Shifting Chronic Pain Perspectives

Fostering biopsychosocial attitudes in healthcare professionals

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Table of content

General introduction 4

Dissertation outline 10

Chapter 1 19

Comparing physiotherapy students' attitudes and beliefs regarding chronic low back pain and knee osteoarthritis: An international multi-institutional comparison between 2013 and 2020 academic years

Chapter 2 37

Cross-cultural adaptation and psychometric testing of the French version of the Knowledge and Attitudes of Pain (KNAP) Questionnaire

Chapter 3 45

Development of an interdisciplinary training program about chronic pain management with a cognitive behavioural approach for healthcare professionals: part of a hybrid effectiveness-implementation study

Chapter 4 73

Enhancing Healthcare Professionals' Biopsychosocial perspective to chronic Pain; Assessing the impact of implementing an Interdisciplinary Training Programme

General discussion 97

General conclusion 105

Supplemental materials 114

Summary 131

Samenvatting 133

Résumé 135

About the author 137

Curriculum Vitae 138

Acknowledgements 145

General introduction

Definitions of (chronic) pain?

Pain is defined by the International Association for the Study of Pain (IASP) as "An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage" and they included six additional statements: (1) Pain is always a subjective experience that is influenced to varying degrees by biological, psychological, and social factors, (2) Pain and nociception are different phenomena: the experience of pain cannot be reduced to activity in sensory pathways, (3) Through their life experiences, individuals learn the concept of pain and its applications, (4) A person's report of an experience as pain should be accepted as such and respected (5) Although pain usually serves an adaptive role, it may have adverse effects on function and social and psychological well-being, and (6) Verbal description is only one of several behaviours to express pain; inability to communicate does not negate the possibility that a human or a nonhuman animal experiences pain [1]. This definition and additional statements integrate the biopsychosocial nature of pain, comprehending biological factors like comorbidity, but also patients' beliefs, expectations, psychological distress, environment & social relations. It shows that pain is a personal experience, with multifactorial causes regardless of nociception caused by tissue damage or physical impairments. When pain persists longer than three months it is defined as chronic pain or persistent pain[2].

Recently, the International Classification of Diseases has made a significant update. This update removed the old classification of pain and introduced two new chronic pain syndromes from a biopsychosocial framework [3]; chronic primary pain and chronic secondary pain [4]. Although it is not integrated into all healthcare systems yet, this update is crucial for healthcare professionals, as it provides a more comprehensive framework for chronic pain conditions [5]. Chronic primary pain is defined as "pain in one or more anatomical regions that persists or recurs for longer than 3 months and is associated with significant emotional distress or functional disability (interference with activities of daily life and participation in social roles), and that cannot be better accounted for by another chronic pain condition" [4]. This new definition represents chronic pain syndromes as independent health conditions, a key development in our field. Chronic secondary pain is defined as "chronic pain linked to other diseases as the underlying cause, for which pain may initially be regarded as a symptom." [4]. Examples of such underlying cause underlying causes are a work accident, cancer, diabetic neuropathy, chronic caries, inflammatory bowel disease, and rheumatoid arthritis [4].

Within this dissertation, we will use the term chronic pain instead of persistent pain, as this is in line with the international classification of diseases. The term 'persistent pain' has our preferences to be used within the communication with patients to avoid the misinterpretation of 'chronicity' in chronic pain, believing that it is endlessly recurrent and/or, per definition, worsens over time.

The impact of chronic pain

Chronic musculoskeletal pain is one of the most common health conditions, affecting approximately 23% of the general population in Belgium [6-8]. Chronic pain is a major burden for patients, HCPs and society. Patients with chronic pain report a significantly lower quality of life than the general population [9]. Chronic pain interfered with their physical functioning, professional life, relationships and family life, social life, sleep quality, and mood. Notably, it is the primary cause of years lived with disability [10], work absenteeism and productivity loss [11,12]. The greatest cause for years lived with disability was chronic low back pain, followed by other causes including chronic neck pain, osteoarthritis and other musculoskeletal disorders [13]. Consequently, chronic pain leads to substantial direct and indirect costs [11,12]. The yearly costs for chronic pain are estimated up to 4% of the gross domestic product [14], which is approximately €22.16 billion in 2022 in Belgium [15]. The prevalence of chronic pain is expected to increase in the next decade with the aging of the population [16], which will also lead to a larger impact on society.

Pain is the primary reason why people seek medical care, with three of the top ten reasons being osteoarthritis, back pain, and headaches [17]. In Belgium, between 33% and 49% of general practitioners' patient contact involved patients with chronic pain, of which the majority (81%) experienced pain for over a year [18]. Pain had been their primary reason to seek help in 78% of the (sub)acute patients and in 54% of the chronic pain patients [18]. This high frequency of HCPs having to treat patients with (chronic) pain and the impact on patients and society shows the necessity for HCPs to be able to provide high-value chronic pain management. Unfortunately, patients experiencing chronic pain perceive their care as inadequate, especially regarding their treatment plan, received recommendations and treatment results [19].

Biopsychosocial chronic pain management

Ideally, chronic pain management aims to assist patients in achieving complete recovery. Yet, with the lack of adequate chronic pain management to 'cure' all patients, focusing on their quality of life and self-management that enables them to engage in society actively might be more realistic [20,21]. Therefore, scientific literature and clinical guidelines advocate for biopsychosocial chronic pain management [22-25]. Clinical guidelines are evidence based and systematically developed summaries and recommendations to assist healthcare professionals in the process of healthcare decision-making. Both international guidelines [22,23,25] and the Belgian guideline from 2017 [24] recommend assessing patients' functional, activity participation, personal and environmental factors while limiting medical imaging [22,23]. Moreover, they support exercise therapy and cognitive behavioural approaches such as educating patients about pain (pain science education (PSE)) and interdisciplinary approaches containing physical and psychological interventions with cognitive-behavioural therapy [22,23]. Additionally, they recommend encouraging patients to maintain or return to physical activity and work. This has to be provided with a patient-centred approach [26,27] and includes shared

decision-making with patients [28], empowering the patient with the knowledge and skills to successfully self-manage their condition in a supportive environment [23].

Cognitive behavioural approaches like PSE and cognitive behavioural therapy are recommended for, addressing patients' misconceptions about pain [29-31]. Such misconceptions, like pain is always a sign of tissue damage, are associated with poorer chronic pain management outcomes and conflict with the advice to stay active and remain or return to work [32]. PSE challenges these misconceptions, aiming to induce a biopsychosocial shift in patients' understanding of the problem; how potential factors such as unhelpful thoughts, emotions, stress, lifestyle factors (e.g. sleep, activity and work participation), personal history, social relationships and behaviour can influence pain [29]. Cognitive behavioural therapy "aims to reduce pain and psychological distress and to improve physical and role function by helping individuals decrease maladaptive behaviours, increase adaptive behaviours, identify and correct maladaptive thoughts and beliefs, and increase self-efficacy for pain management" [31,33]. Studies show that PSE and cognitive behavioural therapy, particularly in a multimodal treatment plan, yield clinical benefits like decreasing emotional distress and improving health-related quality of life and work participation in various chronic pain conditions [21,30,34,35]. Besides, cognitive behavioural approaches support a patient-centered approach towards self-management that can be applied by a large variety of healthcare professionals in a mono- or interdisciplinary approach [33,36].

Clinical decision making

Although clinical guidelines and scientific literature advocate for biopsychosocial chronic pain management, the translation into clinical practice has been slow and suboptimal [37]. Currently, commonly applied chronic pain management is often biomedically oriented and overlooks the crucial role of psychological and social factors [38-40], and clinical decision-making is made accordingly [41,42]. Regardless of the chronic pain condition, these clinical decisions commonly aim to target tissue damage or physical impairments [41,42], characterized by the overuse of medical imaging [41,43], pain medication [41,43,44], and the recommendation to avoid or limit painful activities and support bed rest. This biomedical chronic pain management is considered low-value pain care [45] due to its association with poorer patient outcomes like decreased levels of activity and participation, and increased pain intensity and work absenteeism [46,47].

The translation, or lack of translation of scientific literature into clinical practice, remains poorly understood [48]. A recent systematic review found that up to 63% of physiotherapists provided care recommended by international clinical guidelines (e.g. guidelines from the National Institute for Health and Care Excellence (NICE) [49]) or systematic reviews for various musculoskeletal conditions, up to 43% provided non-recommended care, and up to 81% provided care of unknown value [50]. The percentage of recommended and non-recommended care has remained largely unchanged since the 90's while provided treatments of unknown value has increased. These clinical decisions are influenced by their clinical experience, perspectives, and knowledge of scientific evidence [50]. However, HCPs report that keeping up

to date with scientific evidence is challenging. It costs time and skills to search and interpret evidence [50,51]. Clinical guidelines should therefore support HCPs, and the majority of HCPs recognize the utility of clinical guidelines [51,52]. Yet, adherence to these clinical guidelines remains poor, with up to 70% of HCPs across various disciplines failing to adhere [52]. Barriers to adhere to clinical guidelines include HCPs' lack skills [51-53], confidence [54], resources [51-53], challenges in behaviour change [51,52,55], exposure to treatments with unknown value [50], beliefs that it does not improve quality of care, fear it harms therapeutic alliance with patients [55,56], and the fact that clinical guidelines are often complex [53]. Moreover, HCPs often disagree with guidelines [52] and they often prioritize their clinical experience and peer consensus over adherence to guidelines in chronic pain management [51,52,57]. Consequently, those with stronger biomedical perspectives generally adhere less to clinical guidelines and tend to favour biomedical treatments [39,47,54,58,59].

Healthcare professionals' perspectives

Unfortunately, this biomedical perspective is still commonly found in HCPs. Many HCPs believe that pain is mainly caused by poor posture, heavy physical activity or a poor working environment, putting too much stress on physical constraints which would cause pain by causing tissue damage [60]. Additionally, they believe that painful activities are harmful and recommend patients to limit physical activity and work [54,58]. It is crucial to reduce the gap between scientific literature and clinical guidelines on the one hand and HCP's perspectives and behaviours on the other. Education plays a key role in improving perspectives in HCPs throughout their education [61]. However, their perspectives remained sub-optimal when pain content was not adequately integrated within their education [61]. Many HCPs' education programs provide insufficient and inadequate training about pain due to insufficient hours of pain content [62-64], pain-related modules are not compulsory [62,63], solely monodisciplinary [63-65] and biomedically oriented [61]. HCPs also consider chronic pain training during their education as inadequate and have low satisfaction regarding their provided chronic pain management [66]. Leysen et al. (2021) showed that Dutch and Belgian undergraduate physiotherapists' perspectives shifted towards a more biopsychosocial approach from their second to the fourth year of University/ University College education in 2013 [67]. Yet, most fourth-year undergraduate physiotherapists retained a dominantly biomedical perspective towards chronic low back pain (CLBP) treatment [67]. This biomedical perspective does not only determine clinical decisions, it can negatively influence patients' beliefs, expectations and behaviours [33,68,69] and, consequently, their evolution [68]. As an example, biomedically oriented messages can lead to fear of pain and activity, which in turn can result in avoidance of continuation of activity and work, as explained by the fear-avoidance model [70,71]. Lesser fear-avoidance beliefs in patients is associated with better patient outcomes (e.g. pain and disability) [70]. Consequently, a healthcare professionals' biomedical messages could potentially do more harm than benefit when communicating with a patient [70,72-75]. This strongly illustrates the need to improve HCP's biopsychosocial perspectives to improve the quality of chronic pain management.

This shows that change is needed to facilitate optimal learning, including comprehension, interpretation, analysis and evaluation of knowledge and competencies of practical skills in undergraduate HCPs [61]. Within the last decade, multiple calls for action [62,76,77] were made by researchers and policymakers to improve pain care through changes in pain-related health systems, societal initiatives, and by implementing biopsychosocial pain management within educational curricula to improve the biopsychosocial perspectives of future healthcare professionals, including physical therapists. Nonetheless, it is unknown if adequate changes were made, resulting in better biopsychosocial perspectives in future HCPs. **Therefore, in Chapter one we aimed to evaluate the differences in biopsychosocial perspectives and recommendations in accordance with clinical guidelines regarding chronic pain management in undergraduate physiotherapists in 2020 versus those in 2013. Moreover, we aim to assess the differences between second and fourth-year undergraduate physiotherapists in 2020 and to identify demographics that predict biopsychosocial perspectives and guideline-adherent recommendations in undergraduate physiotherapists.**

Measuring healthcare professionals' perspectives

Defining perspectives is challenging due to the complex and dynamic nature of the cognitive processes that shape them, as well as the impact of environmental and social interactions [54,78]. Commonly used questionnaires use several definitions (e.g.,'beliefs', 'attitudes', and 'knowledge'), reflecting the difficulty of measuring these cognitive processes [54]. In this dissertation's introduction and discussion, we will use 'perspectives' as an overarching term, while the included studies will adhere to the definitions of the applied questionnaire(s).

Commonly used questionnaires to evaluate the perspectives of HCPs regarding pain are the Revised Neurophysiology of Pain Questionnaire (RNPQ) [79], the Pain Attitudes and Beliefs Questionnaire for Physiotherapists (PABS-PT) [80], the Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS) [81] and the Fear Avoidance Beliefs Questionnaire for HCPs (FABQ) for HCPs [82]. However, perspectives of HCPs and chronic pain (management) are complex, and these questionnaires suffer from some limitations to assess both. The questionnaires are missing crucial elements in modern pain science like plasticity of the nervous system and pain neuromatrix (HC-PAIRS, RNPQ, PABS-PT, FABQ), only focus on specific pain conditions (HC-PAIRS and PABS-PT), is scored with true-false answers which do not discriminate in HCPs' convictions (RNPQ), or were developed for specific professions (PABS-PT). Thus, better and more comprehensive questionnaires are needed. Hence, Beetsma et al. (2020) developed the Knowledge and Attitudes of Pain (KNAP) questionnaire [83]. This questionnaire comprehensively assesses HCPs' knowledge and attitudes about modern pain science and is scored on a 6-point Likert scale ranging from completely disagree to completely agree. This questionnaire is available in English [83], Dutch [83], Brazilian [84] and Japanese [85] and showed that it is a valid and reliable questionnaire in undergraduate physiotherapists [83]. Yet, it is not available in French to assess HCPs' comprehensive pain perspectives in Belgium and other French-speaking countries. **Therefore, in Chapter two, we**

aimed to translate the KNAP questionnaire into French and to test its psychometrics in both undergraduate and graduated HCPs.

Changing healthcare professionals' perspectives

The inadequacies in educating many HCPs about pain underscore the necessity to provide adequate training to undergraduate and graduated HCPs across all disciplines who may not have received sufficient education, thereby aiming to address the persisting issue of inadequate care. Within this dissertation, we will focus on implementing post-graduate training programs. These post-graduate educational programs have the potential to improve HCPs' knowledge, skills and behaviour [42,86-90]. Moreover, these educational interventions can result in more behaviour change [91] or intentions to change [92] in accordance with clinical guidelines than solely providing clinical guidelines [93]; although these intentions didn't change actual behaviour [92]. Moreover, the impact on HCPs' perspectives and behaviour varies largely between no improvements or small improvements to large improvements [42,86-90]. This indicates that post-graduate educational programs have the potential role in improving chronic pain management with a biopsychosocial approach but that structural and substantive changes are needed. Recommended changes are interprofessional [94,95] biopsychosocial chronic pain courses, provided via interactive workshops [94,95], integrating competency-based [96] and case-based learning [95], facilitating learning within the workplace [94,95], with discussions and skills training, and instead of purely didactic teaching [94,97,98]. Implementing training programs with interdisciplinary groups provides the opportunity to target various HCPs. However, limited research exists on the development of interdisciplinary training programs and its impact [99], particularly in the context of chronic pain. Therefore, more studies are needed to better understand where and how to improve such training programs and its implementation process. **In Chapter three we aimed to identify stakeholders' perceived barriers and facilitators regarding managing patients with chronic pain. Subsequently, to describe the development and implementation of an interdisciplinary training program regarding chronic pain management with a cognitive behavioural approach, considering these barriers and facilitators.** Integrating and addressing these barriers and facilitators within the development of training programs could potentially improve the impact of training programs on (interdisciplinary) chronic pain management in various HCPs. Additionally, it can improve coherence by recognizing and respecting the roles, responsibilities, and competencies of others, and knowing when, where, and how to involve these other professionals [99,100]. Clinical guidelines also recommend this interdisciplinary collaboration within healthcare [77,101,102]. Moreover, it potentially prevents the differences and contradictions in information patients receive from multiple HCPs. However, little is known about the impact of interdisciplinary educational training programs, especially when focusing on chronic pain. The lack of studies examining the impact of interdisciplinary postgraduate chronic pain training educational programs represents a significant knowledge gap. Particularly because interdisciplinary training programs are also seen as challenging as

they have to align with the applicability, relevance and interests of all HCPs, a factor that could influence their effectiveness [100].

The next step is to assess the impact of this training program on HCPs' competencies. Partially, HCPs' competencies are reflected by their biopsychosocial perspectives and clinical recommendations to patients. **Therefore, in Chapter four, we aimed to assess the impact of the interdisciplinary training program - developed in Chapter 3 - on HCPs' perspectives and recommendations for chronic pain management across various disciplines. Moreover, we aimed to identify HCPs' demographics influenced their perspectives and behaviour.** Chapter 3 and 4 are part of a type 1 hybrid-effectiveness study [103]. Within this type of study, we primarly focused on developing and testing a interdisciplinary training program, but secondary to that, explore related factors to the development and implementation proces. Understanding these underlying factors could also improve a person-centered approach in education to improve the impact on fostering biopsychosocial perspectives.

Dissertation outline

We aimed to contribute to the understanding of HCPs' perspectives towards chronic pain management and the change elicited by educational programs. Therefore, this dissertation will focus on current perspectives towards chronic pain in current undergraduate and graduated HCPs and the impact of the implementation of an interdisciplinary training program about chronic pain management on changing perspectives in graduated HCPs.

This dissertation has four objectives:

1. Assess chronic pain perspectives in undergraduate HCPs
2. Develop a questionnaire to assess comprehensive pain perspectives in French-speaking graduated and undergraduate HCPs
3. Develop an interdisciplinary training program for graduated HCPs
4. Investigate changes following the implementation of the interdisciplinary training program on HCPs perspectives

Chapter 1 – "Comparing physiotherapy students' attitudes and beliefs regarding chronic low back pain and knee osteoarthritis: An international multi-institutional comparison between 2013 and 2020 academic years"

The research aims of this chapter are:

- to evaluate the differences in biomedical and biopsychosocial attitudes and beliefs regarding the management of chronic low back pain and knee osteoarthritis and guideline-adherent recommendations regarding the management of chronic low back pain in Dutch and Belgian undergraduate physiotherapists in 2013 versus those in 2020.
- to examine whether chronic low back pain related attitudes, beliefs, and guideline-adherent recommendations regarding spinal pathology, activity, and work changed from the second to the fourth-year of physiotherapy education in 2020.
- to identify demographics of the undergraduate physiotherapists that predict attitudes, beliefs, and guideline-adherent recommendations regarding chronic low back pain.

Chapter 2 – "Cross-cultural adaptation and psychometric testing of the French version of the Knowledge and Attitudes of Pain (KNAP) Questionnaire"

The objectives of this chapter include:

- to translate and cross-culturally adapt the KNAP into French
- to test the psychometric properties of the French version of the KNAP in graduated and undergraduate HCPs.

Chapter 3 – "Development of an interdisciplinary training program about chronic pain management with a cognitive behavioural approach for healthcare professionals: part of an effectiveness-implementation study"

The research aims in this chapter are:

- to identify barriers and needs expressed by stakeholders for such an interdisciplinary chronic pain training program.
- to describe the development of an interdisciplinary training program about chronic pain for HCPs.

Chapter 4 - "Enhancing Healthcare Professionals' Biopsychosocial Perspective to Chronic Pain: Assessing the Impact of an Interdisciplinary Training Programme"

The research objectives for this chapter are:

- to assess the short and mid-term changes in HCPs' knowledge, attitudes and guideline-adherent recommendations regarding activity, sports, work, bed rest and opioids use towards musculoskeletal chronic pain after an interdisciplinary training program.
- to analyse whether HCPs' demographics predict pain knowledge and attitudes and a change over time.
- to report participants' satisfaction with the interdisciplinary training program directly after and at six-month follow-up.

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Chapter 1

Comparing physiotherapy students' attitudes and beliefs regarding chronic low back pain and knee osteoarthritis: An international multi-institutional comparison between 2013 and 2020 academic years

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Abstract

Background

In 2013, physiotherapy students demonstrated low guideline-adherent recommendations regarding chronic low back pain (CLBP) for spinal pathology, activity, and work.

Objectives

To assess the differences in physiotherapy students' attitudes, beliefs, and adherence to guideline recommendations regarding CLBP and knee osteoarthritis between 2013 and 2020.

Methods

In 2013 and 2020, second and fourth-year physiotherapy students were recruited from 6 Belgian and 2 Dutch institutions. Attitudes and beliefs regarding CLBP and knee OA were evaluated using the Pain Attitudes and Beliefs Scale for Physiotherapists (PABS-PT), the Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS), and a questionnaire regarding therapeutic exercise and knee osteoarthritis. A clinical vignette was used to measure guideline-adherent recommendations regarding spinal pathology, activity and work.

Results

In 2013, 927 second-year and 695 fourth-year students; in 2020, 695 second-year and 489 fourth-year students; were recruited to participate in the study. Compared to 2013, students had less biomedical and stronger biopsychosocial attitudes and beliefs regarding CLBP, more guideline-adherent recommendations for activity, and more biopsychosocial beliefs regarding the benefits of exercise for patients with knee osteoarthritis in both the second year and fourth year. Only fourth-year students in 2020 scored significantly better on HC-PAIRS and guideline-adherent recommendation relating to spinal pathology. No differences were found regarding work recommendations.

Conclusions

Between 2013 and 2020, physiotherapy students made a positive shift towards a more biopsychosocial approach to CLBP and knee osteoarthritis management. Guideline-adherent recommendations for CLBP concerning activity improved, however, concerning work and spinal pathology, it remained low.

Introduction

Although scientific research regarding chronic pain is exponentially rising, the management of chronic pain remains challenging for patients, physical therapists, and society.[1-8] There has been substantial progress in the neuroscientific knowledge of pain, taking into account that biomedical, psychological, and social factors significantly influence chronic pain and pain-related disability.[2,9-12] Yet, many physical therapists think pain and disability result from a specific structural impairment, and pain management remains mainly biomedically oriented.[13-18] Physical therapists with higher biomedical attitudes and beliefs generally adhere less to the clinical guidelines, are more likely to advise patients to restrict physical activities and work, and are associated with worsening pain and poor disability outcomes.[18-22]

Education could play a key role in shifting these misbeliefs towards a biopsychosocial approach.[23-26] However, previous studies found inadequate hours of pain education in pain curricula within educational programs and that pain was not a core part of curricula.[27-29] These findings imply that there was strong potential for improving biopsychosocial beliefs among physiotherapy students towards chronic pain management. Our previous study showed that Dutch and Belgian physiotherapy students' orientation shifted towards a more biopsychosocial approach from their second to fourth-year during education in 2013.[30] Yet, most fourth-year physiotherapy students retained a biomedical orientation towards chronic low back pain (CLBP) treatment.[30]

Within the last decade, multiple calls for action were made by researchers and policymakers to improve pain care through changes in pain-related health systems, societal initiatives, and by implementing biopsychosocial pain management within educational curricula to improve the biopsychosocial knowledge and beliefs of future healthcare professionals, including physical therapists.[28,31,32] However, it is unknown whether these calls for action have resulted in a change in biopsychosocial knowledge and beliefs of future healthcare professionals in line with modern pain science. Interestingly, no studies have investigated if physiotherapy students' pain attitudes and beliefs have become more biopsychosocially oriented over the past few years, reflecting a biopsychosocial shift within physiotherapy education.

The primary objective of this study was to (1) evaluate the differences in biomedical and biopsychosocial attitudes and beliefs regarding the management of CLBP and knee osteoarthritis (OA) and guideline-adherent recommendations regarding the management of CLBP in Dutch and Belgian between second- and fourth-year physiotherapy students educated in 2013 versus those educated in 2020. Secondary objectives were to examine (2) whether CLBP-related attitudes, beliefs, and guideline-adherent recommendations regarding spinal pathology, activity, and work changed from the second to the fourth-year of PT education in 2020 (3) and if age, sex, institutions, history of low back pain (LBP), and current LBP were preditors of attitudes, beliefs, and guideline-adherent recommendations regarding CLBP.

Methods

The study was approved by an independent Medical Ethical Committee (#2020/321) linked to the University Hospital of Brussels, and was conducted in accordance with the Helsinki Declaration of 1975. The study is reported following the STROBE recommendations.[33]

Study design

This study conducted a cross-sectional assessment of physiotherapy students in Dutch and Belgian institutions in 2020 compared to students in 2013.[30] A more detailed description regarding the methods and reliability and validation of the questionnaires can be found in the study reporting the cross-sectional results of 2013.[30]

Recruitment and Participants

Four Flemish (Vrije Universiteit Brussel, University of Antwerp, University of Ghent, and the Catholic University of Leuven), two Walloon (University of Liège and Université Catholique de Louvain), and two Dutch (Hanze University of Applied Sciences Groningen and University of Applied Sciences Rotterdam) institutions participated in 2013 and 2020. All participating institutions' second and fourth-year students were eligible for inclusion. In 2013, students were recruited by phone, through practice visits (convenience sampling), or at lectures. In 2020, due to COVID-19, students were recruited through notifications on digital platforms at their institution, emails, and information during lectures. All participants signed informed consent before participating in the study.

Data collection

Data were collected within the first semester of the academic year in 2013-2014 and 2020-2021. In 2020, students received a link to the online survey at Qualtrics or the questionnaire on paper. In 2013, all students filled in the questionnaire on paper. The questionnaire was provided in French or Dutch, based on the languages in which the students were being taught. To avoid social desirability response bias, all students were told that they were free to express their actual thoughts and beliefs when filling in the questionnaire, that there were no 'correct' responses and that the procedure was not an examination.[34] No further information was given.

Outcome measures

The outcome measures in 2020 were identical to those in 2013. A general questionnaire was used to collect characteristics of the students, i.e. age, sex, personal history, and presence of low back pain (LBP). Attitudes and beliefs regarding CLBP and knee OA were quantified with three questionnaires, and a clinical vignette was used to assess their clinical recommendations regarding CLBP. These tools are described below.

The Pain Attitudes and Beliefs Scale for Physiotherapists (PABS-PT) was used to assess the biomedical and biopsychosocial approach towards the management of patients with CLBP.[35,36] The biomedical subscale (PABS-BM) contains 10 items and score ranges between 10 and 60, and the biopsychosocial subscale (PABS-BPS) contains 9 items and total scores range between

9 and 54. Higher PABS-BM scores indicate a stronger biomedical orientation, and higher PABS-BPS scores indicate a stronger biopsychosocial orientation. The PABS-PT had adequate internal consistency, construct validity, reliability, and responsiveness.[37] However, the discriminative ability of the psychosocial subscale was low and the content validity is unknown.[37,38]

The Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS) evaluates the attitudes and beliefs of healthcare practitioners regarding the functional expectations of patients with CLBP.[39,40] The questionnaire contains 13 items, total scores range from 13-91, and higher scores reflect stronger beliefs about the relationship between pain and impairment. The HC-PAIRS internal consistency, construct validity, and discriminant validity was adequate.[39-41]

The Physical Therapists' Attitudes and Beliefs About Exercise and Knee OA contains 23 attitude statements, 12 statements regarding the benefits of exercise for knee OA and 11 statements regarding the delivery of exercise and exercise adherence.[22] Each attitude statement is scored on a 6-point Likert scale ranging from 'totally disagree' to 6 'totally agree'. Scores of each item are evaluated individually. The psychometric properties of this questionnaire are unknown.

The clinical vignette (Supplemental material 1) contains a clinical case scenario of a patient with CLBP purposed to evaluate if symptoms result from spinal pathology and their treatment recommendations concerning activity and work on a 5-point Likert scale.[42] The following recommendations were defined as consistent with clinical guidelines for spinal pathology: (1) spinal pathology: 'no spinal pathology' and 'mild spinal pathology', (2) activity: 'no activity limitations', 'avoid only painful activities', (3) and work: 'full time, full duty' and 'full time, moderate duty'. The validity of clinical vignettes is unclear and ranges from little differences to poor concordance with actual behaviour and standardized patients.[43-46]

Statistical analysis

Differences in attitudes and beliefs and clinical recommendations between 2013 and 2020 were examined with general(ized) mixed models (GLMM), and students were clustered by institutions. The estimated marginal mean of 2013 and 2020 was calculated through GLMM to account for differences in observations within and between institutions. Age, sex, institution, history of LBP, and current LBP were evaluated to determine whether these factors help to predict the outcomes. Intraclass correlation coefficients of the GLMM were reported to represent the average correlation of students within the clustering of institutions.[47] Institutions pre-arranged to report results anonymously. Subgroups were created for second and fourth-year students. A p-value of 0.05 was considered significant. Single linear regression imputation was used to impute missing values (<5%) for the PABS-PT and HC-PAIR.[48] Cases were excluded for imputation per questionnaire when >50% of the items within that questionnaire had missing data.[48] Due to the limited number of missing values (<5%), it did not suggest any systematic bias. Q/Q'-plots were used to evaluate normality assumptions. *IBM SPSS Statistics 27* was used for statistical analysis.

Results

A total of 2,810 physiotherapy students participated. In 2013, 927 second-year and 695 fourth-year students participated, and in 2020, 699 second-year and 489 fourth-year students were included. Characteristics of all students are presented in Table 1. The characteristics of the 2013 and 2020 samples are similar regarding sex and the percentage of participants experiencing LBP at the time of data collection (Table 1). Fourth-year students' median age was one year higher in 2020 compared to 2013, and 15.0% more second-year students and 16.9% more fourth-year students had a history of LBP in 2020. The number of observations within institutions also differed between 2013 and 2020, and between institutions. One institution did not recruit fourth-year students in 2020.

Table 1. Characteristics of second and fourth-year physiotherapy students in 2013 and 2020 (n = 2,810).

Characteristics		**2013** 2nd year	**2020** 2nd year	**2013** 4th year	**2020** 4th year
n observations		927	699	695	489
Age (years)		19 [19, 20]	19 [19, 20]	21 [21, 22]	22 [21, 23]
% Males (n)		37.9% (351)	35.5% (248)	37.8% (261)	36.8% (180)
% with a history of LBP (n)		43.6% (402)	58.6% (409)	49.9% (345)	66.8% (326)
% with current LBP (n)		14.4% (133)	14.6% (102)	14.6% (101)	13.3% (65)
n observation per institution	**UA**	148	89	77	91
	VUB	68	81	52	37
	UG	193	51	105	9
	KUL	133	184	165	0
	ULG	175	133	47	74
	UCL	63	51	137	170
	HG	91	39	48	59
	HR	54	71	64	49

Data are presented as proportions or median (interquartile range [Q1, Q3])

Legend: UA, University of Antwerp; VUB, Vrije Universiteit Brussel; UG, University of Ghent; KUL, Catholic University of Leuven; ULG, University of Liège; UCL, Université Catholique de Louvain; HG, Hanze University of Applied Sciences Groningen; HR, University of Applied Sciences Rotterdam; LBP, low back pain.

Attitudes and beliefs regarding the management of CLBP

Compared to 2013, the 2020 students had less biomedical beliefs, higher biopsychosocial beliefs, and less beliefs in the relationship between pain and impairment (Table 2). Differences in beliefs were larger in fourth-year students (PABS-BM: MD = -2.58, 95% CI: -3.31, -1.85; PABS-BPS: MD = 2.26, 95% CI: 1.75, 2.77; HC-PAIRS: MD = -2.35, 95% CI: -3.45, -1.26) than for second-year students (PABS-BM: MD = -1.74, 95% CI: -2.31, -1.18; PABS-BPS: MD = 1.16, 95% CI: 0.74, 1.58). There was no significant difference in beliefs between second-year students in the relationship between pain and impairments (HC-PAIRS: MD = -0.24, 95% CI: -1.02, 0.54). Differences in attitudes and beliefs were found when data from all participating institutions were pooled. However, this shift was not found in all institutions. Estimated mean score and

mean differences on the PABS-BM, PABS-BPS, and HC-PAIRS were significantly different (p < .001) between institutions (Figure 1). In one institution, fourth-year students had significantly higher beliefs in the relationship between pain and impairment in 2020 than in 2013.

Table 2. Estimated marginal mean differences between second and fourth-year students' attitudes and beliefs regarding chronic low back pain in 2013 versus 2020.

2nd year	Year	Mean	95% CI	Mean difference	95% CI
PABS-BM	2013	35.95	33.36, 38.54	-1.74	-2.31, -1.18*
	2020	34.21	31.61, 36.80		
PABS-BPS	2013	31.56	30.11, 33.01	1.16	0.74, 1.58*
	2020	32.72	31.26, 34.18		
HC-PAIRS	2013	51.66	48.19, 55.13	-0.24	-1.02, 0.54
	2020	51.42	47.95, 54.90		
4th year	**Year**	**Mean**	**95% CI**	**Mean difference**	**95% CI**
PABS-BM	2013	30.31	27.84, 32.78	-2.58	-3.31, -1.85*
	2020	27.73	25.26, 30.21		
PABS-BPS	2013	33.00	31.78, 34.23	2.26	1.75, 2.77*
	2020	35.26	34.02, 36.49		
HC-PAIRS	2013	45.80	43.33, 48.26	-2.35	-3.45, -1.26*
	2020	43.45	40.96, 45.93		

*CI, Confidence interval; PABS-BM, Pain Attitudes and Beliefs Scale for Physiotherapists biomedical subscale; PABS-BPS, Pain Attitudes and Beliefs Scale for Physiotherapists biopsychosocial subscale; HC-PAIRS, Health Care Providers' Pain and Impairment Relationship Scale. *Group difference p < .05.*

Guideline-adherent recommendations regarding CLBP

Table 3 presents an overview of the difference between students' guideline-adherent recommendations based on the clinical vignette in 2013 versus 2020. Significantly more fourth-year students expected 'no spinal pathology' or 'mild spinal pathology' as the cause for the CLBP symptoms in 2020 than in 2013 (19.5% vs 9.3%; OR = 2.31). No differences were found in second-year students in 2020 compared to 2013 (6.8% vs. 7.1%; OR = 0.96). Regarding activity, "Not limit any activity" or "Avoid only painful activities" was significantly more recommended in 2020 compared to 2013 by second-year students (35.5% to 42.4%, OR = 1.34) and fourth-year students (61.8% to 69.5%, OR = 1.41). Regarding work recommendations in 2020, 11.4% of the second-year students and 27.7% of the fourth-year students recommended "Work full time, full duty" or "Work moderate duty, full time", which was considered guideline-adherent. Both groups did not significantly differ compared to students in 2013 on guideline adherence (yes/no), nor on mean scores (means of the Likert scale scores). No results per institution were given for guideline-adherent recommendations due to the small proportion of guideline-adherent recommendations in physiotherapy students regarding spinal pathology and work in combination with the very low response rate in two institutions. This resulted in groups with zero guideline-adherent recommendations, which provided potentially biased results and difficulty in drawing reliable conclusions on differences between institutions.

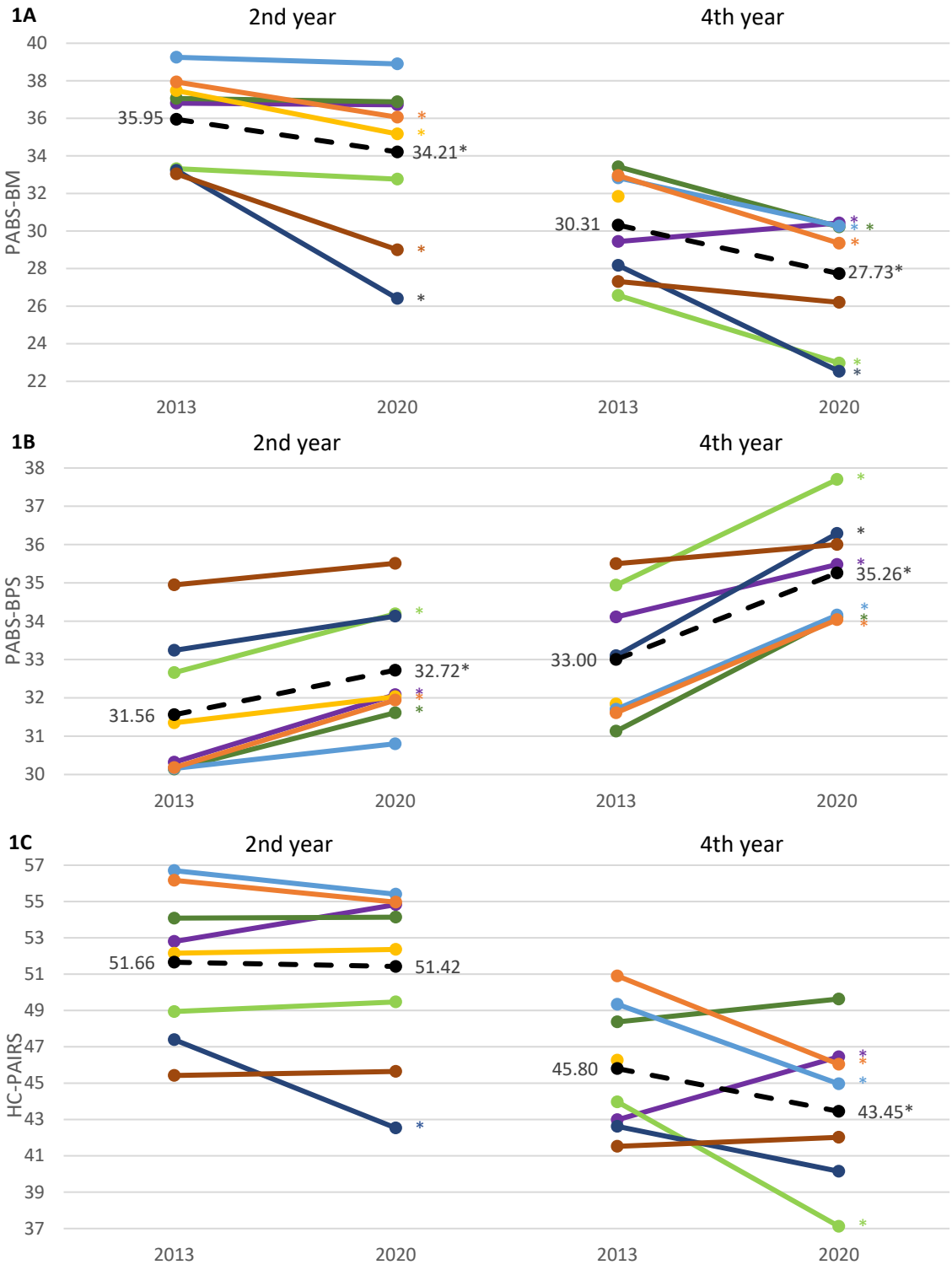

Figure 1: The biopsychosocial shift is seen in many but not all institutions in 2020 compared to 2013 (1A and 1B, n = 2,808; 1C, n = 2,720).

1A Biomedical orientation; Lower scores represent less biomedical beliefs.

1B Biopsychosocial orientation; Higher scores represent stronger biopsychosocial beliefs.

1C Beliefs in relationship between pain and impairment; Lower scores represent less belief in the relationship between pain and impairment.

*Legend: Coloured lines represent mean scores per institution, dashed black line shows the mean scores of all institutions combined. *Group difference p < .05.*

Table 3. Guideline-adherent recommendations, 2013 versus 2020 (n = 2,760).

2nd year	Year	Percentage	95% CI	df	t	Odds	95% CI
Spinal pathology	2013	7.1	5.6, 9.0	1, 1591	-0.21	0.96	0.65, 1.42
	2020	6.8	5.2, 9.0				
Activity	2013	35.5	32.5, 38.6	1, 1596	2.81	1.34	1.09, 1.64*
	2020	42.4	38.7, 46.2				
Work	2013	9.8	8.0, 11.9	1, 1595	1.04	1.19	0.86, 1.64
	2020	11.4	9.2, 14.0				
4th year	**Year**	**Percentage**	**95% CI**	**df**	**t**	**Odds**	**95% CI**
Spinal pathology	2013	11.5	9.3, 14.1	1, 1160	5.17	2.31	1.68, 3.17*
	2020	23.1	19.5, 27.1				
Activity	2013	61.8	58.1, 65.4	1, 1158	2.70	1.41	1.10, 1.81*
	2020	69.5	65.2, 73.5				
Work	2013	23.7	20.7, 27.1	1, 1158	1.53	1.23	0.94, 1.61
	2020	27.7	23.8, 32.0				

*Legend: SE, standard error; CI, conference interval; df, degree of freedom; Odds, Odds ratio. *Group difference p < .05.*

Attitudes and beliefs regarding knee osteoarthritis treatment

In general, a significantly higher percentage of second and fourth-year students in 2020 in comparison to 2013 'largely agreed' or 'totally agreed' with statements supporting the benefits of exercise and the biopsychosocial model (Figure 2).

Exercise therapy is believed to be effective for patients when radiographs show mild, moderate, or severe knee OA in more second-year and fourth-year students in 2020 than in students in 2013. However, radiographic findings influenced students' beliefs regarding exercise effectiveness, the more severe the findings, the less likely the students were to agree that exercise therapy is effective for patients with knee OA. Further, more students in 2020 compared to students in 2013 agreed that general exercise (2^{nd} year: 20.6 vs 16.7%; 4^{th} year: 39.5 vs 23.2%) and local strengthening exercises (2^{nd} year: 33.2 vs 27.8%; 4^{th} year: 43.6 vs 30.7%) should be prescribed for patients with knee OA. Consistent with declining beliefs in exercise effectiveness when magnetic resonance imaging findings show more severe knee OA, the minority of students in 2013 and 2020 believed that both general and local strengthening exercises are safe for everybody to do.

Regarding beliefs relating to the delivery of exercise therapy and adherence, more students in 2020 compared to 2013 believed that patients compliance determined the effectiveness of exercise programs, (2^{nd} year: 78.6 vs 72.1%4^{th} year: 78.5 vs 66.5%), that exercise is most beneficial when it is tailored to meet individual patient needs (2^{nd} year: 86.9 vs 73.4% ; 4^{th} year: 91.5 vs 78.2%), and that the patient is the best person instead of the physical therapist to decide whether they should do exercise at home or in a group setting (2^{nd} year: 42.5 vs 29.9%; 4^{th} year: 56.8 vs 33.0%). Furthermore, more fourth-year students in 2020 compared to students in 2013 (82.5 vs 71.2%) believed that physical therapists should educate patients with chronic knee OA about how to improve their lifestyle and more second and fourth-year students believed that it is important that patients with knee OA increase their overall activity levels (2^{nd} year: 28.6 vs 18.1%; 4^{th} year: 48.7 vs 28.3%).

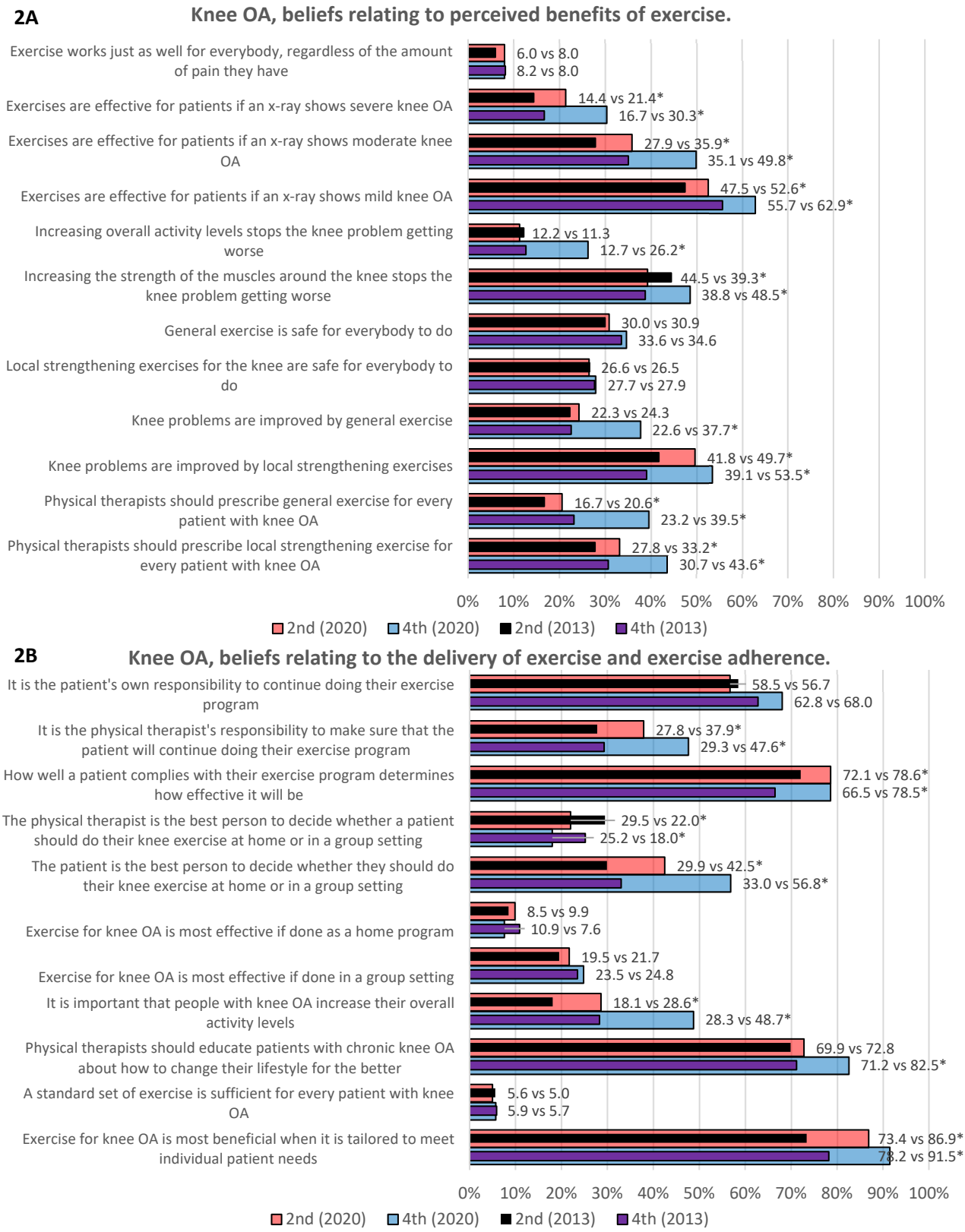

Figure 2. Beliefs relating to perceived benefits of exercise in patients with knee OA and beliefs relating to the delivery of exercise and exercise adherence in patients with knee OA (n = 2,724).

*Legend: Results show differences in percentages of students between students in 2013 and 2020 who largely agree or totally agree on the statements. OA, osteoarthritis; vs, versus. *Group difference p < .05.*

Age, sex, current LBP, history of LBP, institution and year of education

Based on the total sample, sex, current LBP, and history of LBP were no significant predictors for the level of attitudes and beliefs and guideline-adherent recommendations regarding CLBP. Higher age predicted lower biomedical orientation, less belief in the relationship between pain and impairment, and higher guideline-adherent recommendations regarding spinal pathology and activity (Supplemental material 2). Being a fourth-year student predicted less biomedical and stronger biopsychosocial orientation, less belief in the relationship between pain and impairment, and more guideline-adherent recommendations in all outcome measurements. Studying in 2020 predicted better outcomes except for guideline-adherent recommendations regarding work. Institutions explained between 12.1% to 30.6% of the variance in attitudes and beliefs, and guideline-adherent recommendations regarding CLBP.

Discussion

This study aimed to investigate if the 2020 physiotherapy students' attitudes and beliefs regarding CLBP and knee OA and their guideline-adherent recommendations are better than those of the students in 2013. In general, Dutch and Belgian physiotherapy students had stronger biopsychosocial attitudes and beliefs regarding the management of both CLBP and knee OA and guideline-adherent recommendations were higher for spinal pathology and activity in 2020 compared to 2013.

Although physiotherapy students had stronger biopsychosocial attitudes and beliefs towards CLBP and knee OA, their beliefs regarding the relationship between pain and impairment remained high. Previous studies with graduate and undergraduate healthcare professionals reported similar misbeliefs in the relationship between pain and impairment.[49-52] These beliefs are associated with limiting patients' activity and work participation and could explain the relatively small improvements in guideline-adherent recommendations regarding activity and the lack of difference in guideline-adherent recommendations regarding work participation between 2013 and 2020.[53,54] In addition, it is also reflected by the large expectancy of moderate to extreme severe spinal pathology causing CLBP based on the clinical vignette, decreasing beliefs in the effectiveness of exercise therapy when the severity of knee OA increased, and a large percentage of students who believed that exercises are not safe for everybody with knee OA, which are common beliefs in healthcare professionals.[22,55]

The effect of more adequate and comprehensive education in pain is reflected by the stronger biopsychosocial beliefs in fourth-year students compared to second-year students and the significant improvement within several institutions in 2020 compared to 2013.[56] This positive learning curve in 2020 was also found in the cohort of 2013 and is consistent with previous studies observing the change in pain attitude and beliefs in physiotherapy students from first to last year semesters and comparing physiotherapy students between different semesters within an institution.[24-26,57-60] However, these results were not found within every institution in our study, which can be due to differences between pain curricula in educational programs

like pain content and hours taught but also the timing of measurements and pain lectures within the curricula.[27-29,61] Although this study did not examine the curricula of physiotherapy educational programs, the institution was a contributing factor in predicting the physiotherapy students' level of biopsychosocial beliefs and guideline-adherent recommendations regarding CLBP.

To our knowledge, no previous study used a similar design to compare the difference between academic years over a more extended period of time, preventing a comparison of our primary objective. However, the results illustrate that physiotherapy students' biomedical orientation is still too strong and biopsychosocial orientation and guideline-adherent recommendations are still too low, underscoring the need for additional efforts to implement the biopsychosocial model and evidence-based practice for the management of CLBP and knee OA within all physiotherapy educations.

Strengths and limitations

The strengths of this study include the substantial number of students (n = 2,810) who participated in this international multi-institutional-based comparison of cross-sectional measurements in 2013 and 2020. Likewise, the number of participating institutions (n = 8) is a unique feature and has not been done before.

The missing data of this large sample size remained below 5%, limiting the risk of bias and enhancing the likelihood that the sample and the data represented the physiotherapy students population in the Netherlands and Belgium.[62] Moreover, having seven years between both measurements allowed sufficient time for physiotherapy educational programs to adapt curricula in alignment with the biopsychosocial model. Another strength is the addition of attitudes and beliefs assessment regarding knee OA to evaluate whether potential differences in attitudes and beliefs were also found in another chronic musculoskeletal pain beyond CLBP.

This study also has several limitations. The PABS-PT and HC-PAIRS, respectively developed in 2003 and 1995, may not fully align with modern pain science, the PABS-PT's interpretability and content validity are lacking, and its biopsychosocial subscale demonstrated insufficient discriminative ability.[37,63,64] Moreover, clinical vignettes' validity ranges from little differences to poor concordance with actual behaviour and standardized patients, and a difference in attitudes and beliefs, and clinical recommendations based on vignettes do not perfectly reflect a difference in clinical behavior which has multifactorial causations.[43-46] Further, classifying 'avoiding painful activities' as guideline-adherent might have led to overestimating guideline-adherent recommendations regarding activity as it did not distinguish between avoiding painful daily activities and those that exceeding patient's physical capacity.[65,66] Similar, recommending "light duty, full time" could also be considered guideline-adherent as the clinical vignette lacks definition for "moderate duty" and "light duty" and Dutch and Belgian clinical guidelines recommend reducing work absenteeism without commenting on the intensity of work tasks.[65,66]

Clinical relevance

Despite the calls for action, after seven years, overall attitudes and beliefs were 5.1% to 8.5% more biopsychosocial, guideline-adherent recommendations regarding spinal pathology and activity was 11.6% and 7.7% higher, and there was even more variance in attitudes and beliefs of physiotherapy students between institutions. On a large scale, it could indicate a clinically relevant improvement. However, average total scores of attitudes and beliefs differed by approximately 2 points, which makes the impact debatable. No cut-off points are known to decide whether attitudes and beliefs are considered 'strong' or 'weak' or if differences in scores are clinically relevant. There is much room for improvement to address physiotherapy students' misbeliefs regarding CLBP and knee OA management.

Educational programs have been proven effective in enhancing students' biopsychosocial attitudes and beliefs, underscoring the need to revise educational curricula by incorporating more essential pain-related items and increasing the hours taught using pedagogic approaches.[56,67-69] Implementing these in all curricula could decrease the variance between universities, resulting in significant improvements in all institutions over time, and benefit students and physical therapists on the outcomes of this study. Future educational research should explore the role of content, dosage, timing, competence level, quality, years of education, bachelor and or in physiotherapy educational programs on physiotherapy students' attitudes, beliefs and clinical recommendations. Additionally, a broader perspective of personal factors like cultural and social factors on students' learning curves should be explored to determine which factors repel or facilitate the development of biopsychosocial attitudes and beliefs of physiotherapy students, because only age, year of education, academic year and institution were significant predictors in our study. [32,70-74] Further, outcome measures in future studies should also focus on more underlying beliefs and motives to provide a better understanding of physiotherapy students' clinical recommendations.

Conclusion

The comparison of the 2013 and 2020 cohorts of physiotherapy students demonstrated a shift in attitudes and beliefs towards a more biopsychosocial approach and guideline-adherent recommendations for CLBP and knee OA management, but the improvements were limited and varied among institutions. However, no improvement was found in work recommendations, and guideline adherence of physiotherapy students' recommendations remained low, allowing ample room for improvement.

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Chapter 2

Cross-cultural adaptation and psychometric testing of the French version of the Knowledge and Attitudes of Pain (KNAP) Questionnaire

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Dear Editor,

The management of chronic pain by healthcare professionals (HCPs) is partly determined by their knowledge and attitudes towards pain, which predict their therapeutic decisions and treatment outcomes [1-3]. A stronger biomedical approach is associated with lower adherence to pain management guidelines, with poorer pain and disability outcomes compared with HCPs who use a biopsychosocial approach [1,2,4]. Therefore, it is important to both identify and differentiate between HCPs' knowledge, attitudes and beliefs [3].

Many questionnaires have been developed and used to evaluate the knowledge and attitudes of HCPs regarding chronic pain. Commonly used questionnaires include the Revised Neurophysiology of Pain Questionnaire (RNPQ) and the Pain Attitudes and Beliefs Questionnaire for Physiotherapists (PABS-PT) [5]. However, these questionnaires have several limitations. The PABS-PT is missing elements of modern pain science, e.g., neuroplasticity and the pain neuromatrix, and the PABS-PT subscales have low discriminative abilities [6,7]. The RNPQ measures knowledge, but not attitudes, and is rated using true-false responses that do not reflect HCPs' convictions. Therefore, Beetsma et al. (2020) developed the Knowledge and Attitudes of Pain (KNAP) questionnaire [6]. This questionnaire assesses both HCPs' knowledge about modern pain science and their biopsychosocial attitudes towards pain. It is scored on a 6-point Likert scale ranging from completely disagree to completely agree and has adequate measurement properties [6]. The original paper provided both a Dutch and an English version. However, a French version of this questionnaire has not yet been developed.

This study aimed to translate and cross-culturally adapt the KNAP into French and to test its psychometric properties in graduate and undergraduate HCPs.

This study involved two phases: a phase of translation and cultural adaptation and a phase of assessment of the measurement properties. The study was approved by the Liège University Hospital Ethics Committee (2021/421).

The translation and cultural adaptation phase was carried out in accordance with all 5 recommended stages described by Beaton and the COSMIN Study Design checklist for Patient-reported outcome measurement instruments [8,9]. (1) The English version of the KNAP was individually translated and culturally adapted by 2 English-French speaking experts (CD and VG, native French speakers). CD is an expert in chronic pain and VG is a professional translator who does not have a healthcare background. (2) Both translators reached a consensus on the synthesis of the French translations. (3) Two other English-French speaking experts (SB and AS, native English speakers), who were unfamiliar with the original version of the KNAP questionnaire, individually back-translated the questionnaire into English. (4) The 4 bilingual experts, plus an expert in chronic pain (NR) and a linguist reviewed the translations and reached a consensus for the prefinal version of the French KNAP questionnaire. In step four, 18 modifications were made during the expert meeting. One of the developers of the original questionnaire (AB) was contacted to ensure that the final translation reflected the original version of the questionnaire. (5) 20 native French-speaking participants (5 doctors, 5

physiotherapists, 5 medical students and 5 physiotherapy students) completed the questionnaire and were asked about any difficulties encountered during completion. After the testing of this prefinal version, the expert committee used the comments collected to make 3 more modifications to reach the final, consensual version of the French KNAP (Supplemental material 3).

The KNAP questionnaire consists of 30 items, each scored on a 6-point Likert scale, from "strongly disagree" to "strongly agree". In accordance with the calculation method of the original questionnaire, item scores were recoded into Rasch scores, 13 item scores were flipped, and the total scores were converted into scores ranging from 0 to 150. Higher scores indicate knowledge and attitudes that reflect modern pain neuroscience. Details of the scoring and recoding procedures are provided in the original article, Appendix A. Supplementary data [6].

To assess the measurement properties of the KNAP-FR, French-speaking graduate and undergraduate HCPs were recruited in Belgium between February and March 2022. Medical doctors and physiotherapists who treated people with chronic musculoskeletal pain were recruited in hospitals and different independent practices in Belgium. Furthermore, within the University of Liège, third- and fourth-year physiotherapy students and fourth- to sixth-year medical students were invited to participate. The exclusion criterion was age below 18 years. In total, 101 participants were included: 21 doctors, 27 physiotherapists, 26 medical students, and 27 physiotherapy students. The characteristics of the participants and median scores (first; third quartile) are shown in Table 1. Participants completed a battery of questionnaires including demographic characteristics, the KNAP-FR questionnaire, the French RNPQ, and the adapted version of the French PABS-PT, either on paper or electronically. One week after completing the questionnaires, participants were invited to complete the KNAP-FR questionnaire again. Participants who had attended a chronic musculoskeletal pain course were excluded from the retest phases. Of the 101 participants, 53 participants completed the retest evaluation.

The interpretability of the measurement properties was adequate. None of the participants scored the minimum or maximum overall scores; therefore, there was no floor or ceiling effect (<15% of the observations had a maximum or minimum overall score). Data were not missing for any items. The distribution of the scores per item is shown in Figure 1.

The Cronbach's coefficient (0.71) was between 0.70 and 0.95, reflecting adequate internal consistency [10]. The test-retest reliability was determined by calculating the intraclass correlation coefficient (ICC) using a single-measurement, absolute-agreement, two-way mixed effects model [11]. The ICC was 0.87 (95% CI, 0.79−0.93), reflecting good reliability [12]. The Mann-Whitney U test was used to analyze whether the test-retest group represented the total sample. No significant differences were found. The standard error of measurement (SEM) and minimal detectable change (MDC) were calculated from the test-retest reliability [13]. The SEM calculation was SDxx(1−ICC), and the MDC with 90% CI was calculated as SEMx1.65x2. The SEM was 2.12 (95% CI, 1.58−2.73), and the MDC90 was 4.95 (90% CI, 3.69−6.37).

Table 1: Characteristics of the study sample

	Medical doctors (N=21)	**Physiotherapists** (N=27)	**Medical students** (N=26)	**Physiotherapy students** (N=27)	**Total** (N=101)	**Test-retest** (N=53)	***p*-value**
Age (in years)	33 [27.5; 49.5]	25 [24; 30]	23 [22.75; 24]	23 [21; 24]	24 [23; 27.5]	24 [22.5; 26.5]	0.194
Sex: % female	52%	67%	85%	59%	66%	70%	0.720
Nationality:							
- **Belgian**	91%	63%	92%	74%	79%	77%	0.847
- **French**	/	37%	4%	26%	18%	21%	
- **Other**	9%	/	4%	/	3%	2%	
Current chronic musculoskeletal pain:							
- **Yes**	14 %	4%	15%	11%	11%	8%	0.776
- **No, but a history of it**	19%	26%	12%	4%	15%	17%	
- **No**	67%	70%	73%	85%	74%	75%	
KNAP-FR total score	83.15 [80.57; 86.63]	86.21 [83.88; 92.84]	83.33 [81.65; 86.41]	85.00 [82.44; 89.26]	84.25 [81.74; 87.46]	83.88 [81.24; 88.12]	0.073
RNPQ total score	8 [8; 9]	8 [8; 10]	9 [8; 9]	9 [8; 10]	8 [8; 9]	9 [8; 10]	0.598
PABS-PT total score	21 [18; 23.5]	21 [18; 25]	17.5 [15; 20]	21 [18; 21]	20 [17; 22]	21 [17; 22.5]	0.479

KNAP-FR = French version of the Knowledge and Attitudes of Pain; N = number of participants; PABS-PT = Pain Attitudes and Beliefs Questionnaire for Physiotherapists; RNPQ = Revised Neurophysiology of Pain Questionnaire; / = none of the participants provided this answer.

Results are presented as proportions or Median with [Interquartile range]. The p-value was calculated between groups total and test-retest. A p-value < .05 was considered statistically significant.

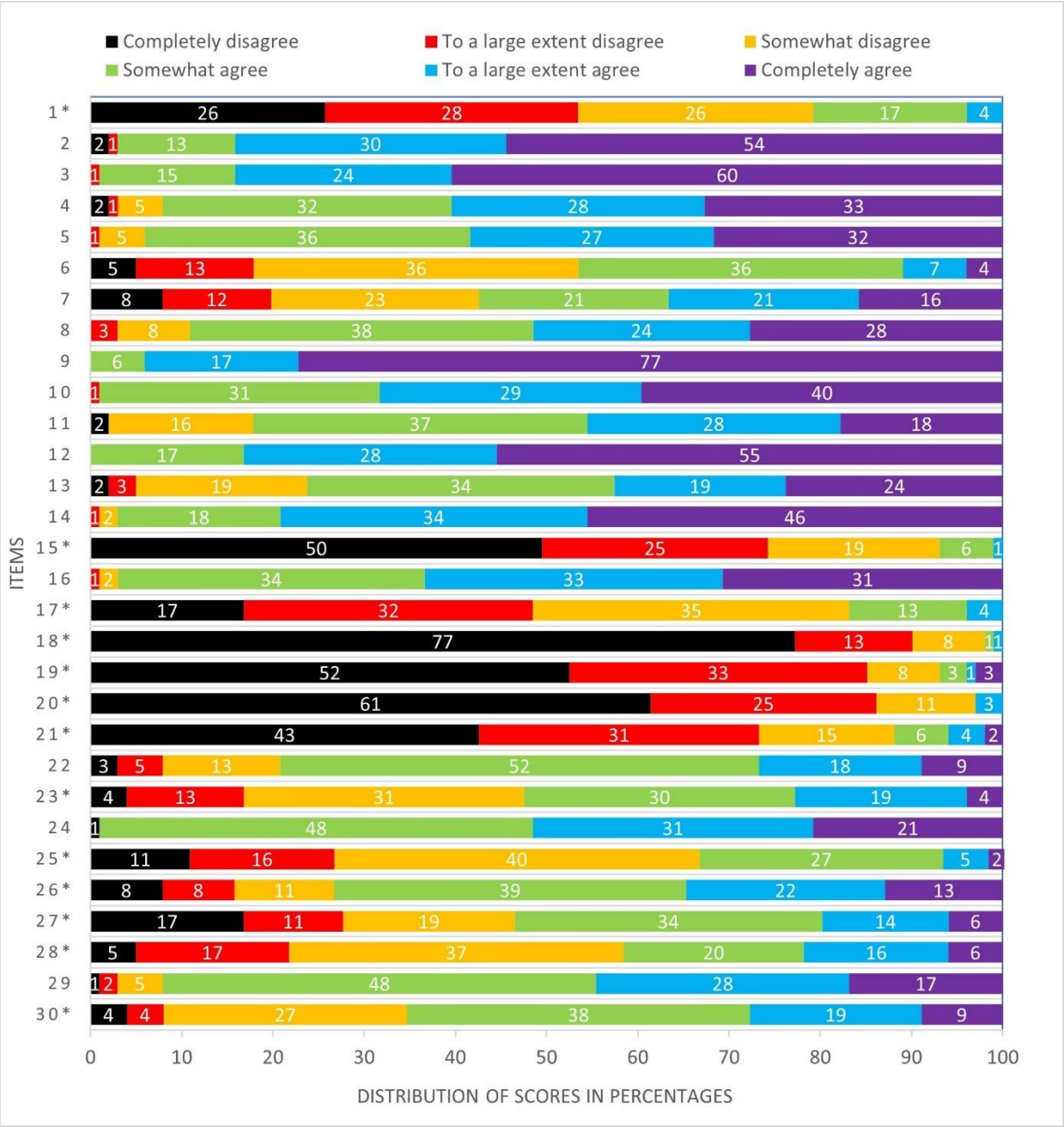

Figure 1. Distribution of the scores for each item of the KNAP-FR.

*Scores represent the percentage of responses per item. * = items that were flipped for scoring.*

The construct validity of the KNAP-FR was evaluated by calculating the correlation coefficient between the KNAP-FR and the French RNPQ and the adapted French PABS-PT. A value <0.1 was considered as no correlation, >0.1 as weak, >0.3 as moderate, and >0.7 as a strong correlation [14]. The RNPQ assesses HCPs' understanding of the neurophysiology of pain, with scores ranging from 0 to 12 [15]. Higher scores indicate better knowledge of pain. The PABS-PT was designed to assess therapists' attitudes and beliefs about low back pain. To avoid making the questionnaire battery too large, pain neurophysiology experts involved in the study selected 5 items of the 19-item version for use in the study (see Table 2). The scores of the biomedical-related items were flipped (i.e., reversed) to calculate the total score (ranging from 5 to 30). A higher total score reflects stronger biopsychosocial attitudes and beliefs. The

construct validity analysis found a moderate correlation between the KNAP-FR and the adapted PABS-PT score ($r(99) = 0.34$, $p < 0.001$) and a weak but significant correlation with the RNPQ total score ($r(99) = 0.24$, $p = 0.017$).

These results are in line with the psychometric measurement properties found for the original KNAP questionnaire [6]. The original study reported similar reliability, with a Cronbach's coefficient of 0.78 and a test-retest ICC of 0.80 [6]. Furthermore, the MDC90 of 4.95, found in our study, is nearly identical to the 4.99 found in the original study [6]. Higher internal consistency was found in a validation study of the Japanese version ($\alpha = 0.92$), but the MDC was larger [16]. This might result from the smaller sample size ($n = 44$) and different study population [16]. A sample size >100 is needed to ensure the stability of the variance [10]. The lack of a floor or ceiling effect was also reported in the previous studies.

A limitation of this study is that the mean age of the medical doctors and physiotherapists was lower than the general population of HCPs. It is very likely that many HCPs in our sample graduated recently and therefore have similar median scores as students in the last semesters of their education. The narrow distribution and similar median scores between the subgroups could explain the weak and moderate correlations with the RNPQ and the adapted version of the PABS-PT. In addition, the selection of 5 items of the PABS-PT probably lowered its discriminative ability, which was already low, and weakened the correlation. Beetsma et al. (2020), who included students from the first to the fourth year, found stronger correlations with the RNPQ ($r = 0.52$) and PABS-PT ($r = 0.58$) [6]. A larger sample variance more similar to the general population of HCPs would likely have increased the construct validity, test-retest reliability, and external validity[17].

The present study showed that the KNAP-FR developed in this study is acceptable, valid, and has good reliability in graduate and undergraduate medical doctors and physiotherapists.
The KNAP-FR is applicable in many health systems because French is the fifth most spoken language in the world; therefore, this study is clinically relevant. In addition, scientists and policymakers are demanding more interventions to address misconceptions concerning musculoskeletal pain in HCPs [18-20]. Valid tools to assess the effectiveness of these interventions are needed. The KNAP-FR questionnaire generates reliable and valid data for the assessment of pain knowledge and attitudes of French-speaking physiotherapists, medical doctors, and undergraduate students within clinical research, education, and healthcare management.
Future studies should assess the measurement properties, including the responsiveness to change and the minimally important differences of the KNAP-FR, within a large-scale study with a broader population of healthcare disciplines and non-HCPs, to explore the validity and the discriminative ability of the questionnaire to identify pain knowledge and attitudes in HCPs.

To conclude, the KNAP-FR is reliable and valid for the evaluation of the knowledge and attitudes of French-speaking physiotherapists, medical doctors, and undergraduate students.

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Chapter 3

Development of an interdisciplinary training program about chronic pain management with a cognitive behavioural approach for healthcare professionals: part of a hybrid effectiveness-implementation study

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Abstract

Background

Many applied postgraduate pain training programs are monodisciplinary, whereas interdisciplinary training programs potentially improve interdisciplinary collaboration, which is favourable for managing patients with chronic pain. However, limited research exists on the development and impact of interdisciplinary training programs, particularly in the context of chronic pain.

Methods

This study aimed to describe the development and implementation of an interdisciplinary training program regarding the management of patients with chronic pain, which is part of a type 1 hybrid effectiveness-implementation study. The targeted groups included medical doctors, nurses, psychologists, physiotherapists, occupational therapists, dentists and pharmacists. An interdisciplinary expert panel was organised to provide its perception of the importance of formulated competencies for integrating biopsychosocial pain management with a cognitive behavioural approach into clinical practice. They were also asked to provide their perception of the extent to which healthcare professionals already possess the competencies in their clinical practice. Additionally, the expert panel was asked to formulate the barriers and needs relating to training content and the implementation of biopsychosocial chronic pain management with a cognitive behavioural approach in clinical practice, which was complemented with a literature search. This was used to develop and adapt the training program to the barriers and needs of stakeholders.

Results

The interdisciplinary expert panel considered the competencies as very important. Additionally, they perceived a relatively low level of healthcare professionals' possession of the competencies in their clinical practice. A wide variety of barriers and needs for stakeholders were formulated and organized within the Theoretical Domain Framework linked to the COM-B domains; 'capability', 'opportunity', and 'motivation'. The developed interdisciplinary training program, including two workshops of seven hours each and two e-learning modules, aimed to improve HCP's competencies for integrating biopsychosocial chronic pain management with a cognitive behavioural approach into clinical practice.

Conclusion

We designed an interdisciplinary training program, based on formulated barriers regarding the management of patients with chronic pain that can be used as a foundation for developing and enhancing the quality of future training programs.

Introduction

Chronic pain affects approximately 20% of the population worldwide [1]. Chronic pain has a tremendous personal and socioeconomic impact: it causes the highest number of years lived with disability [2] and is the largest cause of work-related disability [3,4]. The intensity, functional impact and persistence of pain are influenced by biopsychosocial factors [5-9]. Factors such as comorbidities, physical well-being, behaviour, psychosocial well-being and environmental aspects can all influence the pain a person experiences [5-9]. This understanding of chronic pain has shifted management strategies from pure biomedical treatments to multimodal approaches acknowledging the complex biopsychosocial nature of chronic pain.

Nonetheless, integrating biopsychosocial chronic pain management is complex. As a consequence, many applied treatments remain biomedically oriented and defined as low-value care [10], resulting in poorer pain, activity and work-related outcomes [11-13]. In addition, patients often consider their treatment to be inadequate [1,14-16]. With decades of education, dozens of guidelines and many good intentions to improve care, the gap between science and clinical care remains, which limits the implementation of biopsychosocial chronic pain management in clinical practice. There are multifactorial reasons why clinical guidelines are poorly adhered to by HCPs, e.g. lack of knowledge regarding pain and pain management [17-23], HCPs feel that their skills and confidence are insufficient to change their behaviour, which is sometimes also not applicable in their clinical practice [24-27]. Furthermore, patient ability and preferences also affect HCPs' guideline adherence [21,28,29].

Postgraduate training programs could lower these barriers by improving HCPs' knowledge, skills and confidence to facilitate behavioural change. Studies indicate that educational interventions resulted in more guideline-adherend recommendations regarding activity, bed rest and imaging referral [30] and on actual referral behaviour [31] than solely providing clinical guidelines, although French et al. (2013) found significant differences in guideline-adherent imaging recommendations but not in actual imaging behaviour [30]. In addition to improved guideline adherence, training programs are effective in improving HCPs' knowledge and skills regarding the management of pain with effect sizes ranging from small to large [32-37]. However, this effect can decline over time [38]. Most educational training programs were applied to monodisciplinary groups of HPCs, while there is a need for interdisciplinary training to facilitate interdisciplinary collaboration within healthcare [20,39,40]. In addition, interdisciplinary collaboration in clinical practice is associated with improved psychosocial attitudes and might therefore benefit the mid- and long-term effectiveness of training programs [39,41,42]. However, little is known about the impact of interdisciplinary postgraduate pain educational training programs, especially when focusing on chronic pain. Given the established need for interdisciplinary educational training programs to improve interdisciplinary collaboration within healthcare [20,39,40], the lack of studies examining the impact of interdisciplinary postgraduate chronic pain training educational programs represents a significant knowledge gap. Such interdisciplinary postgraduate chronic pain training programs are also challenging,

as they have to be applicable to all HCPs. Here, we aimed to address the significant knowledge gap by developing an interdisciplinary training program about chronic pain for HCPs.

For the reasons outlined above, within this study, we describe the development of an interdisciplinary training program about chronic pain for HCPs. First, an interdisciplinary expert panel was organised to identify barriers and needs expressed by stakeholders for such an interdisciplinary chronic pain training program. Second, the identified barriers and needs of stakeholders for a chronic pain training program were used for the development of an interdisciplinary training program regarding the management of patients with chronic pain. This study is part of a type 1 hybrid implementation study to evaluate the impact of an interdisciplinary training program about chronic pain on HCPs' knowledge, attitudes, and to assess the determinants of implementation behaviour.

Methods

The study was approved by an independent Medical Ethical Committee (EC-2021-327) linked to the University Hospital of Brussels, Brussels, Belgium and was in accordance with the Guideline for Reporting Evidence-based practice Educational interventions and Teaching (GREET) [43], Template for Intervention Description and Replication (TIDieR) checklist [44] and Standards for Reporting Implementation Studies (StaRi) Statement [45].

Belgian context

Belgium is a European country with 11.7 million inhabitants and is divided into three regions: Flanders – official language Dutch -, Brussels official language Dutch and French - and Wallonia – official language French. Belgium has a federal government (Federal Public Service) that manages substantial parts of public health. Each region has its own governance with powers in fields that are connected with its region. In 2019, 7.9% (€37.2 billion) of the Belgian Gross Domestic Product, is spent on health [46]. In 2022, Belgium had approximately 61.858 medical doctors, 41.535 physiotherapists, 210.079 nurses, 11.086 dentists, 22.508 pharmacists, 14.478 occupational therapists and 14.641 clinical psychologists [47]. However, these are registered HCPs and do not represent all practising HCPs. Most of the care is coordinated by primary care doctors, and access to a physiotherapist or occupational therapist requires a referral. Care will require expenses by the patient because it is partly reimbursed by health insurance – which is mandatory for all inhabitants. Approximately 23% of the Belgian population has chronic pain [1]. Among primary care doctor practices, chronic pain patients account for 33 to 49% of the consultation, with 81% reporting pain lasting for more than a year [48]. Moreover, pain serves as the primary motive for consultation in 78% of (sub)acute patients and 54% of chronic pain patients [48].

The study consortium consists of three partners: an international research group, Pain in Motion, administratively embedded at VUB in collaboration with Université de Liège, Ghent University, Antwerp University and Université Catholique de Louvain; and two primary care doctors associations - SSMG and Domus Medica - who represent Dutch and French-speaking primary care doctors in Belgium. The Belgian Federal Public Service of Health, Food Chain

Safety and Environment funded this study. Together with affiliated healthcare policy organisations, the Federal Public Service was represented in a guidance committee. This committee supervised the progress of the study and provided feedback based on reports and presentations by the study consortium.

Pain management competencies

Pain management competencies were used as a basis to determine if they were appropriate to guide the development of the training program, to assess the extent healthcare providers meet this standard and as learning outcomes for the training program. The competencies were based on the book Explain Pain [49] which aims to demystify the process of understanding and managing pain. This was requested within the funding application of the Belgian Federal Public Service of Health, Food Chain Safety and Environment. Subsequently, the consortium worked collaboratively to refine and formulate these competencies until consensus was achieved among the members who applied for the grant (JN, CD, MDK, MM, & AB). The pain management competencies were:

1. Understand acute and chronic pain within a biopsychosocial framework
    a. Understand the difference between pain and nociception and acute and chronic pain.
    b. Recognize that the purely biomedical model is out-of-date and that the biopsychosocial model of pain should be adopted.

2. Assess patients with (chronic) pain comprehensively
    a. Use questionnaires and interviews to identify patients' biopsychosocial factors which might influence pain experience according to the PSCEBSM model [9] (pain–somatic factors – cognitive factors – emotional factors – behavioural factors – social factors – motivation).
    b. Assess the patients' resources, obstacles to improvement, and their "readiness to change".

3. Integrate contemporary pain science into clinical reasoning in patients with chronic pain
    a. Incorporate patients' biopsychosocial factors when making decisions regarding chronic pain type (e.g. nociceptive, neuropathic and/or nociplastic pain), patients' evaluation and care request.
    b. Design multimodal treatment programs, either mono- or interdisciplinary, according to the patients' representations, beliefs, expectations and needs, e.g. stress self-management program, graded activity program, graded exposure, education/reassurance, etc.

4. Provide tailored and patient-centred strategies to subacute and chronic pain patients
    a. Educational strategies:
        i. Understand that pain science education (PSE) is a continuous process;

ii. Use communication skills to favour therapeutic alliance;
iii. Master pain neurophysiology and the biology behind different pain mechanisms to be able to explain pain to patients by means of metaphors and tools.

b. Use a patient-centred approach to define specific goals that are meaningful to the patient.
c. Manage obstacles to improve the patient's motivation to change.
d. Teach patients pain coping skills aligned with the ideas delivered during PSE.

5. Understand the role of HCPs in an interdisciplinary perspective
    a. Understand other healthcare disciplines' roles in successfully managing chronic pain.
    b. Communicate adequately with other HCPs about the management of chronic pain.

Interdisciplinary expert panel

Knowing the priority groups' setting and the barriers and needs to change is essential to achieve successful implementation [50-54]. We selected priority groups with HCPs working in primary care since these are the first HCPs in contact with patients with chronic pain. We selected primary care doctors, (home)nurses, psychologists, physiotherapists, occupational therapists, dentists and pharmacists. Although we focused on priority groups, the training program was accessible to all HCPs.

An interdisciplinary expert panel was organised and included 23 experts: a Dutch and a French-speaking expert for each priority group, two pain centre specialists, two heads of pain centres, an anaesthetist, a member of a patient association and a member of a Belgian organisation that focuses on guideline implementation and a policy maker working at a hospital and government.

The interdisciplinary expert panel completed an online questionnaire in which they indicated the importance of the established competencies. Additionally, they were asked to provide their perceptions of the extent to which Belgian HCPs already possess the competencies in their clinical practice. Furthermore, the expert panel was asked to formulate barriers and needs relating to training content and the implementation of biopsychosocial chronic pain management with a cognitive behavioural approach in clinical practice within Belgian healthcare, in line with contemporary pain science. They were asked to provide the barriers and needs at the level of HCPs, patients, organisations and the healthcare system. All answers regarding barriers and needs through the online questionnaire were included. The answers were accompanied by a literature search and discussed during the first meeting to provide a deeper understanding of the barriers, needs and specific context variables relevant to the implementation study. We used a framework to guide and organise the barriers and needs, and to characterise interventions and policies to change behaviour [55]. This framework consist of the Theoretical Domain Framework, containing 14 domains regarding behavioural change,

which were mapped into the COM-B model. The COM-B model is a guide to design interventions and includes the domains 'capability', 'opportunity', and 'motivation' [56]. Three online meetings with the expert panel were organised, one to discuss the barriers and needs, one to evaluate the patient materials and one to evaluate the training program prior to implementation. The expert panel received an update about the results of the training program after the completion of the implementation process.

Chronic pain training program

An original and interactive blended learning training program was developed including two e-learning modules and two face-to-face workshops based on the barriers and needs formulated by the literature search and expert panel. The training program aimed to improve HCP's competencies for integrating biopsychosocial chronic pain management with a cognitive behavioural approach into clinical practice. Both a Dutch and French version was developed. Each e-learning module lasts approximately 1 hour, and each workshop lasts 7 hours. This amount of training hours is commonly applied and reported to be effective in changing knowledge, attitudes and determinants of implementation behaviour [57,58].

The e-learning modules provided the theoretical basis to the participants and maximised the time for interactions and skills training during the workshops. The two workshops – in interdisciplinary groups - were designed to focus on skill training and practical implementation of the biopsychosocial model and improved communication techniques and PSE for a cognitive behavioural approach in clinical practice because this is applicable and essential to all HCPs [59-66]. Approximately a month was planned between both workshops so participants can practice in their clinical practice and their experience can be discussed during their second workshop. We used a variety of educational methods, such as interactive lessons, video materials, local opinion leaders [67], demonstrations, illustrations, assignments, skills training, clinical reasoning training, goal settings, role-playing, case studies and interdisciplinary discussions, and peer- and teacher feedback to improving the learning process [67-70]. Interdisciplinary collaborative exercises were applied to facilitate uniformity in communication and chronic pain management approach, and improved collaboration in clinical practice. These methods were used to reduce the barriers and accommodate the needs formulated by the expert panel to implement the biopsychosocial model, corresponding to HCPs' current best-evidence approach in line with modern pain sciences [41,69]. Both workshops included mandatory phases in combination with optional phases that could be adapted to the expectations and needs of the participants.

After participating in the training program, participants were asked if they were interested in sharing their name, work address(es) and contact details. With this information, an interactive map was developed and shared with all participants to improve their interdisciplinary collaboration. The local trainers aimed to facilitate a sustainable change by acting as a chronic pain resource person for the HCPs in the geographic areas after the implementation study.

Patient materials

Patient materials were developed to support the integration of the biopsychosocial model and PSE in clinical practice and the quality of PSE for patients with chronic pain. The patient materials included posters, a patient booklet – which was an update from an existing PSE booklet [71] - and videos explaining pain were created by collaborating with the Retrain Pain Foundation by making videos from their PSE slides [72]. A panel of five Dutch-speaking and five French-speaking patients with chronic pain were organised to co-design these materials. These patients were recruited from two chronic pain patient organisations and within the university hospital of Brussels (UZ Brussel). The patient panel discussed patients' needs, information and messages that were important to patients and provided feedback on the developed materials. The patient materials discusses the impact of pain, why we feel pain, the difference between acute and chronic pain, the role of the nervous system and the brain, an overprotective alarm system and contributing factors, and how to manage chronic pain (e.g. improve understanding about pain, beliefs and expectations, active lifestyle, stress management, social life, sleep, positive and negative effects of medication, self-management and the support from HCPs. The patient materials were evaluated based on the following criteria: 'clarity', 'content', 'usefulness', 'layout', 'understandability', 'added value or not', 'consistency' and 'suggestions for improvements' by the expert panel and patient panel. All materials were updated based on their feedback to improve quality.

Trainer recruitment and train-the-trainer workshop

Each training was provided by a pair of teachers: an expert teacher and a local expert. The experts were affiliated with the consortium, graduated as HCPs, had experience with teaching, and were familiar with chronic pain, the biopsychosocial model and PSE. The local experts were HCPs working in the geographic area of training implementation and helped to tailor the training program to the local context, i.e. taking into account the sociocultural diversity of the patient population in the geographic area and the local, formal and informal networks of HCPs. The criteria for local trainer were as follows: fluently in Dutch or French, three days a week of work with patients with chronic pain in the geographic areas of implementation, expertise in chronic pain, a biopsychosocial perspective, ability to participate in the train-the-trainer workshop, and ability to provide at least two workshops.

The train-the-trainer workshops were implemented to secure the quality of the trainers and to ensure that the trainers' knowledge and attitudes were in line with the training content. It included online one-on-one training sessions and discussions about chronic pain organised by the expert trainer with whom the local trainer forms a training duo. This personal train-the-trainer workshop provided the opportunity to adapt it to the needs of the expert and local trainer. In addition, group meeting(s) with other local trainers were organised for more general discussions to ensure that the core of the training program was the same for all training duos. At the end of the train-the-trainer workshop, all trainers completed the Knowledge And Attitudes of Pain questionnaire to assess their level of knowledge and attitudes toward pain in line with modern pain science [73,74]. Trainers received a fee of €350

for participating in the train-the-trainer workshop and a fee of €600 for each day of provided workshops for HCPs.

Recruitment of healthcare professionals

We aimed to train 500 HCPs at minimum within a total of 25 groups with approximately 20 to 25 HCPs — five training groups in each implementation area; Antwerp, Gent (both Flanders), Brussels (Brussels), Namur, and Liege (both Wallonia). We prioritised recruitment of HCPs working in the cities where we implemented the training to facilitate interdisciplinary collaboration during and after the training program. If there were still available spots for a training group a month prior to the training date, the recruitment was expanded to a wider geographical area. Therefore, all HCPs in Belgium were eligible to register for the training program. HCPs were recruited through multiple methods and networks. The consortium collaborated with organisations associated with HCPs in primary care, the Federal Public Service, and organisations connected to the study to recruit HCPs. All organisations shared information and flyers on their website, magazines, social media and/or within their network. Participants received continuing education credits for participating in the training program to stimulate participation. The cost of the training programs was covered within the funding. Therefore, the training was free for participants, making the training also accessible for HCPs with fewer financial resources. In addition, the training program was implemented at various days of the week - Monday to Saturday - and various periods of the day - morning and afternoon or afternoon and evening - so that it enabled most HCPs to participate within their work scheme.

Data collection and evaluation

HCPs were recruited from August 2021 to May 2022 and October 2022 to June 2023. Workshops were organised from October 2021 to June 2022 and March 2023 to July 2023. Within this study, the results of implementing the training program will be analysed and reported in separate papers. These separate papers will report the short and mid-term changes in HCPs' knowledge, attitudes and guideline adherence regarding chronic pain and HCP's confidence regarding low back pain. In addition, we will assess HCP's barriers and needs of integrating the cognitive behavioural approach. Furthermore, HCPs' training satisfaction will be evaluated after each workshop and after six months. All HCPs who enrolled in the training program were invited to take part in the studies. Each participant was requested to complete an informed consent form.

Results

Interdisciplinary expert panels' perception towards competencies

Within the interdisciplinary expert panel, 17 of the 21 members completed the questionnaire in which they indicated their perceptions of the importance of the competencies and the extent to which Belgian HCPs already possess the competencies in their clinical practice. The expert panel considered 9 competencies as 'very important' to 'extremely important', see

Figure 1. One of the main competence – 'integrate contemporary pain neuroscience into clinical reasoning in patients with chronic pain – and a sub competence 'Use questionnaires and interviews to identify patients' biopsychosocial factors which might influence pain experience according to the PSCEBSM model - were rated between 'moderately important' and 'very important'. Originally, the questionnaire asked for the importance of integrating contemporary pain neuroscience into clinical reasoning. During the meeting, the expert panel recommended that 'integrating pain neuroscience into clinical reasoning' was seen as important when pain science does not solely focus on neurophysiology. Therefore, the competence was changed to 'pain science'. The importance regarding the use of questionnaires were seen as less important compared to other competencies. Its perception the extent to which Belgian HCPs already possess the competencies in their clinical practice ranged from 'neutral' to 'agree'. This showed that there was large room for improvement on all competencies and that the training program needed to take the low competence in account within the training program. This was done by discussing the importance of the competencies and making it accessible and understandable for HCPs who have less experience and possession of the competencies in their clinical practice.

Barriers and needs

All 21 members of the interdisciplinary expert panel completed the questionnaire or participated in the meeting relating stakeholders' barriers and needs related to training content and the implementation of chronic pain management with a cognitive behavioural approach in clinical practice within Belgian healthcare, in line with contemporary pain science. The questionnaire and meeting with the interdisciplinary expert panel and literature search identified a large variety of barriers and needs which are presented in the Theoretical Domain Framework for behavioural change linked to COM-B domains, see Table 1.

In summary, the barriers and needs reflected the importance of the competencies. Based on the domain of psychological capabilities, the training program needed to improve HCPs' knowledge and especially skills related to a biopsychosocial approach and interdisciplinary collaboration for the management of patients with chronic pain. It was advised to develop a general chronic pain course which was not too complex, however, there was a stronger need to focus on improving skills than improving knowledge.

The social and physical opportunities domain showed that many environment factors, such as the biomedical perspectives of healthcare and society, and the lack of biopsychosocial education regarding pain, could limit the acceptance of the biopsychosocial model by the participants. In addition, it showed implications for implementation in clinical practice, such as lack of time, resources and support for HCPs and patients. Furthermore, based on the domain of motivation, many HCPs have a lack of interest in the management of patients with chronic pain and interdisciplinary collaboration. In addition, HCPs have less confidence in assessing psychosocial factors, believe that patients have less interest in a biopsychosocial approach and pain education, do not encourage patient goals focused on self-management and quality of life, and have negative emotions relating to pain management.

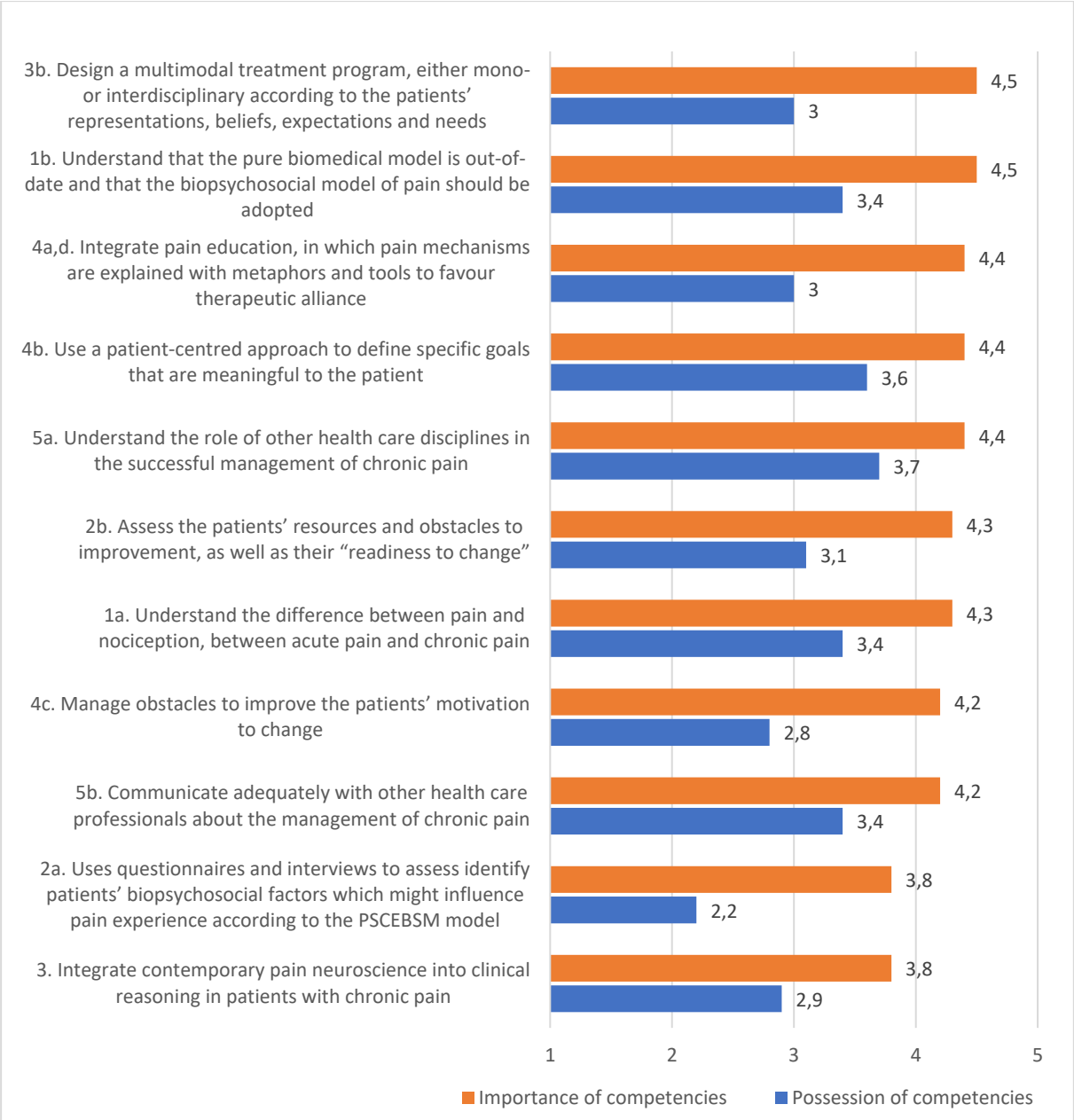

Figure 1. Expert panels' perception towards the importance and HCPs' possession of competencies in clinical practice.

Importance of competencies: 1 = not important at all, 2 = slightly important, 3 = moderately important, 4 = very important, 5 = extremely important.

HCPs' possession of competencies: 1 = totally disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = totally agree.

Higher scores reflect higher importance and stronger possession of HCPs' competencies in clinical practice.

PSCEBSM = pain – somatic factors - cognitive factors – emotional factors – behavioural factors – social factors – motivation

Table 1. Stakeholders' barriers and needs to implement a chronic pain training program.

COM-B		Barriers of HCPs	Needs of HPCs
Capability	**Psychological capability (the capacity to engage in the necessary thought processes)**		
	Knowledge	- Lack of knowledge about pain and its characteristics [75-77,E] - Lack of knowledge about an adequate assessment of pain [75] - Lack of knowledge about the biopsychosocial model[E] - Lack of knowledge about the role, opportunities and barriers of other disciplines[E] - Not familiar with research and literature [77] - Unfamiliar with adverse effects of narcotics [77] - HCPs have a biomedical perspective [78,E] - Patients have a biomedical perspective, and managing it is difficult [79,E]	- Focus training on basic knowledge[E] - Increase knowledge of pain mechanisms[64] - Increase awareness of all factors to consider when treating a person with chronic pain[E] - Provide knowledge not only on managing chronic pain but also on preventing patients from developing chronic pain[E] - Increase knowledge and values of a patient-centred approach[E] - Increase awareness of social influences (e.g. Friends and family)[E] - Increase knowledge of the added value of interprofessional learning and working[E] - Emphasise the importance of a follow-up in treatment programs[E] - Increase awareness that behaviour change techniques pairing is more effective [65] - Make caregivers aware of the burden of chronic pain[E] - Provide awareness of insufficient undergraduate education regarding (chronic) pain[E]
	Skills: cognitive and interpersonal	- Difficulty applying psychosocial perspective [76,78,E] - Difficulty with assessing pain in people with communication difficulties [75] - Problems with interdisciplinary communication [75,77,E] - Lack of communication and listening skills with patients[E] - Inability to treat without an established diagnosis [75] - Incompetence to give PSE to patients [75] - Difficulty in dealing with patients with psychological problems [79,E]	- Make the training practical[E] - Integrate effective resources for multimodal pain management[E] - Practice skills to encourage patients' self-management[E] - Practice adapting treatments based on the individual [64] - Practice using metaphors [64] - Train communication strategies/skills [79,E] - Enhance skills to include and assess social and family factors[E]

	Memory, Attention and Decision processes	- HCPs don't apply a patient-centred approach [76,77] - No assessment of patient behaviours and beliefs [76] - HCPs apply an inadequate assessment of pain and pain relief [75,77] - Poor patient reporting in pain management [75] - HCPs work monodisciplinary, no or too few interdisciplinary consultations are made [76,E] - Follow-up of between HCPs are highly variable [76] - Patients have different expectations [76,79] - Quality of life is not a central objective[E] - Patients are not open to PSE [79,80] - Patients have conflicting information[E] - HCPs have unhelpful attitudes regarding pain [75] - HCPs do not known whether patients ask for pain relief or pain medication [77]	- Use case studies of common problem areas that are applicable to largely the whole group (or can be adapted to the specific caregiver)[E] - Promote interventions co-facilitated by HCPs with different skills[E] - Promote interdisciplinary collaboration [81,E] - Take into account therapeutic alternatives[E] - Practice developing interdisciplinary treatment plans[E] - Provide the message to take the patient seriously [64] - Encourage acceptance of chronic pain and the biopsychosocial approach[E] - Provide sufficient time to discuss the participant's current situation during training[E] - HCPs think that a therapeutic alliance is important [79,E]
	Behavioural regulation	- Too little interest in overly theoretical information[E] - Patients with fear of pain and consequences communicate less well [75]	- Implement the application and handling of "yellow flags" in the ambulatory setting[E] - Spend attention and time for interest in meeting other HCPs within the training (build a "social" identity)[E]
	Physical capability (physical capacity to engage in the activity concerned)		
	Skills: physical		
Opportunity	**Social opportunity (the cultural milieu that dictates the way that we think about things)**		
	Social influence	- Lack of social support for patients[E] - Lack of society's recognition of the problems of chronic pain[E] - Cultural/religious differences [77] - Reluctance of patients to report pain [75] - Patients ashamed of symptoms [81] - Experiences and stories of family and friends [75] - Dominance of anaesthesiologists, giving preference to technical treatments [76]	- Create a status for pain management[E] - Use "Local Opinion Leaders" to increase impact [67] - Let participants discuss chronic pain with colleagues to increase social support [81]

	Physical opportunity (what the environment facilitates in terms of time, resources, location, physical barriers etc.)		
	Environmental context and resources	- Lack of adequate training for the issue of 'chronic pain' in the curriculum of training and courses [76,79,E] - Previous received training was biomedically oriented [80] - Lack of finance/financial compensation (for a comprehensive approach to treating patients with chronic pain) on the Micro, Meso, and Macro level [75-77,79,E] - Not trained for sociofamilial initiatives [76,E] - Lack of pain specialists and training of teams [76,E] - Excessive workload [76,E] - Inadequate or non-existent education materials [77,E] - No accessibility for patients to receive certain treatments (nonavailability/long travel time) [81] - Uneven geographical distribution of interdisciplinary pain centres [62,E] - Lack of time (Micro, Meso, Macro) [75,77,79,E] - Lack of leadership within chronic pain treatment organisations [75,77] - Available information on chronic pain does not support its implementation, nor does it identify its limits[E] - Lack of time to start and complete chronic pain training[E] - Insufficient incentives to support HCPs in such treatments and training initiatives[E] - (Excessive) cost prevent patients from accessing therapy or cause them to stop treatment early[E] - Lack of training in dealing with sensitive topics [79]	- Create a network of therapists working in the field of chronic pain; Create peer review groups[E] - Encourage the use of peer groups for patients with chronic pain[E] - Develop patient pain educational materials like booklets and videos that are available for patients and HCPs as support for PSE[E] - Creating postgraduate PSE courses[E] - Encouraging and creating more available training courses about pain[E] - More hours of education are needed about pain in training courses[E] - Make use of apps on smartphones to coach patients and evaluate treatment progress[E] - Use apps and videos to train caregivers and encourage self-management of caregivers to improve knowledge and skills[E]
Motivation	**Reflective motivation (involves self-conscious planning and evaluations)**		
	Social/Professional Role & Identity	- Lack of interest in interprofessional collaboration and to be in a dynamic of integrated care[E] - Negative attitudes about the role of other disciplines and patients with chronic pain[E]	- Empower HCPs that their management can include psychological and social factors [79,E] - Use feedback(loop) and action goals to increase the effectiveness of the training program [68]

		- Lack of interest in (chronic) pain[E] - Lack of motivation in patients to participate in long-term treatment pathways[E] - Lack of awareness of their actions [78,80] - Different expectations from other HCPs or organisation [78]	
	Beliefs about capabilities	- Lack of confidence in assessing psychosocial factors and in nonpharmaceutical treatments [78,79,81,E] - Less motivated HCPs will be challenging to recruit[E]	- Encourage acceptance that chronic pain management can be ineffective to change pain intensity for some patients and should not be the major goal[E] - Build confidence for effective therapeutic education[E]
	Optimism		- Provide training with a positive attitude towards pain [81]
	Beliefs about consequences	- Lack of visibility of benefits when collaborating between HCPs in treating patients[E] - Possible loss of trust in HCPs who have to perform theoretical education[E] - Anaesthesiologists do not want to go along with guidelines because of increased workload, fear of licensing problems and reduced revenue [77] - Knowledge about the addictive effect of pain medication did not worry HCPs [77]	
	Intentions	- Many HCPs prioritise the importance of other diseases above pain for treatment and training [75] - HCPs seem to lack interest in implementing accumulated knowledge and skills[E] - Change in behaviour is complex, and resistance from HCPs is expected [80,E] - Lack of willingness and empowerment of HCPs to start and continue a training program[E] - Not wanting to believe the patient's reported pain [77]	
	Goals	- Lack of goal to encourage patient self-management[E] - Patients have different values than HCPs [E]	- Focus your training on improving patients' quality of life rather than pain management[E]

	Automatic motivation (involves wants and needs, desires, impulse and reflex responses)		
	Reinforcement		- Reward HCPs with credits for attending training[E]
	Emotions	- Length of treatment is discouraging for the patient and frustrating for the counsellor [76] - Fear of mistakes when implementing new behaviour [77] - Uncertainty of HCPs[E] - Patients feel helpless, that they cannot be helped with their problem[E] - Many HCPs have little trust in the healthcare system[E]	

The overview of barriers and needs relating to the learning processes, competencies and implementation within Belgian healthcare, formulated by the expert panel and literature search.

[E] = Formulated by the expert panel; HCP = Healthcare professional; PSE = Pain science education.

Training program

E-learning modules

The first e-learning module - of approximately one hour - aimed at achieving competencies 1, 2 and 3 (1. Understand acute and chronic pain within a biopsychosocial framework; 2. Assess patients with (chronic) pain; 3. Integrate contemporary pain science into clinical reasoning in patients with chronic pain). It included an "introduction" part explaining the rationale and learning outcomes of the teaching programme and necessary basic theoretical parts, e.g. the impact of chronic pain on patients and society, definitions of pain, physiology of acute pain and chronic pain, the biopsychosocial model, biopsychosocial factors related to chronification and persistence of pain (e.g. stress, anxiety, catastrophising, depression, misbeliefs, insomnia, inactivity, etc.), and types of pain (nociceptive, neuropathic and nociplastic pain).

The second e-learning module aimed at achieving competencies 3, 4 and 5 (3. Integrate contemporary pain science into clinical reasoning in patients with chronic pain; 4. Provide tailored and patient-centred strategies to subacute and chronic pain patients; 5. Understand the role of health care practitioners in an interdisciplinary perspective).
This module started with a summary of the first e-learning module, after which it introduced patient-centred approach, attitudes, beliefs, motivation and coping of patients, PSE strategies, metaphors, the importance of the words used with patients, goal-setting, obstacles for change, motivational interviewing, self-management and lifestyle, needs and expectations of patients, commonly applied modalities/treatments (e.g. imaging, medication, hands-on techniques, and exercise) and the mono- and interdisciplinary approach in the management of chronic pain.

The e-learning modules used interactive educational methods to activate the participants' prior knowledge and experience together with an efficient integration with what is new. The content was delivered through video animations, expert interviews and short texts. Reflection questions complemented the content during and after slides and within a test at the end of each session (such as quizzes, multiple-choice tests and open questions on which the participants received automated feedback).

Face-to-face workshops

The key aspects of the training program were a biopsychosocial pain assessment, specific patient-centred communication techniques and biopsychosocial treatment programs integrating PSE. The interdisciplinary training program can be found in Supplemental material 4.

The first workshop aimed to provide knowledge and skills needed to integrate biopsychosocial (pain) assessment of patients successfully and to give the first introduction to PSE in their practice and to integrate the model and contemporary pain science into clinical reasoning in patients with chronic pain (competencies 1-4). The workshop included lecturing, exercises, interdisciplinary group discussions, and skills training relating to pain assessments, communication, PSE and their barriers and needs to implementing in their clinical practice.

After the first workshop, participants received exercises to implement and practice biopsychosocial pain assessment, specific patient-centred communication techniques and PSE in their clinical practice. Participants received a poster providing key messages for patients regarding chronic pain, a patient booklet to support PSE in their clinical setting and the link to the patient videos. All French and Dutch patient materials can be found on the website of Pain in Motion http://www.paininmotion.be/patients/information-about-persistent-pain.

The second workshop aimed to provide the ability to tailor and apply patient-centred strategies to subacute and chronic pain and to understand the role of HCPs from an interdisciplinary perspective. The workshop included lecturing, exercises, interdisciplinary group discussions, and skills training relating to providing PSE, motivational interviewing, patient-centred approach, mono-/interdisciplinary approach and communication between HCPs.

Both workshops contained nine mandatory phases with objectives per phase and two optional phases to adapt the training to the needs of the participants in the group. We evaluated if these phases were applied and achieved through discussions with participants and questions and observations by the trainers. The degree to which the participants were satisfied with the workshops was evaluated by a satisfaction questionnaire after each workshop.

Adaptations during the implementation process

The workshops were slightly adapted during the process of implementation. However, the core elements of the workshops remained the same. After the first three workshop groups, a group discussion about the factors influencing pain at the start of the first workshop was removed because participants thought it had less added value in addition to the e-learning modules. Furthermore, participants wanted more time for PSE exercises, so a motivational interviewing exercise was moved to the second workshop. In the second workshop, a motivational interviewing exercise was simplified due to difficulties experienced by participants. Furthermore, during the implementation process, minor adjustments were made in slides to support teachers' lecturing.

For the first four workshop groups, we aimed to recruit approximately 20 HCPs for each group. However, many participants cancelled last minute due to situations relating to COVID-19. Therefore, in agreement with the trainers, group sizes were increased to approximately 25 for the remaining 11 workshop groups to train a minimum of 300 HCPs but assure the quality of the training program.

Discussion

The developed interdisciplinary training program regarding the management of patients with chronic pain included a two 7-hour workshops and two e-learning modules - aimed to improve HCP's competencies for integrating biopsychosocial chronic pain management with a cognitive behavioural approach into clinical practice. A large variety of barriers and needs were formulated - by the interdisciplinary expert panel and literature search - relating to

training content and the implementation of chronic pain management with a cognitive behavioural approach in clinical practice. This provided valuable insight into the challenges for the implementation study and for HCPs, which was used to adapt the training program to the Belgian context. This study is part of a type 1 hybrid implementation study to assess the impact of such chronic pain training programs on the knowledge, attitudes and behaviour of HCPs regarding chronic pain management, aiming for higher value care for patients with chronic pain [82].

Recently, Slater et al. (2022) designed a framework in Australia, which is a blueprint for shaping interdisciplinary training about chronic pain with patients, HCPs and pain educators [83]. This framework identified gaps and training targets based on priorities in pain care. Although this study was performed in the Australian context, the identified gaps and training targets are closely aligned with the competencies and content of the training program. It is therefore most likely that our competencies and related barriers and needs are generalizable for many contexts in healthcare worldwide. However, it remains unknown what the optimal dose, intensity and frequency of trainings are needed to address these barriers and needs and to obtain the competencies. Our training program lasted two days, which is a commonly applied duration and has been effective in previous studies to obtain the competencies by improving knowledge, attitudes and behaviour of HCPs [37,38,58,84]. Other studies used training programs ranging from a workshop of multiple hours [32,84], multiple workshops of a few hours [36] to multiple days [85,86]. These studies - with both fewer and more hours of workshops - found significant improved knowledge and skills regarding pain knowledge or to educate patients about pain, indicating that obtaining the competencies is feasible. However, the training programs were monodisciplinary and a detailed training program was not published, making it difficult to compare. Konsted et al. (2019) published a brief training program that aimed to support physiotherapists and chiropractors' integration of the biopsychosocial low back pain management with a cognitive behavioural approach in clinical practice [85]. This training program also included two-day workshops, had similar competences to obtain and a similar mix of theoretical and skills training, was shown to be feasible and effective in changing clinical behaviour [57,87]. In addition to the training programs reported above, our training program included two e-learning modules to support the workshops, which potentially improved the learning experience and satisfaction of participants [88]. To our knowledge, no other interdisciplinary training program plans are available on the topic of pain.

A strength of this study was the co-design with a large interdisciplinary expert panel who formulated barriers and needs of stakeholders and the use of a framework to organise factors relating to behavioural change [56]. These addressed barriers and needs, together with a blended learning design and interactive teaching methods, improved the quality of the training for HCPs in Belgium [51,52]. Furthermore, the two-day training program available for all HCPs and targeted for seven disciplines makes it feasible to implement and scale-up for a large population of HCPs and many healthcare systems. Furthermore, the training program was updated during the implementation process to improve the training based on the experiences

of the trainers and participants. Another strength is the availability of patient materials - which was developed with a patient panel - as support for HCPs to integrate PSE within clinical practice. Lastly, the training program was implemented in five different areas of Belgium, in two different languages, and is available in Dutch, French and English. However, this study also has several limitations. A more intensive co-design throughout the process with experts and patients may have improved the quality of the training program. Furthermore, the formulated barriers and needs were based on a literature search and the expert panel; no systematic literature review was conducted, which could have resulted in some barriers and needs being missed. Besides, the estimated pre-intervention HCPs' possession of competencies in their clinical practice was based on the expert panels' perception and was not based on a large scale survey. Moreover, the training program includes several learning outcomes related to competencies that pose challenges to assess or which are not covered by the initial evaluation plan. Consequently, determining the achievement of some learning outcomes within this implementation study may remain inconclusive.

This study can potentially serve as a foundation for future training, thereby saving the time and resources required to develop training programs de novo. However, training programs need to be further developed and cross-culturally adapted within the geographic areas of implementation. To improve this process, more training programs should be available to facilitate learning from other training programs, e.g. to provide insight into how many hours of practical training is desired or which elements of the training facilitate learning the most effective. By reducing the differences between postgraduate training programs, we might also reduce the differences in knowledge and attitudes between HCPs and potentially improve their interdisciplinary collaboration [89]. Many factors play an important role in the learning experience of HCPs and their behaviour change, and many factors seem poorly understood. Hence, the publication of training programs by projects and studies should be encouraged, and the effectiveness of such training programs and their implementation process in clinical practice should be assessed. Furthermore, studies are needed to compare the effect of interdisciplinary versus monodisciplinary training programs. Although interdisciplinary training groups can facilitate interdisciplinary collaboration, they may introduce variation in the learning effect, as training that focuses on knowledge or skills may not be equally relevant across disciplines [90].

Conclusion

To address the significant knowledge gap of studies examining the effectiveness of interdisciplinary postgraduate chronic pain training programs, as well as the established need for interdisciplinary training to improve interdisciplinary collaboration within healthcare, an interdisciplinary training program was developed to improve HCP's competencies for integrating biopsychosocial chronic pain management with a cognitive behavioural approach into clinical practice for the treatment of patients with chronic pain. To do so, an interdisciplinary expert panel was created to identify the barriers and needs of stakeholders

for such a chronic pain training program. The identified barriers and needs of stakeholders for a chronic pain management training program were used for the development of the interdisciplinary pain management training program. In addition, the training program can be used as a foundation for developing and enhancing the quality of future training programs.

Ethics approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Medical Ethical Committee (EC-2021-327) linked to the University Hospital of Brussels, Brussels, Belgium. All participants provided informed consent.

Consent for publication

Not applicable.

Availability of data and materials

The complete and more detailed training program and materials are available in French and Dutch from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

CD, JN, AB, MM and MDK wrote the original study plan, applied and received the funding for the implementation study.
WM conducted the expert panel meetings, data collection and analysed the data under supervision from MDK
WM, CD, JN and MDK developed the training program with support from all authors
CD and CM translated the training program into French
WM, CD, AB, EK, CM and MDK carried out the implementation
WM and MDK wrote the manuscript with support from all authors
All authors read and approved the final manuscript.

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Chapter 4

Enhancing Healthcare Professionals' Biopsychosocial perspective to chronic Pain; Assessing the impact of implementing an Interdisciplinary Training Programme

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Abstract

Advancements in clinical science have shown the necessity for a paradigm shift away from a biomedical towards a biopsychosocial approach. Yet, the translation from clinical science into clinical practice is challenging. This study aimed to assess the short and mid-term changes in healthcare professionals' (HCP) pain knowledge and attitudes and guideline-adherent recommendations by means of an interdisciplinary training programme about chronic pain. Belgian HCPs, with a priority for medical doctors, physiotherapists, occupational therapists, nurses, psychologists, and pharmacists in primary care, participated in the interdisciplinary training programme, which contained two e-learning modules and two 7-hour workshops provided in small interdisciplinary groups in five cities. The interdisciplinary training programme objective was to improve HCP's competencies for integrating biopsychosocial chronic pain management with a cognitive behavioural approach into clinical practice. Primary outcomes were changes in knowledge and attitudes about pain (KNAP) and guideline-adherent recommendations for continuation of physical activity, sports and work, avoiding bed rest, and not supporting opioid usage measured through two clinical vignettes. They were measured before, immediately after, and six months after the interdisciplinary training programme. Changes were analysed using (generalized) linear mixed models. A total of 405 HCPs participated. The KNAP scores improved at post-training ($\Delta = 9.04$, 95% CI [7.72, 10.36]) and at six-month follow-up ($\Delta = 7.16$, 95% CI [5.73, 8.59]). After the training programme, HCPs provided significantly more recommendations in accordance with clinical guidelines. Thus, an interdisciplinary training programme can improve the biopsychosocial perspective of chronic pain management among HCPs in the short- and mid-term.

Introduction

Musculoskeletal chronic pain management is challenging for both healthcare professionals (HCPs) [1] and patients [2], who often perceive it as inadequate [2,3]. Clinical guidelines recommend biopsychosocial management for chronic pain, including pain science education. However, HCPs adhere poorly to clinical guidelines [4,5]. Currently, chronic pain management is dominantly biomedically oriented, which is associated with poorer patient outcomes, e.g. decreased levels of activity and participation, increased pain intensity and work absenteeism [6,7].

This discrepancy with clinical guidelines is poorly understood but partly stems from HCPs' lack of skills, difficulties in changing behaviour, disagreement with clinical guidelines, and prioritisation of their own clinical experience, peer consensus and original education [5,8,9]. Many HCPs still hold the belief that pain is caused by physical impairments and consider painful activities as harmful, often advising against them [10]. Education plays a crucial role in shaping HCPs' understanding of chronic pain to prioritise high-value care and improve patient experiences. Yet, structural and substantive changes are needed since many HCPs received insufficient training during their education [11], often with a biomedical orientation [11], monodisciplinary focus [12-14] and lacking content about pain management [13-16].

To improve biopsychosocial perspectives and skills to facilitate better chronic pain management in graduated HCPs, post-graduate training programs with a cognitive behavioural approach are needed [17,18]. In response, we developed and implemented an interdisciplinary training programme (ITP). The aim of the ITP was to improve HCP's competencies for integrating biopsychosocial chronic pain management with a cognitive behavioural approach into clinical practice [19]. Competencies encompass knowledge, skills, and attitudes essential to the practice of medicine [20]. This ITP covered the basic theory of chronic pain management through e-learning modules and two workshops that focussed on interdisciplinary discussions, skill training, and practical implementation of biopsychosocial chronic pain management. Little is known about the impact of the ITP on HCPs' knowledge and attitudes towards biopsychosocial chronic pain management with a cognitive behavioural approach. Yet, these elements - knowledge and attitudes - are foundational for developing the competencies needed to effectively implement biopsychosocial chronic pain management in clinical practice.

Therefore, the primary objective of this study was to assess the short and mid-term changes in HCPs' knowledge, attitudes and guideline-adherent recommendations regarding activity, sports, work, bed rest and opioid use towards musculoskeletal chronic pain. Secondary objectives were (1) to analyse HCPs' pain knowledge and attitudes six months after the ITP, (2) analyse whether HCPs' demographics predict HCP's pain knowledge and attitudes and the change over time, and (3) to assess participants' satisfaction with the ITP.

Methods

Study design

This quasi-experimental implementation study was presented in accordance with the Standards for Reporting Implementation Studies (StaRi) Statement [21] and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement [22]. This study was part of a type-1 hybrid effectiveness-implementation study.

Ethics approval

This study was approved by an independent Medical Ethical Committee (EC-2021-327) linked to the University Hospital of Brussels, Brussels, Belgium. All HCPs provided informed consent when participating in the study.

Interdisciplinary training program

Detailed information about the training program and development process is reported elsewhere [19]. More information about the targeted competencies in the ITP can be found in Supplemental material 5. In brief, the ITP was implemented between October 2021 and July 2023 with 24 training groups, i.e. five training groups (of approximately 20 to 25 HCPs) in Antwerp, Brussels, Namur and Liège and four groups in Ghent. The ITP contains two face-to-face workshops of 7 hours each and two online e-learning modules of 1 hour each. The targeted competencies for integrating biopsychosocial chronic pain management with a cognitive behavioural approach into clinical practice can be found in the Supplemental material 6.

Recruitment

HCPs for the ITP were recruited between June 2021 and July 2023. All HCPs working in Belgium were eligible to enrol in the ITP, but the recruitment was prioritised for specific groups in primary care (medical doctors, nurses, psychologists, physiotherapists, occupational therapists, dentists, and pharmacists). All HCPs enrolled in the ITP were invited to participate in the study.

We collaborated with Belgian organisations associated with HCPs in primary care, the Belgian Federal Public Service of Health, and organisations connected to the project to recruit HCPs. All organisations shared information via newsletters, magazines, flyers, information on their website, and social media within their network. At the start, we prioritised recruitment in Antwerp, Ghent, Brussels, Liège and Namur - where we implemented the training. The recruitment area was expanded when a training group was not full a month before the training date. The training was free of cost, and participants received accreditation.

Outcomes

The primary outcome was HCPs' change in knowledge and attitudes about pain (KNAP), including their recommendations to clinical vignettes from baseline, directly after the ITP (post-training) and six months after the ITP (follow-up). To contextualise the changes in

primary outcomes, participants were invited to fill out a satisfaction questionnaire about the ITP directly after each workshop and at six-month follow-up. Except for the satisfaction questionnaire which was filled out at the end of each workshop, all other questionnaires were completed digitally via the platform of Qualtrics.

Participants' demographics

The following information was collected: sex, nationality, healthcare discipline, years of clinical experience, working area, type of clinical team (solo practice, monodisciplinary or in a multidisciplinary team) and the type of institution they work in.

Knowledge and Attitudes about Pain

The KNAP questionnaire containing 30 statements about modern pain science was scored on a six-point Likert scale, ranging from 'totally agree' to 'totally disagree' [23,24]. Scores were transformed based on the Rasch transformation [24] in scores between 0 – 5, and total scores range between 0 – 150. Higher scores indicate that knowledge and attitudes of pain are more congruent with modern pain science, reflecting a stronger biopsychosocial perspective. Both Dutch [24] and French [23] versions were used. They are reported to be acceptable, valid, and reliable. The standard error of the measurement (SEM) was 2.12 (95% CI, 1.58 − 2.73) [23].

Guideline-adherent recommendations

Participants were asked for their clinical recommendations regarding activity, sports, work, bed rest, and how likely they are to support the use of opioids based on two clinical vignettes [25]. The first clinical vignette – developed by Rainville et al. (2000) – is about a 40-year-old male construction worker with chronic low back pain [26]. The authors developed the second clinical vignette based on a clinical case of Nijs et al. (2019) and concerns a 45-year-old female office worker with chronic neck pain [27]. The descriptions of all domains and classification of guideline-adherent recommendations [25,28] are shown in Table 1.

Training satisfaction

After each workshop, participants were asked to complete a questionnaire regarding their overall satisfaction (on a 5-point Likert scale ranging from "Very good" to "Very bad") and specific satisfaction on 13 criteria (Supplemental material 7) about e.g., the objectives, content, materials, trainers, learning process, and applicability) (on a 5-point Likert scale ranging from "Strongly agree" to "Strongly disagree").

At six-month follow-up, a tailored version of the Questionnaire for Professional Training Evaluation was applied, focusing on the domains of Satisfaction, Utility, Gained knowledge, Application to practice, Individual management, and global management, (Supplemental material 7) [29]. Each statement was scored on a scale from 0 to 10, 0= completely disagree to 10 = completely agree.

Table 1. Answers considered guideline adherent within the clinical vignettes

Domains	Guideline-adherent	Non guideline-adherent
Work	1. Return to normal work 2. Return to part-time or light duties	3. Be off work for a further … weeks (stating number of weeks) 4. Be off work until pain has improved 5. Be off work until pain has completely disappeared.
Sports	1. Return to normal sports 2. Return to light sports	3. Refrain from sports for another ... weeks (stating number of weeks) 4. Refrain from sports until pain has improved 5. Refrain from sports until pain has completely disappeared
Activities*	1. Perform usual activities 2. Perform activities within the patient's tolerance	3. Perform only pain free activities 4. Limit all physical activities until pain disappears
Bed rest	1. Avoid resting in bed entirely 2. Avoid resting in bed as much as possible	3. Rest in bed only when pain is severe 4. Rest in bed until pain improves substantially 5. Rest in bed until pain disappears
Support usage of opioids	1. Very unlikely 2. Somewhat unlikely	3. Not likely, nor unlikely 4. Somewhat likely 5. Very likely

* Activities was rated on a 4-point Likert scale.

Statistical analysis

Only HCPs who completed the baseline questionnaire, participated in at least one workshop and completed at least one evaluation after the ITP were included in the analysis. Changes in KNAP scores between baseline, post-training and six-month follow-up were examined with a hierarchical Linear Mixed Model (LMM), and the estimated marginal mean change was reported (delta; Δ). Three levels of random factors were potentially included to account for the hierarchical structure, the level of the participant, the training group and the area of implementation. Years of clinical experience, sex, healthcare discipline, working region and type of clinical team were potential fixed factors to determine whether these factors were predictors of the level of pain knowledge and attitudes. The Reliable Change Index (RCI) was calculated to assess whether individual KNAP scores changed significantly over time [30]. The RCI calculation was RCI = (follow-up measurement – baseline measurement) / standard error of measurement tool [23]. An RCI above 1.96 was considered “Reliably improved”, below -1.96 as “Reliably deteriorated”, and between 1.96 and -1.96 as “No reliable change”. The distribution of KNAP item scores was assessed at six-month follow-up and reported in percentages. Guideline-adherent recommendations were examined with Generalized Linear Mixed Model (GLMM) and the estimated marginal means was reported per measurement. The proportion of the variance explained by the random factors was reported by the intraclass correlation coefficients (ICC) [31]. A Bonferroni correction was employed to address the issue of multiple comparisons. The evaluation of the training was reported descriptively.

A p-value of .05 was considered statistically significant. Q/Q’-plots were used to evaluate normality assumptions. Rstudio V2023.06.1 was used for statistical analysis [32].

Results

Participants' demographics

A total of 509 HCPs enrolled in the ITP (Figure 1). Of these, 104 (20.4%) were excluded for not completing the baseline questionnaire and the post-training or six-month follow-up questionnaire. Most participants in the study (94.3%) attended both workshops. Among the 405 participants, the majority were medical doctors (n = 141) and physiotherapists (n = 162) (Table 2). The other priority groups included 30 psychologists, 26 nurses, 19 occupational therapists, and 9 pharmacists. Eighteen participants belonged to a healthcare discipline other than the priority groups. The median age was 36 years, 78.0% were female, and participants reported a median of 10 years of clinical experience. The majority worked in primary care (66.6%). Only 17.7% worked in a solo practice, 14.9% in a monodisciplinary team, and 67.4% worked in a multidisciplinary team.

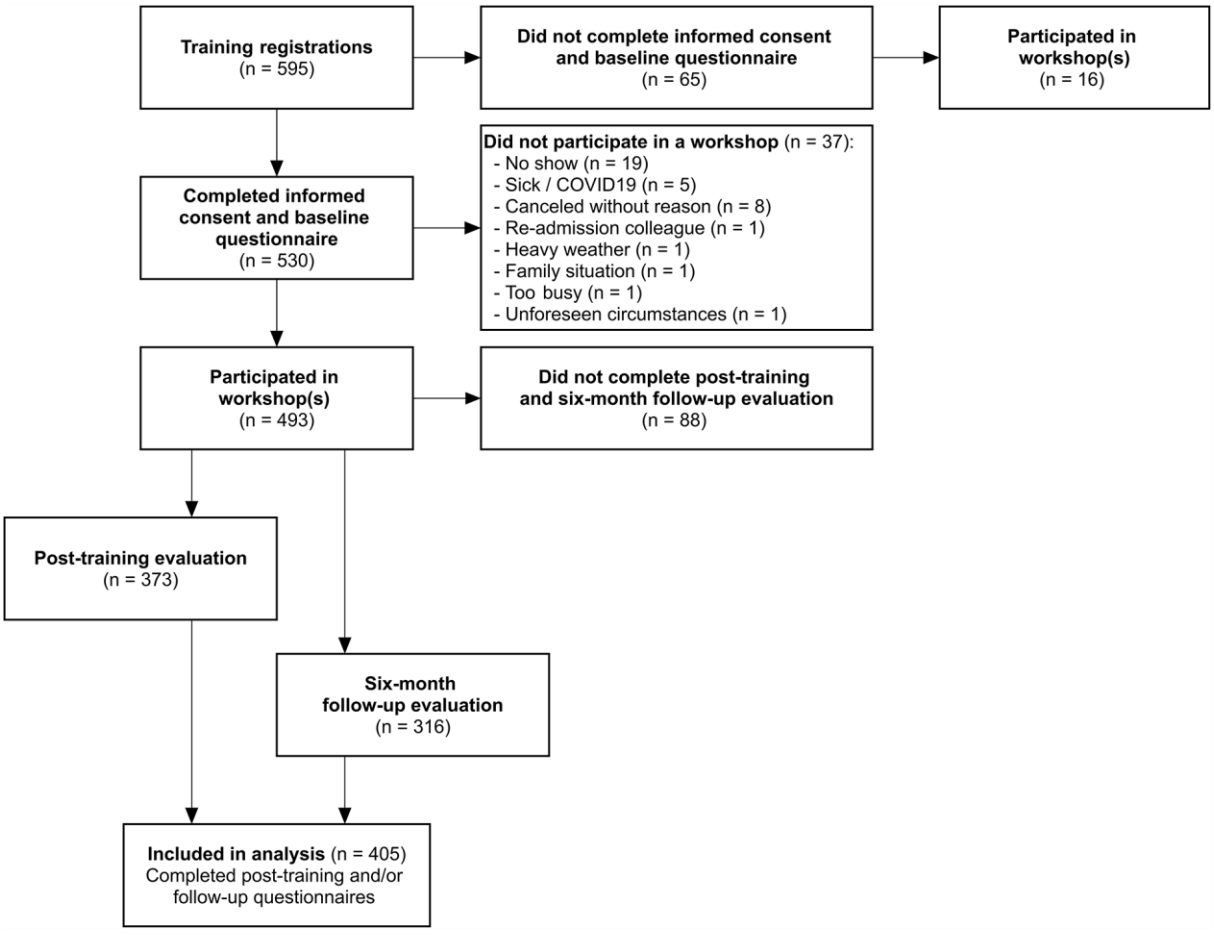


Figure 1. Flowchart

ITP = Interdisciplinary training programme; n = number of healthcare professionals.

Table 2. Overall demographics of the participants in this study and per healthcare discipline

	Total	Medical doctors	Physiotherapists	Psychologists	Nurses	Occupational therapists	Pharmacists	Others
N (%)	405 (100%)	141 (34.8%)	162 (40.0%)	30 (7.4%)	26 (6.4%)	19 (4.7%)	9 (2.2%)	18 (4.4%)
Age in years; Median [IQR]	36 [30 – 47]	35 [30 – 44.50]	35.5 [28 – 49]	39 [31 – 49.25]	44 [40.75 – 49.25]	32 [25 – 41]	39 [30 – 49.50]	38 [26.75 – 47.50]
Sex; n Female (%)	316 (78.0%)	116 (82.3%)	116 (71.6%)	22 (66.7%)	22 (84.6%)	16 (84.2%)	8 (88.9%)	18 (100%)
Years of clinical experience; median [IQR]	10 [4 – 21]	9 [4 – 19]	10.5 [4.38 – 25.25]	7 [4 – 18.5]	16 [11.5 – 25.5]	8 [3 – 15]	8 [5.5 – 21.5]	4 [0 – 16.63]
Area of implementation; n (%)								
Antwerp	80 (19.8%)	17 (12.1%)	28 (17.3%)	14 (46.7%)	5 (19.2%)	7 (36.8%)	1 (11.1%)	8 (44.4%)
Brussels	105 (25.9%)	46 (32.6%)	40 (24.7%)	4 (13.3%)	6 (23.1%)	5 (26.3%)	1 (11.1%)	3 (16.7%)
Namur	82 (20.2%)	31 (22.0%)	32 (19.8%)	4 (13.3%)	7 (26.9%)	2 (10.5%)	2 (22.2%)	4 (22.2%)
Ghent	55 (13.6%)	16 (11.3%)	24 (14.8%)	5 (16.7%)	5 (19.2%)	1 (5.3%)	2 (22.2%)	2 (11.1%)
Liège	83 (20.5%)	31 (22.0%)	38 (23.5%)	3 (10.0%)	3 (11.5%)	4 (21.1%)	3 (33.3%)	1 (5.6%)
Working region; n (%)								
Flanders	136 (33.6%)	35 (24.8%)	52 (32.1%)	19 (63.3%)	10 (38.5%)	7 (36.8%)	3 (33.3%)	10 (55.6%)
Brussels	91 (22.5%)	37 (26.2%)	38 (23.5%)	4 (13.3%)	3 (11.5%)	6 (31.6%)	1 (11.1%)	2 (11.1%)
Wallonia	178 (44.0%)	69 (48.9%)	72 (44.4%)	7 (23.3%)	13 (50.0%)	6 (31.6%)	5 (55.6%)	6 (33.3%)
Institution; n (%) [a]								
Primary care	227 (66.6%)	103 (90.4%)	94 (65.3%)	14 (53.8%)	3 (13.6%)	1 (6.7%)	5 (71.4%)	7 (53.8%)
Hospital	48 (14.1%)	6 (5.3%)	22 (15.3%)	4 (15.4%)	10 (45.5%)	3 (20.0)	2 (28.6%)	1 (7.7%)
Rehabilitation centre	5 (1.5%)	-	3 (2.1%)	-	1 (4.5%)	1 (6.7%)	-	-
Nursing home	12 (3.5%)	-	6 (4.2%)	-	4 (18.2%)	2 (13.3%)	-	-
Different	19 (5.6%)	3 (2.6%)	3 (2.1%)	3 (11.5%)	2 (9.1%)	4 (26.7%)	-	4 (30.8%)
Multiple institutions	30 (8.8%)	2 (1.8%)	16 (11.1%)	5 (19.2%)	2 (9.1%)	4 (26.7%)	-	1 (17.7%)
Missing; n (%)	*64 (15.8%)*	*27 (19.1%)*	*18 (11.1%)*	*2 (13.3%)*	*4 (15.5%)*	*4 (21.1%)*	*2 (22.2%)*	*5 (33.3%)*
Type of clinical team; n (%) [a]								
Solo practice	71 (17.7%)	18 (12.8%)	37 (22.8%)	5 (16.7%)	1 (3.8%)	6 (31.6%)	1 (11.1%)	3 (20.0%)
Monodisciplinary	60 (14.9%)	27 (19.1%)	19 (19.1%)	7 (23.3%)	1 (3.8%)	1 (5.3%)	1 (33.3%)	2 (13.3%)
Multidisciplinary	271 (67.4%)	96 (68.1%)	106 (65.4%)	18 (60.0%)	24 (92.3%)	12 (63.2%)	5 (55.6%)	10 (66.7%)
Missing n (%)	*3 (0.7%)*	-	-	-	-	-	-	*3 (20.0%)*

Group 'others' were a variety of healthcare professionals with disciplines other than the priority groups. Data was reported with number and proportions or median and interquartile range (IQR). - = None, [a] has missing data; percentages do not include missing data; N = number of observations.

Pain knowledge, attitudes and guideline adherence

Overall, HCPs' had significantly improved biopsychosocial pain knowledge and attitudes of pain from baseline to directly after the ITP (Δ = 9.04, 95% CI [7.72, 10.36]) and six-month follow-up (Δ = 7.16, 95% CI [5.73, 8.59]) (Figure 2). A small reduction was found between post-training and six-month follow-up (Δ = -1.88, 95% CI [-3.38, -0.37]). At six-month follow-up, 70.9% reliably improved (n = 224), 26.2% had no reliable change (n = 83), and 2.8% reliably deteriorated (n = 9) (Figure 3).

Guideline-adherent recommendations improved significantly from baseline to post-training and to six-month follow-up in all domains, resulting in a high percentage of HCPs' recommending to continue activities, return to sports, return to work, and avoid bed rest, and being less likely to support opioids (Table 3). Recommendations regarding bed rest and opioids remained relatively less guideline-adherent compared to others at each measurement. However, a significant decrease in guideline-adherent bed rest recommendation was found between post-training and six-month follow-up in the clinical vignette about chronic neck pain.

At six-month follow-up, a significant portion of participants demonstrated a substantial biopsychosocial understanding of pain and supporting non-pharmaceutical pain management, including exercise therapy and pain science education (Figure 4). However, only 66.9% of the participants agreed to a large extent that pain is always the outcome of the brain and 40.7% that hypersensitivity of the pain system can sometimes be beneficial. Moreover, a notable proportion of the participants disagreed to a large extent that correcting malaligned spine (59.6%) and correcting poor posture (30.3%) reduce chronic pain, that painful exercise should be avoided (59.3%), and that activity levels should be increased based on pain experience (23.7%).

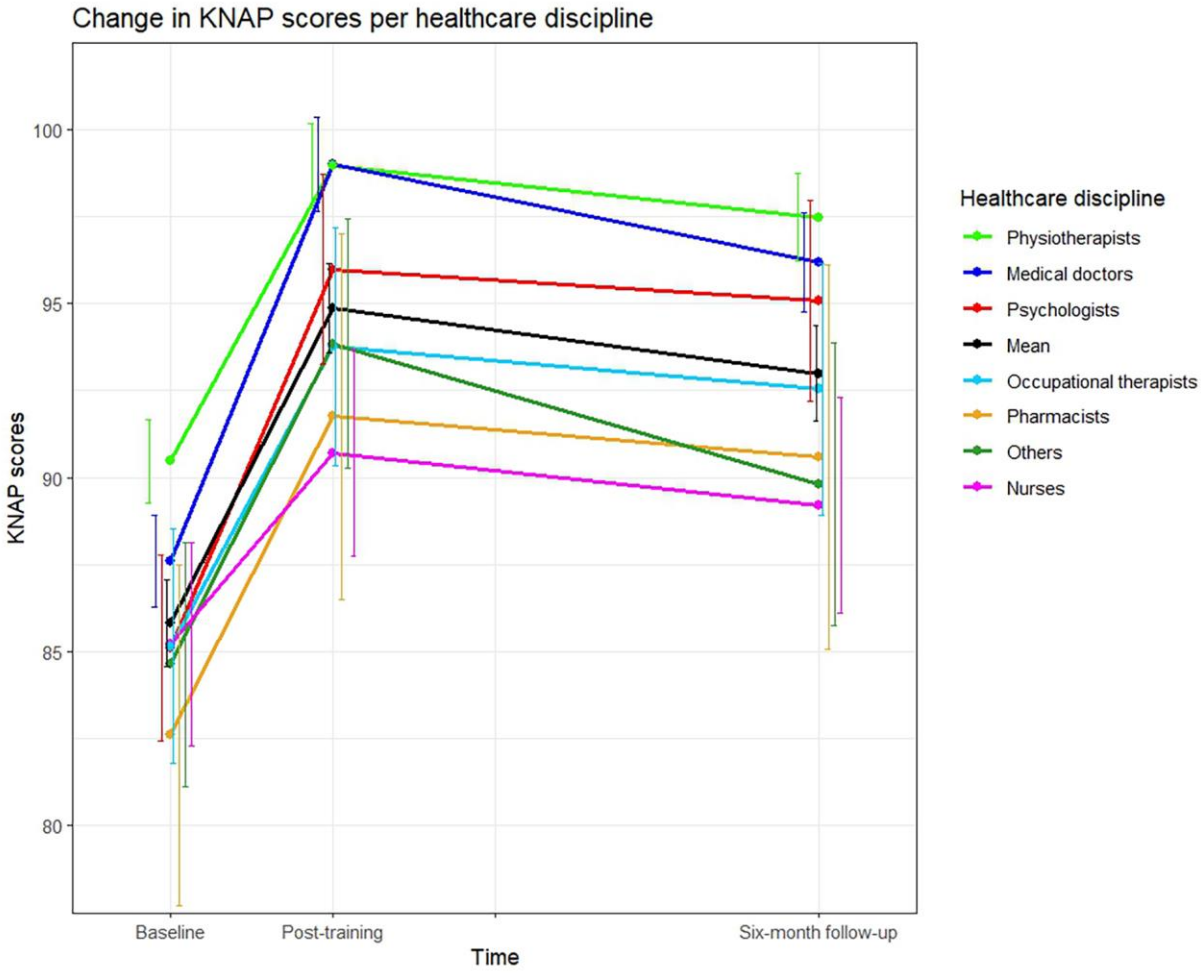


Figure 2. Pain knowledge and attitudes improved in short- and mid-term in the overall group and within all healthcare disciplines after the ITP (N = 405)

Lines represent mean KNAP scores for the overall mean and per healthcare discipline with 95% confidence intervals. Higher KNAP scores mean that knowledge and attitudes of pain are more congruent with modern pain science. KNAP total scores can range from 0 to 150; the current figure ranges from 77.5 to 102.5.

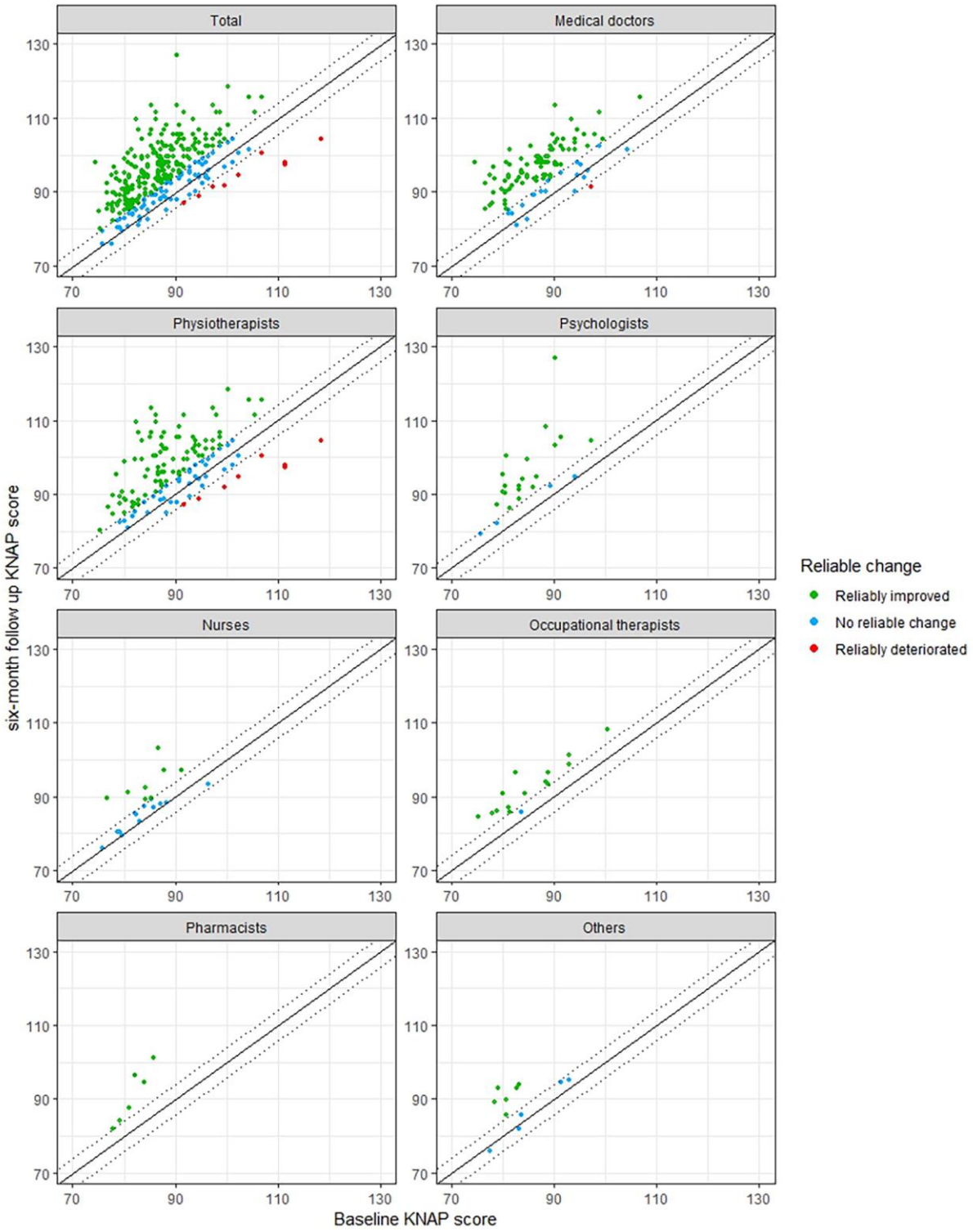
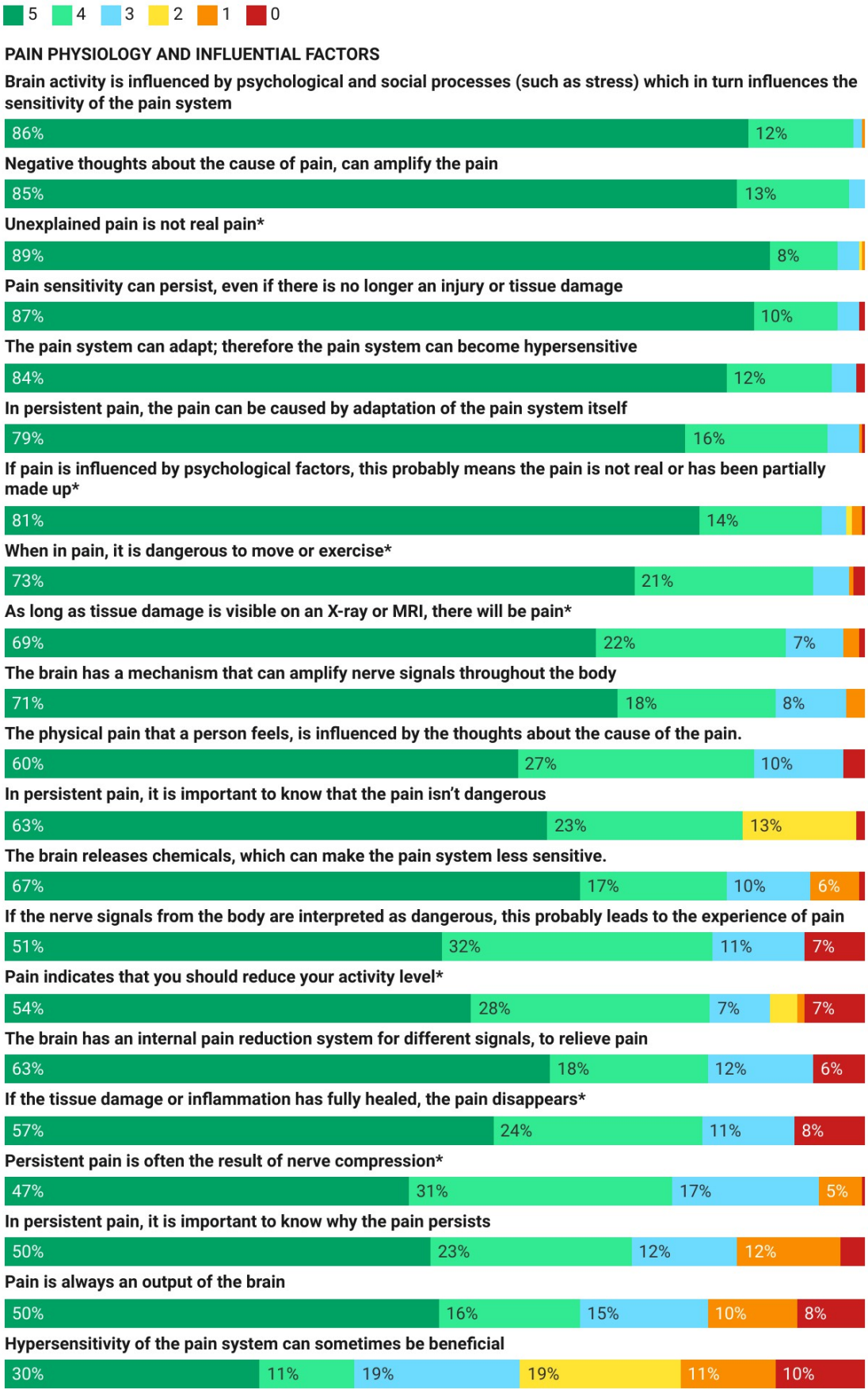


Figure 3 Reliable improvements were found in the majority of the individuals within each discipline, except within nurses.

Figure visualises the reliability of individual changes of participants for the total group and within each healthcare discipline. Each dot represents a participant with their baseline KNAP scores on the x-axis and six-month follow-up KNAP scores on the y-axis. Green dots are participants who reliably improved (Positive change larger than 4.16), red dots who reliably deteriorated (Negative change larger than -4.16), and blue dots who had no reliable change (change between 4.16 to -4.16). Dashed line = a change of 0.00; dotted line = reliable change index thresholds.

4A


5
4
3
2
1
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PAIN PHYSIOLOGY AND INFLUENTIAL FACTORS
Brain activity is influenced by psychological and social processes (such as stress) which in turn influences the sensitivity of the pain system
86%
12%
Negative thoughts about the cause of pain, can amplify the pain
85%
13%
Unexplained pain is not real pain*
89%
8%
Pain sensitivity can persist, even if there is no longer an injury or tissue damage
87%
10%
The pain system can adapt; therefore the pain system can become hypersensitive
84%
12%
In persistent pain, the pain can be caused by adaptation of the pain system itself
79%
16%
If pain is influenced by psychological factors, this probably means the pain is not real or has been partially made up*
81%
14%
When in pain, it is dangerous to move or exercise*
73%
21%
As long as tissue damage is visible on an X-ray or MRI, there will be pain*
69%
22%
7%
The brain has a mechanism that can amplify nerve signals throughout the body
71%
18%
8%
The physical pain that a person feels, is influenced by the thoughts about the cause of the pain.
60%
27%
10%
In persistent pain, it is important to know that the pain isn't dangerous
63%
23%
13%
The brain releases chemicals, which can make the pain system less sensitive.
67%
17%
10%
6%
If the nerve signals from the body are interpreted as dangerous, this probably leads to the experience of pain
51%
32%
11%
7%
Pain indicates that you should reduce your activity level*
54%
28%
7%
7%
The brain has an internal pain reduction system for different signals, to relieve pain
63%
18%
12%
6%
If the tissue damage or inflammation has fully healed, the pain disappears*
57%
24%
11%
8%
Persistent pain is often the result of nerve compression*
47%
31%
17%
5%
In persistent pain, it is important to know why the pain persists
50%
23%
12%
12%
Pain is always an output of the brain
50%
16%
15%
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8%
Hypersensitivity of the pain system can sometimes be beneficial
30%
11%
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4B

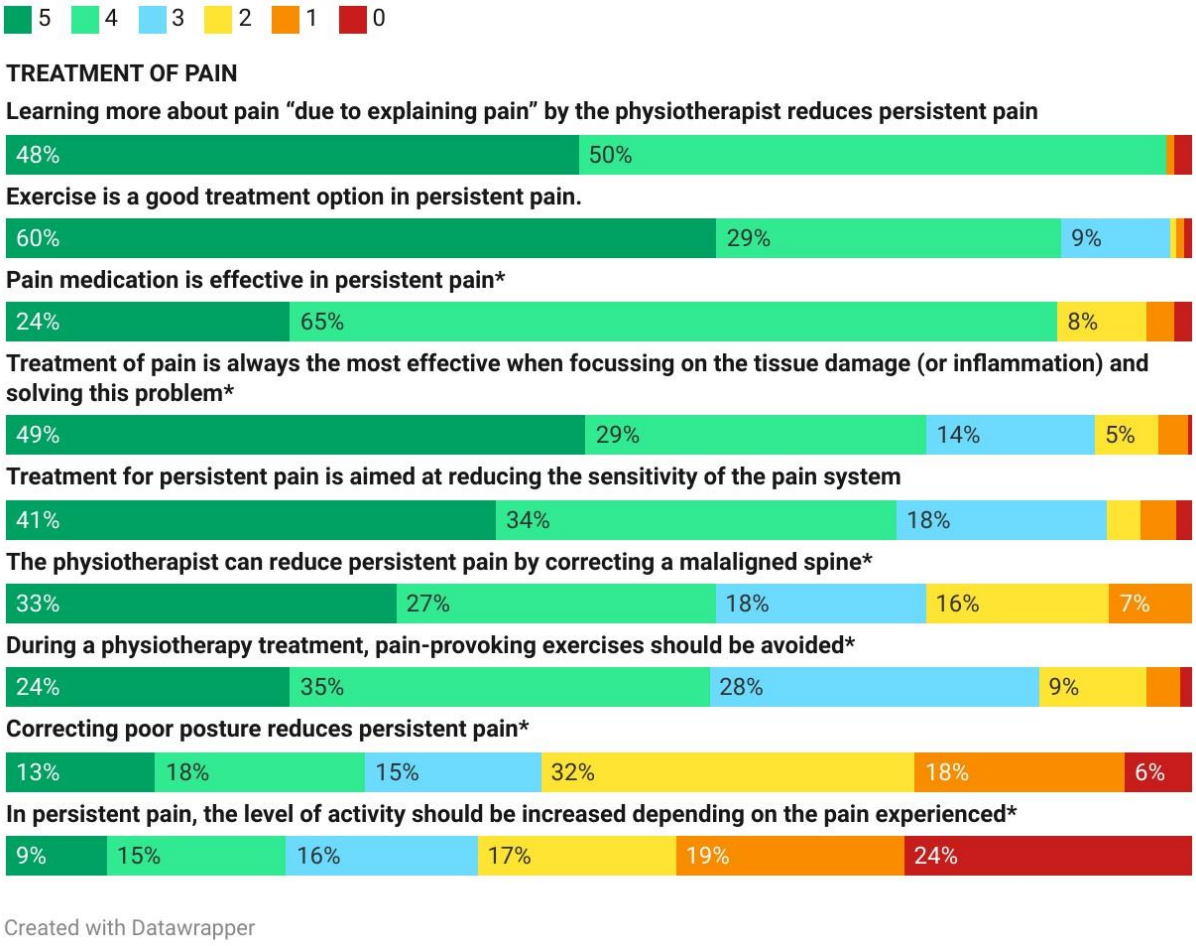

Figure 4. At six-month follow-up, a significant portion of participants demonstrated a substantial biopsychosocial understanding of pain and supporting non-pharmaceutical pain management (n = 316)

4A = the domain 'Pain physiology and influential factors' containing 21 items.

*4B = the domain 'Treatment of Pain' containing 9 items. * Disagreeing with this statement was congruent with modern pain science and, therefore, scores inverted before analysis.*

The distribution of Rasch scores ranging from 0 to 5 per KNAP item is presented in percentages of total observations. Higher scores are more congruent with modern pain science. Scores 4 and 5 are considered 'to a large extent agree'.

Table 3. Short- and mid-term changes resulted in high percentage of guideline-adherent recommendations after the ITP (N = 405)

Clinical vignette about chronic low back pain			
	Baseline	**Post-training**	**Six-month follow-up**
↑ Activity	**91.1** [87.1, 93.9]	**99.5** [97.1, 99.9]*	**99.0** [96.2, 99.8]*
↑ Sports	**93.6** [89.9, 95.9]	**98.1** [95.4, 99.2]*	**99.0** [96.2, 99.8]*
↑ Work	**75.2** [69.8, 80.0]	**93.7** [89.9, 96.2]*	**92.3** [88.5, 95.7]*
↓Bed rest	**55.2** [49.2, 61.0]	**82.8** [77.6, 87.0]*	**77.7** [77.6, 87.0]*
↓ Opioid	**51.1** [45.1, 56.9]	**85.0** [80.0, 89.0]*	**82.3** [76.5, 86.9]*
Clinical vignette about chronic neck pain			
	Baseline	**Post-training**	**Six-month follow-up**
↑ Activity	**93.6** [89.9, 95.9]	**97.8** [94.9, 99.0]*	**97.7** [94.5, 99.1]*
↑ Sports	**88.9** [84.5, 92.1]	**96.9** [93.8, 98.5]*	**97.1** [93.7, 98.7]*
↑ Work	**76.2** [70.8, 80.9]	**94.2** [90.4, 96.5]*	**93.9** [89.7, 96.4]*
↓ Bed rest	**60.6** [54.7, 66.3]	**87.5** [82.7, 91.1]*	**80.3** [74.4, 85.2]*
↓ Opioid	**57.8** [51.8, 63.5]	**87.8** [83.0, 91.3]*	**81.6** [75.8, 86.3]*

*Data represents percentages and 95% confidence interval of participants whose recommendations were in accordance with guidelines. * = p < .05.*

Predictors of pain knowledge and attitudes

Being female and having more years of clinical experience predicted lower KNAP scores independently of the measurement time, and the healthcare discipline also predicted different baseline KNAP scores and the change over time (Figure 2 and Table 4). Physiotherapists had higher KNAP scores at baseline compared to all other disciplines. After six months, there were no differences observed between physiotherapists, medical doctors, and psychologists. However, differences persisted between these healthcare disciplines and nurses, occupational therapists, pharmacists, and others. Working region and type of clinical team were not predictors for KNAP scores.

The proportion of variance in KNAP scores was largely explained (59.6%) by random differences between participants, and a smaller proportion (4.5%) was attributed to random differences between training groups. Random differences between the area of implementation did not explain the variance (0.0%) in KNAP scores and was therefore excluded from the model.

Table 4. Sex, years of clinical experience and healthcare discipline predict KNAP scores; including the random effects (N = 405)

Independent variables	Estimate	95% CI
(Intercept)	89.80	87.83, 91.77
Post-training*	11.42	10.28, 12.56
Six-month follow-up*	8.59	7.37, 9.80
Sex (female)*	-2.07	-3.62, -0.53
Years of clinical experience*	-0.09	-0.14, -0.03
Doctors	Reference	
Physiotherapists*	2.89	1.20, 4.57
Psychologists	-2.50	-5.43, 0.44
Nurses	-2.39	-5.51, 0.73
Occupational therapists	-2.44	-5.99, 1.12
Pharmacists	-5.00	-10.00, 0.00
Others	-2.97	-6.62, 0.68
Post-training × Doctors	Reference	
Post-training × Physiotherapists*	-2.93	-4.49, -1.38
Post-training × Psychologists	-0.54	-3.24, 2.16
Post-training × Nurses*	-5.92	-8.76, -3.09
Post-training × Occupational therapists	-2.81	-6.08, 0.45
Post-training × Pharmacists	-2.26	-7.17, 2.65
Post-training × Others	-2.20	-5.54, 1.14
Follow-up × Doctors	Reference	
Follow-up × Physiotherapists	-1.60	-3.24, 0.04
Follow-up × Psychologists	1.38	-1.51, 4.28
Follow-up × Nurses*	-4.58	-7.60, -1.56
Follow-up × Occupational therapists	-1.21	-4.69, 2.27
Follow-up × Pharmacists	-0.58	-5.79, 4.62
Follow-up × Others	-3.41	-7.30, 0.48
Random Effects		
ICC-Participants	0.596	
ICC-Training group	0.045	
Model		
Marginal R^2 / Conditional R^2	0.320 / 0.725	
AIC	7128.2	

*AIC = Akaike Information Criterion, CI = Confidence interval, ICC = Intra-level correlation coefficient, SE = Standard error, * = p < .05.*

Doctors were the reference category in the estimates for each healthcare discipline. ICC-Area-of-implementation was 0.00 and was therefore excluded from the model.

Training evaluation

The training evaluation scores can be found in the Supplemental material 7. The participants reported high satisfaction scores on the training evaluation directly after each workshop and at six-month follow-up. After six months, 98.7% would recommend the course to colleagues or other HCPs. On the 13 workshop criteria, satisfaction ranged between 84% and 99%. At six-month follow-up, participants' ratings were high for training satisfaction, utility, gained knowledge, application of the knowledge, and impact on their individual and global chronic pain management.

Discussion

Implementation of an ITP resulted in marked short and mid-term improvements in HCPs' biopsychosocial knowledge and attitudes, and their recommendations were more in accordance with clinical guidelines. Six months after the ITP, 70.9% of the participants showed a reliable improvement in knowledge and attitudes, and a significant proportion of participants demonstrated substantial alignment with contemporary pain science, although some biomedical perspectives remained.

This study underscored both the potential and the necessity for improving (interdisciplinary) training programs and thereby HCPs perspectives [33], particularly regarding work participation, bed rest recommendations [34,35] and supporting opioids [36,37]. At six-month follow-up, two-thirds of the HCPs had improved knowledge and attitudes, with a significant portion of participants demonstrating substantial biopsychosocial understanding of pain and supporting non-pharmaceutical pain management, including exercise therapy and pain science education. However, this study also identified the need in educational programs for a greater focus on the fact that chronic pain is often unrelated to physical impairment and that treatments only targeting physical impairment are, thereby, often not effective in chronic pain. A two-day training program with two e-learning modules might be insufficient to effectively address these misbeliefs. Moreover, as found in previous studies, the impact of the ITP marginally declined over time, which could indicate the need for long-term support [38-40].

This study also showed that HCPs with fewer years of clinical experience seem to have slightly stronger biopsychosocial pain management perspectives [41-43], potentially benefiting from updated curricula [44]. Male sex predicted stronger pain knowledge and attitudes. However, more comprehensive studies are needed to explore these differences because previous studies' findings are contradictory [41-43,45]. Moreover, it showed that the ITP can improve pain knowledge and attitudes in a variety of healthcare disciplines. Yet, pain knowledge and attitudes differed between healthcare disciplines [46,47]; the change was also healthcare discipline-specific. The study of Louw et al. (2019) also found significant and discipline-specific improvements in pain attitudes and beliefs in a variety of HCPs [40]. However, no significant differences between healthcare disciplines were found at baseline or follow-up, potentially due to the use of different questionnaires.

HCPs were highly satisfied with the ITP, and there are strong indications that ITP implementation is feasible across healthcare disciplines [48]. However, although satisfaction scores are positively related to the perceived usefulness of a training program [49], they weakly predict behaviour change among HCPs in clinical practice. Moreover, while current training programs seem to be particularly effective in improving HCPs' pain knowledge and attitudes, translating these improvements into clinical practice remains a significant challenge [33,50-52]. In fact, this may pose a larger barrier for interdisciplinary training groups, as it restricts considerable time devoted to healthcare discipline-specific content and skills [53].

Strengths and limitations

The strength of this study is the inclusion of a large and diverse sample of HCPs. The implementation of the ITP was standardised in both Dutch and French by different teachers in five different cities in Belgium. Simultaneously, it included optional workshop phases to meet the participants' needs. This favoured the external validity of the results and the ITP, which was strengthened by the small variances of random differences between the training groups and neglectable variances between the areas of implementation. Furthermore, we assessed both the impact on HCPs' outcomes and the acceptability of the ITP.

Limitations of this study are the challenges in recruiting certain groups of HCPs, which may limit the internal and external validity of differences between healthcare disciplines. Additionally, results are exposed to selection bias since the ITP was probably more likely attended by HCPs particularly motivated in chronic pain management. Besides, we cannot exclude a potential social desirability bias [54]. Moreover, there were several limitations regarding the validity of the questionnaires. The KNAP questionnaire hasn't been psychometrically tested among all priority groups. Therefore, we have only little data about the responsiveness and content validity of this questionnaire. Additionally, it is uncertain if recommendations made by HCPs based on clinical vignettes represent actual clinical behaviour [55-58]. Furthermore, the uncontrolled pre-post study design presents limitations in establishing conclusive attributions of the intervention to observed changes. A fidelity check could have assessed whether the training program was implemented as described within the protocol. it would also have enabled an evaluation of potential variation between training groups, the areas of implementation, and their potential impact on HCPs' knowledge, attitudes and recommendations.

Clinical relevance and future research

The study underscores the potential of ITPs to improve pain knowledge and attitudes among a variety of HCPs. While two-day courses may effectively change chronic pain knowledge and attitudes of HCPs, it remains uncertain if participants have the competencies to implement biopsychosocial chronic pain management with a cognitive behavioural approach in clinical practice. Two days is a short period to cover all relevant pain content comprehensively [16], making it a fundamental course focussing on the basics of chronic pain management. Advanced training courses focussing on in-depth analysis of biopsychosocial factors, communication techniques (e.g. motivational interviewing), and treatment modalities (e.g.

cognitive behavioural therapy and pain science education) often require multiple days to weeks of workshops that are challenging to fit into busy schedules of HCPs. Therefore, shorter courses are more accessible for HCPs [59] and easier to scale up if they prove to be clinically relevant. Therefore, future studies need to assess the impacts on patients' clinical outcomes and healthcare efficiency (e.g., cost-effectiveness). This will also provide more insights into HCPs' competencies and the actual impact on chronic pain management.

To gain a more comprehensive understanding of improved HCPs' behaviour and competencies towards chronic pain management, hybrid mixed-method studies integrating qualitative evaluations and different evaluation tools - such as patient simulations and/or clinic observations – are needed [60]. These methods offer insights into HCPs' competencies, which refer to their ability to successfully execute tasks in clinical practice and the barriers and facilitators they experience, such as a potential lack of confidence [61-63] or poor communication between HCPs and patients [63,64]. Indeed, these competencies are not solely determined by HCPs' knowledge and attitudes. Therefore, it may be necessary to reformulate competencies, providing more specificity in the formulation of competencies and integrating HCPs' actions and performances within clinical practice [65].

Additionally, these insights would provide valuable feedback for refining training programs regarding training content [16], teaching methods, duration of the training, and follow-up seminars. A better understanding is needed of which elements, like physical impairment and chronic pain [66], work participation [66], bed rest, and opioids [67], require more emphasis and how to tailor this to trainees' needs. It will be crucial to evaluate changes in educational programs to understand their impact. This includes assessing the effect of increased or shortened training hours, differences in training content and methods or follow-up seminars. Additionally, evaluating initiatives like creating a network for sustainable feedback and information from experts to optimally improve these competencies and potentially help mitigate the small decline over time.

Conclusions

The implementation of an interdisciplinary training programme about chronic pain management - including two e-learning modules and two workshops - marked a positive impact on various healthcare professionals. This impact reflects stronger biopsychosocial knowledge and attitudes, embracing modern pain science and non-pharmaceutical treatments in both the short and mid-term. Despite high participant satisfaction, continued efforts are needed to refine interdisciplinary training programs for more effective and long-term translation into clinical practice and to improve traditional misconceptions.

Ethics approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Medical Ethical Committee (EC-2021-327) linked to the University Hospital of Brussels, Brussels, Belgium. All participants provided informed consent.

Consent for publication
Not applicable.

Availability of data and materials
The data supporting this study's findings are available from the corresponding author upon reasonable request.

Competing interests
The authors declare that they have no competing interests.

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General discussion

This dissertation delves into chronic pain perspectives in graduate and undergraduate HCPs and contributed to the development of knowledge about educational programs related to chronic pain management. We have realised this by developing and translating a quantitative measurement to assess pain perspectives, investigating the differences between undergraduate physiotherapists' perspectives over the last few years, and developing and testing the relevance of an educational program for changing HCPs' perspectives towards chronic pain.

Current biopsychosocial perspectives in graduated and undergraduate HCPs

Both the results in Chapter 1 and 4 indicated that during the past decade, only a small improvement in biopsychosocial perspectives and clinical recommendations in accordance with clinical guidelines occurred in both undergraduate physiotherapists [1] and graduated HCPs [2]. Although undergraduate physiotherapists had stronger biopsychosocial perspectives and more guideline-adherent recommendations regarding CLBP and knee OA management in 2020 compared to 2013 [1], these differences were small. Similarly, this difference was also small in graduated HCPs, with improvement in biopsychosocial perspectives towards pain in HCPs with fewer years of clinical experience [2]. This could indicate that, in general, current educational programs are not able to forster substantial better biopsychosocial perspectives towards chronic pain in undergraduate HCPs compared to educational programs years ago [2-6]. Yet, this impact could be larger if the comparison is larger than seven years between academic years.

Nonetheless, the biopsychosocial shift from 2nd-year to 4th-year undergraduate physiotherapists was larger in 2020 than in 2013 [1], supporting the potential key role in fostering the biopsychosocial shift in chronic pain management [3,7-12]. However, this improvement varied depending on the institution, reflecting the diverse approaches to pain education, which are often fragmented and inconsistent across different institutions [13,14]. Previous studies found that pain perspectives improved when students had adequate training regarding pain [10], while students with inadequate training demonstrated some improvement, but pain knowledge was still often suboptimal [3]. This would suggest that some institutions provided more adequate education regarding pain in comparison to others [13-17]. However, within the comparison study design, we cannot causally conclude which factors contributed to the differences in biopsychosocial pain knowledge between academic years and between institutions. Yet, we expect an important role of changes made in curricula, taught hours, the content of pain modules, and/or perspectives of teachers [15-17]. The large variety in results between institutions is unlikely caused by cultural factors due to the small geographic distance between some institutions, and these geographic differences did not predict differences in graduated HCPs [2]. It is more likely that these differences occurred due to educational changes induced by the abundant literature published on the topic of chronic pain and the call-for-

actions to improve pain management and educational programs [3,18-22]. Exploring these differences and changes between institutions and their impact on undergraduate HCPs in future studies could provide insights into where and how to improve education.

Improving HCPs education is needed as both studies showed that there is particularly ample room for improvement regarding perspectives on the relationship between pain and physical impairments. This belief in the relationship between pain and physical impairments is a common misbelief in HCPs [3,23-26] and is associated with recommending limiting activity and work [27-33]. These recommendations were also found in a large proportion of fourth-year undergraduate physiotherapists, and more than 75% of them believed that chronic low back pain symptoms most likely arise from moderate to severe spinal pathology. These adverse perspectives are most likely even more common in other educations in Belgium, as previous studies showed better pain knowledge in undergraduate physiotherapists compared to other undergraduate healthcare professions [23,34,35]. In chapter 4, a considerable number of HCPs did recommend continuing activities, sports and work participation [2]. However, paradoxically, 40% of the HCPs also recommended bed rest, particularly when pain is severe. This suggests a cautious and passive approach with patients with higher pain experiences and may convey to patients that it is beneficial to avoid higher pain levels to "prevent further damage" [36-38]. This underscores the necessity of more emphasis across education on primary chronic pain conditions [39]. It also highlights the importance of emphasising that continuing or returning to sports, activities and work is favourable and bed rest is not in chronic pain conditions, regardless of the (level of) pain experienced. Additionally, we need to better understand the underlying rationale of clinical recommendations in graduated and undergraduate HCPs, ideally through qualitative evaluations, because these rationales remain unknown. An understanding of these perspectives could enable more effective implementation of training programs about chronic pain [29].

Measuring HCPs perspectives

Within Chapter 1, we used the PABS-PT and HC-PAIRS, yet these questionnaires were developed decades ago, lacking items regarding nervous system plasticity and the roles that anxiety, fear, and the social environment play in modulating the experience of pain, which often fail to be discussed in educational programs [40]. Therefore, we translated the Knowledge and Attitudes about PAIN (KNAP) into French and assessed the psychometrics of this new version [41]. This resulted in the KNAP-FR, demonstrating acceptable psychometric properties, i.e., good validity and reliability in graduated and undergraduate medical doctors and physiotherapists. These psychometric results were in line with Dutch [42], Brazilian [43] and Japanese version [44], strengthening its reliability and validity. The KNAP-FR can, therefore, be used to assess pain knowledge and attitudes in line with modern pain science in French-speaking undergraduate and graduated physiotherapists and medical doctors, as applied in Chapter 4. However, some psychometric properties of the KNAP-FR, such as its responsiveness, measurement invariance and content validity, remain to be tested or need to be tested further [45]. In the future, this questionnaire could contribute to a better

understanding of pain perspectives in graduated and undergraduate HCPs. Additionally, future studies will provide the opportunity to better compare our results with other studies.

Changing HCPs' chronic pain perspectives

The dominantly biomedical perspective in many undergraduate physiotherapists and the ample room for improvement in HCPs before the training program indicate the need for post-graduate educational interventions to train HCPs that still provide inadequate chronic pain management [46,47]. Within Chapter 3, Belgian stakeholders - including patients, HCPs and policymakers - supported the need for biopsychosocial training for Belgian HCPs. They formulated many barriers in chronic pain management due to a lack of knowledge and skill in HCPs and provided a large variety of barriers regarding the understanding and applicability of biopsychosocial pain management in Belgian HCPs. HCPs seem to be particularly challenged with implementing psychological and social factors into their clinical reasoning [29,48-51]. It shows the need for biopsychosocial training programs with a cognitive behavioural approach to improve chronic pain management, as supported by previous studies [52-61]. Consequently, the developed interdisciplinary training program aimed to improve HCP's competencies for integrating biopsychosocial chronic pain management with a cognitive behavioural approach into clinical practice for the treatment of patients with chronic pain. This interdisciplinary training program resulted in significant improvements in biopsychosocial perspectives and clinical recommendations regarding activity, sport, bed rest, work and opioids in HCPs directly after the training program which sustained until six months later. Six months after the training program, many HCPs demonstrated a substantial biopsychosocial understanding of pain, supporting non-pharmaceutical pain management, including exercise therapy and PSE, and recommended patients to continue activities, sports and work participation. This indicates that this interdisciplinary training program can target certain common biomedical perspectives across various HCPs and foster biopsychosocial perspectives towards chronic pain management. Yet, these changes should also be assessed in the long term as there are indications that these improvements might not completely be maintained in the long term [2,62-65], suggesting the need for long-term support (e.g. follow-up courses, peer support [65,66] or self-directed learning [17]).

However, some biomedical perspectives remained, particularly regarding the relationship between pain and impairment. Interestingly, this was also found in undergraduate physiotherapists. Although this biomedical misconception is discussed within the interdisciplinary training program, it seems that the training was suboptimal to target this misconception. There is a lot of uncertainty about the optimal amount of training hours, adequate pain content, and teaching methods. The training program has large similarities in content recommended by previous studies and educational frameworks [16,47,61,67], including teaching methods like blended and case-based learning with patient simulations and not purely didactic teaching [47]. Yet, it differs in the hours taught and, therefore, the comprehensiveness of chronic pain management content in training programs [47]. Two

interactive e-learning sessions and a two-day workshop may have been insufficient to effectively address HCPs' perspectives on the relationship between pain and impairment.

Moreover, implementing interdisciplinary training programs instead of monodisciplinary training programs also faced challenges. The interdisciplinary training program focuses primarily on the competencies regarding a biopsychosocial understanding of pain, assessing biopsychosocial factors comprehensively, and incorporating this into their clinical reasoning to develop a tailored and patient-centred chronic pain management with a cognitive behavioural approach. However, not all barriers and facilitators are shared or similar in all disciplines [68] (e.g. the lack of knowledge about psychological factors [66] or lack of treatment time). Therefore, this training program might have been too general or potentially too difficult to learn optimal for HCPs from certain disciplines. This also accounts for evaluating HCPs' perspectives. The KNAP questionnaires contain questions specifically regarding exercise therapy, manual therapy, and postural changes. These topics were not extensively discussed as they are mainly applicable to physiotherapists and less to other disciplines. This could partially explain differences in KNAP scores between disciplines.

Predictors for HCPs' perspectives

Understanding and recognizing factors that influence pain perspectives or amplifying the learning curve could improve our understanding of fostering and improving pain perspectives within our interventions. However, there are many uncertainties in predictors of HCPs' perspectives. Within Chapters 1 and 4, stronger biopsychosocial perspectives were predicted by higher age during education [34], fewer years since graduation, male sex, their institution for education, and their profession. While higher age predicted stronger biopsychosocial perspectives during education, graduated HCPs with higher age had lower biopsychosocial perspectives [4-6]. Therefore, fewer years since graduation or years of clinical experience seem to be better predictors, though the impact was small. The influence of sex seems indecisive. We found no influence of sex in undergraduate physiotherapists, while a relatively large difference was found in favour of male HCPs compared to female HCPs. Potentially, the selection bias within studies plays a role in the large difference between male and female, or the inclusion of different HCPs, although sex differences were independent of the profession. Yet, previous studies also found large and undecisive variances in sex differences [4-6,69]. An important predictor in HCPs' perspectives was the profession of the HCPs. Previous studies also found significant differences between professions in graduated and undergraduate HCPs [34,35,64,70-73]. These studies also suggest that physiotherapists have stronger biopsychosocial pain perspectives compared to other professions [23,34,35]. Therefore, differences between professions are important to consider when tailoring educational programs by understanding that HCPs from some professions might already have better biopsychosocial perspectives than others. Additionally, it can also depend on which institution HCPs graduated.

However, while the factors mentioned above accounted for some variability in pain perspectives, a significant portion remained unexplained, largely attributed to individual

differences (Chapter 4). Notably, we have not explored the influence of various cultural factors, such as ethnicity, religion, and gender, which may play a role in fostering pain perspectives [35]. Nonetheless, this underscores the importance of maintaining a person-centred approach when designing and assessing educational initiatives.

Strengths and limitations

The studies' strengths and limitations are detailed in different chapters. Hence, we will specifically address those within the dissertation.

All studies were conducted within the Belgium healthcare system, containing large sample sizes and a diverse population recruited from different cities in all three regions in Belgium. This approach enhances the comparability of the study results and strengthens the ability to make conclusions within the Belgian context. Moreover, these studies have been applied within “real-life” educational contexts of HCPs in Belgium. We used literature and consulted Belgian experts to develop the interdisciplinary training program. Besides, we dealt with actual contextual barriers and facilitators for implementing an interdisciplinary training program about chronic pain in Belgium. Yet, the training was free for participants, which reduced the financial barrier to developing a training program and for HCPs to participate. However, due to its specificity to Belgium, it also limits the generalizability of the findings beyond Belgium. We also took into account the hierarchical structure of the data and the measurements in multiple sites in Belgium within the statistical analysis. We applied linear mixed models which provided the ability to assess the predicting factors within the total sample and gain a deeper understanding of how contextual factors (e.g. differences between individuals, groups, institutions and areas) influence outcomes for more accurate estimations of the true effect. This enhanced the generalizability of the results.

However, we also acknowledge several limitations.

Firstly, we used the term biopsychosocial perspectives or biopsychosocial pain management which may be prone to subjective interpretation or is considered just an empty phrase without practical usefulness [74]. Potentially, biopsychosocial is narrowly interpreted towards biomedical, psychological and social factors [75,76], excluding perspectives towards shared-decision making and patient-centred care, which we consider crucial elements within biopsychosocial pain management. A term like “modern pain science” might offer a broader framework for interpretation. However, we believe that “modern pain science” lacks a clear direction and is, therefore, potentially up to more subjective interpretation.

Secondly, there are challenges in the comparison between our studies due to differences in study samples and measurements. Although our samples were mostly in Belgium, Chapter 1 included undergraduate physiotherapists, Chapter 2 graduate and undergraduate physiotherapists and medical doctors, and Chapter 4 a variety of graduated HCPs. Additionally, their pain perspectives were measured with different questionnaires. With the PABS-PT and HC-PAIRS, we assessed attitudes and beliefs regarding chronic pain [77,78], and the KNAP

knowledge and attitudes about pain, including statements about both (sub)acute pain and chronic pain [42]. Therefore, care has to be taken with the comparison of results.
Moreover, these questionnaires were all self-reported, risking social desirability bias, and with the high likelihood of selection bias, the results most likely overestimated actual general biopsychosocial pain perspectives in Belgian HCPs. Besides, the responsiveness of the KNAP questionnaire has not been tested. Therefore, it is unknown if the change in Chapter 4 potentially underestimates or overestimates the real change in pain knowledge and attitudes after the training program. Although the cut-off points in clinical vignettes were also applied in previous studies[10], these cut-off points are debatable if they were completely in accordance with clinical guidelines. Indeed, some answer options of the vignettes lack nuances, as explained before, and many guidelines do not provide clear statements regarding actual advice to patients. Therefore, depending on the clinical vignette and guideline itself, we might over- or underestimate HCPs' adherence.

Thirdly, no qualitative studies or observations in clinical practice were applied to assess real-life perspectives and behaviour. We used clinical vignettes to provide insights into the recommendations regarding activity, sports, work, bed rest and opioid support towards patients with chronic pain. These clinical vignettes have the advantage of assessing these recommendations in a large population without needing to observe behaviour. However, the validity of predicting actual behaviour in clinical practice via clinical vignettes remains controversial [79-82]. The analysis in Chapters 1 and 4 faced challenges due to the limited variance in responses on clinical vignettes given by participants. This limited the ability to assess the predicting factors of these recommendations and suggests a lack of discriminative ability between HCPs with more dominant biomedical or biopsychosocial perspectives in our sample. Moreover, interpreting these results posed challenges due to the lack of understanding regarding the underlying rationale for the recommendations. Using a simulated patient approach [83] or other questionnaires could have improved the assessment of actual behaviour. Preferably in combination with qualitative evaluations to provide better insight into these recommendations.

Fourthly, a set of competencies was assigned to the interdisciplinary training program to improve biopsychosocial chronic pain management with a cognitive-behavioural approach. Throughout the project, we realised that it is debatable whether these competencies were formulated as learning objectives or as competencies [84]. Besides, these competencies were broadly stated (e.g. "Understand acute and chronic pain within a biopsychosocial framework" and "Assess patients with (chronic) pain comprehensively"). Defining competencies is challenging because of the complexity of the processes that underpin them. Having more specifically stated competencies and quantifying improvements in them could make assessment less challenging to determine if participants have improved [84]. Additionally, more specific descriptions of competencies - especially when competencies are expressed as actions

(”shows” and ”does”) rather than knowledge (”knows how” and ”know”) [84] - could also facilitate the development of training programs aimed at changing behaviour in practice [84,85].

Lastly, as discussed earlier, Chapters 1 is not a longitudinal study and Chapter 4 did not conduct a (randomized) controlled trial. Therefore, we can't determine to what extent the observed changes are for sure attributable to the educational programs in Chapters 1 and 4. Therefore, caution has to be taken about the causality of the results. Applying a type 3 hybrid effectiveness implementation design with a (randomized) controlled trial could be used to assess clinical outcomes associated with the implementation of the training program and determine the utility of the training program and/or strategy [86]. These study designs could provide insight into the impact of specific pain content, hours taught, didactic training methods, and/or interdisciplinary workshops. Furthermore, the effect sizes of the applied questionnaire lack minimally clinically important differences, making it more uncertain if the difference/change is clinically relevant. This leaves more space for own interpretation, but also for researcher bias. Besides, assessing patient and healthcare outcomes was not part of the scope of this dissertation, making it unknown what the actual translation is into clinical care, including the impact on chronic pain management and patient-relevant outcomes.

Future implications

Educational programs have the potential to facilitate the highly needed biopsychosocial perspectives in chronic pain management in undergraduate and graduated HCPs. However, we need to critically examine the educational programs and initiatives to improve chronic pain care. The significant improvements in some institutions and the change facilitated by the interdisciplinary training program suggest that improvements in HCPs perspectives are feasible. We can realise this by improving comprehensive biopsychosocial pain content integrated throughout the basic curricula to create stronger connections between (chronic) pain and the multifactorial influence of biopsychosocial factors instead of separate pain modules [61]. Additionally, stronger collaborations between different disciplines, and educational institutions (e.g. universities and organisations that provide post-graduate training) on both national and international levels. These collaborations could facilitate interdisciplinary training and improve the quality of HCPs' education by learning from each other, each other's curricula, teaching methods and the effectiveness of initiatives to improve the quality of education.

However, we should be aware that improving HCPs' perceptions towards biopsychosocial chronic pain management does not directly imply an improvement in actual chronic pain management, as previous implementation studies have mixed results [65,87-90]. Changing behaviour is complex and multifactorial, not only determined by HCPs' perspectives [65,88]. Implementing biopsychosocial chronic pain management and abandoning or reducing ineffective and harmful interventions is challenging [91,92], also for HCPs who understand and recognize the importance of biopsychosocial chronic pain management [93]. These challenges are also reflected by the wide variety of barriers formulated by the Belgian stakeholders [49].

Improving competencies in various HCPs through interdisciplinary training could be more challenging as interdisciplinary training is less adapted to profession-specific chronic pain management and its barriers and facilitators compared to monodisciplinary [16]. Nor did we train HCPs to provide various treatment options for patients with chronic pain [94], which is one of the priorities for effective chronic pain management [61]. Therefore, within the extension of this project with the Belgian Federal Government of Health, we are assessing the determinants of implementation behaviour of implementing biopsychosocial pain management with pain science education into clinical practice. Within this project extension, we will assess factors such as HCPs' confidence, skills, professional roles, beliefs about capabilities and consequences, intentions, environmental context (e.g. socio-political context, organization, and social influence), emotions, patient relations, innovation strategy and memory [93,95,96]. These factors will be assessed through a mixed method study, using a quantitative questionnaire [95] and focus groups. We anticipate that assessing these determinants, which were not assessed within this dissertation, could offer deeper insights into the (enhanced) competencies of HCPs - as competencies signify the capacity to successfully carry out tasks in the real world [85]. Understanding the capability of HCPs to translate their perspectives and skills into clinical practice (e.g. barriers and facilitators) could support the optimisation of future educational initiatives.

To optimize the efficiency to target these barriers and needs and improve competencies of chronic pain management, HCPs and other stakeholders should be involved in a co-design within the development and implementation [97-99]. The needs of patients should also be a primary concern when training is provided [99] and it should be up to date with policies and expectations of the healthcare system [65]. Together, we need to study optimal (pain)content, hours taught, and teaching methods to optimize the effectiveness of educational programs in improving chronic pain management for both graduate and undergraduate HCPs. While extensive training programs appear necessary to cover all relevant pain content [94], this poses challenges for post-graduate programs. Conversely, programs with fewer hours of training and the integration of e-learning modules offer potential benefits of ease of implementation and scalability with fewer resources. Moreover, shorter training sessions are more feasible for healthcare providers. Hence, it is essential for these training programs to choose content, training methods and teaching methods, a decision that may be guided by determining the optimal duration required for effective learning. Moreover, interdisciplinary training could offer further advantages, including enhancing interdisciplinary collaborations [100] - although this aspect is not addressed in this dissertation. While we did not include specific exercises to improve interdisciplinary competencies, future research should investigate the impact of interdisciplinary training on collaborative practices in clinical settings. Interdisciplinary collaboration is currently lacking yet vital in chronic pain management [101].

Educational and research initiatives should not solely focus on HCPs to facilitate biopsychosocial chronic pain management [102]. Rather, they should encompass all segments of society [102], including local communities, patients, and policy-makers [93]. This global approach

is crucial to achieving alignment between all [102], especially considering patient expectations and the healthcare system influence HCP's decision-making [29]. A deeper understanding of policies and perspectives at all segments of society can, in turn, improve educational programs, aimed at improving HCPs' competencies tailored to their practice environment. It has the potential to yield a greater impact on patient-relevant outcomes (e.g. pain intensity, physical, emotional and social functioning, self-efficacy, and quality of life [103-105]) and healthcare system outcomes (e.g. interdisciplinary collaboration, cost-effectiveness, and referral networks), although the extent of this impact remains uncertain [102].

We are encouraged by the recognition from the Belgian Federal Government of Health regarding the significant burden of chronic pain [106-109] and its societal impact [109-111]. Their commitment to funding and guiding projects aimed at enhancing chronic pain care is commendable. Training 500 HCPs is important, yet, it represents a fraction of the many thousands currently practicing in Belgium [112]. To ensure sustainable educational initiatives reach all HCPs, scaling up is imperative for broader accessibility. By expanding educational initiatives and fostering collaboration across various sectors (e.g. involving governmental bodies, educational institutions, healthcare insurers, and industry stakeholders), we can work towards more effective chronic pain management in Belgium.

General conclusion

Although chronic pain is seen so frequently with its high prevalence and large impact on patients with chronic pain and society, it does not imply that patients with chronic pain receive adequate care. This dissertation highlights the deficiency of biopsychosocial chronic pain perspectives in undergraduate and graduate healthcare professionals. In the past decade, there have been some improvements in biopsychosocial perspectives in Belgian undergraduate physiotherapists, but these improvements were small with persistent adherence to common biomedical views on pain management, such as recommending bed rest and limitation of activity and work. Besides, these improvements were not found across all institutions. This emphasises the need for more adequate training for healthcare professionals. The interdisciplinary training program we developed fostered a more comprehensive biopsychosocial perspective of chronic pain management among various HCPs, supporting non-pharmaceutical pain management, including exercise therapy and PSE, and recommending patients to continue activities, sports and work participation. However, some biomedical perspectives persisted. Moving forward, it is imperative to continue evaluating and refining educational initiatives to improve these perspectives and bridge the gap between scientific literature and clinical practice. Efforts should be made to address the barriers and challenges hindering the implementation of biopsychosocial approaches in clinical settings, including the alignment of clinical guidelines. This underscores the importance of ongoing research in education and implementation projects aimed at enhancing chronic pain care and reducing the burden of chronic pain on patients and society.

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Supplemental materials

Supplemental material 1

Clinical vignette:

A 37 year-old factory foreman has complained of right low back pain radiating into the right calf since being rear-ended in a motor vehicle accident 9 months ago. He describes his back and leg pain symptoms as being moderate to severe, without improvement over the last 6 months. Neurological exam is normal. A recent MRA of the lumbosacral spine showed a central disc bulge at L4-L5. The patient returned to work several months after the accident, but discontinued working within 2 weeks after complaining that standing and walking at work aggravated his back and leg symptoms.

1. **It is most likely that this patient's symptoms result from spinal pathology which is:**

1	2	3	4	5
Not from spinal pathology	Mild	Moderate	Severe	Extremely severe

2. **I would recommend to this patient that he:**

1	2	3	4	5
Not limit any activity	Avoid only painful activities	Limit activities to moderate exertion	Limit activities to light exertion	Limit all physical activities

3. **I would recommend to this patient that he:**

1	2	3	4	5
Work full time, full day	Work moderate duty, full time	Work light duty, full time	Work light duty, part time	Remain out of work

Supplemental material 2. Contributing factors of students' attitudes, beliefs, and adherence to guideline recommendations regarding CLBP

Table A. Contributing factors of students' attitudes, beliefs, and adherence to guideline recommendations regarding CLBP.

	Attitudes and beliefs regarding CLBP			Guideline-adherent recommendations		
Factor	**PABS-BM Estimate (95% CI) (N = 2,794)**	**PABS-BPS Estimate (95% CI) (N = 2,805)**	**HC-PAIRS Estimate (95% CI) (N = 2,758)**	**Spinal pathology OR (95% CI) (N = 2,745)**	**Activity OR (95% CI) (N = 2,748)**	**Work OR (95% CI) (N = 2,745)**
Age	-0.17 (-0.07, -0.28)	/	-0.19 (-0.04, -0.34)	1.07 (1.01, 1.12)	1.07 (1.03, 1.11),	/
Year of education (4th)	-5.59 (-5.11, -6.06)	1.95 (1.36, 1.99)	-6.58 (-5.91, -7.26)	2.39 (1.80, 3.16)	3.05 (2.53, 3.68)	3.04 (2.45, 3.76)
Academic year (2020)	-2.12 (-1.69, -2.55)	1.68 (1.64, 2.25)	-1.17 (-0.56, -1.79)	1.43 (1.10, 1.85)	1.47 (1.25, 1.74)	/
ICC (institutions)	0.212	0.121	0.161	0.306	0.268	0.234

OR, odds ratio; CLBP, chronic low back pain; CI, confidence interval; PABS-BM, Pain Attitudes and Beliefs Scale for Physiotherapists biomedical subscale; PABS-BPS, Pain Attitudes and Beliefs Scale for Physiotherapists biopsychosocial subscale; HC-PAIRS, Health Care Providers' Pain and Impairment Relationship Scale; ICC, intraclass correlation coefficient; /, no significant contributing factor within this model.

Supplemental material 3. Final version of the KNAP-FR

Knowledge and Attitudes of Pain; French version (KNAP-FR)

Sur une échelle de 1 à 6, dans quelle mesure êtes-vous d'accord ou non avec cette affirmation :

1. Pas du tout d'accord.
2. En grande partie pas d'accord.
3. Plutôt pas d'accord.
4. Plutôt d'accord.
5. En grande partie d'accord.
6. Tout à fait d'accord.

Domaine 1 : Physiologie de la douleur et facteurs d'influence :

1) Si les lésions tissulaires ou l'inflammation ont complètement disparu, la douleur disparaît.	1 2 3 4 5 6
2) Le système de la douleur peut s'adapter et peut dès lors devenir hypersensible.	1 2 3 4 5 6
3) Une sensibilité à la douleur peut persister, même s'il n'y a plus de blessure ou de lésion tissulaire.	1 2 3 4 5 6
4) En cas de douleur persistante, la douleur peut être causée par l'adaptation du système de la douleur.	1 2 3 4 5 6
5) Le cerveau libère des substances chimiques qui peuvent rendre le système de la douleur moins sensible.	1 2 3 4 5 6
6) L'hypersensibilité du système de la douleur peut parfois être bénéfique.	1 2 3 4 5 6
7) La douleur est toujours une réponse du cerveau.	1 2 3 4 5 6
8) Le cerveau est doté d'un système interne de réduction de la douleur, afin de soulager la douleur.	1 2 3 4 5 6
9) L'activité cérébrale est influencée par des facteurs psychologiques et sociaux (comme le stress) qui, à leur tour, influencent la sensibilité du système de la douleur.	1 2 3 4 5 6
10) Le cerveau possède un mécanisme capable d'amplifier les signaux nerveux.	1 2 3 4 5 6
11) Si des signaux nerveux du corps sont interprétés comme dangereux, cela conduit probablement à une expérience de la douleur.	1 2 3 4 5 6
12) Les pensées négatives relatives à la cause de la douleur peuvent amplifier la douleur.	1 2 3 4 5 6
13) En cas de douleur persistante, il est important de savoir que la douleur n'est pas dangereuse.	1 2 3 4 5 6
14) En cas de douleur persistante, il est important de savoir pourquoi la douleur persiste.	1 2 3 4 5 6
15) Si la douleur est influencée par des facteurs psychologiques, cela signifie probablement que la douleur n'est pas réelle ou a été partiellement inventée.	1 2 3 4 5 6
16) La douleur physique ressentie par une personne est influencée par les pensées sur la cause de la douleur.	1 2 3 4 5 6

17) La douleur persistante est souvent le résultat d'une compression nerveuse.	1 2 3 4 5 6
18) Une douleur inexpliquée n'est pas une douleur réelle.	1 2 3 4 5 6
19) Lorsqu'on a une douleur persistante, il est dangereux de bouger ou de faire de l'exercice.	1 2 3 4 5 6
20) Tant que les lésions tissulaires sont visibles sur une imagerie (ex : radiographie, IRM), la douleur est présente.	1 2 3 4 5 6
21) La douleur indique toujours que vous devriez réduire vos activités.	1 2 3 4 5 6

Domaine 2 : Traitement de la douleur :

22) En cas de douleur persistante, le traitement vise à réduire la sensibilité du système de la douleur.	1 2 3 4 5 6
23) Le traitement de la douleur est toujours le plus efficace lorsqu'il met l'accent sur les lésions tissulaires (ou l'inflammation) et la résolution de ce problème.	1 2 3 4 5 6
24) L'activité physique est une bonne option de traitement dans le cas d'une douleur persistante.	1 2 3 4 5 6
25) Les antidouleurs sont efficaces dans le cas d'une douleur persistante.	1 2 3 4 5 6
26) Corriger une mauvaise posture réduit une douleur persistante.	1 2 3 4 5 6
27) Le kinésithérapeute peut corriger une colonne vertébrale mal alignée, ce qui réduit une douleur persistante.	1 2 3 4 5 6
28) Lors d'un traitement de kinésithérapie, il faut éviter les exercices qui provoquent la douleur.	1 2 3 4 5 6
29) En savoir davantage sur la douleur grâce aux explications du kinésithérapeute réduit la douleur persistante du patient.	1 2 3 4 5 6
30) En cas de douleur persistante, le niveau d'activité devrait être augmenté en fonction de la douleur ressentie.	1 2 3 4 5 6

Supplemental material 4. Chronic pain training program

Objectives of the first workshop

1. Understand acute and chronic pain within a biopsychosocial framework
    a. Understand the difference between pain and nociception and acute and chronic pain.
    b. Recognize that the purely biomedical model is out-of-date and that the biopsychosocial model of pain should be adopted.

2. Assess patients with (chronic) pain comprehensively
    a. Use questionnaires and interviews to identify patients' biopsychosocial factors which might influence pain experience according to the PSCEBSM model (pain–somatic factors – cognitive factors – emotional factors – behavioural factors – social factors – motivation).
    b. Assess the patients' resources, obstacles to improvement, and their "readiness to change".

3. Integrate contemporary pain science into clinical reasoning in patients with chronic pain
    a. Incorporate patients' biopsychosocial factors when making decisions regarding chronic pain type (e.g. nociceptive, neuropathic and/or nociplastic pain), patients' evaluation and care request.
    b. Design multimodal treatment programs, either mono- or interdisciplinary, according to the patients' representations, beliefs, expectations and needs, e.g. stress self-management program, graded activity program, graded exposure, education/reassurance, etc.

Table A1. Program of the first workshop

Phase and duration (±)	Objectives per phase	Content; Didactic teaching and learning activities	Evaluation of objectives per phase
1st phase, 30 minutes	Introducing trainers, participants, and workshop	*Introduction of teachers and participants* *Identify the motivation and expectations of participants* *Discuss the objectives of the training program*	Evaluate through questions and discussions
2nd phase 20 minutes	Align objectives of training with expectations of participants A brief review of basic concepts	*Discuss the experience of the 1st e-learning module* *A brief review of basic concepts:* *- Pain is a necessary protective mechanism* *- Difference between acute and chronic pain* *- Pain versus nociception* *- Pain is always real* *- Biopsychosocial factors influence pain* *Inform where possible extra time/attention is needed*	Evaluate through questions and discussions
Optional:	Review e-learning content if desired by participants	*Discuss content from the e-learning*	
Break			
4th phase 45 minutes	Discuss and practice patient assessment	*Discuss and apply pain classification (nociceptive pain, neurological pain, nociplastic pain) and PSCEBSM-model based on a patient case - in pairs, followed by a group discussion.* *Discuss different patients' illness perceptions (identity, cause, timeline, consequences, cure and control), possible relevant questionnaires, and conclusions*	Evaluate through questions and discussions
5th phase 45 minutes	Discuss and practice communication during intake/assessment Assess "readiness to change".	*Discussion about barriers and facilitators to apply behaviour change techniques in clinical practice and the importance of adequate communication* *Practice communication to elicit language relating to change in the "patient":* *- Experience how not to; convince the patient how he must change* *- Experience how to; ask open questions (examples):* *- What is the main reason for you to change?* *- What do you hope this change will bring?* *- How important is this change to you?* *- How might you approach it?* *- Do you think it is feasible for you?* *Apply basic principles of motivational interviewing* *- Ask open questions* *- Use a positive approach*	Evaluate through questions, discussions and observation

		- Reflect on patients *- Summarise* *Ambivalence:* *Change in behaviour is influenced by the advantages and disadvantages of the current situation and the new situation. Discuss both situations.*	
Break			
6th phase 45 minutes	Introduction to pain science education (PSE) PSE demonstration	*Discussion about who is currently applying PSE, what elements are essential and what tools/materials you can use* *Present scientific support for PSE* *Classical demonstration of pain education by the teachers*	Evaluate through questions, discussions and observation
7th phase 45 minutes	PSE skills training	*Practice PSE (while using metaphors);* *- Explain acute pain to a patient* *- Explain chronic pain to a patient* *- Discuss biopsychosocial factors with a patient* *- Motivate a patient to change beliefs, lifestyle factors and behaviour* *Exercise to provide PSE based on the patient case*	Evaluate through questions, discussions and observation
8th phase 30 minutes	Improve barriers and facilitators regarding PSE	*Discuss which barriers and facilitators participants foresee for implementing PSE in their clinical practice, and how to reduce these barriers.*	Evaluate through questions and discussions
Optional section 60 minutes	Improve knowledge and skills where desired by participants	*Options:* *Provide more information or practice skills regarding the biopsychosocial model, PSE, communication techniques or management of patients with chronic pain*	
Final phase 10 minutes	Check if the expectations and objectives of the workshop and participants were achieved Provide take-home messages and exercises for implementation	*Inform whether expectations and objectives – which were formulated in the 1st phase - have been met* *Discuss their actions to implement the learned knowledge and skills into clinical practice* *Share take-home messages and explain exercises for implementation for the upcoming month to practice.*	Evaluate through questions and discussions

PSCEBSM-model = pain – somatic factors - cognitive factors - emotional factors - behavioural factors - social factors – motivation; PSE = pain science education

Exercises for implementation

Exercise 1:

- After providing PSE: Immediately after the explanation, have patients tell in their own words how they would explain it to their friends and family.
- After providing PSE: Let patients explain this in their own words during the next treatment.

Exercise 2:

- Use two questionnaires in the treatment plan. Whenever possible, not only during the assessment but also at the end of the entire treatment or after a certain period of time to measure progress objectively.

Exercise 3:

- Give patients assignments or materials to take home to read further on the education of pain at home. Whenever possible, discuss this during the next treatment session.
    - For example, the patient education booklet, available patient videos, watch retrainpain.org, or possibly own materials you use. Ideally, you should offer the patient choices: does the patient prefer to watch an online video or would they rather have a printed brochure to take home? Some patients choose the combination. This is a low-threshold method of shared decision-making that promotes adherence.
    - See: www.paininmotion.be/patients/information-about-persistent-pain
      Go to www.paininmotion.be -> Patients -> Information-about-persistent-pain

Exercise 4:

- Explain to a colleague or team the neurophysiology of pain. Explain and discuss the differences between acute pain and chronic pain in a biopsychosocial model, which factors all have an influence and why.
- Discuss with each other which questionnaires you used and/or which questionnaires can improve assessment or treatment.

Exercise 5:

- Use the ICF model in a patient's report (Function, Activities, Participation, Personal factors, Environmental factors).
- Discuss the report with a colleague using the ICF model for more effective communication.

Second workshop

1. Integrate contemporary pain science into clinical reasoning in patients with chronic pain
    a. Incorporate patients' biopsychosocial factors when making decisions regarding chronic pain type (e.g. nociceptive, neuropathic and/or nociplastic pain), patients' evaluation and care request.
    b. Design multimodal treatment programs, either mono- or interdisciplinary, according to the patients' representations, beliefs, expectations and needs, e.g. stress self-management program, graded activity program, graded exposure, education/reassurance, etc.

2. Provide tailored and patient-centred strategies to subacute and chronic pain patients
    a. Educational strategies:
        i. Understand that pain science education (PSE) is a continuous process;
        ii. Use communication skills to favour therapeutic alliance;
        iii. Master pain neurophysiology and the biology behind different pain mechanisms to be able to explain pain to patients by means of metaphors and tools.
    b. Use a patient-centred approach to define specific goals that are meaningful to the patient.
    c. Manage obstacles to improve the patient's motivation to change.
    d. Teach patients pain coping skills aligned with the ideas delivered during PSE.

3. Understand the role of HCPs in an interdisciplinary perspective
    a. Understand other healthcare disciplines' roles in successfully managing chronic pain.
    b. Communicate adequately with other HCPs about the management of chronic pain.

Table A2. Program of the second workshop

Phase and duration (±)	Objectives per phase	Content; Didactic teaching and learning activities	Evaluation of objectives per phase
1st phase 15 minutes	Introduce trainers, participants, and workshop	*Introduction of teachers and participants* *Identify the motivation and expectations of participants* *Discuss the objectives of the training program*	Evaluate through questions and discussions
2e phase 30 minutes	Align the objective of training with the expectations of participants	*Inform who implemented the biopsychosocial model, PSE, patient materials in their clinical practice and who completed the exercises* *Discuss participants' experiences and their perceived barriers and facilitators* *Discuss the second e-learning module* *Inform where possible extra time/attention is needed*	Evaluate through questions and discussions
Optional: Review topics	*If desired by the participants, extensive discussion about previous content*	*Extensive discussion about content from the e-learning modules and the first workshop*	
3e phase 30 minutes	Improve patient assessment and develop a treatment plan	*Apply the international classification of functioning, disability and health model (ICF-model) to differentiate between types of pain and assess biopsychosocial factors influencing the health problem of a patient case.* *Determine which biopsychosocial factors are important factors for the participant to address in his/her treatment plan*	Evaluate through questions, discussions and observation
Break			
4e phase 60 minutes	Improve PSE and motivational interviewing skills	*Practice PSE with extra attention on explaining:* *- the influence of stress, beliefs, lifestyle factors, and environmental factors on pain* *- How influencing factors not only influence pain but also each other* *- Results from medical imaging* *Practice in groups of 3 so an observer provides detailed feedback, followed by a class discussion*	Evaluate through questions, discussions and observation
5 e phase 45 minutes	Improve communication skills including	*Discuss (stages of) behavioural change* *Motivational interviewing skills:*	Evaluate through questions,

	motivational interviewing	*- Ask for permission* *- Elicit prior knowledge (What do you already know about X?)* *- Share information (in chunks)* *- Elicit meaning (What does X mean to you?)* *Practice responding to a list of patient statements/quotes*	discussions and observation
Break			
6e phase 40 minutes	Setting patient-centered goals	*Discuss and write down specific and realistic treatment goals (SMART; specific, measurable, achievable, realistic, time-bound) for the patient case with chronic pain with a focus on:* *- Activity, participation, self-management and quality of life* *- Patient-centered* *- shared-decision making with the patient*	Evaluate through questions, discussions and observation
7e phase 90 minutes	Developing a treatment plan with a mono/multidisciplinary approach Identification of roles between different disciplines	Participants develop a treatment plan for a patient case. Discussion about mono-/multidisciplinary treatment plans and the roles of different disciplines Discuss commonly applied treatment modalities and advice: - PSE - (Graded) exposure - (Graded) activity - Lifestyle coaching (e.g. sleep, stress, nutrition) - Hands-on techniques - Medication - Medical imaging - Work absenteeism	Evaluate through questions, discussions and observation
8e phase 20 minutes	Create awareness about communication with healthcare providers	*Inform when participants communicate with other HCPs and what information they ask/share* *Discuss how this communication can be improved* *Discuss the integration of ICF into their reports*	Evaluate through questions and discussions
Optional phase	*Improve knowledge* *Practise skills*	*Improve knowledge or practise skills* *based on the needs of the participants*	
Final phase 30 minutes	Check if the expectations and objectives of the workshop and participants were achieved Provide key messages	*Inform whether expectations and objectives have been met* *Discuss their actions to implement the learned knowledge and skills into clinical practice*	Evaluate through questions and discussions

PSE = pain science education; ICF-model = International Classification of functioning disability and health model; SMART = Specific, Measurable, Achievable, Realistic, Time-bound;

Key messages at the end of the chronic pain training program

- Acute and chronic pain are different
- A biopsychosocial perspective is essential
- Differentiate between nociceptive, neuropathic and neuroplastic pain
- Psychosocial factors are greater predictors of pain than biomedical factors (but biomedical factors are still important!)
- Apply a patient-centred approach
- Provide pain science education (unless the patient does not want it)
    - Reduce "danger"
    - Pain does not equal harm
- Use motivational interviewing
- Focus on change in lifestyle factors
    - Activate lifestyle
    - Focus on participation
    - Improve the quality of life
- Stimulate self-management
- Monodisciplinary treatment plans can be effective, but multidisciplinary are more beneficial

Supplemental material 5. Competencies of the learning objective.

Competencies

The learning objectives of the training program' were the improvement of the following competencies:

1. Understand acute and chronic pain within a biopsychosocial framework
    c. Understand the difference between pain and nociception and acute and chronic pain.
    d. Recognize that the purely biomedical model is out-of-date and that the biopsychosocial model of pain should be adopted.

2. Assess patients with (chronic) pain comprehensively
    a. Use questionnaires and interviews to identify patients' biopsychosocial factors which might influence pain experience according to the PSCEBSM model (pain–somatic factors – cognitive factors – emotional factors – behavioural factors – social factors – motivation).
    b. Assess the patients' resources, obstacles to improvement, and their "readiness to change".

3. Integrate contemporary pain science into clinical reasoning in patients with chronic pain
    a. Incorporate patients' biopsychosocial factors when making decisions regarding chronic pain type (e.g. nociceptive, neuropathic and/or nociplastic pain), patients' evaluation and care request.
    b. Design multimodal treatment programs, either mono- or interdisciplinary, according to the patients' representations, beliefs, expectations and needs, e.g. stress self-management program, graded activity program, graded exposure, education/reassurance, etc.

4. Provide tailored and patient-centred strategies to subacute and chronic pain patients
    a. Educational strategies:
        i. Understand that pain science education (PSE) is a continuous process;
        ii. Use communication skills to favour therapeutic alliance;
        iii. Master pain neurophysiology and the biology behind different pain mechanisms to be able to explain pain to patients by means of metaphors and tools.
    b. Use a patient-centred approach to define specific goals that are meaningful to the patient.
    c. Manage obstacles to improve the patient's motivation to change.
    d. Teach patients pain coping skills aligned with the ideas delivered during PSE.

5. Understand the role of HCPs in an interdisciplinary perspective
    a. Understand other healthcare disciplines' roles in successfully managing chronic pain.
    b. Communicate adequately with other HCPs about the management of chronic pain.

Supplemental material 6. Cognitive behavioural approaches

Basic fundamentals

Participants were taught about the importance of therapeutic alliances, shared decision-making, and a patient-centred approach, and these concepts were discussed with them in depth. This includes recognising patients' pain and cognitions, building trust with patients to create a collaborative and supportive treatment environment, and involving patients in their care to understand and address the patient's needs and concerns. Additionally, it includes promoting active participation of patients and setting meaningful and feasible goals with the patient. Moreover, participants were taught how cognitive behavioural approaches can be provided through purely dialogue-based methods as well as within physically active approaches during physical examination or exercise therapy, and these concepts were discussed with them in depth.

Identifying Maladaptive Thinking

Participants were taught about the elements and importance of patients' beliefs and illness perceptions regarding their health problems and how participants can integrate this within the assessment and treatment, and these concepts were discussed with them in depth. Additionally, participants practised recognising maladaptive thinking via a casus and practised the conversation with role-playing to improve their skills in identifying maladaptive thoughts.

Modifying Maladaptive Thinking

Participants were taught about how Pain Science Education and Cognitive Behavioural Therapy can modify maladaptive beliefs, and these concepts were discussed with them in depth. Additionally, they practised Pain Science Education by reconceptualizing patients' beliefs through interactive dialogues and integrating motivational interviewing techniques via role-play exercises. Moreover, participants practised the use of metaphors and patient materials (e.g. patient videos and booklet) within Pain Science Education. Simultaneously, they were taught and stimulated to avoid negative words suggesting 'danger' and to use positive words suggesting 'safety'.

Behavioural activation

Participants were taught about the importance of behaviour activation, and this concept was discussed with them in depth. Additionally, participants practised interactive dialogues with patients about the context, experiences and negative and positive impact of the current situation related to their goals and their expectations regarding the negative and positive impact of behaviour change. Moreover, they practised to increase patients' engagement with behaviour change and aim to facilitate "elicit change talk" in patients.

(Graded) exposure

Participants were taught about the elements and effects of exposure therapy in patients with pain-related fear and anxiety, and these concepts are discussed with them in depth.

Supplemental material 7. Training evaluation questionnaires.

Table C1. Training satisfaction after first workshop

Items workshop 1	Distribution of scores				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The objectives of the training were clearly defined.	205 (60.8%)	120 (35.6%)	9 (2.7%)	1 (0.3%)	1 (0.3%)
The topics covered were relevant to me.	223 (66.0%)	102 (30.2%)	12 (3.0%)	1 (0.3%)	-
The content was organised and easy to follow.	205 (60.8%)	117 (34.7%)	14 (4.2%)	-	-
The material distributed was useful.	206 (61.5%)	114 (34.0)	15 (4.5%)	-	-
The trainers were knowledgeable about the training topics.	290 (85.8%)	44 (13.0%)	3 (0.9%)	-	-
The quality of instruction was good.	220 (65.7%)	107 (31.9%)	7 (2.1%)	-	-
The trainers were well prepared.	280 (83.1%)	53 (15.7%)	3 (0.9%)	-	-
The objectives of the training were achieved.	169 (50.4%)	146 (43.6%)	18 (5.4%)	1 (0.3)	-
The training met my expectations.	157 (47.0%)	149 (44.6%)	23 (6.9%)	3 (0.9)	1 (0.3%)
I was able to learn a lot from this course.	141 (42.0%)	155 (46.1%)	33 (9.8%)	4 (1.2%)	2 (0.6%)
I will be able to apply the knowledge learnt.	75 (22.2%)	221 (65.4%)	36 (10.7%)	5 (1.5%)	-
This training experience will be useful in my work.	201 (59.5%)	122 (36.1%)	12 (3.6%)	2 (0.6%)	-
The time spent on the training was sufficient.	178 (52.8%)	128 (38.0%)	21 (6.2%)	5 (1.5%)	2 (0.6%)

Items were rated on a 5-point Likert scale, ranging from 'Strongly Agree' to 'Strongly disagree'. Data represents number of observations and proportions per item. SD = standard deviation

Table C2. Training satisfaction after second workshop

Items workshop 2	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The objectives of the training were clearly defined.	198 (63.1%)	104 (33.1%)	11 (3.5%)	-	-
The topics covered were relevant to me.	198 (62.5%)	95 (30.0%)	20 (6.3%)	3 (0.9%)	1 (0.3%)
The content was organised and easy to follow.	197 (62.1%)	109 (34.4%)	8 (2.5%)	2 (0.6%)	1 (0.3%)
The material distributed was useful.	198 (62.9%)	98 (31.1%)	17 (5.4%)	2 (0.6%)	-
The trainers were knowledgeable about the training topics.	265 (83.6%)	50 (15.8%)	2 (0.6%)	-	-
The quality of instruction was good.	210 (66.2%)	99 (31.2%)	6 (1.9%)	1 (0.3%)	-
The trainers were well prepared.	255 (80.7%)	58 (18.4%)	2 (0.6%)	-	1 (0.3%)
The objectives of the training were achieved.	185 (58.4%)	111 (35.0%)	18 (5.7%)	1 (0.3%)	1 (0.3%)
The training met my expectations.	150 (47.3%)	129 (40.7%)	30 (9.5%)	7 (2.5%)	1 (0.3%)
I was able to learn a lot from this course.	141 (44.6%)	127 (40.2%)	36 (11.9%)	10 (3.5%)	1 (0.3%)
I will be able to apply the knowledge learnt.	81 (25.6%)	197 (62.3%)	30 (9.8%)	-	1 (0.3%)
This training experience will be useful in my work.	182 (57.4%)	112 (35.3%)	19 (6.0%)	3 (0.9%)	1 (0.3%)
The time spent on the training was sufficient.	153 (48.6%)	126 (40.0%)	31 (9.8%)	4 (1.3%)	1 (0.3)

Items were rated on a 5-point Likert scale, ranging from 'Strongly Agree' to 'Strongly disagree'. Data represents number of observations and proportions per item. SD = standard deviation

Table C3. Participants reported high training satisfaction after each workshop and at six-month follow-up.

General rating after each workshop	Very good	Good	Not good, not bad	Bad	Very bad
How do you rate the first workshop in general?	238 (71.5%)	92 (27.6%)	3 (0.9%)	-	-
How do you rate the second workshop in general?	217 (70.0%)	86 (27.7%)	5 (1.6%)	1 (0.3%)	-
General rating after six months	**Very good**	**Good**	**Not good, not bad**	**Bad**	**Very bad**
How do you rate the training program in general?	196 (65.6%)	95 (31.8%)	7 (2.3%)	1 (0.3%)	-

Items were rated on a 5-point Likert scale, 1 = Very poor, 5 = Very good; - = None.

Table C4. At six-month follow-up, participants reported high satisfaction with the training program and its translation into clinical practice.

Satisfaction	Mean ± SD
I keep the course in good memory	8.99 ± 1.29
I enjoyed the course very much	8.91 ± 1.35
Utility	
The course was very beneficial to my work	8.42 ± 1.70
Participation in this kind of courses is very useful for my job.	8.59 ± 1.69
Gained knowledge	
After the course, I knew substantially more about chronic pain than before.	8.31 ± 2.01
I learned a lot of new things in the course.	8.20 ± 1.94
Application in practice	
In my everyday work, I often use the knowledge gained during the course	7.28 ± 1.86
I successfully manage to apply the content of the course in my everyday work	7.34 ± 1.99
Individual management	
Since the course, I have been more content with my work with patients with chronic pain	7.64 ± 1.97
My treatment of patients with chronic pain has improved through the application of the content of the course.	7.48 ± 1.98
Global management	
Overall, it seems to me that in my practice/clinic, the application of the content of the course has facilitated the treatment of chronic pain	7.56 ± 2.06
Overall, it seems to me that the multidisciplinary collaboration has improved due to the course.	6.71 ± 2.44

Each statement was rated on a scale from 0 to 10, 0 = Completely disagree, 10 = Completely agree. Data represents mean scores and standard deviation of the training evaluation. SD = standard deviation

Summary

Background

Chronic pain is a common condition, affecting around 23% of the Belgian population. It imposes a significant burden on patients, healthcare professionals, and society, being a leading cause of disability, work absenteeism, and productivity loss, and significantly reducing the quality of life for those affected. Advances in clinical science have highlighted the necessity for a paradigm shift from a biomedical approach to a biopsychosocial one, taking into account that biomedical, psychological, and social factors significantly influence chronic pain and pain-related disability. However, translating clinical science into practice remains challenging, in part due to educational programmes that often fall short in fostering biopsychosocial perspectives among healthcare providers in chronic pain management. As a result, both healthcare professionals and patients with chronic pain often find chronic pain management to be inadequate.

This dissertation aims to contribute to understanding healthcare professionals' perspectives on chronic pain management, provide insights into developing an educational programme for healthcare professionals, and assess the impact on healthcare professionals' perspectives towards chronic pain management.

Chapter 1 compares undergraduate physiotherapists' perspectives and clinical recommendations regarding chronic pain management between 2013 and 2020. The findings suggest a small but positive shift towards a more biopsychosocial approach between 2013 and 2020. However, the shift was institution-dependent, and many clinical recommendations still did not align with clinical guidelines, indicating substantial room for improvement in fostering biopsychosocial perspectives in undergraduate physiotherapists.

Chapter 2 focuses on translating the Knowledge and Attitudes about Pain (KNAP) questionnaire into French to assess healthcare professionals' perspectives on modern pain science comprehensively. The resulting French version of the KNAP questionnaire, demonstrated good validity and reliability in assessing pain knowledge and attitudes among both graduated and undergraduate medical doctors and physiotherapists in Belgium and other French-speaking regions.

Chapter 3 offers insights into developing and implementing an interdisciplinary training programme about chronic pain management for various healthcare professionals. It identifies various barriers and facilitators to chronic pain management and educational programmes. Considering these, an interdisciplinary training program was implemented to enhance healthcare professionals' competencies to integrate biopsychosocial chronic pain management with a cognitive behavioural approach into clinical practice.

Chapter 4 examines the short- and mid-term changes in perspectives and clinical recommendations among healthcare professionals who participated in the developed interdisciplinary training programme. The results show stronger biopsychosocial pain perspectives and more guideline-adherent recommendations both immediately after the programme and six months later across the various disciplines. However, some biomedical perspectives persisted. The findings emphasize the need for adequate training programmes to foster biopsychosocial perspectives and ongoing refinement of educational programmes to shift these perspectives further.

Conclusion

Over the past decade, there have been modest improvements in biopsychosocial perspectives towards chronic pain among Belgian undergraduate and graduate healthcare professionals across various disciplines. Many still adhere to traditional biomedical perspectives, such as recommending bed rest and restricting activities and work. The development and implementation of interdisciplinary training programs hold promise in addressing these misconceptions and fostering a more comprehensive biopsychosocial understanding of chronic pain management. However, persistent biomedical perspectives underscore the importance of continuing to implement, evaluate and refine educational initiatives for both undergraduate and graduated healthcare professionals to improve biopsychosocial approaches to chronic pain management further.

Samenvatting

Achtergrond

Chronische pijn is een veelvoorkomende probleem dat ongeveer 23% van de Belgische bevolking treft. Het is een grote last voor zowel patiënten, zorgverleners en de samenleving. Het is de grootste oorzaak van invaliditeit, arbeidsverzuim en productiviteitsverlies en leidt tot een aanzienlijk lagere levenskwaliteit bij patiënten. Vooruitgang in wetenschappen onderzoek heeft de noodzaak aangetoond voor een paradigmaverschuiving van een biomedische naar een biopsychosociale benadering, waarbij rekening wordt gehouden met het feit dat biomedische, psychologische en sociale factoren een significante invloed hebben op chronische pijn en pijn gerelateerde beperkingen. Toch is het uitdagend om deze verschuiving in de zorg te realiseren. Dit komt mede door vaak ontoereikende onderwijsprogramma's om biopsychosociale perspectieven bij zorgverleners ten aanzien van de behandeling van chronische pijn te bevorderen. Als gevolg hiervan vinden zowel zorgverleners als patiënten met chronische pijn de behandeling vaak dat de behandeling van chronische pijn ontoereikend is.

Dit proefschrift heeft als doel bij te dragen aan in het beter begrijpen van perspectieven van zorgverleners ten aanzien van de behandeling van chronische pijn, inzichten te bieden in de ontwikkeling van een interdisciplinaire training voor zorgverleners, en de impact ervan op de perspectieven van zorgverleners ten aanzien van de behandeling van chronische pijn te beoordelen.

Hoofdstuk 1 vergelijkt perspectieven en adviezen van kinesitherapiestudenten (fysiotherapiestudenten) ten aanzien van chronische pijn tussen 2013 en in 2020. De bevindingen suggereren een kleine maar positieve verschuiving naar een meer biopsychosociale benadering tussen 2013 en 2020. Deze verschuiving was echter afhankelijk van de instelling, en een groot deel van de adviezen waren niet in overeenstemming met richtlijnen. Dit toont aan dat er aanzienlijke ruimte is voor het bevorderen van biopsychosociale perspectieven bij kinesitherapiestudenten.

Hoofdstuk 2 richt zich op het vertalen van de Knowlegde and Attitudes about Pain (KNAP) vragenlijst naar het Frans, die de perspectieven van zorgprofessionals omtrent recente pijnwetenschap uitgebreid evalueert. De Franse versie KNAP-vragenlijst toonde een goede validiteit en betrouwbaarheid voor het beoordelen van kennis en attitudes over pijn bij zowel afgestudeerde als studerende artsen en kinesitherapeuten in België en andere Franstalige regio's.

Hoofdstuk 3 biedt inzichten in de ontwikkeling en implementatie van een interdisciplinair trainingsprogramma over de behandeling van chronische pijn voor zorgverleners. Het identificeert een grote verscheidenheid aan barrières en facilitators voor de behandeling van chronische pijn en opleidingsprogramma's. Rekening houdend met deze factoren werd een interdisciplinair trainingsprogramma geïmplementeerd om de competenties van

zorgverleners te verbeteren om biopsychosociale chronische pijnbehandeling met een cognitief-gedragsmatige benadering te integreren in de klinische praktijk.

Hoofdstuk 4 presenteert de korte- en middellangetermijnveranderingen in perspectieven en adviezen bij zorgverleners die deelnamen aan het ontwikkelde interdisciplinaire trainingsprogramma. De resultaten laten sterkere biopsychosociale pijnperspectieven zien en meer adviezen in overeenstemming met richtlijnen, zowel direct na het trainingsprogramma als zes maanden later in de verschillende disciplines. Sommige biomedische perspectieven bleven echter bestaan. De bevindingen benadrukken de noodzaak van adequate trainingsprogramma's om biopsychosociale perspectieven te bevorderen en verdere verbetering van trainingsprogramma's om om deze perspectieven verder te verschuiven.

Conclusie

In de afgelopen decenium zijn er bescheiden verbeteringen opgetreden in de biopsychosociale perspectieven op chronische pijn in Belgische zorgverleners in verschillende disciplines, zowel bij studenten als bij afgestudeerden. Velen blijven echter vasthouden aan traditionele biomedische perspectieven, zoals het aanbevelen van bedrust en het beperken van activiteiten en werk. De ontwikkeling en implementatie van interdisciplinaire trainingsprogramma's tonen potentieel in het aanpakken van deze misvattingen en het bevorderen van een meer omvattend biopsychosociaal begrip van chronische pijnbehandeling onder afgestudeerde zorgprofessionals. De aanhoudende biomedische perspectieven onderstrepen echter het belang van het blijven implementeren, evalueren en verfijnen van opleidingsinitiatieven voor zowel zorgverleners in opleiding als afgestudeerde zorgverleners om biopsychosociale benaderingen van chronische pijnbehandeling verder te verbeteren.

Résumé

Contexte

La douleur chronique est une condition courante, touchant environ 23% de la population belge. Elle constitue un fardeau majeur pour les patients, les prestataires de soins de santé et la société. Elle est la principale cause d'invalidité, d'absentéisme au travail et de perte de productivité, et entraîne une nette diminution de la qualité de vie des patients. Les progrès en sciences cliniques ont montré la nécessité d'un changement de paradigme en passant d'une approche biomédicale à une approche biopsychosociale pour améliorer la prise en charge de la douleur chronique. Cependant, ce changement est difficile sur le terrain, en partie en raison de programmes éducatifs souvent inadéquats pour favoriser les perspectives biopsychosociales chez les prestataires de soins de santé envers la prise en charge de la douleur chronique. Par conséquent, les patients souffrant de douleur chronique reçoivent souvent des soins inadéquats.

Cette thèse visait à contribuer à la compréhension des perspectives des professionnels de la santé sur la prise en charge de la douleur chronique, à contribuer au développement d'un programme éducatif pour les professionnels de la santé, et à évaluer son impact sur les perspectives des professionnels de la santé sur la prise en charge de la douleur chronique.

Le chapitre 1 compare les kinésithérapeutes diplômés en 2013 et en 2020 en termes de perspectives et de recommandations cliniques relatives à la prise en charge de la douleur chronique. Les résultats suggèrent qu'un changement positif, bien que modeste, vers une approche plus biopsychosociale de la prise en charge de la douleur chronique s'est produit entre 2013 et 2020 chez les kinésithérapeutes. Cependant, les résultats dépendaient de l'institution, et en général, une grande proportion des recommandations cliniques n'étaient pas conformes aux recommandations de bonne pratique. Cela démontre la nécessité de poursuivre les efforts pour améliorer les perspectives biopsychosociales des kinésithérapeutes diplômés.

Le chapitre 2 se concentre sur le questionnaire Knowledge and Attitudes about Pain (KNAP), qui évalue de manière exhaustive les perspectives des professionnels de la santé sur les connaisances les plus récentes relatives à la douleur. Cela est particulièrement crucial car les questionnaires couramment utilisés présentent certaines limites. Cela a conduit à la traduction du questionnaire KNAP en français a démontré des propriétés psychométriques acceptables en termes de validité, de fiabilité, permettant une évaluation complète des connaissances et attitudes relatives à la douleur chez les médecins et kinésithérapeutes diplômés et étudiants en Belgique et dans d'autres régions francophones.

Le chapitre 3 est consacré au développement et la mise en œuvre d'un programme de formation interdisciplinaire concernant la prise en charge des patients souffrant de douleurs chroniques. Il identifie une grande variété de barrières et de facilitateurs à la prise en charge

de la douleur chronique formulés par les parties prenantes belges et complétés par une recherche bibliographique. En tenant compte des obstacles et des facilitateurs, nous avons développé un programme de formation interdisciplinaire visant à renforcer les compétences des professionnels de la santé pour intégrer dans la pratique clinique un approche cognitive et comportementale pour une prise en charge biopsychosociale de la douleur chronique.

Le chapitre 4 examine les changements à court et moyen terme dans les perspectives et les recommandations des professionnels de la santé ayant participé au programme de formation interdisciplinaire développé dans le cadre de cette thèse. Immédiatement après le programme de formation et six mois après celui-ci, les professionnels de la santé présentaient une vision plus correcte et plus biopsychosociale de la douleur chronique et leurs recommandations étaient davantage conformes aux lignes directrices cliniques. Cependant, certaines perspectives biomédicales sont restées. Les résultats soulignent la nécessité de programmes de formation adéquats pour favoriser des perspectives plus biopsychosociales et améliorer encore les programmes de formation pour changer la vision purement biomédicale qui persiste chez certains professionnels de la santé.

Conclusion

Au cours de la dernière décennie, il y a eu quelques améliorations chez les professionnels de la santé belges diplômés et étudiants en terme de compréhension de la nécessité d'une prise en charge biopsychosociale de la douleur chronique. Cependant, ces améliorations ont été modestes, etune attitude purement « biomédicale » demeure chez des professionnels de la santé qui recommandent toujours le repos au lit et la limitation des activités et du travail. Le développement et la mise en œuvre de programmes de formation interdisciplinaires semble permettre de corriger ces recommandations inadaptées et favoriser une compréhension plus complète de la douleur chronique des professionnels de la santé, bien que certaines lacunes persistent. Il est donc impératif de continuer à mettre en œuvre, évaluer et affiner les initiatives éducatives pour les professionnels de la santé diplômés et étudiants pour améliorer la prise en charge biopsychosociale de la douleur chronique.

About the author

Wouter Munneke is a doctoral researcher with a strong commitment to implementation science and projects aimed at reducing the gap between scientific literature and clinical practice. Born on October 26, 1989, he graduated as a physiotherapist from Rotterdam University of Applied Sciences in 2016 and obtained his Master's degree in Clinical Epidemiology from Amsterdam University Medical Center – University of Amsterdam in 2019 while working with chronic pain patients.

In 2020, he enrolled as a PhD researcher at the Vrije Universiteit Brussel and University of Liège on the project *"Implementation of the Belgian recommendations regarding the treatment of chronic pain"* and he will publicly defend his dissertation *"Shifting chronic pain perspectives: Fostering biopsychosocial attitudes in Healthcare Professionals"* on September 9, 2024. He developed and implemented an interdisciplinary chronic pain course for healthcare professionals throughout Belgium, (co-)authored 9 publications in peer-reviewed journals, and presented at (inter)national congresses.

Committed to promoting "*Interdisciplinary approach as a fundament to bridge the gap between theory, clinical practice, and society*" Wouter believes that scientists must collaborate with the general population, patients, healthcare professionals, and policymakers to create more rational and real-world-based research. Currently, Wouter is working on a project with governmental organizations to explore healthcare professionals' barriers and facilitators of implementation behavior and is involved in updating the Belgian guideline for chronic pain in primary care.

Curriculum Vitae

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Education

09/ 2017 – 10/ 2019 **Master of Science in Clinical Epidemiology**
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09/ 2012 – 07/ 2016 **Bachelor of Science in Physiotherapy**
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Academical and professional experience

04/ 2020 – Present **PhD researcher**
Vrije Universiteit Brussel – Université de Liège (Joint-PhD)
Project entitled: *"Implementation of the Belgian recommendations regarding the treatment of chronic pain"*

09/ 2017 – 04/ 2020 **Physiotherapist**
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02/ 2019 – 08/ 2019 **Physiotherapist**
Rijndam Revalidatie in het Erasmus MC

02/ 2017 – 07/ 2017 **Physiotherapist (volunteeringwork)**
Municipal Hospital Hohoe (Ghana)

09/ 2016 – 01/ 2017 **Physiotherapist**
Fysiotherapie Starrenburglaan / Fysiotherapie Maaswijk

Training – courses - workshops

2024	Implementation – Theory and Application. (ongoing) Linköping University, Linköping, Sweden
2023	Data Analyst with R. DataCamp, Belgium
2023	Longitudinal and Incomplete Data. Flanders Training Network for Methodology and Statistics (FLAMES), KU Leuven, Belgium
2022	Multilevel Analysis. Flanders Training Network for Methodology and Statistics (FLAMES), University of Antwerp, Belgium
2022	Qualitative Data Analysis with Nvivo. Flanders Training Network for Methodology and Statistics (FLAMES), University of Antwerp, Belgium
2022	From Research Theme to Qualitative Research. Flanders Training Network for Methodology and Statistics (FLAMES), University of Antwerp, Belgium
2022	Focus Groups. Flanders Training Network for Methodology and Statistics (FLAMES), University of Antwerp, Belgium
2022	Essentials of R. Flanders Training Network for Methodology and Statistics (FLAMES), University of Antwerp, Belgium
2022	Generalized Linear Models. Flanders Training Network for Methodology and Statistics (FLAMES), University of Antwerp, Belgium
2022	Mindfulness training. Researcher Training & Development Office, VUB, Belgium
2021	Argumentation & Academic English - An introduction to critical thinking (AE2).

	LSD Doctoral School, VUB, Belgium
2021	Exposure in vivo: from theory to practice. Maastricht University, The Netherlands
2020	Introductory Course in Academic English for PhD candidates (AE1). Researcher Training & Development Office, VUB, Belgium

Publications

Publications in peer-reviewed journals

Malfliet, A., De Baets, L., Bilterys, T., Van Looveren, E., Mairesse, O., Cagnie, B., Meeus, M., Moens, M., Goubert, D., **Munneke, W.,** Daneels, L., Ickmans, K., Kamper, S., & Nijs, J. (2024). Cognitive Behavioral Therapy for Insomnia in Pain Management for Nonspecific Chronic Spinal Pain: A Randomized Clinical Trial. JAMA network open, 7(8), [e2425856]. Doi:10.1001/jamanetworkopen.2024.25856
SCI2023 = 10.500 – Q1 in Medicine, General & Internal (10/325)

Reynebeau, I., Van Buchem, B., Jäger, K., Lexmond, W., Leysen, L., **Munneke, W.**, Nijs, J., Roose, E., Lahousse, A., De Kooning, M. (2024). Psychometric properties of the Dutch version of the revised neurophysiology of pain questionnaire. *Journal of Bodywork and Movement Therapies, 40, 777-785.* Doi: 10.1016/j.jbmt.2024.05.024
SCI2023 = 1.200 – Q3 in Rehabilitation (112/169)

Munneke, W., Demoulin, C., Roussel, N., Leysen, M., Van Wilgen, C. P., Pitance, L., Reezigt, R. R., Voogt, L. P., Dankaerts, W., Danneels, L., Köke, A. J. A., Cools, W., De Kooning, M., & Nijs, J. (2024). Comparing physical therapy students' attitudes and beliefs regarding chronic low back pain and knee osteoarthritis: an international multi-institutional comparison between 2013 and 2020 academic years. *Brazilian Journal of Physical Therapy*, *28*(1), [100592]. doi:10.1016/j.bjpt.2024.100592
SCI2022 = 3.400 – Q1 in Orthopedics (18/86); Q1 in Rehabilitation (13/68)

Munneke, W., Demoulin, C., Nijs, J., Morin, C., Kool, E., Berquin, A., Meeus, M., & De Kooning, M. (2024). Development of an interdisciplinary training program about chronic pain management with a cognitive behavioural approach for healthcare professionals: part of a hybrid effectiveness-implementation study. *BMC Medical Education*, *24*(1), [331]. doi:10.1186/s12909-024-05308-2
SCI2022 = 3.600 – Q1 in Education & Educational Research (63/269); Q2 in Education, Scientific Disciplines (12/43)

Munneke, W., De Kooning, M., Nijs, J., Leclercq, J., George, C., Roussel, N., Bornheim, S., Beetsma, A., Reynebeau, I., & Demoulin, C. (2023). Cross-cultural adaptation and psychometric testing of the French version of the Knowledge and Attitudes of Pain (KNAP) questionnaire. *Annals of Physical and Rehabilitation Medicine*, *66*(7), [101757]. doi:10.1016/j.rehab.2023.101757
SCI2021 = 5.393 – Q1 in Rehabilitation (3/68)

Araújo Almeida, L., Bilterys, T., Van Looveren, E., Mairesse, O., Cagnie, B., Meeus, M., Moens, M., Goubert, D., **Munneke, W.**, Danneels, L., Ickmans, K., Rezende Camargo, P., Nijs, J., Malfliet, A., & De Baets, L. (2023). Do Patients with Chronic Spinal Pain and Comorbid Insomnia Have More Features of Central Sensitization? A Case-Control Study. *Healthcare (Basel)*, *11*(24), [3152]. doi:10.3390/healthcare11243152
SCI2021 = 3.160 – Q2 in Health Care Science & Service (50/109); Q2 in Health Policy & Service (35/88)

Bilterys, T., Van Looveren, E., Malfliet, A., Nijs, J., Meeus, M., Danneels, L., Ickmans, K., Cagnie, B., Goubert, D., Moens, M., De Baets, L., **Munneke, W.**, & Mairesse, O. (2023). Relationship, differences, and agreement between objective and subjective sleep measures in chronic spinal pain patients with comorbid insomnia: a cross-sectional study. *Pain*, *164*(9), 2016-2028. doi:10.1097/j.pain.0000000000002901
SCI2021 = 6.961 – Q1 in Anesthesiology (5/34); Q1 in Clinical Neurology (21/212); Q1 in Neurosciences (33/275)

Van Looveren, E., Bilterys, T., **Munneke, W.**, Cagnie, B., Ickmans, K., Mairesse, O., Malfliet, A., De Baets, L., Nijs, J., Goubert, D., Danneels, L., Moens, M., & Meeus, M. (2021). The Association between Sleep and Chronic Spinal Pain: A Systematic Review from the Last Decade. *Journal of clinical medicine*, *10*(17), [3836]. doi:10.3390/jcm10173836
SCI2020 = 4.241 – Q1 in Medicine, General & Internal (39/169)

Munneke, W., Ickmans, K., & Voogt, L. (2020). The Association of Psychosocial Factors and Exercise-Induced Hypoalgesia in Healthy People and People With Musculoskeletal Pain: A Systematic Review. *Pain Practice*, *20*(6), 676-694. doi:10.1111/papr.12894
SCI2019 = 2.258 – Q3 in Anesthesiology (20/32); Q3 in Clinical Neurology (125/204).

Submitted manuscripts in peer-reviewed journals

Munneke, W., De Kooning, M., Nijs, J., Morin, C., Berquin, A., Meeus, M., Hartvigsen, J., & Demoulin, C. (2024). Enhancing Healthcare Professionals' Biopsychosocial perspective to chronic Pain; Assessing the impact of implementing an Interdisciplinary Training Programme. *Pain*. Accepted.
SCI2023 = 5.900 – Q1 in Anesthesiology (4/64); Q1 in Clinical Neurology (24/277); Q1 in Neurosciences (35/310)

Science communication

Munneke, W. "VUB-onderzoek beveelt nieuwe aanpak van chronische pijn aan" VUB Press. Juli 2024.

Munneke, W. "Project van de Federale Overheid moet zorgverleners ondersteunen in de aanpak van chronische pijn" Prikkel, a magazine of the Vlaamse Pijnliga (Flemisch Pain Association). September 2022.

Munneke, W., De Kooning, M., Nijs, J., Berquin, A., Meeus, M., & Demoulin, C. "Waarom blijft mijn pijn aanhouden en wat kan ik eraan doen?" Booklet for patients published on Pain in Motion Website (www. paininmotion.be). March 2022.

Munneke, W., De Kooning, M., Nijs, J., Berquin, A., Meeus, M., & Demoulin, C. "Pourquoi ma douleur persiste-t-elle et que puis-je faire pour y remédier ?" Booklet for patients published on Pain in Motion Website (www. paininmotion.be). March 2022.

Presentations

International presentations

Oral presentation at the IASP 2024 World Congress on Pain; Pain, Mind & Movement Special Interest Group Satellite Meeting, Personalised pain management: A wish for the future or already here?
Munneke, W., De Kooning, M., Nijs, J., Morin, C., Kool, E., Berquin, A., Meeus, M., Hartvigsen, J., & Demoulin, C. *Changing healthcare professionals' chronic pain perspectives via interdisciplinary training.*

Poster presentation at the IASP 2024 World Congress on Pain.
Munneke, W., De Kooning, M., Nijs, J., Morin, C., Kool, E., Berquin, A., Meeus, M., Hartvigsen, J., & Demoulin, C. *Changing healthcare professionals' chronic pain perspectives via interdisciplinary training.*

Poster presentation at the EFIC congress 2023.
Munneke, W., De Kooning, M., Nijs, J., Morin, C., Kool, E., Berquin, A., Meeus, M., & Demoulin, C. *Interdisciplinary chronic pain training program improved attitudes, beliefs and guideline adherence of healthcare professionals.*

Oral presentation at the Pain Science in Motion IV congress.
Munneke, W., Demoulin, C., Nijs, J., Morin, C., Kool, E., Berquin, A., Meeus, M., & De Kooning, M. *Implementing explain pain and chronic pain treatment guidelines in 8 health care disciplines in Belgium: a 6-months follow-up study.*

Poster presentation at the Pain Science in Motion IV congress.
Munneke, W., Demoulin, C., Roussel, N., Leysen, M., Van Wilgen, C. P., Pitance, L., Reezigt, R. R., Voogt, L. P., Dankaerts, W., Danneels, L., Köke, A. J. A., Cools, W., De Kooning, M., & Nijs, J. *Change in physiotherapy student's attitudes & beliefs regarding the management of chronic low back pain and osteoarthritis: A 7-year follow-up study*

Poster presentation at the EFIC congress 2022.
Munneke, W., Demoulin, C., Roussel, N., Leysen, M., Van Wilgen, C. P., Pitance, L., Reezigt, R. R., Voogt, L. P., Dankaerts, W., Danneels, L., Köke, A. J. A., Cools, W., De Kooning, M., & Nijs, J. *Change in physiotherapy student's attitudes & beliefs regarding the management of chronic low back pain and osteoarthritis: A 7-year follow-up study.*

National presentations

Invited speaker at the Huisartsenconferentie en vakbeurs 2021, Domus Medica.
Munneke, W., Demoulin, C., Nijs, J., Morin, C., Kool, E., Berquin, A., Meeus, M., & De Kooning, M. *Begeleiding van de chronische pijnpatiënt in een biopsychosociaal perspectief*

Invited speaker at the Lokale kwaliteitsgroep (LOK) Orthopedie.
Munneke, W. *Chronische pijn in een biopsychosociaal perspectief.*

Given courses

2023	'The treatment of chronic pain in primary care' for interdisciplinary groups of healthcare professionals within the implementation project.

International mobilty

2023	3-month research stay at the Department of Sports Science and Clinical Biomechanics, University of Southern Denmark (SDU), Denmark

Referee work

Reviewer for international peer-reviewed journals

The Journal of Pain, Quality of Life Research, Clinical Journal of Pain, European Journal of Pain

Supervision students

2023 – 2024	Masters thesis part 2 Mauro Bisschop & Marieke Kuijper
2023 – 2024	Masters thesis part 2 Zelie Georis & Victoria Da Silva
2022 – 2023	Masters thesis part 1 Mauro Bisschop & Marieke Kuijper
2022 – 2023	Masters thesis part 1 Zelie Georis & Victoria Da Silva
2022 – 2023	Masters internship Jeroen Snijder

Grants & awards

2024 Travel Scholarship granted by the Pain, Mind & Movement Special Interest Group of the International Association for the Study of Pain (IASP) to attend the Pain, Mind & Movement Satellite Meeting, Personalised pain management: A wish for the future or already here? at the IASP 2024 World Congress on Pain in Amsterdam, The Netherlands. ($1.000)

2023 Research grant “Healthcare professionals’ barriers and facilitators to implement pain education after following a chronic pain course; a mixed method study”, EBPracticeNet. (€24.998)

2023 LSD Doctoral School Travel Grant (VUB) for the research stay at the Department of Sports Science and Clinical Biomechanics, University of Southern Denmark (SDU), Denmark (€2.000)

2023 Doctoral School Research Mission Grant (University of Liege) for the research stay at the Department of Sports Science and Clinical Biomechanics, University of Southern Denmark (SDU), Denmark (€3.835)

2022 Extension project ‘Implementation of Belgian Guidelines in the treatment of chronic pain.’, Belgian Federal Government of Health. (€138.942)

2022 LSD Doctoral Schools Travel Grant (VUB) for attending the international congress of the European Pain Federation (EFIC) in Dublin, Ireland (€750)

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Jo, you contacted me if I wanted to apply for this job. You were always in for jokes to comfort me, helping me to find a balance between my personal life in the Netherlands and my professional life in Brussels. While dealing with the cultural differences and compromises we had to make sometimes, I admire that it has never affected our social and professional relationship. You kept singing on my birthday, dancing with darts and making jokes about Heineken. On the other hand, you never lost sight of the endpoint of the project(s) and PhD, and kept believing in me while I could think (too) big and lose sight of the track. I can learn a lot from your effectiveness and time management.

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All my co-authors, Nathalie Roussel, Marijke Leysen, Paul Van Wilgen, Laurent Pitance, Roland Reezigt, Lennard Voogt, Wim Dankaerts, Lieven Danneels, Albère Köke, Wilfried Cools, Julie Leclercq, Clara George, Stephen Bornheim, Anneke Beetsma, Iris Reynebeau, Carine Morin, Emy Kool, Anne Berquin, Mira Meeus and Jan Hartvigsen. Thank you for all the support and feedback, which resulted in papers of which I am proud. I hope our paths will cross again during our careers. I want to give special thanks to Anne and Mira—thanks to you and my supervisors, I was able to do my PhD on this project. Marijke and Nathalie, thanks to you, I could continue on your study about perspectives in undergraduate physiotherapists.

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