculoskeletal care, where patients often receive redundant treatments without integrated decision-making.[7,8] The resultant cumulative impact is not just clinical, but personal, leading to frustration, isolation, and loss of trust in the healthcare system.

This experience reminds us that clinical advocacy is care. When patients are exhausted and unheard, sometimes the most impactful thing to do is pause, listen again, look again, and be willing to question why the current approach is not working. Especially for patients with overlapping or non-linear presentations, our role must include facilitating interprofessional collaboration and refusing to accept stagnation. True team-based care requires intentional communication, shared responsibility, and humility.[9,10]

Hope's recovery did not begin in the operating room. It began when she was finally seen as a whole person by a team willing to work together. This is what person-centered spine care can, and should, look like.

Chiropractors with disabilities – an unspoken reality and unrealized opportunity

Scott Dunham, DC, MSc, MEd

Twenty-seven percent of Canadians over the age of 15 live with a disability.[11] As a chiropractor, we've all had those days in practice where we simply aren't at our best but forge on determinedly, putting our energy and efforts into treating patients. But what happens when these rough days become weeks, when disgruntlement turns to depression, or when injuries become permanent impairments? Is there any value of a chiropractor with a disability?

These were the questions I grappled with as I navigated an identity shift from a chiropractor to a chiropractor living with a disability. I found myself undergoing a metamorphosis of sorts, orienting myself to both sides of the gurney, as they say in medicine, with seemingly much more in common with those who I cared for than other chiropractors. I thought to myself - in the age of person-centred care and a renewed focus on the importance of empathy, surely the experience of living with a disability could strengthen relationships with both patients and colleagues alike.

I was diagnosed with Multiple Sclerosis in 2010 and continued teaching students and treating patients. I was determined not to let this diagnosis define me. The reluctance to identity as someone living with a disability fueled my perseverance in practice, my pursuit of additional degrees, and my continued participation in contact sports into my 30s and 40s. But I did so through an ableist lens, as if living with a disability was something to conceal or to be ashamed of. I disclosed my condition selectively to some of my closest patients, friends, colleagues, and students, which strengthened those relationships. However, for the most part I kept to myself, not wanting to wear that

label or acknowledge my own story. Back then I desperately wanted to be a "normal" chiropractor.

It turns out that chiropractors living with disabilities is extremely rare. A 2022 study of diversity within the chiropractic profession in Canada found that only 3% self-report as living with a disability.[12] A total of 7.2% of Canadian physiotherapists and 12.4% of Ontario nurses identify as someone living with a disability.[13,1,4] When comparing these rates to the general Canadian population (27% of Canadians identify as living with a disability), something doesn't add up.

I continued to ruminate on this disparity following my diagnosis. Is it that people living with disabilities aren't attracted to the health professions for employment? Is it that students in health professions education get weeded out through the rigours of academia or unintended ablest messaging? Are practitioners living with disabilities less effective or viewed as unqualified by patients? Are practitioners just hesitant to report personal disabilities, even on anonymous surveys? All of these could possibly explain a disproportionate reported prevalence of health practitioners living with disabilities.

Self-reporting of disability status by health professionals is likely affected by the negative stigma of the term "disabled" and not wanting this attribute part of their professional identity. Biases and prejudices affect how we view others but also play a role in how we view ourselves. A total of 82.4% of physicians have reported beliefs that people living with significant disability have a lower quality of life than those living without disabilities.[15] So in retrospect, my internal dialogue concerning my future and doubts of my abilities may have been predictable, if not still disappointing.

In health care the role duality of doctor and patient can be difficult to navigate while also maintaining genuine displays of empathy towards one's own patients. I certainly struggled with this as I navigated my own evolving identity, trying constantly to balance the relative importance of who I was versus what I did for a living. But some days it was hard caring about a patient with a rolled ankle while I suffered with bouts of neuropathic pain and unrelenting fatigue.

My perspective changed when I recognized the impact I could have by informing and educating other health professionals living with disabilities, and the powerful opportunity of sharing their story. As a chiropractor I firmly believe that education is our most transformative and powerful intervention because of its ability to change personal habits, mindsets, and world views. The impact of our words and our actions is immeasurable, as is the positive effect when bringing our authentic selves to our work. Patients need to see themselves reflected in healthcare providers charged with their well-being. With their continued presence, chiropractors, healthcare professionals, and students living with disabilities have an enormous opportunity to change society's belief of the value and contributions of those living with disabilities.

Whether in healthcare, education, advocacy, or other fields – there is a vital opportunity for the chiropractor living with a disability. Representation matters and I believe that 27% of the Canadian population would wholeheartedly agree.

Linoleum

Melissa Atkinson-Graham, PhD

How often do you think about flooring materials as conditions of possibility? Probably infrequently, but for me, constantly.

My life can be traced in linoleum flooring. Patterned flecks of beige on beige, splotches of grey connecting blue and green borders, speckles of white and black stretching across corridors. All have been underfoot in so many of the moments that have mattered in my life.

I can recall the streaky taupe pattern of the six by six tiles in the office where a resident told my mother that metastasis was a sign of remission – the ecru linoleum that lined the copy room where I found out I won my first national research grant – the cold grey smudges of the anatomy theatre floor that held my gaze for weeks on end to keep me from crying – the squeaks my clogs would make across the linoleum in the hospital hallways where the sexual harassment I experienced as an intern was treated as an inconvenience – the wheat coloured sheets of vinyl that curved slightly along the bottom of the white plaster walls in my clinic room where, for the first time, a patient of mine told me he was dying.

We forget that these surfaces of blood and grief, urgency and collapse, direction and dirt are also surfaces of connection. That where the tile goes and does not go, how the linoleum borders or breaks from a wall, plays a role in our actions and our experiences.

More than matter, anthropologists have long described that the materials of our built environments convey "promise, transformative potential, aesthetic effect, and affective force."[16] The materials used to construct and furnish the spaces where we work and dwell influence the kinds of experiences, emotions, and social relations that can materialize in those spaces. When we pay attention to the materials all around us, anthropologists argue that we can begin to "better understand relationships between people and things, where objects are not just passive physical artifacts, but operate in entangled connections and have the power to construct identity, ascribe meaning, collect memories, preserve heritage and knowledge, and generate action."[17]

We have only to consider what it would feel like, or the kinds of relationships that might take shape, if our clinic rooms were clad in floor to ceiling stainless steel. What forms of connection would be possible against a backdrop of cold, hard edges, undiffused light, and the imagined hum of a freezer fan.

Back to flooring, and back a few years ago to a nursing station in Northern Manitoba with its speckled greenish grey tiles that stretched the entirety of the building. One, contiguous material connecting seven distinct clinical services.

It is of no coincidence that it was in this material context where I experienced integrated practice. There was symbolic and material force in the way the linoleum stretched, uninterrupted, between prenatal care, public health, the emergency department, and my clinic room. The industrial grade flooring was a conduit of connection, signaling the inseparability of our services.

Those great swaths of shared tile that shaped my year in the North provided a pathway to interprofessional collaboration. The same linoleum tiles that offered a surface for a movement assessment were the same tiles that connected me to the attending on call when a constellation of signs and symptoms suggested the need for urgent brainstem imaging. The same tile that steadied my chair as I sat in an intake, listening to a person begin to make sense of the deep emotional undercurrents shaping their experience of chronic pain, was the same tile that we walked together to the counselling office down the hall. Two providers standing on the same surface with a person in need. Our scopes of practice defined like those specks of grey and brown, with no material separation between our work of helping this person in pain.

The expanse of linoleum in the station meant that there were no material distinctions between practices – no changes from vinyl to wood laminate, to terrazzo that would demarcate practical siloes. Even the wall colours were mostly the same – an aesthetic modelling of healthcare as emergency care, primary care, mental health services, and rehabilitation.

I often wonder what that year would have been like if my room in that part of the province was tiled differently. Would I have felt as connected? Would I have been imagined as part of a broader interdisciplinary practice? Would I have spent as much time in the offices of my colleagues, discussing complex cases and collaborative management, seated atop the same linoleum that would later allow me to fidget on my stool as I worked away on charting? Would I have understood, materially, how important integrative practice is for the people whose health I sought to support? Would I have understood, materially, how important it is to practice the limits of my scope – to know that when a person needs more than what I can, or should, offer, that I am always already connected to other professionals who can support such needs for care.

In the company of my tiled histories, I wonder now what practical significance we might find in flooring. What forms of connection are possible when we pay attention to the materials that shape and contain our practices, and what material change might we materialize?

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Secondary prevention of musculoskeletal sports injuries: a scoping review of early detection and early intervention strategies

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Background: *Early detection and early intervention of musculoskeletal sports injuries is a promising, but underexplored area. Poor conceptual clarity of secondary prevention strategies currently hampers research and clinical application.*

Methods: *We conducted a scoping review, aimed at summarizing secondary prevention strategies of musculoskeletal sports injuries into recommendations for researchers, athletes, and clinicians. We searched seven databases for the terms: sport, injury, and early detection/intervention.*

Prévention secondaire des blessures musculo-squelettiques liées au sport : une revue exploratoire des stratégies de détection et d'intervention précoces

Contexte: *La détection et l'intervention précoces des blessures musculo-squelettiques liées au sport est un domaine prometteur, mais peu exploré. La faible clarté conceptuelle des stratégies de prévention secondaire entrave actuellement la recherche et l'application clinique.*

Méthodes: *Nous avons réalisé une revue exploratoire, qui vise à résumer les stratégies de prévention secondaire des blessures musculo-squelettiques liées au sport en formulant des recommandations pour les chercheurs, les athlètes et les cliniciens. Nous avons effectué des recherches sur les termes suivants dans sept bases de données : sport, blessure et détection/intervention précoce.*

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Results: *Nine studies reported early detection/intervention strategies. Strength testing is a promising approach to early injury detection. We recommend caution in interpretating early imaged abnormalities due to heterogeneous findings. Observing early symptoms appears the most adopted pragmatic approach. Early rehabilitation and passive therapies seem effective as early interventions. Early load reduction is likely difficult to implement, due to performance expectations.* Conclusions: *The evidence for early detection/intervention is limited. Further research into assessing early detection/intervention strategies and their use in practice, is necessary to formulate concrete recommendations.*

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KEY WORDS: athletic injury; musculoskeletal sport injury; overuse injury; tendinopathy; strain injury; sprain injury; secondary prevention; secondary prophylaxis; preventing worsening; preventing exacerbation; early diagnosis; early identification; early treatment; early therapy; early rest; early rehabilitation; early phase; early stage; prehabilitation

Résultats: *Neuf études ont débouché sur des rapports sur des stratégies de détection/intervention précoce. Les tests de force sont une approche prometteuse pour la détection précoce des blessures. Nous recommandons la prudence dans l'interprétation des anomalies d'imagerie précoces en raison de résultats hétérogènes. Observer les premiers symptômes semble être l'approche pragmatique la plus adoptée. La réhabilitation précoce et les thérapies passives semblent efficaces en tant qu'interventions précoces. Il est probable que la réduction précoce de la charge soit difficile à mettre en œuvre en raison des attentes en matière de performance.*

Conclusions: *Les données probantes en matière de détection/intervention précoce sont limitées. Des recherches supplémentaires sur l'évaluation des stratégies de détection précoce/intervention et leur application pratique sont nécessaires pour formuler des recommandations concrètes.*

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MOTS CLÉS : blessure athlétique; blessure musculo-squelettique liée au sport; blessure par surutilisation; tendinopathie; blessure de tension; blessure d'entorse; prévention secondaire; prophylaxie secondaire; prévention de l'aggravation; prévention de l'exacerbation; diagnostic précoce; identification précoce; traitement précoce; thérapie précoce; repos précoce; réhabilitation précoce; phase précoce; stade précoce; préhabilitation

Introduction

Risk of musculoskeletal (MSK) injury is an inherent part of an athletic career.[1] Playing with MSK injuries is not only a risk for the individual athlete,[2,3] it is also a major problem for their affiliated clubs and organizations.[4,5] Despite considerable research into prevention strategies, it is still difficult to minimize MSK injuries in elite sports contexts.[6] The numerous efforts to prevent MSK injuries have primarily been evaluated at the group level before the onset of MSK injury (traditionally referred to as primary prevention[7]), in an attempt to reduce the risk of MSK injury.[8] However, primary prevention does not consider that athletes accept the risk of MSK injury in their pursuit of improved performance, and risk avoidance is therefore not a realistic strategy.[9,10] In fact, one might argue in the extreme that risk avoidance merely postpones the inevitable onset of MSK injury.[11,12] Consequently, several international consensus statements in the last decade have argued for a shift on focus towards early detection and early intervention.[13-15]

Early detection and subsequent early intervention fall within the domain of secondary prevention.[16] Yet, secondary prevention, which aims to prevent the complications, recurrence or worsening of a MSK injury, appears relatively under-explored.[16] Available evidence in this area focuses mainly on the prevention of MSK injury com-

plications, particularly knee osteoarthritis after anterior cruciate ligament injury,[17] and prevention of recurrences, particularly of ankle sprains or hamstring strains.[18,19] Moreover, there seem to be much fewer studies on the prevention of index MSK injury worsening. In fact, when examining the citations of a recent comprehensive review on MSK injury prevention strategies, reviews on early detection or early intervention strategies for MSK sports injuries appear absent.[20]

Research into early detection has mainly aimed at predicting future symptoms,[21,22] assessing early MSK injury stages,[23,24] or predicting symptom duration,[25,26] generally providing optimistic strategies for detecting MSK sports injuries early. Concurrently, intervening early appears favorable.[27-29] However, to our knowledge, there is a research gap in the combination of these two clinical practices. Clinicians and newly injured athletes are likely to be impeded by this apparent research disconnect. The high incidence of MSK injuries and athletes' acceptance of the risk of MSK injury underlines the importance of supporting clinicians and athletes in better decision making at the time of MSK injury.

The research gap on early detection and early intervention makes it difficult to compare and contrast such strategies. When secondary preventative strategies used by athletes in practice are unexplored, researchers assessing specific secondary preventative strategies may unintentionally assess strategies irrelevant to athletes in practice. Vice versa, without secondary preventative strategies assessed in experimental research, researchers will struggle formulating inquiries into evidence-based strategies in use among athletes in practice.

With the above in mind, to move the state-of-the art of early MSK injury detection and prevention forward, a summary description and synthesis of the evidence would be helpful to clinicians, athletes, and researchers in decision-making.

Objectives

Our objective was to scope available literature relating to secondary prevention of MSK sports injuries. We operationalized this objective by posing two research questions:

1) How may the purpose, results and strategies of the research literature on early detection and early intervention of musculoskeletal sports injuries be characterized and consolidated?
2) How may the research literature on early detection and early intervention of musculoskeletal sports injuries be articulated into practical recommendations for clinicians, athletes, and researchers?

Methods

We followed a scoping review approach,[30] in order to extract data from multiple study types dispersed across various disciplines,[31] and followed the extended PRISMA guidelines for reporting findings.[30,32]

Protocol and registration

The iterative nature of a scoping review allows for refinement of exclusion and inclusion criteria to ensure an adequate yet feasible scope of relevant evidence.[30] As such, no protocol was published beforehand, to provide the flexibility for this iterative process.[30]

Search strategy development

We performed two preliminary searches. We initially searched Scopus for *athlete*, *injury*, and *secondary prevention*, to identify additional search terms. A larger second search was then performed, inspired by the definitions of Holm-Jensen et al.,[16] on three secondary prevention domains: *Preventing recurrence*, *preventing sequelae/complications,* and *preventing worsening* (the latter mainly identified by the search terms *early detection/intervention*). The preliminary search identified many studies on preventing MSK injury sequelae and recurrence, but only few investigating early detection and early intervention. The studies in these preliminary searches informed our search string that was composed of three blocks: *athlete*, *injury* and *early detection/intervention*. Synonyms, truncation and proximity operators were applied where relevant.

Information sources

The final search string was applied in the Scopus, SportDiscus, Sports Medicine and Education Index, PubMed/Medline, Web of Science, Cochrane library (the Reviews- and Trials-databases), and Cinahl databases. The date of the search was the 10th of January 2024. The search strings for each database are included in the Supplementary Material. We used the software tool Covidence to streamline

the process and auto-remove duplicates before the manual screening.[33] Two independent reviewers screened the titles and abstracts, reaching consensus on disagreements. Finally, two independent reviewers assessed the full text for final study selection, again reaching consensus on disagreements. After the final study selection, a single author screened the reference lists of the included studies for relevant studies.

Study selection/Eligibility criteria

Studies were included if they described or assessed early detection followed by early intervention of MSK sports injuries.

Populations

We included only MSK sports injuries in athletic populations, without limiting the breadth of the search on specific sports. We included studies on ballet dancers and military personnel, due to their traditional performance-optimizing culture, resembling sport environments.[34,35] Concussion (traumatic brain injury) was notably excluded, although on par with MSK sports injuries in sports research in general. However, the preventative strategies for concussion are very different than for MSK sports injuries, such as policy/rule changes, equipment use, and technique alteration, and strategies for early detection and early intervention are not yet adopted in the concussion research literature.[36]

Interventions

The search strategy was structured to identify studies with a secondary preventative aim, i.e. preventing worsening, or early detection followed by early intervention.

Outcomes

We included outcomes of indicators of a MSK injury worsening, such as clinical symptoms, return-to-play time, and more. We excluded outcomes related to risk of MSK injury (traditionally coined primary prevention,[16] or MSK injury recurrences or complications (other secondary prevention domains[16]), to focus our review on preventing MSK injury worsening.

Study designs

We included English peer-reviewed scientific journal articles and book chapters, published between 1.1.2004 and 31.12.2023. We excluded non-original research, such as literature reviews and study protocols, and anecdotal evidence, such as case reports and small (<10) case series. Other noteworthy exclusions are cross-sectional studies, attempting to identify index or recurrent MSK injury risks (primary prevention[16]), and case series, in which the recruitment to the study was made *after* the diagnosis has been made, as such without a preventative aim.

Data extraction

We extracted the following data from the included studies: sport, number of participants, age, competitive level, sex, country, injury (e.g. hamstring strain), study design, purpose, publication year, early detection strategy, early intervention strategy, and outcome. The extraction was performed individually by the lead author using a customized form, designed and created by the author team.

Results

An overview of the identification, screening, and inclusion process is provided in the PRISMA flowchart (Figure 1). Of 5851 manuscripts, 2932 articles underwent title/abstract screening, 86 articles were reviewed in full, and nine studies were included. We identified eight protocols for potentially relevant studies. We sought the published studies, and included seven of these for full text review, excluding the last as it was a duplicate. We identified eight extra studies through colleagues that performed an adjacent review with a similar search strategy.[16]

Excluded studies

We excluded 77 studies after full-text review. Twelve studies had designs unfit for our review, namely non-original research or study protocols. Full text could not be obtained for seven studies. Four of these studies were evaluation of early surgery, and it was unclear how the researchers employed early detection strategies, if any. We excluded three studies employing both early detection and early intervention strategies. One assessed early surgery for hamstring injury, but for a non-athletic population.[37] Another assessed early surgery among athletes, but for skin friction injuries.[38] The last assessed early medication for prevention of bone stress injury, but in mice.[39]

We excluded six studies on other domains of prevention, such as prevention of the index injury, injury recurrences, or injury complications. These distinct domains

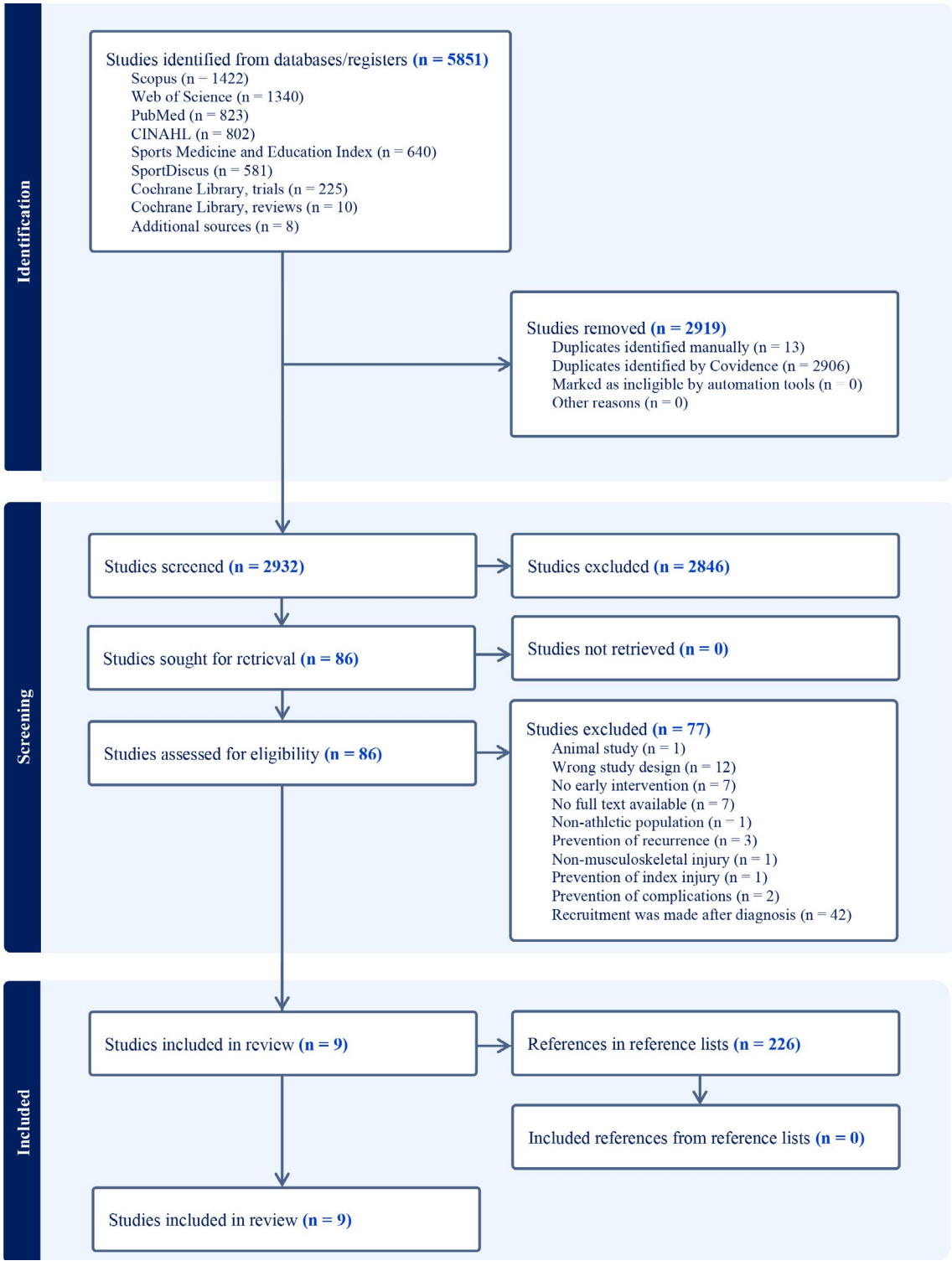

Figure 1.
PRISMA Flowchart demonstrating the identification, screening, and inclusion process.

were identified by Holm-Jensen et al,[16] and while it may be argued that injury recurrences and complications are a subsequent worsening of the index injury, the sport injury researchers define it inconsistently.[16] As argued in the introduction, there are numerous studies investigating the prevention of MSK injury recurrences and complications, but there is a gap in the prevention of index MSK injury worsening, such as detection injuries early and intervening early. These excluded articles assessed strength training regardless of preventative goal, and all without employing any early detection.

Also, we excluded all case series, in which recruitment to the respective study was made after the diagnosis was made, notwithstanding that the researchers employed early intervention. Our rationale was that such studies have no secondary preventative aim. We excluded 42 of such case series, most of them on acute ankle or knee injuries.[40,41] If we had included these studies in our review, our review would be less focused on prevention, but likely describing pain medication, functional rehabilitation, and surgery as early intervention strategies. Also, the dominant early detection strategy would simply be short symptom duration.

Furthermore, we also excluded seven studies on early detection strategies in isolation. These studies, mainly aiming to predict future symptoms,[21,22] assess early injury stages,[23,24] or predict symptom duration,[25,26] are all without an interventional element, and in turn lacks a secondary preventative aim. If we had included these studies, our review would likely have focused on imaging studies of tendinopathy or bone stress injuries, to predict future symptoms or symptom duration.[21,25]

Study characteristics

Of the nine included studies, three cohort studies and two trial studies assessed preventative strategies on 369 athletes in various sports. Four interview studies, although not directly inquiring into early detection/early intervention in their study purpose, nonetheless gave answers to our research questions in their data. These studies were performed on 53 medical personnel and 21 athletes. Full details of study characteristics are summarized in Table 1.

Early detection strategies

Three different early detection strategy domains were identified, these being: strength loss testing, imaging for abnormalities, and observing early symptoms.

Strength loss testing

Wollin *et al*. (2018) and Wollin *et al*. (2020) performed post-match screening of asymptomatic footballers' isometric hip adduction strength and knee flexion strength, respectively.[42,43] Their theory was that strength is reduced immediately preceding injury symptoms. When they identified such strength reduction, indicating early injuries, the athletes immediately reduced high-risk training load and performed strength rehabilitation.[42,43] This strategy was employed in practice in the study by Pizzari *et al*.[44] Their context was preventing osteitis pubis, also a groin injury, in Australian football.[44]

Imaging for abnormalities

Harada *et al*. screened the medial elbow for abnormalities in the throwing-arm of asymptomatic baseball throwers with ultrasound.[45] Their theory was that abnormalities precede injury symptoms. If any abnormalities, such as osteochondritis dissecans, were present and confirmed on plain radiograph, the athletes were advised to stop throwing.[45]

Vincenzo *et al*. screened the knee for bone abnormalities of asymptomatic runners with magnetic resonance imaging.[46] Their theory was that abnormalities precede injury symptoms. If any abnormalities, such as patellar enthesopathy, were present, they were treated with electromagnetic field therapy.[46] Like strength screening, this strategy appeared employed in practice as well, in the context of preventing osteitis pubis in Australian football.[44]

Observing early symptoms

Dimitrova *et al*. monitored asymptomatic wrestlers for onset of low back pain.[47] If presented with an athlete with low back pain, they performed a test battery of strength and range-of-motion of the lower back, and performed strength and mobilization exercises accordingly.[47]

In practice, it appears that the prevailing early detection strategy for MSK injury is observing for early symptoms. Three studies state that observing for persisting pain is such a detection strategy,[48-50] while three studies suggest clinical findings as well, such as joint swelling, crepitus, etc.[49,50] or reduced range-of-motion.[44] Studies are conflicted on altered training load and technique; Two studies employ it is as early detection strategy,[48,50] and one refrains from it.[49] Two studies advocate for athlete educa-

Table 1.
Descriptive summary of the included studies.

REFERENCE	PARTICIPANTS	INJURY	STUDY DESIGN	PURPOSE	EARLY DETECTION STRATEGIES	EARLY INTERVENTION STRATEGIES	OUTCOME
WOLLIN, 2018	27 football players.	Groin strain.	Cohort study.	Observe effect of preventative intervention.	Strength loss testing.	High-risk load reduction. Strength rehabilitation.	Health and function improved quickly in high-risk footballers.
WOLLIN, 2020	74 football players.	Hamstring strain.	Controlled trial.	Compare effects of prevention to no intervention.	Strength loss testing.	High-risk load reduction. Strength rehabilitation.	Lower incidence and burden of injury in the intervention group.
HARADA, 2006	153 baseball players.	Medial elbow injury.	Cohort study.	Observe effect of preventative intervention.	Ultrasound and radiographic imaging for abnormalities.	Sports participation restriction.	Early rate of return to high level function.
DMITROVA, 2011	95 wrestlers.	Low back pain.	Cohort study.	Observe effect of preventative intervention.	Observation of early pain.	Sports participation restriction, strength training, and stretching.	Early rate of return to high level function.
VINCENZO, 2016	20 runners.	Knee bone stress injury.	Controlled trial.	Compare effects of prevention to no intervention.	Magnetic resonance imaging for abnormalities.	Pulsed electro-magnetic field.	Early rate of reduction in bone marrow edema compared to control group.
PIZZARI, 2008	36 medical personnel in Australian football.	Osteitis pubis.	Interview study.	Explore experiences with injury management.	Athlete education on early symptoms. Strength loss testing. Biomedical imaging for abnormalities.	Rest, training load modification, exercise alteration, manual therapy, and gradual return-to-play.	Management of osteitis pubis requires early identification of warning signs.
FAWCETT, 2020	10 medical personnel in gymnastics.	Low back pain.	Interview study.	Explore experiences with injury management.	Observation of early training technique alteration. Athlete education on early symptoms. Observation of pain persistence.	Training load modification and technique modification.	The coach and medical team can improve early detection and outcome.
KOX, 2018	7 medical personnel in different sports.	Overuse wrist injury.	Interview study.	Explore early detection strategies of wrist overuse injury.	Observation of pain severity. Observation of pain persistence.	Pain medication and taping/bracing.	Pain, clicking, crepitation, swelling and limited range of motion were useful for early detection.
KOX, 2019	21 medical personnel in different sports.	Overuse wrist injury.	Interview study.	Explore early detection strategies of wrist overuse injury.	Observation of pain severity. Observation of pain persistence. Monitoring performance reduction.	Rest, pain medication, taping/bracing, and medical help.	Athletes consider pain and limitation during daily activities as early indicators of injury, while sport-related pain and limitations may not be.

tion on early symptoms to promote earlier injury management.[44,48]

Early intervention strategies

The included studies essentially employed three different strategies, these being load reduction, rehabilitation and passive therapies.

Load reduction

Seven of nine included studies employed reduction or modification of training load, four of them being experimental studies,[42,43,45,47] and three of them observational studies.[44,48,50]

Rehabilitation

Strength rehabilitation was employed in four studies, three of them being experimental studies,[42,43,47] and one of them being an observational study.[44] Range-of-motion rehabilitation was employed in one experimental study,[47] and technique rehabilitation was employed in two observational studies.[44,48]

Passive therapies

Several passive therapies were employed. Electro-magnetic field therapy was assessed in one experimental study.[46] Manual therapy,[44] taping/bracing,[49,50] and pain medication[49,50] were reported in observational studies.

Discussion

We identified only nine studies, which stands in stark contrast to the 155 empirical injury prevention studies in other prevention domains.[8] Thus, based on our inclusion criteria we therefore contend that current evidence for early detection and early intervention strategies is limited. Furthermore, the samples, methods, and outcomes of the included studies in our review are heterogenous, leading to further difficulties in formulating recommendations for future clinical practice. No observational studies directly assessed early detection and early detection strategies used by athletes in practice, merely being reported in studies observing either MSK injury management in general, or early MSK injury detection strategies. This is likely to impede researchers from formulating clinically relevant secondary preventative strategies, as the evidence for existing practices is limited. Despite the limited evidence, our study nevertheless offers several novel insights.

Early detection

Firstly, early detection can be grouped into three strategies: *Strength loss testing*, *imaging for abnormalities*, and *observing early symptoms* (Figure 2).

Using strength loss testing as an early MSK injury detection strategy is a rather novel concept, with the studies published in 2018 and 2020.[42,43] The concept is supported by other studies demonstrating that strength testing may be employed to detect early MSK injury,[51,52] and we found no studies contradicting this. While the approach seems promising, and as such we recommend that athletes and clinicians consider this strategy in their early MSK injury management, the number of included participants is low, and therefore it should be explored further in research.

Imaging for abnormalities as an early detection strategy may have merit, but also concerns. Several cross-sectional studies have demonstrated a high prevalence of imaging abnormalities in asymptomatic athletes.[53-55] While these abnormalities may predict future symptoms in athletes,[22] these abnormalities may not be convincingly modifiable with interventions.[56] To formulate clinical recommendations, further research into which imaging abnormalities predict MSK injury, and which may be modifiable with interventions, is required.

Our review identified five studies observing for early symptoms as the early detection strategy.[44,47-50] However,

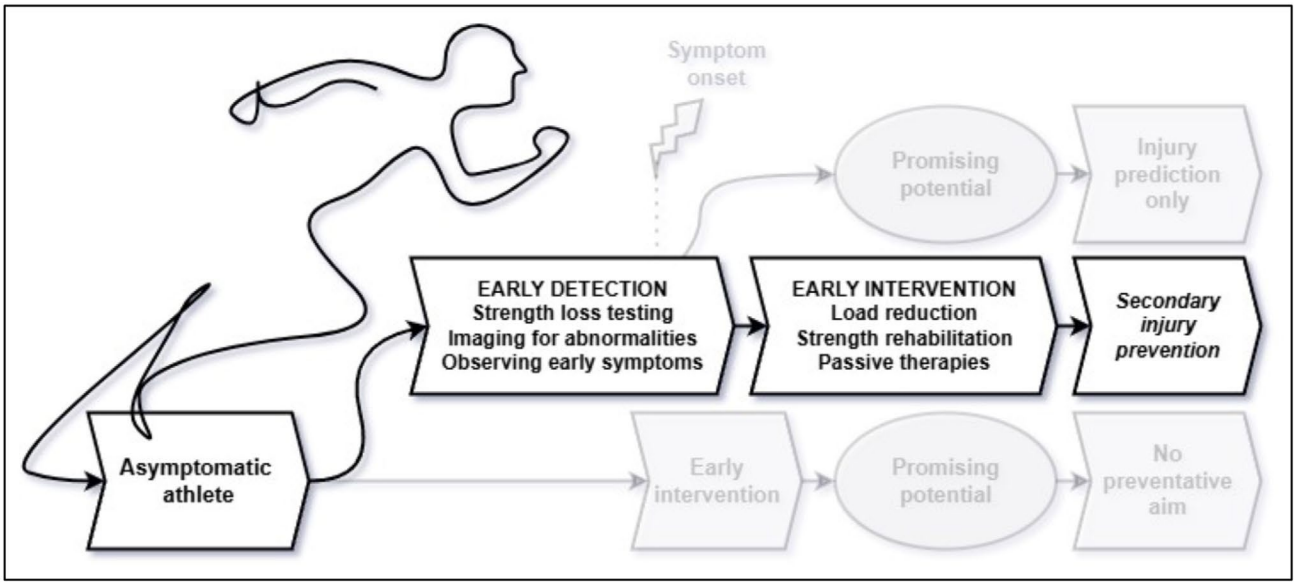

Figure 2.
Visualization of key findings relating to early detection strategies and early intervention strategies.

athletes often self-manage their MSK injuries,[57,58] and await seeking medical support until their symptoms impact on their performance.[59] From a clinical perspective, waiting for the symptom onset may be later than what is ideal. However, we identified no studies comparing these different early detection strategies, and further studies into this are required before we can formulate concrete recommendations.

Preventing worsening of musculoskeletal pain (i.e. chronification) in the general population appears to support mainly patient education.[60,61] In our review, athlete education appears to be a comparatively less employed strategy, only mentioned in observational studies to promote openness to reporting injury symptoms early to the medical teams.[44,48] We recommend that athlete education is considered in both clinical practice and future research. However, as the evidence base is thin, future research may likely either support or disprove this.

Lastly, we did not select studies based on a certain definition of "early". Scholars in this field typically define "early" as asymptomatic findings,[62] some as low disease grade,[63] and some as short symptom duration.[64] In our review, the authors' definition of "early" is linked to their early detection strategy, and thus we did not identify any studies employing low disease grade as an early detection strategy. Researchers in this field are sure to encounter this definition, and the lack of this definition in the included studies in our review highlights the limits of the evidence. We recommend researchers consider assessing and comparing low disease grades with the other identified early detection strategies (strength loss testing, imaging for abnormalities, and observing early symptoms) as well.

Early interventions

Our review also identified three different early intervention domains: *Load reduction*, *rehabilitation*, and *passive therapies* (Figure 2). Load management in general has been explored in other contexts than early intervention strategies. The acute/chronic training load ratio has been explored extensively and reviewed, primarily to assess if it predicts MSK injury or not.[65] Some studies have attempted to modify training load to reduce MSK injury risk, but all in the context of primary prevention.[66,67] Generally, results are promising. Different load reduction strategies exist, from absence-from-play at one end of the spectrum, to lowered intensity in specific training techniques at the other end. In our review, the two trials investigating load reduction did so by reducing specific exposure to sprinting, high-speed running, and explosive acceleration/deceleration activities, based on hamstring strain related injury mechanisms in football.[43,46] While the number of participants in the two included trials is low (74 and 20 participants), this load reduction strategy appears promising.[43,46] In the two cohort studies, the load reduction strategy entailed restricting sports (wrestling or baseball pitching) participation in general, also with promising results.[45,47]

On the contrary, it seems that athletes consistently maintain their training and competing load while injured,[68-71] even though their performance appears to suffer.[72] A proposed reason for this is that athletes consistently strive for better performance and accept the risk of MSK injury.[9,10] Kox *et al*., included in our review, also identified this dilemma,[49] who saw medical personnel refraining from using load reduction as an early detection strategy, arguing that athletes continue training despite MSK injuries.[49] Kox *et al*. also saw that medical personnel observed for performance reduction as an early detection strategy instead.[50] While it was outside of our scope to assess the effect of load reduction (in the case of our results, reduction of sports participation or only high-risk activities), it nonetheless appears promising in research context, but likely troublesome to implement in practice. As such, we recommend both that clinicians and athletes consider this approach for early MSK injury management, but also that researchers adjust studies to reflect real-life behavior of athletes.

Rehabilitation and passive therapies have been examined extensively in other contexts. Low back pain in the general population appears to be the most extensively researched musculoskeletal problem, generally recommending strength rehabilitation and manual therapies.[73] In the context of prevention of MSK sports injuries in general, strength training dominates the research landscape.[8] Although this preventative strategy has mainly been applied before MSK injury onset (i.e. primary prevention), the results have been promising.[74] Passive therapies appear underrepresented in the context of preventing MSK sports injuries,[8] but it may have merit in preventing MSK pain in the general population.[75] While it was outside of our scope to assess the effect of either rehabilitation or passive therapies, it seems safe to recommend these early strategies after early MSK injury detection.

Recommendations for researchers, athletes and clinicians

To summarize our (preliminary) practical recommendations, we encourage researchers to focus on exploring secondary preventative strategies used in practice among athletes. We also suggest that researchers contrast and compare the different early detection strategies in combination with interventions.

Regarding early detection, we suggest that athletes and clinicians consider strength testing as an early MSK injury detection method, but be mindful that the evidence base is thin, and these results are preliminary and may change in the future. We encourage caution in interpreting imaging abnormalities and observing for early symptoms, until these early MSK injury detection strategies have been assessed and compared.

Regarding early intervention, the evidence supports clinicians and athletes employing early use of passive therapies and rehabilitation. In contrast, while we recommend clinicians and athletes use load reduction as an early intervention, it will likely be difficult to implement in athletic practice, due to performance expectations and performance-seeking behavior of athletes.

Limitations

This scoping review was rigorously conducted, following recognized guidelines.[30,32] We nonetheless state a few limitations. This scoping review only includes articles from the last 20 years, and only in English language, nor did we search for grey literature. Additionally, only a single author screened the reference lists of the nine included studies and extracted the data from the included studies. It is possible that without such limitations, our conclusion that the evidence is limited may have been different. We urge future researchers, aiming to reproduce our result, to employ multiple reviewers for this step to lessen bias. Research on non-musculoskeletal injuries was excluded, and even though they are relevant in sport injury context, it is likely that different secondary preventative strategies exist for these conditions.

Conclusions

This scoping review summarizes and consolidates the secondary prevention strategies in the context of musculoskeletal sports injuries. The review identified four experimental studies and five observational studies on early detection and early intervention.

Early detection strategies are strength loss testing, imaging for abnormalities, and observing early symptoms. Strength loss testing is a novel approach and may be considered by clinicians and athletes in their early injury management. The evidence necessitates caution in interpreting imaging abnormalities and observing for early symptoms, until these early musculoskeletal injury detection strategies have been assessed and compared.

Early rehabilitation and passive therapies are likely to be effective as stand-alone or components of early preventative strategies. Early load reduction, although effective as an early intervention, will likely be difficult to implement, due to performance expectations and performance-seeking behavior.

Based on this scoping of the literature, we have found that the evidence for secondary preventative strategies regarding early detection *and* early intervention for musculoskeletal sports injuries is limited. Considering the potential for clinical practice and athlete care optimization, there is a need for both exploratory and experimental research in this area. In particular, no observational studies directly assessed early detection and early intervention strategies in practice, and to formulate clinically relevant future research questions, such assessment is needed.

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Highlights

- The evidence for secondary preventative strategies regarding early detection and early intervention is limited, compared to the sports injury research field in general.
- The explored early detection strategies are strength loss testing, imaging for abnormalities, and observing early symptoms. We recommend heedfulness until these early detection strategies have been assessed and compared.
- The explored early intervention strategies are training load reduction, rehabilitation, and passive therapies. We recommend considering athletic performance-seeking behavior when implementing training load reduction.

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Evaluation of chiropractic students' perspectives on back pain management following one of three clinical evidence-based educational training interventions: a cluster-randomized trial

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Objective: *To assess the effectiveness of educational interventions' impact on chiropractic students' attitudes toward patient-centered care and low back pain (LBP) using knowledge about pain science and stratified LBP management with the MAINTAIN instrument.*

Évaluation des perspectives des étudiants en chiropratique sur la gestion de la douleur dorsale à la suite de l'une des trois interventions de formation éducative fondée sur des données cliniques probantes : un essai randomisé en grappes.

Objectifs: *Évaluer l'efficacité de l'impact des interventions éducatives sur les attitudes des étudiants en chiropratique envers les soins centrés sur le patient et la douleur lombaire (DL) en utilisant des connaissances sur la science de la douleur et la gestion stratifiée de la DL avec l'instrument MAINTAIN.*

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Methods: *From January-August 2022, students were cluster randomized into three groups (information-only, focused-lecture, workshop series) with the Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS) and the Patient-Practitioner Orientation Scale (PPOS) measured at baseline, 4-months, and 8-months. Data were analyzed with descriptive statistics and repeated-measures ANOVA.*

Results: *Of 264 students, response rates declined by 8-months (16.7-31.3%). No significant within- or between-group differences were found across timepoints. A small but statistically significant shift toward doctor-centered attitudes in the instrument-only group (p=0.024) was not clinically meaningful.*

Conclusions: *Educational interventions did not significantly change student attitudes. Contributing factors may include focus on attitudinal change, limited research culture, implementation barriers, and student burnout.*

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KEY WORDS: chiropractic, students, attitude, low back pain, maintenance care

Méthodes: *De janvier à août 2022, les étudiants ont été randomisés en grappes, en trois groupes (information seulement, conférence ciblée, série d'ateliers) avec l'Échelle de la relation entre la douleur et l'incapacité des fournisseurs de soins de santé (HC-PAIRS) et l'Échelle d'orientation patient-praticien (PPOS) mesurées à la ligne de base, à 4 mois et à 8 mois. Les données ont été analysées à l'aide de statistiques descriptives et d'une ANOVA à mesures répétées.*

Résultats: *Parmi 264 étudiants, les taux de réponse ont diminué de 8 mois (16,7-31,3 %). Aucune différence significative n'a été trouvée au sein des groupes ou entre les groupes à travers les points temporels. Un petit changement – statistiquement significatif tout de même – allant dans le sens des attitudes centrées sur le médecin dans le groupe uniquement instrumenté (p=0,024) n'était pas cliniquement significatif.*

Conclusions: *Les interventions éducatives n'ont pas significativement changé les attitudes des étudiants. Parmi les facteurs contributifs, on peut citer un accent mis sur le changement d'attitude, une culture de recherche limitée, des obstacles à la mise en œuvre et l'épuisement des étudiants.*

(JCCA. 2025;69(2):120-130)

MOTS CLÉS : chiropratique, étudiants, attitude, douleur lombaire, soins d'entretien

Introduction

Low back pain (LBP) is a complex and multifaceted condition that varies significantly among patients.[1,2] The attitudes and beliefs of healthcare providers toward LBP can profoundly influence clinical management strategies and patient outcomes. Evidence indicates that adherence to guideline-recommended care improves clinical outcomes and reduces costs.[3] Despite this, variability in musculoskeletal education across healthcare training programs can lead to inconsistencies in knowledge acquisition and clinical decision-making.[4-6] Understanding how educational interventions influence students' perceptions of LBP and patient-centered care is essential for improving future clinical practice.

Educational programs are critical in shaping the knowledge, skills, and attitudes necessary for quality healthcare.[7] However, limited research examines how chiropractic education impacts students' attitudes toward managing LBP or their confidence in applying evidence-based strategies. A deeper understanding of this process is needed to ensure that chiropractic students are equipped to deliver patient-centered, evidence-informed care.

Jack Mezirow's transformative learning theory (1978) provides a framework for understanding how students integrate new knowledge into clinical decision-making.[8] This theory highlights the importance of reflective, experience-based learning in reshaping assumptions and guiding future behavior. Applied to chiropractic education, it supports evaluating whether training interventions—particularly those that emphasize patient stratification and tailored care—can effectively influence students' attitudes toward patient-centered care in LBP management.[9]

Psychology research shows that attitudes toward a behavior often predict future actions.[10,11] In healthcare, cultivating attitudes of continuous learning, patient-centeredness, and clinical adaptability may be a key to improving patient outcomes.[12,13] Patient-centered care, which integrates patient preferences, needs, and values into clinical decision-making, enhances the healthcare experience and reduces unnecessary costs.[14,15] While it is difficult to measure directly,[13,16] key components such as communication, empathy, and professionalism are known to improve satisfaction and adherence.[17,18] To assess these critical attitudes, this study utilized two validated instruments:

- The Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS), which evaluates beliefs about pain-related disability and the role of healthcare providers in patient recovery.[19]
- The Patient-Practitioner Orientation Scale (PPOS), which assesses student attitudes toward doctor-patient relationships and patient-centeredness.[20]

Together, these instruments provide insights into the students' capacity for evidence-informed and patient-aligned clinical decision-making.

Doctors of Chiropractic (DCs) frequently manage LBP.[21] Maintenance care is often recommended for long-term management following initial treatment success.[22] Research from the Nordic Maintenance Care Program has demonstrated that stratified care approaches acknowledge that psychological and behavioral factors influence patients' responses to treatment care plans.[23,24] The MAINTAIN instrument was developed as a stratification tool to assist clinicians in identifying patients psychological profiles and tailoring LBP management strategies accordingly.[22]

Instruction in the use of the MAINTAIN instrument is relevant to this study's outcome measures in two key ways:

1. Influence on HC-PAIRS: The MAINTAIN instrument operationalizes biopsychosocial principles by stratifying care based on psychological risk factors such as pain beliefs, fear-avoidance, and coping strategies.[22] By engaging students with this tool, we hypothesize a reduction in maladaptive beliefs about pain and disability, thus positively influencing HC-PAIRS scores.
2. Influence on PPOS: Training in the MAINTAIN instrument promotes patient-centered care by guiding students to consider individual patient characteristics and preferences in clinical decision-making. This aligns with the principles of shared decision-making and personalized care—central constructs measured by the PPOS.

While the MAINTAIN instrument alone may not account for all expected changes in student attitudes, its use—within a broader educational framework that includes pain science education and evidence-based LBP management—is hypothesized to enhance student readiness to deliver guideline-concordant, patient-centered care.

This study aims to assess the effectiveness of three educational interventions- pain science, stratified LBP management, and the MAINTAIN instrument- on changing DC students' attitudes and beliefs about LBP and patient care. By integrating these tools and concepts and assessing their impact through validated measures, this research seeks to inform curricular strategies that foster clinical preparedness and improve future care for LBP.

Methods

Trial design

This cluster randomized trial was conducted at two chiropractic teaching clinics in the United States. Due to the nature of the research as an educational intervention, a trial registry was not utilized, and the protocol was not made available for publication. The investigators held meetings bi-weekly to assess the study's progress and provide updates. After implementation, no modifications were made to the protocol, and the study was funded entirely by internal resources. The study was approved by Parker University's Institutional Review Board (A-00219) and the protocol was registered *post-hoc* at Open Science Framework (osf.io/qvuxz) in February 2025.

Participants

Three hundred and thirty-six potential students were allocated among 26 supervising clinician/student pods. Each pod, supervised by up to two clinicians, guides students throughout their final year of a 40-month training program. All active supervising clinicians and students were eligible to participate. They were invited to participate during a team pod meeting scheduled with a team investi-

gator where they could access the e-consent and ask questions. If they signed the consent, the demographic and outcome questionnaires became available.

Educational Intervention

Supervising clinician/student pods were randomized to one of the following intervention groups:

1. **Written information –** an informal learning approach**:** All students in this less formalized training only received a copy of the MAINTAIN instrument and a manual detailing its development and best practices. This information was distributed during clinic orientation sessions. Throughout these sessions, the site team leaders and project managers were present to address inquiries, while informed consent and questionnaires were gathered from the students. This intervention was intentionally designed to mirror how many providers receive information – briefly and with minimal guidance on implementing the material.
2. **Focused lecture –** an informal learning approach**:** Students in this less formalized training group received the MAINTAIN instrument information but also participated in a lecture developed by the study investigators. This training model was designed to simulate how a provider might receive information at a conference.
3. **In-depth workshop series –** a transformative learning approach**:** Students allocated to this transformative learning group received both the written information and the lecture, along with monthly workshops that provided more in-depth insights on understanding and effectively implementing the MAINTAIN instrument. The topics and lectures for this group were informed by a mixed-methods qualitative analysis that explored chiropractic students' attitudes toward integrating evidence on chiropractic maintenance care.[25] Topics covered included:
   - Biopsychosocial Model
   - Patient-Centeredness
   - Importance of Knowledge Translation to Produce Evidence
   - Neurobiology of Pain
   - Deep Dive into the MAINTAIN Studies

Outcomes

Two outcome measures were employed to evaluate students' attitudes: the Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS) and the Patient-Practitioner Orientation Scale (PPOS). These assessments were carried out at the baseline and the end of the term, which spanned roughly nine weeks. The HC-PAIRS is a 15-item tool designed to evaluate healthcare providers' attitudes and beliefs regarding functional expectations for patients with chronic LBP,[20] using a 7-point Likert response (1=completely disagree; 7=completely agree). While property measurements have been assessed, they have not been done specifically for the student population, albeit they have been used several times within this population.[26-30] Higher HC-PAIRS scores indicate stronger beliefs that chronic LBP justifies disability and activity limitations, which are not aligned with current clinical practice guidelines.[29] Consequently, a reduction in the scores of healthcare providers and students indicates a transition towards more guideline-concordant beliefs regarding LBP management.

The PPOS was developed by Krupat *et al*.[19] to measure respondents' attitudes toward the doctor-patient relationship. The PPOS scores range from 1 to 6, with a higher score indicating a more patient-centered approach and lower scores suggesting a more doctor-centered approach. The scale comprises 18 equally distributed items across two dimensions: "Sharing" and "Caring." "Sharing" assesses the respondent's belief in the importance of shared decision-making, where doctors and patients are equals in the healthcare relationship. "Caring" evaluates the extent to which the respondent believes a patient's ideas, concerns, expectations, life circumstances, and overall biopsychosocial model of health should influence care. A score of 5 or higher on the PPOS indicates a patient-centered approach, while a score of lower than 5 suggests a doctor-centered orientation.

Each item on the PPOS is a statement (e.g., "The doctor is the one who should decide what is talked about during a visit"), with responses ranging from "strongly agree" to "strongly disagree," assigned numeric values from 1 to 6. For 15 items, "strongly agree" is assigned a 1, with reversed scoring for the remaining three items. The PPOS has demonstrated satisfactory internal consistency among healthcare providers (Cronbach's α =0.73).[20] The study by Shaw *et al*.[31] supports the instrument's validity,

revealing that practitioners with a greater emphasis on patient-centered approaches were more prone to focus on lifestyle issues, engage in rapport building, and place less emphasis on strictly biomedical matters during patient encounters.

Secondary measures

With the development of the MAINTAIN instrument, which emphasizes the psychological characteristics of patients in LBP management, this study examined the impact of transformative educational interventions using surrogate measures. Specifically, we assessed the number of patients each student successfully enrolled into a separate clinical research study utilizing the MAINTAIN instrument as the outcome measure.

Sample size justification

The sample size was based on cluster randomization with HC-PAIRS as the continuous outcome measure. A minimum detectable difference between groups of 0.5, with an SD of 0.6, was used, drawing from prior educational interventions that used HC-PAIRS as the outcome measure.[32-36] Given the absence of a published intraclass correlation coefficient (ICC) that captures the variability within and between clusters for supervising clinicians in chiropractic teaching clinics, an estimation was derived from internal data obtained from a 2020 survey of HC-PAIRS scores. This analysis produced an ICC of 0.02. With an estimated ten students per pod, the study determined a need for five clusters. All pods were offered participation, and all interested participants were enrolled without restricting the smaller sample size to the minimum required.

Randomization

A project manager randomized the supervising clinician/student pods using Excel's randomization formula (Microsoft Corporation, 2018). To ensure allocation concealment, assignments were generated independently and provided to the site's clinical team lead in a sealed format, preventing prior knowledge of group assignments. The clinical team lead, who also served as an investigator, then announced the allocations to the supervising clinicians during a team meeting, with site investigators present to oversee the process and outline the next steps for each group. These measures were implemented to minimize the risk of bias or influence on group behavior during the allocation process.

In Winter 2022, all clinic students were invited to participate, with enrollment contingent upon informed consent signed. Cluster randomization was employed due to the involvement of multiple students within each pod. Pods served as the unit of randomization, while individual students were the unit of analysis.

Blinding

Only the supervising clinicians of the randomized pods were explicitly informed that the pods were assigned to different groups. They were instructed to communicate only the necessary participation requirements to their students, explaining that this limitation was essential for maintaining study blinding and minimizing potential bias. Although the investigators recognized that students might discuss differences across pod activities, efforts were made to present these as routine clinician-led events rather than study-specific interventions, as described in all informed consent documents. No additional blinding measures were employed.

Data analysis

Descriptive statistics were used to summarize the characteristics of all students who consented to participate. The original analysis plan proposed evaluating outcome changes across multiple follow-up time points using non-parametric, repeated-measures analysis of variance (ANOVA), specifically the Kruskal-Wallis test—at the individual level, and comparing the change from baseline to follow-up between groups. However, due to the low response rate at the second follow-up, the analytical approach was revised to employ a non-parametric, one-way ANOVA to assess between-group differences at a single time point was used, still at the individual level. Although multiple imputation techniques and sensitivity analyses were considered to address the missing data, the extent and pattern of the missingness did not satisfy the assumptions required for data to be considered missing at random. Proceeding with imputation under these conditions risked further bias. Therefore, a between-subjects analytical approach was adopted, fully acknowledging its limitations. All statistical analyses were conducted using STATA 14.2 (StataCorp, College Station, TX, USA).

Results

Figure 1 illustrates student participation, starting with a potential pool of 336 students from the initial invitation to the meager response rate for the second-term follow-up.

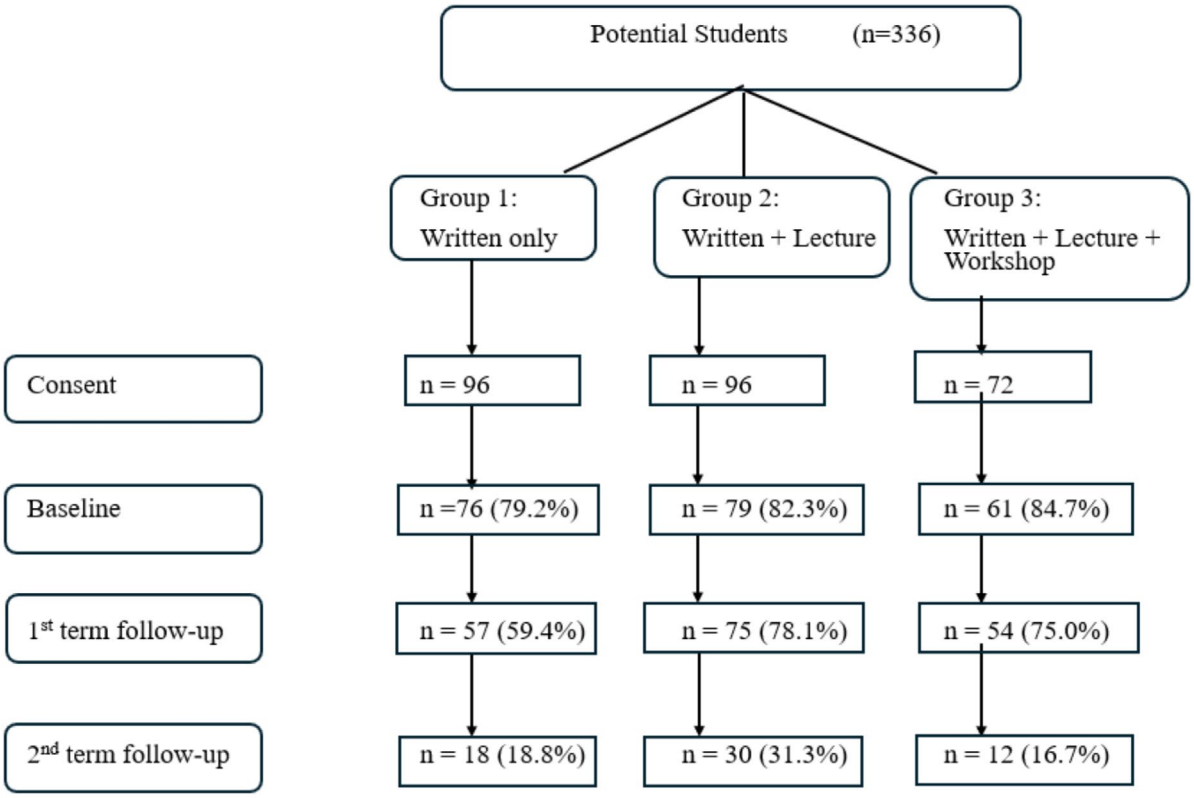

Figure 1.
Flow chart of student participation throughout the study.

Table 1 presents the demographics of the consenting students by group allocation. There was an uneven distribution, with the workshop group (Group 3) having fewer students. Despite this, most students were in their first term in the clinics and had grade point averages (GPA) above 3.2. The outcome measures, baseline HC-PAIRS and PPOS, were balanced across the groups at baseline. (See supplemental table 1 for the baseline findings by responders and non-responders.)

Table 2 displays the mean, SD, and 95% CI for the outcome measures by time point and group, revealing no statistically significant differences within groups across the time points for either of the primary outcomes. Between-group comparisons were not statistically significant at most time point (p=0.078-0.090, first follow-up; p=0.061-0.087, second follow-up), except for the PPOS in Group 1 shifted to a more doctor-centered approach (p=0.024) by the second term follow-up; however, this change was only by a tenth of a point, suggesting it is unlikely to be clinically meaningful.

Discussion

Our study assessed the effectiveness of MAINTAIN instrument-informed educational interventions on DC students' attitudes toward LBP and patient-centered care. Despite previous studies demonstrating the effectiveness of educational interventions in shaping enhance healthcare provider attitudes- particularly when rooted in transformative learning theory[8,37,38] our findings revealed no significant improvement in students' attitudes toward

Table 1.
The demographics of consenting students by term and the surrogate outcome measure.

	Written Only Group 1 (n=96/118)	Lecture Group 2 (n=96/108)	Workshop Group 3 (n=72/90)	Total (n=264/316)
Response Rate, %	81.3%	88.9%	80.0%	83.5%
GPA, mean (SD)	3.28 (0.570)	3.33 (0.355)	3.22 (0.538)	3.28 (0.471)
Term, n (%)				
8	74 (77.1%)	80 (83.3%)	37 (51.4%)	191 (72.4%)
9	22 (22.9%)	15 (15.6%)	35 (48.6%)	72 (27.3%)
10	0 (0%)	1 (1.0%)	0 (0%)	1 (0.4%)
Sex, Female	48 (50.5%)	41 (42.7%)	29 (40.3%)	118 (44.7%)
Education, Bachelors or higher	88 (91.7%)	89 (90.8%)	73 (92.4%)	250 (91.6%)
HC-PAIRS, mean (SD)	56.9 (10.29)	57.7 (10.72)	58.6 (9.13)	57.5 (9.99)
PPOS, mean (SD)	3.9 (0.57)	3.9 (0.48)	3.9 (0.55)	3.9 (0.53)
Enrolled Patients (surrogate measure)	9	20	7	36

*- GPA- Grade Point Average, 4.0 scale; Term- 10 total terms in 3.4 years

Table 2.
Outcome measures by groups with complete outcome measures, mean (SD) (95% CI).

	Baseline	**1st Term Follow-up**	**2nd Term Follow-up**
Group 1: MAINTAIN Instrument Only			
HC-PAIRS	56.9 (10.29) (54.74, 59.15)	58.0 (8.56) (55.64, 60.36)	63.9 (12.76) (56.49, 71.23)
PPOS	3.9 (0.57) (3.78, 4.04)	3.8 (0.55) (3.66, 4.02)	3.8 (0.81) (3.19, 4.34)
Group 2: Instrument + Focused-Lecture			
HC-PAIRS	57.7 (10.72) (55.42, 59.91)	58.4 (11.75) (55.49, 61.22)	55.19 (13.65) (49.68, 60.71)
PPOS	3.9 (0.48) (3.79, 4.01)	3.9 (0.53) (3.79, 4.08)	3.7 (0.83) (3.35, 4.04)
Group 3: Instrument + Lecture + In-depth Workshop Series			
HC-PAIRS	58.6 (9.13) (56.38, 60.91)	57.9 (9.20) (55.27, 60.45)	69.6 (8.12) (62.83, 76.42)
PPOS	3.9 (0.55) (3.75, 4.04)	3.9 (0.59) (3.74, 4.09)	3.8 (0.46) (3.38, 4.24)

patient-centeredness or beliefs about back pain following educational training sessions. Various elements may have contributed to this result, including the study's focus altitudinal change rather than practical application, the prevailing research culture within the clinical settings, the novelty of the educational content, and the potential influence of student burnout.

A clearer alignment between the educational interventions and the chosen outcome measures was established by applying Mezirow's transformative learning theory as a guiding framework.[8] This model emphasizes the role of reflection and critical analysis in reshaping attitudes and behaviors. Within this context, the MAINTAIN instrument was introduced not merely as a clinical tool, but as a pedagogical vehicle to help students better understand the biopsychosocial aspects of LBP. Theoretically, using MAINTAIN was expected to promote more nuanced, patient-centered decision-making by reinforcing individualization of care plans based on psychological risk factors—outcomes measured respectively by the PPOS and the HC-PAIRS. Specifically, exposure to MAINTAIN was intended to reduce maladaptive beliefs about chronic pain and disability (targeting HC-PAIRS scores) and to cultivate attitudes aligned with patient-centered care, such as shared decision-making and clinical empathy (captured by the PPOS). However, study findings did not support this hypothesis, possibly due to the brief duration and implementation context, which may not have allowed for sufficient integration of these concepts into students' attitudes.

Although this study aimed to measure attitudinal change, it may have been more effective to frame the research questions around the implementation of the MAINTAIN instrument.[22] Implementation science highlights the importance of systematically identifying contextual, behavioral, and environmental factors that influence whether a new practice is successfully adopted.[39] Mediating variables such as student engagement, perceived relevance of the training, clinician mentorship, understanding of the MAINTAIN framework, and burnout may have obscured the impact of the intervention on attitudes. Future studies should consider these variables explicitly, as a well-formulated research question-grounded in implementation theory and guided by methodologically sound design-is critical to extracting actionable insights.[40]

Contextual and participant-related factors are essential considerations in educational research. While evidence-based practice has become central to healthcare education, many programs still rely heavily on classroom instruction rather than embedding these principles within clinical environments.[41,42] Supervising clinicians play an essential role in reinforcing these concepts in practice and supporting students' research engagement.[43] However, within the demanding environments of teaching clinics, the research component of this study may have been perceived as an additional burden. This perception likely contributed to the low participation and diminished follow-up response rates.

Moreover, while the MAINTAIN instrument offers innovative application of maintenance care evidence, other tools, such as the Keele STarT Back Screening Tool, may have been more familiar and readily accepted within chiropractic educational settings.[44] While studies using this tool have not directly measured provider attitudes, some suggested these tools offer time-efficient, structured insights into patient risk profiles, which can improve compliance with clinical practice guidelines.[45] Greater familiarity and broader evidence support may have increased student engagement and intervention uptake.

Student burnout represents another critical barrier. Recent findings from one participating institution highlight elevated levels of emotional exhaustion and cynicism beginning in the 8th academic term—precisely when this study took place.[46-48] These emotional burdens may have compromised students' openness to reflection, engagement with content, and attitudinal shifts central to transformative learning.

Additionally, while most chiropractic institutions utilize patient-reported outcome measures, few incorporate tools that detect psychosocial influences, such as the MAINTAIN instrument.[49] As a result, this novel intervention may have been perceived as extra work rather than a meaningful addition to clinical training, further reducing the likelihood of positive attitudinal change and impacting follow-up engagement.

Also of note are the baseline scores for the outcome measures, both of which have been the focus of recent studies aiming to benchmark current results against contemporary standards.[30,50] Specifically, for the HC-PAIRS scale—where lower scores reflect stronger alignment with best practices—previous research reported average scores of 56.54 for healthcare students and 51.67

for practicing chiropractors. In comparison, the baseline average in this study was 57.5, which, while higher, still falls within the 95% confidence intervals reported in this prior study.[30] For the PPOS, which assesses patient-centered attitudes (with higher scores indicating greater patient-centeredness), previous evaluations across various chiropractic training programs found an average score of 4.18, compared to 3.9 in the current study. Although both outcome measure scores fall within reported ranges, these findings suggest that participating students in this study demonstrated baseline attitudes that were slightly further from the desired direction than typically observed in similar cohorts.

While the study did not yield the anticipated changes in the outcome measures, it valuable insights to inform future educational research in chiropractic and other clinical disciplines. The low follow-up response rate-a major limitation-likely reflects the combined factors of contextual constraints, intervention novelty, and burnout. Simplifying the study design to two groups rather than three may have improved power and clarity, through the current approach sought to reflect real-world educational variability. Finally, while students were not informed of their assigned intervention group, peer discussions may have unintentionally introduced performance bias. Important reminder, this study was performed at two chiropractic teaching clinics, therefore results may not be generalizable to other chiropractic teaching clinics or students of other clinical professions.

Conclusion

This study found that educational interventions aimed at introducing a new instrument to assess patients' psychological characteristics did not impact the DC students' attitudes toward LBP and patient-centered care. Since these attitudes are believed to influence patient care, it remains essential to integrate such training into clinical education. Future research endeavors should prioritize the development of implementation strategies and ensure that studies are conducted within environments that promote a supportive research culture.

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Supplemental Table 1

Demographics by responders and non-responders to the 2nd follow-up.

	Total (n=264/316)	2nd Follow-Up Responder (n=60)	2nd Follow-Up Non-Responders (n=204)
GPA, mean (SD)	3.28 (0.471)	3.31 (0.382)	3.27 (0.449)
Sex, Female	118 (44.7%)	24 (46.2%)	92 (45.3%)
Education, Bachelors or higher	250 (91.6%)	45 (84.9%)	191 (93.8%)
HC-PAIRS, mean (SD)	57.5 (9.99)	57.2 (9.825)	57.7 (10.639)
PPOS, mean (SD)	3.9 (0.53)	3.9 (0.755)	3.9 (0.468)

*- GPA- Grade Point Average, 4.0 scale

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Nociplastic pain: an introduction

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Chronic pain is common in chiropractic practice and often presents without clear evidence of tissue injury. Nociplastic pain is a recently defined concept that highlights altered nociceptive processing within the nervous system. This newer understanding of pain provides insight into chronic conditions such as chronic back or neck pain, chronic headaches, and fibromyalgia. These conditions are commonly encountered in chiropractic practice but may be challenging to address using traditional models. This commentary introduces nociplastic pain, outlining potential mechanisms and relevance to chiropractic care. We advocate a collaborative, multimodal management approach that includes patient education, exercise promotion,

Douleur nociplastique: une introduction

La douleur chronique est courante dans la pratique chiropratique et se manifeste souvent sans preuve évidente de blessure tissulaire. La douleur nociplastique est un concept récemment défini qui met en évidence un traitement nociceptif altéré au sein du système nerveux. Cette nouvelle compréhension de la douleur offre un aperçu des problèmes de santé chroniques telles que les douleurs chroniques au dos ou au cou, les maux de tête chroniques et la fibromyalgie. Ces problèmes de santé sont couramment rencontrés dans la pratique chiropratique, mais peuvent être difficiles à traiter lorsqu'on utilise des modèles traditionnels. Ce commentaire présente la douleur nociplastique, en décrivant ses mécanismes potentiels et sa pertinence en ce qui concerne les soins chiropratiques. Nous préconisons une approche de gestion collaborative

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and functional goal-setting within a biopsychosocial framework. Understanding nociplastic pain equips chiropractors to support patients with complex chronic pain through compassionate, evidence-based care that addresses the whole person.

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KEY WORDS: chiropractic; management, pain; pain, chronic; widespread chronic pain; central sensitization; interdisciplinary health teams; fibromyalgia; pain, back; pain, neck; headache; nociplastic; neuropathic; nociception; biopsychosocial

et multimodale qui inclut l'éducation des patients, la promotion de l'exercice et la définition d'objectifs fonctionnels dans un cadre biopsychosocial. Comprendre la douleur nociplastique permet aux chiropraticiens de soutenir les patients aux prises avec des douleurs chroniques complexes grâce à des soins prodigués avec compassion et fondés sur des données probantes, qui tiennent compte de la personne dans son ensemble.

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MOTS CLÉS : chiropratique; gestion, douleur; douleur, chronique; douleur chronique généralisée; sensibilisation centrale; équipes de santé interdisciplinaires; fibromyalgie; douleur, dos; douleur, cou; mal de tête; nociplastique; neuropathique; nociception; biopsychosocial

Introduction

Advances in pain science continue to transform our understanding of pain mechanisms. Traditionally, pain has been mechanistically classified as either nociceptive or neuropathic in nature, and cases that did not fall easily into one of these categories were often labeled as idiopathic or pejoratively suggestive of malingering.[1] This framework, however, was incomplete and left many patients without a clear explanation for their symptoms. By 2017, sufficient evidence had accumulated to describe a third pain mechanistic descriptor (i.e., type of pain), characterized by alterations in nociceptive processing.[2–4] This new understanding of pain is now recognized as nociplastic pain.[5–8] Nociplastic pain is defined as "pain that arises from altered nociception despite no clear evidence of actual or threatened tissue damage causing the activation of peripheral nociceptors or evidence for disease or lesion of the somatosensory system causing the pain" (Table 1).[5,8] The purpose of this commentary is to introduce nociplastic pain, its purported pathophysiologic mechanisms, management strategies, and its implications for clinical decision-making within the chiropractic profession.

Nociplastic pain

Nociplastic pain represents a distinct mechanistic pain category characterized by aberrant pain processing within the nervous system.[10] Unlike nociceptive or neuropathic pain, nociplastic pain is not directly attributable to tissue damage, inflammation, or nerve injury. Instead, nociplastic pain develops from abnormal neuronal signaling, causing increased sensitivity to various sensory stimuli and perpetuating the cycle of persistent pain.[6,10]

Nociplastic pain can provide an explanation for how chronic and recurrent pain conditions, such as chronic non-traumatic low back or neck pain, become established and maintained for prolonged periods.[11] Understanding chronic pain from a nociplastic pain perspective offers a rationale for persistent pain that cannot be fully explained by traditional pathoanatomical models, while avoiding tendencies to attribute such conditions to solely psychopathologic causes.[12] The concept of nociplastic pain may provide validation and reduce stigma for patients who may have been led to believe that pain isn't *real* or that it is *all in their head*.[13] This new mechanistic descriptor of pain promotes a more nuanced approach to evaluating and treating chronic pain, which aligns with the latest advances in pain science.[13]

Mechanisms underlying nociplastic pain

Nociplastic pain develops from altered nociceptive processing in the central and peripheral nervous systems and can occur in the absence of nociceptor activation or

Table 1.
Three types of pain

Type of Pain	Definition[8]	How It Develops	Where the Pain is Felt	Examples
Nociceptive Pain	Pain arising from actual or threatened damage to non-neural tissue and is due to the activation of nociceptors.	From tissue injury, inflammation, or physical stress causing activation of nociceptors.	Pain typically localizes to the area of injury or damage. Referred pain may occur but remains regionally connected to the nociceptive source.	Acute sprain or strain Fracture Burns Post-surgical pain Renal colic (kidney stone) Rheumatoid arthritis
Neuropathic Pain	Pain caused by a lesion or disease of the somatosensory nervous system.	From nerve damage, pressure on a nerve, or inflammation surrounding a nerve.	Pain, paresthesia, or weakness are limited to neuroanatomically plausible distributions (e.g., dermatomes or peripheral nerve distributions).	Lumbar or cervical radiculopathy Neurogenic claudication Diabetic neuropathy Postherpetic neuralgia Trigeminal neuralgia MS-related pain
Nociplastic Pain	Pain arising from altered nociception despite no clear evidence of actual or threatened tissue damage causing the activation of peripheral nociceptors or evidence for disease or lesion of the somatosensory system causing the pain.	Pain caused by alterations in sensory processing, which heightens pain sensitivity, even in the absence of obvious injury.	Pain is chronic, generally widespread or poorly localized, and often does not follow a neuroanatomically plausible distribution. Pain is often accompanied by fatigue, poor sleep, or a lack of mental clarity.	Fibromyalgia Chronic non-traumatic LBP Chronic non-traumatic neck pain Migraines Chronic tension-type headaches Irritable bowel syndrome Chronic TMD CRPS type I Chronic prostatitis Vulvodynia

CRPS, complex regional pain syndrome; LBP, low back pain; MS, multiple sclerosis; TMD, temporomandibular joint disorder. Table adopted from Nijs J, *et al*.[9]

somatosensory pathology.[10,14–17] Current understanding of the neurophysiologic mechanisms of nociplastic pain is complex and remains incomplete, but emerging evidence suggests that the key pathophysiologic changes associated with nociplastic pain include central sensitization, alterations in brain network connectivity, and peripheral nervous system changes.[10,15]

Central sensitization is the hallmark of nociplastic pain and refers to heightened excitability within the central nervous system and amplification of sensory input, resulting in increased pain perception.[5,11,18] Clinically, this may present as an exaggerated pain response to high-threshold stimuli (i.e., hyperalgesia) or a pain response to typically non-painful, low-threshold stimuli such as light touch (i.e., allodynia), reflecting a lowered pain threshold.[10,14,18] Central sensitization occurs due to a variety of mechanisms that remain incompletely understood, but changes within the spinal cord and brain network connectivity are known to play a role.[10,15,18] Spinal mechanisms include regional clustering and convergence of signals from different pain locations, spinal cord reorganization, hyperresponsiveness of spinal dorsal horn neurons, amplified spinal reflex transmission, decreased spinal inhibition, and temporal summation.[6,15,18–20] Evidence also suggests that neuroimmune activation occurs via spinal microglia along with increased concentration of substance P and glutamine levels within cerebrospinal fluid.[14–16,21] Altered connectivity within various brain regions is also implicated in the development of central sensitization, particularly increased connectivity between the default mode network, salience network, and sensorimotor network.[10,14,15] These large-scale brain networks

are involved in self-referential thought, attention and sensory integration, and sensory processing and motor initiation.[10,22] Although these networks appear to become enmeshed, the mechanisms by which this contributes to sensory, emotional, or cognitive aspects of the pain remain unclear. Changes in the size and shape of the gray and white matter, in areas of the brain related to pain perception, have also been observed on magnetic resonance imaging (MRI) as a consequence of chronic pain.[23–26] The function of normal descending inhibitory spinal pathways may also be altered in cases of nociplastic pain.[10,15,27,28] Disturbance of this normal inhibitory nociceptive signaling is referred to as *disinhibition,* but the mechanisms facilitating it are not yet well understood.

Neuronal changes may also occur in the peripheral nervous system of those with nociplastic pain, though they are generally considered to play a lesser role than central mechanisms.[10,14,15,18] *Peripheral sensitization* refers to increased sensitivity to sensory stimuli, resulting in a heightened pain response.[29,30] While this process serves a protective role following acute tissue injury or inflammation, by promoting healing,[30] it becomes pathological when it persists beyond the acute phase of tissue repair, contributing to maladaptive nociception in cases of nociplastic pain.[8,14,15,18] Less is known about peripheral sensitization than central sensitization, but peripheral sensitization is believed to involve an expansion of the receptive field, elevated concentrations of pro-inflammatory cytokines and chemokines, proliferation of sodium channels, and abnormal coupling of primary afferent neurons by sympathetic neurons, known as sympatho-afferent coupling.[14,15,18,31–33] Peripheral sensitization is believed to initiate or maintain central sensitization via perpetual bombardment of the central nervous system with nociceptive stimuli.[10,34] Persistent nociceptive stimulus is characteristic among individuals with chronic inflammatory autoimmune conditions, such as rheumatoid arthritis,[34] and may explain why fibromyalgia is more common among individuals with co-occurring autoimmune inflammatory conditions.[34–38]

Top-down versus bottom-up nociplastic pain subtypes

Emerging research suggests that nociplastic pain may involve potential subtypes, termed *bottom-up* and *top-down*, based on their predominant mechanistic pathway.[10,34,39] Top-down nociplasticity or nociplastic pain arises primarily from impaired descending pain modulation,[28] and is reportedly more common in individuals with substantial psychological comorbidities, often developing at a younger age[10,34]. In contrast, bottom-up nociplastic pain results from persistent peripheral nociceptive input, as seen in conditions like rheumatoid arthritis or advanced osteoarthritis, ultimately leading to central sensitization.[10,34]

Understanding these subtypes may help to inform treatment.[10,34] Treatment of bottom-up nociplastic pain may respond more favorably to treatments targeting peripheral sources of nociception, for example manual therapies, while top-down nociplastic pain is believed to respond more favorably to treatments targeting central pathways, such as cognitive-behavioral therapy (CBT), mindfulness-based strategies, or biofeedback (Figure 1).[10,34,40]

Nociplastic pain conditions

Nociplastic pain may be a component of any chronic pain condition,[10] but conditions characterized by nociplastic pain are those where nociplastic pain is believed to be the *predominant* pain mechanism[41]. These conditions are now beginning to be referred to as *chronic primary pain syndromes* by the International Classification of Diseases (ICD) coding system and have been described as painful conditions in their own right,[42] rather than conditions where pain emerges as a secondary feature of another disease process[43]. The most recognized nociplastic pain syndromes include a wide range of chronic pain conditions such as fibromyalgia, chronic nonspecific low back pain, migraines, chronic tension-type headaches, irritable bowel syndrome (IBS), and temporomandibular joint disorder (TMD).[10,14,41,44] Other conditions involving predominant nociplastic pain mechanisms include complex regional pain syndrome type I (CRPS-I), or chronic pelvic pain syndromes (e.g., chronic prostatitis, vulvodynia) (Table 1).[5,10]

Chronic pain conditions characterized by nociplastic pain often coexist with other chronic pain conditions (i.e., chronic overlapping pain conditions) and are more prevalent in individuals with a higher burden of comorbidities.[10,18,45] The relationship between nociplastic pain and the changes in neurophysiology helps to explain non-painful features that are known to accompany these chronic pain conditions. Comorbid conditions that are as-

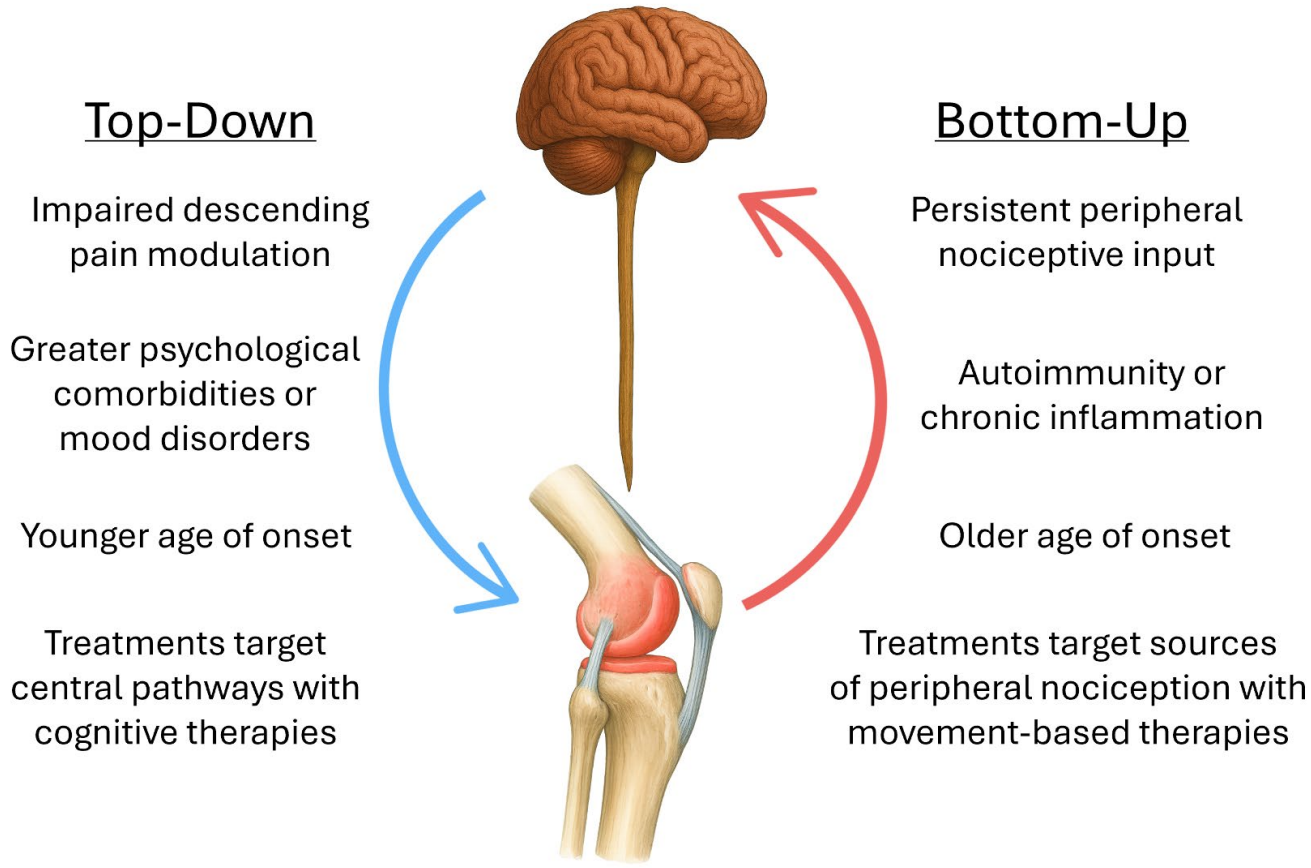

Figure 1.
*Top-Down and Bottom-Up Subtypes of Nociplastic Pain**

*This figure was adapted from the work of Kaplan CM, *et al*.[10] and Murphy AE, *et al*.[34]

sociated with nociplastic pain include depression, anxiety, post-traumatic stress disorder (PTSD), sleep disturbance, poor mental clarity (i.e., brain fog), chronic abdominal or pelvic pain, or other multisensory sensitivities to light, sound, or odors.[10,14,18] The clustering of these chronic conditions supports the concept of shared overlapping neurophysiologic mechanisms within the nervous system.

Diagnosing nociplastic pain

At present, no validated diagnostic tools or biomarkers exist to formally identify nociplastic pain and this mechanistic classification is based on a comprehensive history, physical exam, and clinical judgement.[10] In 2021 the IASP released a grading system to assist clinicians with identification, allowing for nociplastic pain to be qualified as *possible* or *probable* (Figure 2).[6,20] Efforts to further refine this grading criteria continue, with this criteria having recently been refined to include a *non-classifiable pain* designation.[46–48]

Clinical tools, such as the Central Sensitization Inventory (CSI),[49] screening for *yellow flags*,[50] or movement-evoked pain (MEP),[51] have shown potential for measuring aspects of nociplastic pain in clinical settings, but capture only limited aspects of nociplastic pain. Abnormalities associated with nociplastic pain may be quantified via the use of quantitative sensory testing (QST), sensory evoked potentials, or functional MRI,[6,10,11,15,39] but these methods are largely reserved for research settings and are not yet recommended for use in clinical practice[10].

The current lack of validated diagnostic criteria likely

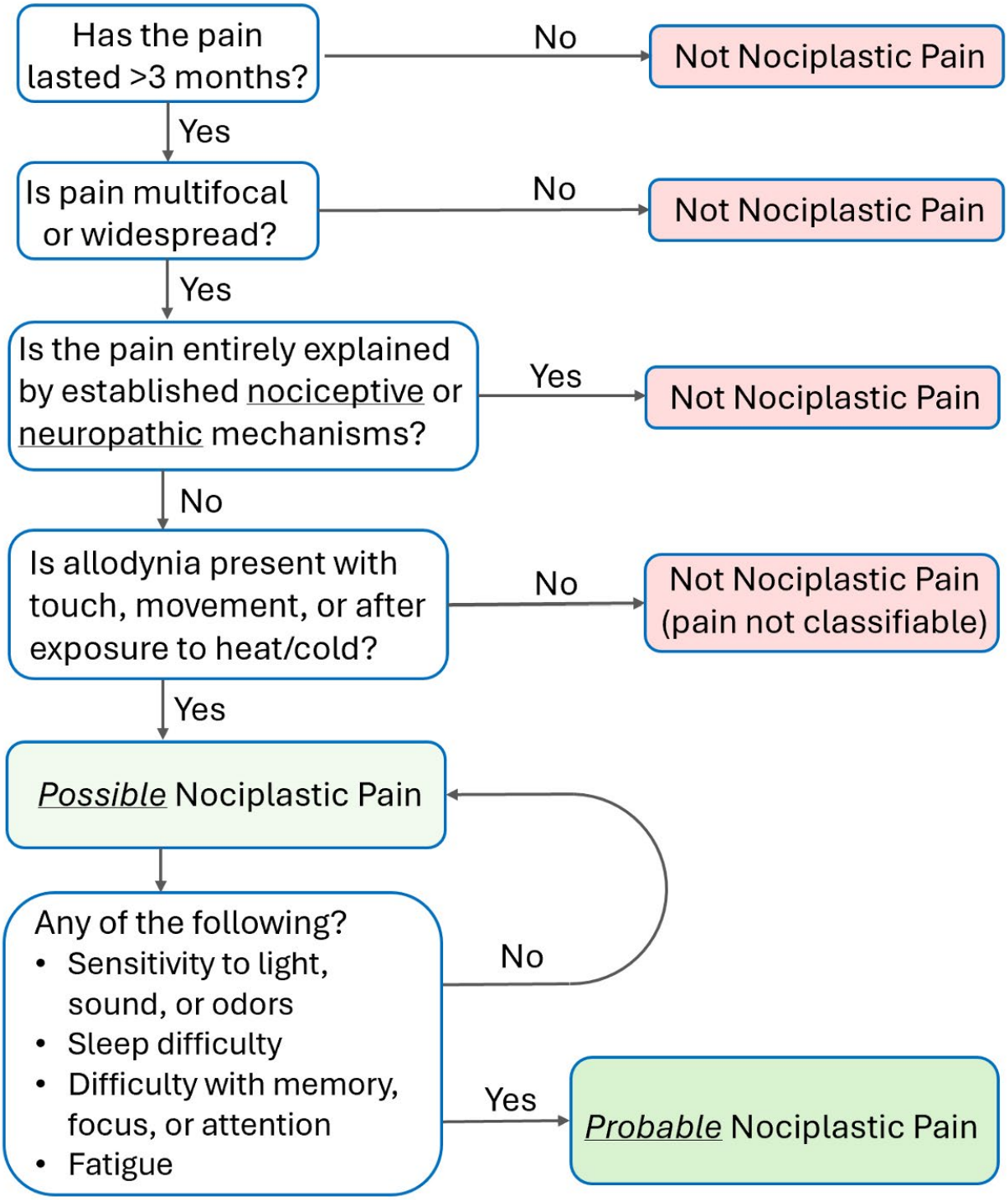

Figure 2.
*Flow chart for identifying and grading nociplastic pain**

*This figure was adapted from the work of Kosek E, *et al.*,[20,47] Nijs J, *et al.*,[58] and Yoo MY, *et al.*[18]

contributes to difficulties in quantifying the prevalence of nociplastic pain conditions.[10,40] Nociplastic pain conditions are likely to be common, but are often underrecognized or attributed to other causes.[40] For context, conditions primarily involving nociplastic pain are known to be widespread. Chronic low back pain affects approximately 13% of adults,[52] fibromyalgia impacts around 5% of the population,[53] and up to 4% of the population experiences chronic tension-type headaches[54]. Increased awareness and recognition of nociplastic pain stands to help guide more targeted treatments aimed at addressing the underlying mechanisms driving these painful conditions. Many conditions now understood to be predominantly nociplastic pain in nature are among the most common conditions managed by chiropractors,[55–57] highlighting the critical importance of recognizing nociplastic pain in clinical practice.

Mixed pain mechanisms

Nociplastic pain may be present in isolation or as part of a mixed pain state. *Mixed pain* refers to the simultaneous involvement of nociceptive, neuropathic, or nociplastic mechanisms, with one or more mechanisms potentially predominating.[59,60] Accordingly, nociplastic pain may occur in combination with nociceptive and/or neuropathic pain.[60,14]

To illustrate this concept, we present a hypothetical clinical scenario. A 58-year-old male experiences persistent back pain and stiffness localized to the thoracolumbar spine and paraspinal regions. His pain is moderate in intensity and began insidiously at age 40 and is aggravated by movements in all planes of thoracolumbar motion and by prolonged sitting. Sitting for longer than 30 minutes significantly increases his pain, while movements involving lumbar lateral bending and extension provoke pain flares lasting approximately five minutes. These activities occasionally lead to pain radiating into the lateral gluteal and posterolateral thigh regions, accompanied by intermittent subjective numbness and tingling into the proximal posterolateral aspects of his calves.

Previous radiographs reveal moderate lumbar spondylosis with zygapophyseal (i.e., facet) joint arthropathy and moderate bilateral L3-L5 lumbar neuroforaminal narrowing. His health history includes class II obesity, chronic bilateral knee pain, intermittent neck and right shoulder pain, migraines, irritable bowel syndrome, depression, anxiety, sensitivity to loud sounds, and non-restorative sleep with moderate daily fatigue. He also reports hesitancy towards exercise due to worries about damaging what he describes as his "crumbling discs" (a phrase reflecting the patient's fear-driven beliefs, rather than a formal diagnosis).

Figure 3 illustrates how varying degrees of overlapping pain mechanisms are present in this case.[61] Increased pain with extension and the presence of facet arthropathy are suggestive of a nociceptive component. Multilevel neuroforaminal narrowing, with pain radiating into the thighs and intermittent paresthesia in the legs, indicates a neuropathic component. Finally, his 18-year history of chronic widespread pain, multi-sensory sensitivities, sleep difficulty, and daily fatigue are suggestive of a *probable* nociplastic pain component.

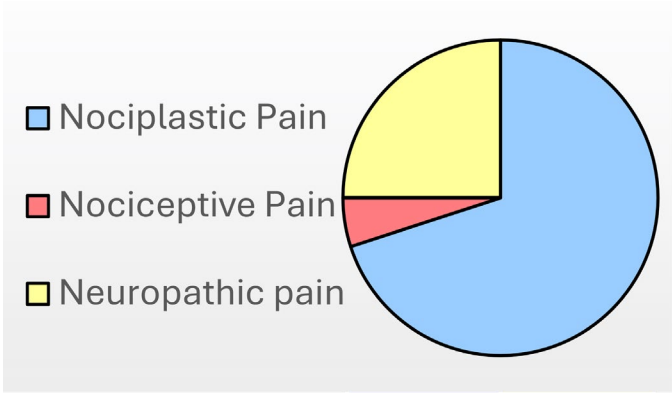

Figure 3.
Components of mixed pain in this chronic low back pain scenario

Implications for chiropractors and other health care providers

Chiropractors diagnose and manage a variety of painful neuromusculoskeletal conditions, which likely involve nociplastic pain.[55,62] These include both widespread pain conditions (e.g., fibromyalgia) and more localized pain conditions (e.g., chronic back pain, chronic migraine, chronic tension-type headaches, and temporomandibular joint disorders). Since some of these do not have an identifiable, peripheral lesion with which to target therapeutic interventions, patients and providers alike may experience distress and confusion regarding the best management approach. Moreover, an overemphasis towards no-

ciceptive and/or neuropathic pain mechanisms may lead to the improper use of imaging or prioritization of structural causes of pain, which have been shown to promote concerns or confusion and limit a patient's recovery.[63,64] It is therefore critical for clinicians and researchers to be aware of and acknowledge nociplastic pain as a legitimate pain mechanism in order to facilitate understanding and to provide reassurance and effective management.[58]

Diagnosis of nociplastic pain can prove clinically challenging with the clinical assessment forming the evaluative backbone.[15] Patients commonly report pain that is longstanding and poorly localized.[65] Nociplastic pain is often disproportionately and unpredictably impacted by aggravating and alleviating factors.[65] Additionally, it is associated with concomitant symptoms such as fatigue, sleep disturbances, cognitive issues, mood disorders, and heightened sensitivity to environmental stimuli.[6] Psychological factors such as stress, anxiety, depression, a history of trauma (e.g., PTSD, adverse childhood experiences), catastrophizing, or fear-avoidance behaviors or kinesiophobia are thought to play a role in the development and/or maintenance of nociplastic pain.[10] Patients may also report a protracted history of pharmacologic, non-pharmacologic, interventional, and surgical treatment, with minimal or transient benefit.[34] The clinical assessment should be used to help rule out other drivers of pain and to assess for features characteristic of nociplastic pain. Patients may display signs of hyperalgesia and allodynia, hesitancy and guarded movements during range of motion testing, and difficulty maintaining prolonged positioning.

It is understandable that many health care providers may be entirely unaware of the nociplastic pain classification as a recognized pain construct, although experienced practitioners may be intuitively familiar with its clinical presentation in their patients. The degree to which current chiropractic students and recent graduates are, or have been, exposed to nociplastic pain concepts in their respective training, is unknown. Research examining whether chiropractic programs are incorporating nociplastic pain education into their curricula would help clarify this gap, and efforts to integrate this content into chiropractic training are encouraged.

Clinicians are encouraged to provide reassurance and validation to patients, emphasizing that their pain will be acknowledged and respected.[66,67] Functional goal-setting and establishing realistic treatment expectations should be discussed from a management-focused perspective, rather than a curative one.[68,69] Clinicians are also encouraged to explain pain constructs, such as neuroplasticity and sensitization, in a patient-centered manner that avoids the use of technical jargon and is solutions-oriented.[40,70] The primary goal of this education is to validate the patient's experience, provide an explanation for their chronic pain, help them understand the drivers of their chronic pain, and discuss potential methods for modifying these factors. Stress management approaches including relaxation techniques, mindfulness, and meditation practices can be introduced to patients by chiropractors to help manage stress-related drivers of sensitivity. Moreover, considering sleep disturbances are a hallmark sign of nociplastic pain, chiropractors should discuss beneficial sleep strategies including adopting a regular sleep schedule, creating a relaxing bedtime routine, and optimizing the sleep environment.[40,71] Prompt referrals should be coordinated to sleep specialists if more intensive approaches are required.

Chiropractors can also help formulate and supervise graded exercise programs that are tailored to individual abilities and focused on functional goals. This may include a mixture of both aerobic exercise and resistance training. Recommendations for pacing activities should be provided and may be accompanied by strategies to track latent soreness (e.g. activity diaries) given that exercising in the presence of pain poses unique barriers to engagement compared to exercising pain-free.[72,73] More recently, a multidimensional rehabilitative approach known as cognitive functional therapy (CFT) has shown promise in reducing disabling chronic low back pain, likely driven by nociplastic pain mechanisms.[74–76] Through addressing negative cognitions (e.g., kinesiophobia), behaviors (e.g., guarded, non-varied movements), as well as healthy lifestyle changes, CFT aims to help patients make better sense of their pain and promote the extinction of safety behaviors through graded exposure to fearful movements. Chiropractors may consider integrating the principles of CFT, in combination with approaches to healthy lifestyle,[77] to help manage chronic nociplastic pain conditions.

The presence of nociplastic pain should not deter providers from evaluating and addressing peripheral dysfunctions as part of an overall treatment plan. Manual

therapies, including joint mobilization or manipulation, soft tissue techniques, and heat or cold applications may also play a role in treating patients with nociplastic pain by reducing peripheral nociception.[11] This "bottom-up" approach is directed to peripheral tissues, rather than central ones, and may help to attenuate peripheral drivers of central sensitization.[10,78–80] In 2010, Srbely proposed that spinal manipulative therapy may serve as a method for modulating neurophysiological sensitization.[81] Recent research has shown that a 4-week trial of 12 sessions of spinal manipulative therapy has the capacity to alter nociplastic pain factors and reduce segmental mechanical hyperalgesia among adults with chronic low back pain.[78] Clinicians are encouraged to avoid prolonged reliance on passive treatments alone, as these approaches are unlikely to provide more than temporary relief and may contribute to learned helplessness, potentially undermining the central role of self-care and lifestyle modification for the management of chronic nociplastic pain conditions.[82,83]

Pharmacologic treatments may play a role in nociplastic pain management. Pharmacologic agents are recommended in a stepwise approach when non-pharmacologic and self-management strategies fail to provide sufficient relief.[14,84] Importantly, national guidelines recommend that the use of pharmacologic treatment should only occur in tandem, rather than in lieu of, non-pharmacologic approaches.[39,84] Various central-acting medication classes have been found to be helpful for managing nociplastic pain including tricyclic antidepressants (e.g., amitriptyline, nortriptyline), selective norepinephrine reuptake inhibitors (e.g., duloxetine, venlafaxine), gabapentinoids (e.g., gabapentin, pregabalin), and low-dose naltrexone.[39,85] Traditional analgesics, such as nonsteroidal anti-inflammatories (NSAIDs) and acetaminophen, are often ineffective for nociplastic pain, while opioids are strongly discouraged.[14,39,86] Considering the significant sleep disturbances often experienced by patients with nociplastic pain, pharmacologic or supplemental sleep aids (e.g., melatonin) as well as advice on general sleep hygiene may play a role in certain cases.

Health care providers are encouraged to prioritize patients' needs and work collaboratively with other healthcare professionals to help provide comprehensive care for nociplastic pain. By integrating evidence-based non-pharmacologic treatments within a broader interdisciplinary pain management plan (Table 2), chiropractors can play a pivotal role in addressing the multifaceted nature of chronic pain conditions involving a significant nociplastic pain component. A patient-centered, multidisciplinary approach ensures that care is tailored to individual patients and stands to improve outcomes and empower patients to actively participate in their pain management.

Conclusion

The concept of nociplastic pain represents a fundamental shift in how chronic pain is understood and managed.[40] By recognizing the role of altered nociceptive processing within the nervous system, chiropractors can move beyond traditional structural and nociceptive models of diagnosis and treatment to providing more comprehensive, evidence-based, and patient-centered care. Many conditions, now considered to be primarily nociplastic in nature, are commonly encountered in chiropractic practice, emphasizing the need for a deeper understanding of this pain mechanism among clinicians.

Chiropractors are uniquely positioned to provide patient education, implement non-pharmacologic care, and collaborate within interdisciplinary teams to improve chronic pain management. While research on the direct effects of manual therapies for nociplastic pain conditions continues to evolve, evidence supports a multimodal approach that includes movement-based treatments, cognitive strategies, and lifestyle modifications within a biopsychosocial framework.[87] Integrating these strategies into chiropractic practice can enhance patient care by addressing both the physiological and psychosocial aspects of chronic pain.

Further research is needed to clarify nociplastic pain mechanisms, develop reliable diagnostic tools, and refine optimal treatment strategies. By staying informed and adaptable, chiropractors can play a pivotal role in advancing pain management strategies that validate patients' experiences and empower them toward meaningful functional improvements and improved quality of life.

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Table 2.
Overview of nociplastic pain management strategies

Non-pharmacological management (first line management)	Doctor-patient relationship	• Foster a trusting relationship involving open and honest communication • Validate the patient's experience • Provide reassurance and support • Set realistic goals, focused on improving function
	Patient education	• Explain nociplastic pain, while avoiding jargon • Promote self-care as the foundation to recovery • Explain treatment strategies in non-technical language
	Lifestyle modifications	• Physical activity • Healthy diet • Sleep hygiene • Stress management • Smoking cessation • Continued participation in work and social activities
	Psychological therapies	• Cognitive-behavioral therapy (CBT) • Acceptance and commitment therapy (ACT) • Mindfulness strategies • Pain reprocessing therapy (PRT)
	Rehabilitative and integrative therapies	• Physical therapy • Occupational therapy • Chiropractic • Acupuncture • Massage therapy • Yoga, Pilates, or Tai Chi
Pharmacological management	Centrally acting medications	• Tricyclic antidepressants (e.g., amitriptyline, cyclobenzaprine) • Serotonin-norepinephrine reuptake inhibitors (e.g., duloxetine, venlafaxine, milnacipran) • Gabapentinoids (e.g., gabapentin, pregabalin)
Management of complicating factors	Comorbidities	• Depression • Anxiety • Post-traumatic stress disorder (PTSD) • Insomnia • Obesity
	Psychosocial risk factors	• Catastrophizing (i.e., concerns about pain) • Fear-avoidance beliefs and behaviors • Kinesiophobia • Withdrawal from, or absence of, social support network

Adapted from Fitzcharles MA, *et al*.,[14] Kaplan CM, *et al*.,[10] and Ablin JN[40]

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Dual task function differences in chronic low back pain: a narrative review

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Chronic low back pain (CLBP) presents complex challenges, with traditional treatments offering only moderate relief. Emerging evidence suggests that impairments in dual task performance—simultaneous cognitive and motor processing—may contribute to CLBP persistence. This narrative review examined 10 studies comparing individuals with CLBP to healthy controls using various dual task paradigms. Findings indicated consistent deficits in gait variability, balance control, and muscle activation patterns among CLBP participants, especially under cognitive load. Neurocognitive impairments, including delayed anticipatory postural adjustments and altered trunk control, were also observed. These deficits likely reflect

Différences de fonction à double tâche dans la douleur lombaire chronique: une revue narrative

La douleur lombaire chronique (DLC) présente des défis complexes, les traitements traditionnels n'offrant qu'un soulagement modéré. Des preuves émergentes suggèrent que des déficits dans la performance de double tâche—traitement cognitif et moteur simultané—peuvent contribuer à la persistance des DLC. Cette revue narrative a examiné 10 études comparant des individus souffrant de lombalgie chronique à des témoins en santé en utilisant divers paradigmes de double tâche. Les résultats ont indiqué des déficits constants dans la variabilité de la démarche, le contrôle de l'équilibre et les schémas d'activation musculaire chez les participants souffrant de lombalgie chronique, en particulier sous charge cognitive. Des déficits neurocognitifs, y compris des ajustements posturaux anticipés retardés et un contrôle du tronc altéré, ont également été observés. Ces déficits reflètent probablement une intégration sensorimotrice perturbée et une compétition pour les

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disrupted sensorimotor integration and resource competition within the central nervous system due to chronic pain. Incorporating dual task interventions into rehabilitation may enhance outcomes by addressing both cognitive and motor domains. Future research should focus on standardized assessments, pain-related cognitive interactions, and neuroimaging methods to further explore these mechanisms and support targeted treatment strategies for CLBP.

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KEY WORDS: chronic low back pain, CLBP, dual-task, neurocognitive, somatosensory, chiropractic

ressources au sein du système nerveux central en raison de la douleur chronique. L'incorporation d'interventions à double tâche dans la réhabilitation peut améliorer les résultats en s'attaquant à la fois aux domaines cognitif et moteur. Les recherches futures devraient être axées sur des évaluations standardisées, les interactions cognitives liées à la douleur et les méthodes d'imagerie cérébrale afin d'explorer davantage ces mécanismes et de soutenir des stratégies de traitement ciblées de la DLC.

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MOTS CLÉS : douleur lombaire chronique, DLC, double tâche, neurocognitif, somatosensoriel, chiropratique

Introduction

Low back pain (LBP) is a leading cause of disability, and the number of workdays lost worldwide with rates between 60-84% for onset at any point in life.[1,2] The rate of LBP has steadily increased by an estimated 54% since 1990 to a point prevalence of 7.3% worldwide in the last decade.[3] Recurrence of LBP episodes is common with an estimated 33% of LBP patients experiencing chronic low back pain (CLBP).[1,4] With nearly 1 in 5 episodes of LBP resulting in sick leave and 30% of all sick leave of 6 months or longer being associated with CLBP, the economic impact of LBP is immense.[1] In the United States alone, LBP is estimated to cost at least 100 billion USD per year in both direct and indirect costs with the average CLBP patient spending $3,622 ($1,383-$8784) in direct medical expenses per year.[5,6]

The treatment for CLBP has historically resulted in relatively weak outcomes. Spinal surgery is reported to have up to 40% of patients not achieving a minimally clinically important difference in pain and nearly 20% of patients continuing to experience similar or worse pain following surgery.[7–9] Conservative treatments, including exercise and manual therapies, often have low to moderate effects on pain and function that are temporary in nature.[10] Prevention methods for LBP have also been underwhelming in their results as models centered around biomechanics, muscle strength and size, and lifestyle factors have shown little or no success in reducing or preventing LBP.[10–12]

One such area of interest in overall chronic pain research has been neurocognitive tasking. Neurocognitive tasking aims to manipulate nervous system pathways by providing an input that requires cognitive processing.[13,14] One popular and easy method to assess neurocognitive abilities in generalized musculoskeletal and CLBP research is dual tasking.[15–17] Dual tasking is a process where the participant is performing a cognitive processing task while performing a motor action. The performance of this task is then compared to the single task condition. Any deficits seen between these conditions are thought to be related to the processing limits of the nervous system.[18,19] Pain is theorized to result in decay of the ability to effectively integrate the required sensory and motor functions in both feedforward and feedback pathways due to it also requiring processing resources.[20,21] As pain often alters movement patterns, we also expect to also see altered cortical function. Individuals experiencing pain are therefore theorized to show a further decrease in task performance. This altered sensorimotor integration is likely a contributor to the chronicity of pain in many conditions, including CLBP. Targeting this integration as a rehabilitation strategy has been shown to be effective for conditions like complex regional pain syndrome and other pain syndromes. For a detailed discussion of the proposed physiology, see the paper by Vittersø and colleagues.[20] Few studies on dual-task function in the context of CLBP have been performed. Due to this, this literature review's purpose is to identify differences in dual task function in individuals with CLBP compared to those without CLBP.

Methods

Research question

A focused research question was formed: do patients with chronic low back pain exhibit differences in dual task functioning compared to healthy, non-pain experiencing controls?

Procedure – literature search

A search for experimental trials related to CLBP and dual task function was completed via PubMed, Scopus, and CINAHL. Dates of publication were limited to January 2014 through 2024 to ensure relevance to contemporary clinical practice and evolving methodologies. The search terms used were the following:

> "Low Back Pain"[MeSH] AND ("dual task" OR "dual-tasking" OR "cognitive-motor task" OR "concurrent task performance")

Included articles required a comparison of CLBP patients with healthy controls and at least 1 dual task paradigm used. This search produced 38 results. 19 results were removed as duplicates. Of the remaining 19, 9 were removed via abstract screening for not meeting the inclusion criteria with the papers being reviews, commentary, or trial proposals. Each of the remaining 10 studies were fully reviewed and included in this review without further exclusion (Figure 1). Each study was evaluated using National Institutes of Health (NIH) quality assessment criteria with summaries of the articles in Table 1. All articles were screened and evaluated by a single reviewer.

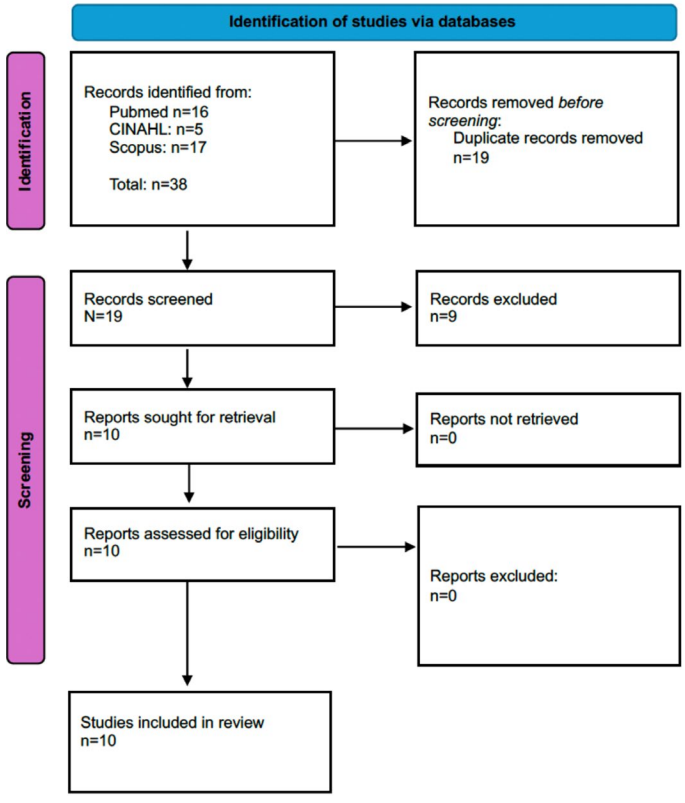

Figure 1.
Search strategy

Results

Gait

Hamacher *et al*. reported an increase in gait stride-to-stride variability for CLBP participants compared to healthy controls ($F(1,22) = 11.506$, $p = 0.003$, $\eta^2 = 0.343$) and a greater dual task cost for CLBP participants ($F(1,22) = 4.583$, $p = 0.044$, $\eta^2 = 0.172$).[22] In a follow-up study, Hamacher *et al*. found increased stride time variability in both single ($Z = -1.963$, $p = 0.050$) and dual task conditions ($Z = -2.540$, $p = 0.010$) for CLBP patients compared to healthy participants. This study also noted that stride length ($Z = -2.824$, $p = 0.005$) and stride time variability ($Z = -2.903$, $p = 0.004$) increased in the CLBP group between task conditions, while only stride time variability increased in controls ($Z = -3.059$, $p = 0.002$). No significant differences in this study's primary outcome, min-

Table 1.
Study summaries

Authors	Title	Participants	Inclusion and Exclusion	Outcome Measure(s)	Results	NIH Quality Assessment
Assessment Hamacher, Hamacher, Schega (2014)	A cognitive dual task affects gait variability in patients suffering from chronic low back pain	12 healthy, 12 CLBP	Inclusion: CLBP = >3 months of self-reported low back pain	Stride-to-stride gait variability, trunk angular velocity, Regensburger word fluency test (RWT) for both single- and dual-task exposures	Gait variability group by condition effect: F 1, 22 = 11.506, p = 0.003, n^2 = 0.343; Dual-tasking group effect: F1,22 = 4.583, p = .044; η2 = 0.172; Trunk velocity dual-task costs higher for CLBP (p=0.001); Condition effect single vs. dual-tasking for CLBP: F1,11 = 16.041, p = .002, η2 = 0.593; No effect on RWT performance.	Fair

Authors	Title	Participants	Inclusion and Exclusion	Outcome Measure(s)	Results	NIH Quality Assessment
Hamacher, et al. (2016)	Are there differences in the dual-task walking variability of minimum toe clearance in chronic low back pain patients and healthy controls?	12 healthy, 12 CLBP	Inclusion: Healthy = VAS 0, no self-reported LBP >3mo duration CLBP = VAS at least 4, duration of pain 3mos or longer, participating in "back therapy training course"	Minimum toe clearnace, stride length, stride time under single and dual-tasking	Stride length ($Z = -2.824$; $p = 0.005$) and time variability ($Z = -2.903$; $p = 0.004$) increased in CLBP group between task conditions. Time variability increased in controls ($Z = -3.059$; $p = 0.002$) between task conditions. No change in MTC for CLBP ($Z = -1.177$; $p = 0.239$) or controls ($Z = -0.628$; $p = 0.530$). CLBP patients experienced higher stride time variability than controls in both single ($Z = -1.963$; $p = 0.050$) and dual-task ($Z = -2.540$; $p = 0.010$). No difference in MTC in single or dual-task between groups ($p>0.050$).	Fair
Shanbehzadeh, et. al. (2018)	Attention demands of postural control in non-specific chronic low back pain subjects with low and high pain-related anxiety	20 healthy, 19 low pain-related CLBP, 19 high pain-related anxiety CLBP	Inclusion: CLBP = patients experience low back pain >6mos or at least 3 self-recurrent pain episodes in the previous year. CLBP patients only tested if pain less than 30mm of 100mm on VAS. Exclusion: CLBP = no specific diagnosis (nsLBP), no medications related to postural control or cognition.	Anticated and actual pain, postural performance assessed via center of pressure (COP) for single and dual task conditions, cognitive performance via single and dual task conditions.	CLBP patients with high pain-related anxiety significantly anticipated greater pain than what they felt during testing ($p < 0.05$). Significant main effects of group for COP area ($F2,55 = 10.57$, $P < 0.05$, $\eta2 = 0.28$) and mean velocity ($F2,55 = 7.67$, $P < 0.05$, $\eta2 = 0.22$). Significant interaction of group by cognitive load was found for COP sway area ($F2,55 = 3.27$, $P = 0.04$, $\eta2 = 0.1$). Post hoc analyses by paired t-tests showed that CLBP participants with high pain-related anxiety and control subjects significantly reduced their sway area during the dual-task conditions. Interactions of group by postural task difficulty by cognitive load were significant for A–P range ($F2,55 = 3.46$, $P < 0.05$, $\eta2 = 0.11$). Significant main effects of postural task condition on reaction time (RT) ($F4,208 = 13.36$, $P < 0.05$, $\eta2 = 0.27$). The interaction between group and postural task condition was significant for RT ($F8,208 = 2.155$, $P < 0.05$, $\eta2 = 0.07$). CLBP subjects with high pain-related anxiety showed significantly slower reactions with increased difficulty of postural tasks ($p<0.05$).	Fair
Bianchi, et al. (2022)	Cognitive dual-task cost depends on the complexity of the cognitive task, but not on age and disease	19 in Younger healthy, 16 in Older healthy, 19 in Parkinson's, 9 in actue (<4 weeks) stroke, 16 in Multiple Sclerosis, 5 in CLBP	Inclusion: >18 years old (18-45 for younger, >60 for older), ability to independently walk. Exclusion: Montreal Cognitive Assessment score <15, other movement disorder affecting mobility	Dual task cost (DTC) from simple reaction time (SRT) while performing stroop numerical test under 3 conditions of congruent, neutral, and incongruent while standing (single task) and walking with turns (dual task)	Significant effect of factor "task" ($F3, 177 = 48.630$; $p < 0.001$; $\eta2p = 0.452$). Post-hoc analysis reveals higher DTC between SRT and stroop conditions ($p<0.001$) with CLBP being statistically different from other groups. Disease state not linked to differences in DTC.	Poor
Yang, et. al. (2023)	Effect of Cognitive Load on Anticipatory Postural Adjustment Latency and its Relationship with PainRelated Dysfunction in Non-specific Chronic Low Back Pain: A Cross-Sectional Study	30 healthy controls and 30 non-specific CLBP participants	Inclusion: 18-50 years old, pain located between the 12th rib and hip, pain duration >3 months, VAS of at least 3, one recurrent LBP pain episode within the past 3-15 months, right handed. Exclusion: Pelvic or spine surgery in the previous 2 years, presence of any identified lumbar pathology, radicular symptoms, BMI >30 kg/m2, LBP treatment within the last 3 months, pregnant or preparing for pregnancy, dysfunction of vital organ(s), visual/auditory/cognitive impairement	Anticipatory postural adjustment (APA) of transverse ab./internal oblique (TrA/IO), and multifidus (MF) during single and dual-task postural perturbations, Roland-Morris Disability Questionnaire (RMDQ)	APA latency of the right TrA/IO was significantly delayed compared with that of the left TrA/IO in the NCLBP group (mean 29.15, 95% confidence interval (CI) 18.81 to 39.50 versus mean 3.69, 95% CI - 6.81 to 14.18, $p = 0.0363$). APA latency of the right MF under cognitive load was significantly delayed compared with that on the left side in patients with NCLBP (mean 25.38, 95% CI 13.41–37.35 versus means - 3.03, 95% CI - 15.18 to 9.13, $p = 0.0220$) and right side in patients with NCLBP without cognitive load (mean 25.38, 95% CI 13.41–37.35 versus means - 5.88, 95% CI - 22.56 to 10.80, $p = 0.0092$). During the dual task, the APA latency of right MF was significantly delayed than that on the right side compared to the control group (mean 25.38, 95% CI 13.41–37.35 versus mean - 5.80, 95% CI - 19.28 to 7.68, $p = 0.0416$) APA latency delay in the right MF ($r = 0.5560$, $p = 0.0017$) and left MF ($r = 0.4010$, $p = 0.0311$) during the dual task in the NCLBP group were positively correlated with RMDQ scores.	Fair
Hemmati, Piroozi, Rojhani-Shirazi (2018)	Effect of dual tasking on anticipatory and compensatory postural adjustments in response to external perturbations in individuals with nonspecific chronic low back pain: Electromyographic analysis	25 female healthy controls, 25 female non-specific CLBP	Inclusion: CLBP = no MRI identified abnormalities, minimum of 3 month duration of LBP, NRS pain between 3 and 5 out of 10, pain of 3 or less at the time of testing, Hospital Anxiety and Depression scale (HADS) score of <=7. Exclusion: Radicular pain, uncorrected vision impairment, vestibular or auditory deficits, diabetes, spinal surgery within previous 3 months, BMI >=30, infection or tumor of the spinal cord, deformity of spine or lower extremity, previous joint or skin conditions, medication that can influence balance, pregnancy.	EMG onsent for lateral gastrocnemius, tibialis anterior, rectus femoris, bicep femoris, rectus abdominus, erector spinae with predictable and unpredictable pertubations during single and dual-task exposures, RMDQ	Tibialis anterior EMG onset activity delayed in patients with CLBP during dual-task compared to single task ($F=5.57$, $p=0.02$). During unpredictable pertubation, there was a statistically significant difference for the condition comparison for gastrocnemius ($F=4.63$, $p=0.03$), rectus femoris ($F=4.58$, $p=0.03$), and for group by condition for gastrocnemius ($F=5.74$, $p=0.02$).	Fair

Authors	Title	Participants	Inclusion and Exclusion	Outcome Measure(s)	Results	NIH Quality Assessment
Sherafat, et. al.(2014)	Effect of Dual-Tasking on Dyanmic Postural Control in Individuals With and Without Nonspecific Low Back Pain	15 CLBP, 15 healthy	Inclusion: CLBP = episodic LBP for at least 12 months, pain at 40/100mm on VAS at time of testing. Exclusion: nerve root pain, history of spinal surgery, spinal pathology/deformities, uncorrected visual impairment, vestibular or respiratory disorders, auditory or cognitive deficits, diabetes, recent lower limb injury, pregnancy, or the use of any medication that interferes with the ability to maintain balance	Postural stability in anterior-posterior, medial- lateral, and overall. Verbal reaction time and error ratio during auditory Stroop task.	3-way ANOVAs showed that the interactions of group by postural task difficulty by cognitive task difficulty were significant for APSI ($F2,56 = 4.66$, $P = .013$), MLSI ($F2,56 = 9.70$, $P < .001$), and OSI ($F2,56 = 11.14$, $P < .001$). Post-hoc 2x2 interaction of group by cognitive task difficulty was significant only in the stability level of 5, eyes-closed condition for APSI ($F1,28 = 18.31$, $P < .001$), MLSI ($F1,28 = 10.65$, $P = .003$), and OSI ($F1,28 = 19.77$, $P < .001$). Concurrent cognitive task in stability level 5, eyes-closed condition significantly increased stability indices compared with single task only in participants with CLBP (APSI; $P < .001$, MLSI; $P = .02$, OSI; $P < .001$) and for APSI ($P = .01$) in the level 3 eyes-closed condition. Interaction between group and postural task difficulty was not significant for RT ($F2,28 = 0.35$, $P = .71$) but was significant for error rate (ER) ($F2,28 = 3.33$, $P = .04$)	Good
Hammati, et. al. (2017)	Evaluation of Static and Dynamic Balance Tests in Single and Dual Task Conditions in Participants With Nonspecific Chronic Low Back Pain	40 CLBP and 40 healthy	Inclusion: CLBP= Pain for at least 3 months with a pain score of 3-5 out of 10 NRS. Pain lower than 3 at time of testing. Hospital Anxiety and Depression Scale score <8. Exclusion: spinal surgery in the previous 3 months, uncorrected vision impairment, vestibular dysfunction, auditory deficits, nerve root compression resulting in neurologic symptoms, trunk or spinal deformity, use of medication that impacts balance, pregnancy.	Static balance during one-leg stance test. Dynamic balance during modified star excursion test via measure of distance in anterior, posteromedial, and posterolateral directions. Timed up-and-go and 10-m walk tests were assesed for dynamic balance. Dual cognitive and dual manual tasks were performed. Accuracy and response speed recorded.	2-way analysis indicates the main effect of task was significant for single-leg stance ($F=15.69$, $P<.001$), timed-up-and-go ($F=69.26$, $P<.001$), and 10-m walk ($F=35.55$, $P<.001$). No difference identified between CLBP and healthy controls.	Fair
Rowley, Winstein, Kulig (2020)	Persons in remission from recurrent low back pain alter trunk coupling under dual-task interference during a dynamic balance task	19 recurrent LBP, 19 healthy controls	Inclusion: CLBP = pain located between lower rib cage and horizontal gluteal fold, functional limitations as outlined in NIH Task Force recommendation and Oswestry Disability Index, at least two episodes of pain over previous year but pain on only about half of the days during the last six months. Pain at time of testing <1.5 out 10 on VAS. Healthy controls = no back pain in previous year. Exclusion: >45 years old, low back surgery, imaging support diagnosis of spinal stenosis, scoliosis, malignancy, infection, or radiculopathy, no previous injury or condition affecting locomotion or balance, no history of diabetes mellitus, rheumatic joint disease, blood clotting disorders, polyneuropathy, or pregnancy.	EMG mean activation amplitude of paraspinals and abdominals, trunk control, center of mass velocity, vertical force produced by spring compared to target force.	Trunk control had a significant interaction effect ($F(2,17) = 6.904$, $p = 0.006$, $!2$ $p=0.448$) but no main effects of group ($F(1,18) = 1.713$, $p = 0.207$, $!2$ $p =0.087$) or condition ($F(2,17) = 1.908$, $p = 0.179$, $!2$ $p=0.183$). CLBP group participants increased trunk coupling in both DTCognitive ($p = 0.006$) and DTBalance ($p = 0.008$). rLBP group had lower trunk coupling, or more dissociated thorax and pelvis motion ($p = 0.024$). No single muscle, muscle activation ratio, or combination of muscles predicted trunk coupling in any conditions for the back-healthy control group or in DTCognitive or DTBalance for the CLBP group. Task Prioritization had a main effect of condition ($F(2,17) = 17.957$, $p < 0.001$, $!2$ $p = 0.679$) with all conditions significantly different from one another ($p \leq 0.034$). There was a main effect of condition ($F(2,15) = 5.719$, $p = 0.014$, $!2$ $p = 0.433$), where there was significantly greater COM velocity in the DTCognitive condition. Self-reported measures of cognitive task difficulty corelated to trunk coupling (DTCognitive: $R = – 0.512$, $p = 0.025$; DTBalance: $R = – 0.522$, $p = 0.022$)	Good
Valizadeh, et. al. (2023)	Walking Performance during Concurrent Cognitive and Motor Tasks in Individuals with Nonspecific Chronic Low Back Pain: A Case- Control Study	20 non-specific CLBP, 20 healthy controls	Inclusion: LBP=18-45 years old, LBP of at least 12 weeks, pain of 4-6/10 NRS, disability on Oswestry of 21- 40%. Exclusion: Spondylolisthesis, pregnancy, radicular pain, spinal or lower limb deformity, tumor or infection, history of lower limb fracture, neurological disorders, rheumatic disease, diabetes, hearing or cognitive impairments, medication that impairs gait.	Gait parameters of cadence, swing time, stride length, step width, and double support time during self-selected and standardized walking speeds. Reaction time and error ratio of cognitive task performance.	In the NSCLBP group, the self-selected speed was slower than the healthy controls ($P = 0.004$). 2-way repeated measures ANOVA showed a significant main effect of the group for shorter swing time ($P = 0.012$) and longer double support time ($P = 0.021$) for CLBP. Significant interaction between the group and condition for lower cadence ($P = 0.004$) in CLBP. CLBP group had a lower cadence during the cognitive dual-task condition compared with the single-task condition ($P = 0.031$) and motor dual-task condition ($P = 0.021$). Stride length has no significant effect of group ($P = 0.467$), condition ($P = 0.460$), or interaction between group and condition ($P = 0.851$). Step width results also indicated no significant effect of group ($P = 0.072$), condition ($P = 0.619$), or interaction between group and condition ($P = 0.372$). Stride time variability had no significant interaction between the group and condition ($P = 0.904$). Post hoc analysis results showed that in all participants stride time variability was decreased under the cognitive dualtask walking compared with the single and motor-dual task walking conditions ($P = 0.030$).	Good

imum toe clearance, was found between groups or task conditions ($Z = -1.177$, $p = 0.239$).[23]

In contrast, Valizadeh *et al*. found no differences in stride length or step width between groups or conditions. This study also reported a decrease in stride time variability for all participants during dual tasking ($p = 0.030$). Additionally, CLBP participants exhibited lower self-selected treadmill speeds ($p = 0.0004$), shorter swing times ($p = 0.012$), longer double support times ($p = 0.021$), and lower walking cadence ($p = 0.004$). Lower cadence was observed in CLBP participants during dual task ($p = 0.031$) and motor dual task conditions ($p = 0.021$) compared to single task conditions.[24]

Balance and posture

Hammati *et al*. evaluated static and dynamic balance, finding significant differences between dual cognitive and dual motor tasks compared with single task conditions for both CLBP and controls, but no differences between the groups in single-leg stance, timed up-and-go, and 10m walk test performance.[25] Hamacher *et al*. noted increased trunk variability under dual task conditions for CLBP patients ($F(1,11) = 16.041$, $p = 0.002$, $\eta^2 = 0.593$).[22] Rowley *et al*. reported reduced frontal plane trunk-pelvis coupling in the CLBP group during single-task conditions but not during dual task conditions, with no differences in center of mass velocity, EMG muscle activation, or dual task performance between groups.[26]

Sherafat *et al*. identified a three-way interaction between group, cognitive task difficulty, and postural task difficulty. As task difficulties increased, postural sway increased for CLBP patients starting at moderate difficulty levels compared to controls. Although reaction time did not differ for the CLBP group, the error rate was higher ($F(2,28) = 3.33$, $p = 0.04$) and influenced by postural task difficulty ($F(2,28) = 8.08$, $p = 0.002$).[27]

Shanbehzadeh *et al*. examined the influence of high and low levels of pain-related anxiety on postural performance. CLBP patients with high pain-related anxiety significantly anticipated greater pain than they experienced ($p < 0.05$). Significant main effects of group were found for center of pressure (COP) area ($F(2,55) = 10.57$, $p < 0.05$, $\eta^2 = 0.28$) and mean velocity ($F(2,55) = 7.67$, $p < 0.05$, $\eta^2 = 0.22$). A significant interaction of group by cognitive load was found for COP sway area ($F(2,55) = 3.27$, $p = 0.04$, $\eta^2 = 0.1$). Post hoc paired t-tests indicated that both CLBP participants with high pain-related anxiety and control subjects significantly reduced their sway area during dual task conditions [28]. This result conflicts with the results of Sherafat *et al*.[27] Additionally, interactions of group by postural task difficulty by cognitive load were significant for anterior-posterior (A–P) range ($F(2,55) = 3.46$, $p < 0.05$, $\eta^2 = 0.11$). Significant main effects of postural task condition on reaction time (RT) were observed ($F(4,208) = 13.36$, $p < 0.05$, $\eta^2 = 0.27$). The interaction between group and postural task condition was also significant for RT ($F(8,208) = 2.155$, $p < 0.05$, $\eta^2 = 0.07$), with CLBP subjects with high pain-related anxiety demonstrating significantly slower reactions as the difficulty of postural tasks increased ($p < 0.05$).[28]

Electromyography

Differences in muscle activation related to dual task performance in CLBP patients were noted in several studies. Hemmati et al. found delayed tibialis anterior EMG onset in CLBP patients during dual task conditions ($F = 5.57$, $p = 0.02$). During unexpected perturbations, early activation of the gastrocnemius ($F = 4.63$, $p = 0.03$) and rectus femoris ($F = 4.58$, $p = 0.03$) muscles was also observed in CLBP compared to healthy controls.[29]

Yang *et al*. investigated anticipatory postural adjustments (APA) in right-handed individuals with CLBP, finding that the APA latency of the right transversus abdominis/internal oblique (TrA/IO) was significantly delayed in the CLBP group compared to the left TrA/IO. The right TrA/IO latency was 29.15 ms (95% CI, 18.81 to 39.50) versus the left TrA/IO at 3.69 ms (95% CI, -6.81 to 14.18) ($p = 0.0363$). The APA latency of the right multifidus (MF) muscle under cognitive load was also significantly delayed compared to the left side in CLBP patients, with right MF latency at 25.38 ms (95% CI, 13.41 to 37.35) versus left MF at -3.03 ms (95% CI, -15.18 to 9.13) ($p = 0.0220$). This delay was also present in the right MF of CLBP patients without cognitive load (25.38 ms, 95% CI, 13.41 to 37.35) compared to -5.88 ms (95% CI, -22.56 to 10.80) ($p = 0.0092$). During dual task conditions, the APA latency of the right MF was significantly delayed compared to the control group, with means of 25.38 ms (95% CI, 13.41 to 37.35) versus -5.80 ms (95% CI, -19.28 to 7.68) ($p = 0.0416$). Additionally, there was a positive correlation between APA latency delay in the right ($r = 0.5560$, $p = 0.0017$) and left MF ($r = 0.4010$, $p = 0.0311$)

during dual task conditions to Roland-Morris Disability Questionnaire (RMDQ) scores in the CLBP group.[30]

In a study comparing those with CLBP to groups of elderly controls, young controls, and those with neurological conditions, Bianchini's analysis revealed a significant effect of the factor "task" on dual task cost (DTC) ($F(3, 177) = 48.630$; $p < 0.001$; $\eta 2p = 0.452$). Post-hoc analysis indicated that the DTC was significantly higher between simple reaction time (SRT) and Stroop task conditions ($p < 0.001$), with CLBP patients showing statistically different results compared to other groups. However, the disease state was not linked to differences in DTC, suggesting that the observed effects may be driven by the complexity of the task rather than the presence of CLBP.[31] As this study only included 5 CLBP participants, extra care should be taken when considering this result.

Discussion

This narrative review examined dual task performance differences between individuals with CLBP and healthy controls. The results of this review align with recent reviews indicating that dual task performance likely is compromised in individuals with CLBP compared to healthy controls.[17] While previous reviews have identified similar findings related to dual task performance, several studies identified here have directly compared psychosocial factors, like pain-related anxiety and self-rated disability, to dual task performance metrics and found significant results indicating new, lesser explored areas.[28,30]

Increased gait variability is noted by several studies for those with CLBP.[22,23] However, conflicting evidence exists, such as Valizadeh *et al*. finding no differences in stride length or step width between groups during dual tasking compared to Hamacher *et al*.[23,24] These two studies also found contradicting results for stride time variability decreasing and increasing, respectively.[23,24] These discrepancies are likely due to variations in study methodologies, sample sizes, and the specific dual task paradigms used.

Differences in muscle activity are also noted by several studies.[25,30] These differences appear to persist beyond just the trunk and include musculature in the lower extremity. As these muscle co-activation patterns change in CLBP, it may partially explain differences in balance and postural stability that are noted previously.[25,26,30] Past studies have not always agreed with these results. Moseley *et al*. found that deep trunk muscle activation did not vary based on tasks with low attentional demands.[32] It has been further hypothesized that task type and level of attentional demand of the task explains differences in results.[27,31,33,34] One such example comes from work by Van Daele and colleagues who noted that visual-auditory stimulation and language related tasks increase postural stability in some populations.[34] Several studies noted in this review also show cognitive demands changing outcomes.

The observed dual task deficits in CLBP patients may have significant clinical implications. These findings suggest that standard rehabilitation protocols should incorporate neurocognitive tasks to address both motor and cognitive impairments. By targeting dual task performance, clinicians can potentially improve functional outcomes and reduce the chronicity of LBP. Interventions that combine physical exercises with cognitive challenges may enhance neuroplasticity and sensorimotor integration, leading to better management of CLBP.[35] A non-randomized study by Celletti and colleagues examining neurocognitive therapies for individuals with hypermobile type Ehlers-Danlos with CLBP noted improvements in pain, movement fear, and Oswestry disability index scores.[36] This population presents with a wide range of clinical challenges so the results may not extrapolate to general CLBP patients. However, no other prospective CLBP neurocognitive clinical trials have been found in the literature at the time of writing.

Several mechanisms likely explain the dual task deficits observed in CLBP patients, and three primary models have historically been used to explain this phenomenon. The cross-domain competition model theorizes there is a finite available capacity of the nervous system to execute tasks. As more tasks are completed simultaneously, the available resources allocated to the individual tasks decreases and may lead to reduced task function.[18] However, evidence exists of a U-shaped nonlinear interaction model where low demand cognitive tasks may improve a concurrent physical tasks.[17,33] A task prioritization model is also used to describe scenarios where a task is heavily prioritized at the detriment for other tasks such as what is noted in fall prevention strategies adopted in the eldery.[17] Xiao *et al*. provides an overview on the literature and further descriptions of these models.[17]

These models, as they currently exist, do not explain all differences in current research results individually and fail

to incorporate psychosocial responses. Pain is known to interfere with cognitive processing, leading to a reduction in the available resources for motor and cognitive tasks. This is supported by the sensorimotor theory of pathological pain, which suggests that chronic pain disrupts the integration of sensory and motor function.[18–21,35,37,38] Additionally, neuroplastic changes associated with chronic pain may alter cortical function and further impair dual task performance.[20,35] It is likely that while limited resources may exist for functions of the central nervous system, not all resource types will experience the same impairment from any or all experienced pain. As neurocognitive tasks are historically placed into domain classes, it is likely that these classes and their subclasses will respond to demands differently. The resources impacted will vary between person based on biopsychosocial factors as well since type, intensity, and location of pain and the attention toward or from pain is also a factor that can be influenced and will impact task performance.[39]

With the currently known information, the previously noted models of dual task interference do not adequately explain differences found in those with CLBP as they do not account for the wide array of difficulties or types of tasks and their cross-domain interactions, loss of cognitive resources to pain, or other psychosocial factors. The author of this review proposes a less rigid framework to explain dual task interference in the CLBP population. As pain is experienced, the motor systems work to dampen it by engaging the descending pain modulating pathways leading to reductions of available motor resources. Combined with pain avoidance behaviors, this has the downstream consequence of altering motor patterns that then provide different than expected proprioceptive feedback, requiring greater reliance on a wider variety of resources within the brain to handle this mismatch of feedforward and feedback pathways, leading to further reductions in resources and overall performance of concurrent tasks. However, the exact reduction in cognitive resources is likely based on the number, type, and difficulty of tasks alongside the patient's level of current and anticipated future pain. As pain increases, it is likely to reach a point of interference resulting in inhibition of task performance regardless of attention. "Automatic" processes are likely preserved at lower levels of pain while the performance of tasks can increase at higher levels of pain with greater active attention directed to the task over pain. The previously noted factors, combined with the overall biopsychosocial factors associated with CLBP, will allow for this point of interference to vary at any given time for all individuals. When pain reaches beyond this point of interference, cross-domain competition for processing resources will exceed the available resources causing reductions in all concurrent task performances regardless of adaptation strategies, producing cognitive-motor interference (Figure 2).

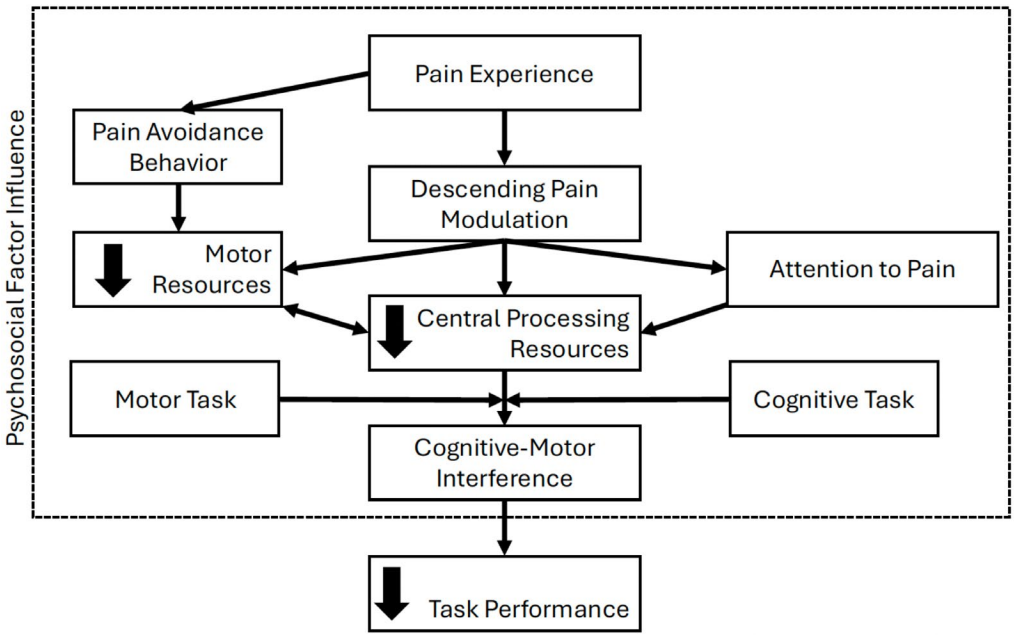

Figure 2.
Model of cognitive motor interference.

Directions for future research

Further investigation is needed to explore the mechanisms underlying dual task deficits in CLBP patients. Longitudinal studies can help determine causal relationships between chronic pain, cognitive impairment, and motor dysfunction in more diverse populations. Standardizing dual task assessment methods will also enable more consistent and comparable results across studies as changes in dual task function may vary based on demand of cognitive tasks, type of task, and number of tasks. Many cognitive tasks currently used in dual task research already utilize multi- and cross-domain resources meaning it may be worth simplifying tasks to as few domains as possible to examine the impact of pain on specific domains. Additionally, research should focus on developing and testing neurocognitive interventions that can be implemented into existing rehabilitation protocols without added strain on providers, patients, or healthcare resources.

Future measures such as event-related potentials, functional near-infrared spectroscopy, and functional MRI may be useful to attempt to measure changes in central nervous system function and locate specific regions of potential impaired function leading to deficits.[40–42] For instance, differences in somatosensory event-related potentials were identified as possible predictors of the transition from acute to chronic LBP.[43] Studies should also incorporate a greater importance on measures of pain, pain-related anxiety, and functional impairments as some correlations were noted in articles included in this review while past studies on chronic pain note the interconnected-ness of pain and motor function.[28,30,35]

Limitations

This review has several limitations. The included studies varied in their methodologies which affects the generalizability of the findings. A potential source of bias revolves around the selection of healthy controls. All studies in this review included controls without LBP but there were no statements about pain in other areas of the body which, if present, may confound results. Many studies also only included participants with low levels of pain. As higher levels of pain may correlate to greater impairment of dual task function, this population will be important to include. Studies also used individuals with "non-specific" LBP. It is currently unknown if differences in underlying pain generators in the low back influence results. As "non-specific" LBP remains a controversial diagnosis related to our current clinical limitations of diagnosis, it is worth including individuals with specific and identifiable low back disorders in future research. Most included studies did not examine how the dual task performance impacted pain and disability. The two studies that included related measures of these noted correlations between pain and performance of dual tasks.[28,30] As these are clinical outcomes stakeholders in healthcare monitor, it is important to follow-up on these factors. Additionally, this review only included articles published in English and consisted of 1 article reviewer.

Conclusions

This narrative review identified potentially significant dual task deficits in individuals with CLBP, including impaired gait, balance, and muscle activation patterns compared to healthy controls. The findings may indicate the importance of incorporating neurocognitive tasks into rehabilitation protocols for CLBP patients. Addressing both cognitive and motor impairments can potentially improve functional outcomes and reduce the chronicity of LBP. Addressing the neurocognitive aspects of CLBP is crucial for effective pain management and rehabilitation. Continued research, implementation, and refinement of dual task assessments in clinical practice are essential for advancing the treatment of CLBP.

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Untangling the association between the burden of chronic back problems, current utilization of chiropractic care, and availability of chiropractors at the health region level: an ecological study protocol

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Background: *Chronic back problems (cBP) are the leading cause of disability in Canada, with chiropractors as second most-consulted professionals for cBP care. However, little is known about chiropractor supply, demand, and gaps between them. We will determine the prevalence of cBP, chiropractic utilization, the chiropractic availability across Canadian health regions; compute a demand-supply measure; and investigate characteristics associated with the demand-supply.*

Démêler l'association entre le fardeau des problèmes chroniques de dos, l'utilisation actuelle des soins chiropratiques et la disponibilité des chiropraticiens dans les régions de santé: Un protocole d'étude écologique
Contexte: *Les problèmes chroniques de dos (PCD) constituent la principale cause d'incapacité au Canada, les chiropraticiens étant les deuxièmes professionnels les plus consultés pour le traitement des PCD. Cependant, peu de choses sont connues sur l'offre et la demande en chiropraticiens, ainsi que sur les lacunes*

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Methods: *We designed an ecological study with 102 Canadian health regions as the unit of analysis. We will estimate derived and observed demand using the Canadian Community Health Survey data (2015/2016, 2021/2022), and supply using Canadian Chiropractic Association membership data (2021/2022). We will use spatial analyses to map the prevalence of cBP (derived demand), chiropractic utilization for cBP (observed demand), and chiropractor availability (supply) across health regions. Poisson regression models will assess the population factors associated with supply and demand-supply disparities.*

Conclusion: *The identification of geographical disparities in chiropractic care and the exploration of contextual factors associated with demand-supply dynamics may inform healthcare planning and resource allocation for the management of chronic back problems in Canada.*

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KEY WORDS: back pain, chronic back pain, chiropractor, chiropractor availability, ecological study

entre elles. Nous déterminerons la prévalence de la douleur chronique au bas du dos, l'utilisation de la chiropratique, la disponibilité des chiropraticiens dans les régions de santé canadiennes; nous calculerons une mesure de la demande et de l'offre et nous examinerons les caractéristiques liées à la demande et à l'offre.

Méthodes: Nous avons conçu une étude écologique avec 102 régions de santé canadiennes comme unité d'analyse. Nous estimerons la demande dérivée et observée en utilisant les données de l'Enquête canadienne sur la santé communautaire (2015-2016, 2021-2022), et l'offre en utilisant les données d'adhésion de l'Association chiropratique canadienne (2021-2022). Nous utiliserons des analyses spatiales pour cartographier la prévalence de la douleur chronique au bas du dos (demande dérivée), l'utilisation de la chiropratique pour la douleur chronique au bas du dos (demande observée) et la disponibilité des chiropraticiens (offre) dans les régions de santé. Les modèles de régression de Poisson évalueront les facteurs de population associés aux disparités entre l'offre et la demande.

Conclusion: L'identification des disparités géographiques dans les soins chiropratiques et l'exploration des facteurs contextuels liés aux dynamiques de demande et d'offre peuvent éclairer la planification des soins de santé et l'allocation des ressources pour la gestion des problèmes chroniques de dos au Canada.

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MOTS CLÉS : mal de dos, mal de dos chronique, chiropraticien, disponibilité du chiropraticien, étude écologique

Introduction

The Canadian healthcare system is facing significant challenges, particularly in providing adequate primary care and rehabilitation to individuals with chronic conditions such as back pain.[1] In 2015, most Canadians with chronic back problems (86.7%) reported receiving regular healthcare from medical doctors, while chiropractors are the second most common regularly consulted professionals, with 14.5% of those with chronic back problems seeking their care, ahead of physical therapists (10.7%) and nurses (6.6%).[2] However, the utilization of chiropractic services has remained stable over the past two decades.[2,3] This is relevant to today's primary care crisis because the engagement of a range of health care specialties is viewed as one solution to the unsustainable demand on the primary health care system.[4]

We have previously shown that chiropractic utilization by Canadians with chronic back problems varies significantly across provinces, ranging from 25.4% in Saskatchewan to 7.6% in the Territories.[2] Moreover, the utilization of chiropractors is associated with personal and contextual factors. For example, older individuals, women, those with lower socioeconomic status and individuals identifying with racial or ethnic groups other than European American, White, non-Hispanic White, or Caucasian are less likely to consult chiropractors.[2,5]

To date, little is known about regional variation in the demand-supply disparities for chiropractic services among Canadians with chronic back problems. Understanding regional variation is important because health regions within each province serve as geographic areas for planning, delivery, and funding of health services.[6] Therefore, understanding the demand and supply of chiropractic services at this level is crucial for decision-makers to make informed choices about the future of primary care in Canada.

Objectives

To better understand the regional variations in chiropractic supply and demand among Canadians with chronic back problems, we propose to conduct a national ecological analysis at the health region level across Canada. We focus on chiropractic care before (2015/16) and at the end of (2021/22) the COVID-19 pandemic. Specifically, our objectives are to: 1) determine and spatially map the prevalence of chronic back problems (derived demand), chiropractic utilization (observed demand), and availability of chiropractors (supply) across the country's health regions; 2) compute and geospatially map the demand-supply measure to quantify the unrealized demand (gap between derived demand and observed demand) given the regional supply for each health region; and 3) investigate which of the populations' aggregated characteristics are associated with supply and with the demand-supply measure at the health region level. By addressing these objectives, the study seeks to describe geographic disparities in chiropractic care availability and utilization and identify areas of high need or service gaps. Ultimately, these findings can inform healthcare policies and resource planning, potentially enhancing access to chiropractic care for all Canadians and contributing to improved health care delivery across the population.

Methods

This study will be reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.[7]

Study design

We designed a national ecological study to examine the demand and supply of chiropractic services at the health region level in Canada. Ecological studies are particularly suited for analyzing population-level relationships between exposures and outcomes, making this design appropriate for understanding the dynamics of chiropractic care across geographic regions. The study will use aggregated data to provide population-level estimates of demand (prevalence of chronic back problems and chiropractic utilization) for two time periods: before the COVID-19 pandemic (2015/16) and at the end of the pandemic (2021/22). The supply data (availability of chiropractors) is available only for the pandemic period (2021/22), but will be used as an estimate for the earlier time period also. This approach will allow for the identification of geographical disparities in chiropractic care and the exploration of contextual factors associated with demand-supply dynamics.

Setting

The Canadian Community Health Survey (CCHS) data is collected from individuals living in private dwellings in over 100 health regions covering all provinces and territories. These regions are geographic areas used for planning, delivering, and funding health services and will be defined using boundary files provided by Statistics Canada.[8]

Data sources

The study will utilize data from two national sources: the Canadian Community Health Survey (CCHS) and the Canadian Chiropractic Association (CCA) membership database. The CCHS provides self-reported information on chronic back problems and chiropractic utilization for 2015/16 and 2021/22. The CCA membership database provides information on the distribution of chiropractors across health regions for 2021/22.

Data access

We will access CCHS datasets through the Open Data Documentation, Extraction Service and Infrastructure

(Odesi) program and the Real Time Remote Access (RTRA) system by Statistics Canada.[9,10] Odesi is a Canadian social science data repository that provides access to more than 5,700 datasets, including Statistics Canada datasets, and is available free of charge at Ontario Tech University.

The CCA will provide postal code information reported by chiropractors that will be linked to the health region boundary files obtained from CCHS.

Participants

Participants in CCHS include Canadians aged 12 and over living in private dwellings. Participation in the survey is voluntary. Exclusions include persons living on reserves and other Aboriginal settlements, full-time members of the Canadian Forces, youth aged 12 to 17 living in foster homes, the institutionalized population, and persons living in specific Quebec health regions. Altogether, these exclusions represent less than 3% of the Canadian population. In CCHS, participants are selected using a multistage stratification strategy to provide reliable estimates at the health region level. The study will include data from approximately 130,000 participants per CCHS cycle, covering over 100 health regions.

The CCA membership data include participants who are members of CCA, covering about 85% of licensed chiropractors in Canada.[11]

Population size in health regions: The CCHS data includes a variable indicating what health region each respondent resides in. The region-specific population size, N, will be estimated by applying the population weights to a count of all respondents in that region.

Chronic back problems: In the CCHS, a chronic condition refers to a long-term condition that is expected to last, or has already lasted six months or more and that has been diagnosed by a health professional.[12] We will identify those who answered "yes" to the question: "Do you have back problems, excluding scoliosis, fibromyalgia and arthritis" as having chronic back problems.[13,14] Previous studies used this question to assess chronic back problems in the Canadian population.[2, 15-17]

Utilization of chiropractic services: We will measure the utilization of chiropractic services (yes or no) based on one question in the module of Primary Health Care: "Other than from your family physician/specialist/nurse practitioner/regular health care provider, who do you receive regular health care from?".[13,14] Discrete response options included: "Another family doctor or general practitioner, specialist doctor, nurse/nurse practitioner, chiropractor, registered dietician, pharmacist, physiotherapist, psychologist/mental health professional, and social worker".[13,14] For our project, we will identify respondents who reported receiving regular health care from a chiropractor as individuals with observed demand of chiropractor.

Conceptual framework

To better understand these variations, we use Andersen's Behavioural Model of Health Services Use for health service utilization. This model was developed to investigate the factors influencing healthcare utilization, evaluate disparities in access to health services, and inform policy-making to ensure equitable access to care.[18-20] The model systematically categorizes factors influencing healthcare use into three components: predisposing factors (e.g., demographic and social characteristics), enabling factors (e.g., income, availability of services), and need factors (e.g., perceived or actual health conditions).[18,21-23] The model is particularly valuable for its flexibility and applicability across diverse populations and settings. Additionally, the model differentiates between potential and actual access, providing deeper insights into the barriers to healthcare and the factors that facilitate the utilization of services.[21] It has been extensively validated in studies addressing various health conditions and healthcare systems, making it a robust model for analyzing disparities in access and utilization.[21]

Covariates

Based on previous research[2, 24, 25], data availability, and Anderson's Behavioural Model of Health Service Use[26,27], we hypothesize the following factors are associated with demand-supply measures. As the study is conducted at the health region level, we will aggregate all covariates at the regional level. The covariates will be grouped as follows as reported in CCHS and PUMF dataset:

i. **Predisposing factors:** Predisposing factors are individual characteristics that influence the likelihood of healthcare utilization, even before a health need arises. These include demographic and social characteristics.[18, 21-23, 28]

   Age: Proportion of individuals in different age groups

(i.e., 12 to 17 years, 18 to 34 years, 35 to 49 years, 50 to 64 years, 65 and older)

Sex and Gender: Proportion of male, female and gender diverse (only for gender) in the health region.

Immigration status: Proportion of individuals in each immigration status category (i.e., Landed immigrant / non-permanent resident; Non-immigrant [Canadian born]).

Cultural or racial origin: Proportion of individuals in each cultural or racial group (i.e., White; Non-White).

ii. **Enabling factors:** Enabling factors are the resources or conditions that facilitate or hinder access to healthcare services (e.g., income, living location).[18,21,22,28]

Household Income: Proportion of individuals in different income groups (e.g., No income or less than $20,000; $20,000 to $39,999; $40,000 to $59,999; $60,000 to $79,999; $80,000 to 99,999; $100,000 or more).

Province: Proportion of individuals in different provinces or territories. Provinces will be categorised into 10 provinces and aggregated territories (11 categories overall) as follows:

a) Provinces: Ontario, Quebec, Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick, Manitoba, Saskatchewan, Alberta, British Columbia.

b) Territories: Nunavut, Northwest Territories, Yukon Territory.

Geographic area: We will categorize the geographic area as urban, rural or both based on postal codes for each health region.

iii. **Need-related factors:** Need-related factors are the perceived or actual health conditions that drive individuals to seek healthcare services (e.g., Chronic illnesses, perceived general health status, and severity of symptoms).[18, 21, 22, 28]

General Health: Proportion of individuals in each health region reporting their perceived health as "Excellent," "Very Good," "Good," "Fair," or "Poor".

Chronic Conditions: Proportion of individuals reporting common chronic illnesses (e.g., diabetes, anxiety disorder, mood disorder such as depression, bipolar, mania, dysthymia) that are frequently associated with chronic low back pain and healthcare utilization.[29-31]

Outcomes

The primary outcomes for this study are derived demand, observed demand, supply, and the demand-supply measure of chiropractic care. To answer the following objectives of our study, we provide specific definitions for each of these terms.

Objective 1: Determine and spatially map the prevalence of chronic back problems (derived demand), chiropractic utilization (observed demand) and availability of chiropractors (supply) at the health region level.

Derived demand: This refers to the number of Canadians with chronic back problems per 100,000 regional population. The term "derived demand" acknowledges the population's fundamental demand for consumption of health services to maintain good health. This will be calculated as:

$$\textit{Derived demand, } D1 = \frac{m_1}{N} \times 100{,}000,$$

where m_1 is the regional number of individuals with chronic back problems, and N is the regional population size, both obtained as population weighted estimates from CCHS.

Observed Demand: This refers to the number of Canadians with chronic back problems utilizing chiropractic services per 100,000 regional population. This measure will be used to quantify to what extent the regional population's demands were realized (i.e., met the demands of the population). This will be calculated as:

$$\textit{Observed demand, } D2 = \frac{m_2}{N} \times 100{,}000,$$

where m_2 is the regional annual number of individuals with chronic back problems receiving regular care from chiropractors, and N is the regional population size, both obtained as population weighted estimates from CCHS.

Supply: This refers to the number of practicing chiropractors per 100,000 regional population in each of the 102 health regions. We will obtain this information from the CCA membership database. This measure provides information about the availability of chiropractors relative to the regional population size. This will be calculated as:

$$Supply,\ S = \frac{L}{N} \times 100{,}000,$$

where L is the regional number of practicing chiropractors in the health region identified by mapping postal codes onto health regions, and N is the regional population size obtained as population weighted estimates from CCHS.

Objective 2: In this objective, we aim to compute and geospatially map the demand-supply measure to quantify the unrealized demand. We will compute a measure of demand-supply to quantify the unrealized demand (gap between derived demand and observed demand) given the regional supply for each health region using the following formula:

$$\text{Demand-supply measure} = \frac{Derived\ demand - Observed\ demand}{Supply} = \frac{D_1 - D_2}{S}$$

Objective 3: In this objective we aim to investigate which of the populations' aggregated characteristics are associated with supply and with the demand-supply measure at the health region level.

Statistical analysis

We will use descriptive statistics to summarise the distribution of all variables across health regions. We will report the mean, standard deviation (SD), minimum, 25th percentile, median, 75th percentile, and maximum to provide a comprehensive summary of the data distribution across health regions. Geographic variations will be quantified using the coefficient of variation (CV), extremal ratio (maximum/minimum), and interquartile ratio (interquartile range/median).

We will create choropleth maps using ArcGIS Pro to visualise the derived demand, observed demand, chiropractor supply, and the demand-supply measure across health regions. Choropleth maps are thematic maps that use differences in shading or colouring to represent the magnitude of a variable across geographic areas.[32] These maps will help identify regions with high unrealized demand or potential service gaps.

Poisson regression models with log link functions will be used to assess the association between ecological predictors (covariates) and chiropractor supply, focusing on univariable models to evaluate the individual association of each covariate. The covariate for Province/Territories will be represented by 10 indicator variables (11 categories, so 10 indicators) with Prince Edward Island serving as the reference category since PEI contains only one Health Region.

The remaining covariates will be represented by the % of the population in the health region that falls within each category of a variable – e.g., % of the population female and % of the population male. Poisson regression models are suitable for count data, with the logarithm of the health region population size (e.g., log(N)) included as an offset. With a sample size of around 100 health regions, there are insufficient observations to build multivariable models including all covariates simultaneously and so we will model one covariate at a time to investigate associations between the covariate and outcome.

Poisson regression models with log link functions will also be used to assess the association between ecological predictors (covariates) and the demand-supply outcome with the outcome defined by m1 – m2 (number of people with chronic back problems not receiving regular care from a chiropractor) and offset variable logarithm of L (number of chiropractors). We will use the same approach to operationalize covariates as described for chiropractor supply and the analysis will focus on univariable models to assess the individual association of each covariate with the demand-supply measure.

Results from Poisson regression models will be presented as exponentiated regression coefficients with 95% confidence intervals, indicating the association of each factor with the outcomes.

Sensitivity analyses will be conducted to evaluate the robustness of results across different categorizations of covariates (e.g., single, multiple, and extreme categories) and model specifications (e.g., one, two, or three covariate categories). For categorical variables, sensitivity analyses will also assess the impact of using different definitions of extreme categories (e.g., logical extremes vs. regions with the highest and lowest proportions).

Strengths and limitations of the study

Our proposed study has the following strengths:

Comprehensive national scope: The study covers 102 health regions across Canada, providing a robust and detailed analysis of chiropractic care demand, supply, and disparities at a national level.

Theoretical framework: The use of Andersen's Behav-

ioural Model of Health Services Use provides a validated and systematic approach to understanding factors influencing chiropractic care utilisation.

Knowledge translation (KT) strategy: The study actively engages partners, including the national and provincial associations, ensuring that findings are relevant, actionable, and widely disseminated.

Our proposed study has limitations such as:

Self-reported data: The Canadian Community Health Survey (CCHS) relies on self-reported data, which may be subject to misclassification bias. This could affect the validity of the derived demand and observed demand measures.

Data availability for supply: Chiropractor supply data is only available for the 2021/22 period, limiting the ability to assess changes in supply over time or its relationship with demand during earlier periods.

Incomplete data on chiropractor availability: We only have about 85% of chiropractors in Canada. [11] Therefore, we will likely underestimate the supply and overestimate the gap between supply and demand.

Population exclusions: The CCHS excludes certain population groups, including persons living on reserves and other Aboriginal settlements, full-time members of the Canadian Forces, youth aged 12 to 17 living in foster homes, the institutionalized population, and persons living in specific Quebec health regions. These exclusions account for less than 3% of the Canadian population but may limit the generalizability of our findings to these groups.

Ethics

Ethical approval was obtained from the Research Ethics Boards (REB) at Ontario Tech University (File no 17688) and at Canadian Memorial Chiropractic College (Project # 232018). All data will be de-identified to ensure participant confidentiality. The CCHS data will be accessed through secure platforms, and de-identified chiropractor data will be provided by the CCA.

Knowledge Translation (KT)

We will use an integrated KT approach.[33] This approach is characterized by the active and continuous engagement of knowledge users as research partners throughout the research process. These partners were involved from the outset, including in the identification of the research questions, study design, and development of study objectives. Our approach focusses on the active engagement of knowledge users throughout the study. Specifically, we will collaborate with the Canadian Chiropractic Association (CCA), six provincial chiropractic associations (i.e., Ontario, Alberta, British Columbia, Quebec, Saskatchewan, and New Brunswick), and one Canadian chiropractic education institution (i.e., Canadian Memorial Chiropractic College). These partners will comprise our project's Advisory Committee, who will be consulted and updated about the project on a quarterly basis and engaged during critical decision points throughout the project.

We will work collaboratively with our Advisory Committee at each stage to co-develop knowledge products. At the completion of each objective, we will prepare evidence briefs which will serve as a medium to communicate our study results. The evidence briefs will be used to develop key messages, infographics and other communication tools with input from the Advisory Committee. We will also disseminate findings to the scientific community through peer-reviewed publications and presentations. At the end of the project, we will organize a conference for key national partners to engage in Human Resource Strategic Planning for the chiropractic profession. This conference will provide a platform for knowledge exchange, strategic planning of policy priorities, and address the workforce needs for chiropractic in Canada. Finally, we will disseminate our findings to the general public through lay language summaries, infographics, and webinars. Our free and accessible webinars will be organized by the Institute for Disability and Rehabilitation Research and made available to the chiropractic community at large.

Abbreviations

CCA: Canadian Chiropractic Association
CCHS: Canadian Community Health Survey
HR: Health region
Odesi: Open Data Documentation, Extraction Service and Infrastructure
RTRA: Real Time Remote Access
YLD: Year lived with disability

Ethics approval and consent to participate: The study protocol was approved by the Research Ethics Board at Canadian Memorial Chiropractic College (Reference # 232018 and Ontario Tech University (Reference # 17688)). Participation in the Canadian Community Health Survey (CCHS) is entirely voluntary, with informed consent obtained from all respondents by Statistics Canada. Under the Statistics Act, the agency is obligated to maintain strict confidentiality, ensuring that no information collected can be released in a manner that identifies individuals, businesses, or organizations unless the respondent provides explicit consent or disclosure is authorized by the Act.

Data sharing

CCHS data can be accessed at Statistics Canada's regional offices or data centers. A public-use file is also available, offering health data for regions across Canada while ensuring participants' privacy is protected.

Author contributions

Conceptualization: PC, DW, JW, SM, SHJ, JRT
Methodology: PC, DW, JW, SM, SHJ, JRT
Writing – Original draft: DW, JRT
Writing – Review and editing: PC, DW, JW, SM, SHJ, JRT

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A comparative audit of chiropractic geriatric courses taught at 17 English-speaking accredited chiropractic educational programs worldwide

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Introduction: *The objective of this study was to conduct a comparative audit of geriatric courses taught at English-speaking accredited chiropractic educational programs (CEPs) worldwide.*

Methods: *Using purposeful sampling course coordinators or administrators were asked to provide geriatric course outlines. Data on learning objectives, course structures and topical outlines were extracted, with data presented descriptively.*

Results: *Thirty-four CEPs were invited to participate and data sets of 17 CEPs (Australia, Canada, Puerto Rico, United Kingdom and the United States) were analyzed. All course content was delivered by lectures, the majority assessed students with written examinations and assignments and all teaching faculty were chiropractors. The five most taught topics were*

Un audit comparatif des cours de chiropratique gériatrique dispensés dans 17 programmes éducatifs chiropratiques accrédités anglophones à travers le monde.

Introduction: *L'objectif de cette étude était de réaliser un audit comparatif des cours gériatriques dispensés dans des programmes éducatifs chiropratiques accrédités de langue anglaise (PEC) à travers le monde.*

Méthodes: *En utilisant un échantillonnage intentionnel, les coordonnateurs de cours ou les administrateurs ont été invités à fournir des plans de cours en gériatrie. Des données sur les objectifs d'apprentissage, les structures de cours et les plans thématiques ont été extraites, des données étant présentées de manière descriptive.*

Résultats: *Trente-quatre PEC ont été invités à participer et des ensembles de données de 17 PEC (Australie, Canada, Porto Rico, Royaume-Uni et États-Unis) ont été analysés. Tous les contenus de cours ont été dispensés par des conférences, la majorité a évalué les étudiants par des examens écrits et des travaux, et tout le corps professoral était composé de*

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neurological disorders, chiropractic care, cognitive disorders, geriatric assessment and falls.

Conclusion: *We identified consistency between CEPs with respect to course delivery, assessment and faculty but there was a great deal of variability with respect to course topics. Further research to develop core competencies for geriatric chiropractic education is warranted.*

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KEY WORDS: audit, chiropractic, curriculum, education, geriatrics

chiropraticiens. Les cinq sujets les plus enseignés étaient les troubles neurologiques, les soins chiropratiques, les troubles cognitifs, l'évaluation gériatrique et les chutes.

Conclusion: *Nous avons identifié une cohérence entre les PEC en ce qui concerne la livraison des cours, l'évaluation et le corps professoral, mais il y avait une certaine variabilité en ce qui concerne les sujets des cours. Des recherches supplémentaires sont nécessaires en vue de développer les compétences de base en matière d'éducation chiropratique gériatrique.*

(JCCA. 2025;69(2):165-183)

MOTS CLÉS : audit, chiropratique, programme d'études, éducation, gériatrie

Introduction

2005 witnessed a watershed demographic event. For the first time in human history, the number of people over the age of 65 years exceeded the number of people under the age of 15 years in many countries, including Canada.[1] This 'grey tsunami' was the result of dramatic demographic changes, especially lower fertility rates and increasing life expectancy. Increases in life expectancy is attributable to a confluence of events including improvements in sanitation, improvements in nutrition, widespread use of vaccination and strides in the medical management of both historically fatal events (e.g. stroke, heart attack) and progressively debilitating conditions (e.g. cancer, diabetes).

The net effect of these improvements in health promotion and disease prevention initiatives is centenarians being the fasting growing segment of the population in many countries.[2] Undergirding these societal changes is the ageing of the Baby Boomers.

Born between 1946 and 1964 in the post-World War II Allied countries of Canada, Australasia, the United Kingdom and the United States, the Baby Boomers represent upwards of one-third of the population in these countries. Visually, this resulted in both the rectangularization and feminization of population pyramids, the later effect due to increased longevity among women compared to men (Figure 1).[2]

As an example, according to Statistics Canada, as of 2023, 7 million Canadians are over the age of 65 years, representing 18.9% of the population, up from 16.9% in 2016. At the higher end of life expectancy, 11.8% of Canadian are over the age of 85 and a startling 15.9% are over the age of 100.[2] Over the next 30 years, some

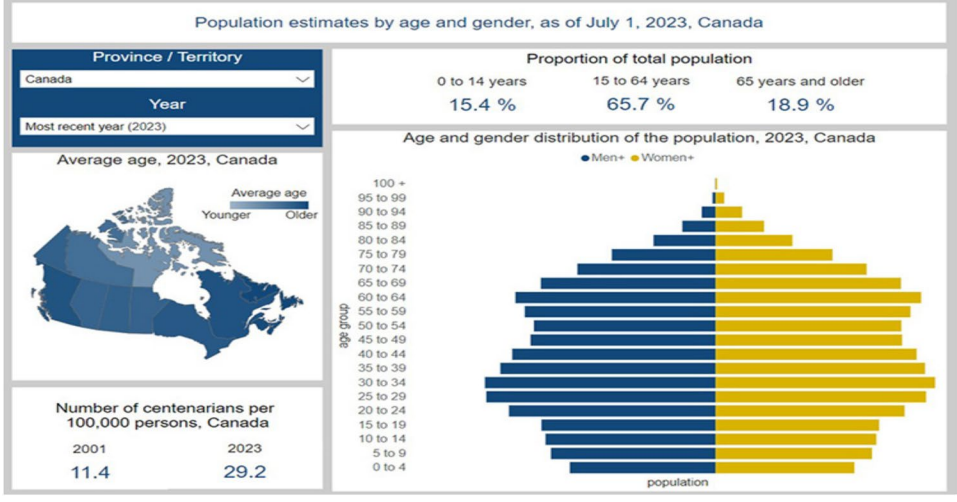

Figure 1.
Population estimates by age and gender, as of July 1, 2023, Canada [2]

of these numbers are expected to triple. Similar demographic trends are seen across developed nations with the percentage of elderly residents even higher in Japan and Southeast Asia due to very low fertility rates.

Research evidence reports older patients are motivated not only to live longer but to live better, to age successfully.[3] From a clinical perspective, this involves maintaining their activities of daily living in order to live independently[4], a key feature of what is referred to as 'active ageing'[5] or, more recently, to 'healthy ageing'[6]. Concurrently, demographic studies investigating practice patterns of community-based chiropractic practices report older patients predominately seek out chiropractic care for neuromusculoskeletal (NMSK) conditions within the scope of chiropractic practice, most commonly spinal pain.[7,8] Spinal pain is the most common cause of disability worldwide and, in regard to low back pain, has a peak prevalence and disability rates in adults from 80 to 85 years of age and is projected to continue to be a significant burden to healthcare in the future.[9] Spinal pain is a condition of healthcare which best aligns with chiropractic's cultural authority.[10,11]

Given these population dynamics and chiropractic practice profiles, a reasonable assumption would be that chiropractic educational programs (CEPs) are allocating considerable time in their curricula to this area of geriatric chiropractic education (GCE). Perhaps there would even be some degree of consistency among CEPs. However, there is evidence to suggest these assumptions are misplaced.

Accreditation boards, councils or agencies (hereafter collectively referred to as 'accrediting agencies') set quality standards in the form of minimal key, enabling or meta-competencies that educational programs must meet.[12-15] The intent of healthcare accrediting agencies is to provide guidance in informing a program's curricular content with the requisite knowledge, skills, attitudes and values that enables graduates to provide direct patient care without supervision.[12-15] In essence, these organizations attest to the educational quality of new and established educational programs. Only graduates from accredited educational programs are eligible for licensure in a jurisdiction that regulates the professions they externally validate.[12-15]

Chiropractic accrediting agencies typically set competencies or standards in areas such as neuromuscular expertise, health advocacy, technique and professionalism. However, a review of the accreditation standards for CEPs in Canada[12], Australasia[13], the United Kingdom[14] and the United States[15] revealed the complete absence of any specific mention of care of older patients (Table 1).

Only two accrediting agencies tangentially mention care of older persons. Metacompetency 3 (collaborator) from the Canadian Federation of Chiropractic Regulatory and Educational Accrediting Boards (CFCREAB) states chiropractors should be able to adopt to a "*variety of patient types and populations*".[12p6] The Council on Chiro-

Table 1.
Geriatric-Related Curricular Requirements from Canadian, American, Australasian and European Chiropractic Accreditation Agencies

Chiropractic Accreditation Agency	**Requirement with Respect to Care of Older Patient**
Canadian Federation of Chiropractic Regulatory and Educational Accrediting Boards, Entry-to-practice (2018)[12]	Metacompetency 3: Collaborator 3.1 Adapt to a variety of patient types and populations
Council on Chiropractic Education Australasia (2017)[13]	Practice Competency 4 (planning care) "…adopts practice according to varying patient needs across the human lifespan" Practice Competency 5 (implementing, monitoring and evaluating care: • Adopts interventions accounting for factors such as age, condition, health status…
European Council on Chiropractic Education, (2019)[14]	None
Council on Chiropractic Education Accreditation Standards, US (2018)[15]	None

practic Education Australasia's Practice Competency 4 (planning care) stated a chiropractor *"…adopts practice according to varying patient needs across the human lifespan"*[11p13] and Practice Competency 5 (implementing, monitoring and evaluating care) stated chiropractors adopt *"interventions accounting for factors such as age, condition, health status*" and other sociocultural characteristics.[13p14]

Coupled with our own experiences in chiropractic education we suspected this lack of guidance from accrediting agencies may have had the unintended consequence of each CEP developing its own geriatric course content. Indeed, this lack of GCE standardization was identified in a comparative audit published in 2009[16] discussed below. In turn, that audit cited previous attempts at GCE standardization a decade earlier.[17] However, to the best of our knowledge, no comparative audit of GCE has been conducted in the intervening years.

The objective of this study was to conduct a comparative audit of geriatric courses currently taught at English-speaking CEPs worldwide. The aim of this study was to describe the geriatric chiropractic curricula offered at these programs.

Methods

Since our study involved no human subject research it was granted ethics exemption by the IRB of Parker University (PUIRB- 2024-2).

Recruitment and sample

Leveraging our experience in the chiropractic educational ecosystem, we used purposeful sampling to contact faculty members or administrators at 34 accredited English-speaking CEPs (18 United States, six Australasian, five United Kingdom, two South Africa, one Canada, one Asian, one Central America) between May and December 2024. We asked to be referred to the person responsible for teaching geriatrics at their respective CEPs. Where no faculty member or administrators was known, we undertook an Internet search of accredited English-speaking CEPs hoping to identify the appropriate person teaching geriatrics. Once identified, individuals responsible for teaching geriatrics were contacted by email and invited to participate. If interested, they were sent 'Participation Information' and ethics exemption documentation and asked to read and sign the 'Consent to Participate' form. When potential respondents did not reply, we contacted them no more than three times. No compensation or incentives were offered to participate in our study.

Data collection and security

Upon consenting to participate, respondents submitted materials that included either a) their geriatric-related course, b) unit profile, or c) an outline of the geriatric-related content provided [Authors' note: some CEPs refer to their course outline as a unit profile]. Data was extracted and collated into pre-determined tables and anonymized by numerically coding each course outline in a non-alphabetical order in the order in which they were received. All data, along with participation information and consent forms, were stored on password protected computers, and the data was not shared externally from the research team.

Data analysis

Learning Objectives: Learning objectives (LOs), which were also often titled 'course objectives' or 'skills', were categorized together under LOs, and used to create a word cloud. The software tool used was WordCloud.com.[18] This is a web-based text visualization tools that generates word clouds based on the frequency of words given in a dataset. The platform supports direct text input or file upload and uses a built-in algorithm to analyze word frequency while allowing for customizable stop word removal. Users can adjust visual elements such as font, color, layout, and shape, though these features do not affect the underlying word frequency analysis.

The software does not perform qualitative coding or advanced linguistic analysis. The program serves as a visual tool to display term prominence. It is commonly used to complement qualitative research by providing an accessible summary of dominant language patterns. No local installation is required, and all processing occurred in the browser. In other words, a word cloud is a visual representation of terms (e.g. words, concepts, phrases) found in a data set: the relative size of each term is a reflection of the frequency of each term used in the data set which is, in turn, a reflection of each term's significance.

In our study, the goal of the word cloud was to accurately represent the core content of the LOs provided by participant CEPs visually, enabling emergence of key themes. This required removing the following non-content categories of word, high frequency filler words, gen-

eric educational phrases, Bloom's Taxonomy and course specific place holder terms. High frequency filler words included conjunctions (e.g. and, but), prepositions (e.g. in, with) and auxiliary verbs (e.g. is, will). Generic educational phrases such as "the student will be able to" and "demonstrate a knowledge of" are often used but do not reflect the course material under review. Bloom's Taxonomy words such as 'define' and 'analyze' were excluded since they also may not accurately reflect the course materials. Course specific place holder terms such as 'content', 'unit', 'assessment' and 'learning' were excluded. Lastly, the words were then revisited to correct misspellings and ensure uniformity in singular and plural terms as well as variations in spelling.

Course structure: The following pre-determined tables were used to categorize the course structure of the CEPs analyzed: delivery methods; direct contact time; assessment strategies; faculty credentials; required and recommended course material and; topical outlines. Following this, a table of topical outlines was created by reviewing materials and creating an alphabetized list for tabulation. This required higher categorization of course topics. For example, the topic category 'adverse drug reaction' also captured 'iatrogenic drug reactions' and 'polypharmacy'. Similarly, 'cognitive impairments' included 'cognitive decline', 'mental health illnesses' as well as 'dementia', 'delirium', 'depression' collectively referred to as the '3-Ds'.

Two members of our team met online to determine agreement on the categories and tables prior to data extraction and tabulation. One investigator (BJG) independently entered all data, and then a second investigator (KC) reviewed all course outlines against the table. A second online meeting was held to resolve discrepancies, with the primary investigator updating tables thereafter. This methodology mitigated any concerns with respect to investigator triangulation[19], increasing the study's dependability.[20]

Results

Of 34 CEPs invited to participate, 24 responded to the recruitment invitation. Of these, two CEPs declined to participate, and three CEPs agreed to participate but stated geriatric-related content was unable to be extracted from their curriculum (data was distributed among several

Table 2.
Course outlines analyzed from the following chiropractic educational programs (n=17).

Chiropractic Educational Program	**Country Located**
Australian Chiropractic College	Australia
Canadian Memorial Chiropractic College	Canada
Central Queensland University	Australia
Cleveland University	United States
D'Youville University	United States
Life University	United States
Life West University	United States
Logan University	United States
National University of Health Sciences – Florida	United States
Northeast College of Health Sciences	United States
Northeast College of Health Sciences	United States
Palmer College of Chiropractic– Davenport	United States
Parker University	United States
Teesside Chiropractic College	United Kingdom
Texas Chiropractic College	United States
University of Bridgeport	United States
Univeridad Central Del Caribe School of Chiropractic	Puerto Rico

courses or geriatric-related course content was currently under curricular review). As a result, those CEPs did not provide data for analysis.

In total, 19 CEPs provided geriatric-related materials. Upon review of the materials provided, we were unable to extract data for analysis from two CEPs, which were subsequently excluded from our study. Thus, data from 17 CEPs from the United States (*n=12*), Australia (*n=2*), United Kingdon (*n=1*), Canada (*n=1*), Puerto Rico (*n=1*) were analyzed.

Learning objectives

The LOs of 15 of the 17 participating CEPs were assessed. The output from the word cloud analysis can be found in Figure 2, where the most significant terms visualized were 'clinical', 'aging', 'management', 'conditions' and 'chiropractic'.

Course structure (Table 3)

Data extracted pertaining to the course structure of each CEP reviewed were tabled under the following sub-headings: course organization; total of contact hours; delivery methods; and; assessment strategies.

Course organization (Table 3)

In total, 15 of the 17 CEPs had a standalone geriatric course. Two other CEPs taught geriatrics within courses that also taught female care/obstetrics and pediatrics.

Figure 2.
Word Cloud of learning objectives of the 17 chiropractic educational programs audited in this study.

Table 3.
Course structure of each chiropractic educational program.

CEP	Standalone Geriatric Course	Total of Contact Hours*	Delivery Methods	Assessment Strategies
1	√	26	L	Q; W
2	√	N/A +	L	W
3	√	20	L	Q; W
4	√	20	L	A; W
5	√	30*	L	A; W
6	√	37	L; P	A; P; Q; W
7	√	26	L	A; W
8	√	28	L	Q; W
9		11	L	A
10	√	17	L; TBL	A; Q; W
11	√	14	L	A; CP; Q; W
12	√	24	L	P; Q; R; W
13	√	24	L	P; Q; W
14		16	L	W
15	√	15	L	A; CP; Q; W
16	√	20	L	F; W
17	√	15	L	A
* Does not include self-directed learning				
+ Delivered online asynchronously with no set time limit				
Abbreviations: A= Assignment; CEP = Chiropractic Educational Program; CP = Class Participation; F = Feedback; L = Lecture; P = Practical Lab; P = Project; Q = Quizzes; R = Referral List; TBL = Team Based Learning; and W= Written Examination				

Delivery methods (Table 3)

All CEPs delivered geriatric course content by lectures. One CEP also included a practical lab and one CEP included a three-hour Team Based Learning (TBL) session.

Direct contact time (Table 3)

Excluding contact hours designated as 'self-directed learning', the number of direct course contact hours for 16 CEPs varied between 11 and 26 (average to 21.4 hours) with one CEP delivering geriatric content online with no designated length of time for each lecture.

Assessment strategies (Table 3)

Among the 17 CEPs, seven different assessment strategies were identified. Fifteen CEPs used written examinations, and nine CEPs (although not the same nine CEPs) also used assignments or quizzes to assess students. Three CEPs used practical assessments, two CEPs used class participation, and two other different CEPs used either 'feedback' (no further information provided) or creation of a 'referral' list (no further information provided). Four CEPs used four different assessment strategies (two of these four CEPs used the same assessment strategies). One CEPs used three different assessment strategies. Seven CEPs used two assessment strategies, with two CEPs using the same two assessment strategies and another two CEPs using the same two (albeit two different) assessment strategies. Four CEPs only used one type of assessment strategy.

Faculty credentials and required and recommended course material (Table 4)

Table 4 presents the credentials of teaching faculty as well as required course and recommended course material used by the chiropractic educational programs reviewed.

Faculty credentials (Table 4)

Teaching faculty who delivered geriatric content at all CEPs were chiropractors, although at 13 CEPs the teaching faculty who delivered geriatric content held other advanced academic credentials.

Required or recommended course material (Table 4)

Eleven CEPs listed required course materials, and eight CEPs listed recommended course materials (e.g. textbooks, journal articles); however, there was very little consistency between CEPs. The most commonly required or recommended course material was the textbook on differential diagnosis by Souza *et al*[21] *(n=5)* followed by the Merck Manual[22] *(n=4)* and the textbooks by either Bougie and Morgenthal[23] *(n=3)* or Gleberzon *(n=3)*.[24] Different CEPs used different versions of either the Merck Manual or textbook by Souza. For the sake of brevity, we have provided one reference for each reference as an example of one of the versions used.

Topical outlines (Tables 5a-5h)

In total, 40 different topics across the 17 course outlines we audited were identified (Tables 5a-5h). No CEP taught all 40 topics; the highest number of topics covered at one CEP was 28 and only one other CEP taught at least half (*n=20*) of all identified topics. The average number of topics taught was 12.8. The most commonly taught geriatric-related topics were neurological disorders (*n=15*), chiropractic care, cognitive impairments, geriatric assessment and falls (each *n=12*), followed by musculoskeletal (MSK) disorders and normal ageing (each *n=11*). Four topics (housing/hospice care, the "I's", sleep disorders and visceral disorders) were taught at only one CEP.

Table 4.
Faculty credentials and required/recommended course material

CEP	Faculty Credentials	Required Course Material	Recommended Course Materials
1	DC; MA	Souza T. Differential diagnosis and management for the chiropractor	None listed
2	DC; DACBR	None listed	Physiological Basis of Aging and Geriatrics by Timiras
3	DC; BA	Essentials of Clinical Geriatrics, 8ed. Kane, Ouslander and Abrass	Merck Manual of Health and Aging, ISBN: 0-911910-36-0 Life University radiology handbook, 3755 Course Documents, BlackBoard
4	DC	Bickley LS. Bate's Guide to Physical Examination and History. Philadelphia, PA: Lippincott, Williams & Wilkins; Latest edition	Merck Research Staff. Merck manual professional version: geriatrics [Internet]. Rahway, NJ: Merck & Co. Inc. c2024. Bougie, J.D, Morgenthal, A.P. The aging body. NY: McGraw-Hill; 2001 Fulmer T, Peloton L. Age-friendly health systems: a guide to using the 4Ms while caring for older adults. Boston, MA: Institute for Healthcare Improvement. 2022 Gleberzon B.J. Chiropractic care of the older patient. Boston, MA: Butterworth-Heinemann; 2001 Kane, R.L. et al. Essentials of clinical geriatrics. 6th ed. NY: McGraw-Hill; 2009 Landefeld, C.S. et al., editors. Current geriatric diagnosis and treatment. NY: Lange Medical Books/McGraw-Hill; 2004

CEP	Faculty Credentials	Required Course Material	Recommended Course Materials
5	DC; BS	Differential Diagnosis and Management for the Chiropractor 5th edition. Souza. Jones & Bartlett Learning, 2016.	Adult – Gerontology Nurse Practitioner Certification Review Guide. 6th Edition. Miller. Jones & Bartlett Learning 2014 The Merck Manual of Geriatrics: 3rd edition. Merck Publishing Co., 2000 Chiropractic Care of the Older Patient: Gleberzon. Butterworth-Heinemann. 1998 Reichel's Care of the Elderly: Clinical aspects of Aging. 5th ed. Gallo, Lippincott, 1999 The Little Black Book of Geriatrics: 3RD ed. Onion. Jones and Bartlett. 2006 Geriatric Compass Notes: by James Van Wagoner. Published by National Board Specialists. Office Care Geriatrics: Rosenthal, Naughton, Williams: Lippincott, Williams & Wilkins. 2006. Fundamentals of Geriatric Medicine: edited by Cape, Coe, Rossman. Raven Press, 1983 Current Geriatric Diagnosis & Treatment:2014 Papadakis, McPhee, Rabow: Lange Medical Books. 2014 Primary Care Geriatrics: A Case-Based Approach. 2nd ed. Ham, Sloane. Mosby Year Book. 1992 Geriatric Physical Diagnosis: A Guide to Observation and Assessment: Williams, McFarland and Company, 2009
6	DC; MS; DACBSP	Rose DJ. Fall Proof! Human Kinetics, 2nd Edition 2010	None listed
7	DC; BA; MHSc	Dougherty P, Hawk C, Weiner CK, Gleberzon BJ et al. The role of chiropractic care in older patients. Chiro and Manal Ther 2012;20(1)	Several articles
8	DC	Chiropractic Care of the Older Patient: Gleberzon. Butterworth-Heinemann. 2001 Souza T. Differential diagnosis and management for the chiropractor	Other assignment readings
9	DC; MS DABCI	Seidel's Guide to Physical Examination by Jane W Ball, Jane W. Ball, John A. Flynn, et al.	
10	DC; BSc; MSc	None listed	None listed
11	DC; MPH; MS	Class notes	Bougie JD, Morganthal. *The Aging Body: Conservative Management of Common Neuromusculoskeletal Conditions,* AP, Mc-Graw Hill, New York, 2001 ISBN-13:9780838503317 Hooper PD, *A Baby Boomer's Guide to Aging and Ergonomics*, The WorkAbility Management Group, Diamond Bar, CA, 2007 Hooper PD, *Age-Proof Your House*, The WorkAbility Management Group, Diamond Bar, CA, 2008 Johnson C, Green BN, Davis JM, Cleveland CS. *Review Questions for the NBCE Examination*, Elsevier, St. Louis, 2006

CEP	Faculty Credentials	Required Course Material	Recommended Course Materials
12	DC; MS; DHED	None listed	None listed
13	DC PhD	None listed	None listed
14	DC	None listed	Bates' Guide to Physical Examination and History Taking 13th ed. Lippincott Williams & Wilkins, 2020. Differential Diagnosis and Management for the Chiropractor 5th ed Souza. Jones & Bartlett, 2016. Merck Manual of Diagnosis and Therapy, 19th ed. Merck & Co, 2011.
15	DC	Ham's Primary Care Geriatrics Subtitle: A Case-Based Approach 7th ed. ISBN: 978-0-323-721684 Authors: Warshaw G, Potter J, Flaherty E, Heflin M, McNabney M, Ham R Publisher: Elsevier Publication Date: 2021 Edition: 7th	None listed
16	DC, PhD	Souza, Thomas. Differential Diagnosis and Management for the Chiropractor, Protocols and Algorithms. Jones & Bartlett Learning LCC; 2016	Wyatt, Lawrence. Handbook of Clinical Chiropractic Care. Jones and Barlett Publishers; 2005. Biedermann, Heiner. Manual Therapy in Children. Churchill Livingstone; 2004.
17	DC; MPH; FHEA; FRSPH, FRCC	None listed	None listed

Abbreviations: BA (Bachelor of Arts); BS (Bachelor of Science); DACBSP (Diplomate of the American Chiropractic Board of Sports Physicians); DABCI (Diplomate of the American Board of Chiropractic); DACBR (Diplomate, American Chiropractic Board of Radiology);DC (Doctor of Chiropractic); DHED; Doctor of Health Education; FHEA (Fellowship of the Health Education Academy); FRCC (Fellow of the Royal College of Chiropractors); FRSPH (Fellow of the Royal Society for Public Health); MHSc (Master of Health Sciences); MPH (Master of Public Health; MS (Master of Science); PhD (Doctor of Philosophy)

Table 5a.
Geriatric course topics: adverse drug reactions to cardiovascular disease

CEP	Adverse Drug Reactions Ω	Ageism	Cancer	Cardiopulmonary Disease	Cardiovascular
1		√			
2	√			√	√
3					√
4		√			
5	√				√
6				√	√
7	√	√	√	√	
8				√	√
9					
10		√			
11					

CEP	Adverse Drug Reactions Ω	Ageism	Cancer	Cardiopulmonary Disease	Cardiovascular
12	√				
13					
14	√				
15			√		√
16			√		√
17					√
Ω Adverse drug reactions; iatrogenic drug reactions; polypharmacy; pharmaceutical concerns					

Table 5b.
Geriatric course topics: chiropractic care to diabetes

CEP	Chiropractic Care*	Cognitive Impairments+	Demographics	Dermatological Disorders	Diabetes
1	√	√			
2	√		√	√	√
3		√	√		
4	√				
5	√	√	√		
6		√			
7	√	√	√		√
8	√	√	√	√	
9		√		√	√
10	√	√	√		
11		√			
12		√			
13	√	√	√		
14	√				
15	√				
16	√				
17	√	√			
*Chiropractic Care includes: manual therapy; modifications to spinal manipulative therapy; Good Life with osteoArthritis Denmark (GLA-D); Lumbar Spinal Stenosis Boot camp; Chiropractic maintenance care					
+Includes Dementia. Delirium and Depression. Alternatively labelled as ‘mental health’ or ‘cognitive decline’					

Table 5c.
Geriatric course topics: elder abuse to funding sources.

CEP	Elder Abuse	Endocrine Disorders	Ethics/ Jurisprudence	Exercise/ Rehabilitation	Falls	Funding Sources
1	√		√		√	
2		√		√		
3	√		√		√	
4	√				√	√
5					√	√
6	√			√	√	√
7				√	√	
8				√		
9	√	√			√	
10			√	√	√	
11				√	√	
12					√	
13				√	√	
14						
15					√	
16				√		
17				√		

Table 5d.
Geriatric course topics: gastrointestinal disorders to hospice (end of life)

CEP	Gastrointestinal Disorders	Geriatric Assessment	Health Promotion/ Disease Prevention#	Housing/Home Care	Hospice (EOL)^
1		√	√	√	
2	√		√		
3					
4		√			
5		√			
6		√			
7		√	√		√
8	√	√			
9		√			√
10		√			
11		√			
12		√			

CEP	Gastrointestinal Disorders	Geriatric Assessment	Health Promotion/ Disease Prevention#	Housing/Home Care	Hospice (EOL)^
13		√	√		
14					
15					
16					
17		√			
# Alternatively labelled as: lifestyle factors; wellness					
^ EOL = End of Life					

Table 5e.
Geriatric course topics: "I's" to Nutrition.

CEP	'I's'§	Immobility	Instability>	'M's'<	MSKΦ	Neurological Disorders**	Nutrition
1					√	√	
2					√	√	√
3		√	√				
4				√			
5					√	√	
6			√		√	√	
7	√	√	√			√	
8			√		√	√	
9			√			√	
10		√	√		√	√	
11			√		√	√	√
12				√		√	
13			√		√	√	
14					√	√	√
15						√	√
16			√		√	√	√
17					√	√	
§ = Iatrogenic drug reactions; instability; immobility; intellectual impairment incontinence; isolation							
>Gait; Dizziness							
<Medication; mental health; mobility; what matters most							
Φ Includes scoliosis; 'orthopedic impairment'							
** Includes Parkinson's; multiple sclerosis; myelopathy							

Table 5f.
Geriatric course topics: Normal ageing to sex and sexuality.

CEP	Normal Ageing	Osteoarthritis λ	Osteoporosis	Sex and Sexuality
1				
2	√			
3	√			
4	√			
5	√			
6	√	√	√	
7	√	√	√	√
8	√	√	√	
9		√		
10	√	√	√	√
11				
12	√		√	
13		√	√	
14	√			
15				
16	√		√	
17				
λ Includes spinal stenosis				

Table 5g.
Geriatric course topics: sleep disorders to terminology.

CEP	Sleep Disorders	Special Needs++	Sociocultural issues^^	Terminology
1			√	
2				√
3				
4				√
5		√		
6				
7	√	√	√	√
8				

CEP	Sleep Disorders	Special Needs++	Sociocultural issues^^	Terminology
9		√		
10			√	√
11			√	
12			√	
13		√	√	
14				
15				
16				
17			√	
++ Persons with disabilities (in wheelchairs). One CEP listed 'social care' which we included here				
^^ Includes: social theories of ageing; economic challenges; diversity, inclusion and equity				

Table 5h.
Geriatric course topics: Theories of ageing to visceral.

CEP	Theories of Ageing	Types of Ageing	Urinary Incontinence	Visceral
1				√
2	√		√	
3			√	
4				
5	√			
6	√	√		
7	√	√	√	
8			√	
9				
10	√		√	
11	√			
12				
13				
14				
15				
16				
17				

Discussion

We found nearly all CEPs had a standalone geriatric course, and that all CEPs delivered geriatric course content by lectures. All lecturers were chiropractors, and two-thirds of these faculty members had other professional degrees. Almost all geriatric content was assessed with written examinations.

There was a high degree of variability of course topics identified, with 40 different topics across the 17 CEPs. There was also a great deal of inconsistency with respect to hours allocated for geriatric education and to both required and recommended course materials. Although certain generic geriatric-related words were highlighted in the word cloud presented above overall learning objectives and outcomes across institutions varied significantly, suggesting a lack of alignment and perhaps differing curricular priorities.

Some of the inconsistency in geriatric-related curriculum most likely originated from the late 1990s, where Hawk, Killinger and colleagues provided recommendations toward a 'model curriculum'. The purpose was to increase the breadth and depth of GCE based on a number of sources, including course syllabi provided by nine of 18 American chiropractic programs.[17] Later, in 2001 Hawk, Byrd and Killinger[25] sought to measure changes in students' attitudes toward care of older patients and interprofessional collaboration after participating in a course based on that model curriculum. Twenty students volunteered to enroll in the model curriculum course, compared to 197 students who attended the regular geriatric course offered by Palmer College-Davenport. Compared to their classmates, students enrolled in the model curriculum course demonstrated more positive attitudes toward older persons. Students in the model curricular course uniformly reported it was a positive experience especially with respect to experiential activities, lecturers provided by a variety of speakers from different professions (e.g. nurses, anthropologists), small group discussions and small class size.[25]

A decade later Borggren, Osterbauer and Wiles[16] conducted a 10 year follow up study of geriatrics course syllabi of 18 English-speaking chiropractic programs across North America. Borggen *et al*.[16] reported all courses were delivered by lectures (including guest lecturers), although a few also included practical demonstrations (*n=2*) and small group discussions (*n=2*). Of the 18 courses surveyed, 15 were taught by chiropractors (three were of unknown credentials based on the syllabus). There was a great deal of variability between assessment strategies, ranging from various activities, projects and presentations to quizzes and final written examinations. Lastly, geriatric courses tended to be taught later in the undergraduate program (for example, 5th to 8th trimester or 9th quarter).[16]

In comparison to Borggren *et al*.'s study where the number of hours of instruction varied between 8 and 48 hours (average 25.9 hours)[16], we found the number of direct course contact hours varied between 11 and 26 (average to 21.4 hours). What was new and novel, however, was one participant CEP in our study stated they delivered geriatric content exclusively online.

In our study, the five most commonly taught topics were neurological disorders, chiropractic care, cognitive disorders, geriatric assessment and falls. Borggren *et al*.[16] reported the five most commonly taught 'essential topics' (as they labelled them) were: pathophysiology of aging (*n=14*); normal aging, physiology and wellness (*n=13*); psychological and mental considerations (*n=9*); concurrent care planning (*n=9*) and; communication skills for providers (*n=8*). Their survey reported no respondent program taught elder abuse, where in our study, six CEPs taught it. Although Borggren *et al*. recommending more time be dedicated to GCE in general and more clinical experiences be included in course planning no specific recommendations were offered with respect to topics or core competencies.[16]

Studies on geriatric education for other healthcare providers

Specific core competencies, topics and enhanced skills that ought to be taught in family medical curricula was published in 2014. These recommended core competencies could serve as a template for the education of other healthcare providers involved in care of older patients, including chiropractic students (see Table 6).[26]

Although there have not been any updates to these recommended core competencies to date there have been other suggestions to enhance the education of healthcare providers working with older patients. In 2017, Tinetti and her colleagues[27] introduced the 5 Ms – mobility, medications, mind, multicomplexity and what matters most – as a simplified and focused framework to enhance education and training in geriatrics for medical students. This 5Ms

Table 6.
Recommended core competencies for family medicine geriatric curriculum[26]

A. Cognitive Assessment
B. Functional Assessment (Self-Care Capacity)
C. Falls, Balance, and Gait Assessment
D. Medical Management
E. Biology of Aging and Atypical Presentation of Disease
F. Adverse Events and Safety
G. Incontinence
H. Transition of Care
I. Healthcare Planning
J. Professionalism
K. Communication
L. Research

framework was used to update and organize the Minimum Competencies in Geriatric for Medical Students in 2021.[28] Soon thereafter Goldberg *et al*.[29] used a 4Ms framework (mind/memory, medications, mobility and what matters most) for an interactive, skills-based session for second year medical students. Lastly, Glassburn *et al*.[30] successfully used a short-term curricular model for advanced learners in geriatric team care settings that focused on five areas of concern: medical management, dementia, depression, falls and myths about ageing. Our audit revealed two CEPs structure their geriatric chiropractic curriculum around the '4M' model (see Table 5e).

Possible implications to clinicians

The lack of consistency revealed in our comparative audit with respect to delivery methods, assessment strategies and required and recommended course material probably have very little impact on the knowledge base or skill level required of clinicians to competently treat their geriatric patients; however, it is certainly possible that the lack of consistency of topics covered between CEPs could impact a clinician's knowledge or skill level.

We propose a model chiropractic educational program regarding older patients worldwide to improve the knowledge base of chiropractic students and, by extension, chiropractors, enhancing patient care for not only the largest growing segment of the population, but 16% of chiropractic patients.[8] Another collateral benefit of improved GCE could enhance opportunities for chiropractors to work collaboratively with other stakeholders, such as medical doctors, geriatricians, nurse practitioners and social workers in the geriatric care milieu, including hospitals, outpatient clinics and long-term care facilities. Ultimately, this may fortify the profession's cultural authority as spinal pain experts, particularly for older persons.

Strengths, weaknesses and limitations of this study

A strength of our study was it included data from 17 CEPs worldwide (Figure 3). This enabled us to conduct a robust and comprehensive comparatively audit of English-speaking accredited CEPs. However, a weakness of this study was we only included English-speaking CEPs; it is possible the inclusion of non-English speaking CEPs would alter our results with respect to topics delivered, percentage of topics taught, characteristics of teaching faculty, delivery methods, types of assessment strategies used, required and recommended course material and the appearance of the word cloud.

Our study was limited due to course outlines submitted for our review represented a 'snapshot' in time. Indeed, several participating CEPs informed us their curricula in general - and the geriatric course in particular - were undergoing review. Another limitation in our study is we could not know if other geriatric-related content was taught in other courses in a particular CEP on an *ad hoc* basis. For example, recommendations to modify high velocity low amplitude-spinal manipulative therapy (HVLA-SMT) for older, frail patients may be taught in technique classes and recommendations for certain exercise targeting older patients may be taught in rehabilitation courses.

The description of topics covered in some of the course outlines were vague. It is therefore possible we misinterpreted them. It is also possible we erred during our strategy to amalgamate a variety of topics into a single topic as we did for 'adverse drug reactions' and 'cognitive impairments'.

It is quite possible course outlines submitted did not include all topics covered. For example, we know of certain geriatric courses analyzed in this study that teach breaking bad news, chiropractic management of non-NSMK conditions (e.g. gastrointestinal reflux disorder) and fibromyalgia but these were not listed in the course out-

line submitted. Similarly, we believe it is unlikely that all CEPs did not devote class time to the topics of geriatric assessment, falls and modification to chiropractic treatment, and yet not our data does not reflect that. To address this limitation we could have contacted each course coordinator and ask them to clarify if topics other than those in the course outline were discussed in class; however, we resisted the temptation to do so since we feared they might feel pressured to state they did in fact discuss this or that topic if even tangentially, lest they give the appearance their course is not comprehensive.

Lastly, it is possible our study suffered from a lack of either method or investigator triangulation[19] but we believe this was sufficiently mitigated by having three authors interpret the data and contribute to the drafting of this manuscript.

Implications for future research

The data generated from this comparative audit may help individual course coordinators improve their respective geriatric courses by adopting topics, delivery methods or assessment strategies they may not have otherwise considered adopting. This data could also be used to: (i) enhance the metacompetencies required by accrediting agencies for chiropractic geriatric courses; (ii) ensure chiropractic geriatric curricula align with core competencies recommended for family medicine curricula and (iii) lead to the development of a model chiropractic geriatric curricula for chiropractic educational programs worldwide.

In order to develop a model chiropractic geriatric curricula, we envision adopting the same methodology Hawk *et al*.[31] used during the development of clinical practice guidelines for the role of chiropractic care in providing health promotion and clinical preventive services for adult patients with MSK pain. It is recommended a multidisciplinary steering committee combine the results of this study with a systematic review of the geriatric literature and draft a set of recommendations for standardized geriatric chiropractic education. A Delphi panel comprised of experienced practitioners and teaching faculty who specialize in geriatrics as well as other subject matter experts would then be tasked with rating these recommendations using a consensus-based methodology such as the one established by the RAND corporation/University of California and develop core competencies and essential curricular topics. These findings could then be compared to existing syllabi to identify any gaps or redundancies. A draft consensus statement would then be generated and distributed to the Delphi panel for final approval prior to publication.[31]

Conclusion

We analyzed course outlines submitted by 17 English-speaking CEPs. There was consistency with respect to teaching faculty, methods of course delivery and assessment strategies; however, we found a great deal of variability between learning objectives and a lack of consistency in required or recommended course resources. More importantly, we found a high amount of variability with respect to topics presented at each CEP reviewed. More research, including the standardization of geriatric curriculum, in this vitally important aspect of chiropractic education is warranted.

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Patient self-reported musculoskeletal symptoms before and after the interruption of chiropractic care during the COVID-19 lockdown in Ontario, Canada: a retrospective case series

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Purpose: *To describe characteristics and course of chiropractic patients' self-reported musculoskeletal (MSK) symptoms following interruption of chiropractic treatment during the COVID-19 lockdown.*

Methods: *Using a retrospective case series design, patient demographic, clinical and patient-reported clinical outcomes variables were abstracted from electronic health records of patients attending a chiropractic teaching clinic. We measured self-perceived changes in symptoms cross-sectionally at each of two time points: before and after the COVID-19 lockdown.*

Results: *133 of 184 patients were eligible. Most had comorbidities and treatment for multiple MSK diagnoses*

Les patients ont signalé eux-mêmes des symptômes musculo-squelettiques avant et après l'interruption des soins chiropratiques pendant le confinement lié à la COVID-19 en Ontario, Canada: une série de cas rétrospective.

But: *Décrire les caractéristiques et l'évolution des symptômes musculo-squelettiques (MSK) auto-rapportés des patients chiropratiques suite à l'interruption du traitement chiropratique pendant le confinement lié à la COVID-19.*

Méthodes: *En utilisant un design de série de cas rétrospective, les variables démographiques des patients, cliniques et les résultats cliniques rapportés par les patients ont été extraites des dossiers de santé électroniques des patients fréquentant une clinique d'enseignement chiropratique. Nous avons mesuré les changements auto-perçus des symptômes de manière transversale à deux moments : avant et après le confinement dû à la COVID-19.*

Résultats: Au total*133 des 184 patients étaient éligibles. La plupart avaient des comorbidités*

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pre-lockdown. Based on patients' self-perception, 17% improved (vs 77% pre-lockdown), 23% did not change (vs 17% pre-lockdown) and 43% worsened (vs 5% pre-lockdown) in MSK symptoms during lockdown. Those reporting worsening post-lockdown had more treatments, longer period of treatment time pre-lockdown, and more severe pain (mean: 7/10) post-lockdown. Upon clinic reopening, 47% of patients returned for care, more often reporting worsened MSK symptoms and higher average pain score (6.2/10) than non-returning patients (3.9/10).

Summary: *Some patients experiencing interruptions in chiropractic care during COVID-19 lockdown returned with worsened MSK symptoms, while others showed improvement and did not return to clinic. Our study helps generate future research hypotheses regarding the contribution of chiropractic treatment (e.g., during pandemics).*

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KEY WORDS: chiropractic, COVID-19, musculoskeletal pain, patient outcomes, treatment interruption, case series

et suivaient un traitement à la suite de plusieurs diagnostics musculo-squelettiques avant le confinement. Selon l'auto-perception des patients, 17 % se sont améliorés (contre 77 % avant le confinement), 23 % n'ont pas changé (contre 17 % avant le confinement) et 43 % se sont détériorés (contre 5 % avant le confinement) en ce qui concerne les symptômes musculo-squelettiques pendant le confinement. Ceux qui signalent une aggravation après le confinement avaient plus de traitements, une durée de traitement plus longue avant le confinement et une douleur plus sévère (moyenne : 7/10) après le confinement. À la réouverture de la clinique, 47 % des patients sont revenus pour des soins et ont le plus souvent signalé une aggravation des symptômes musculo-squelettiques et un score de douleur moyen plus élevé (6,2/10) que les patients qui ne sont pas revenus (3,9/10).

Résumé: *Certains patients ayant connu des interruptions dans les soins chiropratiques pendant le confinement lié à la COVID-19 sont revenus avec des symptômes musculo-squelettiques aggravés, tandis que d'autres ont présenté une amélioration et ne sont pas retournés à la clinique. Notre étude aide à élaborer de futures hypothèses de recherche en ce qui concerne la contribution du traitement chiropratique (par exemple, pendant les pandémies).*

(JCCA. 2025;69(2):184-202)

MOTS CLÉS : chiropratique, COVID-19, douleur musculosquelettique, résultats des patients, interruption de traitement, séries de cas

Introduction

Chiropractors manage a range of musculoskeletal (MSK) conditions, including musculoligamentous sprains and strains, joint dysfunctions, disc injury, radiculopathy and peripheral nerve entrapments.[1,2] MSK conditions constitute a significant burden on the global population, economy and health care resources.[3–5] These conditions are affected by various biopsychosocial factors that can contribute to disability and influence recovery, and thus such factors should be addressed in management plans.[6] The management of MSK conditions, especially in patients with multiple co-morbidities and chronicity, often involves multimodal interventions, including non-pharmacological treatments that may require in-person care, such as chiropractic care, with variable treatment outcomes.[6,7,8]

At a Canadian Memorial Chiropractic College (CMCC) chiropractic teaching clinic, which is part of the Academic Family Health Team in the Department of Family and Community Medicine (AFHT) at St. Michael's Hospital (SMH) in Toronto, Ontario (the Clinic), referred patients (from approximately 50,000 rostered

with the Department) receive multimodal treatments provided by supervised chiropractic interns, addressing symptoms ranging from vertigo to toe numbness. While the patient population represents a variety of socioeconomic backgrounds, the hospital's catchment area includes low socioeconomic districts; approximately 30% of patients are in the lowest income quintile.[9] The majority of patients present with comorbidities, which may[10–13] or may not[14] impact their pain experience and disabilities related to their MSK conditions. This population includes those likely to have had chronic conditions or disabilities with unmet rehabilitation needs attributed to the COVID-19 pandemic.[15,16]

During the COVID-19 pandemic of 2020, chiropractic care in Ontario was deemed a non-essential service by the government.[17] Thus, except for the provision of telehealth and "urgent care," chiropractic clinics were unable to open and remained in "lockdown" from March 16 until it was rescinded on May 26, 2020.[18] Patients who would have otherwise sought chiropractic treatment were left to manage with medications, exercise, and self-care strategies, which may have been part of a comprehensive plan of management even when clinics were open. The Clinic gradually resumed a hybrid of telehealth and in-person patient care on August 5, 2020. However, little is known about how chiropractic patients with MSK conditions managed during the lockdown period.

Manhapra *et al*.[19] reported that, despite decreased utilization of healthcare services, including undescribed physical and rehabilitative therapies, respondents aged over 64 years enrolled in the American National Health Interview Survey reported no worsening of their usual pain. However, Bailly *et al*.[20] found that 41% of chronic low back pain patients reported worsening during the lockdown. Similarly, a systematic review investigating the impact of COVID-19 lockdown restrictions on MSK disorders found that, compared to pre-pandemic assessments, individuals with MSK disorders experienced reduced quality of life, increased pain, and a higher prevalence of MSK injuries.[21] Another systematic review of cross-sectional studies conducted worldwide found that overall, the prevalence and incidence of MSK disorders increased as a result of COVID-19 lockdowns.[22] However, none of these reviews included studies focused on chiropractic patients, nor were any of them conducted in Canada.

While these findings highlight the broader impact of the pandemic on MSK disorders, studies specifically examining chiropractic practices during the COVID-19 lockdowns have been limited. To our knowledge, COVID-19 related chiropractic research has primarily focused on changes to care delivery and practice processes.[23–25] In summary, about half of the surveyed chiropractic practices continued to offer in-person care, employing enhanced public health measures such as using personal protective equipment during patient encounters and disinfecting all contact surfaces. A smaller portion reported incorporating telehealth services for patients. However, the course of the patients' MSK conditions during the lockdown period was not reported.

Hence, little is known about how COVID-19 impacted individuals with MSK conditions living in Canada. In particular, it is unknown what effect, if any, the interruption of chiropractic treatment had on the course of MSK conditions during the COVID-19 lockdown. Documenting patients' self-management regimens during the untreated period caused by the pandemic and comparing their outcomes to those experienced previously while receiving treatment could help generate hypotheses regarding the contribution of passive chiropractic treatment (manual therapy, electrotherapy or thermal-based modalities) to their management.

Therefore, our study examined the course of chiropractic patients' self-reported MSK symptoms following prolonged withdrawal of passive chiropractic treatment during the lockdown of "non-essential" clinics. Specifically, our research objectives were to: 1) describe the course of MSK symptoms status (improved, no change, worsened) in patients post-lockdown; 2) compare demographics, comorbidities, self-management strategies during lockdown, and chiropractic treatment pre-lockdown (type, frequency, duration) among groups of patients who worsened, felt no change, or improved with regards to their pre-lockdown MSK diagnoses; and 3) compare demographics, comorbidities, diagnoses, chiropractic treatment pre-lockdown, self-management strategies, pain post-lockdown and course of symptoms during lockdown among groups of patients who chose to return for chiropractic treatment post-lockdown and those who did not. Given the paucity of literature about the course of MSK conditions during lockdown, we made no assumptions about which patient characteristics or outcomes

would impact course of symptoms. Instead, we took an exploratory approach to address the knowledge gap regarding the impact of COVID-19 lockdown on MSK disorders in chiropractic patients in Canada. The intent of our research is to inform future hypotheses regarding the course of MSK symptoms and role of chiropractic care during pandemics.

Methods

Study design

We conducted a retrospective case series study using patient files of the Clinic. This design allows for a detailed description of the characteristics and outcomes of the clinic patients who faced interruptions in their chiropractic care during the COVID-19 lockdown.[26]

Study setting

After the COVID-19 clinic lockdown (March 16 – August 5, 2020), it was necessary to implement a gradual re-opening of the Clinic. Patient volumes were restricted to accommodate for social distancing and sanitation procedures. Re-opening procedures were to initially assess patients virtually and then to engage in in-person visits. To determine which patients would be prioritized for return to the restricted (in terms of numbers of health care providers, support staff and patients attending at any given time) in-person services, a triage approach was utilized.

In late July 2020 prior to the Clinic reopening, chiropractic interns tried to contact the pre-lockdown patients and used a standard script (Appendix 1) for triaging those who were contacted, then arranged with the patient to conduct a re-assessment based on their reported MSK health status. Based on the information gathered from this initial contact, patients were categorized based on their self-reported MSK health status during the clinic closure period: those who worsened, felt no change, or improved in relation to their pre-lockdown MSK diagnoses. Any new symptoms arising during the lockdown were classified in one of two ways: if the symptom was related to a pre-lockdown condition (e.g., new radiation of low back pain to the buttock), it was considered a worsening of that pre-existing condition; otherwise, it was classified as a new symptom. Patients were also asked if they intended to return for treatment at the Clinic and their responses were recorded in their electronic health record (EHR).

Triaging was based upon the self-reported health status of the patient's MSK condition during the lockdown period. Those patients whose self-reported health status had worsened were categorized as "worsened" and offered a re-assessment appointment. Those whose self-reported health status had remained unchanged were categorized as "no change" and advised to continue with their self-management strategies, as their condition did not deteriorate despite a withdrawal of passive treatments. Finally, those with a self-reported health status that had improved were categorized as "improved" and advised to continue with their self-management strategies excluding passive clinic-based treatments. However, patients in the latter categories who requested return to clinical care were also given appointments for re-assessment, but appointments were prioritized for patients returning with worsened symptoms. Upon re-assessment, chiropractic interns followed a standard approach to examination of patients' MSK complaints and included specific questions related to their MSK health status during the pandemic lockdown (Appendix 2).

Study participants

We included all patients scheduled (whether for new assessments or subsequent treatments) at the Clinic between January 2, 2020, and March 16, 2020, and who were triaged upon the clinic's re-opening. We excluded patients lost to follow-up, patients discharged from the Clinic before March 16, 2020, patients presenting with different complaints than pre-lockdown, new patients (as of August 5, 2020), and existing patients who returned to the Clinic after October 31, 2020. In so doing, we aimed to follow the patients' pre-lockdown MSK conditions.

Data collection

We abstracted data directly from each eligible patient's electronic health record (EHR). Specifically, based on our defined objectives, we extracted and described related variables including demographic, clinical and patient-reported clinical outcomes characteristics (see Table 1). Data were recorded using specifically designed data collection forms that were pilot tested to ensure comprehension and ease of data abstraction by the research assistants.

Table 1.
Data collected from the patient electronic health record (EHR).

Variable	**Collected information from EHR**
Demographics	Age, sex
Pre-lockdown MSK diagnoses	Record the musculoskeletal diagnoses: • Mechanical neck pain (Cervicothoracic sprain/strain, WAD) • Mechanical back pain (Thoracolumbar sprain/strain, Lumbopelvic sprain/strain, SI dysfunction) • Cervicogenic headaches • Tension-type headaches • Migraines • Myofascial pain • Degenerative disc disease/Degenerative joint disease • Thoracic Outlet Syndrome • Spinal central/lateral recess stenosis • Shoulder strain • Radicular pain • Hip strain • Knee strain • Disc herniation/irritation • Temporomandibular joint disorder • Lower limb strain • Upper limb strain • Neurogenic claudication • Bursitis • Piriformis/Gluteal strain • Frozen shoulder • Costovertebral strain/sprain • Subacromial impingement/bursitis
Duration of symptoms	Calculate the number of days of symptoms
Date of initial visit	Enter the date of the patient's first visit
Number of treatments	Indicate how many treatments the patient received
Duration of treatment	Specify the total duration of treatment in days
Treatments received	Record the treatments the patient received at the Clinic (e.g., exercise, mobilization, manipulation, soft tissue therapy, modalities, etc.)
Outcomes of pre-lockdown treatment	Record the outcome of treatments received (no change, worsening, improving, resolved)
Comorbidities	Record the comorbidities categorized using the International Classification of Diseases 11th Revision.[29] We counted the types of comorbidities per patient, rather than the actual numbers of comorbidities (e.g., a patient could have more than one endocrine comorbidity).
Self-reported management during lockdown	Record how patients managed their conditions during lockdown (exercises, thermal applications, medications, emergency room visit, surgery, etc.), assumed to be for the same conditions diagnosed and treated at the Clinic pre-lockdown.

Variable	Collected information from EHR
Post-lockdown pain severity	Record the severity of pain that was reported verbally on an 11-point Numeric Pain Rating Scale (NPRS)[27]
Course of symptoms between closure and return to clinic	Record how symptoms changed during this period: improved, no change, worsened
Date of return to clinic	Record the date if the patient returned to the clinic
Change in diagnosis/plan/prognosis post-lockdown	Record any changes made post-lockdown
Reason for not returning to clinic post-lockdown	Collect reasons described in chart, if applicable

Two research assistants were trained in data abstraction by the senior investigators. To ensure consistency of data abstraction, 20% of the abstracted files were re-abstracted by the other assistant, reviewed and compared by the investigators for consistency. Any discrepancy in data abstraction was discussed between abstractors and the investigators so that a mutual approach could be applied during formal abstraction of the data.

Abstracted data were de-identified and stored on a secured SMH server accessible only to SMH registered personnel. The patient's file number was linked to a unique study identifier accessible by two of the investigators, stored in a separate file, and destroyed at the end of the study.

Data analysis

For Objective 1, we described patients' course of MSK symptoms during the COVID-19 lockdown and the characteristics of the overall sample by reporting frequencies and percentages for categorical variables, and means and standard deviations for continuous variables. In addressing Objective 2, we used select patient (sex, age) and clinical (diagnoses, symptom duration, treatment and outcomes) characteristics and compared them between groups defined by their reported course of MSK symptoms (worsened, no change, or improved) during the COVID-19 lockdown. For Objective 3, we compared the select patient characteristics by their clinic return status. We used contingency tables and chi-square tests to compare categorical characteristics, allowing for the possibility of nonlinear patterns in multi-category variables. We used analysis of variance (ANOVA) for characteristics measured on a continuous scale. A significance level of 0.05 was used to indicate statistically significant differences in proportions or means. We did not use imputation for missing data.

Ethical approvals were obtained from the Research Ethics Boards of St. Michael's Hospital (REB # 21-224) and Canadian Memorial Chiropractic College (REB #2112X02).

Results

Of 184 patients of the Clinic as of January 2020 (pre-COVID-19 lockdown), 12 patients' EHR had been inactivated (e.g., if a patient had passed away, moved away, were no longer patients of the AFHT), and of the remaining 172 patients, 39 did not meet inclusion criteria. (See Figure 1). Thus, a total 133 files were included in this study. We present summarized results for categories with cell sizes ≥5, with full data available (on request to the corresponding author) in a supplementary document.

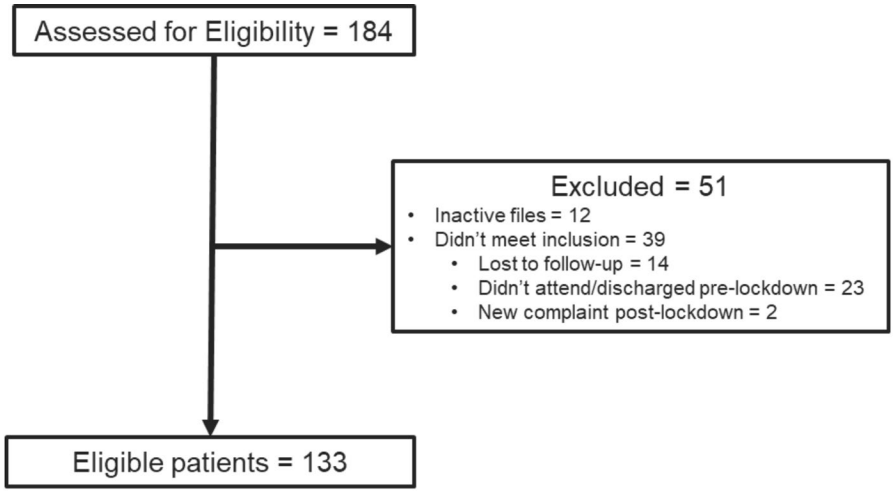

Figure 1.
Study patient flow.

The included 133 patients had a mean age of 56 years and 54% were female. Pre-COVID, most patients had at least one comorbidity, most commonly disorders of the endocrine/nutritional/metabolic (55%) and mental/behavioural/neurodevelopmental (44%) systems (Table 2). They were mostly being treated for chronic conditions, with symptoms having a median duration of over two years, for up to seven MSK diagnoses; 29% had one diagnosis, 31% had two, 22% had three, and 15% had four diagnoses. The most common diagnoses were mechanical back pain (62%) and cervicothoracic sprain/strain (42%) or its variants (e.g., mechanical neck pain, Whiplash Associated Disorder 2 [WAD2]).

Pre-lockdown, the median number of patient visits was 14 and were provided over a median of 104 days (Table 2). The most common treatment modalities used

Table 2.
Characteristics of patients in case series (n=133)

Characteristics	**Frequency (%)**
Demographic	
Sex	
Female	72 (54%)
Age in years: mean (SD), median (IQR)	56 (17), 58 (23)
Pre-COVID Lockdown MSK Diagnosis	
Number of diagnoses	
1	39 (29%)
2	41 (31%)
3	29 (22%)
4	20 (15%)
5 – 7	4 (3%)
More common MSK diagnosis	
Mechanical neck pain (Cervicothoracic sprain/strain, WAD)	56 (42%)
Mechanical back pain (Thoracolumbar or lumbopelvic sprain/strain, SI dysfunction)	82 (62%)
Extremity Strain	58 (44%)
Headaches (cervicogenic, tension-type, migraines)	14 (11%)
Myofascial pain	24 (18%)
Degenerative disc disease/Degenerative joint disease	12 (9%)
Thoracic Outlet Syndrome	7 (5%)
Spinal central/lateral recess stenosis	11 (8%)
Shoulder pain (shoulder strain, subacromial pain, frozen shoulder)	24 (18%)
Radicular pain	8 (6%)
Other	15 (11%)
Duration of symptoms in days (N=130): mean (SD), median (IQR)	2449 (3445), 779.5 (2687)
Pre-COVID Lockdown - Comorbidity	
Certain infectious or parasitic diseases	28 (21%)
Neoplasms	26 (20%)
Diseases of the blood or blood-forming organs	20 (15%)
Endocrine, nutritional, or metabolic diseases	73 (55%)
Mental, behavioural or neurodevelopmental disorders	58 (44%)

Characteristics	Frequency (%)
Sleep-wake disorders	33 (25%)
Diseases of the nervous system	53 (40%)
Diseases of the visual system	25 (19%)
Diseases of the circulatory system	56 (42%)
Diseases of the respiratory system	35 (26%)
Diseases of the digestive system	68 (51%)
Diseases of the skin	27 (20%)
Diseases of the musculoskeletal system or connective tissue	82 (62%)
Diseases of the genitourinary system	37 (28%)
Other	29 (22%)
Pre-COVID Lockdown - Treatment Details	
Treatment/management	
Spinal Manipulation	94 (71%)
Spinal Mobilization	127 (95%)
Soft Tissue Therapy	132 (99%)
Thermal/Energy-Based Modalities	19 (14%)
Electrotherapy modalities	7 (5%)
Biomechanical support (e.g., brace, orthotics, etc.)	11 (8%)
Exercise	131 (98%)
Education	132 (99%)
Number of treatments: mean (SD), median (IQR)	41 (64), 14 (34)
Duration of treatment in days (N=132): mean (SD), median (IQR)	394 (644), 104 (369)
Outcomes of treatment pre-COVID lockdown	
No Change in Symptoms	22 (17%)
Symptoms Worsening	7 (5%)
Symptoms Improving	90 (68%)
Symptoms Resolved	12 (9%)
Not Applicable	2 (2%)
COVID-19 Lockdown – Self-Management	
Pharmacological treatments	32 (24%)
Other Manual Therapist	4 (3%)
Emergency Room Visit	1 (1%)
Naturopathy/Diet	2 (2%)
Home Electrical Modality	2 (2%)
Exercise	97 (76%)
Self-Massage	12 (9%)
Heat/cold	19 (14%)
Mindfulness/breathing	2 (2%)
Acupuncture	1 (1%)
Other treatments	38 (29%)

Characteristics	Frequency (%)
Post-COVID Lockdown	
Severity of pain post-COVID lockdown: mean (SD), median (IQR)	5.3 (3.2), 6 (3)
Return to clinic status	
Not returned	70 (53%)
Returned	63 (47%)
Reason for not returning to the clinic	
Discharged	4 (3%)
Resolved/improved	18 (14%)
Uncomfortable due to pandemic	7 (5%)
Moved away	3 (2%)
Self-managed	3 (2%)
Accessed private care	4 (3%)
Surgical intervention	2 (2%)
Late return	23 (17%)
Unknown	6 (5%)
Time between lockdown and return to treatment (days): mean (SD), median (IQR)	163 (21), 156 (30)
Change in diagnosis/plan of management/prognosis on return	(N=133)
Yes	29 (22%)
No	83 (62%)
Not Applicable	21 (16%)
Course of symptoms between lockdown and return to clinic	(N=133)
Improved	23 (17%)
No change	30 (23%)
Worsened	57 (43%)
Not Applicable	23 (17%)

were patient education (in 99% of treatments), exercise instruction (in 98%), soft tissue therapy (in 98%), spinal mobilization (in 95%), and spinal manipulation (in 71%). Exercise (76% of all patients), non-prescription analgesic medication (17% of all patients), and hot/cold compresses (14% of all patients) were the most frequently employed self-management strategies during the lockdown. The majority of patients reported improvement (68%) or resolution (9%) of symptoms, while a minority reported no change (17%) or worsening (5%) since starting treatment.

Table 3 describes characteristics organized by patient-reported course of their MSK symptoms post-lockdown. Post-lockdown, 43% of the 133 patients reported worsening, 23% no change, and 17% improvement in symptoms, while 17% were unknown. The patients' ages and numbers of diagnoses and co-morbidities were similar between all groups. However, patients that were diagnosed with cervicogenic headache ($p = 0.03$) or mechanical back pain ($p = 0.04$) pre-COVID lockdown reported worsening of symptoms compared to the other groups, whereas those who improved post-lockdown had more often been diagnosed with spinal stenosis ($p = 0.03$). Exercise was most frequently utilized by those who reported improvement post-lockdown (95% of this group), compared to those who reported no change (75% of this group) or worsening (77% of this group) of their symptoms ($p = 0.01$). Overall, those who reported worsening

of symptoms post-lockdown received more treatments ($p = 0.012$) at the Clinic over a longer period of time pre-lockdown ($p = 0.017$), and reported more severe pain post-lockdown ($p < 0.001$) (mean of 7/10 on the 11-point Numeric Pain Rating Scale [NPRS][27]). In contrast, those who reported improvement in their symptoms post-lockdown experienced lower pain severity (mean of 2.1/10 on the 11-point NPRS), and were treated less frequently with spinal manipulative therapy (SMT) (57% of this group) compared to those reporting no change (70%) or worsening (88%) of symptoms ($p < 0.001$). Comorbidities did not differ significantly between groups.

Table 3.
Characteristics of patients by MSK symptom course post-COVID lockdown.

Characteristics	**Musculoskeletal symptom course post-COVID lockdown**				**Independence Test**
	Improved (n=23)	**No change (n=30)**	**Worsened (n=57)**	**Unknown (n=23)**	p-value[§]
Demographic					
Sex					0.217
Female	11 (48%)	15 (50%)	29 (51%)	17 (74%)	
Age (mean [years], SD)	59 (19)	57 (16)	54 (16)	54 (17)	0.702
Pre-COVID Lockdown - MSK Diagnosis					
Number of diagnoses					NA
1	9 (39%)	9 (30%)	11 (19%)	10 (43%)	
2	7 (30%)	13 (43%)	12 (21%)	9 (39%)	
3	1 (4%)	6 (20%)	19 (33%)	3 (13%)	
4	4 (17%)	2 (7%)	13 (23%)	1 (4%)	
5 – 7	2 (9%)	0 (0%)	2 (4%)	0 (0%)	
MSK diagnosis					
Mechanical neck pain					0.099*
Yes	7 (30%)	10 (33%)	31 (54%)	8 (35%)	
Mechanical back pain					0.038**
Yes	12 (52%)	24 (80%)	36 (63%)	10 (43%)	
Cervicogenic headaches					0.032**
Yes	1 (4%)	0 (0%)	8 (14%)	0 (0%)	
Myofascial pain					0.601
Yes	6 (26%)	4 (13%)	9 (16%)	5 (22%)	
Degenerative disc/joint Disease					0.131
Yes	5 (22%)	2 (7%)	4 (7%)	1 (4%)	
Spinal central/lateral stenosis					0.034**
Yes	5 (22%)	0 (0%)	5 (9%)	1 (4%)	
Shoulder strain					0.193
Yes	6 (26%)	2 (7%)	9 (16%)	2 (9%)	

Characteristics	**Musculoskeletal symptom course post-COVID lockdown**				**Independence Test**
	Improved (n=23)	**No change (n=30)**	**Worsened (n=57)**	**Unknown (n=23)**	p-value§
Radicular pain					0.922
Yes	1 (4%)	2 (7%)	3 (5%)	2 (9%)	
Lower limb strain					0.533
Yes	2 (9%)	6 (20%)	12 (21%)	3 (13%)	
Upper limb strain					0.551
Yes	2 (9%)	2 (7%)	9 (16%)	2 (9%)	
Duration of symptoms, No (days), SD	2784 (3329)	2092 (3454)	2703 (3547)	1983 (3436)	0.744
Pre-COVID Lockdown - Treatment Details					
Treatment/management					
Spinal Manipulative Therapy					<0.001***
Yes	13 (57%)	21 (70%)	50 (88%)	10 (43%)	
Spinal Mobilization					0.519
Yes	22 (96%)	28 (93%)	56 (98%)	21 (91%)	
Soft Tissue Therapy					0.368
Yes	23 (100%)	29 (97%)	57 (100%)	22 (96%)	
Laser					0.792
Yes	2 (9%)	4 (13%)	6 (11%)	4 (17%)	
Exercise					0.073*
Yes	23 (100%)	28 (93%)	57 (100%)	23 (100%)	
Education					0.326
Yes	23 (100%)	29 (97%)	57 (100%)	23 (100%)	
Number of treatments pre-COVID lockdown (No, SD)	18 (27)	30 (57)	61 (70)	26 (71)	0.012**
Duration (days) of treatment pre-COVID lockdown (No, SD)	165 (262)	303 (600)	594 (724)	255 (654)	0.017**
Outcomes of treatment pre-COVID lockdown					0.345
No Change	4 (17%)	4 (13%)	9 (16%)	5 (22%)	
Worsening	0 (0%)	3 (10%)	3 (5%)	1 (4%)	
Improving	17 (74%)	20 (67%)	40 (70%)	13 (57%)	
Resolved	2 (9%)	3 (10%)	5 (9%)	2 (9%)	
Not Applicable	0 (0%)	0 (0%)	0 (0%)	2 (9%)	
COVID-19 Lockdown – Self-Management					
OTC Pain Medications					0.114
Yes	4 (17%)	5 (17%)	13 (23%)	0 (0%)	

Characteristics	Musculoskeletal symptom course post-COVID lockdown				Independence Test
	Improved (n=23)	No change (n=30)	Worsened (n=57)	Unknown (n=23)	p-value[§]
Exercise					0.012**
Yes	21 (95%)	21 (75%)	44 (77%)	11 (52%)	
Self-Massage					0.366
Yes	1 (4%)	2 (7%)	8 (14%)	1 (4%)	
Heat/cold					0.082*
Yes	2 (9%)	7 (23%)	10 (18%)	0 (0%)	
Other treatments					<0.001***
Yes	3 (13%)	8 (27%)	21 (37%)	6 (26%)	
Not Applicable	0 (0%)	1 (3%)	2 (4%)	12 (52%)	
Post-COVID Lockdown					
Severity of pain post-COVID lockdown (SD)	2.1 (3.4)	4.8 (2.6)	7.0 (2.0)	3.0 (0.0)	<0.001***
Return to clinic status					<0.001***
Did not return to clinic	12 (52%)	9 (30%)	4 (7%)	22 (96%)	
Returned to clinic	8 (35%)	16 (53%)	38 (67%)	1 (4%)	
Late return to clinic (after Oct. 31, 2020)	3 (13%)	5 (17%)	15 (26%)	0 (0%)	
Reason for not returning to the clinic					NA
Discharged	1 (4%)	0 (0%)	0 (0%)	3 (13%)	
Resolved/improved	10 (43%)	5 (17%)	0 (0%)	3 (13%)	
Uncomfortable due to pandemic	0 (0%)	2 (7%)	1 (2%)	4 (17%)	
Moved away	1 (4%)	0 (0%)	0 (0%)	2 (9%)	
Self-managed	0 (0%)	0 (0%)	0 (0%)	3 (13%)	
Accessed private care	0 (0%)	0 (0%)	1 (2%)	3 (13%)	
Surgical intervention	0 (0%)	1 (3%)	1 (2%)	0 (0%)	
Late return (after Oct. 31, 2020)	3 (13%)	5 (17%)	15 (26%)	0 (0%)	
Unknown	0 (0%)	1 (3%)	1 (2%)	4 (17%)	
Time between closure and return to treatment (days, SD)	158 (16)	174 (21)	160 (22)	162 (NA)	0.119
Change in diagnosis, plan of management, prognosis					<0.001***
Yes	4 (17%)	6 (20%)	18 (32%)	1 (4%)	
No	18 (78%)	21 (70%)	35 (61%)	9 (39%)	
Not Applicable	1 (4%)	3 (10%)	4 (7%)	13 (57%)	

[§]Chi-square or Fisher's exact test for categorical variables, ANOVA for continuous variable.
* p<0.1; ** p<0.05; *** p<0.01; No, Number; SD, standard deviation; NA, not applicable

Once the Clinic resumed patient care, 70 (53%) patients had not returned by November 2020. More commonly reported reasons for not returning to the Clinic included resolved or improved symptoms (26% of non-returners) and aversion to attending in-person treatment during the ongoing pandemic (10%). Of the 63 patients who returned to the Clinic, they did so after a mean absence of about five months. There were no differences between the age, sex, number of diagnoses and comorbidities, and the nature of the diagnosis between those returning and not returning for care, excepting that those returning were more often diagnosed with mechanical back pain ($p = 0.017$). Patients who returned for treatment more often had a higher number of pre-lockdown treatments ($p = 0.035$), a longer treatment duration ($p = 0.037$), and treatment with SMT ($p = 0.008$) (Table 4). Returning patients had higher mean pain score after the lockdown (6.2/10) compared those who did not return (3.9/10). They reported worsening of symptoms, and had their original diagnoses and plans of management changed at the Clinic post-lockdown ($p < 0.001$).

Table 4.
Characteristics of patients by return-to-clinic post-COVID lockdown.

Characteristics	**Return status post-COVID lock down**		**Independence test**
	Did not return (n=70)	**Returned (n=63)**	**p-value**
Demographic			
Sex			0.576
Female	40 (57%)	32 (51%)	
Age (mean [years], SD)	55 (18)	56 (16)	0.727
Pre-COVID Lockdown - MSK Diagnosis			
Number of diagnoses			0.436
1	25 (36%)	14 (22%)	
2	21 (30%)	20 (32%)	
3	13 (19%)	16 (25%)	
4	8 (11%)	12 (19%)	
5 – 7	3 (4%)	1 (2%)	
MSK Diagnoses			
Mechanical neck pain			0.296
Yes	26 (37%)	30 (48%)	
Mechanical back pain			0.017**
Yes	36 (51%)	46 (73%)	
Spinal central/lateral stenosis			0.087*
Yes	9 (13%)	2 (3%)	
Duration of symptoms (days, SD)	2159 (3112)	2777 (3786)	0.309
Pre-COVID lockdown - Treatment Details			
Treatment/Management			
Spinal Manipulative Therapy			0.008***
Yes	42 (60%)	52 (83%)	

Characteristics	Return status post-COVID lock down		Independence test
	Did not return (n=70)	Returned (n=63)	p-value
Spinal Mobilization			0.582
Yes	68 (97%)	59 (94%)	
Soft Tissue Therapy			1
Yes	69 (99%)	62 (98%)	
Exercise			1
Yes	69 (99%)	62 (98%)	
Education			0.958
Yes	70 (100%)	62 (98%)	
Number of treatments pre-COVID lockdown (No, SD)	30 (58)	53 (69)	0.035**
Duration of treatment pre-COVID lockdown (days, SD)	284 (532)	518 (735)	0.037**
Outcomes of treatment pre-COVID lockdown			0.331
No Change in Symptoms	14 (20%)	8 (13%)	
Symptoms Worsening	3 (4%)	4 (6%)	
Symptoms Improving	43 (61%)	47 (75%)	
Symptoms Resolved	9 (13%)	3 (5%)	
Not Applicable	1 (1%)	1 (2%)	
COVID-19 Lockdown – Self-Management			
Over-The-Counter (OTC)Topicals			0.165
Yes	1 (1%)	5 (8%)	
OTC Pain Medications			0.161
Yes	8 (12%)	14 (22%)	
Exercise			0.078*
Yes	46 (69%)	51 (84%)	
Self-Massage			0.621
Yes	5 (7%)	7 (11%)	
Heat/cold			0.227
Yes	7 (10%)	12 (19%)	
Other treatments			0.017**
Yes	17 (24%)	21 (33%)	
Not Applicable	13 (19%)	2 (3%)	
Post-COVID Lockdown			
Severity of pain post COVID closure (SD)	3.9 (3.4)	6.2 (2.7)	0.001***
Change in diagnosis, plan of management, prognosis			<0.001***
Yes	9 (13%)	20 (32%)	
No	43 (61%)	40 (63%)	
Not Applicable	18 (26%)	3 (5%)	

Characteristics	Return status post-COVID lock down		Independence test
	Did not return (n=70)	Returned (n=63)	p-value
Course of symptoms between closure and return to clinic			<0.001***
Improved	15 (21%)	8 (13%)	
No change	14 (20%)	16 (25%)	
Worsened	19 (27%)	38 (60%)	

§ Chi-square or Fisher's exact test for categorical variables, ANOVA for continuous variable.
* p<0.1; ** p<0.05; *** p<0.01; SD, standard deviation

Discussion

Our case series adds to studies assessing the impact of COVID-19 and clinic closure on patients with MSK conditions.[19-22] To our knowledge, this is the first study of the outcomes of chiropractic patients following the interruption of passive chiropractic treatment. Our findings describe the patient characteristics that may be associated with the course of symptoms during interruption of care and may inform future pandemic protocols.

Pre-lockdown, the majority of patients reported improvement (68%) or resolution (9%) of symptoms, while a minority reported no change (17%) or worsening (5%) since starting treatment. Post-lockdown, 17% of patients reported to be improved, 23% did not change and 43% worsened in MSK symptoms during lockdown. It appears that, in general, patients worsened during the lockdown. Those reporting worsening post-lockdown had more treatments, longer period of treatment time pre-lockdown, and more severe pain (mean: 7/10) post-lockdown. Upon clinic reopening, 47% of patients returned for care, more often reporting worsened MSK symptoms and higher average pain score (6.2/10) than non-returning patients (3.9/10) during the lockdown. Our findings support Fatoye et al's [21] systematic review reporting increase in patients' MSK pain during COVID-19 lockdown.

Although the percentage of our patients' sex (54% female) was similar, their mean age (56 years) was older than patients in non-hospital-based chiropractic clinics ([1,2]). Additionally, as about 30% of the patients rostered with our AFHT, from which all Clinic patients are referred, are in the lowest income quintile,[9] we were unable to assess individual patients' socioeconomic status, which has been shown to affect clinical outcomes.[4] Most of our patients had at least one comorbidity in addition to their MSK diagnoses, a finding that aligns with other reports of populations with similar patient demographics.[12,13] Unlike previous studies,[10–13] we did not find any significant difference between our patient demographics or comorbidities and their clinical outcomes post-lockdown. Our findings are consistent with those reported by Bailly *et al.*,[20] who found no significant correlation between patient age, sex or basal metabolic index with the course of low back pain.

Consistent with studies of chiropractic practice in the community,[1,2] the most common MSK diagnoses among patients in our case series were synonymous with mechanical back pain (62% of all patients) and mechanical neck pain (42% of all patients). Diagnoses of mechanical back pain and cervicogenic headache were more often found among patients reporting worsening post-lockdown, whereas those diagnosed with spinal stenosis were associated with reporting improvement. However, the small number of patients with stenosis makes it difficult to draw definitive conclusions on why this was seen. Pre-lockdown, the median duration of treatment was 104 days, and the median number of treatments received was 14. Most patients reported self-managing their pain during lockdown with exercise, use of over-the-counter medication and application of hot/cold compresses.

Upon the Clinic reopening, 47% of patients returned for care. The most common reasons for not returning to the clinic included improvement of symptoms and aversion to in-person care during the pandemic. Patients who received more chiropractic treatments and who were treated with SMT pre-lockdown, and those who reported more severe pain post-lockdown, were among those who

returned for treatment post-lockdown. Patients' perceptions of whether and how their conditions changed during the lockdown may have been influenced (for the worse) by the anxiety and depression experienced by people in general during the pandemic.[16,20] However, it is important to consider that when the Clinic re-opened, an initial triage protocol was implemented, which likely accounts for the differences observed between groups. It was expected that patients returning for care would have worsened symptoms and higher pain scores.

Patients in our study received multimodal treatments for their MSK diagnoses, similar to those reported by the Canadian Chiropractic Guideline Initiative.[7] Given that these patients were receiving guideline-based care in the Clinic pre-lockdown, it is possible that chiropractic treatment, including education and prescription of exercises, played a role in limiting further worsening of symptoms during the lockdown.[28] It is not surprising that patients in our case series who reported improvement post-lockdown used exercise for self-management during the lockdown more so than those who did not improve, consistent with the observations of Bailly et al.[20] This beneficial form of self-management, unlike passive treatments, is amenable to be prescribed, monitored and progressed via telehealth; and would thus be a suitable, valid modality of chiropractic management of patients, especially during periods of interruption of passive care[25].

Limitations

Our study has several limitations. First, as a descriptive retrospective review of patients' EHR, it does not allow for conclusions regarding causation. Additionally, because the study involved patients from a hospital-based chiropractic teaching clinic, the findings may not be generalizable to those in private practice settings. Second, chiropractic interns (pre-licensure learners) obtained and recorded the data in the patients' EHRs under clinician supervision, as well as assessed and treated patients and documented their histories, examinations and treatment notes. Similarly, despite the training and supervision of research assistants, and regular review of abstracted files, some variability in data recording may have persisted, resulting in inconsistencies in the recording. These factors could introduce measurement bias due to inconsistencies and incomplete or inaccurate data recording.

Third, the data were obtained verbally from patients, thus responses were dependent on the accuracy of their recall, possibly introducing recall bias, and upon each patient's comprehension of "improved," "no change" or "worsened," introducing possible variability in their responses and consequent categorization. However, the patients served as their own controls, with information about variables possibly impacting their clinical outcomes. Furthermore, there is a possibility of selection bias, as data pertaining to patients' post-lockdown status was only obtained from those we were able to contact. Consequently, we have no data on others, which could have impacted our findings. For example, it is possible that patients with "unknown" status represent those less likely to seek follow-up care or with milder symptoms, potentially underestimating or overestimating the observed trends in symptom trajectory. Additionally, our sample of cases was relatively small; however, adequate information was available and recorded for most of the patients under study. The data from the 133 patients in this case series may not be representative of the total active cases at the Clinic, nor of patients in chiropractic clinics within the community. Furthermore, we may not have considered prognostic factors that could have influenced outcomes, such as socioeconomic status.[16] Finally, to identify any trends in this sample, the authors grouped various presentations into categories rather than analyzing them as individual diagnoses, introducing the possibility of misclassification bias. Specifically, grouping conditions could result in the loss of important nuances, potentially affecting the accuracy of the findings. There may also be some inaccuracies in categorizing outcomes as better, worse, or no change, which could affect the reliability of the reported trends.

Summary

Our Clinic patients whose chiropractic treatment was interrupted by the COVID-19 lockdown experienced various outcomes but, in contrast to the pre-lockdown trend, the majority reported no change or worsening of their pre-lockdown MSK symptoms. Patients who did return for treatment upon Clinic reopening had more often been diagnosed with mechanical back pain, received more chiropractic treatments and were more often (than non-returners) treated with SMT pre-lockdown, experienced no improvement or worsening during the lockdown, and reported higher pain intensity post-lockdown

compared to those who did not return. Additionally, those who self-managed with exercises during the lockdown more commonly reported improvement post-lockdown. This observation suggests that supervised exercise therapy could be an effective form of management amenable to telehealth during interruption of in-person chiropractic care. These findings can help inform future research investigating the course of symptoms and the contribution of chiropractic treatment for MSK disorders, as observed during this pandemic.

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Appendix 1.
Check-in Call Script

Hello, this is Intern_____ from the St. Michael's chiropractic team. Could I please speak with _____? I am calling to provide you with an update to our chiropractic services. Could I please verify that I am speaking with the correct person? Could you inform me of your birthdate and postal code/ address? Thank you.

We are calling to let you know that we will be commencing chiropractic services at the beginning of August. Would you be interested in returning for chiropractic treatments?

[If "No":]

Is that because you feel alright? We hope you'll be well. Should you feel the need for chiropractic treatment in the future, please have your family doctor or nurse practitioner email us a new referral. [Intern discusses discharging patient with clinician.]

[If "Yes":]

As we return, we will be following our public health initiative and gradually bringing people back into our clinic, starting with those that are in most need of our services. Could you please tell me how your _____pain has been over the past 4 months since stopping your treatments?

Thank you for the update. As part of the ministry plan for re-opening our services, we need to keep a few things in mind and we have developed a few strategies to help keep you safe throughout this pandemic. First, we are making our best efforts at keeping consistent with social distancing. In order to do this, we will be conducting our history interviews as well as much of our intake process through telehealth services.

Do you have a computer with a camera in it? Do you have access to email and internet services? [If has email:] Could you please tell me your email address? Is it alright for us to communicate with you by email?

Our second method of keeping you safe will be to implement active and passive screening measures. Although this may seem tedious, it is very important that we ensure that any symptoms related to the COVID-19 virus are routinely monitored and screened. You can expect that we will be calling ahead of your appointments to ask you these screening questions. We also have a screener at the entrance to the clinic and we will be asking at the beginning of every appointment.

And finally, when you arrive at the clinic, it will not look

the same as it did before. Our entire team will now be wearing scrubs, gloves, masks and face shields. In addition to this we ask that you wear a mask throughout your appointment as well. Will this be a problem for you?

What you can expect next would be that Julinne, our clerical support, will be contacting you to schedule our telehealth history examination. Following this, we will coordinate a Zoom [or telephone, as applicable] call where we will conduct our interview.

[If Zoom:] Attached to the invitation to the Zoom meeting will be an information sheet about telehealth, a form for your informed consent to have a virtual session, and your intake forms. We ask that you complete the consent and intake forms ahead of our meeting and that you send them back to us by replying to the email link.

We would like you to think back on the most recent treatment here. We'll be asking you to complete a brief survey about your experience at the end of our first virtual session. The session should take about an hour.

We look forward to starting your care very soon!

Appendix 2.
Post- COVID-19 Re-evaluation

Re-evaluation History (After introducing yourself & obtaining consent, including for exam)

1. How were you feeling with respect to Complaint #1, Complaint #2, etc. on March 16, 2020? (**per Complaint**: intensity, frequency, duration, effect on ADLs & function)
2. Between the last time you were treated at this clinic and now, how has Complaint #1 (etc.) behaved? (**per Complaint**, change in intensity, frequency, duration, effect on ADLs & function)
3. What have you done between your last treatment at this clinic and today for Complaint #1, etc.? (**per Complaint**: describe rest, exercise, thermal applications, ergonomic changes, medications, any lab/imaging assessments, any treatments in a clinic/hospital, any virtual treatment)
4. How is your Complaint #1, etc. now?

Re-evaluation Physical Exam

Per Complaint: observation, ROMs, & repeat past neuro, ortho, palpation

Re-evaluation Diagnosis

Indicate if changed

Plan of Management

Indicate if changed

Prognosis

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Chiropractic management of a Veteran with persistent spinal pain syndrome-2 status-post L3-L5 laminectomy and Coflex interlaminar stabilization: a case report

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Gina M Bonavito-Larragoite, DC, MBA[3]
Zachary A Cupler, DC, MS[2,4]

Background*: Coflex interlaminar stabilization (CIS) is a second-generation interspinous implant that promotes intersegmental flexion following decompression for moderate to severe lumbar spinal stenosis. We describe the management of a patient with persistent spinal pain syndrome-2 (PSPS-2) status-post CIS implant presenting to a chiropractor's office.*

Case presentation: *A 77-year-old Hispanic male Army veteran presented with PSPS-2 status-post L3-L5 laminectomy and CIS for lumbar spinal stenosis. A 4-visit trial care plan ensued with flexion-distraction*

Gestion chiropratique d'un vétéran atteint du syndrome de douleur spinale persistante-2 après laminectomie L3-L5 et stabilisation interlaminaire Coflex: un rapport de cas

Contexte: *La stabilisation interlaminaire Coflex (CIS) est un implant interépineux de deuxième génération qui favorise la flexion intersegmentaire après décompression pour une sténose spinale lombaire modérée à sévère. Nous décrivons la prise en charge d'un patient atteint du syndrome de douleur spinale persistante-2 (SDPS-2) après un implant CIS, qui se présente au bureau d'un chiropraticien.*

Présentation de cas: *Un vétéran de l'armée hispanique âgé de 77 ans s'est présenté avec un statut PSPS-2 après une laminectomie L3-L5 et une CIS pour sténose spinale lombaire. Un plan de soins d'essai de 4 visites a été*

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Conflicts of Interest:
The authors have no disclaimers, competing interests, or sources of support or funding to report in the preparation of this manuscript.
Veteran provided approval for publication of this report and associated images. The patient's consent to publish was obtained and submitted.
The views expressed in this article are those of the authors and do not reflect the official policy will position of the Department of Veteran Affairs.
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manipulation, drop-assist spinal manipulation, patient education, and repeated lumbar flexion-based stretches. No adverse events occurred. On re-evaluation, the numeric pain rating and Oswestry Disability were unchanged.

Summary: *We describe the multimodal management of a PSPS-2 patient with a CIS implant presenting to a chiropractic clinic. While no clinically meaningful improvement was observed, no adverse events were reported. Further investigation is needed to evaluate the safety and clinical effectiveness of multimodal manual therapy and exercise-based care in patients with PSPS-2.*

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KEY WORDS: case report, Coflex, chronic lower back pain, persistent spinal pain syndrome, chiropractic, spinal manipulation

mis en place avec manipulation par flexion-distraction, manipulation vertébrale par assistance par chute, éducation du patient et étirements répétés basés sur la flexion lombaire. Aucun événement indésirable n'est survenu. Lors de la réévaluation, l'évaluation numérique de la douleur et l'Indice de handicap d'Oswestry sont restés inchangés.

Résumé: *Nous décrivons la gestion multimodale d'un patient PSPS-2 ayant un implant CIS, qui se présente dans une clinique chiropratique. Aucune amélioration cliniquement significative n'a été observée, aucun événement indésirable n'a été signalé. Des examens supplémentaires sont nécessaires pour évaluer la sécurité et l'efficacité clinique de la thérapie manuelle multimodale et des soins basés sur l'exercice chez les patients atteints de PSPS-2.*

(JCCA. 2025;69(2):203-212)

MOTS CLÉS : rapport de cas, Coflex, douleur chronique du bas du dos, syndrome de douleur spinale persistante, chiropratique, manipulation vertébrale

Introduction

Lumbar spinal stenosis (LSS) is a degenerative condition pervasive among older adults.[1] LSS, defined as a narrowing of the central canal, lateral recess, or neural foramen of the spinal canal in the lower back is often associated with increased disability, limited walking capacity, and increased fall risk.[2,3] LSS is the most common reason for spinal surgery in older adults over the age of 65.[4] The management of LSS varies from non-pharmacological therapies, such as spinal manipulation and rehabilitative exercise, medication management, or surgical intervention, such as decompression and fusion.[5,6]

Coflex interlaminar stabilization (CIS) uses a new generation of interspinous device alternative to posterior lumbar interbody fusion (PLIF) following decompression for the management of moderate to severe LSS.[7,8] The Coflex device (Paradigm Spine, LLC, New York, New York) implanted for CIS is a U-shaped compressible titanium device that is interposed between the lamina and the spinous processes after surgical decompression (Figure 1). Compared to PLIF, CIS is less invasive and preserves the motion of intersegmental flexion at the affected and adjacent levels.[7,9] Compared to traditional lumbar decompression and fusion surgeries, CIS is favored because of shorter operation times, decreased intraoperative bleeding, and faster recovery periods.[10]

Persistent post-surgical spinal pain is common, with 20 to 40% of patients developing persistent spinal pain syndrome type 2 (PSPS-2) after lumbar surgery.[11,12] PSPS-2 is defined as recurrent or chronic axial or radicular spinal pain in patients with a history of spinal surgery, previous-

Figure 1.
Coflex interlaminar stabilization device. With permission from Errico TJ et al.[32]

ly referred to as failed back surgery syndrome.[12,13] The etiology of PSPS-2 is not well understood but is likely multifactorial. Postoperative factors like recurrent disc herniation, adjacent segment disease, and nerve root irritation, along with psychosocial factors such as depression, anxiety, and socioeconomic stress, can negatively impact surgical outcomes and recovery.[12,14]

Non-surgical therapies such as exercise, pharmacological management, and interventional injections are often recommended for PSPS-2.[5,11] Descriptions of multimodal manual therapy and exercise-based management of PSPS-2 delivered by a chiropractor are sparse.[15–19] Thus, we aim to describe a multimodal approach of manual therapy and exercise for the management of a patient with PSPS-2 and a novel CIS implant presenting to a chiropractor.

Case presentation

This case was approved by the Miami VA Health Care System Privacy Officer. The patient provided consent for publication. This report followed the CARE guidelines for reporting case reports.[20]

Background

A 77-year-old Hispanic male United States Army veteran was referred by their Veterans Health Administration (VA) primary care physician to a VA chiropractic clinic for chronic low back pain. Four years before his presentation to the chiropractic clinic for evaluation, the veteran had undergone an L3-L4 to L4-L5 laminectomy with L3-4 to L4-5 CIS for right-sided lower extremity radiculopathy and weakness due to LSS. The veteran's right lower extremity radicular pain responded positively to surgical intervention, but axial lumbar pain persisted.

On initial presentation, the veteran described persistent back pain as constant aching with intermittent sharp pains. His pain was localized to the right more than the left side of the axial lumbar spine area. He experienced weekly flare-ups of increased pain intensity described as "sharp and spastic". The veteran denied lower extremity radiation or saddle anesthesia. His back pain was provoked by walking and ascending stairs and was reduced with anti-inflammatory medication, lidocaine patches, heat, and lumbar flexion-biased stretches. His walking was limited to approximately one-quarter mile due to axial lumbar pain. The Oswestry Disability Index (ODI) rated his function as "moderate disability" (17 out of 50 [34%])[21] and his pain rating on a Visual Analog Scale was 6/10.

He attempted multiple management strategies for his back pain since completing surgery in 2019. He trialed 300 mg of Gabapentin three times a day but discontinued due to a lack of efficacy. He received multiple transforaminal epidural steroid injections for lumbosacral pain, with significant relief (percent improvement unknown) from the last injection, but the reason for discontinuing further intervention is unknown. He trialed physical therapy after spinal surgery to return to activity status and later for chronic pain management with benefit.

Prior lumbar plain films on record demonstrated mild levoscoliosis with associated multilevel lumbar degenerative changes, a laminectomy with CIS at L3-5, and a stable grade 1 degenerative anterolisthesis of L4 on L5 (Figure 2). Prior magnetic resonance imaging revealed multilevel degenerative disc disease and facet hypertrophy, a right subarticular disc protrusion at L1-2, a central to right central disc protrusion at L5-S1, moderate spinal canal stenosis at L3-4, and left lateral stenosis at L4-5 (Figure 3).

Medical history was remarkable for type 2 diabetes, prostate cancer treated to remission, giant cell arteritis with polymyalgia rheumatica, and gout. His current medication list included 200 mg Celecoxib, 81 mg aspirin, 1000 mg Metformin HCl, and 300 mg Allopurinol.

Examination

The veteran's gait was steady, characterized by a left antalgic lean and a mild right-sided limp. No lower extremity muscle atrophy was observed. Lumbar range of motion was moderately restricted with lumbar flexion and severely restricted with extension, both of which provoked his lumbosacral pain. Other lumbar planes of motion were moderately limited but did not provoke his back pain. Heel and toe walk, Romberg's test, and heel-to-shin test were performed without difficulty. Neurological examination revealed asymmetry, including decreased sensation in the right L1–L4 dermatomes, reduced muscle strength (4/5) in the right hip flexors, abductors, adductors, knee flexors and extensors, dorsiflexors, hallux extensors, and plantar flexors, along with hyporeflexia (0+) of the right L4 and S1 deep tendon reflexes, otherwise, the left lower extremity was intact neurologically (5/5 muscle strength, 1+ deep tendon reflexes, sensation intact). Both Hoffman's reflex and ankle clonus were absent bilateral-

ly. His lumbosacral pain was elicited with facet loading via Kemp's test, right-sided Gaenslen's test, right-sided thigh thrust, and a supine straight leg raise to 65 degrees. Hip and sacroiliac orthopedic testing with FABER, FADIR, pelvic compression, and sacral thrust tests were unremarkable for his concordant lumbosacral pain. Hip internal and external rotation were limited bilaterally but did not provoke his lumbosacral pain. Segmental joint play was restricted in the thoracic, lumbar, and right sacroiliac regions and caused localized discomfort. On myofascial palpation, hypertonicity was observed in the lumbar paraspinals, quadratus lumborum, and hip external rotators, bilaterally.

Clinical impression

The veteran's working diagnosis was PSPS-2 status-post L3-L5 laminectomy and CIS with associated myofascial and segmental restrictions in the setting of LSS and a lumbar flexion bias.

Treatment recommendations

A recommendation was made to trial multimodal chiropractic care to include manual therapy, therapeutic exercise, and patient education. Manual therapies included: flexion-distraction technique applied to the lumbar spine, drop-assist spinal manipulative therapy of the thoracic region and right sacroiliac joint, manual myofascial release,

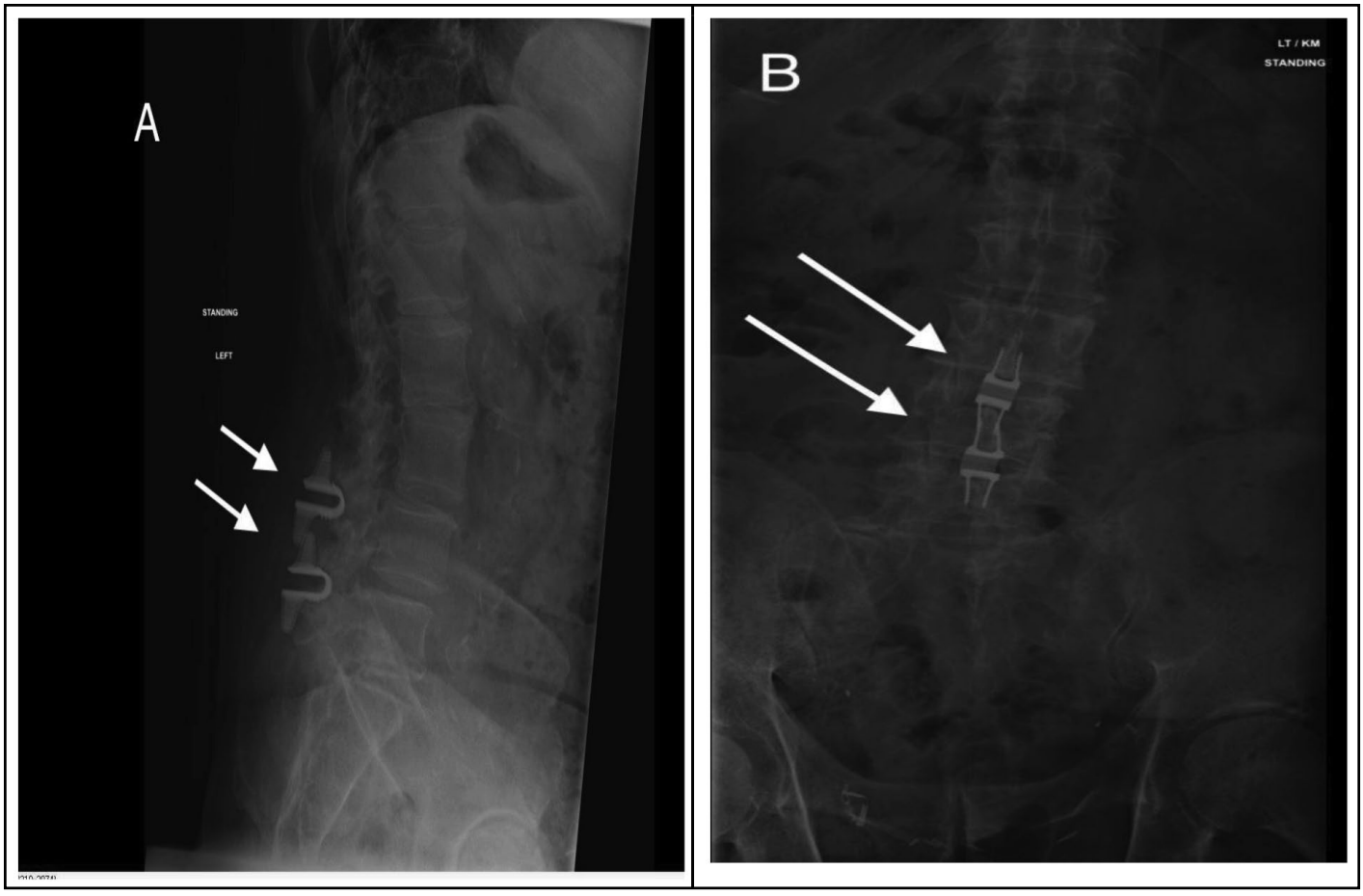

Figure 2.

Case presentation postoperative plain film radiographs of the lumbosacral region with lateral (A) and posterior to anterior views (B) demonstrate an L3 to L5 laminectomy and Coflex interlaminar stabilization (CIS). The CIS implant is demonstrated at L3/L4 and L4/L5 (white arrows). Additional imaging findings include Grade 1 degenerative anterolisthesis of L4 on L5 and left hip osteoarthritis.

and post-isometric relaxation technique applied to lumbar paraspinals, quadratus lumborum, and hip external rotators, bilaterally. At each visit, the veteran was provided home exercise instructions in repetitive lumbar flexion and core stabilization. Exercises included supine double and single knee-to-chests, hook-lying gluteus bridges, bird-dog exercise, and dying bug.[18,22,23]

Re-evaluation

At his fourth visit in five weeks, a re-examination was performed. His lumbar extension range of motion improved to a mild restriction with pain. All other planes of motion remained unchanged and were moderately limited without painful provocation of his chief complaint. Neurological and orthopedic exams were reassessed without significant changes from the baseline evaluation. Repeat ODI rated function "moderate disability" (16 out of 50 [32%]) and Visual Analog Scale pain rating was 6 out of 10, indicating no improvement in his functional status. Due to the lack of improvement following a short trial of care, the patient was discharged from the chiropractic clinic and instructed to follow up with his referring primary care provider.

Discussion

This case report describes multimodal chiropractic management for PSPS-2 with CIS. The existing evidence on chiropractic treatment for PSPS-2 is limited[15,19,24,25] and none of these studies have addressed the condition in the context of CIS. This case adds to the body of post-surgical spine pain management by introducing a new surgical implant that tolerates multimodal manual therapies. While the results of the trial of care were not favorable for the patient's disability or pain intensity, no adverse events or

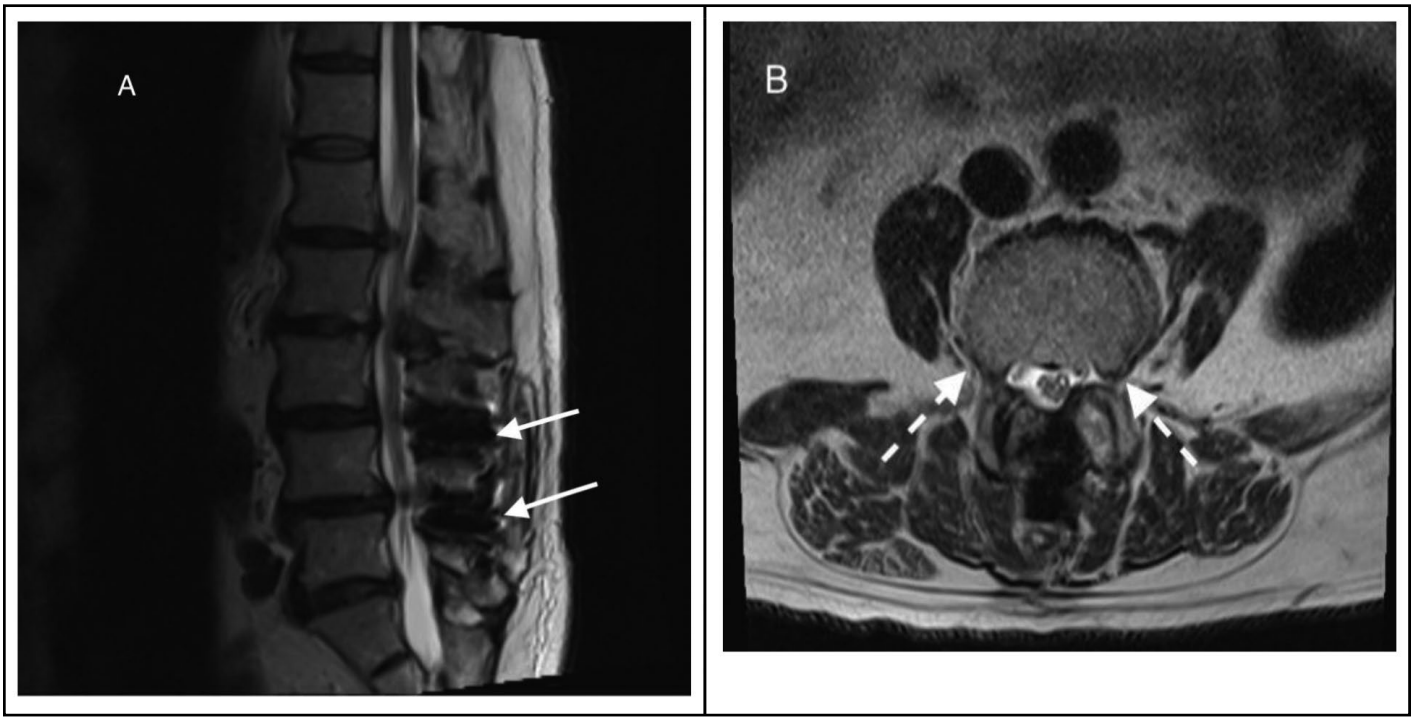

Figure 3.

Case presentation lumbar magnetic resonance imaging demonstrates multilevel degenerative disc disease and moderate spinal canal stenosis on sagittal view (A). The Coflex interlaminar stabilization (CIS) implant is demonstrated at L3/L4 and L4/L5 (A: white arrows) as a signal void. On axial view (B), moderate spinal canal stenosis at L3-4 with a subarticular bugle and left central to foraminal disc extrusion are demonstrated. (B: white dashed arrows highlight the subarticular bulge and disc extrusion).

exacerbations of his condition were reported. In contrast to Chu and Trager, our course of care was limited to four visits over five weeks, where their cohort's mean number of chiropractic visits among 31 patients with PSPS-2 was 21.5±8.7, which occurred over a mean duration of 2.5 ±1.5 months.[19]

As spinal condition experts, chiropractors need to familiarize themselves with the indications for and complications of CIS to support appropriate referral, post-surgical co-management, effective interdisciplinary communication, and optimal patient care outcomes. CIS is an alternative to PLIF for stabilization after decompression of the lumbar spine. As a second generation interspinous device, the primary clinical indication for CIS is LSS and the therapeutic intention is to "offload" pressure on the disc space, increase intervertebral foraminal surface area,

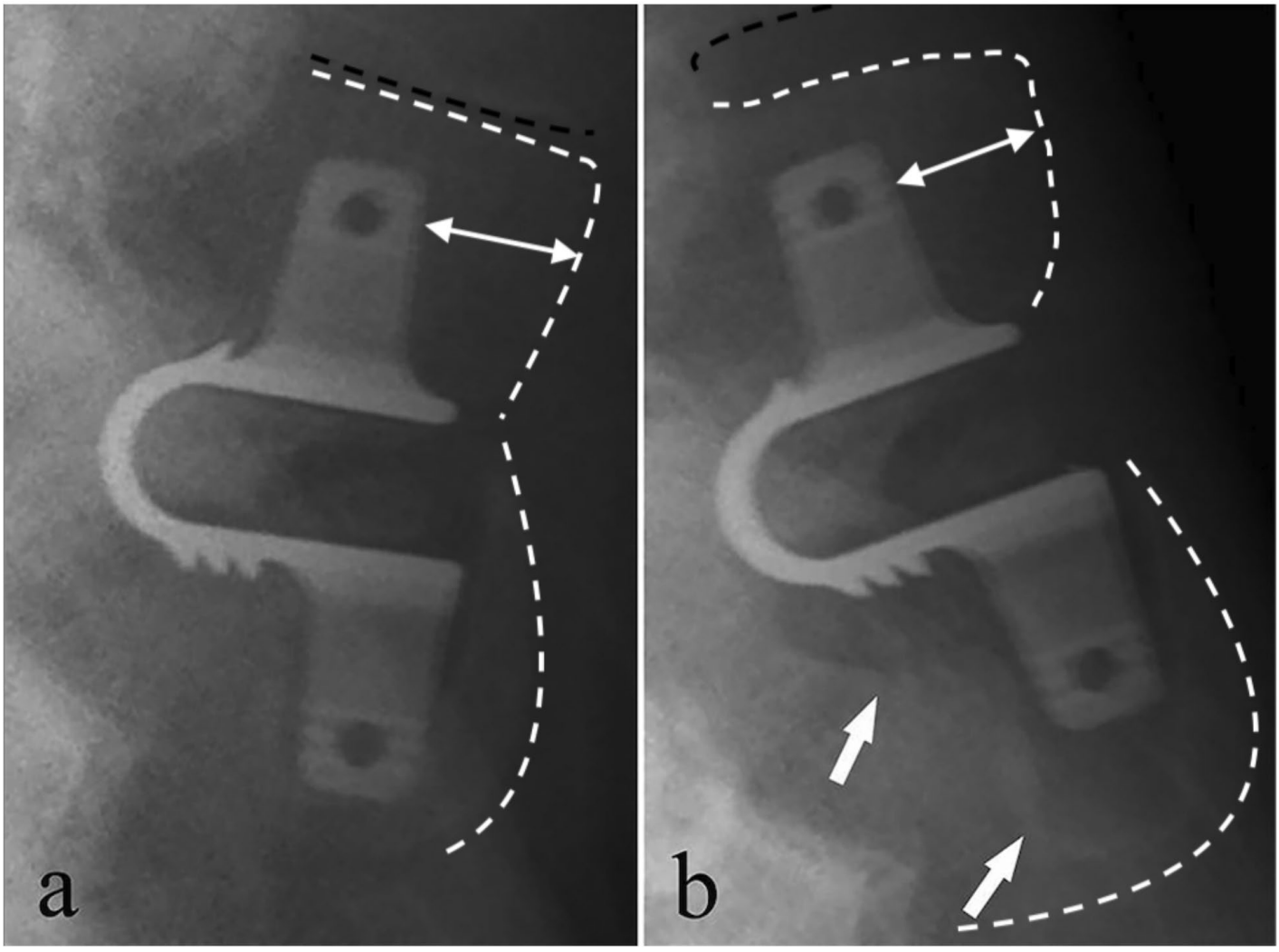

Figure 4.

Example of Coflex interlaminar stabilization (CIS) implant loosening on lateral view plain films. Lateral (a) and over-flexion (b) radiograph views demonstrating areas of CIS implant loosening in an over-flexion position identified by single head white arrows placed by Li et al.). Dashed white lines outline the spinous processes of involved segments. Dashed black lines outline non-involved segment spinous processes. The superior aspect of the implant is stable as indicated by double-headed white arrows. Modified and with permission from Li et al. [28]

increase disc space heights, reverse or preserve lordosis, limit range of motion and stabilize the surgical level(s), and reduce risk of adjacent segment disease.[7,8,26] With CIS, the Coflex device (Figure 1) is placed between the spinous processes of adjacent lumbar vertebrae, after a decompression procedure, and induces a 'flexed' orientation between the segments.

It is also prudent to acclimate to the typical post-operative imaging presentations of CIS to assist with differentiating normal postoperative findings from pathological changes and potential complications of the hardware. Due to its titanium composition, the Coflex device will appear as a bright white structure on plain film imaging. In a lateral view, it appears as a U-shaped device interposed between spinous processes. On posterior-to-anterior view, the CIS implant appears as a symmetrical, radiopaque density midline over the spinous processes (Figure 2). On magnetic resonance imaging, the CIS implant will appear as a void signal (Figure 3) because the titanium does not emit a signal.[27] The void signal and artifact can mimic pathology or obscure structures. Regarding complications, hardware loosening (4.7% to 60%; Figure 4) and osteolysis (39.4%) have been reported.[28,29] Depending on the follow-up period, 42% to 89% of cases develop heterotrophic ossification of the stabilized spinal segments (Figure 5), which has been hypothesized to be due to aseptic inflammation secondary to prolonged friction between CIS implant and surrounding tissues from daily activities.[28,30,31] Extremely rare instances of hardware fracture[28] (Figure 6) and spinous process fracture[29] have been reported.

Although current literature does not specifically consider CIS, conservative treatments are preferred for PSPS-2, including exercise, spinal manipulative therapy, medication, and epidural steroid injections.[11,24] Several studies have found that a multimodal approach of manual care methods, including flexion-distraction technique and active care exercises has been effective in reducing patient-reported disability.[19,30,31] For adults at least 1 year after lumbar spine discectomy, those who received spinal manipulation had lower rates of lumbar spine reoperation compared to controls, which may indicate the potential

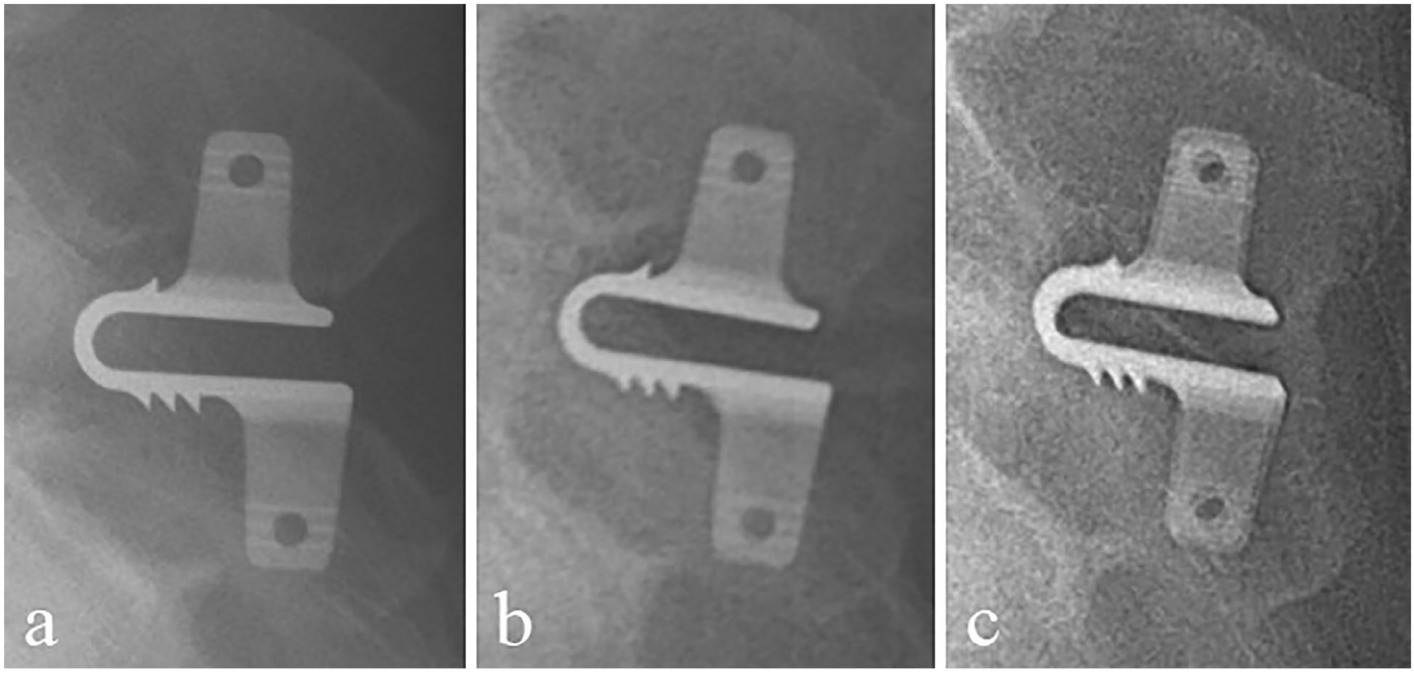

Figure 5.
Example of heterotrophic ossification (HO) at Coflex interlaminar stabilization (CIS) implant site. Lateral view radiograph of one patient with no HO seen immediately after surgery (a.), Grade 1 HO seen at one year after surgery (b), and interspinous fusion at the final follow-up visit (c.). With permission from Li et al.[28]

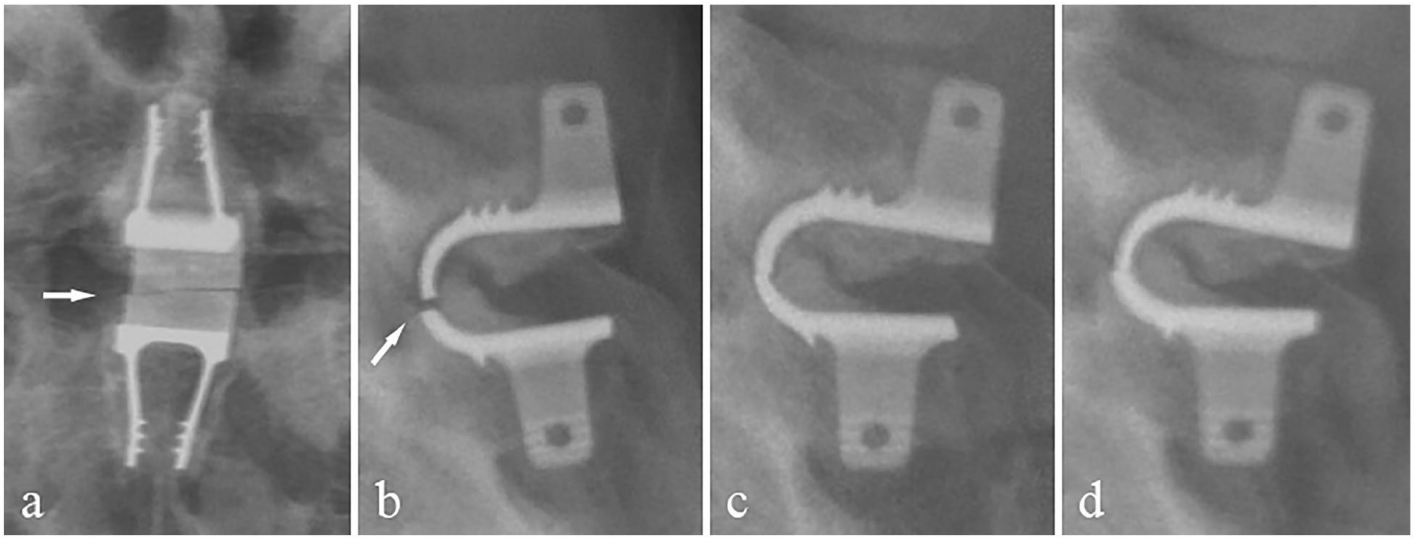

Figure 6.
Example of a Coflex interlaminar stabilization (CIS) implant fracture 14 years post-surgery. Posterior to anterior (a) and lateral view (b,c,d) radiographs demonstrate CIS implant failure with hardware fracture (white arrows placed by Li et al.). With permission from Li et al.[28]

marker of safety of this treatment for this population.[18] As the patient presented several years post-surgery without progression of neurological signs and symptoms, the patient was considered stable and a trial of care was initiated. At the initial visit, the patient was evaluated for the suitability of high-velocity, low-amplitude lumbar spinal manipulation by using pre-loading positioning specific to the technique and obtaining patient feedback on comfort and tolerance. Given the case complexity of the PSPS-2 presentation and patient intolerance to pre-load positions for side-posture high-velocity low-amplitude lumbar manipulation, we elected to trial care utilizing lumbar spine flexion-distraction technique and prone high-velocity, low-amplitude drop-assist thoracic spinal and sacroiliac joint manipulation.[19] The veteran was instructed in flexion-based exercises and core stabilization exercises, given his history of LSS and continued poor tolerance to standing postures accentuating lumbar extension. These exercises encourage independent self-management and are considered safe, low-load movements that focus on spinal stability and motor control.[19,22,23]

Although we report a single case without adverse events, the safety and effectiveness of multimodal conservative care management for patients with PSPS-2 and surgical implants is largely uncertain. Retrospective cohorts or prospective registries should evaluate cost differences, medication utilization, reoperation rates, engagement with health care services, as well as clinical and safety outcomes for patients with PSPS-2 and surgical implants such as CIS. The association between multimodal care and clinical outcomes in patients with PSPS-2 and surgical implants should be explored further with a randomized controlled trial with comparator groups such as physical therapy, medication management, or behavioral intervention.

Limitations

There is limited research on chiropractic care in the management of PSPS-2. This case report is limited to the specific patient encounters during this trial of care and may not necessarily be extrapolated to the general population. There are further nuances related to the PSPS-2 population due to the variety of surgical hardware that may be used, and we described only one type of surgical hardware, CIS. We also recognize the trial course of care may have been insufficient in the dosage of care to effect clinical change on the condition.

Summary

PSPS-2 is a common condition following decompression and fusion lumbar spinal surgery. This study described a case of PSPS-2, specifically with a second-generation interspinous device, CIS, and highlights its characteristic presentation on imaging and potential complications. While the outcomes of the care trial were limited, they underscore the need for further research into the role of chiropractic management in patients with PSPS-2 and subtypes of surgical implants such as CIS.

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Weber-B lateral malleolus fracture: an imaging case review

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A 69-year-old male presented to a chiropractic clinic four days post-injury with lateral ankle pain and swelling. Using the Ottawa ankle rules as a guideline for the need for radiographs, this case was deemed necessary for x-ray evaluation. The radiographic examination demonstrated a Weber B fracture of the distal fibula with a noted widening of the medial clear space of the ankle, which indicated the additional lesion of the deltoid ligament. This patient was referred to an orthopedist to have an open reduction and internal fixation (ORIF) surgery.

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KEY WORDS: fracture, fibula, Ottawa ankle rules, Weber classification, diagnostic imaging

Fracture du malléole latéral de Weber-B: un examen de cas par imagerie

Une personne de sexe masculin, âgée de 69 ans s'est présentée à une clinique chiropratique quatre jours après une blessure avec douleur et enflure à la cheville latérale. En utilisant les règles de la cheville d'Ottawa comme guide pour déterminer la nécessité de radiographies, il a été jugé nécessaire que ce cas subisse une évaluation par rayons X. L'examen radiographique a démontré une fracture de type Weber B de la fibula distale avec un élargissement noté de l'espace clair médial de la cheville, ce qui indiquait une lésion supplémentaire du ligament deltoïde. Ce patient a été référé à un orthopédiste afin de subir une chirurgie de réduction ouverte et de fixation interne (ROFI).

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MOTS CLÉS : fracture, fibula, règles d'Ottawa pour la cheville, classification de Weber, imagerie diagnostique

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The involved patient provided consent for case publication.

Figure 1.
Clinical images taken two days post-injury. There is moderate soft tissue swelling of the left ankle that extends into the toes. There is also bruising at the lateral aspect of the foot and the area around the metatarsophalangeal joints.

Case Presentation

A 69-year-old male presented to a chiropractic clinic four days post-injury with a swollen and bruised left ankle (Figure 1) after an inversion injury while playing hockey. He experienced immediate lateral ankle pain, worsening with twisting movements, and was unable to weight-bear, using a makeshift cane for support. Radiographic studies revealed a fracture of the lateral malleolus at the level of the tibial plafond, classified as Weber B (Figure 2), and was subsequently referred to an orthopedic surgeon.

Gravity stress views were performed at the orthopedist's office, which demonstrated widening of the medial clear space denoting additional deltoid ligament instability (Figure 3). Subsequent Open-Reduction and Internal-Fixation (ORIF) surgery was completed one week later without complications, and follow-up imaging one-week post-surgery confirmed the procedure's success (Figure 4). The patient was instructed to wear a walking boot and use a knee scooter for six weeks to maintain a non-weight-bearing status. Additionally, he was advised to follow a six-week post-operative treatment plan with a physiotherapist, including stretching and strengthening exercises. Twelve weeks following the surgery, the patient was back to full function with no pain and was able to return to playing hockey.

Discussion

Ottawa Ankle Rules

The Ottawa ankle rules (OAR) guide the decision for radiographic imaging after acute trauma, aiming to reduce unnecessary x-rays. Validated in adults with 99% sensitivity, these rules can decrease radiograph costs by 19-38%.[1] The rules include five components: [2]

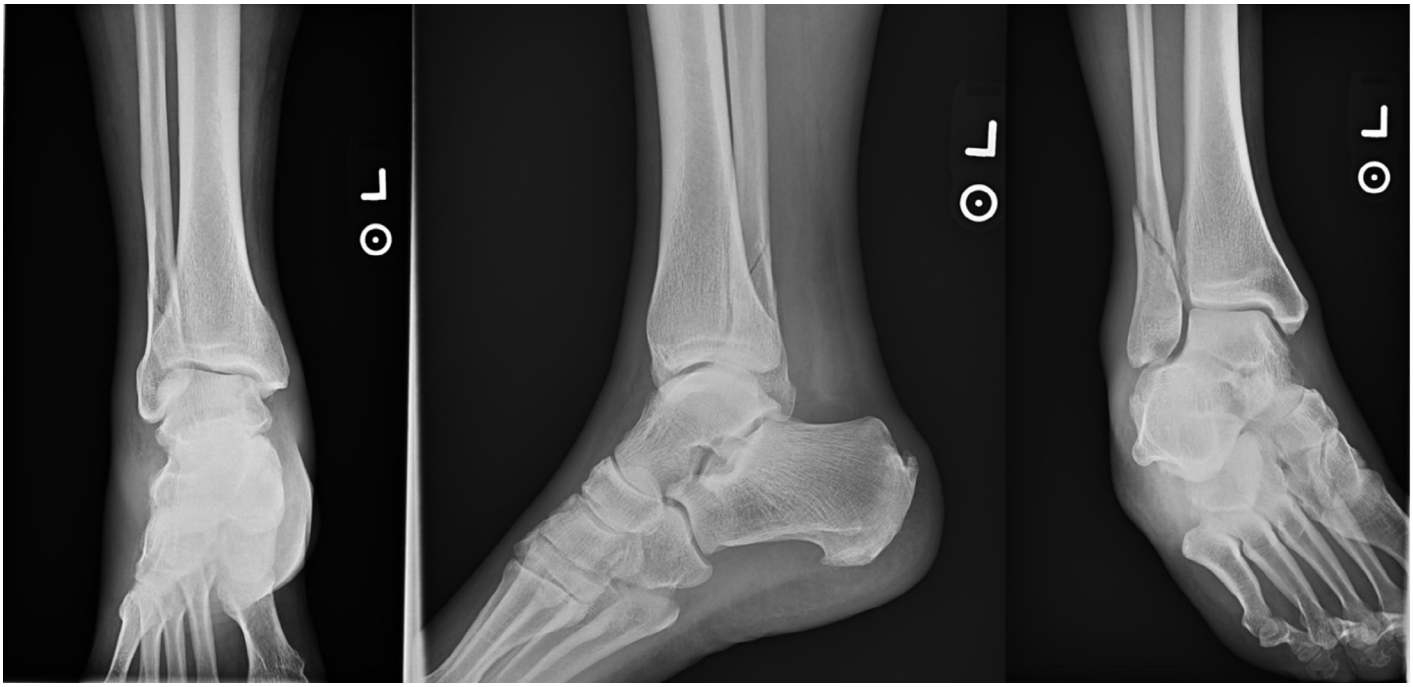

Figure 2.
AP, Lateral, and Medial Oblique left ankle radiographs taken four days post-injury revealed a spiral, non-comminuted, distal fibular fracture, which extends to the level of the tibial plafond. Slight lateral translation was noted without evidence of angulation, rotation, or distraction. Concomitant soft tissue swelling about the ankle.

1. Bony tenderness along the distal 6 cm of the posterior fibula or tip of the lateral malleolus.
2. Bony tenderness along the distal 6 cm of the posterior tibia or tip of the medial malleolus.
3. Bony tenderness at the base of the 5th metatarsal.
4. Bony tenderness at the navicular.
5. Inability to weight bear immediately after injury and for four consecutive steps during the initial evaluation.

Components are categorized by injury type: rules 1, 2, and 5 pertain to ankle injuries, while rules 3, 4, and 5 apply to foot injuries. For ankle fractures, if there is pain in the malleolar zone with the addition of any of rules 1, 2 or 5, a radiograph is warranted. In the present case, the patient experienced pain along the distal 6 cm of the posterior fibula and was unable to weight-bear immediately after the injury and for four consecutive steps during the initial evaluation.

Ankle Stress Views

X-rays have been found the be the most cost effective and readily available method of imaging that yields an accurate diagnosis (Table 1).[3-5] Ankle stress views are recommended when initial imaging does not show clear signs of instability. Three methods exist: manual, gravity, and weight-bearing.[6] The gravity stress view involves positioning the patient side-lying with the affected side down, applying a lateral force across the joint while the foot is in natural plantar flexion. This method is as reliable as manual tests[7] and less painful[8], as confirmed by the patient, who found this position to be comfortable and pain free.

Figure 3.
AP gravity stress view of the left ankle revealed a 2 mm lateral translation of the distal segment of the fibula. Increased clear space at the medial aspect of the ankle was evident, which denoted deltoid ligament instability.

Table 1.
Comparison of advantages and disadvantages of X-ray[3,5], CT[3], MRI[4], and Ultrasound[5] for the evaluation of ankle injuries.

Imaging Modality	**Advantages**	**Disadvantages**
X-ray	• Widely available, inexpensive, quick. • Effective for fractures and joint alignment.	• Limited for soft tissue injuries. • Misses subtle syndesmotic damage.
CT	• Detailed bone visualization. • Useful for subtle fractures and 3D surgical planning.	• Limited for soft tissue injuries. • Higher radiation exposure.
MRI	• Excellent for soft tissue assessment (ligaments, cartilage). • Identifies occult fractures.	• Time-consuming • Limited availability.
Ultrasound	• Non-invasive and portable. • Dynamic assessment of syndesmosis and ligaments.	• Operator-dependent. • Limited for deep or complex fractures.

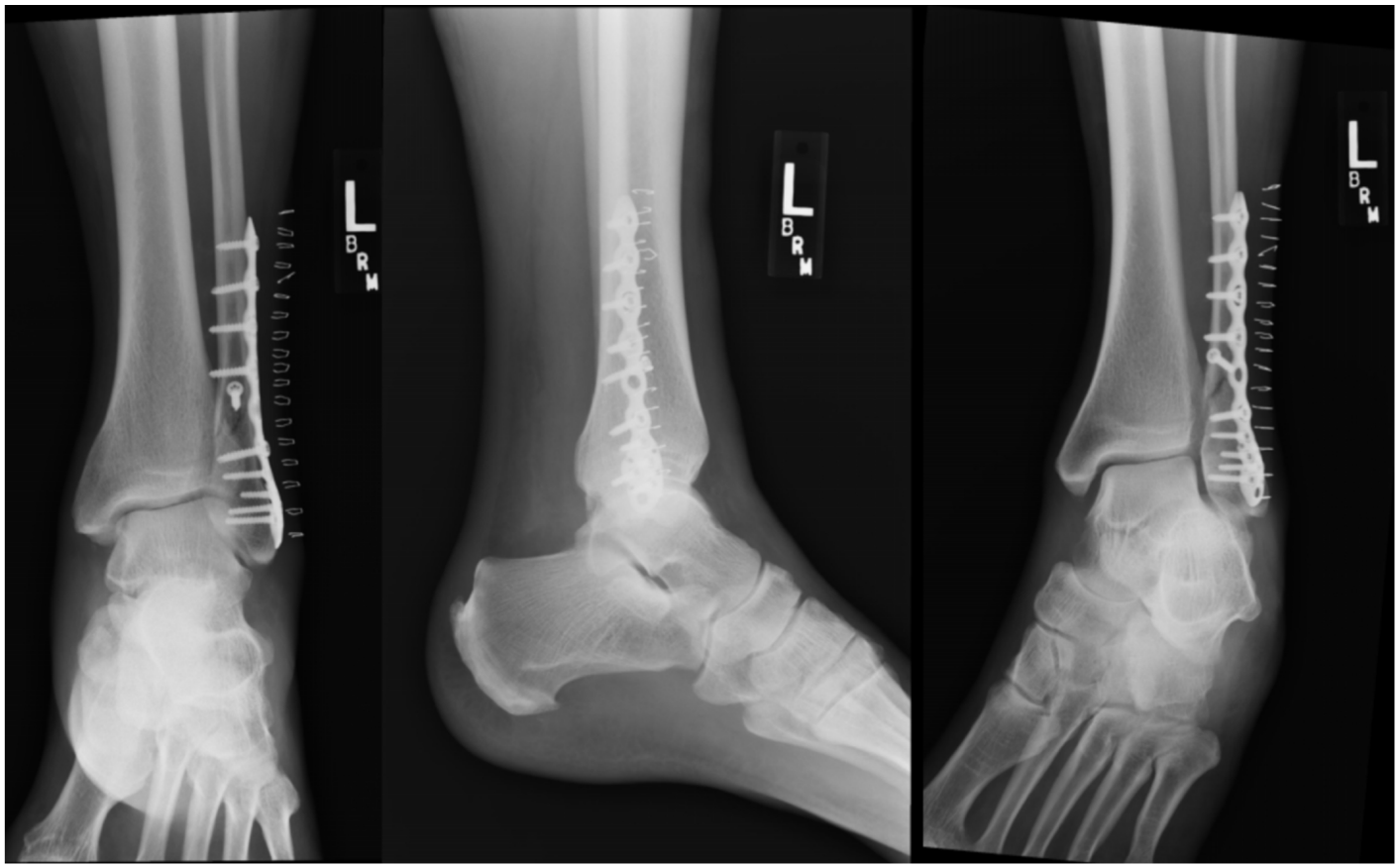

Figure 4.
AP, Lateral, and Medial Oblique left ankle radiographs taken one-week post-surgery (18 days post-injury) revealed the fixated fracture. An Arthrex titanium plate was placed on the distal fibula. An interfragmentary screw was placed first to join the two segments, then a combination of cortical screws, distal locking screws, and proximal locking screws were used to secure the plate, totaling 10 screws. The skin was closed with staples – 18 of which can be seen in the radiograph.

Weber Classification (Danis-Weber Classification)[9]

The Weber classification (or Danis-Weber classification) categorizes distal fibula fractures based on their relation to the ankle joint syndesmosis, guiding treatment decisions. Weber A is a stable fracture of the lateral malleolus, distal to the tibial plafond, without disruption to the syndesmosis or deltoid ligament. Weber B is a fracture through the fibula at the level of the tibial plafond with potential for syndesmosis and deltoid ligament disruption or medial malleolar fracture. These fractures are variable in their stability and may require further imaging and possible ORIF surgery. Weber C is an unstable facture proximal

Key Messages
- Ottawa ankle rules are decision rules to determine the need for radiographs in acute ankle injuries.
- Gravity ankle stress views are a useful tool to assess ankle stability on radiographs.
- The Weber classification system enables clinicians to assess lateral ankle fractures based on radiographic criteria to create a follow up plan.

to the level of the tibial plafond with an associated injury to the syndesmosis often requiring ORIF surgery. There is commonly a fracture of the medial malleolus with deltoid ligament injury.

Summary

The utilization of OAR plays an intricate role in the management of suspected lateral ankle fractures. Combined with the use of the Weber classification system and gravity stress views, chiropractors can properly evaluate the stability of the ankle and understand the potential for surgical intervention.

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