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Assessment of differential diagnostic, neck specific knowledge among physiotherapists in Hungary

PhD thesis

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Abbreviations

musculoskeletal (MSK)

critical medical (CM)

World Confederation of Physical Therapists (WCPT)

Chamber of Hungarian Health Care Professionals (MESZK)

Association of Hungarian Physiotherapists (MGYFT)

bachelor's degree (BSc)

master's degree (MSc)

case study (CS)

odds ratios (ORs)

confidence intervals (95% CIs)

number (No.)

postgraduate training (PGTr)

acceptable (Acc)

unacceptable (UAcc)

i.e. (id est=that is)

1. Introduction

1.1 The importance of differential diagnostic screening in physiotherapy

The work of physiotherapists is an integral part of the healthcare system. During complex physiotherapy examinations, physiotherapists use differential diagnostic models to distinguish musculoskeletal (MSK) complaints from other, more serious conditions. Before starting treatment, it is crucial to recognize warning signs and symptoms, which help the therapist assess the need for physiotherapy based on the patient's complaints and symptoms (optimal physiotherapy elements or referral to another specialist/physician) (Ormosi, 2015). Using the differential diagnostic model, therapists can determine if a patient's symptoms are musculoskeletal, vascular, neurogenic, visceral, or emotional. They can also identify cases where musculoskeletal symptoms are caused by problems in other organ systems (Goodman & Snyder, 2007). The purpose of differential diagnostic screening in complex examinations is to distinguish one disease or condition from others with similar symptoms. Following and applying the differential diagnostic model helps obtain a complete picture of the patient's condition and complaints while also recognizing warning signs and symptoms. The first step in the screening process is taking a detailed personal and family medical history, paying particular attention to previous illnesses and interventions. At the same time, an important role is played by the identification of any risk factors (e.g., risk factors for cancer or cardiovascular disease) (Murphy, 2004). It is crucial to conduct a thorough review of the patient's current symptoms and identify any signs or symptoms of systemic disease during the examination process. After reviewing the information obtained during the examination, the specialist can make an appropriate clinical decision regarding the patient's treatment (Honet & Ellenberg, 2004; Welch, 2011; Goodman & Snyder, 2007). During assessment,the patient's medical history should be systematically compared with physical examination findings. The physical examination can be used to confirm or refute the initial hypotheses established during the medical history (Goodman & Snyder, 2007). The warning signs and symptoms found during the examination draw the therapist's attention to the importance of detailed screening. However, a single warning sign alone does not necessarily justify immediate medical attention for the patient. After reviewing the information and warning signs obtained during the comprehensive examination of the patient, the treating professional must make a context – based decision (Goodman & Snyder, 2007; Nicholas et al., 2011).

According to World Physiotherapy (WP) guidelines, if a physiotherapist discovers results outside their area of expertise during a physiotherapy examination or diagnostic assessment, they should inform the patient and refer them to the appropriate doctor or specialist (WP, 2023a; WP, 2023b). Patients with musculoskeletal (MSK) complaints may also consult their general practitioner or other healthcare professionals working in various fields of healthcare. Worldwide, physiotherapists are among the professionals to whom patients can turn first with acute or chronic MSK problems. Patients can access

physical therapy in two ways: directly, without a prior medical examination or referral, or indirectly, following a medical examination and with a referral (Budtz et al., 2021a). A 2012 survey by Bury and Stokes found that 15 WP countries reported that physiotherapy services were available through indirect access, i.e. following a medical examination and with a referral, while direct access is available in private healthcare, as is the case in Hungary. In Hungary, according to Decree 18/2016 (VIII. 5.) of the Ministry of Human Resources, physiotherapists determine the appropriate interventions based on medical diagnosis and assessment of the patient's condition, independently manage physiotherapy interventions, and assume responsibility for their professional activities. Hungarian legislation does not allow direct access to physiotherapy in the public health care system, unlike in several European and overseas countries, such as Norway, Finland, Sweden, the Netherlands, Belgium, the United Kingdom, Ireland, Portugal, and Estonia, as well as several states in the United States Canada and several states in Australia (Froment et al., 2019; Bury & Stokes, 2013). However, physiotherapy does not require a referral in private practices, and private services are becoming increasingly widespread and widely available. Therefore, the autonomy of the profession requires physiotherapists to have well-founded and confident skills in recognizing clinical signs and symptoms that indicate life-threatening conditions in order to ensure patient safety (Honet & Ellenberg, 2003; Welch, 2011; WP, 2023 c).

1.2 Conditions affecting the cervical spine, warning signs and symptoms (red flags)

Spinal complaints affect a large proportion of the working-age population worldwide. Neck and lower back pain can result in limitations or even disability, placing a heavy burden on the economy, families, and those around them (Safiri et al., 2020). In Europe, patients most often seek professional help for cervical and lumbar spine conditions in primary care (Corp et al., 2021). Neck pain is the fourth most common complaint worldwide in terms of years lived with disability (Murray et al., 2013; Cohen, 2015), while low back pain (LBP) involves psychological, social, and biological factors (Takegami et al., 2024; Woo, 2010).

The Global Burden of Disease Study found that people in Western Europe, East Asia, North Africa, and the Middle East experienced the most years with neck pain (Safari, S., et al., 2020). In their 2021 study, Wu et al. examined 27 countries and territories across 12 regions. An estimated 203 million people worldwide suffered from neck pain in 2020, which is a 77.3% increase from the 115 million people who suffered from neck pain in 1990. The percentage of people living with neck pain in Central European countries increased by 8.9% from 1990 to 2020 (Wu et al., 2021). Globally, women experienced higher levels of pain and more years lived with disability than men (Kazeminasab et al., 2022).

The cervical spine differs from other sections of the spine in structure and function (Goodman & Snyder, 2007). It functions as a complex sensorimotor system, playing a crucial

role in posture and balance. Due to the presence of vital organs, blood vessels, and nerves in the neck, the examination and treatment of the cervical spine requires a different approach than that used for the lumbar spine, for both physicians and physical therapists (Yusuf et al., 2019).

The development of problems in the cervical region can be caused by a number of risk factors, which may be demographic and socioeconomic (Wu, 2021). Age, female gender, concurrent low back pain, computer use, lack of physical activity, stress, low social support, and reduced quality of life are all considered risk factors (Aggarwal, 2010; Popescu and Lee, 2019).

An international framework for red flags of potential serious spinal pathologies (Finucane et al., 2020) is available for physiotherapeutic examination and treatment of the spine. Knowledge of and ability to apply this framework is essential for healthcare professionals working in this field. According to the 2016 Global Burden of Disease (GBD) study, neck pain is the third leading cause of disability-adjusted life years (DALYs) worldwide, with a significant number of people seeking healthcare for this condition (Hoy et al., 2017). Addressing this problem is important for all healthcare professionals involved (Corp et al., 2021). Early detection of serious neck pathologies is essential for safe patient care; therefore, screening for pathologies that present as non-specific musculoskeletal neck pain poses a significant challenge (Finucane et al., 2020).

Complaints arising in the cervical region are most often caused by musculoskeletal disorders such as myofascial pain syndrome, intervertebral disc degeneration, spondylarthrosis, spondylosis, spondylolysis, spondylolisthesis, spinal canal stenosis, foraminal stenosis, and radiculopathy or myelopathy may develop alongside these disorders (Popescu and Lee, 2020). In addition to musculoskeletal disorders, a number of other conditions can cause pain and symptoms in the neck region (Table 1) (Cohen, 2015). These conditions may include tumorous lesions, infections, cardiovascular, respiratory, and digestive disorders, endocrine diseases, and rheumatological disorders (Goodman and Snyder, 2007; Aggarwal et al., 2010; Corwell and Davis, 2020). Appropriate differential diagnostic knowledge (Goodman & Snyder, 2007) and the guidelines now available in the international literature, which are evidence-based (Feller, 2024), are essential for recognizing the pathologies behind neck pain and distinguishing between the different causes of the symptoms.

Table 1 Other possible causes of neck problems caused by non-musculoskeletal conditions (Goodman & Synder, 2007; Aggarwal et al., 2010)

Other non-MSK causes of neck pain	Pathologies
Tumor	bone tumors affecting the cervical spine, cervical spinal cord tumors, metastatic lesions, lung tumor (Pancoast tumor), esophageal tumor, thyroid tumor
Infection	osteomyelitis, meningitis, epidural abscess, retropharyngeal abscess, Lyme disease
Cardiovascular diseases	angina pectoris, myocardial infarction, pericarditis, aortic aneurysm, vertebral/carotid artery dissection, vertebrobasilar insufficiency
Respiratory system diseases	chronic bronchitis, pneumothorax, pleuritis, tracheitis
Digestive system disorders	esophagitis, pharyngitis
Endocrine disorders	thyroid disease, thyroiditis
Rheumatic diseases	rheumatoid arthritis, atlantoaxial subluxatio, psoriatic arthritis, polymyalgia rheumatica, ankylosing spondylitis, fibromyalgia

The characteristics and patterns of complaints caused by other non-musculoskeletal conditions and the recognition and interpretation of the severity of symptoms play a crucial role in the identification of serious neck pathologies by the unit treating the patients (Rushton et al., 2023; Corwell and Davis, 2020; Popescu and Lee, 2020). It is estimated that in 5-20% of all cases presenting to the emergency department with neck pain, severe neck pathology is diagnosed late, which can have life-threatening consequences (Platzer et al., 2006, Sizer et al., 2007). Budtz et al. (2021a) found in a survey of more than 1.5 million people that 2.3% of patients referred for physiotherapy and subsequently treated had a serious pathology (e.g., tumors, infections, fractures). Although the prevalence of serious diseases underlying complaints is low, it is nevertheless of paramount importance to recognize warning signs and symptoms in order to avoid serious consequences.

Table 2 Red flags relating to the cervical spine

Category	Red flags	Source
Medical history	current or previous tumor disease	Goodman & Snyder, 2007
Suspected tumor / infection	persistent (≥6 weeks) constant pain; age <18 years or >50 years; recent/ongoing infection (within the last 6 weeks); frequent flu-like symptoms; intravenous drug use; recent surgery (with epidural anesthesia); immune system suppression (transplantation, steroid treatment)	Corwell et al., 2020; Goodman & Snyder, 2007
Risk of fracture	age >50 years; osteoporosis; prolonged steroid use; recent trauma	Goodman & Snyder, 2007
General symptoms	fatigue, weakness; loss of appetite; unexplained weight loss; fever, chills, sweating; nausea, vomiting, diarrhea; shortness of breath; dizziness, fainting	Goodman & Snyder, 2007
Neurological signs	motor/sensory impairment; muscle tone changes; bowel and bladder dysfunction; sexual dysfunction; gait disturbance	Corwell et al., 2020; Bier et al., 2018
Symptom patterns	unknown origin, insidious onset; constant, nocturnal or gradually worsening pain; bilateral/symmetrical symptoms; migratory or non-localizable pain; morning joint stiffness; joint pain with skin changes, lumps; pain originating from internal organs (e.g., myocardial infarction)	Goodman & Snyder, 2007; Aggarwal et al., 2010
Other suspicious signs	Symptoms disproportionate to the injury; prolonged complaints; pain that does not improve with rest or change of position; complaints that cannot be physically provoked; condition that does not respond to physical therapy or improves temporarily and then worsens	Goodman & Snyder, 2007; Aggarwal et al., 2010

1.3 Physiotherapists' knowledge of differential diagnosis

The diagnostic and clinical decision-making abilities of physical therapists have been evaluated in several recent studies on the treatment of MSK disorders. Research has confirmed that physiotherapists are well prepared to assess, diagnose, and treat MSK disorders, and that their accuracy is comparable to that of physicians. Cattrysse et al. (2024) conducted a review analysis of 22 studies (5 systematic reviews + 17 primary studies) that evaluated the quality of direct access physical therapy for musculoskeletal disorders from the perspective of patients, providers, and society (Cattrysse et al., 2024). This review highlighted the effectiveness and safety of physiotherapist-led treatment of musculoskeletal disorders in the direct access model. A systematic review found that high-level physiotherapists provide high diagnostic accuracy, appropriate triage, and effective treatment for MSK disorders (Lafrance et al., 2023). In addition, several studies have examined the differential diagnostic decision-making abilities of graduate physiotherapy students and experienced practicing physiotherapists, with a particular focus on the recognition of warning signs and symptoms (Jette et al., 2006; Lackenbauer et al.,

2017; Ladeira, 2018; Budtz et al., 2021 b; Keller et al., 2023; Alzahrani et al., 2024; Vigier-Fretey et al., 2025; Otero-Ketterer et al., 2023).

Jette et al. (2006) examined the decision-making abilities of 394 physiotherapists. Based on 12 case studies, the participants had to make the right treatment decision for musculoskeletal problems that were outside the scope of a physical therapist's expertise and required immediate medical examination or physical therapy. According to the results of the study, in cases describing critical health conditions requiring immediate medical examination, the professionals made the correct differential diagnosis in 79% of cases.

Lackenbauer et al. (2017) assessed the differential diagnostic thinking of final-year physiotherapy students enrolled in undergraduate programs at institutions belonging to the European Network of Physiotherapy in Higher Education (ENPHE), based on 12 cases used by Jette et al. Only 8 respondents (11% of participants) correctly identified all medically critical cases and correctly chose to refer the patient without any physiotherapy intervention.

Ladeira (2018) conducted a survey involving 410 physical therapists practicing in the United States. The aim was to assess whether professionals recognize red, yellow, and orange flags in patients with low back pain. More than half of the participants (53%) made the right decision regarding patients with red flag symptoms of low back pain. Only 28.5% of participants made the correct clinical decision for patients with orange flags (indicating a more serious health risk), and 43.2% for patients with yellow flags (indicating psychosocial risk factors).

Budtz et al. (2021 b) conducted a survey among physiotherapists practicing in Denmark, also with the aim of examining the differential diagnostic decision-making of professionals. Nineteen-five therapists were asked to decide on the most appropriate treatment method for 12 case descriptions. In cases describing critical medical conditions (at least 2 out of 3), 34% of respondents gave the correct answer.

Keller et al. (2023) assessed the knowledge of 1,492 physiotherapists in 12 case studies, finding that therapists made the correct decision in 40.5% of cases involving critical medical interventions.

Alzahrani et al. (2024) aimed to assess Saudi Arabian physiotherapists' awareness of red flags for low back pain (LBP) and their application in clinical practice. The cross-sectional

questionnaire survey involved 643 physiotherapists from public and private hospitals, who answered questions about red flags characteristic of LBP and their practical application.

Vigier-Fretey et al. (2025) aimed to explore French physiotherapists' attitudes, knowledge, and clinical practice regarding the differential diagnosis of chronic neck pain. The cross-sectional questionnaire survey involved 80 physiotherapists experienced in the treatment of chronic neck pain. The 33-question survey examined demographic and training data, information on continuing education experience, questions to assess knowledge of differential diagnostic criteria, and the frequency of their use in everyday clinical practice. In addition, participants assessed their opinions on the importance of differential diagnosis and the difficulties encountered in its application, such as lack of time or limited access to diagnostic tools.

Otero-Ketterer et al. (2023) aimed to assess the ability of Spanish physiotherapists to identify psychosocial (PS) risk factors in acute low back pain (LBP) and to determine which factors (e.g., age, gender, professional experience, social and emotional intelligence) influence this. The study involved 484 Spanish physiotherapists working in public and private healthcare services. Their online questionnaire included questions on demographic and professional data (age, gender, professional experience, postgraduate training in psychosocial factors) and three patient vignettes: cases of acute LBP with different biopsychosocial (BPS) clinical presentations.

1.4 Clinical competencies, patient safety and lay knowledge

Neck pain that affects the musculoskeletal system, as well as critical cases that arise from other organ systems, require an interdisciplinary approach and modern educational strategies. The international literature consistently emphasizes the need for a biopsychosocial approach to caring for patients with chronic pain (Popescu et al., 2020; Ladeira, 2018). Early education in this approach can ensure that future healthcare professionals, including physiotherapists, acquire the skills to recognize and consider psychosocial factors when making clinical decisions during their studies (Shavit et al., 2025). The quality of clinical care depends on professional knowledge as well as appropriate empathic communication, recognition of psychological status, and education and clinical competence. The latter includes the knowledge, skills, and attitudes that enable healthcare professionals to make accurate diagnoses, select appropriate treatments, and safely carry out interventions (Nembhard et al., 2023; Nie et al., 2011; Szczotkowski et al., 2025).

Patient safety aims to prevent adverse events and minimize errors, which is directly dependent on the existence and quality of clinical competencies (Zaitoun et al., 2023). A lack of competence is a direct risk factor, particularly when patients seek professional help directly, without a referral from a doctor. In these cases, differential diagnostic knowledge, the identification of red flags, and rapid, accurate decision-making are crucial for the timely recognition of serious conditions (Goodman and Snyder, 2007). International studies (Jette et al., 2006; Lackenbauer et al., 2017; Keller et al., 2023) have shown that professionals and students often have a lower rate of recognition of non-musculoskeletal critical conditions, which can lead to delayed diagnosis and mistreatment.

However, the competence of the specialist alone does not determine patient safety – the patient's (lay) knowledge and understanding of health are at least as important. Several studies have examined the knowledge of laypeople regarding spinal complaints (Table 3). The level of knowledge of laypeople influences their ability to recognize warning signs (e.g., persistent pain, neurological symptoms), how accurately they can describe their complaints, and how promptly they seek medical attention (Kim et al., 2020; Fan et al., 2021). Often, patients and laypeople view neck pain as a simple, harmless problem, even though serious conditions may underlie the symptoms. It is important to educate laypeople and communicate existing warning signs and symptoms in an understandable way (Heymans et al., 2004).

Raising patient awareness can encourage them to seek help in a timely manner and improve therapeutic cooperation. An increasing amount of international literature emphasizes a biopsychosocial approach to chronic pain management that takes psychological and social factors into account (Popescu et al., 2020; Shavit et al., 2025). This approach requires the active participation of both professionals and patients, making education a fundamental component of effective care. Research shows that a lack of lay knowledge directly increases risk. Heymans et al. (2004) and Maciel et al. (2009) demonstrated that educational programs, such as "back school," and validated knowledge assessment tools (e.g., LKQ), significantly increase knowledge about musculoskeletal disorders. These programs increase patients' knowledge (Maciel et al., 2009) and improve self-management, increasing the chances of recovery (Adams, 2021). Participation in these programs helps individuals understand the nature of pain, seek help early, and promotes the healing process by raising awareness of warning signs. Furthermore, movement therapy is successful not only when complaints are recognized, but also when knowledge about therapy is transferred. This often requires patient education about posture, movement patterns, and self-management (Hayden et al., 2009).

To provide effective care, physiotherapists must continuously develop their diagnostic skills, especially in recognizing serious conditions. At the same time, it is crucial to educate laypeople so they can recognize warning signs and seek help appropriately. Interdisciplinary collaboration, a biopsychosocial approach, and education contribute to patient safety and effective treatment.

Table 3 Examination of laypersons' knowledge and education regarding LBP

Author (Year)	Target group	Topic / Tool	Connection	Outcome
Heymans et al. (2004)	Non-specific LBP patients	"Back school" programs	Structured, education-based interventions	Significant improvement in knowledge and functional status.
Maciel et al. (2009)	General population	Development and validation of the LKQ questionnaire	Standard basis for knowledge measurement	The questionnaire is a valid and reliable method for measuring LBP knowledge.
Hayden et al. (2005)	Patients with LBP	Effect of exercise therapy	Exercise promotion, educational purpose	Exercise therapy improves pain and functional outcomes.
Adams (2010)	General patients	Patient education, literature review	General educational effects	Education improves disease prognosis and reduces complications.

2. Objective

The primary aim of our study was to evaluate the expertise of physiotherapists working in Hungary in terms of differential diagnosis, and to compare them with results from international studies.

We also aimed to assess the therapists' knowledge of red flags for cervical musculoskeletal disorders and serious pathologies, as well as to evaluate the appropriateness of therapeutic interventions in different cases.

In addition, we aimed to identify the variables that influence the differential diagnostic thinking and decision-making processes of the participating therapists.

3. Materials and methods

3.1 Methodology of the study

The Hungarian Chamber of Health Care Professionals (MESZK) professional section for physiotherapy keeps a register of physiotherapists who are qualified and actively working

in Hungary. According to the 2021 report " Mozgásterápia, fizioterápia szakterületi helyzet értékelése" there were 5,987 registered therapists in Hungary in 2019. Therapists were invited to participate in the survey through MESZK and the Hungarian Association of Physiotherapists (MGYFT). Participating physiotherapists were able to take the survey online using the EvaSys software system. The online questionnaire was available on the www.mgyft.hu and www.meszk.hu online platforms from June 23 to September 10, 2022. Participation was voluntary and anonymous; respondents could complete the questionnaire once, after providing informed consent.

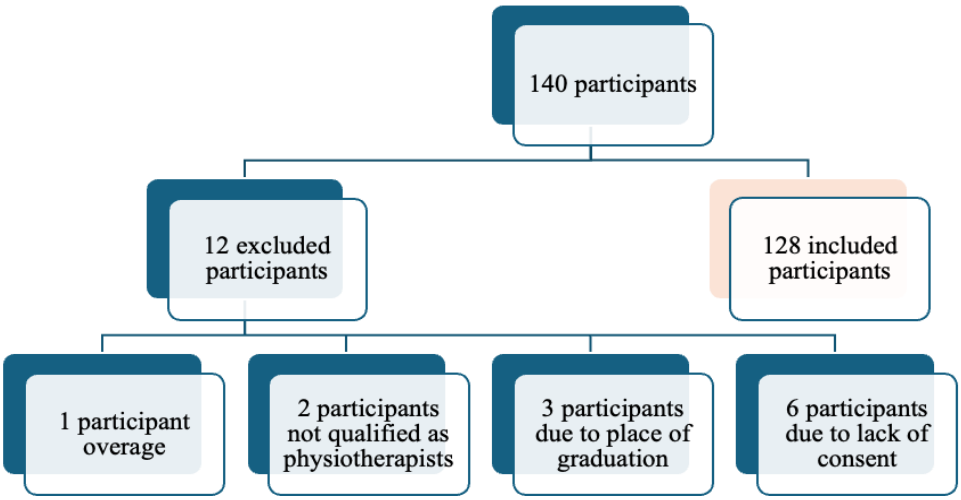
The study was approved by the Scientific Ethics Committee (ETT TUKEB), license number: IV/3426-1/2022/EKU.

3.2 Participants

The selection criteria for the study included age between 25 and 65, higher education in Hungary, a minimum of a Bachelor of Science (BSc) degree in physiotherapy, and current employment in Hungary. We excluded from the study those who were no longer actively practicing and those who did not meet the selection criteria (Figure 1).

A total of 140 volunteers completed the questionnaire. After applying the exclusion criteria, 128 responses were included in the analysis. The mean age of participants was 34.65 ± 8.88 years; 114 were women and 14 were men.

Figure 1 Flow chart of excluded participants



3.3 Survey development

The study design was based of the methodologies of Jette et al. (2006) and Ladeira (2018).

The first section of the questionnaire was collected demographic information, details of previous studies, and data on the practical professional experience of the respondents (Appendix 1).

The second section assessed differential diagnostic knowledge through eight case studies (CS 1-8) and related treatment options (Appendix 2). Each case included condensed medical history and physical examination findings. Two cases involved with musculoskeletal (MSK) complaints (CS 4, CS 6) (Wachidah and Herawati, 2021; Rahman and Godfred, 2014; Abd Jalil et al., 2010), while six cases described serious or ptentially life-threatening conditions (CM cases) (CM= critical medical) (CS 1, CS 2, CS 3, CS 5, CS 7, CS 8) (Ross et al., 2008; Smith et al., 2014; Mathers, 2012; Gomez et al., 2020; Bayer et al., 2019; Lyons et al., 2018; Chaniotis, 2011) (Appendix 3).

After reviewing the case studies, respondents were asked to select a minimum of 1 and a maximum of 5 intervention options from 18 possible interventions (Appendix 4). These included various physiotherapy treatments (physiotherapy treatment methods and techniques for the cervical spine in accordance with international professional protocols (Hurwitz et al., 2009; Cote et al., 2016), as well as recommendations and options for referral to other specialists. Correct treatment decisions were based on the published case reports (Table 4).

Table 4 Case studies and correct treatment decisions

Group	CS	Correct treatment decision
MSK cases	CS 4: cervical radiculopathy CS 6: myofascial pain syndrome	physiotherapeutic intervention
CM cases	CS 1: dens fracture CS 2: cervical myelopathy CS 3: angina pectoris CS 5: arteria vertebralis dissectio CS 7: atlantoaxial instability CS 8: metastatic bone tumor	provide or refer to another healthcare professional/physician

The responses provided by the respondents were evaluated according to correct and incorrect treatment decisions. In cases involving signs and symptoms indicating serious, life-threatening health conditions, which were interpreted as red flags, the correct treatment decision was to refer the patient to a physician without initiating physiotherapy. The red flag symptoms and signs justifying referral are shown in Appendix 3. If, in cases containing red flag signs, the respondent selected the option of referral to a physician without starting physiotherapy treatment and also recommended imaging, and/or neck immobilization, and/or bed rest, and/or consultation with a psychologist, this was considered a correct decision. We considered it an incorrect response if the respondent only indicated physiotherapy treatment options or if they indicated physiotherapy treatment methods in addition to referral to a doctor.

In cases involving musculoskeletal disorders falling within the scope of physiotherapists, we considered the indication of physiotherapy treatment options to be the correct decision. We considered it an incorrect decision if the respondent chose referral to a physician without starting physical therapy treatment or if they indicated referral to a physician in addition to physical therapy treatment.

3.4 Content validity of the case studies

The selected case studies were adapted from published case reports in English in international peer-reviewed journals. These cases focused on cervical spine complaints because recognizing the pathomechanism of cervical spine complaints is crucial for health professionals. Articles were identified through PubMed, ScienceDirect, Medline, and Scopus databases using search terms including “differential diagnosis,” “differential diagnostic knowledge,” “neck pain,” “cervical spine,” “referral pain,” “fracture,” “myelopathy,” “cardiovascular,” “cervical radiculopathy,” “arterial vertebral dissection,” “myofascial pain syndrome,” “atlantoaxial instability,” and “metastatic tumor.”

Each CM case included warning signs, symptoms, and clinical data gathered from general practitioners, specialists, and physiotherapists, as deemed appropriate. The reports were translated into Hungarian by two physiotherapists with Master’s degrees in physiotherapy. The cases were subsequently reviewed by a physiotherapist with a PhD in physiotherapy and a postgraduate specialist with a degree in medical translation and interpretation. The final review was conducted by a multidisciplinary team of physicians (neurologists, neurosurgeons) and physiotherapists.

4. Statistical Analyses

Statistical analyses were performed in R software (version 4.0.2). Descriptive statistics were used to characterize the subjects and treatment decisions and their distribution relative to the case reports. Treatment decisions were categorized as referral to another healthcare professional (with or without additional advice) or physiotherapeutic intervention (Appendix 4). A referral in addition to treatment was classified as an intervention. The results are presented as the means ± SDs and frequencies (%). Factors influencing decisions in the MSK and CM categories and their relationships were analyzed via logistic regression. The odds ratios (ORs) and corresponding confidence intervals (95% CIs) were calculated, $p \leq 0.05$ was considered significant. Associations between correct decision-making and the number (No.) of years of practice, clinical experience, educational level (BSc, MSc/PhD), and postgraduate training (PGTr) in cervical spine management were determined. These associations were examined for the MSK and CM categories and separately for each case. For cases in the CM category, decisions were considered acceptable if the participant gave the correct answer for at least three of the six cases. For the MSK category, a response was acceptable (Acc) only if the respondent correctly rated both cases. All other decisions were unacceptable (UAcc) in both categories.

5. Results

5.1 Participants and descriptive data

The questionnaire was completed by 140 volunteers, and 128 responses (34.65 ± 8.88 years; 114 females and 14 males) were processed after applying the exclusion criteria. As shown in Table 1, 78.91% of the physiotherapists (101 persons, age: 35.22 years ± 9.30 years, work experience 10.04±8.17 years) held a bachelor's degree (BSc), and 21.09% (27 persons, age: 32.46 ± 6.1, work experience: 8.51 ± 6.61 years) held a master's degree (MSc) or a PhD (26 persons MSc, 1 person PhD). All participants graduated between 1987 and 2022. The participants had a minimum of 1 and a maximum of 34 years of work experience, and 60.9% of the participants completed postgraduate training in cervical spine treatment, including the McKenzie method (45.57%), manual therapy methods (34.18%), and cervical spine stabilization training (31.65%). Fewer than 10% of the participants completed soft tissue mobilization techniques and postgraduate training for treating cervico-cranio-mandibular dysfunction. 3.12% of participants acquired differential diagnostic knowledge within the framework of master's degree programs, or acquired knowledge related to differential diagnostics through McKenzie method (40.62%), manual therapy method (21.88%), various

fascia treatment techniques (17.97%), cervical spine stabilization training (13.28%), Schroth therapy (12.5%), neurodynamic (6.25%), treatment of cervico-cranio-mandibular dysfunction (4.69%). Approximately two-thirds (68.8%) of the therapists treated patients with indirect access, i.e., via specialist referrals.

Cervical complaints represented less than 30% of daily patient care for most (90.62%) participants; only 9.38% of the therapists treated patients with cervical symptoms for more than 30% of their work time. Two-thirds of the respondents (67.2%) had experience in orthopedics, 61.7% had experience in traumatology, and less than 50% had experience in neurology and neurosurgery, pediatrics, surgery, rheumatology, and other clinical areas.

Table 5 Characteristic of participating physiotherapist (N=128)

	Frequency (%)	**Mean (SD)**
age		34.648 (8.882)
sex		
female	114 (89.1%)	
male	14 (10.9%)	
Educational level		
BSc	101 (78.9%)	
age		35.22 (9.30)
work experience		10.04 (8.17)
MSc/PhD	27 (21.1%)	
age		32.46 (6.1)
work experience		8.61 (6.61)
Work experience		9.727 (7.822)
Postgraduate training		
yes	78 (60.9%)	
no	50 (39.1%)	
Access		
yes	88 (68.8%)	
no	40 (31.2%)	
No. of patients with neck problem		
10%	52 (40.6%)	
10%-30%	64 (50.0%)	
30%<	12 (9.4%)	
Clinical experience		
orthopedics	86 (67.2%)	
traumatology	79 (61.7%)	
neurology	57 (44.53%)	

neurosurgery	29 (22.66%)
pediatrics	12 (9.38%)
surgery	23 (17.97%)
rheumatology	16 (12.5%)
other	21 (16.41%)

5.2 Results of responses to case studies

The participants' responses were first reviewed on a case-by-case basis and categorized as correct or incorrect decisions. None of the cases involved 100% of participants making the correct treatment decision. In the presented cases, the percentage of participants who made the correct decision ranged from 3.91% to 82.81%. Table 6 shows the distribution of correct and incorrect answers by case.

Table 6 Distribution of correct and incorrect decisions in the 8 cases

CS	frequency of correct decisions (N)	relative frequency of correct decisions (%)	frequency of incorrect decisions (N)	relative frequency of correct decisions (%)
1	80	62,50	48	37,50
2	14	10,94	114	89,06
3	5	3,91	123	96,09
4	90	70,31	38	29,69
5	45	35,16	83	64,84
6	106	82,81	22	17,19
7	29	22,66	99	77,34
8	37	28,91	91	71,09

After reviewing each case, we examined how often each respondent made the correct decision. No one made the correct decision in any of the eight case studies presented. Of all the cases, 35.16% of participants (N=45) answered at least four questions correctly. The highest proportion of participants (32.81%) made the correct decision in three cases. One participant did not make the correct decision in any of the cases. Table 7 shows the distribution of the number of correctly answered cases.

Table 7 Number and frequency of correctly answered cases

No. of correctly answered cases	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
frequency of correct answers (N)	1	10	30	42	27	9	6	3	0
relative frequency of correct answers (%)	0,78	7,81	23,44	32,81	21,09	7,03	4,69	2,34	0

5.2.1 CM cases

The results were continued to be processed by analyzing the correct and incorrect answers in cases requiring further referral. With the exception of the first case, in which 62.5% of participants answered correctly, a higher proportion of participants answered incorrectly than correctly (referral to another professional/physican before starting physiotherapy). Table 8 shows the percentage distribution of correct and incorrect answers for the six cases requiring referral.

Table 8 Distribution of correct and incorrect responses in CM cases

CS	**frequency of correct decisions (N)**	**relative frequency of correct decisions (%)**	**frequency of incorrect decisions (N)**	**relative frequency of correct decisions (%)**
1	80	62,50	48	37,50
2	14	10,94	114	89,06
3	5	3,91	123	96,09
5	45	35,16	83	64,84
7	29	22,66	99	77,34
8	37	28,91	91	71,09

In cases involving signs and symptoms indicating serious health conditions that contraindicate the initiation of physiotherapy, at least 3 correct answers were given by 22.66% (N=29) of respondents. Less than three correct answers were given by 77.34% (N=99) of respondents. Only 0.78% of respondents correctly identified all six cases requiring referral to a physician. 23.44% of participants did not give a correct answer to any of the cases containing red flag signs or symptoms. The distribution of correct answers for the six cases requiring referral is shown in Table 9.

Table 9 Number and frequency of correctly answered CM cases

No. of correctly answered cases	**0**	**1**	**2**	**3**	**4**	**5**	**6**
frequency of correct answers (N)	30	35	34	15	9	4	1
relative frequency of correct answers (%)	23,44	27,34	26,56	11,72	7,03	3,12	0,78

In CM cases (Table 10), the only factor that significantly influenced the correct decision in at least three cases was the age of the participating physiotherapists (p=0.019). Older participants made the correct decision in a higher proportion of cases. For each additional year of age, the likelihood of making the correct decision increased by 1.06 times (OR = 1.06).

Table 10 Analysis of factors influencing correct decisions in CM cases, results of logistic regression

Influencing factors	OR (95% KI)	p-value
sex	0,54 (0,08-2,13)	0,434
age	1,06 (1,01-1,11)	0,019*
educational level	0,73 (0,23-2,01)	0,564
work experience	1,04 (0,99-1,01)	0,099
cervical spine PGTr	1,86 (0,77-4,83)	0,182
neck complaints (>30% of patient)	0,66 (0,10-2,70)	0,605

*p-value less than 0.05

5.2.2 MSK cases

In both MSK cases, a higher proportion of respondents gave the correct answer (i.e., physiotherapy treatment was used). The percentages were 70.31% for CS 4 and 82.81% for CS 6. Table 11 shows the percentage distribution of respondents who gave correct and incorrect answers in MSK cases.

Table 11 Distribution of correct and incorrect responses in MSK cases

CS	frequency of correct decisions (N)	relative frequency of correct decisions (%)	frequency of incorrect decisions (N)	relative frequency of correct decisions (%)
4	90	70,31	38	29,69
6	106	82,81	22	17,19

Only MSK correctly identified both cases by 61.72% of respondents (N=79), meaning that they would use physiotherapy treatment methods to treat the patient and would not refer the patient for further medical examination. Only 1 of the 2 cases was correctly identified by 29.69% of the respondents (N=38). Furthermore, 8.59% of the participants (N=11) made the wrong decision in both cases.

Upon examining the correlation between the correct decision in both MSK cases and the completion of the cervical spine treatment course, we obtained a value at the threshold of significance (p=0.051). Table 12 shows the results of the examination of factors influencing the correct treatment decision in cases requiring physiotherapy intervention.

Table 12 Analysis of factors influencing correct decisions in MSK cases, results of logistic regression

Influencing factors	OR (95% KI)	p-value
sex	2,48 (0,73-11,41)	0,181
age	0,99 (0,95-1,03)	0,605
educational level	1,62 (0,67-4,26)	0,301
work experience	1,02 (0,97-1,07)	0,505
cervical PGTr	2,07 (0,99-4,35)	0,051
neck complaints (>30% of patient)	0,59 (0,17-1,99)	0,384

*p-value less than 0.05

The results of responses to all CM and MSK cases were not significantly influenced by level of education, mode of access, or continuing education related to the cervical spine. However, we obtained significant results regarding decision-making in individual cases and the impact of postgraduate training specifically focused on the neck.

5.3 Factors influencing the decision-making process

5.3.1 Number of years of work experience

The years of work/professional experience significantly influenced the recognition of the two CM cases and decisions about the required intervention. The warning signs and symptoms of dens fracture (CS 1) and cervical myelopathy (CS 2) were recognized by a high proportion of therapists (Table 13). The number of years of practice significantly influenced the selection of the appropriate treatment in these cases.

Table 13 Impact of years of work experience on decision-making

	OR (95% CI)	p-value
CS 1	1.07 (1.02-1.14)	0.015*

CS 2	1.09 (1.03-1.16)	0.006*
CS 3	0.97 (0.83-1.09)	0.699
CS 4	1.03 (0.98-1.09)	0.282
CS 5	1.03 (0.99-1.08)	0.143
CS 6	0.99 (0.93-1.05)	0.674
CS 7	1.05 (1.00-1.10)	0.067
CS 8	1.04 (1.00-1.10)	0.076

*p-value less than 0.05

5.3.2 Clinical experience

Participants with clinical experience in orthopedics and traumatology also made appropriate treatment decisions about the cervical myelopathy case (CS 2), the atlantoaxial instability case (CS 7) and the metastatic tumor case (CS 8). Experience in trauma significantly affected decisions about dens fracture case (CS 1) (Table 14).

Table 14 Effect of clinical experience on the proportion of correct decisions in different cases

	Orthopedics		Traumatology	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**
CS 1	0.56 (0.24-1.21)	0.147	0.45 (0.20-0.97)	0.046*
CS 2	0.23 (0.07-0.71)	0.012*	0.21 (0.05-0.67)	0.012*
CS 3	0.31 (0.04-1.94)	0.209	0.40 (0.05-2.49)	0.323
CS 4	1.79 (0.81-3.95)	0.148	1.07 (0.49-2.33)	0.857
CS 5	1.56 (0.71-3.55)	0.277	0.89 (0.43-1.90)	0.768
CS 6	1.21 (0.45-3.11)	0.697	1.14 (0.44-2.89)	0.781
CS 7	0.42 (0.18-0.99)	0.047*	0.28 (0.11-0.65)	0.004*
CS 8	0.38 (0.17-0.84)	0.017*	0.24 (0.11-0.54)	0.001*

* p-value less than 0.05

5.3.3 Educational level and completion of postgraduate training

The accuracy of decisions was also evaluated according to combined educational levels and the completion of postgraduate training (Table 15). Participants who completed postgraduate training in cervical spine care in addition to their education made more appropriate

treatment decisions. The correct decision rate was at least 50% for the CS 1 CM case, and the proportion of correct decisions was less than 30% for cases CS 2 and CS 3.

Table 15 Descriptive statistics. Ratio of acceptable and unacceptable answers based on the educational level and combination with the neck-specific postgraduate training

	BSc (N=43)	MSc (N=7)	BSc with PGTr (N=58)	MSc with PGTr (N=20)	Total (N=128)
CS 1					
Acc	19 (44.2%)	2 (28.6%)	47 (81.0%)	12 (60.0%)	80 (62.5%)
UAcc	24 (55.8%)	5 (71.4%)	11 (19.0%)	8 (40.0%)	48 (37.5%)
CS 2					
Acc	1 (2.3%)	0 (0.0%)	10 (17.2%)	3 (15.0%)	14 (10.9%)
UAcc	42 (97.7%)	7 (100.0%)	48 (82.8%)	17 (85.0%)	114 (89.1%)
CS 3					
Acc	1 (2.3%)	0 (0.0%)	2 (3.4%)	2 (10.0%)	5 (3.9%)
UAcc	42 (97.7%)	7 (100.0%)	56 (96.6%)	18 (90.0%)	123 (96.1%)
CS 4					
Acc	24 (55.8%)	5 (71.4%)	44 (75.9%)	17 (85.0%)	90 (70.3%)
UAcc	19 (44.2%)	2 (28.6%)	14 (24.1%)	3 (15.0%)	38 (29.7%)
CS 5					
Acc	14 (32.6%)	3 (42.9%)	24 (41.4%)	4 (20.0%)	45 (35.2%)
UAcc	29 (67.4%)	4 (57.1%)	34 (58.6%)	16 (80.0%)	83 (64.8%)
CS 6					
Acc	34 (79.1%)	6 (85.7%)	49 (84.5%)	17 (85.0%)	106 (82.8%)
UAcc	9 (20.9%)	1 (14.3%)	9 (15.5%)	3 (15.0%)	22 (17.2%)
CS 7					
Acc	4 (9.3%)	2 (28.6%)	18 (31.0%)	5 (25.0%)	29 (22.7%)
UAcc	39 (90.7%)	5 (71.4%)	40 (69.0%)	15 (75.0%)	99 (77.3%)
CS 8					
Acc	11 (25.6%)	1 (14.3%)	20 (34.5%)	5 (25.0%)	37(28.9%)
UAcc	32 (74.4%)	6 (85.7%)	38 (65.5%)	15 (75.0%)	91 71.1%)

5.3.4 Postgraduate training in cervical spine care

Participants who had completed postgraduate training in the neck were significantly more likely to make appropriate decisions for cases CS 1 (95% CI 2.02-9.36, p=0.001), CS 2 (95% CI 1.86-181.02, p=0.030), CS 4 (95% CI 1.20-5.72, p=0.016), and CS 7 (95% CI 1.21-8.89, p=0.025) than participants who did not complete postgraduate training in the neck.

For MSK cases, the detection of cervical radiculopathy (CS 4) was significantly associated with both McKenzie (95% CI 1.39-11.45, p = 0.014) and manual therapy (95% CI 1.53-20.86, p = 0.016) training. Decisions about CM cases (CS 1, CS 2, CS 7, and CS 8) were significantly influenced by continuing education in cervical spine stabilization training. The participants who attended McKenzie training were more likely to recognize the signs and symptoms of fracture (CS 1) (95% CI 1.22-7.28, p = 0.021) (Table 16).

Table 16 Impact of postgraduate training on the proportion of correct decisions in different cases

	McKenzie method		Cervical spine stabilization training		Manual therapy method	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
CS 1	2.84(1.22-7.28)	0.021*	3.26(1.22-10.36)	0.027*	1.44(0.61-3.64)	0.415
CS 2	2.01(0.62-6.24)	0.229	4.70(1.46-15.24)	0.009*	0.92 (0.20-3.22)	0.907
CS 3	0.60(0.03-4.26)	0.657	2.61 (0.33-16.59)	0.307	2.37 (0.30-15.01)	0.358
CS 4	3.64(1.39-11.45)	0.014*	0.81(0.33-2.07)	0.641	4.74(1.53-20.86)	0.016*
CS 5	1.18(0.53-2.59)	0.685	1.35 (0.56-3.22)	0.495	0.51 (0.19-1.26)	0.162
CS 6	1.47(0.53-4.78)	0.484	0.66 (0.24-2.02)	0.437	2.06 (0.64-9.25)	0.275
CS 7	1.72(0.70-4.08)	0.226	3.17 (1.25-7.99)	0.014*	0.86 (0.29-2.27)	0.774
CS 8	0.72(0.29-1.69)	0.467	2.43 (1.00-5.90)	0.049*	0.92 (0.35-2.25)	0.859

* p-value less than 0.05

6. Discussion

The aim of our research was to explore the extent to which physiotherapists are able to apply differential diagnostic reasoning and make appropriate treatment decisions in relation to clinical cases of different nature involving the cervical spine. Our findings show that physiotherapists were significantly more likely to make correct decisions in musculoskeletal

(MSK) cases (61.7%) than in conditions requiring critical medical intervention (CM) (22.7%). This suggests that therapists are more confident and accurate when working within their professional scope, but their ability to recognize conditions requiring urgent medical referral remains limited.

Previous international studies have reported similar findings. According to Jette et al. (2006), therapists made correct treatment decisions in 87.3% of all MSK cases, while Budtz et al. (2021b) reported this rate at 42%. In our study, 61.7% of participants made appropriate treatment decisions in both MSK cases. When examining MSK cases separately, outstanding performance was observed in myofascial pain syndrome (CS 6) (82.8%) and cervical radiculopathy (CS 4) (70.3%).

Several studies have established that healthcare professionals often do not pay sufficient attention to red flag signs and symptoms indicating serious pathology, and physiotherapists are less likely to make appropriate differential diagnostic decisions in cases requiring medical evaluation and immediate care (Jette et al., 2006; Ladeira, 2018; Budtz et al., 2021b). In our study, the proportion of correct decision-making in six CM cases was alarmingly low, particularly in cervical myelopathy (CS 2) and angina pectoris (CS 3), where 89.1% and 96.1% of respondents, respectively, failed to refer the patient to a physician and instead recommended physiotherapy. This finding is concerning, as both conditions require immediate medical evaluation and intervention—the omission of which may be life-threatening. International studies similarly report that only a small proportion of physiotherapists make correct referral decisions in cases of critical medical conditions. In our study, just one participant (0.78%) correctly identified the contraindication to physiotherapy in all referral cases—lower than the 5% reported by Budtz et al. (2021b) in Denmark.

Our results therefore support the trend observed in the international literature, namely that physiotherapists are less effective in recognizing red flag conditions requiring emergency care (Ladeira, 2018; Keller et al., 2022). According to Ladeira (2018), 52.7% of therapists identified the critical condition. In the study by Keller et al. (2022) examining Swiss therapists' knowledge, the recognition rate of red flag cases was 62%. Similarly, Jette et al. (2006) found that physiotherapists made correct treatment decisions in 79% of all cases of critical health conditions; however, only 49.6% of participants made correct treatment decisions consistently across all such cases.

It should be noted that comparison of results is substantially limited by the fact that the aforementioned studies included case descriptions involving other anatomical regions (e.g., Ladeira, 2018 – lumbar spine) or applied cases from other specialties (Jette et al., 2006; Lackenbauer et al., 2018; Budtz et al., 2021b). According to our findings, physiotherapists participating in our study demonstrated limited recognition of warning signs and symptoms when making differential diagnostic judgments about cervical spine complaints.

The lack of knowledge can partly be explained by the fact that fewer than 10% of respondents reported working regularly with cervical spine-related complaints. Considering that the anatomy, biomechanics, and physiology of the cervical spine differ significantly from the lumbar region, targeted, region-specific knowledge is essential for appropriate clinical decision-making. The scientific foundation of examination and treatment methods specific to the cervical region became increasingly significant from the 1990s, and their effectiveness has been supported by clinical evidence since the 2000s (Wang et al., 2003; Vernon et al., 2007; Kendall et al., 2005).

Among the factors influencing decision-making, we examined professional experience, specialization, and participation in continuing education. Although several international studies (e.g., Budtz et al., 2021b) have found a correlation between higher levels of experience and correct decision-making, others (Jette et al., 2006; Keller et al., 2022) have not confirmed this. In our study, overall professional experience did not show a significant association with the correct assessment of all cases, although in certain cases longer experience increased the likelihood of correct decisions. However, in cases requiring medical intervention, the age of participants significantly influenced correct referral decisions, which we believe is linked to practical professional experience.

Our findings also indicate that therapists primarily working with orthopedic or trauma cases made correct decisions at significantly higher rates (67.2% and 61.7%). Examining individual cases, these therapists were more likely to recognize warning signs and symptoms and choose appropriate management in fracture (CS 1), cervical myelopathy (CS 2), instability (CS 7), and metastatic bone tumor (CS 8). Similar associations were demonstrated by Jette et al. (2006) and Ladeira (2018), who reported that therapists with orthopedic specialization were more likely to recognize critical conditions. According to Jette et al. (2006), therapists with orthopedic specialization recognized signs and symptoms of critical health conditions in 62.2% of cases, compared to 46.5% among those without specialization. In Ladeira's (2018) study, therapists with orthopedic specialization identified CM cases in 53.5% of instances. It is

important to note, however, that in Hungary there is currently no possibility of obtaining postgraduate specialization tied to clinical fields, which limits direct comparison with international data. In our study, we found no significant relationship between educational levels (BSc, MSc/PhD) and the proportion of correct decisions in either referral cases or physiotherapy cases, nor between the combination of academic degrees and cervical-spine-specific continuing education. Therefore, only the effect of differential diagnostic knowledge acquired through postgraduate cervical spine courses can be interpreted. Participation in postgraduate training, however, had a significant impact on the quality of decision-making. Therapists who had completed training in the "McKenzie" method or G. D. Maitland's manual therapy demonstrated greater confidence in recognizing warning signs and symptoms, such as in fracture-related cases (Maitland, 1986). The Hungarian postgraduate training course "Examination and treatment of the cervical spine in segmental instability" may also have contributed to the development of differential diagnostic skills. Of the participants, 31.65% had completed such training, and 34.18% had manual therapy training.

In this regard, we believe that completing training related to the treatment of the cervical spine had a positive effect on decision-making concerning musculoskeletal problems. This suggests that professionals with qualifications in the management of musculoskeletal disorders of the cervical spine, and possessing broader physiotherapeutic knowledge, make correct clinical decisions with greater confidence.

Available international findings highlight that the differential diagnostic competence of physiotherapists plays a key role in the effective recognition and treatment of musculoskeletal disorders—particularly in cervical and lumbar spine conditions. Alzahrani et al. (2024) demonstrated a discrepancy in Saudi Arabian physiotherapists between awareness of red flag recognition and the clinical application of such knowledge, which may affect the quality of patient care. Similarly, Vigier-Fretey et al. (2025) found measurable differences among French physiotherapists between knowledge of differential diagnostic criteria for chronic neck pain and their application in daily practice, influenced partly by access to continuing education opportunities and diagnostic tools.

Professional knowledge and the quality of clinical decision-making are directly associated with patient education, which significantly influences recovery outcomes. According to the Cochrane review by Heymans et al. (2004), structured "back school" programs combining education and exercise therapy—particularly in chronic low back pain—may be more effective in the short and medium term than other conservative interventions, though

results are heterogeneous. The effectiveness of educational interventions is significantly enhanced by the use of the Low Back Pain Knowledge Questionnaire (LKQ), which demonstrated substantial knowledge gains among participants (Maciel et al., 2009). Furthermore, Hayden et al. (2009) emphasized that exercise programs are most effective when supplemented with educational components, as these promote the development of correct movement patterns and self-management strategies. Adams et al. (2021) further confirmed that patient education improves not only functional status but also self-efficacy, coping ability, and patient satisfaction.

In summary, our findings confirm that correct diagnostic decision-making in cervical spine complaints strongly depends on practical experience in the given area, as well as on specific knowledge acquired through postgraduate training. Our results align with the recent findings of Shavit et al. (2025), which concluded that participation in differential diagnostic and medical screening training increases physiotherapists' confidence, clinical effectiveness, and self-efficacy. Furthermore, structured patient education and accurate diagnostic decision-making act as mutually reinforcing factors: precise diagnostic decisions enable the use of targeted educational interventions, which measurably improve clinical outcomes and long-term rehabilitation results among patients.

7. Limitations

This study has several limitations that should be acknowledged. First, the cross-sectional design prevents predictive conclusions from being drawn. Second, our questionnaire provided only a partial assessment of participants' knowledge, as respondents could not clarify uncertainties or ask follow-up questions after reviewing the cases. The information gained in this manner is not equivalent to that achieved through face-to-face examinations. Additionally, the interpretability of our results is limited due to the critical health conditions in the case reports, which require knowledge of key warning signs and symptoms. Since our questionnaire focused on cases of cervical spine complaints, further studies are needed to get a more complete picture of the differential diagnostic decision-making ability of physiotherapists working in Hungary.

8. Conclusion

To our knowledge, the effects of the differential diagnostic knowledge of Hungarian physical therapists in the recognition of warning signs and symptoms have not been previously studied. Although limited by self-report, cross-sectional design, the results of our study are particularly important because an increasing number of professionals trained in Hungary are working in private practices, where patients arrive without prior medical examination, and rapid consultation and referral of cases are not always possible.

In contrast, physiotherapy as a scientific discipline is constantly evolving. Every year, new research findings, professional guidelines, and international recommendations are published to raise the standard of clinical practice. These sources increasingly emphasize the importance of differential diagnosis, paying particular attention to warning signs and symptoms that may indicate life- or health-threatening conditions.

In Hungary, the training outcome requirements for physiotherapists do not include differential diagnostic knowledge (Barczi et al., 2017). Moreover, to the best of our knowledge, no postgraduate training course in Hungary specifically teaches the process of differential diagnosis in physiotherapy, but differential diagnosis is part of the curriculum of some training courses. In line with the conclusions of international publications, our results suggest that an independent postgraduate course aimed at acquiring differential diagnostic thinking and skills should be added to the curriculum, contrary to the current practice in Hungary. However, we are pleased to share that, based on our results, BSc students will receive a 14-hour course on the basics of differential diagnosis starting in 2024 at the Faculty of Health Sciences and Social Studies of the University, with special emphasis on recognizing red flags and life-threatening conditions.

Our research clearly shows the need to incorporate differential diagnosis into basic training. This would allow future physiotherapists to develop the critical thinking and decision-making abilities necessary for safe and effective clinical work at an early stage.

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11. Appendix

Appendix 1 Data from respondents of the survey

This part of the survey includes 14 questions about your demographics, education and work experience. The questionnaire takes 2 minutes to complete. Please answer all questions if you can.

1. Age: _____

2. Sex:

- female
- male

3. When did you earn your bachelor's degree? (year) _____

4. Where did you earn your first graduate degree? _____

5. What is your highest level of education as a physiotherapist?

- BSc
- MSc
- PhD
- Other: _____

6. Have you participated in postgraduate training?

- yes
- no

If so, what kind of training was it? _____

7. What courses have you attended to acquire knowledge in differential diagnosis?

_____

8. Have you completed a course on cervical spine treatment?

- yes
- no

If so, which one? _____

9. How many years of practical experience do you have? _____

10. Where have you worked in the past year? (You can tick more than one answer.)

- clinic/hospital: outpatient care
- clinic/hospital: inpatient care
- private practice
- other: _____

11. What was the average number of patients you had per week in the past year?

- between 0 and 10
- between 11 and 20
- between 21 and 30
- between 31 and 40
- between 41 and 50
- between 51 and 60
- over 60

12. On average, what kind of problems do you deal with?

- orthopedics
- traumatology
- neurology
- neurosurgery
- pediatrics
- surgery
- other: _____

13. Do patients usually come to you with a doctor's referral?

- yes
- no

14. What percentage of your caseload are patients presenting with neck pain?

- 0 %
- under 10 %
- 10 – 30 %
- 31 – 50 %
- over 50 %

Appendix 2 Survey based on case studies

Below, we present eight different cases published in international literature as case studies. Please select from the list the treatment options that you would apply based on your professional knowledge and experience, according to the descriptions provided.

CS 1

Medical history: A 73-year-old woman presents to a physical therapist with neck pain radiating to her left upper extremity. Her symptoms began 15 days ago following a fall in which she struck her forehead while supporting herself with her left arm. The pain in her neck and left upper limb is constant. Painkillers and rest provide temporary relief. She reports difficulty sleeping since the fall, cannot find a comfortable position, and experiences severe night pain.

She denies significant weight loss, bowel or bladder dysfunction, dizziness, or balance problems. Relevant medical history includes cervical spondylosis, osteoporosis, hypertension, breast cancer 8 years ago, and a humerus fracture 2 years ago secondary to a fall.

Physical examination: The patient helds her head slightly tilted to the left and supports her left arm with her right hand. Palpation of the upper cervical spine is painful. Cervical spine and left shoulder joint range of motion is significantly restricted in all directions. Cervical spine movements provoke sharp pain (VAS 9/10) in the upper cervical region, with increased pain radiating tot he left upper extremity. Muscle strength testing could not be performed due to severe pain. Sensory testing reveals reduced sensation ont he left corresponding to dermatomes C2-3.

Please select the treatment options you would use for the patient described in the case study. Select a minimum of 1 and a maximum of 5 treatment options.

bed rest	education about necessary lifestyle changes (posture and exercise to alleviate symptoms)	muscle strengthening exercises, restoring the function of local stabilizers	traction on the cervical spine
cervical collar	referral to a physician without physiotherapy treatment	exercises to improve coordination	cervical spine manipulation
cooling/heating	imaging	endurance and strength exercises	physiotherapy treatment and referral to other healthcare professional/physician
electrotherapy	consultation with a psychologist	compiling a program of physiotherapy exercises to be done at home	neurodynamic mobilization
massage, trigger point therapy			mobilization exercises, preferred movement directions

CS 2

Medical history: A 79-year-old retired man presented to a physical therapist with neck pain that had been present for 8 weeks. He has no prior history of neck complaints or trauma. The symptoms developed insidiously over 2–3 days. His family doctor ordered a cervical spine X-ray, which revealed degenerative changes from C4 to Th1, and referred him for physiotherapy.

The patient reports pain with all cervical movements, but no pain at rest, night pain, or radiating pain. He also reports unsteadiness while walking and clumsiness in both hands, including difficulty writing, eating, and buttoning clothes. Comorbidities include hypertension and hypercholesterolemia, both managed with medication.

Physical examination: Cervical spine range of motion is age-appropriate, but movement in all directions reproduces the patient's pain (VAS 5/10), which resolves upon returning to neutral. Muscle strength is 4/5 in both upper limbs and 5/5 in both lower limbs. Gait is slow and shuffling. Sensory testing reveals decreased sensation in the fingertips. Reflexes are brisk in both upper and lower limbs.

Please select the treatment options you would use for the patient described in the case study. Select a minimum of 1 and a maximum of 5 treatment options.

bed rest	education about necessary lifestyle changes (posture and exercise to alleviate symptoms)	muscle strengthening exercises, restoring the function of local stabilizers	traction on the cervical spine
cervical collar	referral to a physician without physiotherapy treatment	exercises to improve coordination	cervical spine manipulation
cooling/heating	imaging	endurance and strength exercises	physiotherapy treatment and referral to other healthcare professional/physician
electrotherapy	consultation with a psychologist	compiling a program of physiotherapy exercises to be done at home	neurodynamic mobilization
massage, trigger point therapy			mobilization exercises, preferred movement directions

CS 3

Medical history: A 64-year-old man presents to the physiotherapist with a referral from a neurosurgeon. A CT scan of the cervical spine at the C3–C4 level revealed spondylarthrosis and mild anterolisthesis. He reports neck pain that began 8 weeks ago, initially occurring in the anterior and posterior cervical regions approximately 15 minutes after starting to run. Since then, the pain occurs during all running and brisk walking, forcing him to stop exercise, after which the pain resolves within a few minutes. He rates the intermittent pain as 6/10 on the VAS and describes it as dull and pressing. He reports morning stiffness and neck discomfort when lifting objects (e.g., a bag).

He denies pain radiating to the upper limbs, trauma, dizziness, or other systemic symptoms. Comorbidities include hypertension, depression, dyslipidemia, hypothyroidism, reflux, and recent thyroidectomy. ECG prior to thyroid surgery indicated signs of a previous myocardial infarction. BMI is 31.3. Before the onset of symptoms, he was running several times per week without limitations.

Physical examination: A well-healed surgical scar is visible on the anterior neck. Poor posture is noted. Cervical spine movement is mildly restricted in lateral flexion bilaterally and in extension, with generalized stiffness. No tenderness or pressure sensitivity is present. Neurological examination is normal. Cervical compression, traction tests, and Spurling's test are negative. Symptoms could not be reproduced during the clinical examination.

Please select the treatment options you would use for the patient described in the case study. Select a minimum of 1 and a maximum of 5 treatment options.

bed rest	education about necessary lifestyle changes (posture and exercise to alleviate symptoms)	muscle strengthening exercises, restoring the function of local stabilizers	traction on the cervical spine
cervical collar	referral to a physician without physiotherapy treatment	exercises to improve coordination	cervical spine manipulation
cooling/heating	imaging	endurance and strength exercises	physiotherapy treatment and referral to other healthcare professional/physician
electrotherapy	consultation with a psychologist	compiling a program of physiotherapy exercises to be done at home	neurodynamic mobilization
massage, trigger point therapy			mobilization exercises, preferred movement directions

CS 4

Medical history: A 45-year-old woman presents with neck pain radiating to her left upper limb for the past two months. The pain originates on the left posterior cervical region and extends to the left arm and fingers, accompanied by tingling. She describes her neck as tight and stiff. Symptoms worsen with looking up and to the left, prolonged sitting, and riding a motorcycle. Pain is temporarily relieved by rest and analgesics. She reports no comorbidities.

Physical examination: Neck and shoulder muscles are tense and tender to palpation. Cervical range of motion is limited in extension and left rotation, provoking sharp neck pain and tingling in the left upper extremity. Pain intensity is rated 6/10. Cervical compression and traction tests performed in neutral position are negative. Left-sided Spurling test is positive. Superficial sensory testing of the left upper extremity reveals decreased sensation. Muscle strength and deep tendon reflexes are preserved.

Please select the treatment options you would use for the patient described in the case study. Select a minimum of 1 and a maximum of 5 treatment options.

bed rest	education about necessary lifestyle changes (posture and exercise to alleviate symptoms)	muscle strengthening exercises, restoring the function of local stabilizers	traction on the cervical spine
cervical collar	referral to a physician without physiotherapy treatment	exercises to improve coordination	cervical spine manipulation
cooling/heating	imaging	endurance and strength exercises	physiotherapy treatment and referral to other healthcare professional/physician
electrotherapy	consultation with a psychologist	compiling a program of physiotherapy exercises to be done at home	neurodynamic mobilization
massage, trigger point therapy			mobilization exercises, preferred movement directions

CS 5

Medical history: A 37-year-old woman reports posterior neck pain present for two weeks. Prior to this, she experienced constant dull pain on the right side of her neck, which she attributed to physical activity and poor sleeping posture. Recently, she frequently visited an amusement park and rode roller coasters. She engaged in yoga and received connective tissue massage to relieve her symptoms. Subsequently, she developed severe bilateral posterior cervical pain radiating to the back of her right eye, accompanied by headache, dizziness, occasional nausea and vomiting, and tingling in both upper limbs. Her medical history includes fibroids, dyslipidemia, and asthma. She takes oral contraceptives and does not smoke or consume alcohol. She reports no trauma.

Physical examination: Neck muscles are tense and tender to palpation, while the spinous processes are non-tender. Active and passive cervical range of motion is full and pain-free. Muscle strength in the upper and lower extremities is preserved, with no sensory deficits. Neurological examination reveals no abnormalities. Gait is normal.

Please select the treatment options you would use for the patient described in the case study. Select a minimum of 1 and a maximum of 5 treatment options.

bed rest	education about necessary lifestyle changes (posture and exercise to alleviate symptoms)	muscle strengthening exercises, restoring the function of local stabilizers	traction on the cervical spine
cervical collar	referral to a physician without physiotherapy treatment	exercises to improve coordination	cervical spine manipulation
cooling/heating	imaging	endurance and strength exercises	physiotherapy treatment and referral to other healthcare professional/physician
electrotherapy	consultation with a psychologist	compiling a program of physiotherapy exercises to be done at home	neurodynamic mobilization
massage, trigger point therapy			mobilization exercises, preferred movement directions

CS 6

Medical history: A 36-year-old woman presents with constant right-sided neck pain that has persisted for 4 months, radiating into the right upper limb. The pain originates in the right interscapular region and extends to the posterior neck and along the right arm toward the thumb. She denies any underlying disease or history of trauma. Her occupation involves prolonged sitting, which exacerbates her symptoms.

Physical examination: The right trapezius and anterior scalene muscles are tender to palpation. Pressure over the anterior scalene reproduces pain radiating into the radial side of the right forearm. The patient rates her pain as 7/10 on the VAS. Cervical spine range of motion is full, but right rotation and flexion provoke severe pain in the right interscapular region, radiating to the thumb. Upper limb muscle strength and sensory function are intact. Deep tendon reflexes are moderately brisk. Spurling's test is negative bilaterally.

Please select the treatment options you would use for the patient described in the case study. Select a minimum of 1 and a maximum of 5 treatment options.

bed rest	education about necessary lifestyle changes (posture and exercise to alleviate symptoms)	muscle strengthening exercises, restoring the function of local stabilizers	traction on the cervical spine
cervical collar	referral to a physician without physiotherapy treatment	exercises to improve coordination	cervical spine manipulation
cooling/heating	imaging	endurance and strength exercises	physiotherapy treatment and referral to other healthcare professional/physician
electrotherapy	consultation with a psychologist	compiling a program of physiotherapy exercises to be done at home	neurodynamic mobilization
massage, trigger point therapy			mobilization exercises, preferred movement directions

CS 7

Medical history: A 47-year-old woman presents to a physical therapist with neck pain that began insidiously one year ago and has progressively worsened. She also reports constant pain in both hands, both feet, and the right knee. She denies weakness, numbness, dizziness, or gait unsteadiness. Her past medical history is notable for a 13-year history of rheumatoid arthritis.

Physical examination: Neck and shoulder muscles are markedly tense. Cervical spine range of motion is limited in all directions, particularly in flexion and bilateral rotation, with severe pain provoked during movement. During gentle cervical traction, the patient reports a sensation of losing control of her head and needing to support it with her hands. Muscle strength in the upper and lower limbs is preserved, and no neurological deficits are observed.

Please select the treatment options you would use for the patient described in the case study. Select a minimum of 1 and a maximum of 5 treatment options.

bed rest	education about necessary lifestyle changes (posture and exercise to alleviate symptoms)	muscle strengthening exercises, restoring the function of local stabilizers	traction on the cervical spine
cervical collar	referral to a physician without physiotherapy treatment	exercises to improve coordination	cervical spine manipulation
cooling/heating	imaging	endurance and strength exercises	physiotherapy treatment and referral to other healthcare professional/physician
electrotherapy	consultation with a psychologist	compiling a program of physiotherapy exercises to be done at home	neurodynamic mobilization
massage, trigger point therapy			mobilization exercises, preferred movement directions

CS 8

Medical history: A 56-year-old woman presents to a physical therapist with neck and upper limb complaints that have persisted for 4 months. She reports that the symptoms began suddenly after performing heavy housework. The pain is localized to the lower cervical spine and radiates to the left scapular region, shoulder, and along the ulnar side of the forearm, extending to the little finger. She also experiences numbness in her left hand, which has gradually worsened since onset. The pain is intermittent but often present at night. Prolonged sitting and head rotation aggravate her symptoms, while lying on her right side provides relief. Since symptom onset, she has also noticed weakness, particularly when rising from a chair or climbing stairs. She denies prior neck problems. Her past medical history is significant for thyroid surgery 20 years ago and a mastectomy for primary breast cancer 8 years ago.

Physical examination: Cervical spine range of motion is preserved. Cervical retraction at end range provokes neck pain, while lateral flexion and rotation to both sides exacerbate her upper limb symptoms. She rates her pain as 4/10 on the VAS scale. Shoulder flexion and abduction are limited. Spurling's and cervical traction tests are negative. Sensory testing reveals decreased sensation on the left, reported in the C6 dermatome distribution (though symptoms suggest possible C8 involvement). Reflexes are normal. Muscle strength in both upper and lower extremities appears preserved on gross testing.

Please select the treatment options you would use for the patient described in the case study. Select a minimum of 1 and a maximum of 5 treatment options.

bed rest	education about necessary lifestyle changes (posture and exercise to alleviate symptoms)	muscle strengthening exercises, restoring the function of local stabilizers	traction on the cervical spine
cervical collar	referral to a physician without physiotherapy treatment	exercises to improve coordination	cervical spine manipulation
cooling/heating	imaging	endurance and strength exercises	physiotherapy treatment and referral to other healthcare professional/physician
electrotherapy	consultation with a psychologist	compiling a program of physiotherapy exercises to be done at home	neurodynamic mobilization
massage, trigger point therapy			mobilization exercises, preferred movement directions

Appendix 3 Cases with musculoskeletal problems and cases with warning signs and symptoms

MSK cases	
CS 4 cervical radiculopathy (Wachidah et Herawati, 2021; Farhana et al, 2014)	
CS 6 myofascial pain syndrome (Jalil et al, 2010)	
CM cases	**warning signs and symptoms**
CS 1 odontoid fracture (Ross&Cheeks, 2008)	age, trauma, severe osteoporosis, tumor, limited mobility, severe pain on movement (VAS 9/10), pain persisting at rest, reduced sensation corresponding to C2-3 dermatome
CS 2 cervical myelopathy (Smith et al, 2014)	age, complaint for 8 weeks, gait disturbance, clumsiness of both hands, brisk upper and lower limb reflexes
CS 3 angina pectoris (Mathers, 2012)	pain on running/exercise, signs of myocardial infarction on prior ECG
CS 5 vertebral artery dissection (Gomez-Rojas et al, 2020)	severe bilateral neck pain, dizziness after connective tissue massage, nausea/vomiting, numbness of both upper extremities
CS 7 atlantoaxial instability (Bayer et al, 2021; Lyons et al, 2018)	neck pain for more than 1 year, progressively worsening, 13 years of RA, total limitation of cervical spine movement in all directions, pain, loss of control during traction
CS 8 metastatic tumor (Chaniotis, 2012)	pain at night, weakness, difficulty getting up from a chair or going up the stairs, loss of sensation corresponding to C6 dermatome

Appendix 4 Classification of management decisions

Provide advice, refer to another healthcare	**Physiotherapeutic intervention**
cervical collar	massage, trigger point therapy
bed rest	electrotherapy
cooling/heating	neurodynamic mobilization
imaging	traction on the cervical spine
referral to a physician without physiotherapy treatment	cervical spine manipulation
consultation with a psychologist	mobilization exercises, preferred movement directions
education about necessary lifestyle changes (posture and exercise to alleviate symptoms)	muscle strengthening exercises, restoring the function of local stabilizers
	exercises to improve coordination
	endurance and strength exercises
	compiling a program of physiotherapy exercises to be done at home
	physiotherapy treatment and referral to other healthcare professional/physician