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Diagnostic and management concordance between chiropractors and neurosurgeons for patients with low back pain

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Low back pain is the leading contributor to disability worldwide and a major cause of primary care visits. Alternative models of care delivery drawing on musculoskeletal experts' skills and knowledge have received increasing attention for their potential ability to improve timely access to appropriate healthcare for patients with musculoskeletal disorders. The aim of this study was to evaluate diagnostic and management concordance between chiropractors, known as musculoskeletal experts, and neurosurgeons for patients with low back pain. Before being seen by a neurosurgeon, 101 eligible participants (mean age: 60.32 years) were evaluated by a chiropractor. Overall diagnostic agreement between chiropractors and neurosurgeons was 74.7%, with a moderate inter-rater diagnosis agreement (κ = 0.51; 95%CI [0.35–0.68]). Chiropractors were significantly less likely to attribute a diagnosis of non-specific LBP to participants (31.6%) compared to neurosurgeons (43.2%) ($p = 0.02$), with an agreement proportion of 80.0%. Overall management agreement was 82.0%, indicating that chiropractors possess good skills in triaging patients with low back pain, which can optimize patient trajectories by accelerating management of non-surgical cases and reducing waiting lists for spine surgery consultations. Prospective studies are needed to evaluate the impact of a chiropractor-informed triage on clinical outcomes and healthcare utilization for patients with low back pain.

Keywords Low back pain, Concordance, Models of care, Access to care, Specialized services, Tertiary care

Musculoskeletal disorders (MSDs) are the leading contributor to disability worldwide, with low back pain (LBP) being the primary cause of disability in 160 countries[1,2]. The prevalence of MSDs has steadily increased, from 23.0% in 1990 to 27.8% in 2017 in Canada, which may be influenced by factors such as sedentary lifestyles and population aging[1]. In its latest report addressing costs associated with major diseases and injuries, the Public Health Agency of Canada reported that $6.7 billion, representing 6.0% of Canada's annual health expenditures, were attributed to direct costs related to MSDs (i.e., medications, hospital care and physicians care)[3]. An analysis of Ontario's administrative databases for the 2013–2014 fiscal year revealed that 28.5% of adults made one or more ambulatory visit to a physician for MSDs during the study year, representing 5.6 million primary care visits annually[4].

Although international practice guidelines for the management of LBP exist, significant gaps between evidence and clinical practices persist, contributing to the inappropriate use of diagnostic and therapeutic approaches, including the overuse of opioid prescriptions and imaging, as well as the over-reliance on medical specialists' expertise[5,6]. In 2016, in the province of Quebec, Canada, the Ministry of Health and Social Services introduced

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the Service Request Management Center (*Centre de répartition des demandes de services*-CRDS), a centralized waiting list for all specialized services, where patients are placed in a queue based on medical priority (defined by pre-established criteria presented in Supplementary File SI)[7,8]. In 2018, a CRDS has been implemented to enhance timely access to specialized care within the area served by the *Centre intégré universitaire de soins de santé et de services sociaux de la Mauricie-et-du-Centre-du Québec* (CIUSSS-MCQ). In this administrative region, neurosurgeons are the exclusive specialists responsible for patients with LBP requiring specialized care, except for trauma cases. This limits accessibility further compared to other regions, where care is distributed among multiple specialties. Accordingly, during the year 2024–2025, 2156 patients (covering all conditions managed by neurosurgeons) were awaiting a neurosurgery consultation at CIUSSS-MCQ[9]. Of these consultations, 83.1% were deemed overdue according to patients' medical priority[9]. Furthermore, a retrospective analysis of medical health records revealed that 80.4% of LBP referrals to the neurosurgery department at CIUSSS-MCQ were inappropriate either due to the patient's clinical profile or non-compliance with CRDS criteria, with 88.4% of these referrals originating from general practitioners[10]. These findings highlight that, despite the CRDS's prioritization criteria, the current system remains insufficient to ensure optimal referral pathways for patients with LBP.

In recent years, alternative models of care delivery drawing on musculoskeletal experts' skills and knowledge have received increasing attention for their potential ability to improve access to care and promote optimal use of healthcare resources for patients with MSDs. A systematic review with meta-analyses including 19 concordance studies and 6 randomized controlled trials revealed that advanced practice physiotherapists (APPTs) and physicians displayed good to very good diagnostic (pooled κ 0.76 [95% CI 0.68–0.85]) and management (pooled κ 0.71 [95% CI 0.63–0.78]) agreement for patients with MSDs[11]. Additionally, patients with MSDs managed by APPTs in these studies reported comparable or superior clinical outcomes (i.e., reductions in pain and disability) when compared to the physician-led model of care. In the provinces of Ontario, Manitoba, and Saskatchewan, Canada, the Inter-professional Spine Assessment and Education Clinics (ISAEC) were established to improve access, referral appropriateness and delivery of care for both surgical and nonsurgical patients, using nurse practitioners, chiropractors, and physical therapists (PTs) as adjunctive members of the medical team[12]. A retrospective review of prospective data from ISAEC clinics in Ontario showed that this shared-care interprofessional model significantly improved referral appropriateness, efficiency of MRI utilization, and wait times for surgical assessment for patients with LBP[13].

In the province of Quebec, Canada, similar initiatives have been evaluated, most of them focusing on the ability of PTs to assess and manage patients suffering from peripheral MSDs[14–19]. One study specifically investigated the impact of a model of care led by APPTs on health-related outcomes in surgical and non-surgical patients with spinal disorders and reported high diagnostic and management concordance between APPTs and spine surgeons[17]. As a result, PTs are being increasingly integrated into a variety of clinical settings, such as emergency departments and orthopedic clinics[19]. Given their professional training and expertise[20]chiropractors also have the potential to play a key role in triaging patients with LBP and optimizing referral pathways, whether by offering an alternative entry point into the healthcare system, or by triaging patients already crowded onto waiting lists. However, the lack of integration of chiropractors into the public healthcare system prevents them from directing patients to appropriate healthcare resources.

To address gaps in the current referral process for LBP, we aimed, as a first step, to assess the level of agreement between chiropractors and neurosurgeons in both diagnosis and management decisions. This assessment will help determine whether chiropractors can serve as intermediaries in the care pathways of patients with LBP, potentially reducing unnecessary waits times for medical specialist consultations. Accordingly, this study aimed to evaluate diagnostic and management concordance between chiropractors and neurosurgeons for patients with LBP referred for a neurosurgery consultation. Secondarily, we aimed to determine the patients' characteristics that influence the odds of diagnostic and management disagreements.

Methods

Design

To address these objectives, a secondary analysis of a randomized controlled trial (RCT) was conducted. The RCT aimed to evaluate the effects of evidence-based triaging by a chiropractor on patients' clinical outcomes and care trajectories for LBP (www.clinicaltrials.gov, NCT04923308). In the RCT, the randomization did not determine whether the participant received treatment but rather whether the chiropractor's assessment conclusions were communicated to the neurosurgeon. In other words, regardless of group allocation, all participants underwent a chiropractor's assessment and were subsequently evaluated by the neurosurgeon. For participants in the intervention group, neurosurgeons were kept blinded to the chiropractors' conclusions until they completed their own patient evaluation. This study was reviewed and approved by the Centre intégré universitaire de santé et de services sociaux de la Mauricie-et-du-Centre-du-Québec (CIUSSS-MCQ) (CER-2021-488-766) and the Université du Québec à Trois-Rivières (UQTR) (CER-20-269-07.13) independent research ethics boards. All methods were performed in accordance with the relevant guidelines and regulations. All participants signed an informed consent form prior to participation.

Setting

The study was conducted in collaboration with the neurosurgery outpatient clinic affiliated to the CIUSSS-MCQ. The latter serves a population of more than 530,000 people, including 82.5% over the age of 18[21]. During the study period, the CIUSSS-MCQ's neurosurgery department was staffed by 3 neurosurgeons. Chiropractors' evaluations were conducted by 3 licensed chiropractors, employed as full-time professors or as lecturers at the UQTR (Quebec, Canada), with experience in treating patients with MSDs ranging from 4 to 20 years. To ensure standardized evaluation procedures, chiropractors received an in-person training. The training program

was specifically designed to leverage chiropractors' existing knowledge and expertise. As chiropractors are not formally integrated into the public health system in Canada, the training included a 3-hour theoretical session that provided an overview of the public healthcare system's structure, the procedures for referring patients to specialized care, the CRDS's role and pre-established criteria, as well as a revision of key LBP-related topics. These concepts were integrated into a clinical decision-making algorithm (see Supplementary File S2), which served as a decision-aid. To familiarize chiropractors with the application of the algorithm, a 3-hour practical session was conducted, involving case-based scenarios that participants completed individually and then discussed in groups led by the lead clinician of the research team. The training focused on providing chiropractors with the tools to seamlessly integrate their existing expertise into the structured referral process, ensuring they could confidently navigate the system. Neurosurgeons, on the other hand, carried out their evaluations according to their usual clinical practice, to reflect typical real-world healthcare settings.

Participants

All patients referred for a neurosurgery consultation for LBP from July 2021 to November 2023 were identified by the neurosurgery department's administrative staff using primary complaint reported at the time of appointment scheduling. Each patient who consulted in the neurosurgery department was assigned a priority code (A to E) that corresponds to a specific timeframe within which the neurosurgery consultation should occur after the referral is sent (Supplementary File SI). Patients for whom consent was obtained were subsequently contacted by a research assistant to ascertain their eligibility. Inclusion criteria were: [1] being aged 18 years or older; [2] referred for an initial neurosurgery consultation for a primary complaint of LBP (either acute, chronic, or recurring episode); and [3] able to legally consent to participate. As this study was part of an RCT examining the effect of a triage approach led by musculoskeletal experts on patients' clinical outcomes and care trajectories, patients were excluded if they were involved in litigation related to their LBP condition (worker's compensation, public automobile insurance plan or other litigations) as these situations were considered likely to impact patients' prognosis and healthcare utilization.

Procedures and data collection

Before being seen by the neurosurgeon, each eligible participant was invited to come to the facilities of UQTR's *Chaire de recherche internationale en santé neuromusculosquelettique* to be evaluated by the chiropractor. Participants first completed a standardized questionnaire with the research assistant where they provided sociodemographic data, followed by an 11-point numerical rating scale (NRS) to measure back and leg pain intensity, the Oswestry Disability Index (ODI) for LBP-related disability, and the STart Back Screening Tool (SBST) designed to screen patients with LBP for poor prognostic factors. The NRS, ODI and SBST are all valid, reliable, and responsive assessment tools that are suitable for use in clinical practice[22–24]. The chiropractor then conducted an evidence-based triage evaluation[25]which consisted of a standardized history taking and physical examination. Table 1 presents all variables that were considered by the chiropractor in determining the primary diagnosis (i.e., the most probable) and the most suitable management strategy for each patient.

After the assessment, chiropractors completed a standardized clinical note (see Supplementary File S3) where they recorded their final conclusions. Table 2 defines the possible consultation outcomes (i.e., the diagnostic and management categories in which patients were stratified). The diagnosis was determined by considering patient demographics, pain characteristics (i.e., primary site of pain, pain distribution, aggravating and relieving factors), the presence of objective neurological deficits, and the presence of red flags (i.e., indicators of an underlying pathology). The best management strategy was established based on the patient's history of treatments and diagnostic tests, progression of symptoms, level of disability (ODI questionnaire), risk of poor prognosis (as determined by the SBST) and risk of aggravation of the condition. In cases where an underlying pathology was suspected, the International Framework For Red Flags published by Finucane et al.[27] was used to clinically assess the relevance of the information gathered and to determine the most appropriate course of clinical action. To facilitate comparability of decisions made by chiropractors and neurosurgeons, diagnostic and management categories were determined considering best evidence synthesis[25] and after consultation with the neurosurgeon team member (C-É.C). Of note, chiropractors were not tasked to determine whether surgery was indicated or not. Their role was limited to assessing whether the patient required the expertise of a neurosurgeon, either surgical or non-surgical. Similarly, neurosurgeons were not required to specify which type of conservative care was needed but rather to decide if a conservative approach was the most appropriate management strategy for the patient. The use of general diagnostic and management categories in this study allowed both chiropractors and neurosurgeons to evaluate cases based on their respective expertise and knowledge. Neurosurgery consultations' outcomes were retrieved from patients' medical files by a trained research assistant that was kept blinded to the study objectives.

Statistical analysis

The Kolmogorov-Smirnov normality test was performed for all continuous variables to determine data distribution. Patients' clinical profiles, care trajectories and consultation outcomes were summarized using frequency distributions for categorical variables, and means, medians and standard deviations for continuous variables. Two independent evaluators (J.M., A-A.M.) reviewed diagnoses and management strategies to establish if they were concordant. A third evaluator (M.D.) was involved when consensus was not reached. The proportion of agreement was calculated for overall diagnostic and management agreement, and Cohen's kappa (κ) with associated 95% confidence intervals (95% CI) were calculated for overall diagnostic and management agreement, as well as for each diagnostic category. The strength of agreement for κ was interpreted as described in previous studies on diagnostic agreement: 0.00-0.20: weak; 0.21–0.40: slight; 0.41–0.60: moderate; 0.61–0.80: good; 0.81–0.90: very good, and 0.91-1.00: excellent[11].

Category	Variable	Outcome
Clinical data		
History taking	Presence of red flags (i.e., indicators of an underlying pathology)	Bladder and bowel dysfunction, saddle anesthesia, fever, chills, progressive neurological symptoms, history of trauma, prolonged corticosteroid use, recent history of infection, previous history of cancer, unexplained weight loss, intravenous drug use, being immunocompromised, morning stiffness, improvement in back pain with exercise but not with rest, awakening because of pain in the second half on the night, alternating buttock pain, and failure to improve with conservative care
	Pain dominance	Back, leg(s) or both
	Pain status	Intermittent, constant
	Pain duration	Acute (< 4 wks), Subacute (4-12wks) or chronic (> 12 wks)
	Symptoms progression	Stable, aggravating, improving
	Prognostic factors	History of spinal surgery Smoking status Type and number of comorbidities
Self-reported questionnaires	Pain intensity	NRS-11[23]: measure of pain intensity ranging from 0 (no pain) to 10 (pain as bad as it could be)
	Disability	ODI[24]: regroups 10 questions related to different domains including pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sexual life, social life, and traveling. Each question is rated on a scale of 0 to 5 points with a maximum score of 50. Higher scores indicate greater disability.
	Risk of poor prognosis	SBST[22,26]: brief validated tool (9-item version): designed to screen patients with LBP for prognostic factors and group patients in 3 categories of risk of poor outcome – low, medium, and high risk
Physical examination	Presence of neurological deficits	Sensory, motor, deep tendon reflex deficits
	CNS disorder	Presence of pathological reflexes
Care trajectories data		
History taking	Use of advanced imaging and diagnostic testing for LBP prior to the neurosurgery consult	Number and type
	Use of conservative care prior to the neurosurgery consult	Number and type of treatments Type of health professional seen

Table 1. Variables used to inform diagnostic and management strategies. *CNS* Central nervous system, *NRS-11* 11-point Numerical Rating Scale, *ODI* Oswestry Disability Index, *SBST* STarT Back Screening Tool, *wks* weeks.

Chi-square tests were used to compare the proportions of patients assigned to each diagnostic category and management strategy. Binomial logistic regression analyses using the Wald backward selection method was also conducted to determine if any clinical or care trajectories variables predicted diagnostic or management disagreement. Odds ratios (OR) and 95% CI were calculated and reported for each included variable. All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 18.0.0 (Armonk, NY: IBM Corp.). Statistical significance was defined as a two-tailed p value < 0.05. A posteriori power analysis was used to determine if an appropriate statistical power was reached. In our study, data from the RCT (www.clinicaltrials.gov, NCT04923308) were used to perform a secondary analysis exploring the diagnostic concordance between professionals and post hoc power analyses provide insight into whether the sample size was adequate for detecting an effect. Considering the sample size, a significance level of 0.05 and a null hypothesis $\kappa_0 \leq 0.4$, we reached a statistical power of 0.8.

Results

Participants

One hundred and fifty potential participants were identified by the neurosurgery department staff at appointment scheduling. Figure 1 presents a flowchart summarizing the recruitment of participants. A total of 101 eligible patients agreed to participate and were included in the study. The mean age of the sample was 60.32 years (SD = 14.69) and 52.5% of included participants were male. The number of days between the chiropractor evaluation and the neurosurgery consultation ranged from 0 to 27 days (median: 1.0; IQR: 1.0–3.0). All participants included in this study were assigned to priority codes C (appointment needed within 28 days), D (appointment needed within 3 months) and E (appointment needed within 12 months).

Clinical profiles

Patients' clinical characteristics are detailed in Table 3. Of the 101 participants included in the analysis, 42.6% presented with one or more red flags (range 1–6), the most frequent being unusual fatigue (29.7%), night pain (28.8%), and progressive neurological deficit (23.8%). Sixty-one participants (60.4%) reported back pain worse than leg pain, and 57.4% exhibited intermittent symptoms. Most participants (94.1%) were experiencing chronic pain (> 12 weeks), 45.5% had an impaired sensory function, 70.3% had objective motor deficits, and 27.7% showed asymmetrically diminished deep tendon reflexes. Thirty-one participants (30.7%) had stable or improving symptoms at the time of the chiropractor's assessment, and 55.4% exhibited a deterioration in symptomatology. A review of participants' medical history revealed that 10.9% had a previous history of lumbar surgery, and that 15.8% were current smokers. In 67.3% of cases, participants were classified as multimorbid, presenting two or more comorbidities[32]the most frequent being cardiovascular diseases (60.4%), endocrine

Diagnosis		
Category	**Main characteristics**	**Nomenclature**
1. Non-specific LBP[28]	Exclusion of radicular syndrome and specific LBP No known pathoanatomical cause	Mechanical LBP, chronic primary LBP, SIJ dysfunction
2. Radicular syndrome[29,30]	Radicular pain	Sciatica Lumbar disc herniation Lumbar nerve root involvement/compression/impingement
	Leg pain typically worse than back pain Dermatomal distribution Unilateral (below the knee for L4, L5, S1)	
	Radiculopathy	
	Presence of weakness, loss of sensations, or loss of deep tendon reflexes Dermatomal distribution Unilateral Can coexist with radicular pain	
	LSS	
	Typically, bilateral leg pain with or without LBP Pain relief upon sitting, or when bending forward Pain exacerbation while standing up or walking	Neurogenic claudication
3. Specific LBP[29–31]	Pain arises from an underlying pathoanatomical cause Presence of red flags (i.e., indicators of an underlying pathology)	Spinal fracture Cauda equina syndrome Malignancy/spinal tumor Spinal infection Axial spondyloarthritis
4. Other	Pain arises from problems beyond the lumbar spine	e.g., Cervical myelopathy, vascular disorders, peripheral joints disorders
Management strategies		
Category	**Chiropractors**	**Neurosurgeons**
1. Conservative care	Indication to pursue or to initiate conservative treatments Surgical consultation not indicated	a) The patient is discharged from the neurosurgery service or b) A FUP visit, or phone call is scheduled after the conservative care trial
2. Further diagnostic tests needed	Lack of appropriate diagnostic tests or tests not sufficiently up to date to determine the primary diagnosis and the best management strategy	Neurosurgeons determined that there was a lack of appropriate diagnostic tests to establish the diagnosis or identify the best management strategy The patient is advised to undergo the appropriate diagnostic tests (e.g., imaging, EMG) and a FUP visit is scheduled
3. Neurosurgery referral indicated	The patient's clinical profile warrants a neurosurgical consultation (e.g., progressive neurological signs and symptoms, high levels of disability combined to failure of conservative treatments or with evidence of structural abnormalities)	a) Clear surgical indication (i.e., preoperative examinations are scheduled) b) Relative surgical indication[a], a FUP visit is scheduled to monitor the progression of symptoms c) The neurosurgeon determined the surgery was not indicated at this stage but prescribed other tests or interventions, along with a follow-up visit
4. Medical emergency	The patient presents a condition that poses an immediate risk to their life or long-term health (e.g., suspicion of a leaking aortic aneurysm)	Immediate referral to the emergency department
5. Falls under another specialty	Spinal surgery not indicated but the patient needs to be seen by another specialist (e.g., vascular surgeon)	The patient is discharged from the neurosurgery service and is referred to another specialist

Table 2. Consultation outcomes. *FUP* Follow-up, *LBP* Low back pain, *LSS* Lumbar spinal stenosis, *SIJ* Sacroiliac joint. [a]Potential surgical indication if symptoms persist or worsen after conservative treatment or for clinically stable patients with persistent disabilities.

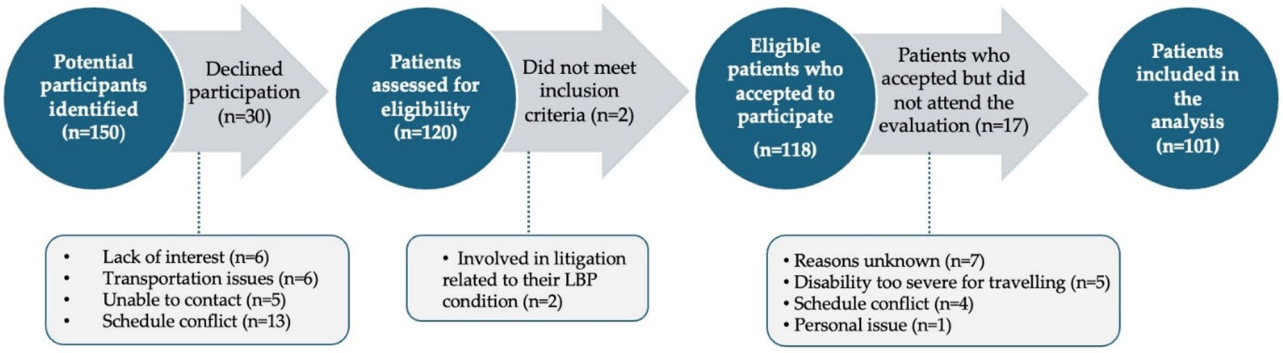

Fig. 1. Flowchart of study participants.

Characteristics ($N = 101$)	N (%) or Mean ± SD	Missing value, n (%)
Presence of one or more red flags (yes)	43 (42.6)	–
Red flags (type)		–
Unusual fatigue	30 (29.7)	
Night pain	29 (28.7)	
Progressive neurological deficit	24 (23.8)	
Morning stiffness	19 (18.8)	
Urinary or fecal incontinence	18 (18.7)	
History of cancer	17 (16.8)	
Urinary retention	16 (15.8)	
Night sweats	14 (13.9)	
Other	20 (19.8)	
Pain dominance		–
Back dominant	61 (60.4)	
Leg dominant	40 (39.6)	
Pain status		–
Constant pain	–	
Intermittent pain	–	
Pain duration		–
Acute	2 (2.0)	
Subacute	4 (4.0)	
Chronic	95 (94.1)	
Symptom progression		14 (13.9)
Stable	12 (11.9)	
Aggravation	56 (55.4)	
Improvement	19 (18.8)	
History of spinal surgery (yes)	11 (10.9)	–
Smoking status		3 (3.0)
Non-smoker	51 (50.5)	
Current smoker	16 (15.8)	
Former smoker	30 (29.7)	
Comorbidities (number)		–
0–1	33 (32.7)	
Multimorbidity (≥ 2)	68 (67.3)	
Comorbidities (type)		–
Cardiovascular	61 (60.4)	
Endocrine	38 (37.6)	
Gastrointestinal	19 (18.8)	
Psychological	18 (17.8)	
Neurological	13 (12.9)	
Other	50 (49.5)	
Pain intensity (NRS-11)		1 (1.0)
Back pain	5.3 ± 2.5	
Leg pain	4.2 ± 2.8	
Disability (ODI)	39.4 ± 17.0	1 (1.0)
Risk of poor prognosis (SBST)		1 (1.0)
Low risk	25 (24.8)	
Medium risk	42 (41.6)	
High risk	33 (32.7)	
Sensory function		4 (4.0)
Hypoesthesia	44 (43.6)	
Hyperesthesia	1 (1.0)	
Allodynia	1 (1.0)	
Normal	51 (50.5)	
Motor function		1 (1.0)
Motor deficit	71 (70.3)	
Normal	28 (27.7)	

Continued

Characteristics ($N = 101$)	N (%) or Mean ± SD	Missing value, n (%)
Reflexes		2 (2.0)
Hyporeflexia	28 (27.7)	
Hyperreflexia	0 (0.0)	
Normal	70 (69.3)	
Presence of pathological reflexes		1 (1.0)
Clonus	5 (5.0)	
Positive Babinski sign	1 (1.0)	
Positive Hoffman sign	1 (1.0)	

Table 3. Clinical profiles based on chiropractors' assessments. *NRS-11* 11-point Numerical Rating Scale, *ODI* Oswestry Disability Index, *SBST* STarT Back Screening Tool, *SD* Standard deviation.

Characteristics ($N = 101$)	N (%)	Missing value, n (%)
Diagnostic tests prior to the neurosurgery consultation (yes)	93 (92.1)	2 (2.0)
Diagnostic tests (type)		1 (1.0)
MRI	86 (85.1)	
CT-scan	21 (20.8)	
X-rays	7 (6.9)	
Other[a]	8 (7.9)	
Conservative treatments prior to the consultation (yes)	75 (74.3)	–
Non-pharmacological conservative treatments prior to the consultation		–
Physiotherapy	52 (51.5)	
Massage therapy	17 (16.8)	
Chiropractic	35 (34.7)	
Other[b]	16 (15.8)	
Pharmacological conservative treatments prior to the consultation		26 (25.7)
Pain medication	91 (90.1)	
Anesthetic injections	47 (46.5)	
Previous consultation with a neurosurgeon for the same LBP problem (yes)	22 (21.8)	–

Table 4. Previous examinations and treatments. *CT-scan* Computed tomography, *MRI* Magnetic resonance imaging, *X-rays* Radiographs. [a]Angiography scan, Electromyography, Scintigraphy. [b]Kinesiology, Osteopathy, Acupuncture, Occupational therapy.

diseases (37.6%) and gastrointestinal disorders (18.8%). Participants experienced moderate back (M = 5.3 ± 2.5) and leg pain intensity (M = 4.2 ± 2.8) and reported moderate LBP-related disability (M = 39.4 ± 17.0). As for risk of poor prognosis determined by the SBST, 24.8% of patients were stratified as low risk, 41.6% as medium risk, and 32.7% as high risk.

Care trajectories

Table 4 presents detailed information regarding participants' care trajectories for their current LBP episode. Nearly all (92.1%) participants were referred by their primary physician for further diagnostic testing prior to their initial neurosurgery consultation, with MRI (85.1%) and CT-scan (20.8%) being the most frequently prescribed imaging procedures. Seventy-five participants (74.3%) received conservative treatments prior to the neurosurgery consultation, including 41.8% for whom pain medication was prescribed, 46.5% who received anesthetic injections, 51.5% who underwent physiotherapy treatments, and 34.7% who had seen a chiropractor.

Consultation outcomes

The final conclusions of the chiropractors' assessments are presented in Table 5. Sixty-five participants (64.4%) were diagnosed with a radicular syndrome, with each participant having one of the following conditions: radicular pain, lumbar radiculopathy or lumbar spinal stenosis. The diagnosis of non-specific LBP was attributed to 29.7% of participants, with the remaining suffering from specific LBP (1.0%) or experiencing symptoms unrelated to lumbar spine disorders (5.0%). Upon chiropractors' assessment, conservative care was considered the most appropriate management strategy for 50.5% of participants, while 43.6% were deemed to require a neurosurgery consultation. For 3 participants, further diagnostic tests were considered necessary to determine the best management strategy.

Of the 101 participants, 100 attended their consultation with the neurosurgeon. Neurosurgery consultation outcomes are presented in Table 6. A clear spinal surgery indication was documented in 9.0% of participants. 35% of participants were discharged from the neurosurgery service and advised to pursue or initiate conservative

Characteristics ($N=101$)	N (%)
Diagnostic	
1. Non-specific LBP	30 (29.7)
2. Radicular syndrome	65 (64.4)
3. Specific LBP	1 (1.0)
4. Other	5 (5.0)
Management strategies	
1. Conservative care	50 (50.5)
2. Further diagnostic tests needed	3 (3.0)
3. Neurosurgery referral indicated	44 (43.6)
4. Medical emergency	0 (0.0)
5. Falls under another specialty	4 (4.0)

Table 5. Outcomes of chiropractors' evaluation. *LBP* Low back pain.

Characteristics ($N=100$)	N (%)	Missing value, n (%)
Diagnostic		
1. Non-specific LBP	41 (41.0)	5 (5.0)
2. Radicular syndrome	52 (52.0)	
3. Specific LBP	0 (0.0)	
4. Other	2 (2.0)	
Management strategies		
1. Conservative care		–
a) Discharge from the neurosurgery service and advise to pursue or initiate conservative treatments	35 (35.0)	
b) Conservative care and FUP	16 (16.0)	
2. Further diagnostic tests needed[a]	3 (3.0)	
3. Neurosurgery referral indicated		
a) Clear surgical indication (surgery performed)	9 (9.0)	
b) Relative surgical indication	2 (2.0)	
c) Other tests and FUP		
Anesthetic injections and FUP	20 (20.0)	
Imaging and FUP	11 (11.0)	
4. Falls under another specialty	4 (4.0)	
5. Medical emergency	0 (0.0)	

Table 6. Neurosurgery consultations' outcomes. *FUP* Follow-up, *LBP* Low back pain. [a]Neurosurgeons determined that there was a lack of appropriate diagnostic tests to establish the diagnosis or identify the best management strategy.

treatments, and 16.0% were prescribed a follow-up visit after their conservative care trial. For participants non-surgically managed by neurosurgeons (i.e., those for whom the neurosurgeon determined the surgery was not indicated at this stage but prescribed other tests or interventions, along with a follow-up visit) (33.0%), 20.0% were referred for anesthetic injections, and 11.0% for advanced imaging or other tests (e.g., EMG). Three participants (3.0%) attended the neurosurgery consultation without the required imaging. As a result, neurosurgeons determined that there was a lack of appropriate diagnostic tests to establish the diagnosis or identify the best management strategy.

Diagnostic agreement

Of the 101 participants, 6 were excluded from the diagnostic agreement analysis, including 5 for whom no formal diagnosis was retrieved from the patient's file by the research assistant and 1 who did not attend the neurosurgery consultation (due to a personal issue). Overall diagnostic agreement between chiropractors and neurosurgeons was 74.7% (71/95) and inter-rater diagnosis agreement was moderate ($\kappa = 0.51$; 95%CI [0.35–0.68]). Table 7 presents agreement proportions and inter-rater diagnosis agreement per diagnostic category. Chiropractors were significantly less likely to attribute a diagnosis of non-specific LBP to participants (31.6%) compared to neurosurgeons (43.2%) ($p = 0.02$), with an agreement proportion of 80.0%. Sixty participants (63.2%) were diagnosed with a radicular syndrome by the chiropractors, compared to 54.7% by the neurosurgeons ($p = 0.09$), with an agreement proportion of 75.0%. Chiropractors were more likely than neurosurgeons to consider a problem beyond the lumbar spine as the cause of LBP (5.3% vs. 2.1%), but this difference was not statistically significant ($p = 0.08$).

Primary diagnosis	Chiropractors (%)	Neurosurgeons (%)	Chi-square test (*p* value)	Agreement proportion (%)	κ (95% CI)
1. Non-specific LBP	30 (31.6)	41 (43.2)	5.26 (0.02)*	24/30 (80.0)	0.49 (0.32–0.66)
2. Radicular syndrome	60 (63.2)	52 (54.7)	2.91 (0.09)	45/60 (75.0)	0.53 (0.35–0.70)
3. Specific LBP	0 (0.0)	0 (0.0)	–	–	–
4. Other	5 (5.3)	2 (2.1)	3.00 (0.08)	2/5 (40.0)	0.56 (1.12–0.99)

Table 7. Diagnostic agreement. κ: Cohen's kappa; LBP: Low back pain; *$p < 0.05$.

Management strategy	Chiropractors (%)	Neurosurgeons (%)	Chi-square test (*p* value)	Agreement proportion (%)
1. Conservative care	49 (49.0)	51 (51.0)	0.22 (0.815)	41/49 (83.7)
2. Further diagnostic tests needed	3 (3.0)	3 (3.0)	–	3/3 (100.0)
3. Neurosurgery referral indicated[a]	44 (44.0)	42 (42.0)	0.89 (0.481)	34/44 (77.3)
4. Medical emergency	0 (0.0)	0 (0.0)	–	–
5. Falls under another specialty	4 (4.0)	4 (4.0)	–	4/4 (100.0)

Table 8. Management agreement. *$p < 0.05$. [a]Chiropractors determined that the participant's condition warranted the expertise of a neurosurgeon. Neurosurgeons managed the participant either surgically or non-surgically.

Management agreement

Of the 101 participants, one was excluded from the management agreement analysis for not attending the neurosurgery consultation (due to a personal issue). Overall management agreement between chiropractors and neurosurgeons was 82.0% (82/100), with good inter-rater agreement (κ 0.68; 95%CI [0.54–0.82]).

Table 8 presents agreement proportion per management category. Chiropractors determined that undergoing conservative care treatments was the best management strategy for 49.0% of participants, compared to 51.0% for neurosurgeons ($p = 0.815$), with an agreement proportion of 83.7%. Both the chiropractors and neurosurgeons identified 3 participants that needed to undergo further diagnostic tests and 4 participants that needed to be seen by another specialist (i.e., vascular surgeon, ENT specialist), with an agreement proportion of 100.0%. Chiropractors determined that 44.0% of participants presented with a condition warranting the expertise of a neurosurgeon, while 42.0% of the participants were managed by neurosurgeons ($p = 0.481$), either surgically or non-surgically, with an agreement proportion of 77.3%.

Figure 2 details neurosurgeons' decisions for the participants for whom chiropractors recommended conservative care or a neurosurgery consultation. We defined agreement between providers for conservative care as occurring when neurosurgeons also recommended conservative care, with or without a follow-up visit. We defined an agreement between providers for a neurosurgery referral as occurring when neurosurgeons managed the patient either surgically or non-surgically (i.e., by prescribing additional tests or interventions along with a follow-up visit). Of the 49 participants who were advised to initiate or pursue conservative care by chiropractors, 28 (57.1%) were discharged from the neurosurgery service upon initial consultation (i.e., the neurosurgeon determined that their expertise was not required, and that the patient should initiate or pursue conservative treatment), and 13 (26.5%) were recommended conservative care combined with a follow-up visit. Eight participants (16.3%) for which conservative care was determined to be the best management strategy by the chiropractors were managed by neurosurgeons, of whom 7 (14.3%) were prescribed other tests with a follow-up visit, and one (2.0%) who underwent spinal surgery. Ten participants (22.7%) for whom the neurosurgery consultation was deemed necessary by the chiropractors were advised by neurosurgeons to pursue conservative treatments, including 7 (15.9%) who were discharged from the neurosurgery service, and 3 (6.8%) for which a follow-up visit was scheduled. Thirty-four participants (77.3%) were managed by neurosurgeons as recommended by the chiropractors including 26 (59.1%) who were prescribed other tests with a follow-up visit, and 8 (18.2%) who underwent spinal surgery.

Predictors of diagnostic and management disagreement

Regression analyses revealed two predictors of diagnostic disagreement. The presence of urinary retention was associated with a six-fold increase in the odds of diagnostic disagreement ($p = 0.007$; OR 6.397; 95% CI [1.648–24.831]). Additionally, the presence of asymmetrically diminished tendon reflexes was associated with a 77.9% decrease in the odds of diagnostic disagreement ($p = 0.040$; OR 0.221; 95% CI [0.052–0.937]. None of the variables included in the binomial regression analysis emerged as predictors of management disagreement. Results of regression analyses are detailed in Supplementary File S4.

Discussion

The increasing prevalence of MSDs, especially LBP, has strained healthcare systems' capacity to manage limited resources. Overreliance on the expertise of medical specialists has contributed to long waiting lists, delaying access to appropriate care for patients with LBP. Given their expertise, chiropractors can play a crucial role in triaging patients with LBP and optimizing referral pathways, enabling a more efficient use of healthcare

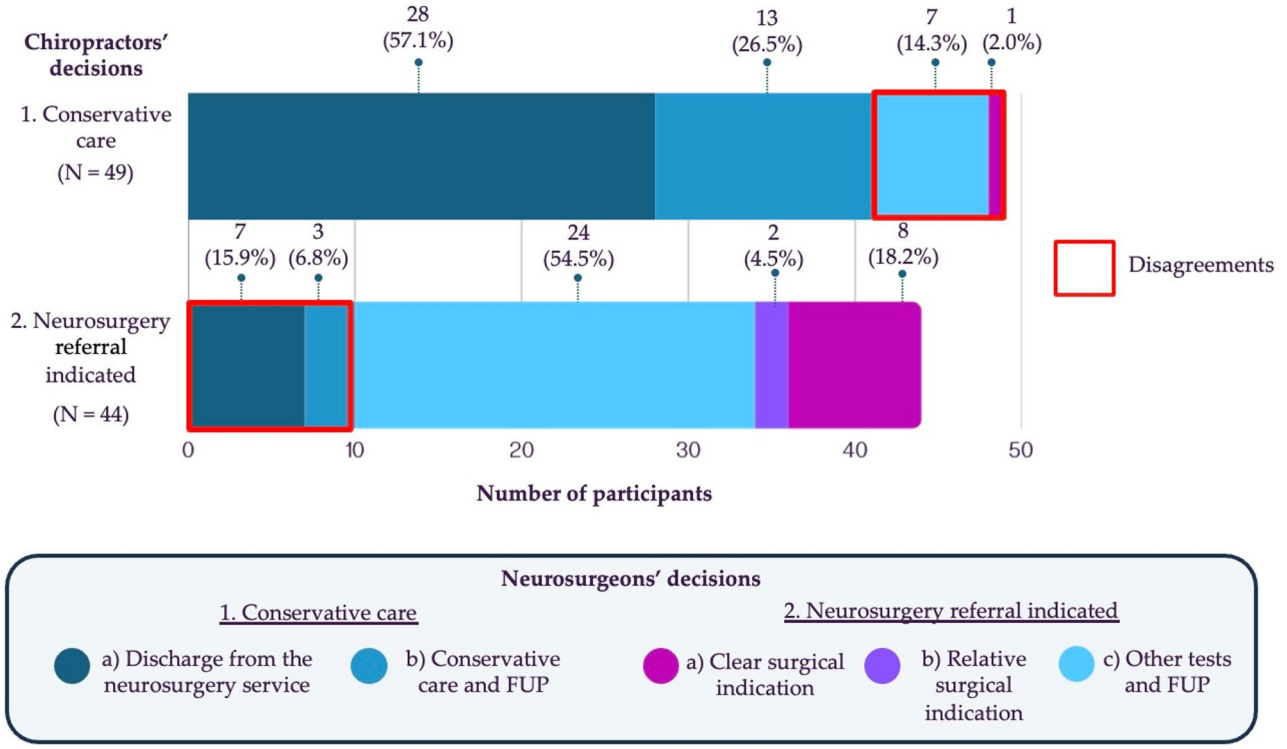

Fig. 2. Comparison of recommended management strategies between chiropractors and neurosurgeons. This figure details the neurosurgeons' decisions for participants for whom chiropractors recommended either conservative care (indicated by the upper bar) or a neurosurgery consultation (indicated by the bottom bar). Cases where there was disagreement between providers are highlighted by a red rectangle.

resources while minimizing unnecessary wait times for specialist consultations. As a first step, this study aimed to evaluate the diagnostic and management concordance between chiropractors and neurosurgeons for patients with LBP referred for a neurosurgery consultation, and to identify the patients' characteristics that influence the odds of diagnostic and management disagreements between providers.

One hundred and fifty eligible patients were identified by the neurosurgery department, including 30 (20.0%) who declined to participate. Compared to previous diagnostic concordance studies where non-participation rates ranged from 0.0%-to 11.4%[14–19], this study observed higher rates of non-participation. The primary reasons cited to decline participation were schedule conflicts and transportation issues. In this study, chiropractors and neurosurgeons were not working in the same facilities, requiring patients to travel to both sites and allocate extra time in their schedules to participate, which may explain these differences.

Ultimately, the study sample included 101 participants, with a mean age of 60 years. Chiropractors' and neurosurgeons' diagnostic agreement was moderate. Diagnostic agreement was slightly lower compared to previous diagnostic concordance studies focusing on various MSK disorders and peripheral joints disorders (i.e., hip, knee, and shoulder), reporting overall agreement ranging from 86.0 to 92.2% and good to very good inter-rater agreement (κ 0.63; 95%CI [0.13-1.00] – 0.89; 95%CI [0.83–0.94])[14–19]. However, several contextual factors, had they been different, may have contributed to a higher level of agreement between providers. For instance, some assessments were not performed on the same day as the neurosurgery consultation, as the timing of the neurosurgery appointment did not leave sufficient time for chiropractors to perform their assessments beforehand. For 5 out of the 8 participants for whom the delay between appointments exceeded one week, disagreements between the two providers regarding diagnosis and/or management strategy were observed. As chronic LBP is fluctuating in nature[33,34]a shorter delay between assessments would likely minimize changes in the clinical profile, thereby limiting the potential for conflicting clinical decisions. Higher diagnostic concordance might also have been achieved if chiropractors had access to the same diagnostic tests as neurosurgeons (e.g. bladder scan, MRI). This is particularly relevant in cases involving bladder dysfunction, which can result from a wide range of conditions. In such situations, a subjective assessment of symptoms may not be sufficient for definitive diagnosis, which could partly explain the differences observed in diagnostic conclusions. Furthermore, considering the variability in performance of evaluation components for the diagnostic triage of patients with LBP and the potential for subjectivity in interpreting results[25]the lack of standardization in assessment protocols between chiropractors and neurosurgeons could also be a factor contributing to diagnostic discordance.

Overall management agreement between chiropractors and neurosurgeons was good. This result is comparable to previous studies investigating management agreement for diverse MSK conditions, reporting overall management agreement ranging from 64.0 to 91.6% and slight to good inter-rater agreement (κ 0.27 95%CI

[0.07–0.45] – 0.77 95%CI [0.65–0.88]) between providers[14,15,17–19]. Overall agreement for conservative care was high, with only 8 disagreements, including 7 patients for whom other tests were prescribed with neurosurgery follow-up. Neurosurgeons mentioned informally that they might be more likely to provide immediate care (i.e., either surgical or non-surgical) to patients with complex clinical profiles, even when conservative care could have been beneficial, acknowledging that these patients often face long waiting lists to see a medical specialist, which might partly explain these discrepancies. Higher management concordance might also have been achieved if chiropractors had access to imaging results. These were not available to chiropractors as they did not share the neurosurgery clinic's facilities and therefore had no access to centralized patient medical records. Out of 10 cases where neurosurgeons recommended conservative care despite chiropractors determining that a neurosurgery consultation was necessary, imaging findings supported neurosurgeons' decisions in 3 of these cases, showing a discordance between MRI results and the patient's clinical profile or a reduction in disc herniation compared to previous imaging. One patient also informed the chiropractor of a sacral tumor, which was later rule out with imaging. Considering that chiropractors have since gained access to the Dossier Santé Québec, a secure platform that facilitates real-time sharing of health information between authorized organizations and healthcare providers, diagnostic concordance between chiropractors and neurosurgeons is likely to improve further. Additionally, a better access to health information should help to minimize situations of uncertainty, where chiropractors refer patients to neurosurgeons as a precaution. A patient with dominant leg pain, without objective neurological signs, yet with severe disability, may be an example where primary care clinicians might be concerned about the progression or severity of the condition and judge that a referral to the medical specialist is appropriate despite the absence of objective neurological signs. Another difference lies in the use of the SBST and ODI questionnaires[22,24]which informed chiropractors on the patient's level of disability and risk of poor prognosis. In addition to providing information on the risk of persistent pain and disability, the SBST questionnaire was designed to directly guide treatment or referral decisions by using risk-prediction thresholds[35]. Stratified care approaches using the SBST questionnaire have been shown to lead to better health outcomes compared to usual care for patients with LBP[36,37]. Incorporating the results of the SBST and ODI questionnaires into the neurosurgeons' assessments could have increased the level of agreement in management decisions.

Nevertheless, chiropractors and neurosurgeons agreed that a significant proportion of patients with LBP could have benefited from conservative management. These study findings suggest that a chiropractor-led model of care could help reduce unnecessary wait times for medical specialist consultations and improve timely access to appropriate care for patients with LBP.

Strengths and limitations

To our knowledge, this is the first study to evaluate diagnostic and management agreement between chiropractors and neurosurgeons, specifically for patients suffering from LBP and referred for neurosurgery consultation. The sample encompasses patients with diverse clinical profiles representative of the study population, which enhances the generalizability of the results. However, our study has some limitations. Although the sample is representative, it primarily includes patients with more complex clinical profiles than those typically seen by chiropractors. Additionally, for patients where two types of pain coexist (e.g., non-specific and radicular pain), the delay between consultations may have led to a shift in the dominant pain type. Categorizing these patients into a single diagnostic category could have potentially created an impression of disagreement between providers where none existed. Furthermore, this study did not account for the nociplastic dimension of pain. While this represents a critical aspect of pain assessment, current LBP clinical practice guidelines do not yet provide clear recommendations for evaluating this type of pain. Another limitation is that chiropractors were aware that the patient had already been referred to neurosurgery, and given the high proportion of referrals deemed inappropriate[10]this may have introduced a perception bias. It remains unclear whether this bias overestimated or underestimated the level of agreement between the professionals. However, it is possible that these results may not be generalizable to primary care settings where chiropractors assess patients before any referral decision has been made. Additionally, this study focuses solely on evaluating the concordance between the two types of providers. Although both neurosurgeons and chiropractors are highly trained and are expected to inform their decisions based on clinical practice guidelines, the study does not allow us to draw conclusions about the validity of their diagnoses or management strategies. This study also involved clinical assessments whose results may vary based on personal judgment and clinical experience. The inter-rater reliability was not measured in this study, which could have help quantify the impact of these variations on study's validity. However, to mitigate variability, only skilled and experienced clinicians conducted the assessments. Consequently, results might differ if chiropractors with less training and experience were involved.

Conclusion

Despite clinical evaluations by chiropractors and neurosurgeons occurring at different time points and chiropractors having limited access to medical records, moderate diagnostic agreement and good management agreement were observed between the two groups of providers. This underscores the potential for chiropractors to play a key role as intermediaries in the care pathway of patients with LBP, potentially leading to a more efficient use of health resources. Future research is needed to evaluate the impact of a chiropractor-integrated model of care, including triaging, on clinical outcomes, care pathways and healthcare utilization for patients with LBP.

Data availability

The datasets supporting the conclusions of the current study will be made available by the corresponding author upon a reasonable request.

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References

1. Global National incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the global burden of disease study 2017. *Lancet* **392**, 1789–1858. https://doi.org/10.1016/s0140-6736(18)32279-7 (2018).
2. *Musculoskeletal health*, (2022). https://www.who.int/news-room/fact-sheets/detail/musculoskeletal-conditions
3. Public Health Agency of Canada, (2017).
4. Power, J. D. et al. Healthcare utilization and costs for musculoskeletal disorders in ontario, Canada. *J. Rhuematol.* **49**, 740–747 (2022).
5. Bishop, P. B. & Wing, P. C. Compliance with clinical practice guidelines in family physicians managing worker's compensation board patients with acute lower back pain. *Spine J.* **3**, 442–450. https://doi.org/10.1016/s1529-9430(03)00152-9 (2003).
6. Debono, B., Sabatier, P., Koudsie, A., Buffenoir, K. & Hamel, O. Managing spine surgery referrals: the consultation of neurosurgery and its nuances. *Neurochirurgie* **63**, 267–272. https://doi.org/10.1016/j.neuchi.2017.05.003 (2017).
7. (ed Ministère de la Santé et des Services Sociaux) (Gouvernement du Québec, (2022).
8. Breton, M. et al. How the design and implementation of centralized waiting lists influence their use and effect on access to healthcare - A realist review. *Health Policy*. **124**, 787–795. https://doi.org/10.1016/j.healthpol.2020.05.023 (2020).
9. *Tableau De bord - Performance Du Réseau De La Santé Et Des Services Sociaux* (Gouvernement du Québec, (2025).
10. Mathieu, J., Robert, M. È., Châtillon, C. É., Descarreaux, M. & Marchand, A. A. Appropriateness of specialized care referrals for LBP: a cross-sectional analysis. *Front. Med.* **10**, 1292481 (2024).
11. Lafrance, S., Vincent, R., Demont, A., Charron, M. & Desmeules, F. Advanced practice physiotherapists can diagnose and triage patients with musculoskeletal disorders while providing effective care: a systematic review. *Journal Physiotherapy* (2023).
12. Fourney, D. R. et al. A systematic review of clinical pathways for lower back pain and introduction of the Saskatchewan Spine Pathway. *Spine (Phila Pa)* 36, S164-171 (2011).) 36, S164-171 (2011). (1976). https://doi.org/10.1097/BRS.0b013e31822ef58f
13. Zarrabian, M. et al. Improving spine surgical access, appropriateness and efficiency in metropolitan, urban and rural settings. *Can. J. Surg.* **60**, 342 (2017).
14. Décary, S. et al. Diagnostic validity and triage concordance of a physiotherapist compared to physicians' diagnoses for common knee disorders. *BMC Musculoskelet. Disord.* **18**, 445. https://doi.org/10.1186/s12891-017-1799-3 (2017).
15. Desmeules, F. et al. Validation of an advanced practice physiotherapy model of care in an orthopaedic outpatient clinic. *BMC Musculoskelet. Disord.* **14**, 162. https://doi.org/10.1186/1471-2474-14-162 (2013).
16. Gagnon, R. et al. Diagnostic concordance between physiotherapist and emergency physicians for patients with a musculoskeletal disorder in the emergency department. *medRxiv*, 2010. 2028.20221762 (2020). (2020).
17. Lafrance, S. et al. Advanced practice physiotherapy surgical triage and management of adults with spinal disorders referred to specialized spine medical care: a retrospective observational study. *Physiother. Theory Pract.* **40**, 704–713 (2024).
18. Lowry, V. et al. Physiotherapists' ability to diagnose and manage shoulder disorders in an outpatient orthopedic clinic: results from a concordance study. *J. Shoulder Elbow Surg.* **29**, 1564–1572 (2020).
19. Matifat, E. et al. Concordance between physiotherapists and physicians for care of patients with musculoskeletal disorders presenting to the emergency department. *BMC Emerg. Med.* **19**, 1–10 (2019).
20. Schneider, M., Murphy, D. & Hartvigsen, J. Spine care as a framework for the chiropractic identity. *J. Chiropr. Humanit.* **23**, 14–21. https://doi.org/10.1016/j.echu.2016.09.004 (2016).
21. (Centre intégré universitaire de santé et de services sociaux de la Mauricie-et-du-Centre-du-Québec, (2023).
22. Bruyère, O. et al. Validity and reliability of the French version of the start back screening tool for patients with low back pain. *Spine* **39**, E123–E128 (2014).
23. Hawker, G. A., Mian, S., Kendzerska, T. & French, M. Measures of adult pain: visual analog scale for pain (VAS pain), Numeric Rating scale for pain (NRS pain), McGill pain Questionnaire (MPQ), Short-Form McGill pain Questionnaire (SF-MPQ), Chronic pain Grade scale (CPGS), Short Form-36 Bodily pain scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis pain (ICOAP). *Arthritis Care Res. (Hoboken)*. **63** (Suppl 11), S240–252. https://doi.org/10.1002/acr.20543 (2011).
24. Vianin, M. Psychometric properties and clinical usefulness of the Oswestry disability index. *J. Chiropr. Med.* **7**, 161–163 (2008).
25. Mathieu, J., Pasquier, M., Descarreaux, M. & Marchand, A. A. Diagnosis value of patient evaluation components applicable in primary care settings for the diagnosis of low back pain: A scoping review of systematic reviews. *J. Clin. Med.* **12** https://doi.org/10.3390/jcm12103581 (2023).
26. Robarts, S., Razmjou, H., Yee, A. & Finkelstein, J. Risk stratification in a tertiary care spine centre: comparison between startback and OSPRO-YF screening tools. *Physiother Can.* **75**, 158–166. https://doi.org/10.3138/ptc-2021-0026 (2023).
27. Finucane, L. M. et al. International framework for red flags for potential serious spinal pathologies. *J. Orthop. Sports Phys. Therapy*. **50**, 350–372 (2020).
28. Maher, C., Underwood, M. & Buchbinder, R. Non-specific low back pain. *Lancet* **389**, 736–747 (2017).
29. Hartvigsen, J. et al. What low back pain is and why we need to pay attention. *Lancet* **391**, 2356–2367. https://doi.org/10.1016/s0140-6736(18)30480-x (2018).
30. Knezevic, N. N., Candido, K. D., Vlaeyen, J. W. S., Van Zundert, J. & Cohen, S. P. Low back pain. *Lancet* **398**, 78–92. https://doi.org/10.1016/s0140-6736(21)00733-9 (2021).
31. Henschke, N. et al. Red flags to screen for malignancy in patients with low-back pain. *Cochrane Database Syst. Reviews* (2013).
32. Belche, J. L. et al. [From chronic disease to multimorbidity: which impact on organization of health care]. *Presse Med.* **44**, 1146–1154. https://doi.org/10.1016/j.lpm.2015.05.016 (2015).
33. Kongsted, A., Hestbæk, L. & Kent, P. How can latent trajectories of back pain be translated into defined subgroups? *BMC Musculoskelet. Disord.* **18**, 285. https://doi.org/10.1186/s12891-017-1644-8 (2017).
34. Kongsted, A., Kent, P., Axen, I., Downie, A. S. & Dunn, K. M. What have we learned from ten years of trajectory research in low back pain? *BMC Musculoskelet. Disord.* **17**, 220. https://doi.org/10.1186/s12891-016-1071-2 (2016).
35. Croft, P., Hill, J. C., Foster, N. E., Dunn, K. M. & van der Windt, D. A. Stratified health care for low back pain using the STarT Back approach: Holy Grail or doomed to fail? *Pain* (2024). https://doi.org/10.1097/j.pain.0000000000003319
36. Choudhry, N. K. et al. Effect of a biopsychosocial intervention or postural therapy on disability and health care spending among patients with acute and subacute spine pain: the SPINE CARE randomized clinical trial. *Jama* **328**, 2334–2344. https://doi.org/10.1001/jama.2022.22625 (2022).
37. Hill, J. C. et al. Comparison of stratified primary care management for low back pain with current best practice (STarT Back): a randomised controlled trial. *Lancet* **378**, 1560–1571. https://doi.org/10.1016/s0140-6736(11)60937-9 (2011).

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Author contributions

Conceptualization: J.M., A.-A.M. and M.D. Methodology: J.M., C.-É.C., M.B. C.H., P. S., M.D. and A.-A.M. Data collection: J.M., J.O. and A.-A.M. Data interpretation: J.M., C.-É.C., A.-A. and M.D. Writing—original draft preparation: J.M. Writing—review and editing: J.M., M.B., C.-É.C., J.O., C.T., C.H., P. S., M.D. and A.-A.M. Supervision: A.-A.M. and M.D. Project administration: J.M. Funding acquisition: A.-A.M. All authors have read the manuscript and agreed to be accountable for all aspects of the work.

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Declarations

Competing interests

The authors declare no competing interests.

Additional information

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