ALMA MATER EUROPAEA
EUROPEAN CENTRE, MARIBOR
Physiotherapy

DOCTORAL THESIS

Iva Lončarić Kelečić

ALMA MATER EUROPAEA
European Centre, Maribor

Doctoral thesis of the third-cycle Bologna study program
PHYSIOTHERAPY

RAZMERJE IZHODNE KONCEPTUALIZACIJE BOLEČINE Z IZIDI PRI BOLNIKIH S KRONIČNO NESPECIFIČNO BOLEČINO V KRIŽU

RELATIONSHIP OF BASELINE PAIN CONCEPTUALISATION WITH OUTCOMES IN PATIENTS WITH CHRONIC NONSPECIFIC LOW BACK PAIN

Mentor: Assoc.Prof. dr. Snježana Schuster

Candidate: Iva Lončarić Kelečić

Maribor, November 2024

ACKNOWLEDGEMENTS

First, I thank my mentor, Associate Professor Dr. Schuster Snježana, for accepting my mentorship and guiding me in preparing this doctoral dissertation. I thank her for every suggestion and constructive criticism, supporting and inspiring my scientific uprising, and being a pillar of encouragement during my scientific, professional, and personal burdens.

I thank the University of Alma Mater Europaea—ECM for supporting my doctoral studies. It enabled me to acquire the highest scientific competence and establish new professional acquaintances and meaningful, sincere friendships.

I am grateful to Associate Professor Dr. Babrović Toni, scientific advisor from the Ivo Pilar Institute of Social Sciences, for awakening me in a new scientific and research thinking dimension. Thanks, Assistant Professor Dr. Kovačič Tine, for the support in Slovenian. To Professor Dr. Bastič Majda; thank You, I will always strive for better than good.

I thank the physician specialists in physical medicine and rehabilitation at the University Clinical Hospital Center Zagreb for their cooperation. To my fellow physiotherapists and intern, the Clinic Head PT, and the Department Head PT, thank you all for supporting and appreciating my scientific work. Thanks to each patient who participated and those interested in research; having patients' trust is an exceptional acknowledgement.

Thanks to my paternal family's moral and emotional support throughout my life. Dear Mother, despite your occasional objections, your sentiment is exceptional, and I know You and my brother are more proud of me than anyone else. This dissertation would make my father proud, too; You are deeply missed.

Last but most importantly, I would like to express my enormous gratitude and profound apologies to my family: my daughter Mara and husband Marko. Thank You for all your support, patience, understanding and, most of all, unconditional love. Although it may seem different, the time spent on PhD programme and this doctoral dissertation have gained non-losable meaning, and the time to come is only ours.

This doctoral dissertation is dedicated to my daughter.

POVZETEK

Uvod: Kronična nespecifična bolečina v spodnjem delu hrbta (KNBVSDH) predstavlja pomembno breme, kar zahteva učinkovito fizioterapijo za izboljšanje izidov pri pacientih. Ugotavljanje interakcije med začetno konceptualizacijo bolečine in izidi pacientov lahko prispeva k razumevanju (re)konceptualizacije in kliničnemu odločanju.

Metode: Kvantitativna raziskava s primerjavo rezultatov pred in po fizioterapevtskem zdravljenju je bila izvedena v ambulantni fizioterapiji. Udeleženci s KNBVSDH (n = 84) so bili deležni vadbene terapije in pred zaključkom zdravljenja posredovali ustrezne podatke; sociodemografski in klinični podatki, izidi glede bolečine, invalidnost/zmanjšana zmožnost in z zdravjem povezana kakovost življenja (ZZPKŽ) ter mere konceptualizacije bolečine. Preverjena je bila splošna kot specifična povezava med začetno konceptualizacijo bolečine in izidi pacientov ter razlika v konceptualizaciji glede na njihovo izobrazbeno raven. Uporabljen je bil program SPSS, z uporabo deskriptivnih in inferenčnih statističnih metod po konvencionalni sprejemljivosti statistične značilnosti.

Rezultati: Ugotovljeno je bilo, da je začetna konceptualizacija bolečine povezana s splošnimi izidi pacientov, s čimer je razložila varianco bolečine (r = -0.273, p = 0.012; r^2 = 0.075), invalidnosti/zmanjšano zmožnosti (r = -0.259, p = 0.018; r^2 = 0.067) in izid ZZPKŽ (r = 0.295, p = 0.007; r^2 = 0.087, oziroma r = 0.323, p = 0.003; r^2 = 0.104) po fizioterapiji. Nižja začetna konceptualizacija bolečine ni bila povezana z zmanjšanjem bolečine ali invalidnostjo/zmanjšano zmožnostjo, niti z manj izboljšano ZZPKŽ po fizioterapiji. Pacienti z nižjo stopnjo izobrazbe so pokazali nižjo konceptualizacijo bolečine (t = -2.219, p = 0.014; d = 0.55).

Zaključek: Pri kronični nespecifični bolečini v križu je konceptualizacija bolečine ob začetku zdravljenja povezana z izidi bolečine, invalidnosti in kakovosti življenja po fizioterapiji, vendar ne vpliva na obseg izboljšav teh izidov. Bolniki z nižjo izobrazbo so lahko ogroženi z slabšimi končnimi izidi.

Ključne besede: kronična bolečina, znanje, znanost o bolečini, fizioterapija, hrbtenica.

SUMMARY

Introduction: Chronic nonspecific low back pain (CNSLBP) imposes a significant burden, necessitating effective physiotherapy to enhance patient outcomes. Ascertainment of the interaction between baseline pain conceptualisation and patient outcomes may aid comprehension of (re)conceptualisation and clinical decision-making.

Methods: Quantitative, pre-post research was conducted in outpatient physiotherapy. Participants with CNSLBP (n=84) underwent exercise therapy and provided relevant data before and after treatment cessation; sociodemographic and clinical data, pain, disability and health-related quality of life (HRQoL) outcome, and pain conceptualisation measures. The relationship between baseline pain conceptualisation and patient outcomes in an overall and specific manner and the difference in conceptualisation concerning educational attainment were verified. The SPSS program was employed, with descriptive and inferential statistical methods utilised under conventional acceptance of statistical significance.

Results: Baseline pain conceptualisation was found to be related to overall patient outcomes, thereby explaining variances in pain ($r = -0.273$, p = 0.012; $r^2 = 0.075$) disability ($r = -0.259$, p = 0.018; $r^2 = 0.067$), and HRQoL outcomes ($r = 0.295$, p = 0.007; $r^2 = 0.087$, respectively $r = 0.323$, p = 0.003; $r^2 = 0.104$) following physiotherapy. Lower baseline pain conceptualisation was associated neither with less pain or disability reduction nor less improved HRQoL outcomes following physiotherapy. The lower-educated patients showed lower pain conceptualisation (t = -2.219, p = 0.014; d = 0.55).

Conclusion: In CNSLBP, baseline pain conceptualisation is related to overall pain, disability, and HRQoL outcomes following physiotherapy but does not influence the extent of improvement in these outcomes. Lower-educated patients may be at risk for poorer overall outcomes.

Keywords: chronic pain, knowledge, pain science, physiotherapy, spine.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

This doctoral dissertation investigates the baseline pain conceptualisation of chronic nonspecific low back pain patients and its correlation to physiotherapy outcomes. The study aims to determine if the initial concept of pain can predict physiotherapy outcomes regarding pain reduction, disability improvement, and health-related quality of life. The research will also identify risk groups based on educational background that may be more prone to poorer outcomes.

The dissertation introduction will address the issue of low back pain, including its health and socioeconomic burden. Additionally, clinical aspects of diagnosing, treating, and predicting the natural course of chronic nonspecific low back pain will be discussed. The role of pain neuroscience education in promoting the understanding of pain will also be explored.
The dissertation's theoretical section will engage the concept of pain, focusing on chronic nonspecific low back pain. It will explore various theoretical and empirical viewpoints, including biological, functional, and quality-of-life alterations. The objective is to examine the existing knowledge on the problem of pain, its conceptualisation, and how it affects patient outcomes following physiotherapy.

The report's third section covers the methodology, research questions, goals, and hypotheses. This is followed by a quantitative analysis that explores the relationship between the baseline pain conceptualisation and physiotherapy outcomes regarding pain, disability, and health-related quality of life in individuals with chronic nonspecific low back pain, with findings providing a basis for further discussion in the field.

The dissertation explored for the first time the relationship between the concept of pain and core physiotherapy outcomes in the specific patient group. Ultimately, it offers an understanding of how conceptualisation, without priming, interacts with patient outcomes and aids comprehension of the reconceptualisation process and its interaction with physiotherapy outcomes. Findings inform decision-making, may initiate health-related activities, close gaps in the existing body of knowledge, and impose the need for new, translational research.

1.1 The burden of chronic low back pain

Chronic musculoskeletal disorders represent the main health problems worldwide and are the highest contributor to the global need for rehabilitation (World Health Organization 2022). They are associated with persistent or recurrent pain lasting longer than three months, which interferes with daily functioning, often accompanied by distress and ultimately becoming a primary source of suffering (Treede et al. 2019). Of the musculoskeletal disorders, low back pain (LBP) stands out as the most common (World Health Organization 2022). A recent analysis of Global Burden of Disease 2019 data showed that approximately 1.71 billion people globally live with chronic musculoskeletal conditions, with LBP as the main contributor to the overall burden, responsible for 7.4% of global years lived with disability (DALYs) (Cieza et al. 2020). Because of DALYs (Driscoll et al. 2014) and poor quality of life (Lubkowska and Krzepota 2019) of adults in their otherwise productive age, chronic low back pain (CLBP) represents both individual and societal burden (Breivik et al. 2013).

Costs, healthcare use, and disability from CLBP vary substantially between countries. They are influenced by culture, social systems, and beliefs about cause and effect, whereby simultaneous projections indicate an apparent increase in the number of people with LBP in the future and even more rapidly in low-income and middle-income countries (Hartvigsen et al. 2018). However, it was recently shown that LBP risk increases in parallel with the sociodemographic index (SDI), and according to a linear fit based on data of the last 20 years, incidence, prevalence and DALYs of LBP may increase by ~1.4 fold by the year 2050 (Mattiuzzi et al. 2020). In 2019, LBP was among the ten most common causes of disability in Croatia and second place in DALYs, compared to other countries with a high to middle SDI (Institute for Health Metrics and Evaluation 2023).

According to current indicators and predictions for the future, LBP is shown to be a constant health and socioeconomic burden that challenges the United Nations' Sustainable Development Goals of eliminating poverty and improving health and well-being by possibly pushing people with lower socioeconomic positions into greater poverty and even more disability (Sharma and Mcauley 2022, 233).

1.2 Chronic nonspecific low back pain

The most common form of LBP is nonspecific low back pain (NSLBP) (Maher, Underwood, and Buchbinder 2017). NSLBP is defined as pain lasting more than one day between the lower rib margins and the buttock creases (Robinault et al. 2023), with or without leg pain (Koes et al. 2006) and is not affiliated with a clear nociceptive-specific cause (Hartvigsen et al. 2018). NSLBP represents the most prevalent chronic pain syndrome encountered in clinical practice (Baron et al. 2016). However, understanding its underlying causes remains limited (Robinault et al. 2023). In chronic pain syndromes, pain can be the sole or leading complaint, while in NSLBP, chronic pain can be conceived as a disease in its own right (Treede et al. 2019, 19).

Chronic nonspecific low back pain (CNSLBP) is typically characterised by persistent pain, mobility, and dexterity limitations, reducing people’s ability to work and participate in society (World Health Organization 2022). CNSLBP represents a complex and multifaceted problem (Wand et al. 2023) derived from diverse biomechanical, physical, environmental, genetic, psychosocial and cultural factors (Balagué et al. 2012), including cause and effect beliefs (Hartvigsen et al. 2018). That might explain the difficulty in establishing its specific aetiology (Rose-Dulcina et al. 2018) and justify it as a disease in its own right. Since NSLBP is not accounted for by a plausible cause in terms of a specific classified disease or associated with tissue damage, CNSLBP represents a form of primary chronic pain (Perrot et al. 2019), which features be more elaborated in the theoretical part.

1.2.1 Epidemiology and risk factors

LBP poses a significant worldwide epidemiologic burden and a primary healthcare issue, displaying an escalating trend that is not expected to reverse soon (Mattiuzzi et al. 2020). Around 90% (World Health Organization 2023) to 95% of all LBP are NSLBP cases (Bardin et al. 2017). Related to the disease course, previous evidence suggests that of all those who experience LBP, around 32% (Stevans et al. 2021) to 40% become chronic (Traeger et al. 2014) pain patients. Meucci, Fassa, and Xavier Faria (2015) estimated the world prevalence of CLBP to be 19.6% in those aged between 20 and 59 and 25.4% in the older population. Related to CNSLBP, certain evidence of this specific prevalence exists and ranges from 15.4% (Iizuka et al. 2017) to 36.1% (Wong et al. 2022). However, its prevalence is limited to the middle-aged and older adult population. Investigating CNSLBP and related factors in younger adults, Vilar Furtado et al. (2014) found a prevalence of almost 30% in a sample of 198 subjects aged 18-29. It must be emphasised that the prevalence estimates vary depending on the definition of LBP used in research (Balagué et al. 2012).

Although the specific causes of NSLBP are still unknown, some known factors are associated with NSLBP (Shahin et al. 2022). Risk factors for the onset of NSLBP pain are mechanical-related (e.g., prolonged standing or walking and heavy weights lifting), lifestyle-related (e.g., obesity, smoking), psychological-related (e.g., depression and job dissatisfaction), and related to previous LBP episodes (Taylor et al. 2014). Related to the meta-analysis mentioned above, results implicate that the incidence is similar in community and occupational settings regardless of the LBP definition. Regarding non-modifying factors, all age groups are affected by NSLBP (Balagué et al. 2012). However, older men are more susceptible (Bento et al. 2020), while females are a more vulnerable group regardless of their age (Vilar Furtado et al. 2014; Bento et al. 2020), which highlights the importance of genetic constitution (Balagué et al. 2012) in the onset of NSLBP.

Considering that every disease, including NSLBP, has an onset which precedes a chronic condition, paying attention to the risk factors that influence the risk of developing CNSLBP is essential. Recently, findings of a large prospective, multicenter study including 5233 patients showed that the transition from acute to chronic NSLBP of 32% was associated with obesity, smoking, insurance coverage, NSLBP with leg pain, baseline disability, and diagnosed affective disorders (Stevans et al. 2021). Previously, an observational study with five years of follow-up of patients with NSLBP showed higher risks of persistent pain among those with higher pain intensity, lower socioeconomic status, negative cognitive and emotional responses to LBP and maladaptive coping behaviours (Chen et al. 2018). In addition to those mentioned above, heavy loads and positions, particularly physical work in general, are also shown to be explicitly predictive of NSLBP chronicity (Nieminen et al. 2021).

Although many of the factors mentioned earlier are difficult to change or nonmodifiable altogether, one independent of these factors is the exposure to nonconcordant processes of care during the early phase of NSLBP treatment, which proved to be a risk of transition to

CNSLBP (Stevans et al. 2021). Although the healthcare system faces enormous challenges, with both the disability and overall financial burden related to LBP escalating, emerging evidence suggests that current practice is discordant with contemporary evidence and is often exacerbating an already existing problem (O'Sullivan et al. 2016). The risk of nonconcordant processes of early NSLBP care is highly prevalent and a significant driver of increased healthcare expenditures, confirmed by the findings of a retrospective cohort study of nearly 2.5 million patients diagnosed with onset LBP (Kim et al. 2019).

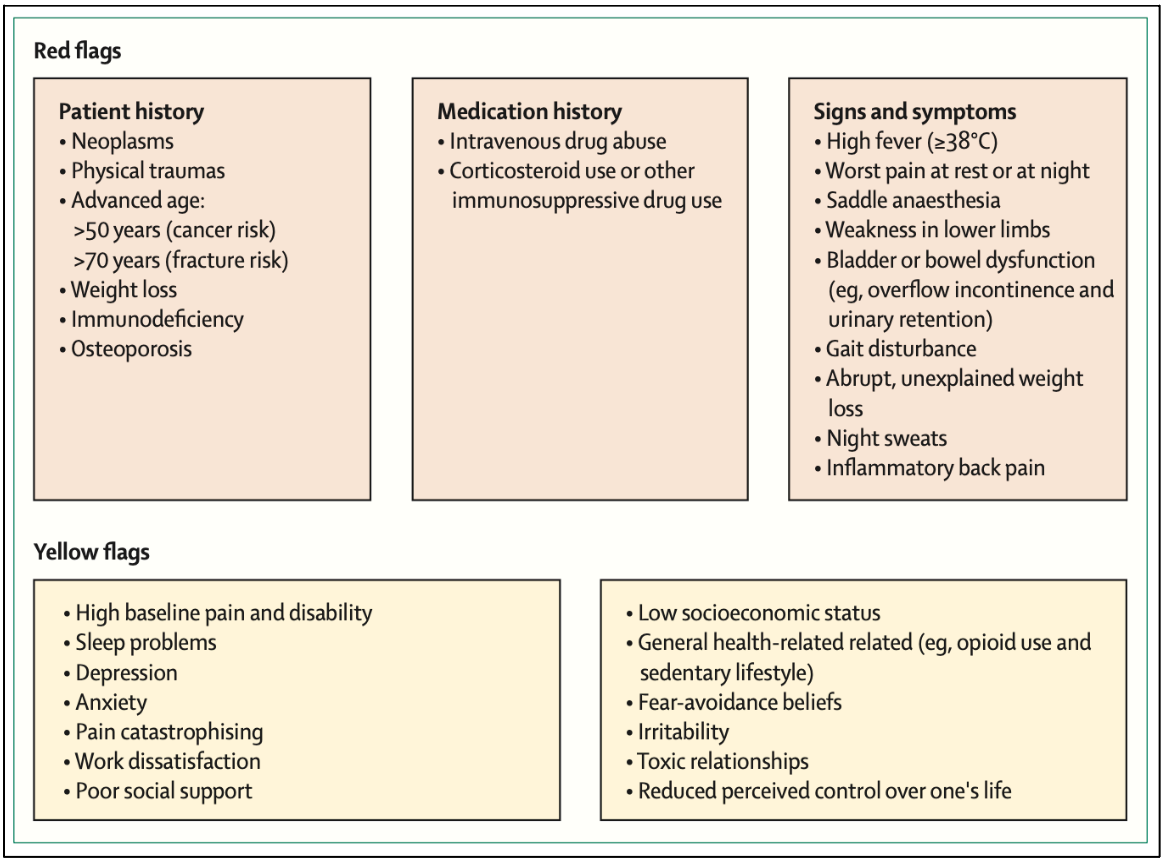
1.2.2 Diagnosis and clinical assessment

Most clinical practice guidelines recommend establishing NSLBP diagnosis after specific spinal and nonspinal disorders; respectively, pathoanatomical causes are ruled out through medical history taking and physical examination (Van Zundert and Cohen 2021; Chiarotto and Koes 2022). History taking should include attention to so-called red flags, which warrant consideration of an occult serious diagnosis and also elicit whether the pain is limited to the lower back or is more widespread; the latter may point to other conditions (Chiarotto and Koes 2022). In the physical examination, using provocation tests such as the ipsilateral straight-leg-raising test and contralateral straight-leg-raising test, disc herniation can be differentiated, and the sensitivity of these tests is shown to be high in 92% of patients, respectively 90% (Deyo and Mirza 2016). Evaluation of weakness, loss of sensation, or decreased reflexes can rule out possible radiculopathy (Chiarotto and Koes 2022, 1734). Although other clinical diagnostic tests have high specificity for sacroiliac joint pain, spondylolisthesis, disc herniation with nerve root involvement, and spinal stenosis (Petersen et al. 2017), they have generally low diagnostic accuracy in the identification of NSLBP (Chiarotto and Koes 2022, 1734). De facto, the probability of other pain-causing conditions progressively rises as the size of the NSLBP category reduces (Petersen et al. 2017).

The guideline's recommendations are uniform against the endorsement of imaging in patients with NSLBP; however, more than half recommend imaging in patients with red flags and endorsing so-called yellow flags during clinical assessment (Van Zundert and Cohen 2021, 83). Red and yellow flags are generally helpful in differentiating specific from nonspecific low back pain. Figure 1 shows their recent overview from the original work of Van Zundert and Cohen (2021, 84).

Even though nonspecific conditions imply unknown aetiology, some disorders procuring NSLBP generally have discernable aetiology, pathology, natural history and prognosis (Malik et al. 2022). For instance, the probability of the intervertebral disc or sacroiliac joint (but not the facet joint) as the source of LBP is usually small and, at best, moderate (Hancock et al. 2007). However, it does exist. Furthermore, apart from spinal and sacroiliac dysfunction, the cause of the pain can be an attribute of muscle pathology or any ligamentous strain (Neha Chitale et al. 2022). In addition, NSLBP-associated muscular pain, known as myofascial pain, is widespread and often a reactive response from nociception from other structures, which is characterised by the presence of trigger points that are located in the fascia, tendons, and muscles (Ramsook and Malanga 2012). Psychosocial problems procuring NSLBP are not negligible, which is confirmed by meta-analysis findings; exposure to diverse psychological vulnerability factors such as depression, anxiety, psychological distress, and fear, among others, may increase the risk of the onset of musculoskeletal pain (Martinez-Calderon et al. 2020). Therefore, the seemingly disparate NSLBP disorders can be confined, based on their shared characteristics, to four distinct groups: (1) syndromes linked to dysfunction of the intravertebral discs; (2) soft tissue syndromes; (3) pain originating from the sacroiliac joint complexes, and (4) psychosocial phenomena confounding the LBP (Malik et al. 2022). Hence, it must be emphasised that during the clinical assessment and diagnosis, it is necessary to consider all possible factors, or at least as many factors, that procure the onset of NSLBP based on evidence of their accuracy.

Figure 1: Red and yellow flags for low back pain



Red flags

Patient history
- Neoplasms
- Physical traumas
- Advanced age:
  >50 years (cancer risk)
  >70 years (fracture risk)
- Weight loss
- Immunodeficiency
- Osteoporosis

Medication history
- Intravenous drug abuse
- Corticosteroid use or other immunosuppressive drug use

Signs and symptoms
- High fever (≥38°C)
- Worst pain at rest or at night
- Saddle anaesthesia
- Weakness in lower limbs
- Bladder or bowel dysfunction (eg, overflow incontinence and urinary retention)
- Gait disturbance
- Abrupt, unexplained weight loss
- Night sweats
- Inflammatory back pain

Yellow flags

- High baseline pain and disability
- Sleep problems
- Depression
- Anxiety
- Pain catastrophising
- Work dissatisfaction
- Poor social support

- Low socioeconomic status
- General health-related related (eg, opioid use and sedentary lifestyle)
- Fear-avoidance beliefs
- Irritability
- Toxic relationships
- Reduced perceived control over one's life

Source: Van Zundert and Cohen 2021, 84.

While the diagnostic approach for acute LBP is well codified, the diagnostic approach for CLBP needs to be more consistent; moreover, specific recommendations have yet to be made in international guidelines regarding clinical examination, including medical history or physical tests (Nicol et al. 2023). Regarding pain per se, CLBP is often centralised and has a specific set of signs and symptoms that may include allodynia and hyperalgesia (Casiano et al. 2023). When considering NSLBP as a chronic pain syndrome, it should be pointed out that in clinical practice, distinguishing CLBP from various chronic pain syndromes can be difficult due to similarities in diagnostic criteria and assessment (Maixner et al. 2016).

Patients seeking help for back pain are a diverse group; their pain is a final common pathway of multiple pathologies (Nguyen et al. 2018, 2547). For instance, symptoms like fatigue, musculoskeletal pain and general malaise could indicate CLBP, fibromyalgia, myofascial pain, or chronic fatigue syndrome (Carnago et al. 2021). Most chronic pain syndromes are heterogeneous, with a high degree of overlap or co-prevalence of other joint pain conditions, along with the influence of biopsychosocial factors; hence, a particular diagnosis is primarily based on exclusion and nuances of difference to determine which features are more salient (Maixner et al. 2016). However, a mitigating factor in differentiating CLBP is that patients with LBP are less likely to report specific chronic overlapping pain conditions than patients with other forms of chronic pain (Wang and Frey-Law 2022). Therefore, until particular recommendations are made, clinically diagnosed NSLBP is considered chronic and differentiated from other chronic pain syndromes if it includes the presence of pain in the anatomical location of the lower back over the prior three months, which limits usual daily activities and is not associated with fever or menstruation (Ohrbach et al. 2020).

This implies that the accuracy of a CNSLBP diagnosis as a disease exclusive of pathology-specific causes and dependent on time depends on the appropriate clinical assessment, physical examination, and detailed history taking. In addition, we will begin to address this significant health issue by understanding and diagnosing the specific cause of an individual's back pain, whether structural or functional (Nguyen et al. 2018, 2547).

1.2.3 Natural history and prognosis

NSLBP is often categorised by focusing on the duration of the current episode: acute (<6 weeks), subacute (>6 to 12 weeks) and chronic (>12 weeks) (Furlan et al. 2015). Evidence suggests that of all those who experience onset LBP, around 32% (Stevans et al. 2021) to 40% will become chronic (Traeger et al. 2014). However, this duration-based concept was not so recently challenged by recognising that LBP is often episodic (Kongsted et al. 2016). In addition, sometimes, the diagnosis solely, for instance, acute or chronic NSLBP, tells very little about the prognosis (Kongsted et al. 2016). The concept of disease/diagnosis is dichotomous and challenged by the frequent use of diagnostic indicators with continuous distributions, which can not be utilised for the prognosis of chronic pain syndromes, including LBP (Croft et al. 2015). In contrast, the prognostic concept proposed by Croft et al. extends beyond disease and diagnosis, embracing a wide range of information (i.e. non-disease factors and genetic and other biomarkers) to predict future patient outcomes.

Hence, regarding disease course and in contrast to a duration-based concept, NSLBP represents a long-term condition with a variable trajectory rather than isolated, unrelated episodes (Chiarotto and Koes 2022, 1733). Of course, this does not exclude the fact that CNSLBP is a chronic pain condition, excluded from pathology-specific causes, characterised by pain in the lower back over the prior three months that interferes with usual daily activities (Ohrbach et al. 2020). In the context of the disease course, this novel paradigm implies that both acute and chronic NSLBP have trajectories (Chiarotto and Koes 2022) and differentiates between a recent onset, first-time experienced episode and a recent flare-up of recurrent LBP (Kongsted et al. 2016). Within the prognostic model: biological, social, and clinical prognosis-related factors (Croft et al. 2015), patients with LBP trajectories of mild or transient pain will have a minor activity limitation and most minor psychological issues, whereas patterns of high-intensity pain are associated with more constant pain, higher levels of disability, depression, anxiety, work absenteeism and other indicators of poor health-related quality of life (Kongsted et al. 2016). The majority of those with acute NSLBP (approximately 70%) have a pain trajectory that is recovery prognostic. In contrast, this trajectory is less frequent in patients with CNSLBP (approximately 30%), who have an ongoing pain trajectory (40 to 50%) (Chiarotto and Koes 2022).

In addition to prognosis, according to reviews of observational studies, generic factors that are consistently associated with poor outcomes (i.e., persistent pain and disability) in patients with LBP included the presence of widespread pain, malfunction, somatisation, high pain intensity, prolonged pain, high levels of depression and anxiety, previous episodes of LBP, and poor coping strategies (Artus et al. 2017). Furthermore, an observational study with five years of follow-up involving 281 patients with NSLBP showed higher risks of a persistent pain trajectory among patients with high pain intensity, low socioeconomic status, negative cognitive and emotional responses to pain, and passive behavioural coping (Chen et al. 2018). Previously, in a meta-epidemiologic study which compared risk factors for return to work in patients with different durations of NSLBP, it was found that the pattern of risk factors, in general, does not change markedly with increasing symptom duration; however, a higher proportion of modifiable factors was found in the subacute group compared to the chronic group and emphasis was placed on the role of psychosocial factors in the development of chronic NSLBP (Heitz et al. 2009). As confirmed by meta-analysis, although the typical course of acute NSLBP is initially favourable, after six weeks, improvement slows. After that, only small reductions in mean pain and disability are apparent for up to one year, which indicates an unfavourable course of CNSLBP (Menezes Costa et al. 2012).

Based on previous evidence and regarding the course and prognosis, it can be concluded that NSLBP is a long-term condition with a variable trajectory, which depends on biological, psychosocial, and clinical factors, and those that are more altered and salient will determine the poorer outcome path. Here, it is essential to emphasise the necessity of moving away from the diagnostic model alone towards the prognostic concept, as the interaction of disease with non-disease factors and starting point with a broader incorporation of factors relevant to patient outcomes than sole diagnosis (Croft et al. 2015). Only in this way the burden of LBP can be adequately addressed, regardless of whether patients whose pain is of a pathoanatomical nature or those in whom biopsychosocial factors play a role (Nguyen et al. 2018, 2547).

1.2.4 Treatment

Since the diagnosis of NSLBP implies no known pathoanatomical cause (Maher et al. 2017), without a defined pathoanatomical cause, the rationale for appropriate intervention may be questionable (Nguyen et al. 2018; Nguyen et al. 2021). Additionally, CNSLBP is conceived as a disease in its own right (Treede et al. 2019) and represents a complex and multifaceted problem (Wand et al. 2023) derived from diverse biomechanical, physical, environmental, genetic, psychosocial and cultural factors (Balagué et al. 2012), including cause and effect beliefs (Hartvigsen et al. 2018), representing an additional challenge in providing appropriate treatment. Countless potential targets for management across the biopsychosocial spectrum have been detected; still, due to patient heterogeneity, the efficiency of the recommended treatments for CNSLBP can be poor (Hayden et al. 2012).

Regarding treatment recommendations, recently reviewed international guidelines recommend non-pharmacological treatments over pharmacological, including physical activity and exercise, physiotherapy, and education; however, in selected cases, a multidisciplinary approach is the core treatment recommended for people with CNSLBP (Nicol et al. 2023). The findings of this latest review are mainly consistent with the previous one by Oliveira et al. (2018). Of the above, physiotherapy, respectively therapeutic exercise, represents the first line of treatment (Bailly et al. 2021, 20), followed by patient education and psychological treatment, but in combination with physiotherapy (Nicol et al. 2023), actually very consistent with the previous review of high-quality clinical guidelines by Lin et al. (2020). Interestingly, the current recommendations of Croatian physician specialists, to a certain extent, include different treatment strategies, which, along with education and exercise, include physical modalities and massage, pharmacological therapy, but a biopsychosocial treatment only in case of severe disability (Grazio et al. 2012).

1.2.4.1 Physiotherapy

Referring to the above, physiotherapy represents a first-line treatment for CNSLBP or patients with risk factors for developing it (Bailly et al. 2021, 20); however, specific physiotherapy techniques are only sometimes detailed in clinical guidelines (Nicol et al. 2023). Therefore, the following will discuss only recent recommendations and evidence implications on CNSLBP physiotherapy treatment approaches. In the context of physiotherapy approaches in general, three prominent are highlighted: movement, education and advice, and manual therapy (The National Health Service 2023).

The Department of Veterans Affairs and the Department of Defense (VA/DoD) guidelines (2022) recommend structured, clinician-directed exercise programs which involve organised and progressive activity to improve pain, disability and physical function; exercise programs targeted at the lumbar, abdominal, and hip muscles and additionally, generalised exercises not specifically targeting the back, respectively, peripheral muscle training. French guidelines recommendations on CNSLBP physiotherapy treatment, supported by appropriate evidence and strong consensus, include the patient's active participation and therapeutic exercises adaptation to the clinical context, taught by a physiotherapist and continued at home Bailly et al. (2021, 20-21). Guidelines of the Orthopaedic Section of the American Physical Therapy Association (APTA) recommend that physiotherapists should use exercise training interventions, including trunk muscle strengthening and endurance, multimodal exercise interventions, specific trunk muscle activation exercise, and aerobic exercise for patients with CNSLBP, and in addition, may provide movement control exercise or trunk mobility exercise (George et al. 2021). The Lancet Low Back Pain Series Working Group also pledges exercise therapy as the first-line treatment that should be routinely used and recommends graded therapeutic exercise and activity that focus on functional improvements (Foster et al. 2018). The American College of Physicians (ACP) guidelines also recommend therapeutic exercises, emphasising those aimed at motor control improvement (Qaseem et al. 2017). The National Institute for Health and Care Excellence (NICE) guidelines (2016) recommend considering exercise programmes emphasising biomechanical, aerobic, mind-body or a combination of approaches.

Deliberating recommendations regarding therapeutic exercises, it is evident that there still needs to be a firm consensus on the most effective type and mode of conducting (i.e. individual or group), which is also implicated in previous reviews (Foster et al. 2018; Oliveira et al. 2018). What stands out are patients' specific needs, preferences, and capabilities as precursors when choosing the type of exercise (National Institute for Health and Care Excellence 2016; Chou et al. 2018). This lack of unanimity is not crucial, given that exercise, predominantly aerobic and resistance exercise, is generally considered an essential component of effective chronic pain management, and it is well-established that long-term exercise training provides pain relief (Rice et al. 2019). In addition, if supervised, individual and group therapeutic exercise (Lemieux et al. 2020) improves patient outcomes in CNSLBP (Matarán-Peñarrocha et al. 2020). Summarising the recommendations, physiotherapy exercises as the first line of treatment for CNSLBP should be aimed at mobility, strengthening, stabilisation and establishment of pelvic-trunk motor control, graded according to the patient's capabilities and needs, and ultimately aimed at functional recovery.

Patient education, particularly person-centred education, is consistently recommended for persons with LBP (O’Hagan et al. 2023) in addition to therapeutic exercises. The NICE guidelines (2016) advocate advice and information tailored to patient's needs and capabilities to help them self-manage their LBP, inform them of the nature of LBP and encourage them to continue with everyday activities. In the paradigm of patient-centred care, VA/DoD guidelines (2022) emphasise good communication as essential and must be supported by evidence-based information tailored to each need. The APTA guidelines strongly recommend delivering pain neuroscience education alongside other physiotherapy interventions, using active treatments instead of stand-alone standard educational interventions (i.e. advice related to exercise and staying active) for patients with chronic NSLBP (George et al. 2021). French guidelines strongly recommend patient education (i.e., reinsurance, fight against fears and beliefs, and awareness of the benefits of physical activity) as part of biopsychosocial management. In contrast, pain neurophysiology education is recommended as a second-line treatment based on expert consensus (Bailly et al. 2021, 21). Despite some discrepancies between the guidelines, pain neuroscience (Louw et al. 2019) or neurophysiology education (Keen et al. 2021), learning about pain and its biopsychosocial interaction components (Louw et al. 2016; 2019) nowadays is widely propagated.

As for Croatia, there is no evidence that such a targeted patient education model has found its place in physiotherapy or the multidisciplinary management of CLBP. Referring to the Masterclass on person-centred education and advice for LBP (O'Hagan et al. 2023), not only do people want to know about the cause of LBP, but specific messages of reassurance about the cause and severity of LBP are consistently more predictive of intention to self-manage than those encouraging physical activity. Hence, physiotherapists should consider education and advice on messages about cause, severity, and imaging, and in doing so, focus on the patient to remove barriers to physical activity, exercise, and support self-management (O'Hagan et al. 2023).

Related to passive approaches concerning the patient's participation (i.e. manual therapy, physical therapeutic agents, forms of acupuncture), there are certain inconsistencies between guidelines; some passive interventions are not recommended due to the lack of evidence or the weakness of the existing ones or else there is a firm basis for their non-application. For instance, the APTA guidelines recommend using thrust or nonthrust joint mobilisation to reduce pain and disability in patients with CLBP and the possibility of soft tissue mobilisation and neural mobilisation in conjunction with other treatments for short-term improvements. In contrast, mechanical traction is not recommended (George et al. 2021). The VA/DoD guidelines (2022) suggest spinal mobilisation/manipulation, but based on weak evidence and highlighting insufficient evidence to recommend for or against mechanical lumbar traction. NICE guidelines (2016) do not recommend traction for management while considering spinal manipulation, mobilisation or soft tissue techniques as part of a treatment package, including exercise. The ACP guidelines (2017) recommend spinal manipulation for CLBP but on low-quality evidence. French guidelines also consider manual techniques as second-line treatment and only as a part of a multimodal treatment combination, including a supervised exercise program (Bailly et al. 2021, 21). For acupuncture and related forms, the VA/DoD (2022) guidelines report insufficient evidence to recommend it; NICE guidelines (2016) strongly do not recommend it; APTA guidelines (2021) consider using, while ACP (2017) recommend it, but with a poor evidence quality foundation.

The recommendations on manual therapies and acupuncture are inconsistent but in different aspects; they vary mainly regarding the circumstances in which the intervention should be provided, respectively, implicating discrepancies related to its use in patients with NSLBP (Oliveira et al. 2018). In addition, manual therapy and acupuncture are two treatments that most guidelines agree should be administered only as adjuvant therapy (Nicol et al. 2023).
Regarding physical agent modalities, a substantial agreement can be observed between guidelines. Such therapies as laser, transcutaneous electrical nerve stimulation, and ultrasound are not recommended in CLBP management (National Institute for Health and Care Excellence 2016; Qaseem et al. 2017; Bailly et al. 2021, 24; The Diagnosis and Treatment of Low Back Pain Group 2022), while the APTA guidelines (2021) do not

mention or address physical agent modalities at all. Therefore, applying manual therapy and other directed therapies can only be considered an adjunct to therapeutic exercises. In contrast, applying physical agent modality has no scientific stronghold.

1.3 Pain understanding

The term "low back pain" can be observed from several perspectives. From the diagnosis perspective and the perspective of symptoms resulting from different known or unknown abnormalities or diseases (Hartvigsen et al. 2018). From any angle we look at it, pain is a precursor term in both perspectives. Understanding the underlying (patho)anatomy helps understand how LBP can develop (Chou 2023). Respectively, to understand pain, it is necessary to understand what pain is, what function it serves, and what biological processes are thought to underpin it (Moseley and Butler 2015, 808). Understanding the biology and origins of pain can have a powerful influence on individuals' health and well-being since it changes how people think about pain, reduces its threat value and improves their management of it (Butler and Moseley 2013, 16-17).

As Moseley (2007, 169) states, the biology of pain is never really straightforward, even when it appears to be. Understanding pain simply as a direct consequence of physiological dysfunction (Ongaro and Kaptchuk 2019) and a marker of tissue damage (Moseley and Butler 2015, 808) is contrary to the understandings, evidence, and knowledge advocated by modern pain science (Malfliet et al. 2017).

From the longitudinal perspective of NSLBP, psychosocial factors are undeniable (Ramond-Roquin et al. 2015), including pain understanding as an undoubtedly psychosocial factor, considering its critical cognitive (psychological) and social (environmental) constructs (Asmundson et al. 2014, 37; Craig and MacKenzie 2021). The overall ability of patients to seek, understand, and apply health information, including those about pain, plays an essential role in managing chronic pain conditions (Edward et al. 2018). In addition, all health professionals must be knowledgeable about pain for effective pain management and patients' well-being (Nuseir et al. 2016), and conflicting information from healthcare professionals is a known iatrogenic contributor to pain (Parker and Madden 2020, 4). Pain understanding, which is based on outdated pain models and laden with misconceptions that are contrary to the best evidence, is a barrier to effective pain management (Ryan et al. 2023).

According to the study findings from Darlow et al. (2013), healthcare professionals have the most substantial and possibly long-term influence on patients’ understanding of the source and meaning of pain symptoms. However, evidence shows that patients with LBP have pain misunderstandings (Darlow et al. 2014; Tarimo and Diener 2017; Grøn et al. 2019; Ampiah et al. 2022), as well as healthcare professionals involved in their care (Valenzuela-Pascual et al. 2021; Ampiah et al. 2022). Systematic reviews show evidence that health professionals' understanding of LBP is associated with the understanding of their patients and that misunderstanding is associated with LBP management and possibly outcomes (Darlow et al. 2012). Healthcare professionals with pain misunderstandings are more likely to recommend non-evidence-based care, and healthcare commissioners with such understandings may be more likely to direct resources to non-evidence-based pathways; hence, this domino effect creates an environment where non-evidence-based care is perpetuated, leading to poorer outcomes for all (Ryan et al. 2023). Additionally, information from the social environment that supports patients' LBP misunderstandings is more than available and trustworthy in opposition to those countering them (Wand et al. 2023). Along with pain misunderstandings and supporting constructs, patients themselves are unaware of the proper care pathway to undertake, which may have implications for their overall quality of life (Lepri et al. 2023).

Today, the fact that pain is a complex phenomenon made up of different biopsychosocial constructs is widely known in science. Still, pain remains one of the most misunderstood medical problems (Mathews 2011). Understanding modulators is also beneficial in understanding the multifactorial nature of pain (Shala et al. 2021); hence, it is essential to know and understand that pain is dependent on its perceived cause and that emotions, thoughts, beliefs and behaviours can be the percussor of pain, as well as that lack of knowledge and understanding may have their input into pain experience (Butler and Moseley 2013, 21-39). Understanding the problem is particularly important in CNSLBP, where the conventional treatment approach is entrenched in robust beliefs and attitudes (Moseley 2003, 184). CNSLBP is a complex problem that is best understood through a biopsychosocial lens, particularly one that incorporates a contemporary understanding of the neurobiology of the pain experience; hence, patients should be provided with a less threatening and more hopeful understanding of their problem (Wand et al. 2023).

1.3.1 Pain Science Education in the management of chronic nonspecific low back pain

Optimisation of CNSLBP management and improvements in treatment outcomes may emerge from a richer understanding of the interaction between modifiable contributing factors across the biopsychosocial spectrum and how these issues coalesce to shape the pain experience and trajectory (Wand et al. 2023). In general, the patient's understanding of pain is the target of education. Pain science education improves understanding of "how pain works“ and has been demonstrated to improve patients' pain and disability outcomes (Ryan et al. 2023). Pain education is a popular treatment approach for chronic pain that involves learning various concepts about pain, an essential part of recovery (Leake et al. 2021), and it is indicated when the patient presents maladaptive illness perceptions (Nijs et al. 2011).

Pain science education is underpinned by theories, primarily educational psychology (Moseley et al. 2023), of which conceptual change theory is the leading originator (Moseley and Butler 2015, 807). Emerging in the early 2000s, intensive education about "how pain works“ has evolved into diverse educational approaches with deliberated and targeted content and strategies aimed at pain understanding (Moseley et al. 2023). The widely known educational model known as pain neuroscience (Louw et al. 2019) or pain neurophysiology education (PNE) (Keen et al. 2021), as the name suggests, relies on education about the biology of pain on a neuroscientific basis, but at a level comprehensible to patients. A key aspect to understand is that pain is produced by the brain when it perceives danger to body tissue, and additionally, pain does not equal pain caused by damage to body tissue (Shala et al. 2021). More broadly, key learning targets in pain science education include the variable relationship between danger messages, that is, nociception and pain; the potency of context on pain; upregulation in the nociceptive system as pain persists; the coexistence of multiple protective systems, including pain itself, but the only one that the sufferer necessarily knows has been engaged; the potency of these other protective systems on pain; the adaptability, and therefore trainability, of our biology (including neuroplasticity) and the knowledge that this adaptation back to normality is to be expected to be slow (Moseley and Butler 2015, 808-809).

Along with PNE, several other educational models have been developed, such as the Fit-for-Purpose Model (FFPM), which shares some characteristics with the approaches above to understanding and managing CNSLBP but extends them by integrating cognitive and behavioural factors with modifiable neuroimmune processes (Wand et al. 2023). Pain science education is not a specific set of procedures or techniques; it is a range of educational interventions that increase knowledge of pain-related biology, decrease catastrophising, and reduce pain and disability (Moseley and Butler 2015, 807-808) in pain sufferers. The common thread of pain science educational models is that understanding their pain helps patients progress towards self-management and recovery of life roles (Parker and Madden 2020, 3).

Although clinical practice guidelines recommend pain education as a part of the first-line treatment for managing chronic musculoskeletal pain, including CNSLBP, more pain education programs in healthcare are needed (Baroni et al. 2023). The evidence of systematic reviews and meta-analyses in the existing body of knowledge favour PNE in CNSLBP treatment since it appears to contribute to better clinical outcomes both in the short to medium term (Wood and Hendrick 2019; Ferlito et al. 2022; Bonatesta et al. 2022) when combined with the usual physiotherapy treatments, first line with exercise, (Bonatesta et al. 2022; Cuenca-Martínez et al. 2023; Lepri et al. 2023) and as a part of an interdisciplinary program (White et al. 2018). The most recent meta-analysis has shown that adding just a single session of PNE to physiotherapy treatment programs would lead to more efficacious effects for CNSLBP, and with a group-based approach, it may be more beneficial (Ma et al. 2023). In general, communicative and educative strategies have gained significant relevance in managing CNSLBP, whereas pain science education in the first line is most effective for behaviour modification and compliance with exercise in the long term (Barbari et al. 2020). The uptake of patient pain science education as a treatment approach has required a dramatic shift in the type of education given by physiotherapists, away from explanations focussed on structural pathology and ergonomic advice, both of which are linked to poor outcomes, and towards explanations focusing on the biopsychosocial mechanistic constructs of pain, the benefits of which are supported by scientific evidence (Parker and Madden 2020, 3). However, more profound scientific knowledge is needed for physiotherapists and other health professionals to have a critical and deep engagement in how treatments act to potentially influence clinical outcomes (Parker and Madden 2020, 3).

2 THEORETICAL BACKGROUND OF THE CONCEPT OF PAIN AND THE RELATIONSHIP WITH PATIENT OUTCOMES

The theoretical part of the dissertation explores the concept of pain, encompassing different theoretical and empirical perspectives, including biological, functional, and quality of life changes. The main objective is to analyse the existing knowledge about pain, its conceptualisation, and its relationship with patient outcomes in CNSLBP.

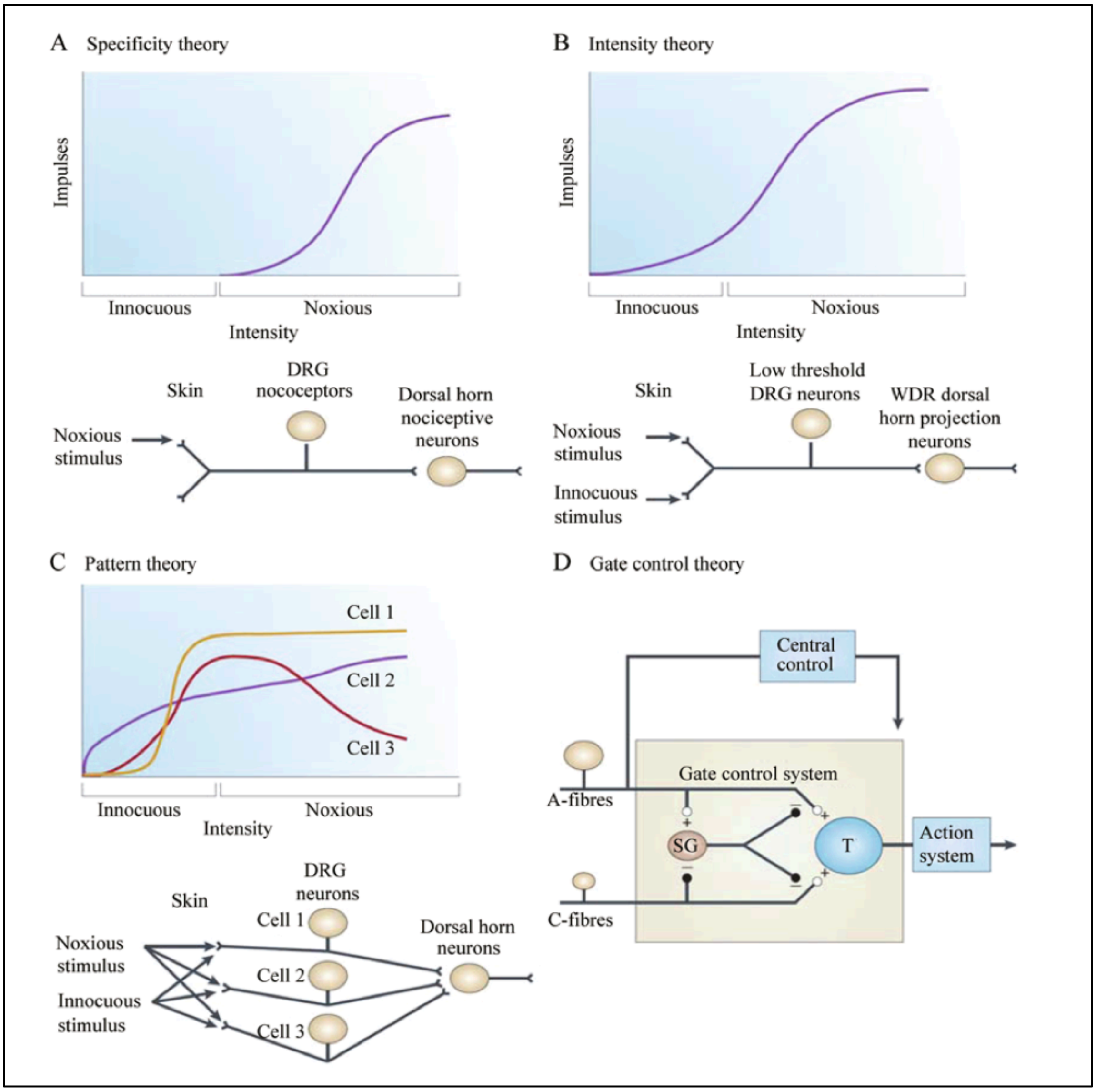
2.1 Theories of Pain

Although pain is humankind's oldest medical problem and universal physical affliction, throughout history, pain as a cause of human suffering primarily had philosophical, political and religious meanings (Meldrum 2003, 2470). Pain experience has remained a topic of long debate since its emergence in ancient times when Aristotle saw pain not as sensation but as emotion, not connected with the brain but with the heart as a central organ (Chen 2011, 343). Hippocrates believed that pain was caused by an imbalance in the vital fluids of a human (Linton 2005, 11).

The initial ideas of pain were formulated in both the East and the West before 1800. Since 1800, due to the development of experimental sciences, different theories of pain have emerged and become central topics of scientific debates (Chen 2011, 343). Different theories have been developed to aid in comprehending pain, and through time, besides various religious, philosophical, political, and cultural models, these have been based on scientific considerations as well, and each of those pain theories continued to exert influence on pain deliberation (Linton 2005, 9). The salience of pain as a problem in its own right has grown since 1945, and as a result of research and new knowledge, new theoretical perspectives with further pain assessment and treatment implications were developed (Meldrum 2003, 2470).

The perspective of time, respectively, and the historical course of pain is essential in understanding this problem. Pain has been a vital experience throughout recorded history, and some of the various models of how pain functions have evolved continue to influence how pain is viewed today; in addition, how we experience pain changes with time, as do the consequences for us (Linton 2005, 18). Since the 17th century, theories postulated are considered the most influential throughout history, including the Specificity, Intensity, Pattern, and Gate Control Theories of Pain (Moayedi and Davis 2013, 5). In general, each of the theories has typical assumptions about the relationships between stimuli and primary afferent signalling in pain, as Chen (2011, 345) has succinctly shown (Figure 2) by adapting work from Perl (2007).

Figure 2: Theories of Pain



Source: Chen 2011, 345.

The Specificity Theory (Figure 2 A) was one of history's most influential (Chen 2011, 344) and one of the first modern pain theories. It refers to the presence of dedicated pathways for each somatosensory modality; hence, it postulates that there is a dedicated fibre that leads to a dedicated pain pathway to the sensory modality’s region of the brain, therefore suggesting the existence of a pain-specific pathway (Moayedi and Davis 2013, 5-8). Initially presented by Charles Bell in 1811 (1774–1842) (Chen 2011, 346), the theory is similar to Renee Descartes' (1596-1650) dualistic approach to pain in the way that it delineates different types of sensations to different pathways, still; postulating brain as a complex structure with various components and not a homogenous object as Descartes believed it was (Trachsel et al. 2023). As Bell, who suggested motor activity depends on the ventral roots, François Magendie (1783-1855) demonstrated dorsal spinal roots as afferent, consequently providing powerful tools for work to come on functions of the spinal cord and ultimately on pain mechanisms (Perl 2011). Throughout a century and a half, scientists and philosophers further developed the specificity theory; in the mid-1800s, Johannes Muller revealed that individual sensations were the result of specific energy experienced at certain receptors, including the ability of an individual to discriminate between different sensations, and in 1894, Maximillian von Frey advanced the concept by the discovery of four separate somatosensory spots found throughout the body (Trachsel et al. 2023); touch, cold, warmth and pain (Pearce 2006, 1317). The revelation of specialised sense organs - nociceptors, synaptic transmission and modulation in the central nervous system (CNS), a principle of brain structure and functions, spawned a comprehensive Specificity theory; nociceptors have thresholds at or near noxious levels, increasing activity with more potent noxious stimuli; as special peripheral afferent neurons, they have selective connections to particular spinal and brainstem projection neurons (Chen 2011, 346).

Although this theory and the related findings provided significant advancement to the understanding of pain, it still failed to account for factors other than those of a physical nature that result in the sensation of pain and like the dualistic approach, it lacked an explanation for why sometimes pain persists long after the healing of the initial injury which continued additional researches and new theories (Trachsel et al. 2023).

The Intensity Theory of Pain (Figure 2 B) proposed in 1874 by Wilhelm Erb (Chen 2011, 346; Moayedi and Davis 2013, 8) reasoned pain as the outcome of any solid sensory stimulation, arguing that intense activation of any sensory modality is unpleasant (Perl 2011). However, the theory goes back to Plato (c. 428 to 347 B.C.), who defined pain not as a unique experience but as an emotion occurring when the stimulus is intense and lasting; centuries later, today there is an awareness that pain, especially chronic pain, is a dynamic experience, profoundly changeable in a spatial-temporal manner (Trachsel et al. 2023). The Intensity theory of pain was supported by the characteristics of the visceral sensory system in the 20th century, specifically the spinal cord and stimulus-response (Chen 2011, 346).

The Pattern Theory of Pain (Figure 2 C) was introduced by John Paul Nafe (1888-1970) in 1929, revealing ideas directly opposite to the ideas suggested in the Specificity theory regarding sensation (Trachsel et al. 2023). He proposed a system for sensing physical sensations based on specific activity patterns; patterns were determined by the frequency and timing of individual nerve fibres' discharges concerning impulses from other fibres in the group with no specialisation of incoming fibres to perceive specific types of stimulation (Perl 2011). The theory unequivocally declares that somaesthetic sensations are encoded through precise neural firing patterns in peripheral nerves based on their spatial and temporal profile (Moayedi and Davis 2013, 8-9). At the time, this encoding was considered to accurately represent the type and intensity of the stimulus, leaving no room for ambiguity or doubt. However, with further research and the discovery of unique receptors for each type of sensation, it can be stated with certainty that this theory is an inaccurate explanation for how we feel pain (Trachsel et al. 2023).

In 1965, a theory that considered pain from a holistic perspective was presented. The Gate Control Theory (Melzack and Wall 1965) (Figure 2 D), introduced by Patrick David Wall

(1925–2001) and Ronald Melzack (1929–2019), was a mind-body perspective that partially supported previous theories of pain but also presented more knowledge to advance the understanding of pain further (Trachsel et al. 2023). According to the Melzack and Walls theory and summarised by Chen (2011, 347), there is a mechanism known as "gating" at the first synaptic relay between primary afferents and transmission (T) cells; cells are responsible for transmitting pain signals and are found in the substantia gelatinosa (SG) of the spinal dorsal horn. The theory has three main parts: (i) when neural activity is mediated by large (L) non-nociceptive afferent fibres, it inhibits the activity of small (S) nociceptive afferent fibres through the activation of inhibitory SG interneurons which results in hypoalgesia or analgesia, (ii) when nociceptive afferent fibres' activity prevails, it exacerbates pain by deactivating the inhibitory SG interneurons, and (iii) the "gating" mechanism is dynamically modulated by central control of descending or segmental origin. In simple terms, by Trachsel et al. (2023), the "gate" refers to the mechanism that controls the flow of information from the periphery to the spinal cord and, ultimately, to the brain. When the gate is closed, the brain receives no information from the periphery. However, when the signal travelling to the spinal cord reaches a certain level of intensity, the gate opens, allowing the signal to travel to the brain, where it is processed. This is when the individual begins to experience pain. The theory also slowly initiated the idea that pain may not solely result from physical injury but rather a complex experience influenced by diverse factors (Perl 2011; Trachsel, et al. 2023).

Each of the major pain theories discussed provided a partial explanation of the observations about the nociceptive system and pain perception (Moayedi and Davis 2013, 9) and may be appropriate for the interpretation of some aspects of pain (Chen 2011, 348); still, none of them adequately accounted for the complexity of the pain system (Moayedi and Davis 2013, 9). Additional research was necessary to comprehend the mechanisms and aetiology of pain completely, precipitating the introduction of new philosophies regarding pain (Trachsel et al. 2023).

2.2 Concepts pertinent to understanding pain, related disability and quality of life

The concept of pain is ancient and has been interpreted and understood differently throughout the historical course. Additionally, illness and health were differently understood at the cultural and conceptual levels (Rocca and Anjum 2020, 225). Conceptual models are a set of ideas used to shape the practice of scientific medicine, constructed from general theories and further used as learning tools; these models undergo regular assessment and manipulation in light of new data, ideas, and concepts. If new evidence renders them insupportable, they are modified or eventually discarded and replaced by more valuable models (Quintner et al. 2008, 824-825).

From a historical perspective, two concepts stand out that imply the understanding of pain: traditional and contemporary (Asmundson et al. 2014, 35-36). Due to the development and interaction of science and technology and in the light of new knowledge, several concepts today are interconnected through a biopsychosocial framework and enable a broader and deeper understanding of pain and chronic musculoskeletal pain in particular.

2.2.1 The biomedical concept

The traditional biomedical concept entails specific ways of understanding health, illness and disease. It explains illness as one or more physical malfunctions at a lower level of organisation and health as the absence of physical signs of disease (Rocca and Anjum 2020, 225-230). The biomedical concept implies pain as a sensory experience resulting from physical damage due to injury or disease (Asmundson et al. 2014, 35); such a structural-pathology concept supposes pain as an accurate indication of the tissue state and straightforward injury consequence (Moseley 2007, 169). In addition to pain, the biomedical model views disability as a direct result of disease processes that require treatment or intervention (Zale and Ditre 2015). Hence, the biomedical model is primarily based on a structural conceptualisation of pain (Mescouto et al. 2022) and disability. In this concept, the brain is mainly a passive stimulus-driven organ that absorbs sensory signals from the body and converts them directly into conscious experience (Ongaro and Kaptchuk 2019). Therefore, if an individual suffered an injury, whether it be through trauma, infection, or disease, a signal would be transmitted to the brain, which would, in turn, result in the sensation of pain (Trachsel et al. 2023). The experience of pain is reduced to an elaborate broadcasting system of nerve signals rather than viewing it as moulded and shaped by the person experiencing it and their particular sociocultural context (Bendelow 2013, 455).

The biomedical concept encompasses theories of pain created up to the mid-1900s, which implied that pain experience was exclusively due to an injury somewhere in the body (Trachsel et al. 2023). The concept is consistent mainly with Cartesian dualism and the idea that mind and body are non-overlapping entities; is both reductionistic by linking all diseases directly to specific physical pathology; and exclusionary of any social, psychological, and behavioural mechanisms of illness (Asmundson et al. 2014, 35). The historical concept of dualism that suggests pain as solely caused by physical injury also entails any increase in pain due to additional damage to the body (Linton 2005, 12). The concept of quality of life and disability in the field of biomedicine is closely linked to the idea of biological normality, and this view is well-articulated and forms an integral part of biomedical understandings (Amundson 2005); life quality is explained by the person’s degree of "normality" rather than by environmental accessibility (Amundson 2005).

Quintner et al. (2008, 825) applied the biomedical conceptual model to the problem of clinical pain. The model suggests a direct and predictable relationship between tissue damage and the experience of pain and assumes that there is a neurobiological connection between the site of the damage and the brain and that nociception (detecting potentially harmful stimuli) is a necessary condition for pain. Therefore, the pain is not considered "real" without nociception. Pain not defined in organic pathology is given low clinical importance (Bendelow 2013, 455).

Empiricism is a highly influential perspective in philosophy and science, particularly when it comes to understanding causality; hence, after being assessed in light of new knowledge that rendered the biomedical pain concept insupportable, it was discarded and replaced by a more helpful model supporting multiple constructs of the pain experience (Rocca and Anjum 2020, 62).

2.2.2 The biopsychosocial concept

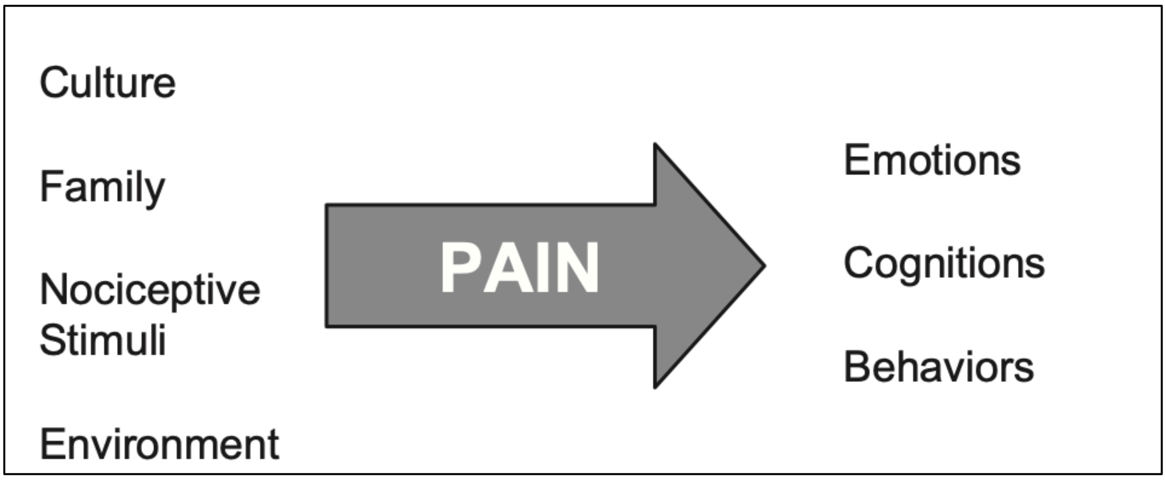
As stated by Asmundson et al. (2014, 36), contemporary pain models share the recognition that biological, psychological, and sociocultural factors influence pain and, hence, are essential for understanding and assessing pain. The Gate Control Theory (Melzack and Wall 1965) has significant historical importance since it challenged the primary assumptions of the traditional biomedical models regarding pain's reciprocal influence on cognition and mood, and vice versa. It is a crucial part of the contemporary biopsychosocial, respectively holistic approach to understanding pain.

Bevers et al. (2016, 99) described the biopsychosocial concept, in general, as an approach that considers the whole person, recognising the interconnection of the body and mind. Considering the biological, psychological, and social factors contributing to pain and illness, this model emphasises how individuals cope with and respond to symptoms or disease rather than solely focusing on the disruption of bodily systems caused by underlying physiological, anatomical, or pathological processes, which is the main focus of the biomedical disease model. Trachsel et al. (2023) also summarised that illness and disease result from complex interactions between biological, psychological, and sociological factors affecting an individual’s physical and mental well-being. In addition, health-related quality of life (HRQoL) is a vital indicator of the overall well-being and life satisfaction experienced by individuals with a disease (Fong et al. 2024), including pain. Above all, scientific research has shown that many factors influence our pain perception; pain is not simply a neurophysiological phenomenon (Linton 2005, 14).

The biopsychosocial model is the only conceptual construct that provides the most comprehensive explanation of why people experience pain and the unique nature of each patient’s experience (Trachsel et al. 2023). Despite the complexity of the pain experience itself, Linton (2005) very simply and vividly described the biopsychosocial concept of pain and the constructs that form it (Figure 3). Accordingly, sensory stimulus, culture, family and environment influence pain perception (Linton 2005, 14–15; Asmundson et al. 2014, 36-41). However, the figure underscores that pain perception, respectively experience, also cognitive (i.e. beliefs, mood, anxiety and fear, and spirituality), and behavioural constructs (i.e. avoidance, activity limitations, coping strategies) (Asmundson et al. 2014, 39–40) thereby implying that pain experience involves how we process and react to physiological stimuli (Linton 2005, 15).

Regarding behavioural and cognitive influences on pain, the biopsychosocial concept does not focus solely on the disease but the illness, viewed as a type of behaviour. It emphasises that illness behaviour is a dynamic process where biological, psychological, and social factors change relative importance as the condition evolves. While a painful condition may be initiated by biological factors like physical injury or pathology, psychological and social factors may play a primary role in maintaining and exacerbating pain (Asmundson et al. 2014, 37). Therefore, unlike biomedically-based concepts, the biopsychosocial concept encompasses pain and disability as a multidimensional, dynamic integration among diverse factors that reciprocally influence one another through a temporal perspective, from the onset of pain to its maintenance (Meints and Edwards 2018).

Figure 3: Factors of pain perception



Source: Linton 2005, 15.

Evaluation of the integrated "whole person," with the mind and the body together as interconnected entities, recognising biological, psychological, and social components of pain and illness (Bevers et al. 2016, 99), implies the same biopsychosocial approach in treatment. Despite recommendations for the approach (National Institute for Health and Care Excellence 2016), it is still unclear whether there is a sufficient understanding of what the biopsychosocial model means in physiotherapy research and practice, and there are questions regarding whether psychological and social aspects are given sufficient attention (Mescouto et al. 2022). In addition, individuals can experience pain differently, which can result in unique symptom patterns for specific patients. This highlights the importance of personalising interdisciplinary pain management programs for each patient during the assessment and treatment. Adopting a holistic approach to pain management is crucial, especially when addressing chronic conditions, by expanding the scope of interdisciplinary assessment and treatment (Bevers et al. 2016, 99).

The biopsychosocial perspective of modern pain science recognises that pain is a complex phenomenon, and other factors are also likely to be important in patients' pain experiences (Mescouto et al. 2022). Hence, to conceptually understand (Mescouto et al. 2022) pain properly, there are four key points: (i) pain is not a measure of the tissue state; (ii) it is modulated by many somatic, psychological and social factors; (iii) the relationship between pain and the tissue state becomes less predictable as pain persists; and (iv) pain can be understood as a conscious correlate of the implicit perception of tissue danger (Moseley 2007, 169). A partial or reductionist understanding of the biopsychosocial concept of pain may be iatrogenic from the perspective of research and practice and outcomes in general.

2.2.3 The concept of central sensitisation

While acute pain helps individuals to identify things that may be harmful or situations that could be dangerous, thus allowing them to avoid contact with those things and protecting their damaged tissues while they heal, when the pain persists, its helpful nature is overshadowed by adverse effects that can have a significant impact on both individuals and society (Nijs et al. 2021). A profound understanding of chronic pain is of high significance in medical and health-related sciences, and it has been shown as a complicated, inevitable, constant and meanwhile unpredictable concept in the process of evolution, which is still not known thoroughly (Rostami et al. 2019, 6).

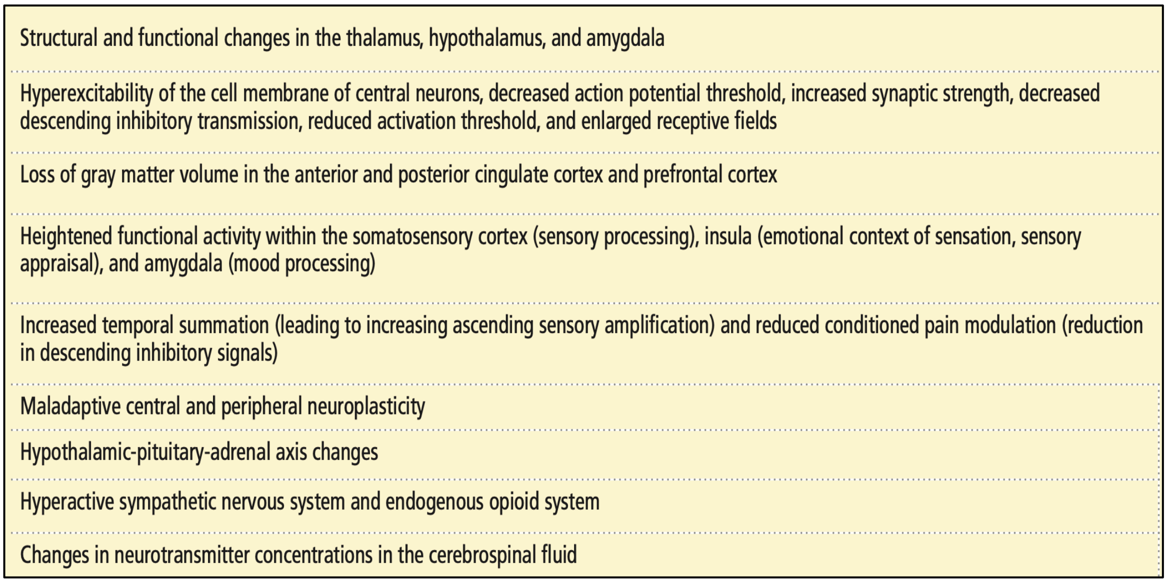
Traditionally, chronic pain is a type of pain that continues more than its usual amount (Rostami et al. 2019, 1) and is widely recognised as teleologically distinct from acute pain by portending tissue damage (Fitzcharles et al. 2022). Within the framework of the modern International Association for the Study of Pain (IASP) definition, CNSLBP entails pain with no specific biological causes, with duration extending the time needed for tissue healing which persists or recurs for more than three months and is associated with significant emotional distress and functional disability (Treede et al. 2019, 19). Given its multifactorial nature and its sequelae, CNSLBP falls under the umbrella of chronic primary pain diagnoses, more precisely chronic primary musculoskeletal pain, a stem category encompassing the fact of pain existence not due to tissue abnormalities; however, pointing out some aspects that only can be mechanistically explained (Fitzcharles et al. 2022).

Advances in neuroscientific research have significantly improved our understanding of pain, including understanding the central nervous system's role in creating and amplifying prolonged pain experiences (Nijs et al. 2023). Empirical studies, including neuroimaging research (Harte et al. 2018), confirm neuroplasticity-based reorganisational changes due to pain presence, amplification, and persistent pain experiences (Nijs et al. 2017, 109). These neuroplastic brain adaptations due to chronic pain lead to the modulation of cognitive domains, affecting pain perception (Khera and Rangasamy 2021). In addition, brain network communication creates pain perception, dynamically integrating cognitive, affective, and sensorimotor aspects on multiple timescales with fluctuating attentional states (Kucyi and Davis 2015). Most cases of chronic musculoskeletal pain are characterised by alterations in central nervous system processing (Nijs et al. 2011), and new scientific knowledge consequently led to the development of a new concept enabling a more comprehensive understanding of chronic pain.

This new and vital concept of central sensitivity (Yunus 2007) respectively, central sensitisation (CS) (Nijs et al. 2011; Woolf 2011; Nijs et al. 2023) embraces the biopsychosocial approach (Yunus 2007) to chronic pain. The concept itself is the foundation of the International Statistical Classification of Diseases and Related Health Problems (ICD) stem category of chronic primary pain (Fitzcharles et al. 2022) and is an evidence-based explanation for many cases of chronic musculoskeletal pain referred to as nonspecific (Nijs et al. 2011). Described as a consequence of ongoing nociceptive input (Harte et al. 2018), CS is operationally defined as an amplification of neural signalling within the central nervous system that elicits pain hypersensitivity (Woolf 2011). However, CS is an umbrella term, hence a concept, covering several partly overlapping and highly related mechanisms (Nijs et al. 2023). Summarised by Dahmani et al. (2023); an increase in synaptic transmission that occurs due to the loss of inhibitory interneurons in the spinal cord, the facilitation of pain transmission pathways that travel up to the brain, changes to the pathways that generally inhibit pain signals from descending, an increase in the emotional and cognitive components of pain perception, and changes to the way the brain processes incoming pain signals.

According to Nijs, Malfliet, and Nishigami (2023), CS is a homeostatic mechanism with a wide range of clinical and biological presentations, adaptive in the short term; still, in the long term, it becomes maladaptive, with pain losing its protective value, which is seen in patients with persistent pain. In addition, neuroimaging research has shown that due to CS, changes occur in the grey matter regions of the brain that process pain, additionally with neurochemical imbalances and altered resting brain-network connectivity between pronociceptive and antinociceptive brain areas and also immune system abnormalities (Harte et al. 2018). A brief overview of structural, functional, and neurochemical changes associated with CS can be seen in Figure 4.

Figure 4: Structural, functional, and neurochemical changes associated with central sensitisation



Structural and functional changes in the thalamus, hypothalamus, and amygdala

Hyperexcitability of the cell membrane of central neurons, decreased action potential threshold, increased synaptic strength, decreased descending inhibitory transmission, reduced activation threshold, and enlarged receptive fields

Loss of gray matter volume in the anterior and posterior cingulate cortex and prefrontal cortex

Heightened functional activity within the somatosensory cortex (sensory processing), insula (emotional context of sensation, sensory appraisal), and amygdala (mood processing)

Increased temporal summation (leading to increasing ascending sensory amplification) and reduced conditioned pain modulation (reduction in descending inhibitory signals)

Maladaptive central and peripheral neuroplasticity

Hypothalamic-pituitary-adrenal axis changes

Hyperactive sympathetic nervous system and endogenous opioid system

Changes in neurotransmitter concentrations in the cerebrospinal fluid

Source: Volcheck et al. 2023, 246.

Essentially, CS is the primary underlying mechanism of nociplastic pain, a pain phenotype (Nijs et al. 2023) suggested to cover a subset of patients with CLBP who experience widespread hyperalgesia, facilitated temporal summation of pain, and impaired conditioned pain modulation despite the absence of clear evidence of actual or threatened tissue damage (Schuttert et al. 2021).

The existing body of knowledge confirms that CS has a significant impact on pain, function, physical performance and HRQoL in patients with chronic primary musculoskeletal pain, CNSLBP in particular (Akeda et al. 2021; Dahmani et al. 2023), simultaneously confirming the contribution of cognitive-emotional factors (Nijs et al. 2023) such as pain catastrophising, stress, hypervigilance, lack of acceptance, depressive thoughts, and maladaptive illness perceptions, to the already sensitised central nervous system (Nijs et al. 2016). By reviewing evidence, Roussel et al. (2013) reported that patients with CNSLBP exhibit altered central nociceptive processing and exaggerated pain responses, also implying a relationship between psychosocial characteristics and CS in this particular population.

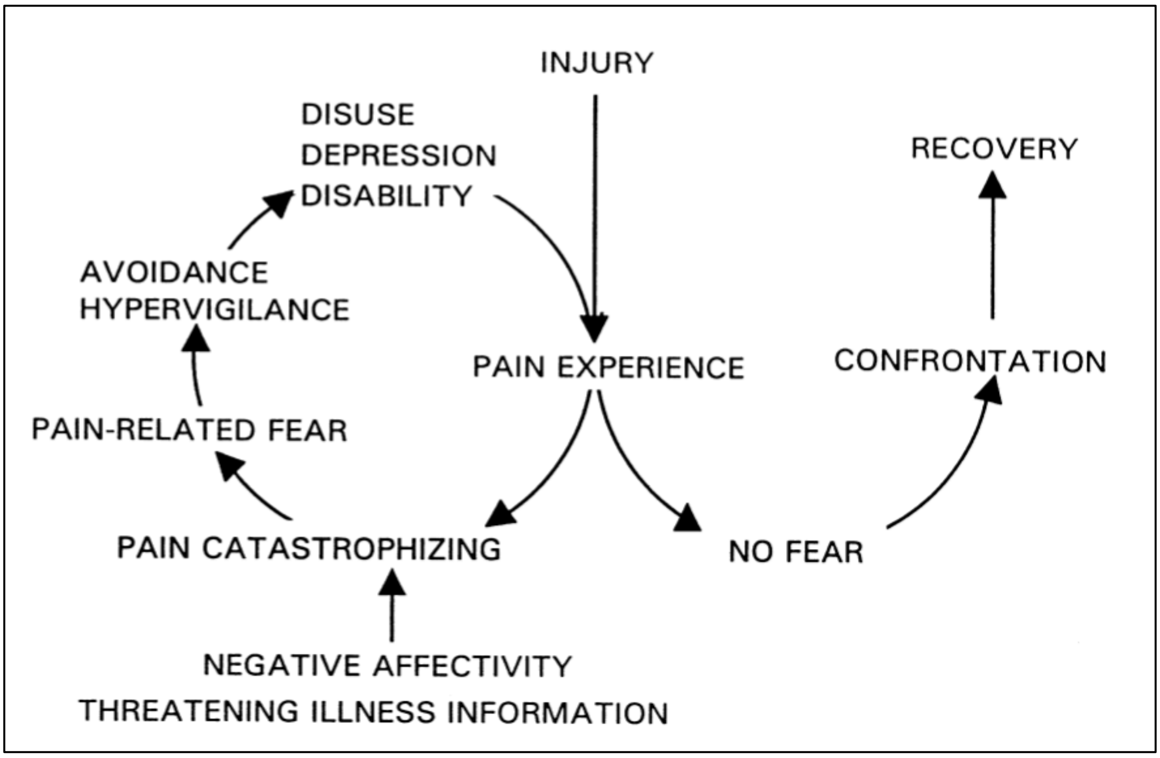
Volcheck et al. (2023, 245) summarise that CS is a pathophysiologic process in which the central nervous system undergoes changes that alter pain processing and other sensory stimuli. As existing evidence implies, this mechanism is responsible for various unexplained musculoskeletal pain conditions, including CNSLBP. In addition, because of CS sequelae, patients frequently misunderstand the cause of their pain and pursue unnecessary evaluations and treatments; hence, clinicians have a pivotal role in decreasing this misunderstanding, which can alter pain perception and treatment, resulting in disability and decreased quality of life (Volcheck et al. 2023, 245).

2.2.4 The fear of pain avoidance concept

Research increasingly acknowledges the contribution of fear and anxiety in chronic pain, building upon knowledge from general research. The Fear Avoidance Model (FAM), underlined by fear of pain as the central concept (Vlaeyen and Linton 2000, 317), was advanced more than twenty years ago to explain the development and persistence of debilitating back pain, and since then, it has been widely accepted and become a leading paradigm for understanding disability associated with musculoskeletal pain (Wideman et al. 2013). By observing the existing body of knowledge, it has long been a well-established fact that pain sufferers frequently encounter various forms of fear that emerge when stimuli that are related to pain are perceived as a main threat, such as fear of injury, movement, work-related activities, and pain itself (Leeuw et al. 2007). In addition and consistent with the FAM of chronic pain, pain-related fear contributes to the development and maintenance of pain-related disability (Zale et al. 2013) and greater pain-related fear is associated with more severe disability and may predict the progression of disability over time (Zale and Ditre 2015). The current understanding underpinned by the FAM is that pain-related fear is a psychopathological problem whereby patients become trapped in a vicious cycle of avoidance behaviour, pain, and disability (Bunzli et al. 2017), which is provoked by patients' negative interpretations of their pain and fear of movement as a consequence (Zhao et al. 2023).

As vividly implied by Vlaeyen and Linton (2000, 329) (Figure 5), when someone experiences pain, possibly due to an injury, if they interpret it as threatening (known as pain catastrophising), it can lead to pain-related fear, causing them to avoid certain behaviours and become hypervigilant about bodily sensations eventually leading to disability, disuse, and even depression. Unfortunately, this can keep the pain experiences going, thus fueling a vicious circle of increasing fear and avoidance. It is believed that negative affectivity and threatening information about the illness can influence pain catastrophising, while on the other hand, non-catastrophizing patients do not experience pain-related fear and are more likely to confront daily activities and recover quickly (Vlaeyen and Linton 2000, 329).

Figure 5: The cycle of the fear avoidance model



Source: Vlaeyen and Linton 2000, 329.

Evidence implies that pain-related fear can also be seen as a common-sense response to dealing with LBP (Bunzli et al. 2017). When one is presented with a model of one's vulnerable, degenerating, or damaged lower back, avoidance is a common-sense response to protect a damaged back (Bunzli et al. 2017). Therefore, the concept of pain as a result of tissue damage has significant implications for individuals who are trying to understand their condition based on their internal resources, as well as for the information they receive from their family, social networks, and the world at large (Wand et al. 2023). It makes intuitive sense to consider acute LBP as a marker of damage, as it is usually characterised by pain that is triggered by movement and relieved by rest and inactivity (Wand et al. 2023), so avoidance behaviours may be adaptive in the context of acute pain, long-term avoidance of physical activity is thought to impair daily functioning and result in more significant physical disability (Zale et al. 2013). According to FAM's proposal, confronting normal activities without catastrophising can lead to recovery when someone first develops LBP; for individuals stuck in the fear-avoidance cycle, the pathway to recovery is less clear (Bunzli et al. 2017). Pain-related fear may be reinforced negatively by avoidance behaviours, which can lead to the maintenance and progression of disability (Zale et al. 2013). Therefore, due to a combination of social, psychological, experiential, and clinical factors that have shaped their thinking patterns, individuals experiencing LBP tend to view their back as fragile and unsuitable for everyday activities and perceive their back to be in danger and in need of protection, which can lead to a negative cycle of pain and fear (Wand et al. 2023).

Wideman et al. (2013) proposed that these cyclical relationships needed further examination, including fear as phobia, the link between pain and disability, and disability's independence from pain-related physiological processes. According to Wand et al. (2023), when a person perceives their body as damaged, fragile, or unhealthy, they may start to feel increasingly so, which reinforces the belief that their back is not capable and needs protection, which is further confirmed by the feedback they receive from their own back due to deconditioning, degraded spine motor control and disrupted self-perception, resulting with a self-sustaining cycle. Research has shown that individuals with more potent pain-catastrophizing thoughts tend to experience a higher level of pain intensity and interference, which can lead to adverse effects such as anxiety, depression (Severeijns et al. 2001), and higher fear of movement, referring to excessive and debilitating fear of carrying out activities that may cause injury or re-injury, with the condition associated with increased pain disability, both cross-sectionally and longitudinally (Luque-Suarez et al. 2019). Regarding the predictive value of pain fear, high pain catastrophism has been revealed as the only predictor consistently associated with poor LBP outcomes in the long term (Otero-Ketterer et al. 2022). In addition, research has brought the fear of movement and avoidance behaviours into line with CS in patients with CNSLBP. Huysmans et al. (2018) revealed that CS is significantly associated with psychosocial and cognitive behavioural factors and outcomes in patients with CNSLBP. Findings from Dahmani et al. (2023) showed psychosocial symptoms such as pain catastrophising, anxiety and depression associated with CS, and therefore of influence on pain, function and physical performance in patients with chronic musculoskeletal pain, including CNSLBP.

Considering the theoretical origins and empirical findings elaborated earlier in the text, it is possible to imply that the biopsychosocial concept, CS and fear avoidance interplay under the umbrella of chronic musculoskeletal pain, respectively CNSLBP. Understanding pain-related fear from a common-sense perspective enables physiotherapists to provide individuals with LBP and high fear a pathway to recovery by altering their sense of pain (Bunzli et al. 2017). The fear of movement can be assessed by examining one's beliefs and attitudes towards the connection between pain and injury, respectively, hurt and harm (Zhao et al. 2023), while the factors that contribute to shaping beliefs that the back is injured and fragile and that this condition is challenging to reverse can originate from one’s internal as well as external resources (Wand et al. 2023).

2.3 Personal concept of pain

One's personal concept of pain refers to how one understands what pain actually is, what function pain serves, and what biological processes are thought to underpin it (Pate et al. 2020). Understanding is a complex cognitive process that depends on learning, interpreting, generalising, and acting upon information (Blaha et al. 2022). Under the umbrella of pain science (Pate et al. 2022) and conceptual change theory that underpins pain science education (Moseley and Butler 2015), one's personal pain concept is conditioned by individual prior knowledge (Vosniadou 2012) and beliefs (Pons et al. 2012; Vosniadou 2012; Pate et al. 2022). In addition, the probability of pain, based on Bayes' theorem, is based on prior knowledge of the conditions that could be associated with this event (Hackenberger 2019). Hence, knowledge and beliefs are essential for one's concept of pain (Pate et al. 2022), respectively, pain conceptualisation (Moseley 2007).

Although united in the pain concept, beliefs and knowledge are two distinct cognitive constructs. Beliefs are often firm opinions that may not always be rational and can persist over time (Caneiro et al. 2021). Unlike other cognitive constructs, such as knowledge, they involve a significant self-referential element not always found in knowledge (Connors and Halligan 2014). Science, particularly philosophy, highlights significant differences between knowledge (*episteme*) and belief (*doxa*); knowledge is considered a long-standing objective of human endeavours and is typically associated with education and scientific understanding that provides truth, while belief is perceived as mere appearances or subjective opinions, usually based on sense perceptions (Halla 2018).

However, there is still considerable overlap between knowledge as common sense understanding and belief since different cognitive constructs may involve common foundations, and even the eliminativist perspective implies that a better specified neuropsychological theory can replace "folk" understandings – belief (Connors and Halligan 2014). In addition, although the merit of pain conceptualisation and science in general, as the term itself implies, is knowledge, pain neuroscience education itself intends to influence patients' pain beliefs by transferring relevant knowledge to patients, allowing them to understand their pain and, hence, to act appropriately upon information (Nijs et al. 2017, 111).

Elaborating on the theories and conceptual models of pain, one's personal pain concept can be considered biomedical or, as modern pain science advocates, biopsychosocial. In addition, patient pain knowledge can be aligned with modern pain science (Pate et al. 2022) or misaligned, while pain beliefs can be organic, centring on the notion that pain indicates immediate or imminent physical harm or psychological, and centring on the notion that internal and external factors mediate pain (Asmundson et al. 2014, 38). In this regard, it is necessary to refer again to factors which, along with internal resources, contribute to shaping pain beliefs and misbeliefs: families, social networks, and society in general (Wand et al. 2023). In contrast, knowledge as common sense understanding (Connors and Halligan 2014) relies heavily on education and science that provide truth (Halla 2018), and as pain science knowledge, it is underpinned by theories, deliberated and targeted content of pain understanding (Moseley et al. 2023).

Based on the theoretical origins of pain concepts, especially those related to chronic pain, as well as empirical evidence, one's understanding of pain may play a crucial role in determining its health outcomes. The understanding of pain, pain avoidance behaviour and pain presence are interconnected, and pain presence can lead to changes in the brain's reorganisational patterns. Additionally, misinformation and misunderstanding about pain can lead to further complications. Thus, the concept of pain may be significant in physiotherapy treatment outcomes in patients with CNSLBP.

2.4 The existing body of knowledge on pain conceptualisation and its relationship with outcomes in patients with chronic nonspecific low back pain

An extensive literature review was conducted to gain insight into the existing body of knowledge on the conceptualisation of pain and its relationship to outcomes in patients with CNSLBP. The main focus was on pain conceptualisation, beliefs and knowledge as pain concept constructs and pain, disability and HRQoL - core outcomes (Chiarotto et al. 2018) in patients with CNSLBP. The research gap was determined concerning the theoretical origins of the concept of pain and the unknown in the existing body of knowledge.

A view is posited that CNSLBP pain results from the sufferer holding a strong cognitive model of a damaged and fragile spine that cannot be altered (Wand et al. 2023). As Bayes' theorem suggests, persistent pain can alter cognitive models in the brain, independent of objective pathophysiology (Edwards et al. 2012). Pain as an indicator of the spine's condition represents the structural-pathology model (Moseley 2007) and contradicts pain understandings advocated by modern pain science (Malfliet et al. 2017). Chronic patients may experience pain due to the cognitive model of an unhealthy body, leading to maladaptive responses and attentional protective behaviours (Hechler et al. 2016; Ongaro and Kaptchuk 2019). This pain model is a pragmatic and vivid representation of a concept (Fitzpatrick and McCarthy 2016) of pain within the concept analysis framework. Conditioned by individual prior knowledge (Vosniadou 2012) and beliefs (Pons et al. 2012; Vosniadou 2012; Pate et al. 2022), one's concept of pain refers to how one understands what pain is, what function it serves, and what processes are thought to underpin it (Pate et al. 2020). Hence, in addressing pain misconceptions (Pate et al. 2022) and pain conceptualisation (Moseley 2007), addressing both knowledge and beliefs regarding pain science is essential (Pate et al. 2022). Along with the theory of conceptual change (Moseley and Butler 2015), this is also supported by the fact that beliefs versus knowledge involve a significant self-referential element not always found in knowledge (Connors and Halligan 2014).

However, the terms 'beliefs' and 'concept' are often used interchangeably in the current body of knowledge. When Pons et al. (2012) reported their findings on the association between pain beliefs and functioning, they defined beliefs as mental appraisals and understanding that ultimately form a preexisting concept of pain. In their 1989 paper, Williams and Thorn introduced a questionnaire designed to explore patients' beliefs and perceptions of pain; arguing that these beliefs reflect how patients conceptualise pain and what it signifies to them (Williams and Thorn 1989). Despite its age, this paper remains essential for pain science research. In developing a questionnaire on the concept of pain in patients with chronic pain, Newman et al. (2021) began by focusing on beliefs about pain as the starting point and focus of the assessment. Per various theorems highlighted in the background of the research problem, beliefs are not the only contributing factor to the concept of pain in an individual. Prior knowledge of the phenomenon is another crucial aspect that creates the overall pain perception. Therefore, exchanging the terms 'beliefs' and 'concept of pain' should not be taken for granted. Most research in continuation has focused on studying individual beliefs about pain rather than the concept of pain in its essentials. However, these studies still have significant value and contribute to the existing body of knowledge while challenging previously established ideas.

Although contemporary research and guidelines consistently advocate biopsychosocial understandings of LBP, patients' beliefs are negative and structural-pathology-directed, both in developed and undeveloped countries (Ben Darlow et al. 2014; Setchell et al. 2017; Tarimo and Diener 2017; Grøn et al. 2019; Ampiah et al. 2022). A potential consequence of negative beliefs is avoidance of physical activities, likely increasing morbidity (Setchell et al. 2017) and contributing to the transition from acute to chronic musculoskeletal pain (Caneiro et al. 2021, 20). In the general population, beliefs about LBP diagnosis (Christe et al. 2021) are similar to those of LBP patients, as well as their management options wrong beliefs (Hall et al. 2021). In addition to beliefs, patients with CLBP pain themselves are unaware of the proper care pathway to undertake, which has implications for pain, disability and quality of life (Lepri et al., 2023).

Using a mixed-method study approach, Briggs et al. (2010) revealed that LBP-related beliefs, rather than pain intensity and health literacy skills, are significant correlates of disability related to CLBP; more disabled patients had poorer back pain beliefs to physical activity. Evidence suggests that fear avoidance beliefs are prognostic for poor outcomes in subacute NSLBP and contribute to the development of CNSLBP (Wertli et al. 2014). In addition, previously, there was moderate evidence that fear avoidance beliefs predict work outcomes in persons with NSLBP (Iles, Davidson, and Taylor 2008), consistent with later study findings of Besen et al. (2015). Feitosa et al. (2016) reported in their prospective study that fear avoidance beliefs negatively influenced the outcomes of pain and disability in patients with CNSLBP. Similarly reported by other studies, patients' beliefs about LBP were related to their poorer clinical outcomes (Baird and Sheffield 2016; Grøn et al. 2019). A study by Ng et al. (2017) found that negative back beliefs were associated with persistent high-intensity LBP over two years in community-based individuals. Alyousef et al. (2018) examined the relationship between beliefs and the development and progression of LBP and disability over two years in community-dwelling women; pessimistic beliefs about back pain were associated with persistently high levels of low back disability. In the same year, findings from a retrospective cross-sectional and longitudinal prospective study from Wertli et al. (2018) highlighted that patients' negative and positive beliefs were associated with their perceptions of disability; however, only positive beliefs were associated with LBP treatment outcomes.

Recently, no clear link was found between patients' beliefs and disability, and the relationship between beliefs and pain was revealed to be weak, so the general usefulness of belief assessment for predicting or explaining the course of LBP is questioned now (Grøn et al. 2022). Studies have methodological limitations and heterogeneity in interventions and outcome measures, making it uncertain to determine the association between psychosocial factors, such as self-efficacy, catastrophising and fear of movement, respectively, beliefs, and pain and disability outcomes in CLBP (Alhowimel et al. 2018).

Regarding pain knowledge, previous research in patients with LBP by Maciel et al. (2009) showed low knowledge levels, similar to the recent study by Kanaan et al. (2023). Awwad and Altowim (2017) evaluated the level of knowledge of patients with NSLBP about their condition and other problems related to the spine and found limited knowledge. Tarimo and Diener's (2017) cross-sectional assessment of patients with acute and chronic LBP revealed that many patients need to be more adequately knowledgeable about LBP and that their knowledge has a significant relationship with negative attitudes and beliefs regarding LBP. Ferreira et al. (2019) revealed that patients with chronic musculoskeletal pain possess low levels of neurophysiological pain knowledge, regardless of their pain mechanism classification. Previously, in a similar group, Fletcher et al. (2016) found an inverse relationship between knowledge and the fear-avoidance level, where patients highly knowledgeable about pain reported less fear avoidance and lower disability. The more recent research on patients with CLBP has shown a significant relationship between LBP knowledge with pain, social function, general health, quality of life (Járomi et al. 2021) and emotional state of anxiety, particularly (Kanaan et al. 2023).

Earlier systematic reviews and meta-analyses have shown that better pain knowledge is primarily associated with lower pain ratings and reduced disability in patients with CLBP (Louw et al. 2016; Tegner et al. 2018). Of the more recent ones, better pain knowledge was also related to better treatment outcomes regarding pain and disability (Wood and Hendrick 2019; Ferlito et al. 2022). In addition to lower pain ratings, better pain cognition in individuals with CLBP has a long-term carryover effect on kinesiophobia (Shin and Kim 2023). In general, in patients with chronic musculoskeletal pain, including CNSLBP, better pain knowledge is associated with better treatment outcomes in terms of pain reduction, decreased disability, kinesiophobia, and catastrophising when combined with the usual physiotherapy treatments in the first line with exercise (Bonatesta et al. 2022; Siddall et al. 2022; Cuenca-Martínez et al. 2023; Lepri et al. 2023; Ma et al. 2023). In recent onset NSLBP, better pain knowledge is associated with less pain and better movement in patients, potentially preventing progression to chronicity (Louw et al. 2019). Gallagher et al. (2013) and Meeus et al. (2010) showed that better pain knowledge reduces pain catastrophisation in a mixed sample of patients with chronic musculoskeletal pain.

However, it must be emphasised and related to the evidence of both single studies and systematic reviews, as mentioned earlier, that it is not about prior knowledge and its relationship with treatment outcomes but about knowledge that has become better under the influence of pain neuroscience education, respectively, the process of reconceptualisation (Meeus et al. 2010; Gallagher et al. 2013; Louw et al. 2016; Tegner et al. 2018; Louw et al. 2019; Wood and Hendrick 2019; Ferlito et al. 2022; Bonatesta et al. 2022; Cuenca-Martínez et al. 2023; Lepri et al. 2023; Ma et al. 2023; Shin and Kim 2023). In addition, more significant treatment improvements in chronic pain, including CNSLBP, in terms of pain and disability are associated not solely with better knowledge but with PNE in conjunction with physiotherapy modalities in first-line exercise (Wood and Hendrick 2019; Bonatesta et al. 2022; Cuenca-Martínez et al. 2023; Siddall et al. 2022; Ma et al. 2023). Regarding pain knowledge, various outcome measures were used in the research, mainly the Low Back Pain Knowledge Questionnaire (LKQ) (Maciel et al. 2009; Awwad and Altowim 2017; Tarimo and Diener 2017; Járomi et al. 2021; Kanaan et al. 2023), the Neurophysiology of Pain Questionnaire (NPQ) or the revised version (rNPQ) (Meeus et al. 2010; Gallagher et al. 2013; Fletcher, Bradnam, and Barr 2016; Ferreira et al. 2019; Louw et al. 2019). Although often used, the mentioned outcome measures are related to pain knowledge *per se*, at the same time specific to the disease and include various medical concepts and definitions that healthcare professionals use (Moseley 2003; Maciel et al. 2009), unlike patients, usually laypeople. Some of the limitations were elaborated in the work of Pate et al. (2022) and noted in that of Vaughan et al. (2019).

The examination of the conceptualisation of pain was also approached through other different research methods. Using collaborative modelling, (Hodges et al. 2022) showed that conceptual models in patients are primarily biomedical and narrower than clinicians. Keen et al. (2021), using a qualitative exploration, revealed that patients understand pain through inconsistent experiential models and have diverse and dissonant conceptualisations, anchoring chronic pain in concepts of diagnoses and the adapted nervous system while objectifying pain as sensory and through images of tissue damage. King et al. (2018) addressed conceptualisation pre- and post-PNE by qualitative methods, although very narrowly, in terms of conceptualising pain as tissue damage and associated emotions. A body of qualitative research has developed quite a lot in the past decade describing and interpreting the subjective experiences of persons with CLBP across their personal, social, and healthcare experiences; however, it has yet to be reviewed in an integrated manner (MacNeela et al. 2015).

As implied, most existing research focuses on reconceptualisation rather than the conceptualisation and prior concept of pain. Keen et al. (2021) also highlighted the analytic focus of existing research on post-PNE reconceptualisation rather than prior conceptualisation as unprimed sense-making. In addition, King et al. (2018) highlighted the narrow scope of the outcome measures in existing studies and the non-existence of a validated questionnaire to measure pain conceptualisation. Keen et al. (2021) emphasised that understanding how education interacts with prior pain conceptualisation requires an appreciation of prior conceptualisation. In addition, Louw et al. (2016) emphasised the need for further research into its connection with patient outcomes needs to be conducted.

Regarding a reliable and valid quantitative assessment tool for the concept of pain, (Pate et al. 2020) recently developed the Concept of Pain Inventory (COPI) for children to guide targeted pain science education, an inventory based on which COPI-Adult further originated (Pate et al. 2022). A brief questionnaire with good psychometric properties identifies conceptual gaps or misconceptions by assessing pain science knowledge and beliefs, particularly reliably in persons without pain science education (Pate et al. 2022). In the psychometric testing of the COPI-Adult, where the majority of respondents were patients with LBP and recurrent pain, findings suggest that formal medical education may influence one's concept of pain and that better pain outcomes are related to higher COPI-Adult scores due to the existence of previous pain science education (Pate et al. 2022). Hence, now, there is an opportunity to examine the concept of pain in its essence by addressing both knowledge and beliefs in patients with CNSLBP.

Consequently, we emphasise that knowing how reconceptualisation interacts with patient outcomes requires understanding how prior conceptualisation without priming or pain directive counselling interacts with patient outcomes. Existing research exudes heterogeneity in the LBP population, pain conceptualisation assessment and outcome measures and focuses on pain and disability post-PNE reconceptualisation. In contrast, no quantitative research has addressed the relationship between baseline pain conceptualisation and, at the same time, pain, disability, and HRQoL as core outcomes (Chiarotto et al. 2018) following physiotherapy in patients with CNSLBP. In addition, no research has used a reliable and valid questionnaire to address both knowledge and beliefs, respectively, the concept of pain in its essence. Therefore, it was considered worth filling the gap in the existing body of knowledge of how the concept of pain, respectively, baseline pain conceptualisation, interacts with treatment outcomes in patients with CNSLBP by using a specific inventory for pain conceptualisation and utilising core physiotherapy outcome measures.

3 EMPIRICAL PART

The dissertation's third part discusses the goals, main research question and hypotheses, and research methodology. This is followed by a quantitative analysis investigating the relationship between the concept of pain and physiotherapy outcomes regarding pain, disability, and HRQoL in individuals with CNSLBP. The results provide a foundation for further discussion in the field.

3.1 Purpose and goals of the research

This doctoral dissertation research aimed to investigate and describe the existence and nature of the relationship between baseline pain conceptualisation and pain, disability and HRQoL outcomes in patients with CNSLBP following physiotherapy. Following the purpose of the research, six specific goals and one sub-goal were set.

1. Ascertain whether baseline pain conceptualisation is related to pain outcome following physiotherapy.

2. Ascertain whether baseline pain conceptualisation is related to disability outcome following physiotherapy.

3. Ascertain whether baseline pain conceptualisation is related to HRQoL outcomes following physiotherapy.

4. To examine the relationship between the level of baseline pain conceptualisation and the level of pain following physiotherapy.

5. To examine the relationship between the level of baseline pain conceptualisation and the level of disability following physiotherapy.

6. To examine the relationship between the level of baseline pain conceptualisation and the level of HRQoL following physiotherapy.

7. To identify risk groups with a lower level of baseline pain conceptualisation regarding the level of education.

3.2 Research hypotheses

As a preface to the hypotheses, the main research question was posed: "*In patients with CNSLBP, what is the relationship between baseline pain conceptualisation and outcomes following physiotherapy?*" Subsequently, the following research hypotheses (H) were put forward:

H1 - In patients with CNSLBP, baseline COPI-Adult scores are related to pain outcomes following physiotherapy.

H2 - In patients with CNSLBP, baseline COPI-Adult scores are related to disability outcomes following physiotherapy.

H3 - In patients with CNSLBP, baseline COPI-Adult scores are related to HRQoL outcomes following physiotherapy.

H4 - In patients with CNSLBP, less pain reduction following physiotherapy is associated with lower baseline COPI-Adult scores.

H5 - In patients with CNSLBP, less disability reduction following physiotherapy is related to lower baseline COPI-Adult scores.

H6 - In patients with CNSLBP, less improvement in HRQoL following physiotherapy is related to lower baseline COPI-Adult scores.

H7 – Baseline COPI-Adult scores are significantly lower in lower-educated patients with CNSLBP.

3.3 Research approach and methodology

This chapter begins with a general view of correlational research as the foundation for the chosen research approach. It then describes the research methodology, inventory, and outcome measures used, including participants, treatment protocol, and how the data were collected and processed. Ethical considerations are implied.

3.3.1 Research approach

The doctoral dissertation research design is a quantitative study with clinical implications conducted on a cohort of patients with CNSLBP. Given that the main goals and related hypotheses stated are to describe and predict, the correlational research strategy was chosen, considering it enables the researcher to achieve both goals (Jhangiani et al. 2019). Findings from correlational research can be used to determine prevalence and relationships among variables, to predict events from current data and knowledge, and can be used to inform decision-making and to improve or initiate health-related activities or change (Curtis, Comiskey, and Dempsey 2016).

3.3.2 Research setting and protocol

The research was conducted in the Department for Physiotherapy (Clinic for Rheumatic Diseases and Rehabilitation) of the University Clinical Hospital Center in Zagreb from January to the end of June 2024.

Participants were recruited through daily clinical practice and an internal research advertisement on the premises of outpatient physiotherapy, where patients fluctuated. The research advertisement did not have a ban on further reproduction and could be photographed for forwarding. The public was informed about all general research aspects and was invited for further information, voluntary response and screening for participation in the research. The researcher could be contacted on-site, by e-mail or by phone for additional, non-binding research information. By responding and personally coming to the research environment to participate, the researcher once again informed each person about all aspects of the research and started communicating research eligibility criteria. Additionally, eligibility screening was also done among patients regularly admitted to outpatient physiotherapy; if eligible, patients were informed and offered to participate. Respondents were fully eligible to start the research protocol after obtaining informed consent to participate and initially determined sociodemographic and clinical criteria for inclusion. Participants' self-withdrawal without reason was enabled and implied.

The beginning and end of the research protocol in one subject were not dependent on that of another, and vice versa, so the recruitment and inclusion and the implementation of the research protocol ran in parallel. Common to all participants was the content and duration of the research protocol. As part of the research protocol, participants underwent a physiotherapy exercise program that was not experimental in nature. Prior to the exercise program, a basic assessment was conducted to collect sociodemographic and clinical data and to determine the concept of pain and outcome measures of current pain intensity, disability, and HRQoL. Immediately after the exercise program was completed, another assessment was conducted to determine current pain intensity, disability, HRQoL and the concept of pain.

Data was collected in paper-pen form during both the initial and final assessments. After the research was completed, the data was reviewed, filtered, and organised into an electronic database. Based on this database, statistical processing was performed to test the hypotheses.

3.3.3 Participants

Eligibility screening was conducted to comply with the aim and requirements of this doctoral dissertation's research. Those who met the inclusion criteria elaborated below and signed the informed consent were eligible. The participants were sampled among patients with CNSLBP, both genders and legal adults of otherwise working age, 18 (Social Welfare Act 2022) to 64 years (OECD 2023) through self-referral and consecutive recruitment (Thewes et al. 2018).

The conditions for inclusion in the research were: subjects with CNSLBP lasting at least three months, without clinical symptoms radiating to the leg below the knee, subjects with current moderate pain intensity of at least 4 on the Numeric Pain Rating Scale (Haefeli and Elfering 2006), degree of disability of at least 5 as measured by Roland Morris Disability Questionnaire (Roland and Morris 1983), and not outgoing any other LBP treatment, except exercise and systemic analgesics as previously prescribed or continuous therapy (except opioid analgesics). Subjects with cognitive abilities, the ability to follow verbal instructions, and the capability to self-completion the questionnaires were considered eligible. In addition and mandatory, self-referred patients had to have a previous examination and a report by a physician specialist in physical medicine and rehabilitation from which the diagnosis, respectively, the clinical picture of CNSLBP and pertinent clinical information were clear.

Conditions for not being included and excluded from the study were: persons under the age of 18 and above 64 years, having undergone pain science education, clinical findings of radiculopathy, simultaneous different spine level pain, motor deficit (inability to stand and walk on toes - heels), spinal trauma within a year, current and previous neurological diseases, subjects with depression and on antidepressants, diabetes, inability to control faecal excretion and urine, cardiorespiratory insufficiency, acute infections, malignant processes in the last five years, pregnancy, osteoporosis, inflammatory rheumatic diseases, significant multi-system comorbidities, those patients who have undergone physiotherapy treatment for LBP in the past three months, usage of opioid analgesics, during treatment, and due to possible pain exacerbation, patients taking a higher dose of systemic analgesics than prescribed for continuous therapy (except paracetamol). Individuals undergoing intensive hormone therapy, those with impaired cognitive abilities, inability to follow verbal instructions and physical and mental problems that could reduce the reliability in self-completion of the questionnaires (deafness, illiteracy, behavioural disorders, cognitive issues, etc.) were considered ineligible. Additionally, self-referred patients without a previous examination and a report by a physician specialist were neither suitable for screening nor for inclusion in the research. The data of those with an incomplete therapeutic and assessment protocol were considered unsuitable for further research procedures.

3.3.4 Description of research instrumentation

The following describes the research instrumentation, including a questionnaire on the participants' sociodemographic and clinical backgrounds and outcome measures used to assess current levels of pain, disability, HRQoL, and the concept of pain. The questions included in the research instruments were mainly of the close-ended type, where the participants chose from the offered answer options, except for years of life, body height and weight, and data on medications that were self-reported. The participants filled out the questionnaires independently, but the researcher was always by their side for assistance.

3.3.4.1 Questionnaire on sociodemographic and clinical background data

Sociodemographic data on gender (female/male), age (years in numbers), and level of education (elementary, secondary, college, university) were collected on the first day before the start of the treatment. Regarding the level of education obtained, participants were further stratified as lower-educated (elementary and secondary education) and higher-educated (college and university education).

Clinical data related to height (centimetres), weight (kilograms), the duration of the disease (in months, further categorised) and previous physiotherapy (number, further categorised) were also collected before the start of the treatment. Data on the current intake and type of medication (further categorised) were collected initially and checked throughout the treatment. Body height and weight values were used to calculate the Body Mass Index (BMI) using the Metric BMI calculator (National Heart Lung and Blood Institute 2024).

The participants' previously presented sociodemographic and clinical backgrounds were collected jointly through the questionnaire shown in Appendix A.

3.3.4.2 Pain outcome measure

For the pain outcome measure reported by participants, a Numeric Pain Rating Scale (NPRS) was used; a unidimensional measure of pain intensity ranging from 0 (no pain) to 10 (worst pain imaginable), which categorises pain as mild (scores 1–3), moderate (scores 4–6), and severe (>7) (Haefeli and Elfering 2006; Marini et al. 2017).

Addressing responsiveness of the NPRS in patients with LBP, Childs, Piva, and Fritz (2005) reported that a 2-point change in the NPRS represents a clinically meaningful change exceeding the bounds of measurement error. The NPRS has good sensitivity and generates data that can be statistically analysed (Williamson and Hoggart 2005). The NPRS is freely available in various public domains and is intended for clinical and research work. The scale used in this research is implied in the Appendix B. The pain outcome measure was collected before and after exercise program cessation.

3.3.4.3 Disability outcome measure

For the disability outcome measure reported by participants, the 24-item Roland Morris Disability Questionnaire (RMDQ) (Roland and Morris 1983) was used (Appendix C). The RMDQ contains 24 statements related to physical functions, most often altered in persons with LBP. One marked statement carries one point, ranging from 0 to 24 points, where a higher sum indicates a higher level of disability (Roland and Morris 1983; Kamper et al. 2010). In general, specific disability groups, according to the RMDQ, are no disability (0 to 3 points), minimal disability (4 to 10 points), moderate disability (11 to 17 points), and severe disability (18 to 24 points).

The intraclass correlation of RMDQ ranges from 0.42 – 0.91 (Macedo et al. 2011), and a threshold value of 4/24 best distinguishes changes in disability (Stratford and Riddle 2016). The original RMDQ can be found free of charge in several online databases. For this research, a Croatian version, available online, in open access and free of use, was used. The Croatian version of RMDQ was validated on persons with LBP by Jurinić et al. (2002). The disability outcome measure was collected before and after exercise program cessation.

3.3.4.4 HRQoL outcome measure

HRQoL reported by respondents was assessed using The 5-level EQ-5D version (EQ-5D-5L) (EuroQol Group 2009) (Appendix D). HRQoL, measured with EQ-5D, consists of two scales: one scale measuring QOL with five categorical questions (mobility, self-care, usual activities, pain/discomfort and anxiety/depression) and the other measuring current health state on a visual analogue scale (EQ-VAS) (0–100) (Soer et al. 2012). EQ-5D-5L has five categories-related levels, corresponding to none, slight, moderate, severe and extreme problems (Garratt et al. 2021). A health state for one respondent represents a combination of a given level for each domain, resulting in a five-digit value, which can be converted to a single index value ranging from less than 0 (value of a health state equivalent to dead; negative values representing values as worse than dead) to 1 (the value of full health), with higher scores indicating higher health utility (EuroQol Group 2019).

Data collected using EQ-5D-5L can be presented in various ways, including presenting results from the EQ-VAS and EQ-5D-5L index value, which was, considering the recommendations for use in LBP (Garratt et al. 2021) used as an outcome measure in this research. For the 5-level EQ-5D Croatian version, permission was obtained through research registration and is filed under EuroQol ID: 60074. The HRQoL outcome measure in health state and EQ-VAS was collected before and after exercise program cessation. To calculate the index, the EQ-5D-5L index value Calculator was used; index values were based on using this Calculator (Van Hout et al. 2012), and since there is no value set for Croatia, scoring in our sample was carried out according to the nearby/similar country.

3.3.4.5 Assessment of pain conceptualisation

Pain conceptualisation was assessed using the Croatian version of the Concept of Pain Inventory for Adults (COPI-Adult), derived from the original version of Pate et al. (2022) (Appendix E). The inventory consists of 13 items about individual considerations of what pain is, why they feel pain, and how they feel pain, and the originators considered it particularly suitable for persons without pain science education. The following scale is assessed for all 13 items with no reversed scores (0 = Strongly Disagree, 1 = Disagre, 2 = Unsure, 3 = Agree, 4 = Strongly Agree). Sum scores can range from 0-52, where higher COPI-Adult scores reflect greater alignment with contemporary pain science. Psychometric properties revealed that Internal consistency for the 13-item COPI-Adult was acceptable (Cronbach alpha= 0.78), and the estimate for the total score was calculated to be 0.84 (95% CI: 0.71-0.91), reflecting “good” reliability (Pate et al. 2022).

The Croatian version of the COPI-Adult inventory used in the research of this doctoral dissertation was translated and psychometrically tested (Cronbach alpha = 0.803) as a part of the scholarly research project "Conceptualisation of pain in Croatian Adults - pilot study" at the University of Applied Health Sciences in Zagreb (Registry Number: 251-379-10-22-02; Class: 602-03/22-18/639). The permission to use, with psychometric characteristics of COPI-Adult contained in it (Appendix F), was communicated to the project leader (SS), whose project associates are the doctoral researcher herself and the originator of the original questionnaire (JP). COPI-Adult, respectively COPI, was applied before and after the treatment protocol cessation.

3.3.5 Therapeutic exercises program

The quasi-experimental treatment protocol was an "exercise only" program for all subjects, without any pain directive counselling or therapist-patient interaction in the form of PNE that would influence the concept of pain. Regarding the content and duration of the exercise program, spine mobility, strengthening and stabilisation exercises in sitting, pronated and supinated positions; in the form of activation of the lumbar-sacral-pelvic complex and deep muscles with stimulation of proper breathing were included in the duration of 10 days, as in regular practice (approx. 30 minutes, consecutive days, excluding non-working days, i.e. weekends).

Participants performed exercises individually, but mainly in supervised individualised groups of two to a maximum of three, considering group-based exercise as a preferred choice given potential advantages in motivation and cost (Lemieux et al. 2020) in time terms, and supervised exercise being more effective in both the short and long-term regarding patient-reported outcomes (Matarán-Peñarrocha et al. 2020). A visual representation of the exercises can be found in Appendix G.

In general, it was a standard exercise program for CLBP patients who otherwise attend physiotherapy in the settings where the research was conducted and aligned with recommendations derived from the best evidence on the effect of strength and stabilisation exercise programs over other interventions in the treatment of CLBP (Searle et al. 2015; Tian and Zhao 2018). Regarding the absence of PNE, it was not a deliberate omission because PNE *per se* does not exist as a regular approach in the treatment of CLBP, nor in general, and the addition of PNE to exercises in the context of pain reconceptualisation (Wood and Hendrick 2019; Bonatesta et al. 2022; Cuenca-Martínez et al. 2023; Siddall et al. 2022; Ma et al. 2023) has yet to be considered in Croatia.

3.3.6 Addressing potential sources of bias

The researcher carried out the research protocol, including screening, treatment protocol, and data collection and processing. Regarding the treatment protocol, respectively, pain conceptualisation as a potential predictor of outcome, including COPI-Adult inventory features over time, the researcher held statistical control by applying no pain directive counselling or therapist-patient interaction in the form of PNE that would influence pain conceptualisation. Statistical control is a common practice applied in correlational or quasi-experimental studies to remove confounding effects from a regression coefficient; controlling for relevant confounders can debias the estimated causal effect of a predictor on an outcome and bring the estimated regression coefficient closer to the value of the true causal effect (Wysocki et al. 2022).

To reduce the risk of potential confounding factors related to the clinical picture, inclusion or exclusion criteria, along with a detailed physiotherapy assessment and anamnestic interview, the medical documentation was reviewed and, in case of need for additional determination of the factual situation, an attending physician specialist in physical medicine and rehabilitation was consulted. Analgesic use was checked daily. In the recruitment process, along with self-referral, consecutive principles were applied, reducing the possibility of active selection and selection bias and contributing to a representative sample (Bjorn et al. 1998, 225-228).

Hypothesis testing is accompanied by a profound statistical analysis to prevent additional bias in the conclusions. In addition, recommendations from the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines were applied wherever possible (Cuschieri 2019) for reporting research procedures and results based on the doctoral dissertation research design.

3.3.7 Sample size

The minimum required sample size was defined based on the main research question and related correlational statistical method *a priori* using the G* Power (the University of Dusseldorf, Germany version 3.1.9.5/14 January 2020) program. Sample size with an effect size of 0.35, 5% type error and 80% statistical power condition required at least 84 participants in the total sample. For the ordered population, consecutive sampling as the most typical and easiest technique was applied, and, since it is one of the non-probability sampling techniques, before concluding the research protocol for each participant, it was checked whether or not data had been collected from the process of recruitment (Bujang and Sapri 2018).

3.3.8 Processing of data

The following describes how the collected data was handled, starting with the initial raw data, preparation for analysis, and statistical processing features. The description allows for clear insight and judgment about the adequacy of handling the collected data.

3.3.8.1 Raw data processing

After the research protocol, which refers to data collection, has been concluded, all the research material, including the questionnaires of each participant, was reviewed and prepared for further processing. The data contained on the paper were manually entered into the electronic database, a worksheet of the Excell application of the Microsoft Office program on the personal portable computer of the researcher, and at the same time stored on an external hard drive in an encrypted folder. Research documents in paper format were stored safely and in a location known only to the researcher.

When qualitative and quantitative data collected through research were entered into the electronic database, all participants' direct identifiers were excluded, and indirect identifiers that were not necessary for statistical analysis were removed or adjusted (Celjak et al. 2020, 22-23) so that they were organised into certain categorical or continuous variables; anonymisation is implied. The database, which contained cleaned, filtered data relevant to the research, was the subject of statistical analysis.

3.3.8.2 Statistical data processing

The IBM SPSS Statistics for Windows (Version 23.0. Armonk, NY: IBM Corp) program was used for statistical data processing. Skewness and kurtosis were used to assess the normality of data distributions before and after physiotherapy treatment; if the ratio of skewness or kurtosis to its standard error is less than -2 or greater than +2, the normality may be rejected (IBM 2023b). Descriptive statistics such as minimum (Min), maximum (Max), mean (M), and standard deviation (SD) were used for all measured variables and of importance for inferential statistics (NPRS, RMDQ, EQ-5D-5L index, EQ-5D VAS, COPI) before and after physiotherapy treatment. Basic sociodemographic continuous and clinical data is also shown through the same description methods, while categorical variables are presented in numbers (N) and percentages (%). In general, the outcome measures of pain level, disability and HRQoL measures were handled as continuous variables. At the same time, COPI-Adult was initially observed as a continuous variable and dichotomised according to statistical prerequisites.

The t-test for paired samples (repeated measures) was used to determine the significance of differences between matched pairs (Xu et al. 2017) in pain levels (NPRS), disability (RMDQ), quality of life (EQ-5D-5L index, EQ-5D VAS), and the concept of pain (COPI) before and after physiotherapy treatment.

Regarding H1, H2 and H3, the Person correlation analysis primarily examined the relationship between COPI and all measured variables (NPRS, RMDQ, EQ-5D-5L index, EQ-5D VAS) after physiotherapy treatment, additionally before treatment. In correlated data, the change in the magnitude of 1 variable is associated with a change in the magnitude of another variable, either in the same (positive correlation) or in the opposite (negative correlation) direction, with coefficients ranging from –1 to +1, where 0 indicates that there is no linear or monotonic association, and the relationship gets more robust and ultimately approaches a straight line (Schober and Schwarte 2018). In addition, the coefficient of determination, generally indicated by r^2, quantifying how much the dependent variable is determined by the independent variables in terms of the proportion (or percentages) of variance (Chicco et al. 2021), was calculated from the Pearson correlation coefficient (r).

The t-test for independent samples was used to determine the significance of differences between (Xu et al. 2017) two different groups of respondents (people with lower and higher education), which is covered by H7 and contributes to other analyses to a certain extent.

Testing of H4, H5 and H6 was approached in two ways. In the first, using Person coefficient correlation, it was determined whether there was a correlation between the baseline COPI-adult and the dependent criterion variable, which was the difference between two values of a variable pre-and post-treatment. Difference variables, the so-called *delta* (Δ), are a measure of the change in a parameter (difference between two values of a variable) and may indicate how much of the change in the coefficient of determination was caused or explained by a given step (American Psychological Association 2024). The delta difference was calculated by subtracting the first from the second measurement (Min-Sun et al. 2023), and correlations of these variables (NPRS, RMDQ, and HROoL measures) with baseline COPI-Adult were calculated. In the second approach, changes due to treatment and baseline pain conceptualisation were observed as factors. A mixed analysis of variance (ANOVA) and multivariate analysis of variance for repeated measures (MANOVA) were used. MANOVA and mixed ANOVA generally determine differences in multiple correlated dependent variables (for MANOVA) or a single dependent variable (for mixed ANOVA) over time or between treatments, where participants have been measured at all time points or taken part in all treatments. These analyses investigate interactions between factors affecting the dependent variable(s). As in an example of Laerd Statistics (2024), in total, our 84 participants who took part in the research were divided into two groups with an equal number of participants in each group, which reflects the between-subjects factor, "COPI-Adult" or baseline pain conceptualisation (where 0 stands for those with lower COPI-Adult scores, and 1 for those with higher, indicating lower knowledge and higher knowledgable). The dependent variable(s), measured over two-time points (level of pain, disability and HRQoL (pre and post-treatment), reflected the within-subjects factor "time". To determine whether any change in variable(s) of pain, disability and HRQoL level is the result of the interaction between the COPI-Adult group (0 vs 1) and "time" or simply due to the within-subjects factor "time", the features of both factors within the Tests of within-subjects effects were observed (Laerd Statistics 2024). Visualisations of univariate analysis are presented, and interaction effects and effect size (Murphy and Aguinis 2022) of partial eta squared known as η^2_p (Lakens 2013) were observed both for univariate and multivariate analysis.

Under the conventional acceptance of statistical significance, a p-value of <0.05 or 5% and a confidence interval (CI) of 95% (Flechner and Tseng 2011) was observed, but also at the 0.01 level.

3.3.9 Ethical considerations

The research of this doctoral dissertation follows the doctoral thesis research proposal (number: 39-2022/23), which was publicly presented and defended in front of the Evaluation Commission of the University of Alma Mater Europaea - ECM in November 2023. An Institutional Ethical Permit (Class: 8.1-23/315-2; number: 02/013 AG) for the conduct of the research was obtained from the Ethical Committee of the University Clinical Hospital Center Zagreb, Croatia (Appendix H). The research protocol started after the confirmation of the Commission for Scientific and Research Work and the Senate of the University of Alma Mater Europaea - ECM in January 2024.

The informed consent of each participant is implied, as well as their open possibility of withdrawing from the research without giving reasons. The doctoral dissertation research aligns with the principles established by national and international regulations, including the Declaration of Helsinki (World Medical Association 2013). All personal data was handled following Regulation (EU) 2016/679 of the European Parliament and Council of the European Union (2016).

The doctoral dissertation research was transparent and supported by the researcher's working associates. When conducting the quantitative part of the doctoral research, the quality of care for regular patients in the clinical area and daily clinical work were not hindered at any moment. All respondents, including self-referred and convenient, were approached following ethical and professional standards, and a therapeutic program of the same high quality was provided. The research protocol did not represent a risk that was more significant than that of everyday life and possibly in everyday clinical practice; it was carried out under controlled conditions and in compliance with safety standards, and no adverse events occurred.

3.4 Results

3.4.1 Description of the sample

The research initially included 85 respondents, but due to one dropout, the results are analysed based on a sample of 84, corresponding to the defined minimum sample. Table 1 presents the basic sociodemographic and clinical characteristics of the sample.

As seen in Table 1, the investigated sample is mainly based on convenient respondents (62%) and females (76.2%), less on self-referred (38%) and males (23.8%). With an average age of 49.86 ± 10.39 years, the sample equally includes those with (51.2%) and without higher education (48.8%). In a little more than a third of the respondents, pain lasting over three years was reported (35.7%), followed by those with pain over ten years (29.8%) and up to 3 years (16.7%). Respondents' anthropometric characteristics show an average height of 169.80 ± 8.9 and a weight of 80.76 ± 19.58, with a Body Mass Index of 27.76 ± 7.78. There was no prescribed continuous therapy with consequential pain interference; 40% reported taking painkillers as needed, of which the majority were non-steroidal anti-inflammatory drugs. Two-thirds of the respondents have undergone one or more LBP physiotherapy cycles (67.9%). During the research protocol, two analgesic uses were reported, one of 1000 mg of paracetamol for headache and the other of 500 mg for menstrual pain.

Table 1: Basic sociodemographic and clinical characteristics of the sample

Continuus variables	N	Min	Max	Mean	SD
Age	84	22	64	49.86	10.39
Height	84	150	192	169.80	8.9
Weight	84	46	130	80.76	19.58
Body Mass Index	84	17.6	44.6	27.76	7.78
Categorical Variables	N (of total 84)			% (of total 100)	
Recruirement					
Self-reffered	32			38	
Convinient	52			62	
Gender					
Male	20			23.8	
Female	64			76.2	
Level of Education					
Lower educated*	41			48.8	
Higher educated**	43			51.2	
Pain Duration					
>3 to 6 months	10			11.9	
>6 to 12 months	5			5.9	
>1 to 3 years	14			16.7	
>3 to 10 years	30			35.7	
>10 years	25			29.8	
Previous physiotherapy treatment for low back pain					
Yes	57			67.9	
No	27			32.1	
OTC*** pain relief drugs	N (of total 26)			% (of total 100)	
NSAID****	25			96.1	
Analgetics/Antipiretics	1			3.8	

** elementary and secondary, ** college and university, ***Over-the-counter **** non-steroidal anti-inflammatory drugs; Characteristics may not sum up to 100% because of the effects of rounding*

Source: Author's own 2024.

3.4.2 Results of preliminary statistical analysis

The following shows the pre-analytical steps that precede the main data analysis, including testing the distributions' normality and assessing the effectiveness of the physiotherapy treatment, including the reliability of the pain conceptualisation measure.

3.4.2.1 Normality testing for measured variables pre and post-physiotherapy treatment

Using the values presented in Table 2, a Z score was calculated by dividing the skewness values or kurtosis values by their standard errors (Mishra et al. 2019). Considering value ratio -2 or greater than +2 (IBM 2023b), significant deviations in the form of ratios were observed for skewness in EQ-5D-5L index pre (-2.613), EQ-5D-5L index post (-7.274) and EQ-VAS post (-3.426), while for kurtosis, ratios were evasive for NPRS pre (-2.233) and EQ-5D-5L index post (10.992). However, in clinical research, for medium-sized samples (50< n< 300), the threshold of 3.29 for the absolute z-value should be considered (Kim 2013); hence, only the distribution of EQ-5D-5L index post and EQ-VAS post can be considered significantly deviated from normality due to skewness ratio.

Regarding skewness, ceiling effects were observed in the EQ-5D-5L index post (maximum value of 1) and EQ-VAS post (maximum value of 100) variables. In biomedical studies, a ceiling may be reflected as asymmetry and skewness distribution (Arslan and Benke 2023); but given that the EQ-5D-5L is conceptualised to measure deviations from full health (or negative health) and is more prone to larger ceilings (Feng et al. 2021), asymmetry, respectively, skewness was to be expected. The kurtosis ratio of the EQ-5D-5L index observed in our sample can also be considered expectedly higher than allowed, considering the same being observed in existing research, for example, the one of Hernandez et al. (2019) in which the values of kurtosis and standard error were already intuitive for the evasive ratio. For the EQ-5D-5L, it is difficult to elucidate whether it has problems with sensitivity to change regarding certain populations or certain treatments; however, despite this limitation, its responsiveness is found acceptable (Feng et al. 2021).

Table 2: Descriptive statistics for all measured variables pre and post-physiotherapy treatment

Variable	N	Min	Max	M	SD	Skewness (Std.Error)	Kurtosis (Std. Error)
NPRS* pre	84	4.0	9.0	6.214	1.3269	.165 (.263)	-1.161 (.520)
NPRS post	84	.0	7.0	3.798	1.7340	.206 (.263)	-.742 (.520)
RMDQ** pre	84	5.0	20.0	12.012	3.9255	-.084 (.263)	-.772 (.520)
RMDQ post	84	.0	18.0	6.738	4.3882	.409 (.263)	-.880 (.520)
EQ-5D-5L index pre	84	.194	.910	.66771	.163614	-.687 (.263)	-.330 (.520)
EQ-5D-5L index post	84	.313	1.000	.79658	.110453	-1.913 (.263)	5.716 (.520)
EQ-VAS pre	84	20.0	92.0	58.929	17.4320	-.238 (.263)	-.375 (.520)
EQ-VAS post	84	25.0	100.0	72.726	15.5341	-.901 (.263)	.658 (.520)
COPI*** pre	84	13.0	49.0	32.190	6.6884	-.212 (.263)	.033 (.520)
COPI post	84	11.0	52.0	33.202	6.9884	-.289 (.263)	.613 (.520)

**Numeric Pain Rating Scale, **Roland Morris Disability Questionnaire, ***COPI-Adult*

Source: Author's own 2024.

3.4.2.2 Physiotherapy treatment effectiveness

As seen in Table 3, the differences between pre and post-treatment scores are statistically significant for all four measures, as indicated by the p-values well below the level of 0.05. The average pain score (NPRS) significantly decreased by 2.41 points after treatment, which is highly significant, with a 95% CI indicating the true mean difference lies between 2.08 and 2.74. The disability score (RMDQ) decreased on average by 5.27 points, showing significant improvement post-treatment, with the 95% CI ranging from 4.51 to 6.03. A considerable increase can also be observed for the EQ-5D-5L index; with an average increase of 0.128 points, the 95% CI of -0.155 to -0.102 confirms this significant change. A significant improvement in EQ-VAS manifests with an average increase of 13.79 points, supported by the 95% CI of -15.894 to -11.700.

Table 3: Differences in outcome measures pre and post-physiotherapy treatment

Pair	Paired Differences					t-value	df[§]	Sig.[†]
	Mean	SD[¶]	SEM[¶¶]	95% CI[††]				
				Lower	Upper			
NPRS* pre - NPRS post	2.41	1.506	.164	2.08	2.74	14.701	83	.000
RMDQ** pre - RMDQ post	5.27	3.503	.382	4.51	6.03	13.797	83	.000
EQ-5D-5L index pre - EQ-5D-5L index post	-.128	.123	.013	-.155	-.102	-9.602	83	.000
EQ-VAS pre - EQ-VAS post	-13.79	9.662	1.054	-15.89	-11.70	-13.087	83	.000

**Numeric Pain rating Scale, **Roland Morris Disability Questionnaire, [¶]Standard deviation, [¶¶]Standard Error measurement, [§]Degrees of freedom, [†]2-tailed, [††]Confidence Interval*

Source: Author's own 2024.

3.4.2.3 Reliability of the pain conceptualisation measure

Based on Pearson's correlation coefficient, the COPI-Adult variables across two measurements exhibit a high level of stability, with a correlation coefficient of $r = 0.943$ and a significance level of $p < 0.001$; thus, the strong and significant correlation supports the use of COPI as a stable metric measurement.

3.4.3 Results of main data analysis

In continuation, the findings of the main analysis are presented regarding the main research question and the related hypotheses. In addition to those related to the hypotheses, the presentation also includes the results of parallel analyses, which are informative in nature but possibly significant for understanding the research problem.

3.4.3.1 Relationship of Baseline Pain Conceptualisation with Outcome Measures

In Table 4, it is possible to see that baseline pain conceptualisation, measured by COPI-Adult, at the point before physiotherapy treatment correlates only with HRQoL measures, while after physiotherapy treatment, baseline COPI correlates with all outcome measures.

Table 4: Correlations of baseline pain conceptualisation with outcome measures

		NPRS¶ pre	RMDQ¶¶ pre	EQ-5D-5L index pre	EQ-VAS pre	NPRS post	RMDQ post	EQ-5D-5L index post	EQ-VAS post
COPI†	(r) Pearson Correlation	-.116	-.082	.298**	.236*	-.273*	-.259*	.295**	.323**
	Sig. (2-tailed)	.293	.460	.006	.031	.012	.018	.007	.003

†COPI-Adult pre-treatment, ¶Numeric Pain Rating Scale, ¶¶Roland Morris Disability Questionnaire, *Correlation is significant at the 0.05 level, ** Correlation is significant at the 0.01 level

Source: Author's own 2024.

More specifically, we find a positive correlation between baseline pain conceptualisation and HRQoL measures before physiotherapy treatment, respectively, with higher COPI scores being associated with higher EQ-5D-5L index values ($r = 0.30$, p = 0.006) and higher EQ-VAS values ($r = 0.236$, p = 0.031) and vice versa; implying that those more knowledgable about pain perceive their HRQoL to be higher. Regarding outcome measures after physiotherapy treatment, NPRS scores and RMDQ scores significantly and negatively correlated with baseline COPI scores ($r = -0.273$, p = 0.012; $r = -0.259$, p = 0.018), while HRQoL measures, the EQ-5D-5L index and EQ-VAS correlate positively ($r = 0.295$, p = 0.007; $r = 0.323$, p = 0.003). This means there is sufficient evidence to conclude a significant relationship between baseline COPI-Adult scores and outcomes following physiotherapy; higher baseline COPI-Adult scores are associated with lower pain outcomes and lower disability, and in contrast, with better HRQoL, and vice versa.

Additionally, to quantify how much the dependent variable is determined by the independent variable in terms of the proportion of variance, we calculated the coefficient of determination (r^2) from the Pearson correlation coefficient. Consequent to the calculation, baseline conceptualisation determined by COPI-Adult scores can explain the 7.5% ($r^2 = 0.075$) variance in pain outcomes, 6.7% ($r^2 = 0.067$) variance in disability outcomes, and 8.7% ($r^2 = 0.087$), respectively 10.4% variance ($r^2 = 0.104$) in HRQoL related outcomes. Since all the values of the coefficients of determination are above 0, considering the unit interval (0 to 1) as the meaningful range (Chicco, Warrens, and Jurman 2021), the proportion of variance explained by our model can theoretically be explained, in contrast from negative values (Chicco, Warrens, and Jurman 2021) or 0, respectively 0%, which indicates that the model explains none of the variability (Minitab Blog Editor 2013).

Based on the findings, baseline COPI-Adult scores statistically and significantly correlate with physiotherapy outcomes; higher COPI-Adult scores correlate with lower pain and disability scores and higher HRQoL following physiotherapy. In addition, the variance explained by COPI-Adult scores as a predictor is modest yet meaningful, with r^2 values indicating that pain conceptualisation explains approximately 7.5% of the variance in pain, 6.7% in disability, and 8.7% to 10.4% in HRQoL.

3.4.3.2 Risk groups with lower levels of baseline pain conceptualisation regarding the level of education

Table 5 shows a statistically significant difference in COPI-Adult scores between higher-educated and lower-educated (t = -2.219, p = 0.014), with an effect of d = 0.55 falling into a range of medium to large effect (Brydges 2019).

Table 5: Differences in COPI-Adult scores between lower and higher-educated

Group	N	Mean	Std.Deviation	d†	t-value	Sig.*
Lower Educated	41	30.37	6.244	0.55	-2.219	0.014
Higer Educated	43	33.93	6.703			

**Significant the 0.05 and 0.01 level, †Cohen's d effect size*

Source: Author's own 2024.

3.4.3.3 The relationship of baseline pain conceptualisation level with changes in the levels of pain, disability and HRQoL measures

Below are the results of the analysis, which was approached in two ways: by determining the existence of correlations between baseline pain conceptualisation measured by COPI-Adult and delta differences of NPRS, RMDQ, and HRQoL-related and by visualising and additionally checking the extent to which baseline pain conceptualisation affects changes in dependent variables due to treatment.

Table 6: Correlations between baseline pain conceptualisation and delta differences for pain, disability, and HRQoL

		NPRS¶_delta	RMDQ¶¶_delta	EQ-5D-5L index_delta	EQ-VAS_delta
COPI†	Pearson Correlation (*r*)	-.212	-.232*	-.132	.094
	Sig. (2-tailed)	.053	.034	.231	.396

†COPI-Adult pre-treatment, ¶Numeric Pain Rating Scale, ¶¶Rolan Morris Disability Questionnaire,
**Correlation is significant at the 0.05 level (two-tailed)*

Source: Author's own 2024.

As shown in Table 6, the only Pearson correlation significant coefficient is between COPI-Adult and RMDQ_delta (*r* = -0.232, p = 0.034), which is negative and relatively low. However, it implies that increasing COPI-Adult scores decreases the value of RMDQ_delta. Given that, we know that RMDQ_delta is calculated as the difference RMDQ post - RMDQ pre and that the RMDQ post-treatment values are significantly reduced compared to the initial ones, with greater treatment efficiency, the values of RMDO become increasingly lower. This negative association between COPI-Adult and RMDQ_delta indicates that in those more knowledgeable about pain, physiotherapy treatment had a somewhat more potent effect on reducing disability; however, cautiously considering because of a weak correlation on the verge of significance. Other significant correlations did not yield.

Tables 7, 8, 9, and 10 show descriptive statistics for each group (COPI-Adult = 0 and COPI-Adult = 1) pre and post-treatment. Examining the means, standard deviations, and sample sizes ensured that the analysis of variance assumptions were met and results valid (Laerd Statistics 2024) to determine the effects of time (pre vs. post-treatment), group (dichotomised COPI-Adult, 0 vs 1), and their interaction on the dependent variable: NPRS, RMDQ and HRQoL.

Table 7: Descriptive statistics for Numeric Pain Rating Scale scores pre- and post-treatment by COPI-Adult Group

	COPI-Adult (dih*)	Mean	Std. Deviation	N
NPRS** pre treatment	0	6.463	1.3435	41
	1	5.977	1.2815	43
	Total	6.214	1.3269	84
NPRS post treatment	0	4.146	1.8243	41
	1	3.465	1.5939	43
	Total	3.798	1.7340	84

**Dichotomised, **Numeric Pain Rating Scale*

Source: Author's own 2024.

Table 8: Descriptive statistics for Roland Morris Disability Questionnaire scores pre- and post-treatment by COPI-Adult Group

	COPI-Adult (dih*)	Mean	Std. Deviation	N
RMDQ** pre treatment	0	12.390	4.1885	41
	1	11.651	3.6702	43
	Total	12.012	3.9255	84
RMDQ post treatment	0	7.659	4.1869	41
	1	5.860	4.4432	43
	Total	6.738	4.3882	84

**Dichotomised, **Roland Morris Disability Questionnaire*

Source: Author's own 2024.

Table 9: Descriptive statistics for EQ-5D-5L index scores pre- and post-treatment by COPI-Adult Group

	COPI-Adult (dih*)	Mean	Std. Deviation	N
EQ-5D-5L index pre treatment	0	.63195	.178169	41
	1	.70181	.142232	43
	Total	.66771	.163614	84
EQ-5D-5L index post treatment	0	.76876	.131603	41
	1	.82312	.078344	43
	Total	.79658	.110453	84

**Dichotomised*

Source: Author's own 2024.

Table 10: Descriptive statistics for EQ-VAS scores pre- and post-treatment by COPI-Adult Group

	COPI-Adult (dih*)	Mean	Std. Deviation	N
EQ-VAS pre treatment	0	54.634	17.9371	41
	1	63.023	16.0912	43
	Total	58.929	17.4320	84
EQ-VAS post treatment	0	67.561	16.3218	41
	1	77.651	13.1256	43
	Total	72.726	15.5341	84

**Dichotomised*

Source: Author's own 2024.

The results of ANOVA are shown below and separately for each dependent variable, as well as profile plots for between-factor interaction that indicate whether the estimated marginal means are increasing or decreasing across different levels or time; in the case of two factors, parallel lines on the plot suggest no interaction between the factors, indicating that the levels of only one factor are at play, while nonparallel lines indicate an interaction (IBM 2023a).

In Table 11, it is possible to see that the within-subjects effects for the factor of time (pre vs. post-treatment NPRS) showed a significant reduction in NPRS scores post-treatment across both groups ($p < 0.01$), with an effect size of $\eta^2_p = 0.723$. This indicates that the treatment significantly reduced pain levels, which is already known and shown in Table 3. However, the interaction between the time factor and dichotomised COPI-Adult was insignificant ($p = 0.557$); this implies that the treatment effect was consistent across the COPI-Adult groups, but the COPI-Adult variable was insignificant on the change in NPRS scores over time. The associated profile plot (Figure 6) shows COPI-Adult 0 and 1 lines moving parallel over time due to previously described non-interaction.

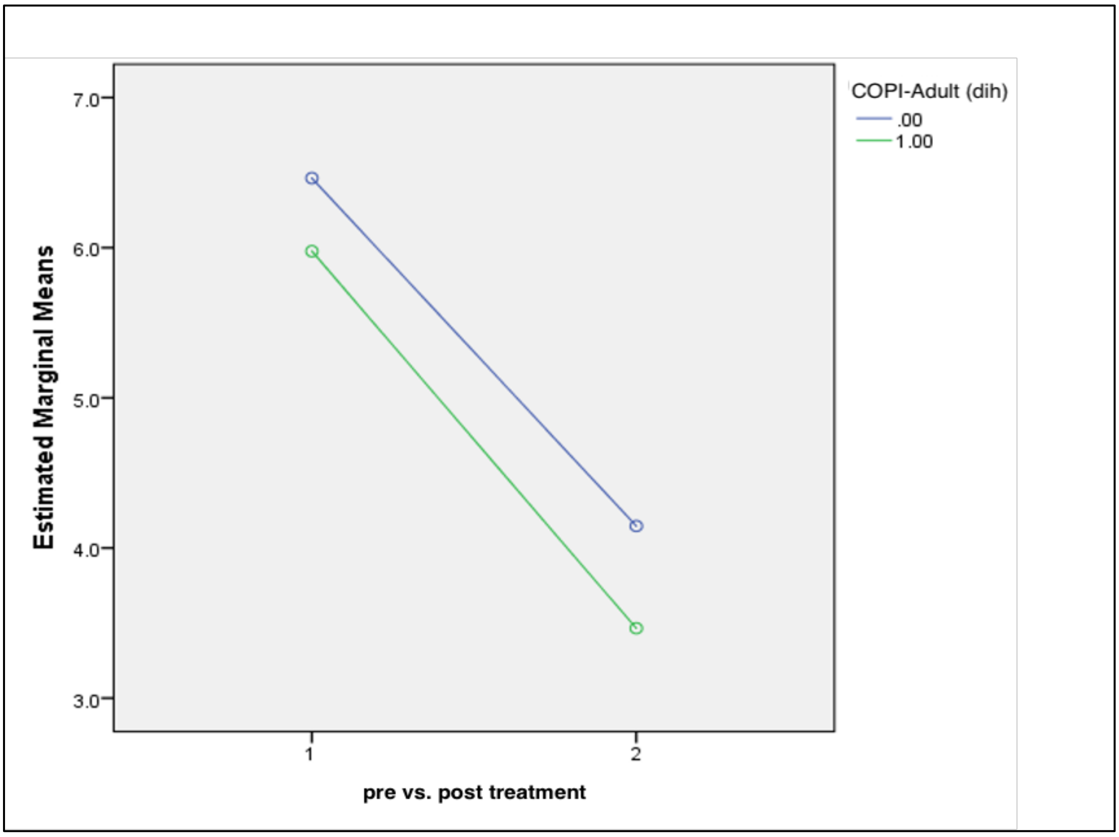
Table 11: Within-subjects effects on pain scores over time (ANOVA)

Source of Variation	Sum of Squares[†]	df[††]	Mean Square	F	p-value	η^2_p
Time (pre vs. post treatment NPRS[¥])	244.683	1	244.683	213.877	.000	.723
Time * COPI-Adult (dih[§]) Interaction	.397	1	.397	.347	.557	.004
Error (Within-Subjects)	93.811	82	1.144			

[¥]Numeric Pain Rating Scale, [§]Dichotomised, [†]Type III Sum of Squares, [††]Degrees of freedom

Source: Author's own 2024.

Figure 6: Profile plot for pain scores over time by dichotomised COPI-Adult



Source: Author's own 2024.

Findings and visualisations continue to show that this trend, without interaction within subjects and with parallel directions of the COPI-Adult dichotomous factors over time, is also present in the cases of all other dependent variables. As seen in Table 12, while the effects of time (pre vs. post-treatment RMDQ) are significant ($p < 0.01$) and with an effect size of $\eta^2_p = 0.700$, therefore indicating a significant reduction in RMDQ scores post-treatment across both groups, the interaction between the time factor and dichotomised COPI-Adult on disability scores is insignificant ($p = 0.167$), indicating treatments similarly effective regardless of the COPI-Adult group, therefore parallel in line as seen in Figure 7.

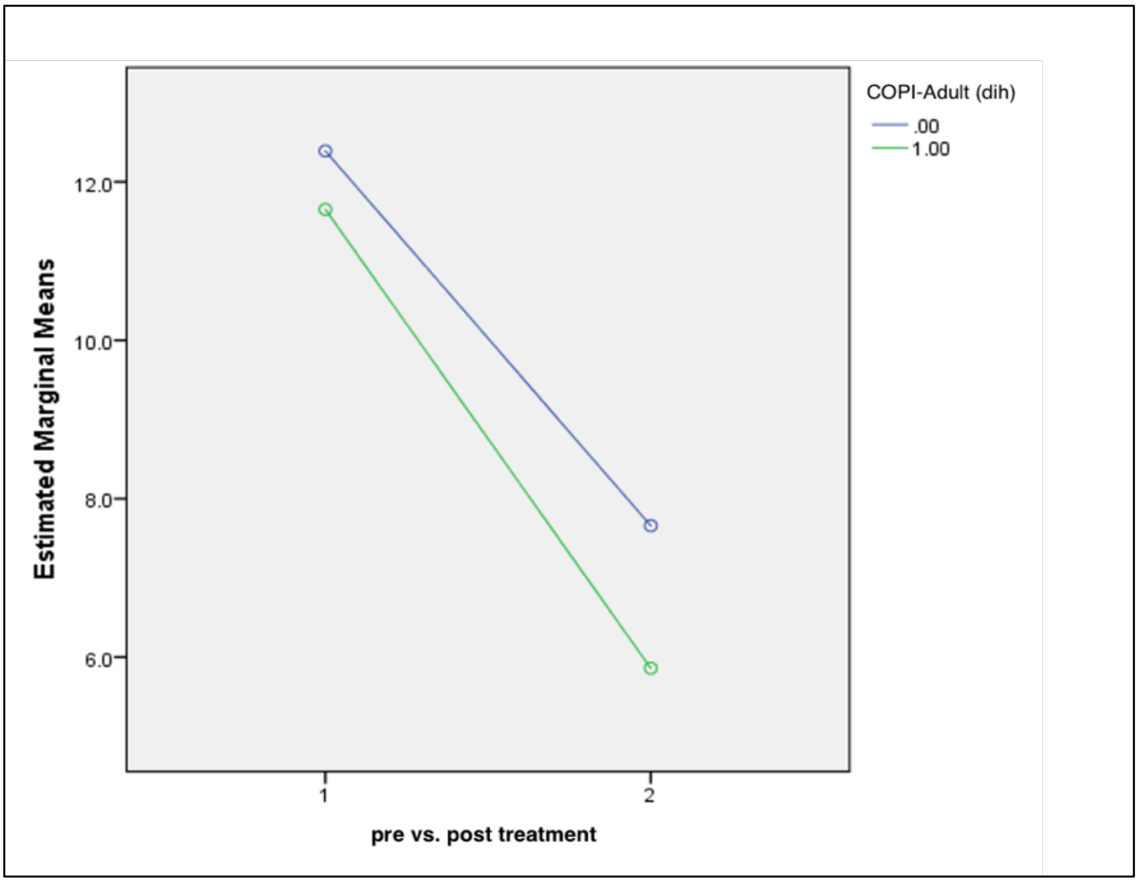
Table 12: Within-subjects effects on disability scores over time (ANOVA)

Source of Variation	Sum of Squares[†]	df[††]	Mean Square	F	p-value	η^2_p
Time (pre vs. post treatment RMDQ[¥])	1161.912	1	1161.912	191.479	.000	.700
Time * COPI-Adult (dih[§]) Interaction	11.769	1	11.769	1.939	.167	.023
Error (Within-Subjects)	497.583	82.000	6.068			

[¥]Roland Morris Disability Questionnaire, [§]Dichotomised, [†]Type III Sum of Squares, [††]Degrees of freedom

Source: Author's own 2024.

Figure 7: Profile plot for disability scores over time by dichotomised COPI-Adult



Source: Author's own 2024.

For the variables of HRQoL, time factor (pre vs. post-treatment) is significant ($p < 0.01$) with an effect size of $\eta^2_p = 0.528$, indicating a significant increase in EQ-5D-5L index values post-treatment across both groups, while the interaction between the time factor and dichotomised COPI-Adult is not ($p = 0.567$), indicating that the treatment effect was similar regardless of COPI group status and which is visualised by parallel directional movement of factors 0 and 1 shown in the profile plot (Figure 8). The same scenario is seen in EQ-VAS (Table 14 and Figure 9), with time being significant ($p < 0.01$) in score improvement post-treatment across both groups and with an effect size of $\eta^2_p = 0.675$, and with neither COPI factor interaction on the dependent variable ($p = 0.423$), which is manifested in parallel movements of 0 and 1 through time.

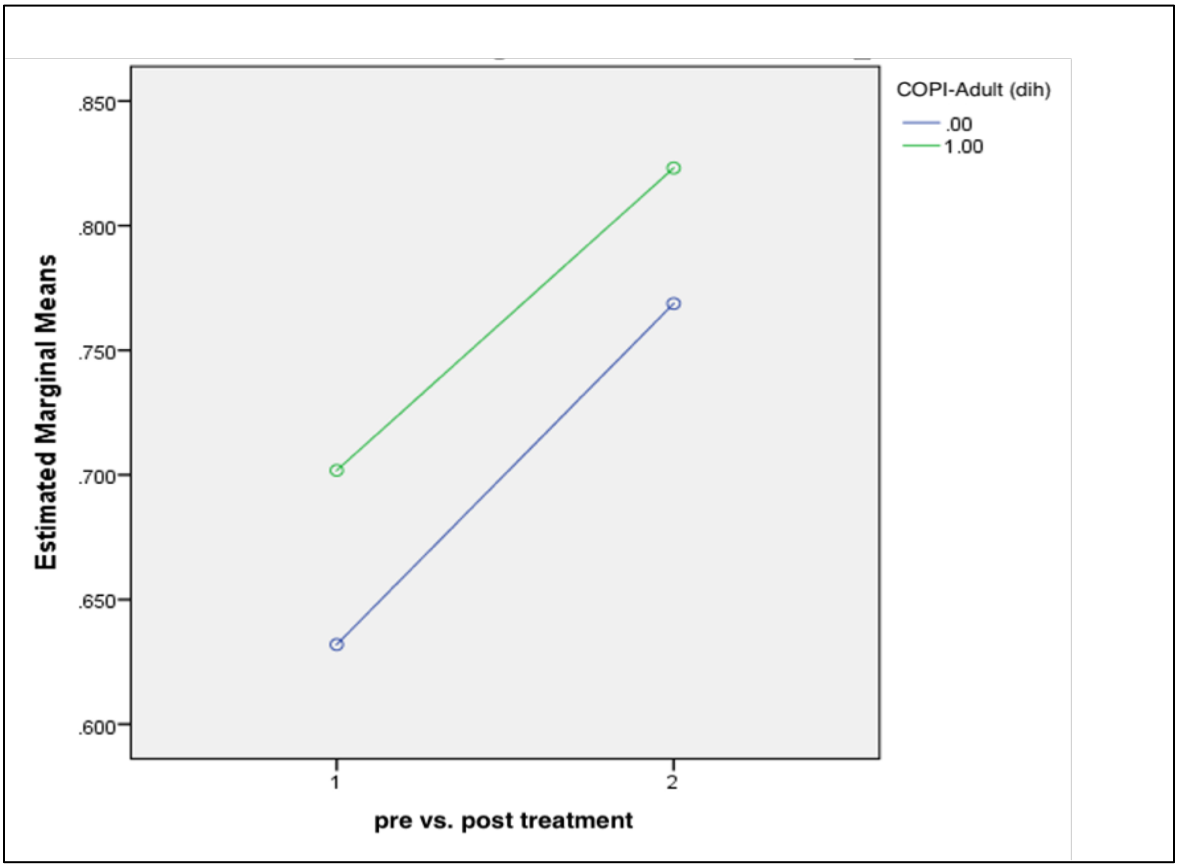
Table 13: Within-subjects effects on EQ-5D-5L index value over time (ANOVA)

Source of Variation	Sum of Squares[†]	df[††]	Mean Square	F	p-value	η^2_p
Time (pre vs. post treatment EQ-5D-5L index)	.699	1	.699	91.661	.000	.528
Time * COPI-Adult (dih[§]) Interaction	.003	1	.003	.331	.567	.004
Error (Within-Subjects)	.625	82	.008			

[§]Dichotomised, [†]Type III Sum of Squares, [††]Degrees of freedom

Source: Author's own 2024.

Figure 8: Profile plot for EQ-5D-5L index values over time by dichotomised COPI-Adult



Source: Author's own 2024.

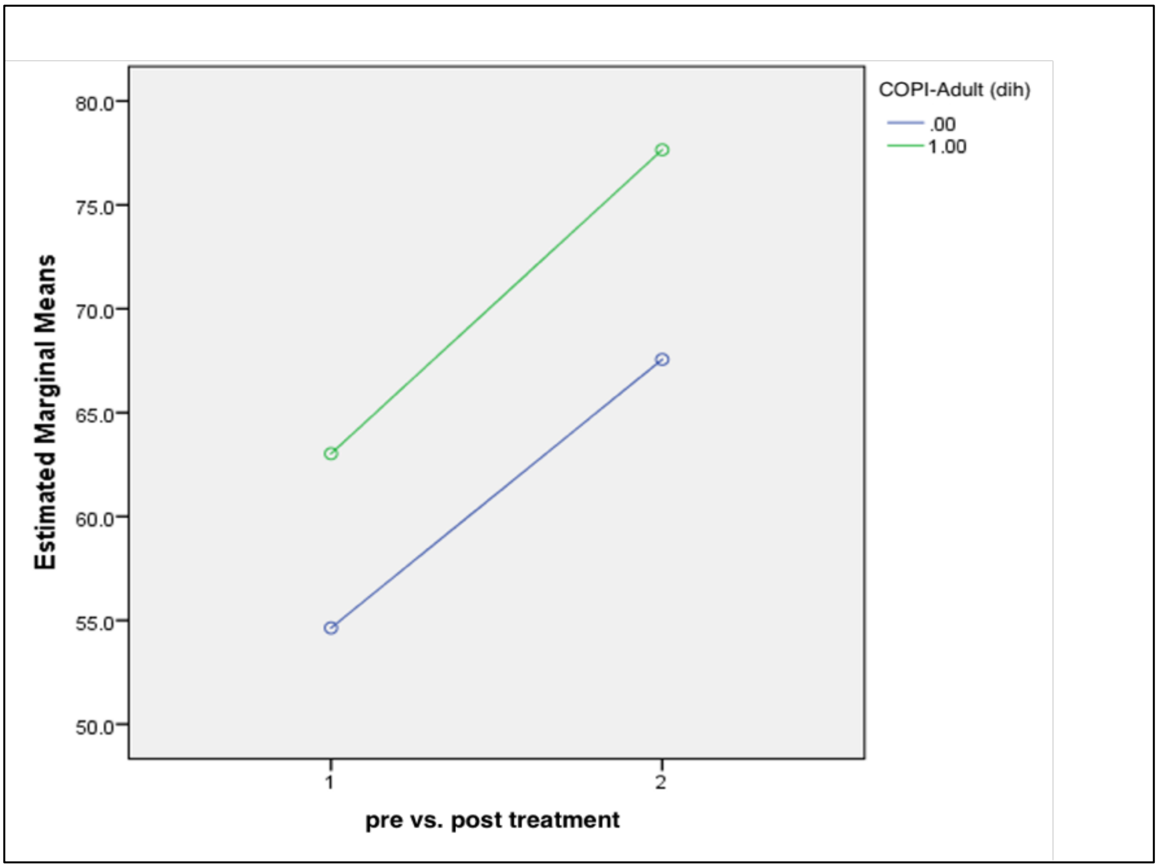
Table 14: Within-subjects effects on EQ-VAS scores over time (ANOVA)

Source of Variation	Sum of Squares†	df††	Mean Square	F	p-value	η^2_p
Time (pre vs. post treatment EQ-VAS)	7967.747	1	7967.747	169.949	.000	.675
Time * COPI-Adult (dih§) Interaction	30.366	1	30.366	.648	.423	.008
Error (Within-Subjects)	3844.413	82	46.883			

§Dichotomised, †Type III Sum of Squares, ††Degrees of freedom

Source: Author's own 2024.

Figure 9: Profile plot for EQ-VAS scores over time by dichotomised COPI-Adult



Source: Author's own 2024.

The previously presented ANOVA results are consistent with the MANOVA analysis, meaning that both methods show the same conclusion: COPI group, respectively, level of pain conceptualisation (0 vs 1) does not have a statistically significant effect on changes in dependent variables (pain, disability and HRQoL) over time. In the MANOVA analysis (Table 15), we found no significant interaction between COPI and time, which means that when all dependent variables are considered together, the effect of COPI over time is not significant.

More precisely, the Wilks' Lambda value of 0.211, combined with a highly significant p-value ($p < 0.001$), indicates that “time” explains a substantial portion of the variance in the combined dependent variables (pain, disability, and HRQoL). The large effect size ($\eta^2_p = 0.789$) suggests that changes over time account for a significant proportion of the variance in these outcomes. In contrast to the effect of time, respectively, the effect of treatment, the Wilks' Lambda value of 0.910, alongside a non-significant p-value ($p = 0.109$), indicates that the COPI level (0 vs 1) alone does not significantly affect the combined dependent variables. The small effect size ($\eta^2_p = 0.090$) further suggests that differences between COPI groups do not meaningfully impact pain, disability, or HRQoL when analysed collectively. The interaction effect between time and COPI level has a Wilks' Lambda of 0.936, with a non-significant p-value ($p = 0.257$). This indicates that the interaction between these variables does not explain a statistically significant portion of the variance in the combined outcomes. The small effect size ($\eta^2_p = 0.064$) further suggests that the effect is modest. Therefore, we conclude that no significant interaction exists between Time and COPI level in influencing changes in pain, disability, or HRQoL.

Table 15: Within-subjects effects on pain, disability, and HRQoL (MANOVA)

Effect	Wilks′ Lambda	F	Hypothesis df†	Error df††	p-value	η^2_p
COPI-Adult (0 vs 1)	0.910	1.958	4	79	0.109	0.090
Time (repeated measures)	0.211	74.035	4	79	0.000	0.789
Time * COPI-Adult (0 vs 1) Interaction	0.936	1.354	4	79	0.257	0.064

†Represents the four dependent variables in the analysis—NPRS (pain), RMDQ (disability), EQ-5D-5L index, and EQ-VAS (HRQoL)

Similarly, univariate ANOVAs for each dependent variable show that there is no significant interaction between COPI and time on each of these variables (pain, disability, and HRQoL) separately. Therefore, this consistent result between MANOVA and ANOVA confirms that baseline pain conceptualisation has no significant effect on the pattern of changes in dependent variables over time.

3.5 Discussion

The primary objectives of this doctoral dissertation research were to ascertain whether, in patients with CNSLBP, baseline pain is related to pain, disability, and HRQoL outcomes following physiotherapy and to examine the relationship between baseline pain conceptualisation and the amount of change in these outcomes, considered in the existing body of knowledge as core. Additionally, this doctoral dissertation research aimed to identify risk groups with a lower level of baseline pain conceptualisation, particularly in relation to their education level.

The findings of this doctoral dissertation research imply that baseline pain conceptualisation is significantly related to pain, disability and HRQoL outcomes following physiotherapy in a general manner. In addition, the variance explained by baseline pain conceptualisation is modest yet meaningful, with pain conceptualisation accounting for a small but significant portion of the variability in overall pain, disability, and HRQoL outcomes. Moreover, lower levels of baseline pain conceptualisation were shown to be related to lower educational levels, therefore highlighting a potential risk group. The findings on how baseline pain conceptualisation interacts with patient outcomes in a specific manner of change through time yield no significant relationship; hence, although baseline pain conceptualisation may significantly relate to overall patient outcomes following physiotherapy, it will not influence the amount or extent of improvement in these outcomes. In the integrated manner of the doctoral dissertation research, the hypotheses related to the objectives were tested, presented and discussed, following on from the previously established findings.

The hypothesis (H1), which posed that baseline COPI-Adult scores are related to pain outcomes in patients with CNSLBP following physiotherapy, is confirmed. Lower NPRS scores after physiotherapy were found to be significantly and negatively correlated with higher baseline COPI-Adult scores. Additionally, the variance explained by COPI-Adult scores is modest yet meaningful, indicating that pain conceptualisation accounts for approximately 7.5% of the variance in pain.

The hypothesis (H2), which posed that baseline COPI-Adult scores are related to disability outcomes in patients with CNSLBP following physiotherapy, is confirmed. Lower RMDQ scores after physiotherapy were found to be significantly and negatively correlated with higher baseline COPI-Adult scores. Additionally, COPI-Adult scores explain approximately 6.7% of the variance in disability, indicating a modest yet meaningful association.

The hypothesis (H3), which posed that baseline COPI-Adult scores are related to HRQoL outcomes in patients with CNSLBP following physiotherapy, is confirmed. Higher EQ-5D-5L index scores following physiotherapy were found to be significantly and positively correlated with higher baseline COPI-Adult scores. Additionally, COPI-Adult scores explain between 8.7% and 10.4% of the variance in HRQoL, also indicating a modest yet meaningful association.

The hypothesis (H4), which proposed that less pain reduction following physiotherapy is associated with lower baseline COPI-Adult scores in patients with CNSLBP, is not confirmed. When analysed as a continuous variable, COPI-Adult scores showed no significant correlation with changes in NPRS scores, indicating no meaningful association between baseline COPI-Adult levels and pain reduction. In addition, both multivariate and univariate analyses, where COPI-Adult was treated as a categorical factor, showed no significant interaction between COPI-Adult level and time on pain outcomes. This confirms that baseline COPI-Adult scores have no significant relationship with the pattern of pain reduction over time.

The hypothesis (H5), which proposed that less reduction in disability following physiotherapy is related to lower baseline COPI-Adult scores in patients with CNSLBP, can be initially considered partially supported. When COPI-Adult was analysed as a continuous variable, there was a weak but significant negative correlation with changes in RMDQ, suggesting a modest association where higher COPI-Adult scores were linked to slightly more potent reductions in disability. However, this effect is weak and on the verge of significance. In contrast, both multivariate and univariate ANOVAs, where COPI-Adult was treated as a factor, did not show any significant interaction with time on disability outcomes, reinforcing the conclusion that baseline COPI-Adult does not significantly influence disability reduction patterns over time.

The hypothesis (H6), which proposed that less improvement in HRQoL following physiotherapy is associated with lower baseline COPI-Adult scores in patients with CNSLBP, is not confirmed. No significant correlations were found between COPI-Adult scores (as a continuous variable) and changes in either EQ-5D-5L index or EQ-VAS values, indicating no significant relationship between baseline COPI-Adult levels and HRQoL improvement. Additionally, both multivariate and univariate analyses treating COPI-Adult as a factor did not reveal any significant interaction between COPI-Adult level and time on HRQoL outcomes. This suggests that baseline pain conceptualisation, as measured by COPI-Adult, has no significant relationship with changes in HRQoL following physiotherapy.

The hypothesis (H7), which posed that baseline COPI-Adult scores are significantly lower in lower-educated patients with CNSLBP, is confirmed since a statistically significant difference in COPI-Adult scores between higher-educated and lower-educated was established, with lower-educated patients having lower COPI-Adult scores, additionally with a medium to large effect size.

As presented in the rationale for this current research, both single observational or experimental studies and comprehensive analytical research on CNSLBP or CLBP explored the relationship of overall patient outcomes with knowledge and beliefs, generally regarded as common sense and "folk" understandings (Connors and Halligan 2014). As this research, to the best of our knowledge, is first of a kind, considering its uniqueness regarding the research problem, study design, and methodological approach, it was expected that no direct comparable research would be available. However, although the research gap of this doctoral dissertation is based on what is missing in the existing body of knowledge, namely the conceptualisation of pain as unprimed sense-making and its relationship with core patient outcomes in CNSLBP, our findings are consistent with those in the existing body of knowledge that explored the relationship of overall patient outcomes with pain conceptualisation and understanding through sense-making, respectively, reconceptualisation. In considering the 'knowledge half-life', which refers to the phenomenon in which older knowledge is discounted in favour of newer research (Chow et al. 2023) and from research levels of evidence as an essential component of evidence-based medicine and practice (Burns et al. 2011), most recent and comprehensive analytical research accessible, with findings relevant or comparable to the research problem and findings of this doctoral dissertation is primarily discussed.

Wood and Hendrick (2019) analysed randomised controlled studies (RTC) that applied reconceptualisation of pain among patients with CLBP through PNE, enhancing their understanding of pain. This improved conceptualisation was related to significant changes reflected in short-term pain and disability outcomes following physiotherapy, as demonstrated by the meta-analysis. Although HRQoL outcomes were not included in the research, these findings underscore the relevance of baseline pain conceptualisation in significantly influencing overall patient outcomes regarding pain and disability and related to this current research. Ma et al. (2023) RTC analysis revealed significant reductions in pain and disability when PNE is added to exercise or physiotherapy interventions, suggesting that enhanced pain conceptualisation has a crucial role in improving short-term patient outcomes, except for HRQoL, which was not observed.

CSLBP has also been explored under umbrella reviews on chronic spinal pain (Bonatesta et al. 2022) and musculoskeletal pain (Cuenca-Martínez et al. 2023; Lepri et al. 2023; Siddall et al. 2022). Findings of Bonatesta et al. (2022) imply that exercise therapy in conjunction with PNE reduces pain, disability, kinesiophobia, and catastrophising in patients with chronic nonspecific spinal pain, therefore suggesting, as previous findings, improvements in patient outcomes as related to enhanced baseline pain conceptualisation. The same suggestions about the association of significantly improved pain and disability outcomes with improved pain conceptualisation in chronic musculoskeletal pain are reflected in the umbrella review of Cuenca-Martínez et al. (2023) and Lepri et al. (2023), as well as of Siddall et al. (2022). Therefore, as established in this current research and suggested by findings of previous analyses on CNSLBP as a single entity and umbrella reviews, better or enhanced pain conceptualisation is related to better patient outcomes following physiotherapy and therapeutic exercise in the first line. Although studies have not objectively and quantitatively analysed HRQoL, it is already well established that lower HRQoL is associated with higher pain and disability (Alfalogy et al. 2023).

However, it must be noted, and referring to the umbrella review of meta-analysis from their inception to 2022 by (Martinez-Calderon et al. 2023), that, given their methodological quality and opposite findings, it is impossible to make clear clinical recommendations for delivering PNE, suggesting that although the relationship between pain conceptualisation and patient outcomes is undeniable, there are still certain unknowns in that relationship. In addressing the variability of the overall PNE efficacy (Keen et al. 2021; Martinez-Calderon et al. 2023; Ram et al. 2023), the findings of this doctoral dissertation research may serve as support.

Namely, the results of this current research show that the level of pain conceptualisation, measured in COPI-Adult scores, has a possible predictive value (Minitab Blog Editor 2013;

Chicco et al. 2021) in the overall outcomes following physiotherapy; however, it may explain only a portion of the variance (ranging from 6.7% to 10.4%) in pain, disability and HRQoL overall outcomes. Therefore, some other factors determine and explain the remaining 89.6% to 93.3% of the variance in patient outcomes. Furthermore, this current research revealed findings that did not align with the three hypotheses. These findings suggest that changes in patient outcomes due to physiotherapy may be influenced by factors other than the level of pain conceptualisation before treatment. The level of baseline pain conceptualisation did not correlate with changes in patient outcomes following physiotherapy, suggesting no predictive value in the amount or extent of changes in pain, disability, and HRQoL outcomes. In addition, there was no interaction between the dichotomised COPI-Adult levels and change during treatment, indicating that exercise therapy in patients with CNSLBP was effective regardless of their conceptualisation of pain, respectively equal between those more knowledgeable and less knowledgeable about pain.

Among research on pain conceptualisation, we found only one study, a systematic review with meta-analysis, that addressed the association between pain knowledge changes and outcomes after treatment in patients with chronic musculoskeletal pain. Based on the low to very low certainty of evidence and studies using only the NPQ instrument to measure pain neurophysiology knowledge, no significant associations were found between short-term changes in pain neurophysiology knowledge and changes in pain intensity, function, quality of life, pain catastrophising, or kinesiophobia after a PSE intervention; exploratory analysis suggests that changes in pain conceptualisation have no overall correlation with changes in patient outcomes following treatment (Ram et al. 2023). Although in the general context of chronic musculoskeletal pain, the findings are consistent with ours in the specific context of CNSLBP, thus also suggesting no predictive value of pain conceptualisation in the amount or extent of changes in pain, disability and HRQoL outcomes. Ram et al. (2023), by acknowledging the sparse certainty on which their findings are based, suggest a quantifiable change in knowledge, therefore in pain conceptualisation, may well be less important than what happens as a result of that change and that the demonstrated benefits of enhanced conceptualisation may instead act through some other as yet not identified mechanisms.

Hence, the findings of this current research and those from the previous meta-analysis suggest that it may be less important to focus on a quantifiable change in knowledge and pain conceptualisation; instead, more attention should be paid to the results of that change, which may stem from mechanisms that have not yet been fully determined. These findings should be discussed in the context of informed decision-making in providing physiotherapy for CNSLBP since they are underlined by theoretical and empirical rationale. Physiotherapy is designed to decrease costs associated with sick leave or disability pensions; therefore, physiotherapists should carefully assess the benefits to patients of each therapy in terms of health improvements and costs, ensuring that their treatments are effective and time-limited (Mengshoel et al. 2021). Furthermore, these findings also suggest that tailoring physiotherapy to the needs of people with CNSLBP, which are centred around their desire for a diagnosis, expectations, and healthcare utilisation overuse (Lim et al. 2019), and taking into account psychosocial and neuroplasticity-related factors may have a more substantial impact on overall patient outcomes and the extent of recovery, rather than providing PNE alongside other physiotherapy interventions (George et al. 2021) as standard care.

Several possible explanations exist for this divergence, which is discussed in the context of factors that influence physiotherapy treatment outcomes. To begin with, the conceptualisation of pain in participants in this current research reflects their low knowledge alignment with modern pain science (Pate et al. 2022). There is also solid empirical evidence confirming the psychosocial factors that may influence the outcome of treatment, besides cognitive factors, are vigilance, distraction, fear, anxiety, depression, distress, and general pain behaviour, and have been recognised for over a decade as significant factors that can impact the success of treatment, leading to the long-term effects of pain and disability (Linton and Shaw 2011). Patient expectations (Fleckenstein et al. 2022), preference, treatment motivation, treatment credibility and self-efficacy are also essential and have been found to have a positive association with both the short and long-term pain and disability outcomes in CLBP (Mohamed Mohamed et al. 2020). In addition, contextual factors such as therapeutic alliance and treatment expectations likely influence a patient's engagement and acceptance of the information (Ram et al. 2023) during physiotherapy treatment. Moreover, a systematic review by Alhowimel, AlOtaibi, et al. (2018) reported psychological factors present after the experience as pain fear-avoidance model elements associated with pain and disability outcomes in people with CLBP treated by physiotherapists, with HRQoL also associated with both higher disability and higher anxiety levels in people with CLBP (Bid et al. 2017).

The potential correlation between central sensitisation in CNSLBP patients and the prediction of treatment response using relevant outcome measures has not been thoroughly investigated (Bid et al. 2017); however, considering that CS predicts poor treatment outcomes in various patient populations with chronic musculoskeletal pain, it is rational to account for it during physiotherapy treatment (Nijs et al. 2016). Taking CS into account when treating patients with chronic pain implies not relying on short-term changes in pain outcomes in response to interventions; furthermore, short-term changes in pain outcomes should not be relied upon when measuring the efficacy of treatment such as exercise therapy (Nijs et al. 2023) which results in slight improvements in patients with chronic musculoskeletal pain featuring CS (Arribas-Romano et al. 2020). While we may wonder whether CS is just an epiphenomenon, evidence supports the clinical importance of CS (Nijs et al. 2023); patients with CLBP and predominant CS experience much higher pain severity, disability and lower HRQoL compared to their counterparts without CS (Smart et al. 2012). It also should be taken into account that patients with a predominance of CS report longer pain duration; however, chronicity of pain is not sufficient to distinguish CS predominance (Nogueira et al. 2016). The contribution of cognitive-emotional factors (Nijs et al. 2023), such as pain catastrophising, stress, hypervigilance, lack of acceptance, depressive thoughts, and maladaptive illness perceptions to CS (Nijs et al. 2016) was already highlighted.

When analysing outcome variations, it's essential to consider potential biases in the pain conceptualisation assessment inventory and measures. The NPQ tends to focus on assessing the neurophysiology of pain knowledge; still, it may only partially capture other essential elements of pain conceptualisations, such as the psychological and social aspects of pain (Ram et al. 2023). Some of the limitations of the NPQ were also previously elaborated in the work of Pate et al. (2022) and noted in that of Vaughan et al. (2019). In addition, outcome measures assessing pain knowledge *per se* include various medical concepts and definitions used by healthcare professionals (Moseley 2003; Maciel et al. 2009), which may be highly unknown to patients. In contrast to previous, this current research utilised the COPI-Adult inventory, considered particularly suitable for persons without pain science education, and for assessing pain conceptualisation through one individual consideration of what pain is, why they feel pain, and how they feel pain by quantifying these considerations into COPI-Adult scores, therefore, measuring alignment with contemporary pain science (Pate et al. 2022). In addition to the mentioned advantages of the COPI-Adult, the inventory showed high reliability and stability of the measure over time in our sample of patients with CNSLBP.

By elaborating on the main findings and taking into account possible implications, it can be stated that some of the hypotheses in this doctoral dissertation remained unconfirmed because they relied too much on the pain conceptualisation while underestimating the influence of psychosocial factors and neuroplasticity-based changes (Nijs et al. 2017, 109) and their possible influence in the extent of changes in pain, disability, and HRQoL following physiotherapy. This should serve as an example for future research, ensuring that the established and proven theories are not underestimated. Instead, they should aid in discovering new empirical evidence and theories that have yet to be fully confirmed. In addition, future findings should be obtained through translational research, integrating basic sciences, social sciences, and political sciences to optimise patient care (Mehić 2011) and ensure healthcare sustainability.

The factor of educational attainment in the conceptualisation of pain in this current research, except in filling the research gap, is also of symbolic significance, given that it is related to knowledge and understanding that provides truth, which is, as previously stated, a long-standing objective of human endeavours (Halla 2018). Educational attainment is an important predictor of key midlife health problems, with significant mediating effects on health behaviour (Ping and Oshio 2023). Furthermore, research has shown that the overall level of education may affect an individual's experience of pain through a combination of socioeconomic, health-related behaviour, social, and medical factors, with higher levels of education associated with lower reporting of pain and better health outcomes (Zajacova et al. 2020). With this current research, we confirmed that the level of pain conceptualisation differs between the lower educated and the higher educated, which may imply the findings of the previous study and thus contribute to emerging research on critical but neglected educational endpoints and health, simultaneously identifying potentially vulnerable groups to pain researchers and clinicians (Zajacova et al. 2020).

After elaborating on the research findings in this doctoral dissertation and existing research, although this dissertation carries significant implications, it also has potential methodological limitations, of which we highlight those of evident importance. These limitations mainly stem from the fact that while potential confounding factors were considered, they were only partially addressed. Despite efforts to control and manage confounding factors, there is an inevitable possibility of central sensitisation and overlooked psychosocial factors, which could ultimately impact the validity of the results and lead to biased conclusions. Denied or mental conditions not yet addressed by an appropriate medical professional are also possible. The duration and follow-up following physiotherapy might have needed longer to observe significant changes in patient outcomes influenced by pain conceptualisation. Therapeutic alliance and treatment expectations may have influenced the patient's engagement and acceptance of the information (Ram et al. 2023) during physiotherapy, such as exercise instructions. Furthermore, despite the recommendations for using core outcome measures in LBP, patient-reported outcome measures (PROMs) have limitations despite their benefits. Internal factors like mood, expectations, and time and external factors such as treatment context and interactions with healthcare providers influence PROMs and patients may only sometimes recognise improvements in their health; additionally, what patients prioritise may need to align with their actual choices, therefore, combining PROMs with functional outcomes is vital to understanding the physiological impact and patients' well-being (Kluzek et al. 2022).

In addition to the limitations that do not arise from the doctoral dissertation research, there needs to be more evidence of the research problem in the specific context of CNSLBP. A significant lack of directly comparable research resulted in a shift to alternative but still in the research context, whose findings and derived implications remained consistent with the current research findings and served as a supporting and explanatory tool.

3.6 Contribution of doctoral dissertation findings

The contribution of this doctoral dissertation has broad implications for both science and clinical practice, as well as in a translational research context. Firstly, the doctoral dissertation findings aid the more in-depth understanding of both pain conceptualisation and the process of reconceptualisation by revealing the relationship of baseline pain conceptualisation, as unprimed sense-making, with overall pain, disability, and HRQoL outcomes in CNSLBP patients following physiotherapy.

Findings acknowledge the limited effect of pain conceptualisation on the extent of physiotherapy treatment improvements. They inform clinical decision-making and may encourage physiotherapists to integrate other therapeutic strategies besides over-relying on patient pain science education as the primary intervention alongside physiotherapy.

The doctoral dissertation research contributes to the growing body of knowledge by clarifying the role of pain conceptualisation in CNSLBP treatment outcomes and suggesting that a singular focus on this aspect may need to be revised. It provides empirical support for inherence in considering multiple influencing factors and mechanisms in physiotherapy, such as psychosocial aspects, neuroplasticity, patient expectations, treatment credibility, and therapeutic alliance, aligning with the principles of evidence-based medicine.

The findings also shed light on the relationship between educational attainment and pain conceptualisation, suggesting that higher education levels are associated with better pain understanding and, hence, with overall patient outcomes. This identifies educational attainment as a potential factor in pain management and patient education strategies.

The dissertation emphasises future research to explore other mechanisms influencing physiotherapy outcomes beyond pain conceptualisation as a prerequisite; therefore, it calls for translational research that integrates various scientific disciplines to optimise patient care and healthcare sustainability. In addition, employing the COPI-Adult inventory provides researchers with a reliable and stable measure of pain conceptualisation in Croatian, particularly suitable for individuals without formal pain science education.

4 CONCLUSION

According to the findings of this doctoral dissertation research, baseline pain conceptualisation may significantly relate to overall pain, disability, and health-related quality of life outcomes in patients with chronic nonspecific low back pain following physiotherapy.

This doctoral dissertation research reveals that lower baseline pain conceptualisation is not associated with less pain reduction, less disability reduction, or less improvement in health-related quality of life outcomes following physiotherapy.

The conceptualisation of pain differs significantly between educational attainments, with the lower-educated patients showing lower pain conceptualisation than their higher-educated counterparts.

Therefore, although baseline pain conceptualisation may relate to overall pain, disability, and health-related quality of life outcomes in chronic nonspecific low back pain patients following physiotherapy, it does not influence the extent or amount of improvement in these outcomes. The research found no evidence that baseline pain conceptualisation had significant effects on the magnitude of change in pain, disability, or HRQoL. This suggests that while pain conceptualisation is associated with overall outcomes of pain, disability and HRQoL, it does not influence the degree of improvement following treatment.

The research findings are valid and may apply to other entities of chronic musculoskeletal pain. They provide empirical support in clinical decision-making and neglected educational endpoints and health. Future research should utilise translational research to explore other mechanisms which, in coexistence with pain conceptualisation, may impact how patients respond to physiotherapy treatment.

5 LIST OF LITERATURE AND SOURCES

1. Akeda, Koji, Norihiko Takegami, Junichi Yamada, Tatsuhiko Fujiwara, Akinobu Nishimura, and Akihiro Sudo. 2021. “Central sensitization in chronic low back pain: A population-based study of a Japanese mountain village.” *Journal of Pain Research* 14: 1271–1280. doi:10.2147/JPR.S301924.
2. Alfalogy, Enas, Sahar Mahfouz, Samah Elmedany, Nahla Hariri, and Salah Fallatah. 2023. “Chronic low back pain: Prevalence, impact on quality of life, and predictors of future disability.” *Cureus* 15 (9). doi:10.7759/cureus.45760.
3. Alhowimel, Ahmed, Mazyad Al Otaibi, Kathryn Radford, and Neil Coulson. 2018. “Psychosocial factors associated with change in pain and disability outcomes in chronic low back pain patients treated by physiotherapist: A systematic review.” *SAGE Open Medicine* 6. doi:10.1177/2050312118757387.
4. Alyousef, Bothaina, Flavia M Cicuttini, Susan R Davis, Robin Bell, Roslin Botlero, and Donna M Urquhart. 2018. “Negative beliefs about back pain are associated with persistent, high levels of low back disability in community-based women.” *Menopause* 25 (9): 977–984. doi:10.1097/GME.0000000000001145.
5. American Psychological Association. *APA Dictionary of Psychology: Delta*. Accessed June 25, 2024. https://dictionary.apa.org/delta.
6. Ampiah, Josephine Ahenkorah, Fiona Moffatt, Claire Diver, and Paapa Kwesi Ampiah. 2022. “Understanding how patients’ pain beliefs influence chronic low back pain management in Ghana: a grounded theory approach.” *BMJ Open* 12 (12): e061062. doi:10.1136/bmjopen-2022-061062.
7. Amundson, Ron. 2005. “Disability, ideology, and quality of life: A bias in biomedical ethics.” In *Quality of Life and Human Difference,* edited by David Wasserman, Jerome Bickenbach and Robert Wachbroit, 101–124. Cambridge: Cambridge University Press.
8. Arribas-Romano, Alberto, Josué Fernández-Carnero, Francisco Molina-Rueda, Santiago Angulo-Diaz-Parreño, and Marcos José Navarro-Santana. 2020. “Efficacy of physical therapy on nociceptive pain processing alterations in patients with chronic musculoskeletal pain: A systematic review and meta-analysis.” *Pain Medicine* 21 (10): 2502–2517. doi:10.1093/pm/pnz366.
9. Arslan, Janan, and Kurt Benke. 2023. “Statistical analysis of ceiling and floor effects in medical trials.” *Applied Biosciences* 2 (4): 668–681. doi:10.3390/applbiosci2040042.
10. Artus, Majid, Paul Campbell, Christian D Mallen, Kate M Dunn, and Danielle A W van der Windt. 2017. “Generic prognostic factors for musculoskeletal pain in primary care: A systematic review.” *BMJ Open* 7 (1): e012901. doi:10.1136/bmjopen-2016-012901.
11. Asmundson, Gordon J. G., Lydia Gómez, and Ashley Richter. “The Psychology of Pain: Models and Targets for Comprehensive Assessment.” In *Pain: A Textbook for Health Professions*, 2nd ed., edited by Hubert van Griensven, Jenny Strong, and Anita

Unruh, 35–48. Elsevier Ltd, 2014. https://www.researchgate.net/publication/51986644.

12. Awwad, Waleed, and Abdullah Altowim. 2017. "Knowledge around back pain and spinal disorders among Saudi patients: A cross-sectional study." *Journal of the Pakistan Medical Association* 67 (8): 1228-1231.
13. Bailly, Florian, Anne Priscille Trouvin, Sandrine Bercier, Sabrina Dadoun, Jean Philippe Deneuville, Rogatien Faguer, Jean Baptiste Fassier, et al. 2021. "Clinical guidelines and care pathway for management of low back pain with or without radicular pain." *Joint Bone Spine* 88 (6): 105227. doi:10.1016/j.jbspin.2021.105227.
14. Baird, Andrew, and David Sheffield. 2016. "The relationship between pain beliefs and physical and mental health outcome measures in chronic low back pain: direct and indirect effects." *Healthcare* 4 (3): 58. doi:10.3390/healthcare4030058.
15. Balagué, Federico, Anne F Mannion, Ferran Pellisé, and Christine Cedraschi. 2012. "Non-specific low back pain." *The Lancet* 379 (9814): 482–491. doi:10.1016/S0140-6736(11)60610-7.
16. Barbari, Valerio, Lorenzo Storari, Aldo Ciuro, and Marco Testa. 2020. "Effectiveness of communicative and educative strategies in chronic low back pain patients: A systematic review." *Patient Education and Counseling* 103 (5): 908–929. doi:10.1016/j.pec.2019.11.031.
17. Bardin, Lynn D, Peter King, and Chris G Maher. 2017. "Diagnostic triage for low back pain: A practical approach for primary care." *Medical Journal of Australia* 206 (6): 268–273. doi:10.5694/mja16.00828.
18. Baron, Ralph, Allan Binder, Nadine Attal, Roberto Casale, Anthony H Dickenson, and Rolf Detlef Treede. 2016. "Neuropathic low back pain in clinical practice." *European Journal of Pain* 20 (6): 861–873. doi:10.1002/ejp.838.
19. Baroni, Marina P, Luiz Hespanhol, Gisela C Miyamoto, Christiane R Daniel, Lívia G Fernandes, Felipe JJ dos Reis, Joshua W Pate, and Bruno T Saragiotto. 2023. "Implementation of an online pain science education for chronic musculoskeletal pain in Brazilian public health system: Protocol for a hybrid type iii randomised controlled trial with economic evaluation." *BMC Musculoskeletal Disorders* 24 (1): 1–16. doi: 10.1186/s12891-023-06360-7.
20. Bendelow, Gillian. 2013. "Medicine and society: chronic pain patients and the biomedical model of pain." *American Medical Association Journal of Ethics* 15 (5): 455–459. https://journalofethics.ama-assn.org/sites/joedb/files/2018-05/msoc1-1305.pdf.
21. Bento, Thiago Paulo Frascareli, Caio Vitor dos Santos Genebra, Nicoly Machado Maciel, Guilherme Porfírio Cornelio, Sandra Fiorelli Almeida Penteado Simeão, and Alberto de Vitta. 2020. "Low back pain and some associated factors: is there any difference between genders?" *Brazilian Journal of Physical Therapy* 24 (1): 79–87. doi:10.1016/j.bjpt.2019.01.012.
22. Besen, Elyssa, Amanda E Young, and William S Shaw. 2015. "Returning to work following low back pain: Towards a model of individual psychosocial factors."

Journal of Occupational Rehabilitation 25 (1): 25-37. doi:10.1007/s10926-014-9522-9.

23. Bevers, Kelley, Lynette Fausett Watts, and Robert Gatchel. 2016. “The biopsychosocial model of the assessment, prevention, and treatment of chronic pain.” *US Neurology* 12 (2): 98–104. doi:10.17925/USN.2016.12.02.98.
24. Bid, D Dibyendunarayan, C Neela Soni, S Abhishek Yadav, and V Priyanshu Rathod. 2017. “A study on central sensitization in chronic non-specific low back pain.” *Indian Journal of Physiotherapy and Occupational Therapy - An International Journal* 11 (4): 165-175. doi:10.5958/0973-5674.2017.00140.X.
25. Bjorn, Mette MS, Connie Brendstrup, Sven Karlsen, and Jan Erik Carlsen. 1998. “Consecutive screening and enrollment in clinical trials: the way to representative patient samples?” *Journal of Cardiac Failure* 4 (3): 225–230. doi:10.1016/S1071-9164(98)80009-2.
26. Blaha, Leslie M, Mitchell Abrams, Sarah A Bibyk, Claire Bonial, Beth M Hartzler, Christopher D Hsu, Sangeet Khemlani, et al. 2022. “Understanding is a process.” *Frontiers in Systems Neuroscience* 16: 800280. doi: 10.3389/fnsys.2022.800280.
27. Bonatesta, Lorenzo, Juan D Ruiz-Cárdenas, Luis Fernández-Azorín, and Juan J Rodríguez-Juan. 2022. “Pain science education plus exercise therapy in chronic nonspecific spinal pain: A systematic review and meta-analyses of randomized clinical trials.” *The Journal of Pain* 23 (4): 535–546. doi:10.1016/j.jpain.2021.09.006.
28. Breivik, Harald, Elon Eisenberg, and Tony O’Brien. 2013. “The individual and societal burden of chronic pain in Europe: The case for strategic prioritisation and action to improve knowledge and availability of appropriate care.” *BMC Public Health* 13 (1). doi:10.1186/1471-2458-13-1229.
29. Briggs, Andrew M, Joanne E Jordan, Rachelle Buchbinder, Angus F Burnett, Peter B O’Sullivan, Jason YY Chua, Richard H Osborne, and Leon M Straker. 2010. “Health literacy and beliefs among a community cohort with and without chronic low back pain.” *Pain* 150 (2): 275–283. doi:10.1016/j.pain.2010.04.031.
30. Brydges, Christopher R. 2019. “Effect size guidelines, sample size calculations, and statistical power in gerontology.” *Innovation in Aging* 3 (4). doi:10.1093/geroni/igz036.
31. Bujang, Mohamad Adam, and Fatin Ellisya Sapri. 2018. “An application of the runs test to test for randomness of observations obtained from a clinical survey in an ordered population.” *The Malaysian Journal of Medical Sciences* 25 (4): 146–151. doi:10.21315/mjms2018.25.4.15.
32. Bunzli, Samantha, Anne Smith, Robert Schütze, Ivan Lin, and Peter O’Sullivan. 2017. “Making sense of low back pain and pain-related fear.” *Journal of Orthopaedic and Sports Physical Therapy* 47 (9): 628–636. doi: 10.2519/jospt.2017.7434.
33. Burns, Patricia B., Rod J. Rohrich, and Kevin C. Chung. 2011. “The levels of evidence and their role in evidence-based medicine.” *Plastic and Reconstructive Surgery* 128 (1): 305–310. doi: 10.1097/PRS.0b013e318219c171.
34. Butler, David, and Lorimer Moseley. 2013. *Explain pain second edition*. Adelaide City West: Noigroup Publications.

35. Caneiro, J. P., Samantha Bunzli, and Peter O'Sullivan. 2021. "Beliefs about the body and pain: The critical role in musculoskeletal pain management." *Brazilian Journal of Physical Therapy* 25 (1): 17–29. doi:10.1016/j.bjpt.2020.06.003.
36. Caneiro, J.P, Samantha Bunzli, Peter O'Sullivan, J Caneiro, S Bunzli, and P O'Sullivan. 2021. "Beliefs about the body and pain: the critical role in musculoskeletal pain management." *Brazilian Journal of Physical Therapy* 25: 17–29. doi:10.1016/j.bjpt.2020.06.003.
37. Carnago, Lisa, Amy O'Regan, and Jaime M. Hughes. 2021. "diagnosing and treating chronic pain: Are we doing this right?" *Journal of Primary Care and Community Health* 12. doi:10.1177/21501327211008055.
38. Casiano, Vincent E, Gurpreet Sarwan, Alexander M Dydyk, and Matthew Varacallo. 2023. "Back pain." *StatPearls*. Accessed December 6, 2023. https://www.ncbi.nlm.nih.gov/books/NBK538173/.
39. Celjak, Draženko, Ivana Dorotić Malič, Marta Matijević, Ljiljana Poljak, Kristina Posavec, and Ivana Turk. 2020. *How to Manage Research Data*. Zagreb: SRCE. https://repozitorij.srce.unizg.hr/islandora/object/srce%3A327/datastream/FILE0/view.
40. Chen, Jun. 2011. "History of pain theories." *Neuroscience Bulletin* 27 (5): 343–350. doi:10.1007/s12264-011-0139-0.
41. Chen, Ying, Paul Campbell, Victoria Y Strauss, Nadine E Foster, Kelvin P Jordan, and Kate M Dunn. 2018. "Trajectories and predictors of the long-term course of low back pain: Cohort study with 5-year follow-up." *Pain* 159 (2): 252–260. doi:10.1097/j.pain.0000000000001097.
42. Chiarotto, Alessandro, Maarten Boers, Richard A Deyo, Rachelle Buchbinder, Terry P Corbin, Leonardo O P Costa, Nadine E Foster, et al. 2018. "Core outcome measurement instruments for clinical trials in nonspecific low back pain." *Pain* 159 (3): 481–495. doi:10.1097/j.pain.0000000000001117.
43. Chiarotto, Alessandro, and Bart W Koes. 2022. "Nonspecific low back pain." *New England Journal of Medicine* 386 (18): 1732–1740. doi: 10.1056/NEJMcp2032396.
44. Chicco, Davide, Matthijs J. Warrens, and Giuseppe Jurman. 2021. "The coefficient of determination r-squared is more informative than SMAPE, MAE, MAPE, MSE and RMSE in regression analysis evaluation." *PeerJ Computer Science* 7: 1–24. doi: 10.7717/peerj-cs.623.
45. Childs, John D, Sara R Piva, and Julie M Fritz. 2005. "Responsiveness of the Numeric Pain Rating Scale in patients with low back pain." *Spine* 30 (11): 1331–1334. doi:10.1097/01.brs.0000164099.92112.29.
46. Chou, Roger. "Patient education: low back pain in adults (beyond the basics)." *UpToDate*. Accessed December 6, 2023. https://www.uptodate.com/contents/low-back-pain-in-adults-beyond-the-basics.
47. Chou, Roger, Pierre Côté, Kristi Randhawa, Paola Torres, Hainan Yu, Margareta Nordin, Eric L Hurwitz, Scott Haldeman, and Christine Cedraschi. 2018. "The global spine care initiative: Applying evidence-based guidelines on the non-invasive

management of back and neck pain to low- and middle-income communities.” *European Spine Journal* 27 (6): 851–860. doi:10.1007/S00586-017-5433-8.

48. Chow, Natalie L.Y., Natalie Tateishi, Alexa Goldhar, Rabia Zaheer, Donald A. Redelmeier, Amy H. Cheung, Ayal Schaffer, and Mark Sinyor. 2023. “Original research: Does knowledge have a half-life? An observational study analyzing the use of older citations in medical and scientific publications.” *BMJ Open* 13 (5): 72374. doi:10.1136/bmjopen-2023-072374.
49. Christe, Guillaume, Valentina Pizzolato, Meghann Meyer, Jessica Nzamba, and Claude Pichonnaz. 2021. “Unhelpful beliefs and attitudes about low back pain in the general population: A cross-sectional survey.” *Musculoskeletal Science & Practice* 52. doi:10.1016/j.msksp.2021.102342.
50. Cieza, Alarcos, Kate Causey, Kaloyan Kamenov, Sarah Wulf Hanson, Somnath Chatterji, and Theo Vos. 2020. “Global estimates of the need for rehabilitation based on the global burden of disease study 2019: A systematic analysis for the global burden of disease study 2019.” *The Lancet* 396 (10267): 2006–2017. doi:10.1016/S0140-6736(20)32340-0.
51. Connors, Michael H, and Peter W Halligan. 2014. “A cognitive account of belief: a tentative road map.” *Frontiers in Psychology* 5. doi:10.3389/fpsyg.2014.01588.
52. Craig, Kenneth D, and Nicole E MacKenzie. 2021. “What is pain: are cognitive and social features core components?” *Paediatric & Neonatal Pain* 3 (3): 106–118. doi:10.1002/pne2.12046.
53. Croft, Peter, Douglas G Altman, Jonathan J Deeks, Kate M Dunn, Alastair D Hay, Harry Hemingway, Linda LeResche, et al. 2015. “The science of clinical practice: disease diagnosis or patient prognosis? Evidence about ‘what is likely to happen’ should shape clinical practice.” *BMC Medicine* 13 (1). doi:10.1186/S12916-014-0265-4.
54. Cuenca-Martínez, Ferran, Luis Suso-Martí, Joaquín Calatayud, Francisco José Ferrer-Sargues, Vicente Muñoz-Alarcos, Patricio Alba-Quesada, and Gemma Biviá-Roig. 2023. “Pain neuroscience education in patients with chronic musculoskeletal pain: an umbrella review.” *Frontiers in Neuroscience* 17. doi: 10.3389/fnins.2023.1272068.
55. Curtis, Elizabeth A, Catherine Comiskey, and Orla Dempsey. 2016. “Importance and Use of Correlational Research.” *Nurse Researcher* 23 (6): 20–25. doi:10.7748/nr.2016.e1382.
56. Cuschieri, Sarah. 2019. “The STROBE Guidelines.” *Saudi Journal of Anaesthesia* 13: S31–S34. doi: 10.4103/sja.SJA_543_18.
57. Dahmani, Doha, Fatima Zahrae Taik, Imane Berrichi, Maryam Fourtassi, and Fatima Ezzahra Abourazzak. 2023. “Impact of central sensitization on pain, disability and psychological distress in patients with knee osteoarthritis and chronic low back pain.” *BMC Musculoskeletal Disorders* 24 (1): 1–9. doi: 10.1186/s12891-023-07019-z.
58. Darlow, Be, Brona M. Fullen, Sarah Dean, DA Hurley, David G Baxter, and Anthony Dowell. 2012. “The association between health care professional attitudes and beliefs and the attitudes and beliefs, clinical management, and outcomes of patients with low

back pain: A Systematic review." *European Journal of Pain* 16 (1): 3–17. doi:10.1016/j.ejpain.2011.06.006.

59. Darlow, Ben, Anthony Dowell, David G Baxter, Fiona Mathieson, Meredith Perry, and Sarah Dean. 2013. "Annals journal club: the enduring impact of what clinicians say to people with low back pain." *Annals of Family Medicine* 11 (6): 527–534. doi:10.1370/afm.1518.
60. Darlow, Ben, Meredith Perry, James Stanley, Fiona Mathieson, Markus Melloh, G David Baxter, and Anthony Dowell. 2014. "Cross-sectional survey of attitudes and beliefs about back pain in New Zealand." *BMJ Open* 4 (5): e004725. doi:10.1136/bmjopen-2013-004725.
61. Deyo, Richard A, and Sohail K Mirza. 2016. "Herniated Lumbar Intervertebral Disk." *New England Journal of Medicine* 374 (18): 1763–1772. doi: 10.1056/NEJMcp1512658.
62. Driscoll, Timothy, Gemma Jacklyn, Jessica Orchard, Erin Passmore, Theo Vos, Garry Freedman, Stephen Lim, and Laura Punnett. 2014. "The global burden of occupationally related low back pain: estimates from the global burden of disease 2010 study." *Annals of the Rheumatic Diseases* 73 (6): 975–981. doi:10.1136/annrheumdis-2013-204631.
63. Edward, Jean, Leah Yacat Carreon, Mark V Williams, Steven Glassman, and Jing Li. 2018. "The importance and impact of patients' health literacy on low back pain management: a systematic review of literature." *The Spine Journal* 18 (2): 370–376. doi: 10.1016/j.spinee.2017.09.005.
64. Edwards, Mark J, Rick A Adams, Harriet Brown, Isabel Pareés, and Karl J Friston. 2012. "A Bayesian Account of 'Hysteria.'" *Brain* 135 (11): 3495–3512. doi:10.1093/brain/aws129.
65. European Parliament, and Council of the European Union. 2016. "Regulation (EU) 2016/679 of The European Parliament and of the Council of 27 April 2016 on the Protection of Natural Persons with Regard to the Processing of Personal Data and on the Free Movement of Such Data, and Repealing Directive 95/46/EC (General Data Protection Regulation)". *Official Journal of the European Union* L 119/1. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32016R0679.
66. EuroQol Group. 2009. "Digital Demo Versions – EQ-5D-5L." https://euroqol.org/eq-5d-instruments/sample-demo/.
67. EuroQol Group. 2019. "EQ-5D User Guides – EQ-5D." https://euroqol.org/publications/user-guides/.
68. Feitosa, Aloma SA, Jaqueline Barros Lopes, Eloisa Bonfa, and Ari SR Halpern. 2016. "A prospective study predicting the outcome of chronic low back pain and physical therapy: the role of fear-avoidance beliefs and extraspinal pain." *Revista Brasileira de Reumatologia* 56 (5): 384–390. doi: 10.1016/j.rbre.2016.03.002.
69. Feng, You Shan, Thomas Kohlmann, Mathieu F. Janssen, and Ines Buchholz. 2021. "Psychometric Properties of the EQ-5D-5L: A systematic review of the literature." *Quality of Life Research* 30 (3): 647–673. doi: 10.1007/s11136-020-02688-y.

70. Ferlito, Rosario, Chiara Blatti, Ludovico Lucenti, Umberto Boscarino, Marco Sapienza, Vito Pavone, and Gianluca Testa. 2022. "Pain education in the management of patients with chronic low back pain: a systematic review." *Journal of Functional Morphology and Kinesiology* 7 (4): 74. doi:10.3390/jfmk7040074.
71. Ferreira, Paula S, Leticia A Corrêa, Juliana V Bittencourt, Felipe JJ Reis, Ney Meziat-Filho, and Leandro AC Nogueira. 2019. "Patients with chronic musculoskeletal pain present low level of the knowledge about the neurophysiology of pain." *European Journal of Physiotherapy* 23 (4): 203–208. doi:10.1080/21679169.2019.1676307.
72. Fitzcharles, Mary Ann, Steven P Cohen, Daniel J Clauw, Geoffrey Littlejohn, Chie Usui, and Winfried Häuser. 2022. "Chronic primary musculoskeletal pain: a new concept of nonstructural regional pain." *Pain Reports* 7 (5). doi:10.1097/PR9.0000000000001024.
73. Fitzpatrick, Joyce J., and Geraldine McCarthy. 2016. "Concept Analysis." In *Nursing Concept Analysis*. New York: Springer Publishing Company. doi:10.1891/9780826126825.0001.
74. Flechner, Lawrence, and Timothy Y. Tseng. 2011. "Understanding results: p-values, confidence intervals, and number need to treat." *Indian Journal of Urology* 27 (4): 532–535. doi:10.4103/0970-1591.91447.
75. Fleckenstein, Johannes, Philipp Floessel, Tilman Engel, Laura Krempel, Josefine Stoll, Martin Behrens, and Daniel Niederer. 2022. "Individualized exercise in chronic non-specific low back pain: a systematic review with meta-analysis on the effects of exercise alone or in combination with psychological interventions on pain and disability." *The Journal of Pain* 23 (11): 1856–1873. doi: 10.1016/j.jpain.2022.07.005.
76. Fletcher, Claire, Lynley Bradnam, and Christopher Barr. 2016. "The relationship between knowledge of pain neurophysiology and fear avoidance in people with chronic pain: a point in time, observational study." *Physiotherapy Theory and Practice* 32 (4): 271–276. doi: 10.3109/09593985.2015.1138010.
77. Fong, Hugo Pak Yiu, Shirley Yue Kwan Choi, Maria Kwan Wa Leung, Hermione Hin Man Lo, Bo Wang, Samuel Yeung Shan Wong, and Regina Wing Shan Sit. 2024. "Determinants of health-related quality of life in older people with chronic musculoskeletal pain: a cross-sectional study." *BMC Geriatrics* 24 (1): 1–8. doi: 10.1186/s12877-024-04669-z.
78. Foster, Nadine E, Johannes R Anema, Dan Cherkin, Roger Chou, Steven P Cohen, Douglas P Gross, Paulo H Ferreira, et al. 2018. "Prevention and treatment of low back pain: evidence, challenges, and promising directions." *Lancet* 391 (10137): 2368–2383. doi:10.1016/S0140-6736(18)30489-6.
79. Furlan, Andrea D, Antti Malmivaara, Roger Chou, Chris G Maher, Rick A Deyo, Mark Schoene, Gert Bronfort, and Maurits W Van Tulder. 2015. "2015 Updated method guideline for systematic reviews in the cochrane back and neck group." *Spine* 40 (21): 1660–1673. doi:10.1097/BRS.0000000000001061.
80. Gallagher, Laura, James McAuley, and Lorimer Moseley. 2013. "A randomized-controlled trial of using a book of metaphors to reconceptualize pain and decrease

catastrophizing in people with chronic pain." *Clinical Journal of Pain* 29 (1): 20–25. doi:10.1097/AJP.0b013e3182465cf7.

81. Garratt, Andrew M, Håvard Furunes, Christian Hellum, Tore K Solberg, Jens Ivar Brox, Kjersti Storheim, and Lars Gunnar Johnsen. 2021. "Evaluation of the EQ-5D-3L and 5L versions in low back pain patients." *Health and Quality of Life Outcomes* 19 (1): 1–9. doi:doi.org/10.1186/s12955-021-01792-y.
82. George, Steven Z, Julie M Fritz, Sheri P Silfies, Michael J Schneider, Jason M Beneciuk, Trevor A Lentz, MPH R John Gilliam, Stephanie Hendren, and Katherine S Norman. 2021. "Clinical practice guidelines interventions for the management of acute and chronic low back pain: revision 2021." *Journal of Orthopaedic Sports Physiotherapy* 51 (11): 1–60. doi:10.2519/jospt.2021.0304.
83. Grazio, Simeon, Božidar Ćurković, Tonko Vlak, Vanja Bašić Kes, Miroslav Jelić, Danijel Buljan, Zoja Gnjidić, et al. 2012. "Diagnosis and conservative treatment of low back pain: review and guidelines of the croatian vertebrologic society." *Acta Medica Croatica* 66 (4): 259–294.
84. Grøn, Søren, Rikke K Jensen, and Alice Kongsted. 2022. "beliefs about back pain and associations with clinical outcomes: a primary care cohort study." *BMJ Open* 12 (5): e060084. doi:10.1136/bmjopen-2021-060084.
85. Grøn, Søren, Rikke Krüger Jensen, Tue Secher Jensen, and Alice Kongsted. 2019. "Back beliefs in patients with low back pain: a primary care cohort study." *BMC Musculoskeletal Disorders* 20 (1): 1–12. doi:10.1186/s12891-019-2925-1.
86. Hackenberger, Branimir K. 2019. "bayes or not bayes, is this the question?" *Croatian Medical Journal* 60 (1): 50. doi:10.3325/cmj.2019.60.50.
87. Haefeli, Mathias, and Achim Elfering. 2006. "Pain assessment." *European Spine Journal* 15 (1): S17–S24. doi: 10.1007/s00586-005-1044-x.
88. Hall, Amanda, Danielle Coombs, Helen Richmond, Krystal Bursey, Brad Furlong, Rebecca Lawrence, and Steven J Kamper. 2021. "What do the general public believe about the causes, prognosis and best management strategies for low back pain? A cross-sectional study." *BMC Public Health* 21 (1): 1–7. doi:10.1186/s12889-021-10664-5.
89. Halla, Kim. 2018. "Kant and Fichte on Belief and Knowledge." *Revista de Estud(i)Os Sobre Fichte* 17. doi:10.4000/ref.895.
90. Hancock, M.J, CG Maher, J Latimer, MF Spindler, JH McAuley, M Laslett, and N Bogduk. 2007. "Systematic review of tests to identify the disc, SIJ or facet joint as the source of low back pain." *European Spine Journal* 16 (10): 1539–1550. doi: 10.1007/s00586-007-0391-1.
91. Harte, Steven E, Richard E Harris, and Daniel J Clauw. 2018. "The neurobiology of central sensitization." *Journal of Applied Biobehavioral Research* 23 (2): e12137. doi:10.1111/jabr.12137.
92. Hartvigsen, Jan, Mark J Hancock, Alice Kongsted, Quinette Louw, Manuela L Ferreira, Stéphane Genevay, Damian Hoy, et al. 2018. "What low back pain is and why we need to pay attention." *Lancet* 391 (10137): 2356–2367. doi:10.1016/S0140-6736(18)30480-X.

93. Hayden, Jill A, Jennifer L Cartwright, Richard D Riley, Maurits W vanTulder, Tom Bendix, Melinda Cairns, Francesca Cecchi, et al. 2012. "Exercise therapy for chronic low back pain: protocol for an individual participant data meta-analysis." *Systematic Reviews* 1 (1): 1–10. doi:10.1186/2046-4053-1-64.
94. Hechler, Tanja, Dominik Endres, and Anna Thorwart. 2016. "Why harmless sensations might hurt in individuals with chronic pain: about heightened prediction and perception of pain in the mind." *Frontiers in Psychology* 7: 1638. doi:10.3389/fpsyg.2016.01638.
95. Heitz, Cam, R Hilfiker, LM Bachmann, H Joronen, T Lorenz, D Uebelhart, A Klipstein, and Florian Brunner. 2009. "Comparison of risk factors predicting return to work between patients with subacute and chronic non-specific low back pain: systematic review." *European Spine Journal* 18 (12): 1829–1835. doi:10.1007/s00586-009-1083-9.
96. Hernandez, Gimena, Olatz Garin, Alexandra L. Dima, Angels Pont, Marc Martí Pastor, Jordi Alonso, Eric Van Ganse, et al. 2019. "EuroQol (EQ-5D-5L) validity in assessing the quality of life in adults with asthma: cross-sectional study." *Journal of Medical Internet Research* 21 (1): e10178. doi:10.2196/10178.
97. Hodges, Paul W, Jenny Setchell, Emily Daniel, Matt Fowler, Angela S Lee, John M Popovich, and Jacek Cholewicki. 2022. "How individuals with low back pain conceptualize their condition: a collaborative modeling approach." *Journal of Pain* 23 (6): 1060–1070. doi:10.1016/j.jpain.2021.12.014.
98. Hout, Ben Van, M. F. Janssen, You Shan Feng, Thomas Kohlmann, Jan Busschbach, Dominik Golicki, Andrew Lloyd, Luciana Scalone, Paul Kind, and A. Simon Pickard. 2012. "Interim Scoring for the EQ-5D-5L: Mapping the EQ-5D-5L to EQ-5D-3L Value Sets." *Value in Health : The Journal of the International Society for Pharmacoeconomics and Outcomes Research* 15 (5): 708–715. doi: 10.1016/j.jval.2012.02.008.
99. Huysmans, Eva, Kelly Ickmans, Dries Van Dyck, Jo Nijs, Yori Gidron, Nathalie Roussel, Andrea Polli, Maarten Moens, Lisa Goudman, and Margot De Kooning. 2018. "Association between symptoms of central sensitization and cognitive behavioral factors in people with chronic nonspecific low back pain: a cross-sectional study." *Journal of Manipulative and Physiological Therapeutics* 41 (2): 92–101. doi:10.1016/j.jmpt.2017.08.007.
100. IBM. 2023a. *GLM Profile Plots*. Last modified August 4, 2023. https://www.ibm.com/docs/en/spss-statistics/saas?topic=analysis-glm-profile-plots.
101. IBM. 2023b. *Summarize Statistics*. Last modified August 4, 2023. https://www.ibm.com/docs/en/spss-statistics/saas?topic=summarize-statistics.
102. Iizuka, Yoichi, Haku Iizuka, Tokue Mieda, Daisuke Tsunoda, Tsuyoshi Sasaki, Tsuyoshi Tajika, Atsushi Yamamoto, and Kenji Takagishi. 2017. "Prevalence of chronic nonspecific low back pain and its associated factors among middle-aged and elderly people: an analysis based on data from a musculoskeletal examination in Japan." *Asian Spine Journal* 11 (6): 989–997. doi:10.4184/asj.2017.11.6.989.
103. Iles, Ross A, M Davidson, and NF Taylor. 2008. "Psychosocial predictors of failure to return to work in non-chronic non-specific low back pain: a systematic review."

Occupational and Environmental Medicine 65 (8): 507–517. doi: 10.1136/oem.2007.036046.

104. Institute for Health Metrics and Evaluation. *Croatia*. Accessed 15 April 2023. https://www.healthdata.org/croatia.
105. Járomi, Melinda, Brigitta Szilágyi, Anita Velényi, Eleonóra Leidecker, Bence László Raposa, Márta Hock, Petra Baumann, Pongrác Ács, and Alexandra Makai. 2021. "Assessment of health-related quality of life and patient's knowledge in chronic non-specific low back pain." *BMC Public Health* 21 (1): 1–8. doi: 10.1186/s12889-020-09506-7.
106. Jhangiani, Rajiv S, I-Chant A Chiang, Carrie Cuttler, and Dana C Leighton. 2019. "Correlational Research." In *Research Methods in Psychology,* 4th ed*.,* 148–156. Surrey, Canada: Kwantlen Polytechnic University.
107. Jurinić, Antun, Marija Graberski-Matasović, and Maja Pogorelić. 2002. "Reability of the croatian version of Rolland-Morris Questionnarie in functional evaluation of persons with mechanically caused low-back pain." In *Od Struke Do Profesije*, ed. Antun Jurinić, 87–92. Zagreb: Croatian Society of Physiotherapists.
108. Kamper, Steven J, Christopher G Maher, Robert D Herbert, Mark J Hancock, Julia M Hush, and Robert J Smeets. 2010. "How little pain and disability do patients with low back pain have to experience to feel that they have recovered?" *European Spine Journal* 19 (9): 1495–1501. doi:10.1007/S00586-010-1366-1.
109. Kanaan, Saddam F, Hadeel MK Alissa, Ala'a F Jaber, Khader A Almhdawi, Zaid M Mansour, and Mohammad Alhanada. 2023. "knowledge related to low back pain and its associated factors in patients with low back pain: a cross-sectional study." *Journal of Back and Musculoskeletal Rehabilitation* 36 (1): 217–225. doi:10.3233/BMR-220004.
110. Keen, Sam, Martha Lomeli-Rodriguez, and Amanda C De C Williams. 2021. "Exploring how people with chronic pain understand their pain: a qualitative study." *Scandinavian Journal of Pain* 21 (4): 743–753. doi:10.1515/sjpain-2021-0060.
111. Khera, Tanvi, and Valluvan Rangasamy. 2021. "Cognition and pain: a review." *Frontiers in Psychology* 12: 673962. doi: 10.3389/fpsyg.2021.673962.
112. Kim, Hae Young. 2013. "Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis." *Restorative Dentistry & Endodontics* 38 (1): 52–54. doi:10.5395/rde.2013.38.1.52.
113. Kim, Lily H, Daniel Vail, Tej D Azad, Jason P Bentley, Yi Zhang, Allen L Ho, Paras Fatemi, et al. 2019. "Expenditures and health care utilization among adults with newly diagnosed low back and lower extremity pain." *JAMA Network Open* 2 (5): e193676. doi:10.1001/jamanetworkopen.2019.3676.
114. King, Richard, Victoria Robinson, Helene L Elliott-Button, James A Watson, Cormac G Ryan, and Denis J Martin. 2018. "Pain reconceptualisation after pain neurophysiology education in adults with chronic low back pain: a qualitative study." *Pain Research and Management* 2018. doi:10.1155/2018/3745651.

115. Kluzek, Stefan, Benjamin Dean, and Karolina A. Wartolowska. 2022. “Patient-reported outcome measures (PROMs) as proof of treatment efficacy.” *BMJ Evidence-Based Medicine* 27 (3): 153–155. doi: 10.1136/bmjebm-2020-111573.
116. Knezevic, Nebojsa Nick, Kenneth D Candido, Johan W S Vlaeyen, Jan Van Zundert, and Steven P Cohen. 2021. “Low back pain.” *Lancet* 398 (10294): 78–92. doi:10.1016/S0140-6736(21)00733-9.
117. Koes, B. W., M. W. Van Tulder, and S. Thomas. 2006. “Diagnosis and treatment of low back pain.” *BMJ : British Medical Journal* 332 (7555): 1430–1434. doi:10.1136/BMJ.332.7555.1430.
118. Kongsted, Alice, Peter Kent, Iben Axen, Aron S Downie, and Kate M Dunn. 2016. “What have we learned from ten years of trajectory research in low back pain?” *BMC Musculoskeletal Disorders* 17 (1): 1–11. doi: 10.1186/s12891-016-1071-2.
119. Kucyi, Aaron, and Karen D Davis. 2015. “The dynamic pain connectome.” *Trends in Neurosciences* 38 (2): 86–95. doi:10.1016/j.tins.2014.11.006.
120. Laerd Statistics. *How to perform a mixed ANOVA in SPSS statistics.* Accessed June 27, 2024. https://statistics.laerd.com/spss-tutorials/mixed-anova-using-spss-statistics.php.
121. Lakens, Daniël. 2013. “Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs.” *Frontiers in Psychology* 4: 863. doi: 10.3389/fpsyg.2013.00863.
122. Leake, Hayley, Lorimer Moseley, Tasha Stanton, Edel O’Hagan, and Lauren Heathcote. 2021. “What do patients value learning about pain? A mixed-methods survey on the relevance of target concepts after pain science education.” *Pain* 162 (10): 2558–2568. doi: 10.1097/j.pain.0000000000002244.
123. Leeuw, Maaike, Mariëlle Goossens, Steven Linton, Geert Crombez, Katja Boersma, and Johan Vlaeyen. 2007. “The fear-avoidance model of musculoskeletal pain: current state of scientific evidence.” *Journal of Behavioral Medicine* 30 (1): 77–94. doi: 10.1007/s10865-006-9085-0.
124. Lemieux, James, Vahid Abdollah, Brandyn Powelske, and Greg Kawchuk. 2020. “Comparing the effectiveness of group-based exercise to other non-pharmacological interventions for chronic low back pain: a systematic review.” *PLoS ONE* 15 (12). doi:10.1371/journal.pone.0244588.
125. Lepri, Beatrice, Daniele Romani, Lorenzo Storari, and Valerio Barbari. 2023. “Effectiveness of pain neuroscience education in patients with chronic musculoskeletal pain and central sensitization: a systematic review.” *International Journal of Environmental Research and Public Health* 20 (5). doi:10.3390/ijerph20054098.
126. Lim, Yuan Z., Louisa Chou, Rebecca TM Au, KL Maheeka D. Seneviwickrama, Flavia M. Cicuttini, Andrew M. Briggs, Kaye Sullivan, Donna M. Urquhart, and Anita E. Wluka. 2019. “People with low back pain want clear, consistent and personalised information on prognosis, treatment options and self-management strategies: a systematic review.” *Journal of Physiotherapy* 65 (3): 124–135. doi: 10.1016/j.jphys.2019.05.010.

127. Lin, Ivan, Louise Wiles, Rob Waller, Roger Goucke, Yusuf Nagree, Michael Gibberd, Leon Straker, Chris G Maher, and Peter PB O'Sullivan. 2020. "What does best practice care for musculoskeletal pain look like? Eleven consistent recommendations from high-quality clinical practice guidelines: systematic review." *British Journal of Sports Medicine* 54 (2): 79−86. doi:10.1136/bjsports-2018-099878.
128. Linton, Steven. 2005. "Models of Pain Perception." In *Understanding pain for better clinical practice*, 1st ed., 16:9–18. Elsevier.
129. Linton, Steven, and William Shaw. 2011. "Impact of psychological factors in the experience of pain." *Physical Therapy* 91 (5): 700–711. doi:10.2522/ptj.20100330.
130. Louw, Adriaan, Kevin Farrell, Breanna Choffin, Brooke Foster, Grace Lunde, Michelle Snodgrass, Robert Sweet, Matthew Weitzel, Rebecca Wilder, and Emilio J Puentedura. 2019. "Immediate effect of pain neuroscience education for recent onset low back pain: an exploratory single arm trial." *The Journal of Manual & Manipulative Therapy* 27 (5): 267–276. doi:10.1080/10669817.2019.1624006.
131. Louw, Adriaan, Emilio J Puentedura, Ina Diener, Kory J Zimney, and Terry Cox. 2019. "Pain neuroscience education: which pain neuroscience education metaphor worked best?" *South African Journal of Physiotherapy* 75 (1): a1329. doi:10.4102/sajp.v75i1.1329.
132. Louw, Adriaan, Kory Zimney, Emilio J Puentedura, and Ina Diener. 2016. "The efficacy of pain neuroscience education on musculoskeletal pain: a systematic review of the literature." *Physiotherapy Theory and Practice* 32 (5): 332–355. doi:10.1080/09593985.2016.1194646.
133. Lubkowska, Wioletta, and Justyna Krzepota. 2019. "Quality of life and health behaviours of patients with low back pain." *Physical Activity Review* 7: 182–192. doi:10.16926/par.2019.07.22.
134. Luque-Suarez, Alejandro, Javier Martinez-Calderon, and Deborah Falla. 2019. "role of kinesiophobia on pain, disability and quality of life in people suffering from chronic musculoskeletal pain: a systematic review." *British Journal of Sports Medicine* 53: 554–559. doi:10.1136/bjsports-2017-098673.
135. Ma, Xiaopeng, Ruohan Chen, Wei Li, and Peng Huang. 2023. "A systematic review and meta-analysis of pain neuroscience education for chronic low back pain: short-term outcomes of pain and disability." *Physiotherapy Theory and Practice*. Advance online publication. doi:10.1080/09593985.2023.2232003.
136. Macedo, Luciana Gazzi, Chris G Maher, Jane Latimer, Mark J Hancock, Luciana AC Machado, and James H McAuley. 2011. "Responsiveness of the 24-, 18- and 11-Item versions of the Roland Morris Disability Questionnaire." *European Spine Journal* 20 (3): 458-463. doi:10.1007/S00586-010-1608-2.
137. Maciel, Simone Carazzato, Fabio Jennings, Anamaria Jones, and Jamil Natour. 2009. "The development and validation of a low back pain knowledge questionnaire – LKQ." *Clinics* 64 (12): 1167–1175. doi:10.1590/S1807-59322009001200006.
138. MacNeela, Padraig, Catherine Doyle, David O'Gorman, Nancy Ruane, and Brian E McGuire. 2015. "Experiences of chronic low back pain: a meta-ethnography of qualitative research." *Health Psychology Review* 9 (1): 63–82. doi:10.1080/17437199.2013.840951.

139. Maher, Chris, Martin Underwood, and Rachelle Buchbinder. 2017. "Non-specific low back pain." *Lancet* 389 (10070): 736–747. doi:10.1016/S0140-6736(16)30970-9.
140. Maixner, William, Roger B Fillingim, David A Williams, Shad B Smith, and Gary D Slade. 2016. "Overlapping Chronic Pain Conditions: Implications for Diagnosis and Classification." *The Journal of Pain* 17 (9): 93–107. doi:10.1016/j.jpain.2016.06.002.
141. Malfliet, Anneleen, Laurence Leysen, Roselien Pas, Kevin Kuppens, Jo Nijs, Paul Van Wilgen, Eva Huysmans, Lisa Goudman, and Kelly Ickmans. 2017. "Modern pain neuroscience in clinical practice: applied to post-cancer, paediatric and sports-related pain." *Brazilian Journal of Physical Therapy* 21 (4): 225–232. doi:10.1016/j.bjpt.2017.05.009.
142. Malik, Khalid M, Ariana M. Nelson, Ting-Hsuan Chiang, Farnad Imani, and Seyed-Hossein Khademi. 2022. "The specifics of non-specific low back pain: re-evaluating the current paradigm to improve patient outcomes." *Anesthesiology and Pain Medicine* 12 (4): 131499. doi:10.5812/aapm-131499.
143. Marini, Mirca, Benedetta Bendinelli, Melania Assedi, Daniela Occhini, Maria Castaldo, Jacopo Fabiano, Marco Petranelli, Mario Migliolo, Marco Monaci, and Giovanna Masala. 2017. "Low back pain in healthy postmenopausal women and the effect of physical activity: a secondary analysis in a randomized trial." *PLOS ONE* 12 (5): e0177370. doi:10.1371/journal.pone.0177370.
144. Martinez-Calderon, Javier, Mar Flores-Cortes, Jose Miguel Morales-Asencio, and Alejandro Luque-Suarez. 2020. "Which psychological factors are involved in the onset and/or persistence of musculoskeletal pain? An umbrella review of systematic reviews and meta-analyses of prospective cohort studies." *Clinical Journal of Pain* 36 (8): 626–637. doi:10.1097/AJP.0000000000000838.
145. Martinez-Calderon, Javier, Emma Kwan Yee Ho, Paulo Henrique Ferreira, Cristina Garcia-Muñoz, Olga Villar-Alises, and Javier Matias-Soto. 2023. "A call for improving research on pain neuroscience education and chronic pain: an overview of systematic reviews." *Journal of Orthopedic & Sports Physical Therapy* 53 (6): 353–368. doi: 10.2519/jospt.2023.11833.
146. Matarán-Peñarrocha, Guillermo A, Inmaculada Carmen Lara Palomo, Eduardo Antequera Soler, Esther Gil-Martínez, Manuel Fernández-Sánchez, María Encarnación Aguilar-Ferrándiz, and Adelaida María Castro-Sánchez. 2020. "Comparison of efficacy of a supervised versus non-supervised physical therapy exercise program on the pain, functionality and quality of life of patients with non-specific chronic low-back pain: a randomized controlled trial." *Clinical Rehabilitation* 34 (7): 948–959. doi:10.1177/0269215520927076.
147. Mathews, Lulu. 2011. "Pain in children: neglected, unaddressed and mismanaged." *Indian Journal of Palliative Care* 17: S70–S73. doi:10.4103/0973-1075.76247.
148. Mattiuzzi, Camilla, Giuseppe Lippi, and Chiara Bovo. 2020. "Current epidemiology of low back pain." *Journal of Hospital Management and Health Policy* 4: 15–15. doi: 10.21037/jhmhp-20-17.
149. Meeus, Mira, Jo Nijs, Jessica Van Oosterwijck, Veerle Van Alsenoy, and Steven Truijen. 2010. "Pain physiology education improves pain beliefs in patients with chronic fatigue syndrome compared with pacing and self-management education: a

double-blind randomized controlled trial." *Archives of Physical Medicine and Rehabilitation* 91 (8): 1153–1159. doi:10.1016/j.apmr.2010.04.020.

150. Mehić, Bakir. 2011. "Translational research in medicine." *Bosnian Journal of Basic Medical Sciences* 11 (2): 73. doi:10.17305/bjbms.2011.2583.
151. Meints, Samantha M, and Robert R Edwards. 2018. "Evaluating psychosocial contributions to chronic pain outcomes." *Progress in Neuro-Psychopharmacology & Biological Psychiatry* 87 (B): 168–182. doi:10.1016/j.pnpbp.2018.01.017.
152. Meldrum, Marcia L. 2003. "A capsule history of pain management." *JAMA*, 290: 2470–2475. doi:10.1001/jama.290.18.2470.
153. Melzack, Ronald, and Patrick D Wall. 1965. "Pain Mechanisms: A New Theory: A gate control system modulates sensory input from the skin before it evokes pain perception and response." *Science* 150: 971–979.
154. Menezes Costa, Luciolada Da C, Christopher G Maher, Mark J Hancock, James H McAuley, Robert D Herbert, and Leonardo OP Costa. 2012. "The prognosis of acute and persistent low-back pain: a meta-analysis." *CMAJ : Canadian Medical Association Journal* 184 (11): E613–E624. doi:10.1503/cmaj.111271.
155. Mengshoel, Anne Marit, Wenche Schrøder Bjorbækmo, Merja Sallinen, and Astrid Klopstad Wahl. 2021. " 'It takes time, but recovering makes it worthwhile'- a qualitative study of long-term users' experiences of physiotherapy in primary health care." *Physiotherapy Theory and Practice* 37 (1): 6–16. doi:10.1080/09593985.2019.1616343.
156. Mescouto, Karime, Rebecca E Olson, Paul W Hodges, and Jenny Setchell. 2022. "A critical review of the biopsychosocial model of low back pain care: time for a new approach?" *Disability and Rehabilitation* 44 (13): 3270–3284. doi:10.1080/09638288.2020.1851783.
157. Meucci, Rodrigo Dalke, Anaclaudia Gastal Fassa, and Neice Muller Xavier Faria. 2015. "Prevalence of Chronic Low Back Pain: Systematic Review." *Revista de Saúde Pública* 49: 73. doi:10.1590/S0034-8910.2015049005874.
158. Minitab Blog Editor. *Regression analysis: how do i interpret r-squared and assess the goodness-of-fit*? May 30, 2013. https://blog.minitab.com/en/adventures-in-statistics-2/regression-analysis-how-do-i-interpret-r-squared-and-assess-the-goodness-of-fit.
159. Min-Sun, Kim, Park Chan-Jeoung, Namgoong Seung, Kim Seung-Il, Cho Young-Uk, and Jang Seongsoo. 2023. "effective and practical complete blood count delta check method and criteria for the quality control of automated hematology analyzers." *Annals of Laboratory Medicine* 43 (5): 418–424. doi:10.3343/alm.2023.43.5.418.
160. Mishra, Prabhaker, Chandra M. Pandey, Uttam Singh, Anshul Gupta, Chinmoy Sahu, and Amit Keshri. 2019. "descriptive statistics and normality tests for statistical data." *Annals of Cardiac Anaesthesia* 22 (1): 67–72. doi:10.4103/ACA.ACA_157_18.
161. Moayedi, Massieh, and Karen D Davis. 2013. "Theories of pain: from specificity to gate control." *Journal of Neurophysiology* 109 (1): 5–12. doi:10.1152/jn.00457.2012.
162. Mohamed Mohamed, Walid Jumma, Leonard Joseph, Guy Canby, Aatit Paungmali, Patraporn Sitilertpisan, and Ubon Pirunsan. 2020. "Are patient expectations associated with treatment outcomes in individuals with chronic low back pain? A systematic

review of randomised controlled trials." *International Journal of Clinical Practice* 74 (11): e13680. doi:10.1111/ijcp.13680.

163. Moseley, Lorimer. 2003. "Unraveling the barriers to reconceptualization of the problem in chronic pain: the actual and perceived ability of patients and health professionals to understand the neurophysiology." *The Journal of Pain* 4 (4): 184–189. doi:10.1016/S1526-5900(03)00488-7.
164. Moseley, Lorimer. 2007. "Reconceptualising pain according to modern pain science." *Physical Therapy Reviews* 12 (3): 169–178. doi:10.1179/108331907X223010.
165. Moseley, Lorimer, and David Butler. 2015. "Fifteen years of explaining pain: the past, present, and future." *The Journal of Pain* 16 (9): 807–813. doi:10.1016/j.jpain.2015.05.005.
166. Moseley, Lorimer, Hayley Leake, Anneke Beetsma, James Watson, David Butler, Annika van der Mee, Jennifer Stinson, et al. 2023. "Teaching patients about pain: the emergence of pain science education, its learning frameworks and delivery strategies." *The Journal of Pain* 25 (5): 104425. doi:10.1016/j.jpain.2023.11.008.
167. Murphy, Kevin R., and Herman Aguinis. 2022. "Reporting interaction effects: visualization, effect size, and interpretation." *Journal of Management* 48 (8): 2159–2166. doi: 10.1177/01492063221088516.
168. National Heart Lung and Blood Institute. *Metric BMI Calculator.* Accessed June 30, 2024. https://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmi-m.htm.
169. National Institute for Health and Care Excellence (NICE). 2016. "Low back pain and sciatica in over 16s: assessment and management." Last updated December 11, 2020. https://www.nice.org.uk/guidance/ng59.
170. Neha Chitale, JR, Deepali S Patil, Pratik Phansopkar, and Aditi Joshi. 2022. "A review on treatment approaches for chronic low back pain via Mulligans movement with mobilization and physical therapy." *Cureus* 14 (8): e28127. doi:10.7759/cureus.28127.
171. Newman, Andrea K, Calia A Morais, Benjamin P Van Dyke, and Beverly E Thorn. 2021. "An initial psychometric evaluation of the pain concepts questionnaire in a low-SES setting." *Journal of Pain* 22 (1): 57–67. doi:10.1016/j.jpain.2020.05.002.
172. Ng, Sin Ki, Flavia M Cicuttini, Yuanyuan Wang, Anita E Wluka, Bernadette Fitzgibbon, and Donna M Urquhart. 2017. "Negative beliefs about low back pain are associated with persistent high intensity low back pain." *Psychology, Health & Medicine* 22 (7): 790–799. doi:10.1080/13548506.2016.1220602.
173. Nguyen, Christelle, Marie-Martine Lefèvre-Colau, David J Kennedy, Byron J Schneider, and François Rannou. 2018. "Low back pain." *Lancet* 392 (10164): 2547. doi:10.1016/S0140-6736(18)32187-1.
174. Nguyen, Christelle, Mathieu De Sèze, and François Rannou. 2021. "The challenges of precision medicine in chronic low back pain: lessons learned from active discopathy." *Annals of Physical and Rehabilitation Medicine* 64 (2): 101504. doi:10.1016/j.rehab.2021.101504.
175. Nicol, Vanina, Claire Verdaguer, Camille Daste, Hélène Bisseriex, Éric Lapeyre, Marie Martine Lefèvre-Colau, François Rannou, Alexandra Rören, Julia Facione, and Christelle Nguyen. 2023. "Chronic low back pain: a narrative review of recent

international guidelines for diagnosis and conservative treatment." *Journal of Clinical Medicine* 12 (4):1685. doi:10.3390/jcm12041685.

176. Nieminen, Linda Karoliina, Liisa Maria Pyysalo, and Markku Juhani Kankaanpää. 2021. "Prognostic factors for pain chronicity in low back pain: a systematic review." *Pain Reports* 6 (1): e919. doi:10.1097/PR9.0000000000000919.
177. Nijs, Jo, Jacqui Clark, Anneleen Malfliet, Kelly Ickmans, Lennard Voogt, Sanneke Don, Hester den Bandt, et al. 2017. "In the spine or in the brain? Recent advances in pain neuroscience applied in the intervention for low back pain." *Clinical and Experimental Rheumatology* 35 (5): S108–S115.
178. Nijs, Jo, Steven Z George, Daniel J Clauw, César Fernández-de-las-Peñas, Eva Kosek, Kelly Ickmans, Josué Fernández-Carnero, et al. 2021. "Central sensitisation in chronic pain conditions: latest discoveries and their potential for precision medicine." *The Lancet Rheumatology* 3 (5): e383–e392. doi:10.1016/S2665-9913(21)00032-1.
179. Nijs, Jo, Dorien Goubert, and Kelly Ickmans. 2016. "recognition and treatment of central sensitization in chronic pain patients: not limited to specialized care." *Journal of Orthopaedic and Sports Physical Therapy* 46 (12): 1024–1028. doi: 10.2519/jospt.2016.0612.
180. Nijs, Jo, Anneleen Malfliet, and Tomohiko Nishigami. 2023. "Nociplastic pain and central sensitization in patients with chronic pain conditions: a terminology update for clinicians." *Brazilian Journal of Physical Therapy* 27 (3): 100518. doi:10.1016/J.bjpt.2023.100518.
181. Nijs, Jo, C Paul van Wilgen, Jessica Van Oosterwijck, Miriam van Ittersum, and Mira Meeus. 2011. "How to explain central sensitization to patients with 'unexplained' chronic musculoskeletal pain: practice guidelines." *Manual Therapy* 16 (5): 413–418. doi:10.1016/j.math.2011.04.005.
182. Nogueira, Leandro Alberto Calazans, Aline De Oliveira Chaves, Ariane Dos Santos Wendt, Raphael Luz Soares de Souza, Felipe José Jandre Reis, and Fernanda Guimarães de Andrade. 2016. "Central sensitization patients present different characteristics compared with other musculoskeletal patients: a case–control study." *European Journal of Physiotherapy* 18 (3): 147–153. doi:10.3109/21679169.2016.1150509.
183. Nuseir, Khawla, Manal Kassab, and Basima Almomani. 2016. "Healthcare providers' knowledge and current practice of pain assessment and management: how much progress have we made?" *Pain Research & Management* 2016: 8432973. doi:10.1155/2016/8432973.
184. The Organisation for Economic Co-operation and Development (OECD). *"Working age population (indicator)."* Accessed May, 2023. https://www.oecd.org/en/data/indicators/working-age-population.html
185. O'Hagan, Edel T, Aidan G Cashin, Adrian C Traeger, and James H McAuley. 2023. "Person-centred education and advice for people with low back pain: making the best of what we know." *Brazilian Journal of Physical Therapy* 27 (1): 100478. doi:10.1016/j.bjpt.2022.100478.
186. Ohrbach, Richard, Sonia Sharma, Roger B Fillingim, Joel D Greenspan, Jonathan D Rosen, and Gary D Slade. 2020. "Clinical characteristics of pain among five chronic

overlapping pain conditions." *Journal of Oral & Facial Pain and Headache* 34: s29-s42. doi:10.11607/ofph.2573.

187. Oliveira, Crystian B, Chris G Maher, Rafael Z Pinto, Adrian C Traeger, Chung Wei Christine Lin, Jean François Chenot, Maurits van Tulder, and Bart W Koes. 2018. "Clinical practice guidelines for the management of non-specific low back pain in primary care: an updated overview." *European Spine Journal* 27 (11): 2791–2803. doi:10.1007/S00586-018-5673-2.
188. Ongaro, Giulio, and Ted J Kaptchuk. 2019. "symptom perception, placebo effects, and the Bayesian brain." *Pain* 160 (1): 1–4. doi:10.1097/j.pain.0000000000001367.
189. O'Sullivan, Peter, Joao Paulo Caneiro, Mary O'Keeffe, and Kieran O'Sullivan. 2016. "Unraveling the complexity of low back pain." *Journal of Orthopaedic and Sports Physical Therapy* 46 (11): 932–937. doi:10.2519/jospt.2016.0609.
190. Otero-Ketterer, Emilia, Cecilia Peñacoba-Puente, Carina Ferreira Pinheiro-Araujo, Juan Antonio Valera-Calero, and Ricardo Ortega-Santiago. 2022. "Biopsychosocial factors for chronicity in individuals with non-specific low back pain: an umbrella review." *International Journal of Environmental Research and Public Health* 19 (16): 10145. doi:10.3390/ijerph191610145/s1.
191. Parker, Romy, and Victoria J Madden. 2020. "State of the art: what have the pain sciences brought to physiotherapy?" *South African Journal of Physiotherapy* 76 (1). doi:10.4102/SAJP.V76I1.1390.
192. Pate, Joshua W, Laura E Simons, Mark J Hancock, Julia M Hush, Tim Noblet, Meg Pounder, and Verity Pacey. 2020. "The concept of pain inventory (COPI): assessing a child's concept of pain." *Clinical Journal of Pain* 36 (12): 940–949. doi:10.1097/AJP.0000000000000884.
193. Pate, Joshua W, Laura E Simons, Gillian Rush, Mark J Hancock, Julia M Hush, Arianne Verhagen, and Verity Pacey. 2022. "The concept of pain inventory for adults (COPI-Adult)." *Clinical Journal of Pain* 38 (1): 32–40. doi:10.1097/AJP.0000000000000990.
194. Pearce, John MS. 2006. "Von Frey's pain spots." *Journal of Neurology, Neurosurgery, and Psychiatry* 77 (12): 1317. doi:10.1136/JNNP.2006.098970.
195. Perl, Edward R. 2007. "Ideas about pain, a historical view." *Nature Reviews Neuroscience* 8 (1): 71–80. doi:10.1038/nrn2042.
196. Perl, Edward R. 2011. "Pain mechanisms: a commentary on concepts and issues." *Progress in Neurobiology* 94 (1): 20–38. doi:10.1016/j.pneurobio.2011.03.001.
197. Perrot, Serge, Milton Cohen, Antonia Barke, Beatrice Korwisi, Winfried Rief, and Rolf Detlef Treede. 2019. "The IASP classification of chronic pain for icd-11: chronic secondary musculoskeletal pain." *Pain* 160 (1): 77–82. doi:10.1097/j.pain.0000000000001389.
198. Petersen, Tom, Mark Laslett, and Carsten Juhl. 2017. "Clinical classification in low back pain: best-evidence diagnostic rules based on systematic reviews." *BMC Musculoskeletal Disorders 2017 18:1* 18 (1): 1–23. doi:10.1186/S12891-017-1549-6.
199. Ping, Ruru, and Takashi Oshio. 2023. "Education level as a predictor of the onset of health problems among china's middle-aged population: cox regression analysis." *Frontiers in Public Health* 11: 1187336. doi: 10.3389/fpubh.2023.1187336.

200. Pons, Tracey, Edward Shipton, and Rodger Mulder. 2012. “The relationship between beliefs about pain and functioning with rheumatologic conditions.” *Rehabilitation Research and Practice* 2012: 1–9. doi:10.1155/2012/206263.

201. Qaseem, Amir, Timothy J Wilt, Robert M McLean, and Mary Ann Forciea. 2017. “Noninvasive treatments for acute, subacute, and chronic low back pain: a clinical practice guideline from the American College of Physicians.” *Annals of Internal Medicine* 166 (7): 514–530. doi:10.7326/M16-2367.

202. Quintner, John L, Milton L Cohen, David Buchanan, James D Katz, and Owen D Williamson. 2008. “Pain medicine and its models: helping or hindering?” *Pain Medicine* 9 (7): 824–834. doi:10.1111/j.1526-4637.2007.00391.x.

203. Ram, Adrian, John Booth, Jeanette M. Thom, Mitchell T. Gibbs, and Matthew D. Jones. 2023. “Are improvements in pain neurophysiology knowledge following pain science education associated with improved outcomes in people with chronic pain? A systematic review and meta-analysis.” *Clinical Journal of Pain* 39 (1): 41–52. doi:10.1097/AJP.0000000000001086.

204. Ramond-Roquin, Aline, Céline Bouton, Cyril Bègue, Audrey Petit, Yves Roquelaure, and Jean François Huez. 2015. “Psychosocial risk factors, interventions, and comorbidity in patients with non-specific low back pain in primary care: need for comprehensive and patient-centered care.” *Frontiers in Medicine* 2: 73. doi:10.3389/fmed.2015.00073.

205. Ramsook, Ryan R, and Gerard A Malanga. 2012. “Myofascial low back pain.” *Current Pain and Headache Reports* 16 (5): 423–432. doi:10.1007/s11916-012-0290-y.

206. Rice, David, Jo Nijs, Eva Kosek, Timothy Wideman, Monika I Hasenbring, Kelli Koltyn, Thomas Graven-Nielsen, and Andrea Polli. 2019. “Exercise-induced hypoalgesia in pain-free and chronic pain populations: state of the art and future directions.” *Journal of Pain* 20 (11): 1249–1266. doi: 10.1016/j.jpain.2019.03.005.

207. Robinault, Lucien, Imran Khan Niazi, Nitika Kumari, Imran Amjad, Vincent Menard, and Heidi Haavik. 2023. “Non-specific low back pain: an inductive exploratory analysis through factor analysis and deep learning for better clustering.” *Brain Sciences* 13 (6): 946. doi:10.3390/brainsci13060946.

208. Rocca, Elena, and Rani Lill Anjum. 2020. “Complexity, Reductionism and the Biomedical Model.” In *Rethinking Causality, Complexity and Evidence for the Unique Patient: a causehealth resource for healthcare professionals and the clinical encounter*, edited by Rani Lill Anjum, Rocca, Elena and Copeland Samantha, 75–94. Springer International Publishing. doi: 10.1007/978-3-030-41239-5.

209. Roland, Martin, and Richard Morris. 1983. “A study of the natural history of back pain. Part I: development of a reliable and sensitive measure of disability in low-back pain.” *Spine* 8 (2): 141–144. doi:10.1097/00007632-198303000-00004.

210. Rose-Dulcina, Kevin, Nicolas Vuillerme, Anne Tabard-Fougère, Romain Dayer, Dennis E. Dominguez, Stephane Armand, and Stéphane Genevay. 2018. “Identifying subgroups of patients with chronic nonspecific low back pain based on a multifactorial approach: protocol for a prospective study.” *JMIR Research Protocols* 7 (4): e104. doi:10.2196/resprot.9224.

211. Rostami, Khatereh, Saeed Hamidi Zadeh, and Mahnaz Rakhshan. 2019. “Chronic pain: a concept analysis.” *Electronic Journal of General Medicine* 16 (2): em130. doi:10.29333/ejgm/94098.

212. Roussel, Nathalie A, Jo Nijs, Mira Meeus, Veit Mylius, Cécile Fayt, and Rob Oostendorp. 2013. “Central sensitization and altered central pain processing in chronic low back pain: fact or myth?” *Clinical Journal of Pain* 29 (7): 625–638. doi: 10.1097/AJP.0b013e31826f9a71.

213. Ryan, Cormac G, Emma L Karran, Sarah B Wallwork, Joshua W Pate, Mary O’Keeffe, Brona M Fullen, Nick Livadas, et al. 2023. “We are all in this together—whole of community pain science education campaigns to promote better management of persistent pain.” *The Journal of Pain* 25(4): 902–917. doi:10.1016/j.jpain.2023.10.024.

214. Schober, Patrick, and Lothar A. Schwarte. 2018. “Correlation coefficients: appropriate use and interpretation.” *Anesthesia and Analgesia* 126 (5): 1763–1768. doi:10.1213/ANE.0000000000002864.

215. Schuttert, Ingrid, Hans Timmerman, Kristian K Petersen, Megan E McPhee, Lars Arendt-Nielsen, Michiel F Reneman, and André P Wolff. 2021. “The definition, assessment, and prevalence of (human assumed) central sensitisation in patients with chronic low back pain: a systematic review.” *Journal of Clinical Medicine* 10 (24): 5931. doi:10.3390/jcm10245931/s1.

216. Searle, Angela, Martin Spink, Alan Ho, and Vivienne Chuter. 2015. “Exercise interventions for the treatment of chronic low back pain: a systematic review and meta-analysis of randomised controlled trials.” *Clinical Rehabilitation* 29 (12): 1155–1167. doi:10.1177/0269215515570379.

217. Setchell, Jenny, Nathalia Costa, Manuela Ferreira, Joanna Makovey, Mandy Nielsen, and Paul W Hodges. 2017. “Individuals’ explanations for their persistent or recurrent low back pain: a cross-sectional survey.” *BMC Musculoskeletal Disorders* 18 (1): 1–9. doi:10.1186/s12891-017-1831-7.

218. Severeijns, Rudy, Johan WS Vlaeyen, Marcel A Van Den Hout, and Wim EJ Weber. 2001. “Pain catastrophizing predicts pain intensity, disability, and psychological distress independent of the level of physical impairment.” *The Clinical journal of pain* 17 (2), 165–172. doi:10.1097/00002508-200106000-00009.

219. Shahin, Md. Abu, Rijwan Bhuiyan, Rowsan Ara, Md. Nazrul Islam, Minhaj Rahim Choudhury, Syed Atiqul Haq, and Mohammad Mostafa Zaman. 2022. “Risk factors of non-specific low back pain in a rural community of bangladesh: a case-control study.” *F1000Research* 11: 871. doi:10.12688/f1000research.123396.1.

220. Shala, Rilind, Nathalie Roussel, G Lorimer Moseley, Thomas Osinski, and Emilio J Puentedura. 2021. “Can we just talk our patients out of pain? should pain neuroscience education be our only tool?” *Journal of Manual and Manipulative Therapy* 29 (1): 1–3. doi:10.1080/10669817.2021.1873259.

221. Sharma, Saurab, and James H. McAuley. 2022. “Low back pain in low- and middle-income countries, part 1: the problem.” *Journal of Orthopaedic & Sports Physical Therapy* 52 (5): 233–235. doi:10.2519/jospt.2022.11145.

222. Shin, Seungwoo, and Hyunjoong Kim. 2023. “Carryover effects of pain neuroscience education on patients with chronic lower back pain: a systematic review and meta-analysis.” *Medicina* 59 (7): 1268. doi:10.3390/medicina59071268.
223. Siddall, Benjamin, Adrian Ram, Matthew D Jones, John Booth, Diana Perriman, and Simon J Summers. 2022. “Short-term impact of combining pain neuroscience education with exercise for chronic musculoskeletal pain: a systematic review and meta-analysis.” *Pain* 163 (1): E20–E30. doi:10.1097/j.pain.0000000000002308.
224. Smart, Keith M., Catherine Blake, Anthony Staines, and Catherine Doody. 2012. “Self-reported pain severity, quality of life, disability, anxiety and depression in patients classified with ‘nociceptive’, ‘peripheral neuropathic’ and ‘central sensitisation’ pain. the discriminant validity of mechanisms-based classifications of low back (±leg) pain.” *Manual Therapy* 17 (2): 119–125. doi:10.1016/j.math.2011.10.002.
225. *Social Welfare Act*. 2022. Official Gazette of the Republic of Croatia. No 18 of February 9, 2022. https://narodne-novine.nn.hr/clanci/sluzbeni/2022_02_18_181.html.
226. Soer, Remko, Michiel F Reneman, Bert L Speijer, Maarten Coppes, and Patrick C Vroomen. 2012. “Clinimetric properties of the EuroQol-5D in patients with chronic low back pain.” *Spine Journal* 12 (11): 1035–1039. doi:10.1016/j.spinee.2012.10.030.
227. Stevans, Joel M, Anthony Delitto, Samannaaz S Khoja, Charity G Patterson, Clair N Smith, Michael J Schneider, Janet K Freburger, et al. 2021. “Risk factors associated with transition from acute to chronic low back pain in us patients seeking primary care.” *JAMA Network Open* 4 (2): e2037371–e2037371. doi: 10.1001/jamanetworkopen.2020.37371.
228. Stratford, Paul W, and Daniel L Riddle. 2016. “A roland morris disability questionnaire target value to distinguish between functional and dysfunctional states in people with low back pain.” *Physiotherapy Canada* 68 (1): 29–35. doi:10.3138/PTC.2014-85.
229. Tarimo, Nesto, and Ina Diener. 2017. “Knowledge, attitudes and beliefs on contributing factors among low back pain patients attending outpatient physiotherapy treatment in Malawi.” *The South African Journal of Physiotherapy* 73 (1): 395. doi:10.4102/sajp.v73i1.395.
230. Taylor, Jeffrey B., Adam P. Goode, Steven Z. George, and Chad E. Cook. 2014. “Incidence and risk factors for first-time incident low back pain: a systematic review and meta-analysis.” *The Spine Journal* 14 (10): 2299–2319. doi:10.1016/j.spinee.2014.01.026.
231. Tegner, Heidi, Pernille Frederiksen, Bente A Esbensen, and Carsten Juhl. 2018. “Neurophysiological pain education for patients with chronic low back pain.” *Clinical Journal of Pain* 34 (8): 778–786. doi:10.1097/AJP.0000000000000594.
232. The Diagnosis and Treatment of Low Back Pain Group. 2022. “The VA/DoD clinical practice guideline for the diagnosis and treatment of low back pain. version 3.0.” Washington, DC. www.tricare.mil.
233. The National Health Service. *Physiotherapy Techniques*. Accessed December 1, 2023. https://www.nhs.uk/conditions/physiotherapy/how-it-works/.

234. Thewes, Belinda, Judith AC Rietjens, Sanne W van den Berg, Félix R Compen, Harriet Abrahams, Hanneke Poort, Marieke van de Wal, et al. 2018. “One way or another: the opportunities and pitfalls of self-referral and consecutive sampling as recruitment strategies for psycho-oncology intervention trials.” *Psycho-Oncology* 27 (8): 2056-2059. doi:10.1002/pon.4780.

235. Tian, Simiao, and Dewei Zhao. 2018. “Comparative effectiveness of exercise interventions for low back pain: a systematic review and network meta-analysis of 41 randomised controlled trials.” *Lancet* 392: S21. doi:10.1016/S0140-6736(18)32650-3.

236. Trachsel, Lindsay A, Sunil Munakomi, and Marco Cascella. 2023. “Pain theory.” *StatPearls*. Accessed January 7, 2024. https://www.ncbi.nlm.nih.gov/books/NBK545194/.

237. Traeger, Adrian, Lorimer Moseley, Markus Hübscher, Hopin Lee, Ian Skinner, Michael Nicholas, Nicholas Henschke, et al. 2014. “Pain education to prevent chronic low back pain: a study protocol for a randomised controlled trial.” *BMJ Open* 4 (6): e005505. doi:10.1136/bmjopen-2014-005505.

238. Treede, Rolf Detlef, Winfried Rief, Antonia Barke, Qasim Aziz, Michael I Bennett, Rafael Benoliel, Milton Cohen, et al. 2019. “Chronic pain as a symptom or a disease: the IASP classification of chronic pain for the international classification of diseases (ICD-11).” *Pain* 160 (1): 19–27. doi:10.1097/j.pain.0000000000001384.

239. Valenzuela-Pascual, Fran, Ester García-Martínez, Fidel Molina-Luque, Jorge Soler-González, Joan Blanco-Blanco, Francesc Rubí-Carnacea, Carolina Climent-Sanz, and Erica Briones-Vozmediano. 2021. “Patients’ and primary healthcare professionals’ perceptions regarding chronic low back pain and its management in spain: a qualitative study.” *Disability and Rehabilitation* 43 (18): 2568–2577. doi:10.1080/09638288.2019.1705923.

240. Vaughan, Brett, Jane Mulcahy, Kylie Fitzgerald, and Philip Austin. 2019. “Evaluating patient’s understanding of pain neurophysiology.” *Clinical Journal of Pain* 35 (2): 133–139. doi:10.1097/AJP.0000000000000658.

241. Vilar Furtado, Rita Neli, Luiza Helena Ribeiro, Bruno de Arruda Abdo, Fernanda Justo Descio, Celso Eduardo Martucci Junior, and Débora Coutinho Serruya. 2014. “Nonspecific low back pain in young adults: associated risk factors.” *Revista Brasileira de Reumatologia* 54 (5): 371–377. doi:10.1016/j.rbre.2014.03.018.

242. Vlaeyen, Johan, and Steven Linton. 2000. “Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art.” *Pain* 85 (3): 317–332. doi:10.1016/S0304-3959(99)00242-0.

243. Volcheck, Mary M, Arya B Mohabbat, Stephanie M Graham, Connie A Luedtke, and Kevin C Fleming. 2023. “Central sensitization, chronic pain, and other symptoms: better understanding, better management.” *Cleveland Clinic Journal of Medicine* 90 (4): 245–254. doi:10.3949/ccjm.90a.22019.

244. Vosniadou, Stella. 2012. “Reframing the Classical Approach to Conceptual Change: Preconceptions, Misconceptions and Synthetic Models.” *Second International Handbook of Science Education*, January. Springer Netherlands, 119–130. doi:10.1007/978-1-4020-9041-7_10.

245. Wand, Benedict, Aidan Cashin, James McAuley, Matthew Bagg, Gemma Orange, and Lorimer Moseley. 2023. “The fit-for-purpose model: conceptualizing and managing chronic nonspecific low back pain as an information problem.” *Physical Therapy* 103 (2): pzac151. doi:10.1093/ptj/pzac151.
246. Wang, Dan, and Laura A Frey-Law. 2022. “Quantifying chronic overlapping pain conditions (COPCs) in fibromyalgia versus headache and back pain.” *The Journal of Pain* 23 (5): 30–30. doi:10.1016/J.JPAIN.2022.03.116.
247. Wertli, Maria, Ulrike Held, Angela Lis, Marco Campello, and Sherri Weiser. 2018. “Both positive and negative beliefs are important in patients with spine pain: findings from the occupational and industrial orthopaedic center registry.” *The Spine Journal* 18 (8): 1463–1474. doi:10.1016/j.spinee.2017.07.166.
248. Wertli, Maria, Eva Rasmussen-Barr, Sherri Weiser, Lucas Bachmann, and Florian Brunner. 2014. “The role of fear avoidance beliefs as a prognostic factor for outcome in patients with nonspecific low back pain: a systematic review.” *The Spine Journal* 14 (5): 816-836.e4. doi:10.1016/j.spinee.2013.09.036.
249. White, Lynita D, Pamela Summers, and Alex Scott. 2018. “Changes in clinical status after completion of an interdisciplinary pain management programme incorporating pain neurophysiology education.” *Physiotherapy Canada* 70 (4): 382–392. doi:10.3138/ptc.2016-72.ep.
250. Wideman, Timothy H, Gordon GJ Asmundson, Rob JEM Smeets, Alex J Zautra, Maureen J Simmonds, Michael JL Sullivan, Jennifer A Haythornthwaite, and Robert R Edwards. 2013. “Rethinking the fear avoidance model: toward a multidimensional framework of pain-related disability.” *Pain* 154 (11): 2262–2265. doi:10.1016/j.pain.2013.06.005.
251. Williams, David A, and Beverly E Thorn. 1989. “An empirical assessment of pain beliefs.” *Pain* 36 (3): 351–358. doi:10.1016/0304-3959(89)90095-x.
252. Williamson, Amelia, and Barbara Hoggart. 2005. “Pain: a review of three commonly used pain rating scales.” *Journal of Clinical Nursing* 14 (7): 798–804. doi:10.1111/J.1365-2702.2005.01121.X.
253. Wong, Charles KW, Rebecca YW Mak, Terence SY Kwok, Joshua SH Tsang, Marco YC Leung, Martha Funabashi, Luciana G. Macedo, Liz Dennett, and Arnold YL Wong. 2022. “Prevalence, incidence, and factors associated with non-specific chronic low back pain in community-dwelling older adults aged 60 years and older: a systematic review and meta-analysis.” *The Journal of Pain* 23 (4): 509–534. doi:10.1016/j.jpain.2021.07.012.
254. Wood, Lianne, and Paul A Hendrick. 2019. “A systematic review and meta-analysis of pain neuroscience education for chronic low back pain: short-and long-term outcomes of pain and disability.” *European Journal of Pain* 23 (2): 234–249. doi:10.1002/ejp.1314.
255. Woolf, Clifford J. 2011. “Central sensitization: implications for the diagnosis and treatment of pain.” *Pain* 152 (3): S2-S15. doi:10.1016/j.pain.2010.09.030.
256. World Health Organization. *Musculoskeletal health*. 2022. Last updated July 14, 2022. https://www.who.int/news-room/fact-sheets/detail/musculoskeletal-conditions.

257. World Health Organization. *Low back pain*. 2023. Last updated June 19, 2023. https://www.who.int/news-room/fact-sheets/detail/low-back-pain.

258. World Medical Association. 2013. “World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects.” *JAMA* 310 (20): 2191–2194. doi:10.1001/jama.2013.281053.

259. Wysocki, Anna C, Katherine M Lawson, and Mijke Rhemtulla. 2022. “Statistical control requires causal justification.” *Advances in Methods and Practices in Psychological Science* 5 (2). doi: 10.1177/25152459221095823.

260. Xu, Manfei, Drew Fralick, Julia Z. Zheng, Bokai Wang, Xin M. Tu, and Changyong Feng. 2017. “The differences and similarities between two-sample t-test and paired t-test.” *Shanghai Archives of Psychiatry* 29 (3): 184–188. doi:10.11919/j.issn.1002-0829.217070.

261. Yunus, Muhammad B. 2007. “Fibromyalgia and overlapping disorders: the unifying concept of central sensitivity syndromes.” *Seminars in Arthritis and Rheumatism* 36 (6): 339–356. doi:10.1016/j.semarthrit.2006.12.009.

262. Zajacova, Anna, Richard G. Rogers, Eric Grodsky, and Hanna Grol-Prokopczyk. 2020. “The relationship between education and pain among adults aged 30–49 in the United States.” *The Journal of Pain* 21 (11–12): 1270-1280. doi:10.1016/j.jpain.2020.03.005.

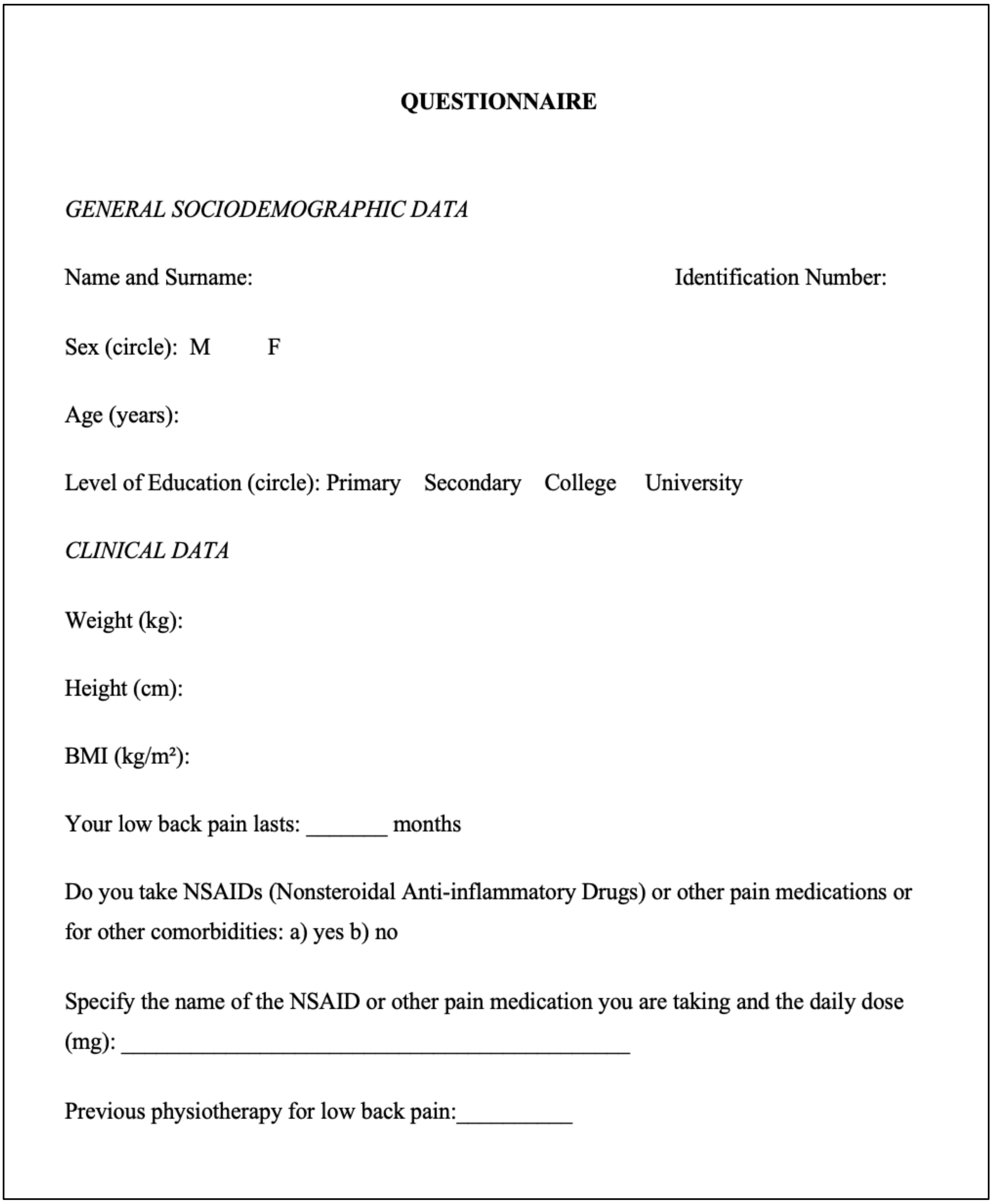
263. Zale, Emily L, and Joseph W Ditre. 2015. “Pain-related fear, disability, and the fear-avoidance model of chronic pain.” *Current Opinion in Psychology* 5: 24–30. doi:10.1016/j.copsyc.2015.03.014.

264. Zale, Emily L, Krista L Lange, Sherecce A Fields, and Joseph W Ditre. 2013. “The relation between pain-related fear and disability: a meta-analysis.” *The Journal of Pain* 14 (10): 1019–1030. doi:10.1016/j.jpain.2013.05.005.

265. Zhao, Xiang, Katja Boersma, Björn Gerdle, Peter Molander, and Hugo Hesser. 2023. “Fear network and pain extent: interplays among psychological constructs related to the fear-avoidance model.” *Journal of Psychosomatic Research* 167: 111176. doi:10.1016/j.jpsychores.2023.111176.

APPENDICES

Appendix A: Questionnaire on sociodemographic and clinical background data



QUESTIONNAIRE

GENERAL SOCIODEMOGRAPHIC DATA

Name and Surname: Identification Number:

Sex (circle): M F

Age (years):

Level of Education (circle): Primary Secondary College University

CLINICAL DATA

Weight (kg):

Height (cm):

BMI (kg/m²):

Your low back pain lasts: _______ months

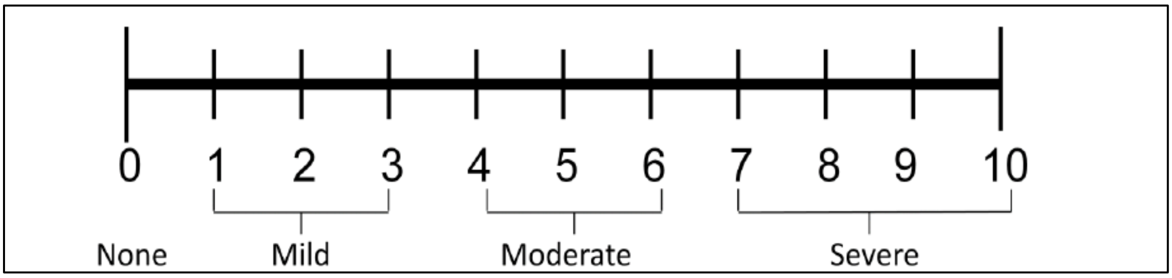
Do you take NSAIDs (Nonsteroidal Anti-inflammatory Drugs) or other pain medications or for other comorbidities: a) yes b) no

Specify the name of the NSAID or other pain medication you are taking and the daily dose (mg): ____

Previous physiotherapy for low back pain:__________

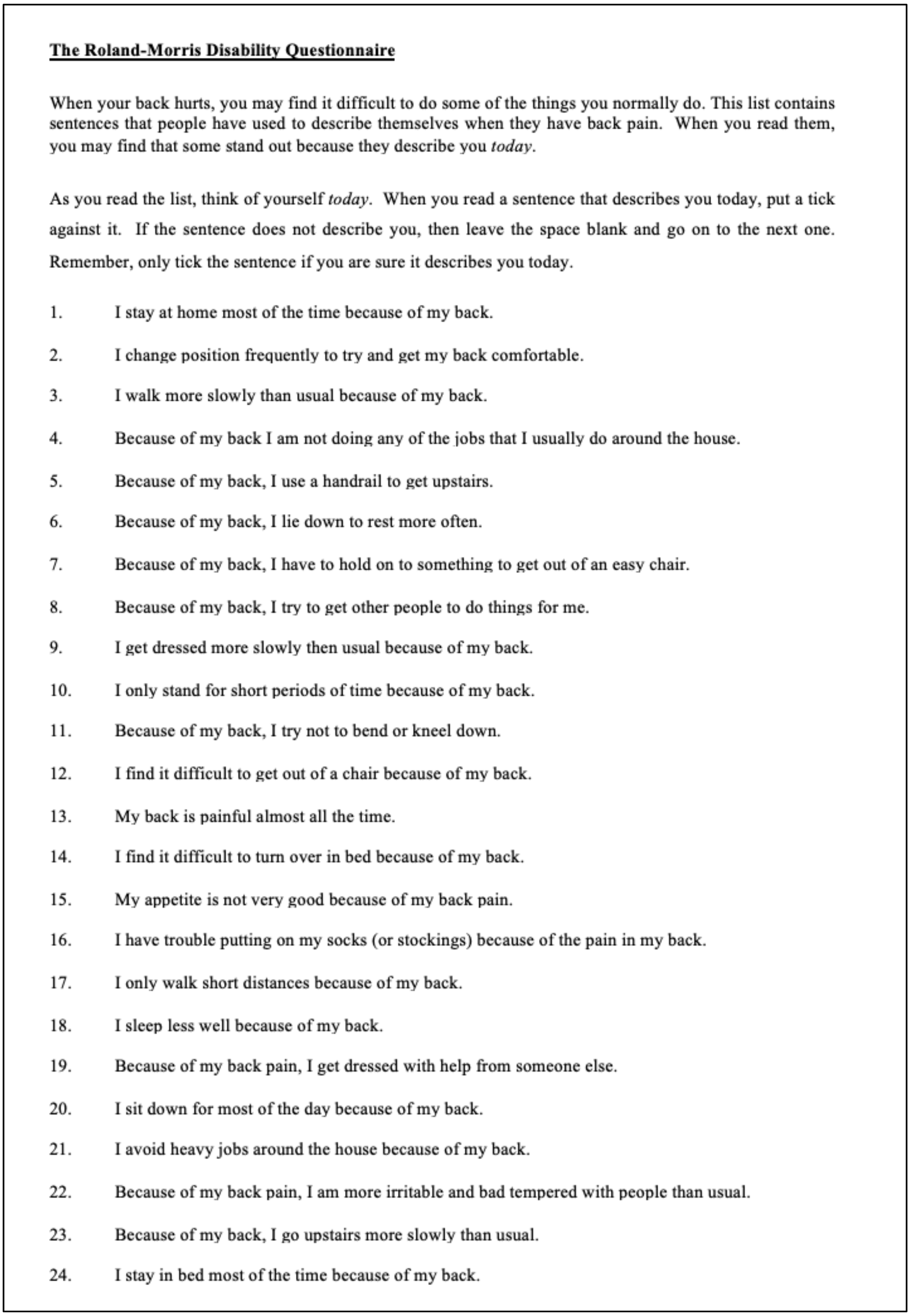
Source: Author's own 2024.

Appendix B: Numeric Pain Rating Scale



Source: McCaffery et al. 1989. Available at: https://www.sralab.org/rehabilitation-measures/numeric-pain-rating-scale

Appendix C: Roland Morris Disability Questionnaire in original



The Roland-Morris Disability Questionnaire

When your back hurts, you may find it difficult to do some of the things you normally do. This list contains sentences that people have used to describe themselves when they have back pain. When you read them, you may find that some stand out because they describe you *today*.

As you read the list, think of yourself *today*. When you read a sentence that describes you today, put a tick against it. If the sentence does not describe you, then leave the space blank and go on to the next one. Remember, only tick the sentence if you are sure it describes you today.

1. I stay at home most of the time because of my back.
2. I change position frequently to try and get my back comfortable.
3. I walk more slowly than usual because of my back.
4. Because of my back I am not doing any of the jobs that I usually do around the house.
5. Because of my back, I use a handrail to get upstairs.
6. Because of my back, I lie down to rest more often.
7. Because of my back, I have to hold on to something to get out of an easy chair.
8. Because of my back, I try to get other people to do things for me.
9. I get dressed more slowly then usual because of my back.
10. I only stand for short periods of time because of my back.
11. Because of my back, I try not to bend or kneel down.
12. I find it difficult to get out of a chair because of my back.
13. My back is painful almost all the time.
14. I find it difficult to turn over in bed because of my back.
15. My appetite is not very good because of my back pain.
16. I have trouble putting on my socks (or stockings) because of the pain in my back.
17. I only walk short distances because of my back.
18. I sleep less well because of my back.
19. Because of my back pain, I get dressed with help from someone else.
20. I sit down for most of the day because of my back.
21. I avoid heavy jobs around the house because of my back.
22. Because of my back pain, I am more irritable and bad tempered with people than usual.
23. Because of my back, I go upstairs more slowly than usual.
24. I stay in bed most of the time because of my back.

Source: Roland and Morris 1983. Available at: https://www.rmdq.org/Download.htm

Appendix D: The 5-level EQ-5D version

EQ-5D-5L

Health Questionnaire

English version for the UK

Under each heading, please tick the ONE box that best describes your health TODAY.

MOBILITY

I have no problems in walking about ☐
I have slight problems in walking about ☐
I have moderate problems in walking about ☐
I have severe problems in walking about ☐
I am unable to walk about ☐

SELF-CARE

I have no problems washing or dressing myself ☐
I have slight problems washing or dressing myself ☐
I have moderate problems washing or dressing myself ☐
I have severe problems washing or dressing myself ☐
I am unable to wash or dress myself ☐

USUAL ACTIVITIES *(e.g. work, study, housework, family or leisure activities)*

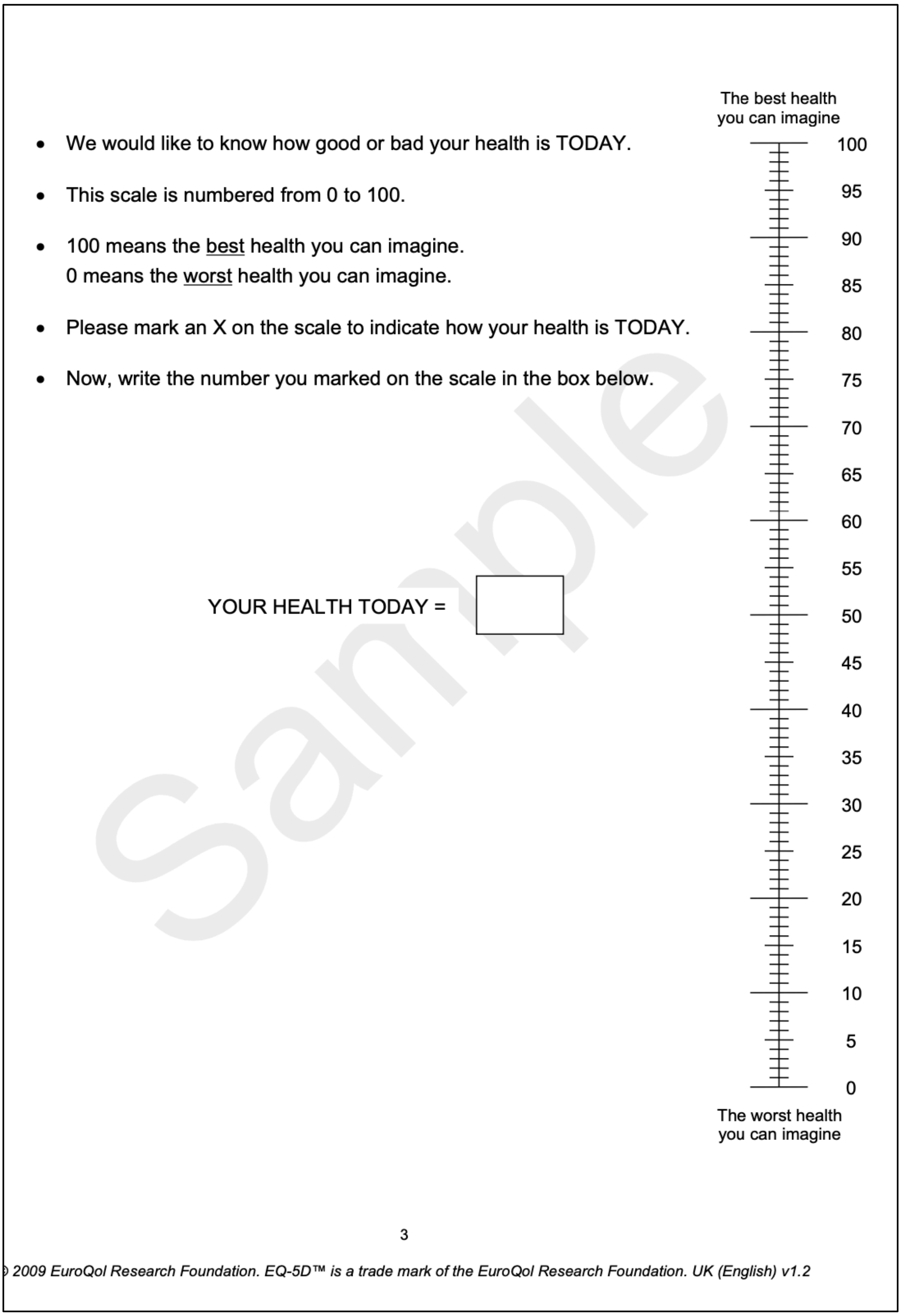
I have no problems doing my usual activities ☐
I have slight problems doing my usual activities ☐
I have moderate problems doing my usual activities ☐
I have severe problems doing my usual activities ☐
I am unable to do my usual activities ☐

PAIN / DISCOMFORT

I have no pain or discomfort ☐
I have slight pain or discomfort ☐
I have moderate pain or discomfort ☐
I have severe pain or discomfort ☐
I have extreme pain or discomfort ☐

ANXIETY / DEPRESSION

I am not anxious or depressed ☐
I am slightly anxious or depressed ☐
I am moderately anxious or depressed ☐
I am severely anxious or depressed ☐
I am extremely anxious or depressed ☐

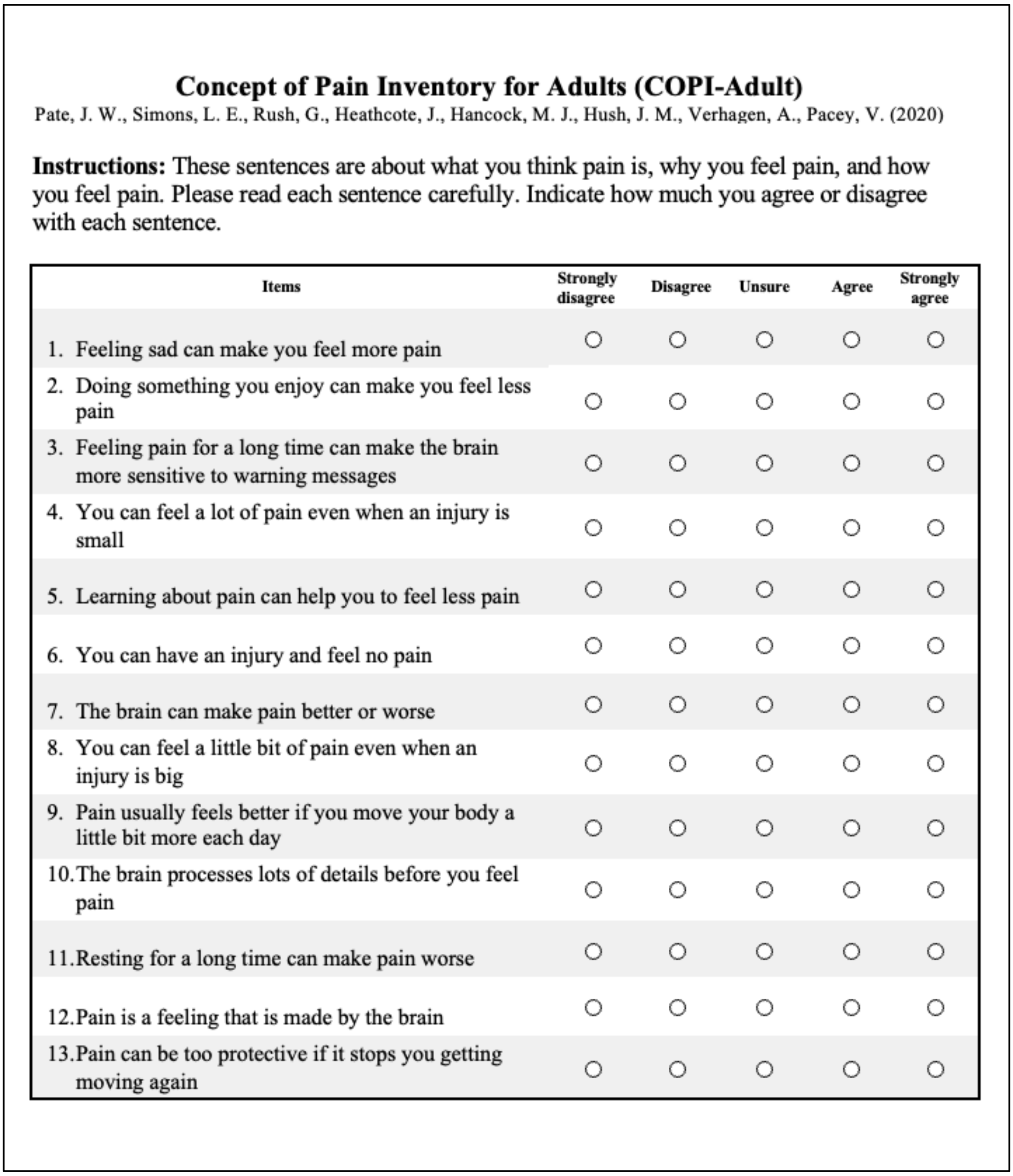


- We would like to know how good or bad your health is TODAY.
- This scale is numbered from 0 to 100.
- 100 means the best health you can imagine.
  0 means the worst health you can imagine.
- Please mark an X on the scale to indicate how your health is TODAY.
- Now, write the number you marked on the scale in the box below.

YOUR HEALTH TODAY = ☐

Source: EuroQol Group 2009. Available at: https://euroqol.org/eq-5d-instruments/sample-demo/

Appendix E: The Concept of Pain Inventory for Adults (COPI-Adult) in original



Concept of Pain Inventory for Adults (COPI-Adult)

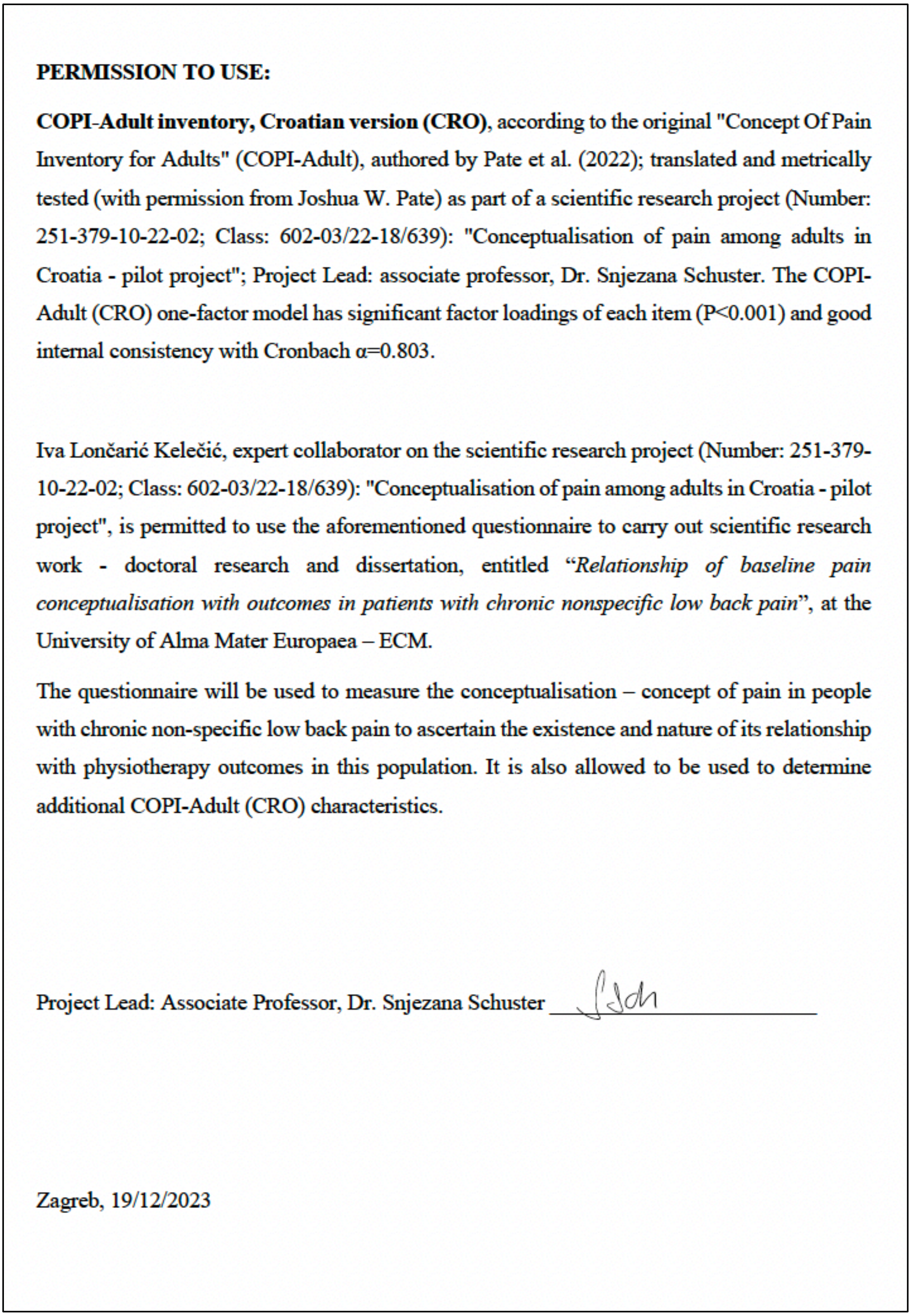
Pate, J. W., Simons, L. E., Rush, G., Heathcote, J., Hancock, M. J., Hush, J. M., Verhagen, A., Pacey, V. (2020)

Instructions: These sentences are about what you think pain is, why you feel pain, and how you feel pain. Please read each sentence carefully. Indicate how much you agree or disagree with each sentence.

Items	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
1. Feeling sad can make you feel more pain	○	○	○	○	○
2. Doing something you enjoy can make you feel less pain	○	○	○	○	○
3. Feeling pain for a long time can make the brain more sensitive to warning messages	○	○	○	○	○
4. You can feel a lot of pain even when an injury is small	○	○	○	○	○
5. Learning about pain can help you to feel less pain	○	○	○	○	○
6. You can have an injury and feel no pain	○	○	○	○	○
7. The brain can make pain better or worse	○	○	○	○	○
8. You can feel a little bit of pain even when an injury is big	○	○	○	○	○
9. Pain usually feels better if you move your body a little bit more each day	○	○	○	○	○
10. The brain processes lots of details before you feel pain	○	○	○	○	○
11. Resting for a long time can make pain worse	○	○	○	○	○
12. Pain is a feeling that is made by the brain	○	○	○	○	○
13. Pain can be too protective if it stops you getting moving again	○	○	○	○	○

Source: Pate et al. 2022.

Appendix F: Permission for the COPI-Adult Croatian Version



PERMISSION TO USE:

COPI-Adult inventory, Croatian version (CRO), according to the original "Concept Of Pain Inventory for Adults" (COPI-Adult), authored by Pate et al. (2022); translated and metrically tested (with permission from Joshua W. Pate) as part of a scientific research project (Number: 251-379-10-22-02; Class: 602-03/22-18/639): "Conceptualisation of pain among adults in Croatia - pilot project"; Project Lead: associate professor, Dr. Snjezana Schuster. The COPI-Adult (CRO) one-factor model has significant factor loadings of each item ($P<0.001$) and good internal consistency with Cronbach $\alpha=0.803$.

Iva Lončarić Kelečić, expert collaborator on the scientific research project (Number: 251-379-10-22-02; Class: 602-03/22-18/639): "Conceptualisation of pain among adults in Croatia - pilot project", is permitted to use the aforementioned questionnaire to carry out scientific research work - doctoral research and dissertation, entitled "*Relationship of baseline pain conceptualisation with outcomes in patients with chronic nonspecific low back pain*", at the University of Alma Mater Europaea – ECM.

The questionnaire will be used to measure the conceptualisation – concept of pain in people with chronic non-specific low back pain to ascertain the existence and nature of its relationship with physiotherapy outcomes in this population. It is also allowed to be used to determine additional COPI-Adult (CRO) characteristics.

Project Lead: Associate Professor, Dr. Snjezana Schuster ____________________

Zagreb, 19/12/2023

Appendix G: Therapeutic exercises

Sequence of pictures 1. The supine arm and leg lengthener exercise

Sequence of pictures 2. The Laying Knee Pull exercise; single leg and alternately

Sequence of pictures 3. The Laying Knee Pull exercise; double leg

Sequence of pictures 4. Leg lift at the hip with activation of the abdominal muscles

Sequence of pictures 5. Activation of core trunk muscles with leg adductors activation

Sequence of pictures 6. The Pelvic Lift exercise with activation of the thigh adductors

Sequence of pictures 7. Activation of deep abdomen flexor muscles and pelvic floor

Sequence of pictures 8. Modified lumbar neural/tensioner mobilisation in supine

Sequence of pictures 9. The Pelvic Lift exercise with an additional lever

Sequence of pictures 10. Self-mobilisation of the Th/Ls in the lateral position

Sequence of pictures 11. Prone Leg Raise or Prone Hip Extension

Sequence of pictures 12. Modified Superman exercise[8]

Sequence of pictures 13. The Sphinx position exercise

Sequence of pictures 14. Core control and Th self-mobilisation in quadrupedal pose

Sequence of pictures 15. The Piriformis and Body Flexion stretch combine

Sequence of pictures 16. The Advanced Reach exercise

Sequence of pictures 17. Self-mobilisation of Th/Ls in a sitting position with a combined rotation movement

Sequence of pictures 18. The Pelvic Tilt exercise with additional directional movement

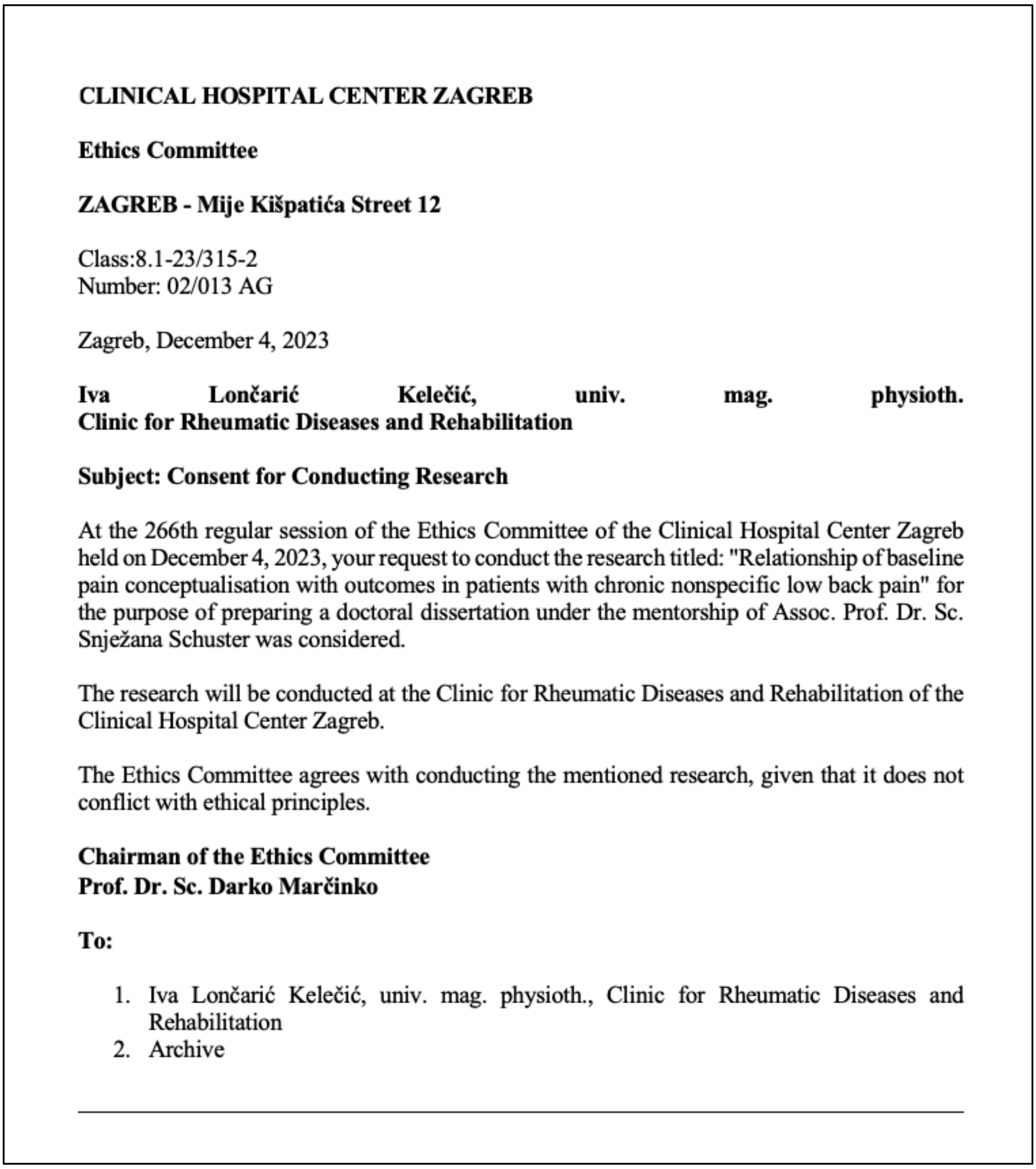
Sequence of pictures 19. Lumbar neural/tensioner self-mobilisation via SLUMP position

Sequence of pictures 20. Chest expansion - ‘The Ballerina’ exercise

Source of all pictures: Author's own 2024. Model: work colleague, with permission.

Appendix H: Clinical Institution Ethical Permission translated in English (1) and in original (2)

(1)



CLINICAL HOSPITAL CENTER ZAGREB

Ethics Committee

ZAGREB - Mije Kišpatića Street 12

Class:8.1-23/315-2
Number: 02/013 AG

Zagreb, December 4, 2023

Iva Lončarić Kelečić, univ. mag. physioth.
Clinic for Rheumatic Diseases and Rehabilitation

Subject: Consent for Conducting Research

At the 266th regular session of the Ethics Committee of the Clinical Hospital Center Zagreb held on December 4, 2023, your request to conduct the research titled: "Relationship of baseline pain conceptualisation with outcomes in patients with chronic nonspecific low back pain" for the purpose of preparing a doctoral dissertation under the mentorship of Assoc. Prof. Dr. Sc. Snježana Schuster was considered.

The research will be conducted at the Clinic for Rheumatic Diseases and Rehabilitation of the Clinical Hospital Center Zagreb.

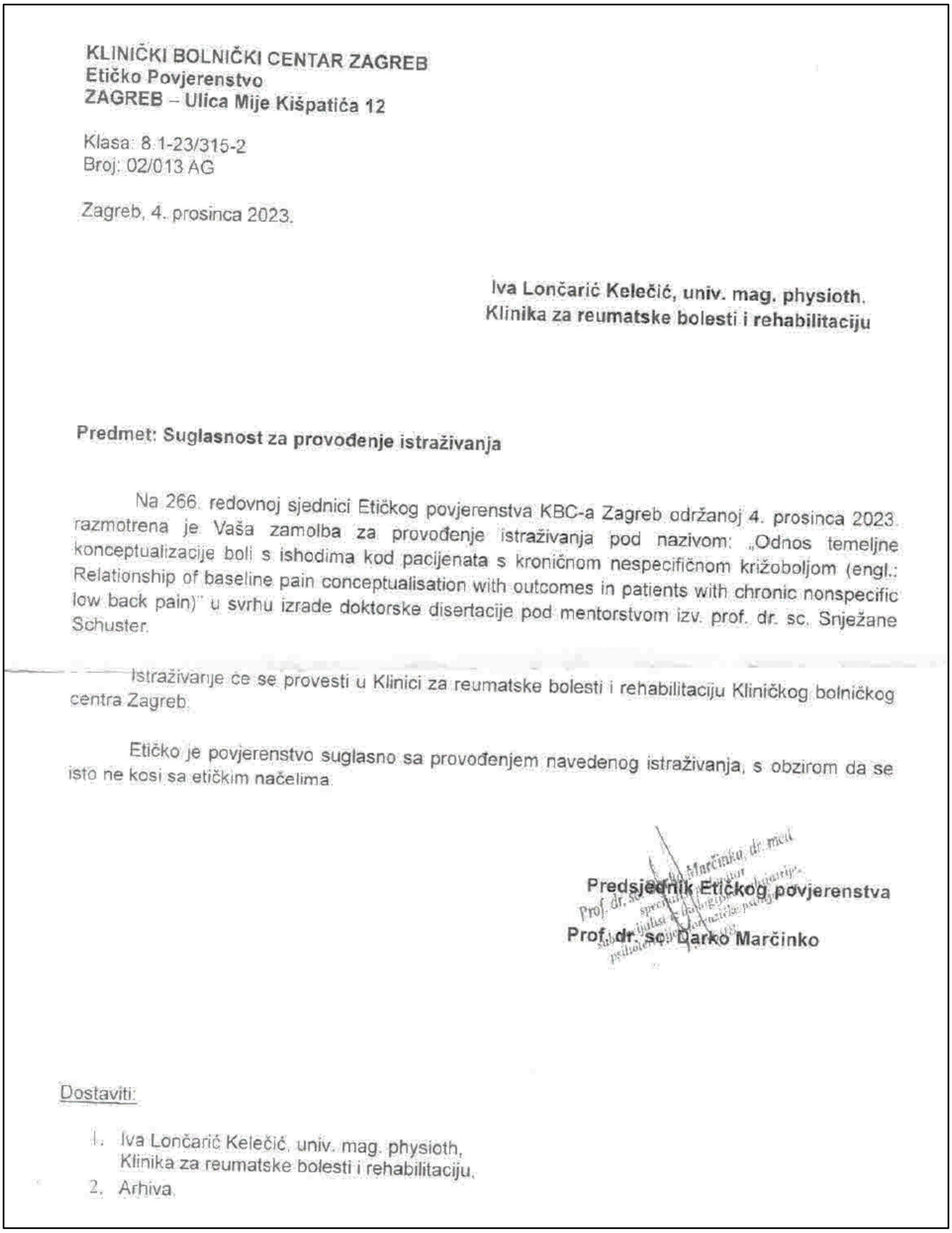
The Ethics Committee agrees with conducting the mentioned research, given that it does not conflict with ethical principles.

Chairman of the Ethics Committee
Prof. Dr. Sc. Darko Marčinko

To:

1. Iva Lončarić Kelečić, univ. mag. physioth., Clinic for Rheumatic Diseases and Rehabilitation
2. Archive

(2)



KLINIČKI BOLNIČKI CENTAR ZAGREB
Etičko Povjerenstvo
ZAGREB – Ulica Mije Kišpatića 12

Klasa: 8.1-23/315-2
Broj: 02/013 AG

Zagreb, 4. prosinca 2023.

Iva Lončarić Kelečić, univ. mag. physioth.
Klinika za reumatske bolesti i rehabilitaciju

Predmet: Suglasnost za provođenje istraživanja

Na 266. redovnoj sjednici Etičkog povjerenstva KBC-a Zagreb održanoj 4. prosinca 2023. razmotrena je Vaša zamolba za provođenje istraživanja pod nazivom: „Odnos temeljne konceptualizacije boli s ishodima kod pacijenata s kroničnom nespecifičnom križoboljom (engl.: Relationship of baseline pain conceptualisation with outcomes in patients with chronic nonspecific low back pain)" u svrhu izrade doktorske disertacije pod mentorstvom izv. prof. dr. sc. Snježane Schuster.

Istraživanje će se provesti u Klinici za reumatske bolesti i rehabilitaciju Kliničkog bolničkog centra Zagreb.

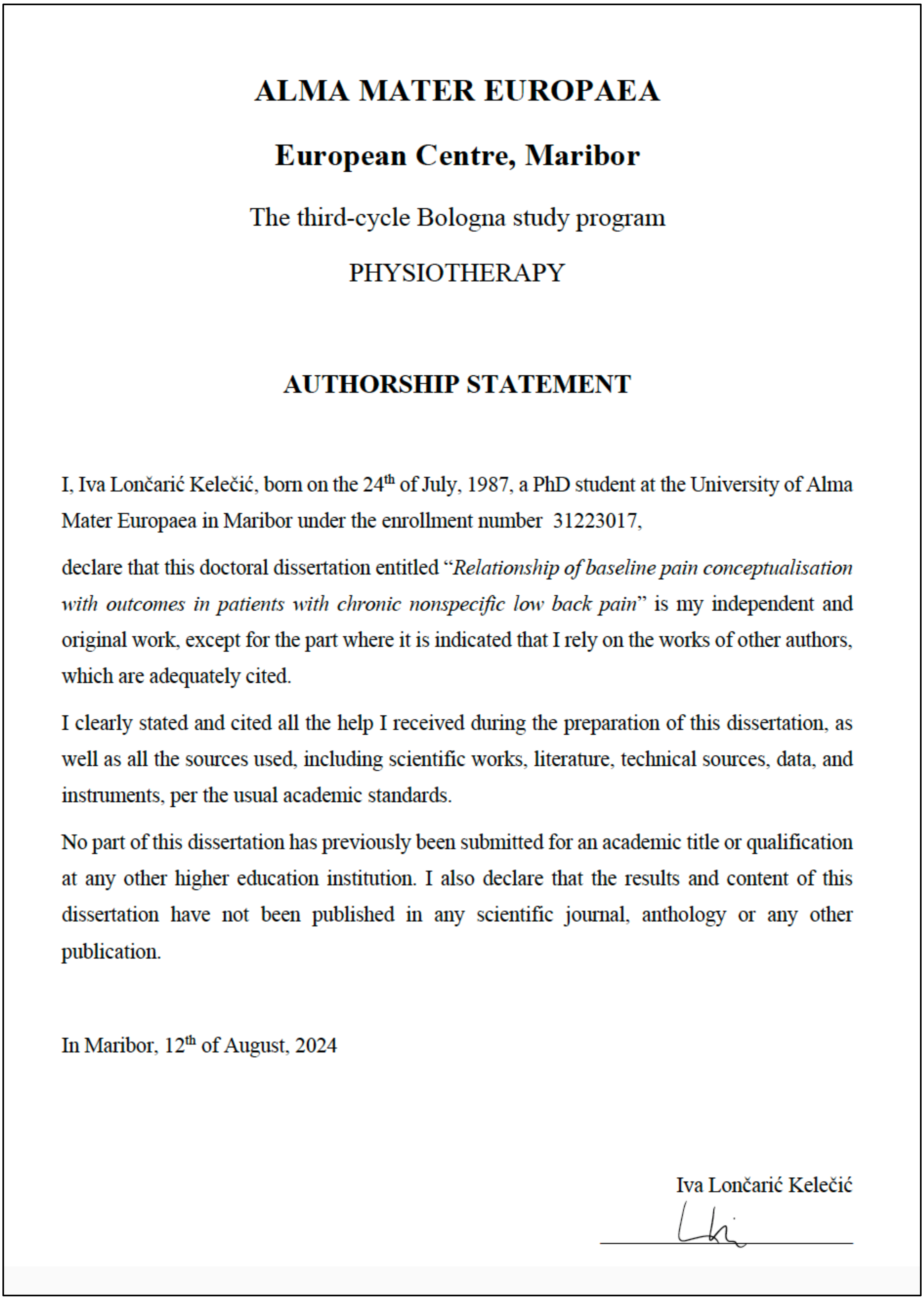
Etičko je povjerenstvo suglasno sa provođenjem navedenog istraživanja, s obzirom da se isto ne kosi sa etičkim načelima.

Predsjednik Etičkog povjerenstva
Prof. dr. sc. Darko Marčinko

Dostaviti:

1. Iva Lončarić Kelečić, univ. mag. physioth,
   Klinika za reumatske bolesti i rehabilitaciju.
2. Arhiva.

STATEMENT OF AUTHORSHIP



ALMA MATER EUROPAEA

European Centre, Maribor

The third-cycle Bologna study program

PHYSIOTHERAPY

AUTHORSHIP STATEMENT

I, Iva Lončarić Kelečić, born on the 24th of July, 1987, a PhD student at the University of Alma Mater Europaea in Maribor under the enrollment number 31223017,

declare that this doctoral dissertation entitled "*Relationship of baseline pain conceptualisation with outcomes in patients with chronic nonspecific low back pain*" is my independent and original work, except for the part where it is indicated that I rely on the works of other authors, which are adequately cited.

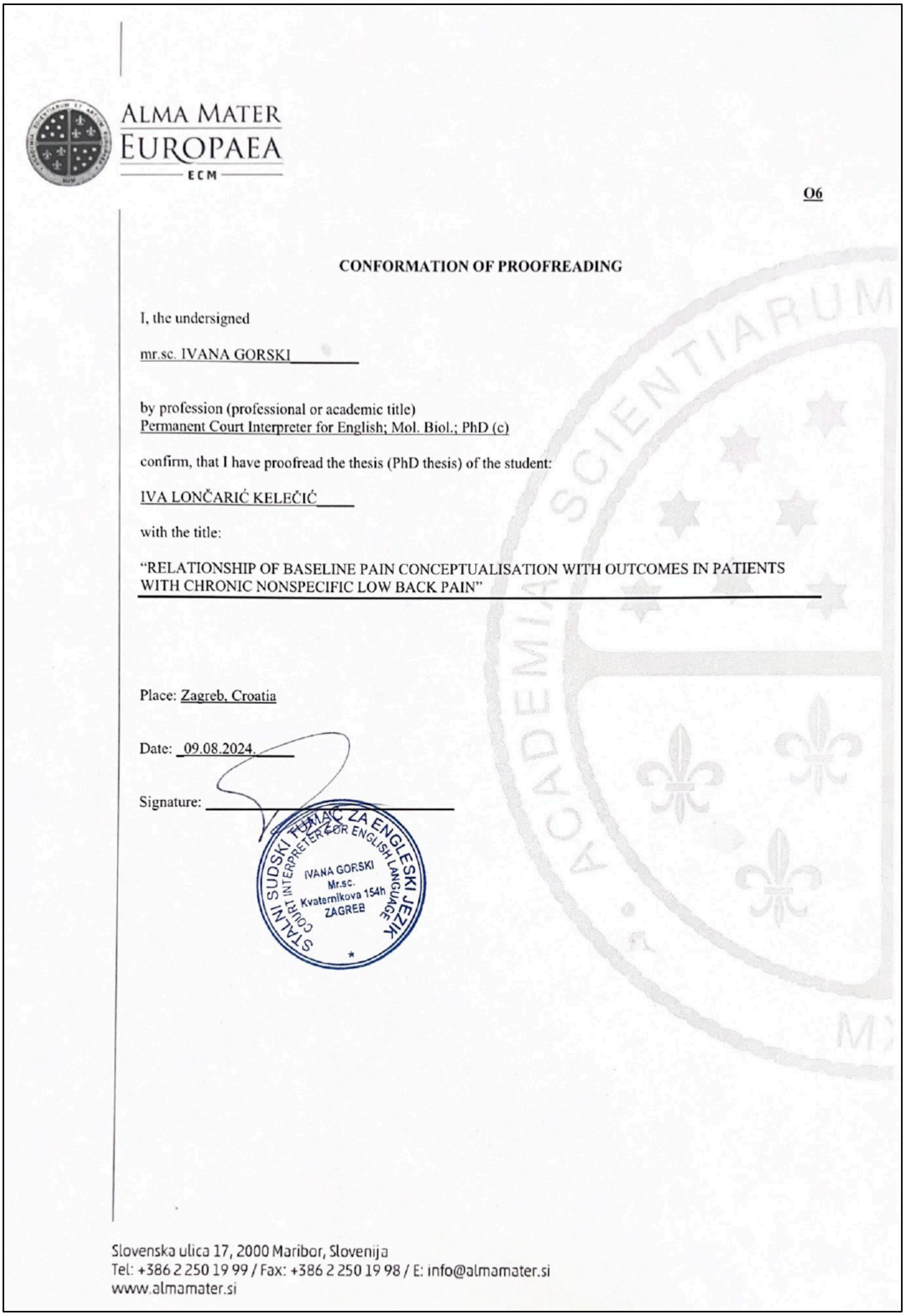
I clearly stated and cited all the help I received during the preparation of this dissertation, as well as all the sources used, including scientific works, literature, technical sources, data, and instruments, per the usual academic standards.

No part of this dissertation has previously been submitted for an academic title or qualification at any other higher education institution. I also declare that the results and content of this dissertation have not been published in any scientific journal, anthology or any other publication.

In Maribor, 12th of August, 2024

Iva Lončarić Kelečić

STATEMENT OF THE PROOFREADER



ALMA MATER
EUROPAEA
ECM

O6

CONFORMATION OF PROOFREADING

I, the undersigned

mr.sc. IVANA GORSKI

by profession (professional or academic title)
Permanent Court Interpreter for English; Mol. Biol.; PhD (c)

confirm, that I have proofread the thesis (PhD thesis) of the student:

IVA LONČARIĆ KELEČIĆ

with the title:

"RELATIONSHIP OF BASELINE PAIN CONCEPTUALISATION WITH OUTCOMES IN PATIENTS WITH CHRONIC NONSPECIFIC LOW BACK PAIN"

Place: Zagreb, Croatia

Date: 09.08.2024.

Signature:

STALNI SUDSKI TUMAČ ZA ENGLESKI JEZIK
COURT INTERPRETER FOR ENGLISH LANGUAGE
IVANA GORSKI
Mr.sc.
Kvaternikova 154h
ZAGREB